Assortment

	500 Series Ball							500 Series Roller				400 Series								AccuMini	MicroGuide		T-Series			
	Standard		Narrow					Standard		Narrow		Standard		Narrow						Standard	Standard	Wide	Standard			
—		Long		Long		Long	Short		Long		Long		Long			Long		Long	Short							
	—	—	—	—	High	High		—	—	—	—	—	—	—		—	High	High			—	—	—	—	—	—
Size [mm] 5																					•					
7																					•	•				
9																					•	•				
10																				•						
12																					•	•				
15	•		•		•		•					•	•	•		•	•		•	•	•	•				
20	•	•	•	•			•					•	•	•	•			•	•	•			•	•	•	•
25	•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•				•	•	•	•
30	•	•	•	•	•	•						•	•	•		•	•	•	•							
35	•	•	•	•	•	•		•	•	•	•	•	•	•		•	•	•	•				•	•	•	•
45	•	•	•			•		•	•	•	•		•	•		•	•	•								
55								•	•	•	•	•	•	•		•	•	•								
65								•	•	•	•															
Style	A	B	C	D	E	F	G	A	B	C	D	A	B	C	K	D	E	F	G	A	N/A	N/A	A	G	E	F
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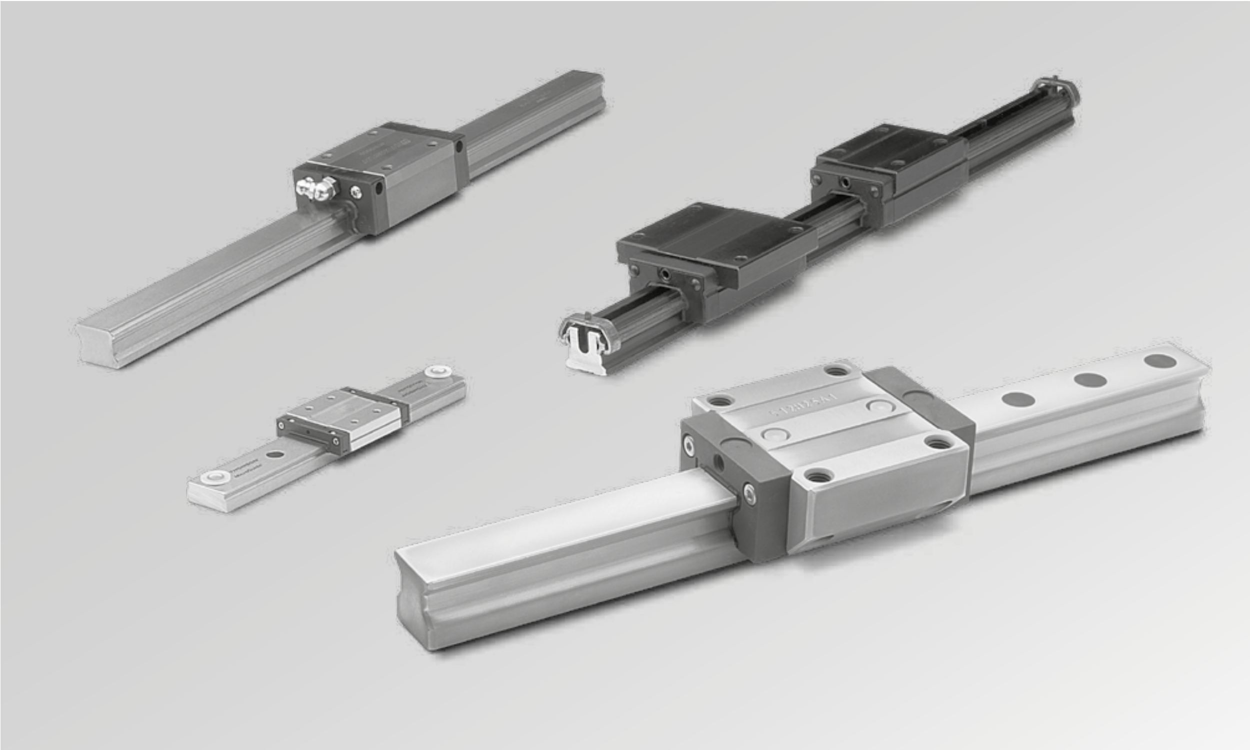
Application Criteria

Feature	500 Series Ball	500 Series Roller	400 Series	AccuMini	MicroGuide	T-Series
Load Capacity	•••	••••	•••	••	•	••
Equivalent Loads all directions	•••	••••	•••	••	••	•
Ultra Compactness	•	•	••	•••	••••	•
High Travel Accuracy	••••	••••	•••	••••	••••	•••
Rigidity	•••	••••	••	••	••	•
Smoothness	•••	••	•••	••••	••••	•••
Friction Characteristic	••••	••	•••	••••	••••	••
Admissable Speed	••••	•••	••••	••••	••••	•••
Ease of Installation	•••	••	•••	••	•••	••••
Lightweight	•	•	•	••	•••	••••
Industry Standard Dimensions	••••	••••	••••		••••	••••
Page	8	48	78	99	103	111

• = satisfactory   •••• = excellent

THOMSON
Linear Motion. Optimized.

Profile Rail Engineering Guide



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Profile Rail Selection

The selection of a linear guide can greatly affect machine performance and overall cost. In order to meet the wide variety of demands created by today's applications, proper selection from a broad range of linear guides is required.

For example, selecting a guide with too much rigidity will decrease the allowable installation tolerances, therefore, greatly increasing surface preparation costs. If the mounting surface is not prepared properly, the guide will run rough, and need to be replaced more frequently due to an unexpected reduction in travel life.

Consider all criteria appropriate for the application. Selection criteria include:

- Rigidity
- Travel accuracy
- Travel life
- Smoothness of travel
- Speed & Acceleration
- Envelope
- Environment
- Cost of Product
- Cost of Installation
- Cost of Replacement

Selection of the most appropriate type of guide, should be based on quantitative/qualitative requirements and ranking by importance of the above selection criteria, as well as the following guidelines for the technology available.

Technology Overview
The performance of a linear guide is based upon contact type, rolling element type, inner race geometry (Round Rail and Profile Rail), and other characteristics such as self-aligning capabilities. It is important to recognize that the options available for each characteristic have performance attributes. The selection process should be focused on matching these attributes with the most critical requirements of the application. The following technology guidelines can be used to assist in selecting the most appropriate type of profile rail. For a detailed application analysis, contact the **Thomson Customer Support** or your local Thomson distributor.

Sizing & Defining Guide Characteristics

The following 9 step procedure can be used to select the characteristics necessary to generate the appropriate part number:

1. Determine the load on the most heavily loaded carriage or bearing (see Applied Loading Calculations). Multiply by a safety factor if desired in your application.

2. Determine the minimum required travel life for the application based on the intended duty cycle.

3. Calculate the **Minimum Required Dynamic Load Rating**, C_{min}.

4. Select the size which offers the load rating, C, equal to or greater than the minimum required dynamic load rating, C_{min}. Also, consider **Dynamic Load Limit** and **Static Capacities**.

5. If the guide selected offers various preload† levels, select a preload based upon the allowable bearing deflection. Contact the factory for detailed deflection information. Some carriage or bearing **Deflection Charts** are provided in this catalog.

6. If the guide selected offers various accuracy classes, select an accuracy class based upon the required travel accuracy.

7. Determine the need for accessories or options.

8. Calculate the guide length based upon the stroke and platten length. Remember to include additional length of accessories (i.e. self-lubricating option) and the stroke reduction caused by the use of bellows, if applicable.

9. Once the above characteristics have been determined, assign the appropriate part number based on the part numbering instructions located in the catalog section corresponding to the linear guide selected.

† Choosing a higher preload level will reduce the allowable installation tolerances. For this reason, the minimum preload which meets the applications requirements should be selected. If the highest preload level does not meet the deflection requirements, a larger size may be required.

Applied Loading Calculations

The majority of applications utilize a four carriage or bearing and two rail design for stability. Shown are four typical configurations and calculations for the resultant loads applied to each bearing. Resultant loads are divided into a horizontal and a vertical components, which represent the static or constant velocity condition and account for gravity but not acceleration.

Use the appropriate configuration to determine the horizontal and vertical components of the resultant applied load on the most heavily loaded carriage or bearing. These values will be referred to henceforth as FH & FV, respectively.

Terms:

d_0 = distance between centerlines of carriages or bearings (in) or (mm)

d_1 = distance between centerlines of rails (in) or (mm)

d_2 = distance from centerline of carriage or bearing to load action point (in) or (mm)

d_3 = distance from centerline of carriage or bearing to load action point (in) or (mm)

W = Applied Load (lbf) or (N)

FNH = Horizontal component of resultant applied load with respect to each carriage or bearing (lbf) or (N)

FNV = Vertical component of resultant applied load with respect to each carriage or bearing (lbf) or (N)

Reminder:

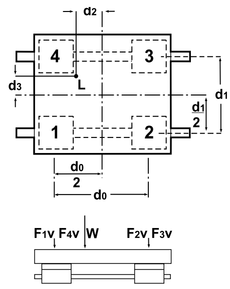
- Be sure to use consistent units (English or metric).
- Be sure to use the appropriate sign (positive or negative).
- A negative number is used when the actual force is in the opposite direction represented by the arrow.

$$F_{1v} = \frac{W}{4} + \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) - \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{2v} = \frac{W}{4} - \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) - \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{3v} = \frac{W}{4} - \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) + \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{4v} = \frac{W}{4} + \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) + \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$



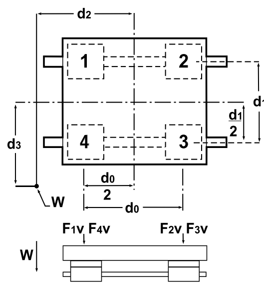
Horizontal Application I
At the time of movement with uniform velocity or at the time of stop.

$$F_{1v} = \frac{W}{4} + \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) - \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{2v} = \frac{W}{4} - \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) - \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{3v} = \frac{W}{4} - \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) + \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{4v} = \frac{W}{4} + \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right) + \left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$



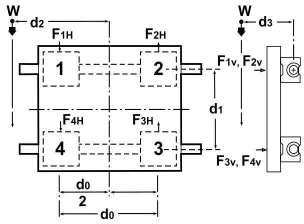
Horizontal Application II
At the time of movement with uniform velocity or at the time of stop.

$$F_{1v} = F_{2v} = -\left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{3v} = F_{4v} = +\left(\frac{W}{2} \bullet \frac{d_3}{d_1}\right)$$

$$F_{1H} = F_{4H} = \frac{W}{4} + \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right)$$

$$F_{1H} = F_{4H} = \frac{W}{4} - \left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right)$$

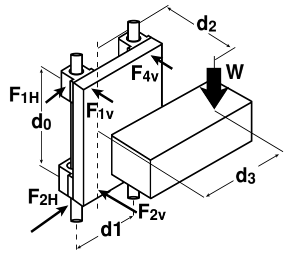


Side Mounted Application
At the time of movement with uniform velocity or at the time of stop.

$$F_{1v} = F_{4v} = -\left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right)$$

$$F_{3v} = F_{4v} = +\left(\frac{W}{2} \bullet \frac{d_2}{d_0}\right)$$

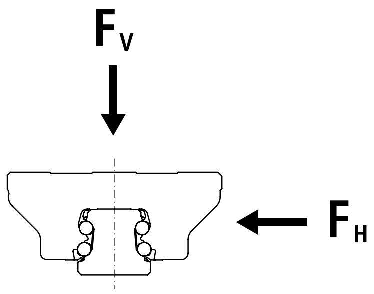
$$F_{1H} = -F_{2H} = -F_{3H} = F_{4H} = \frac{W}{2} \bullet \frac{d_3}{d_0}$$



Vertical Application
At the time of movement with uniform velocity or at the time of stop.
At the time of start & stop, the load varies because of inertia.

Engineering Guide

Equivalent Applied Load†



An equivalent load is used to consolidate applied load components into one value which can later be used to calculate the minimum required load rating and the expected life of the carriage/bearing selected.

For ProfileRail* Carriages & Closed RoundRail* Bearings:

$$F_{EQ} = F_H + F_V$$

F_{EQ} = Equivalent Load
F_H = Horizontal Component of Resultant Applied Load
F_V = Vertical Component of Resultant Applied Load

For Single Carriage or Single Rail Configurations:

$$F_{EQ} = F_H + F_V + (M/M_C) \times C$$

M = Applied Moment Load
M_C = Dynamic Moment Capacity of Bearing
C = Dynamic Load Capacity of Bearing

For Preloaded Carriages [Only when $F_{EQ} < (3 \times F_P)$]:
Even with no external load applied, a preloaded bearing has a load on the races. A load greater than the externally applied load is present within a bearing with an externally applied load less than the preload end point. In order to calculate the loads on the load sets, the following formulae may be employed:

$$F_{EQ} = F_p + {}^2/_3\,(F_H + F_V)$$

F_p = Initial Preload Force
(i.e., for ‘B’ Preload Designation $F_p = .03 \times C$)

† Before calculating F_{EQ}, make sure that neither F_H or F_V exceeds the Dynamic Load Limit of the guide intended for use.
‡ The 0.6 value used accounts for a derating factor of the capacity during tensile loading. Therefore, when calculating expected life based on F_{EQ}, the Full Dynamic Load Rating (C) may be used.

Mean Dynamic Load

In applications with loads of varying magnitude, a mean dynamic load should be calculated.

$$F_{EQ} = \sqrt[P]{F^P_{EQ1}\left(\frac{d1}{D}\right) + F^P_{EQ2}\left(\frac{d2}{D}\right) + \ldots + F^P_{EQn}\left(\frac{dn}{D}\right)}$$

Where:
$F_{EQ1} \ldots F_{EQn}$ = equivalent dynamic load for distances d1 through dn
D = total distance of stroke = d1+d2…+dm
P = 3 (linear guides w/Ball Type Rolling Elements)
10/3 (linear guides w/Roller Type Rolling Elements)

Load Ratings for Rolling Element Guides

Dynamic Load Rating, C, and Travel Life
The dynamic load rating, C, is the load at which when applied will yield the rated travel life. The rated travel life, Lr, for most linear guides is 100 km for metric products and 4 million inches for inch products (the rated travel life is listed on the page with the dynamic load rating). For a given applied load, P, the dynamic load rating and rated travel life are used to calculate the travel life using the following load/life equation:

$$\mathbf{L = (C/F_{EQ})^n \times L_r}$$

Where:
L = calculated travel life
C = dynamic load rating
F_{EQ} = equivalent applied load
n = 3 for ball guides, 10/3 for roller guides
L_r = rated travel life

Some manufacturers dynamic load ratings are based upon a 50 km life. To compare dynamic load ratings for guides with a 50 km rated life with a 100 km life, divide the 50 km dynamic load rating by 1.26.

C 100 km = C 50 km / 1.26

Some types of linear guides do not have the same dynamic load rating in all directions. The dynamic load rating for orthogonal load directions is shown as a percentage of C. It is not necessary to use this percentage of C in the load/life equation provided that the **Equivalent Applied Load Section** has been adhered to, because the calculations for equivalent applied load already account for it.

Calculating the Minimum Required Dynamic Load Rating, C_{min}

The load / life equation above can be rewritten to calculate the minimum required dynamic load rating which should be selected for a given applied load and minimum required travel life :

$$C_{min} = P(L_m/L_r)^{1/n}$$

Where :

C_{min} = minimum required dynamic load rating
P = applied load
L_m = minimum required travel life
L_r = rated travel life
n = 3 for ball guides, 10/3 for roller guides

Note : Check that the applied load, P does not exceed the dynamic load limit.

Dynamic Load Limit
The dynamic load limit, is the maximum load which should be applied to the carriage / pillowblock. In some cases, the dynamic load capacity equals the dynamic load rating. In others, a limit shown as a percentage of the dynamic load rating is the maximum load which should be applied. A dynamic load limit less than the dynamic load rating does not derate the life of the guide.

Static Capacities
The static capacities are the maximum loads that should be applied to the bearing while there is no relative motion between the rolling elements and the raceways. The value C_0 is the static load capacity for a radial load acting orthogonal to the axis of travel. The values M_{0L} and M_{0Q} are the static roll, pitch, and yaw moment capacities.

It is important to analyze the application so that shock loads do not exceed these capacities. Exceeding these capacities may permanently deform the rolling elements and raceways. This type of damage will be realized by an increase in friction, noise, and vibration, as well as by an increase in clearance between the carriage and the rail.

For systems experiencing repetitive shock loading less than the static load capacities, the bearing life should be determined by means of fatigue calculations.

Preloading & Linear Guide Deflection

Preload
A preloaded bearing has a condition of interference between the races of the rails, the rolling elements, and the races of the carriage.

Preloading decreases the deflection due to external loads. This occurs because the contact reaction has already developed, eliminating much of the initial non-linear deflection associated with rolling elements.

The rolling element reactions within a preloaded bearing may be considered as having two components. One component acts in the direction of external load, and one component acts in the opposing direction in order to maintain static equilibrium. These components are referred to as load sets. As external load is applied, one load set increases in load, as the opposite load set decreases in load. At some point, the load on the decreasing load set becomes zero. This point, at which the preload is relieved, is called the preload end point. Preload end typically occurs when the external load is approximately three times the preload.

Preload end point:

$$F_{ext} = 3F_p$$

where:
F_{ext} = externally applied load
F_p = preload

By definition, a preloaded bearing, loaded beyond the preload endpoint, has the same deflection characteristics of an unpreloaded bearing externally loaded to that percentage of its dynamic load capacity. A preload level is assigned as a percentage of the dynamic load capacity of the bearing.

Deflection Curves

The following pages contain deflection charts for the 500 Series Profile Rail Linear Guides. The charts shown are calculated. The calculation is based on theoretical conditions regarding shape, position and dimension of the balls and raceways of the carriage and rails under the specified loading. The real behavior of the carriage can vary slightly in the application as a result of base flatness, angle of loading, temperature, etc.

Note that the deflection decreases as the preload or the bearing size increases.

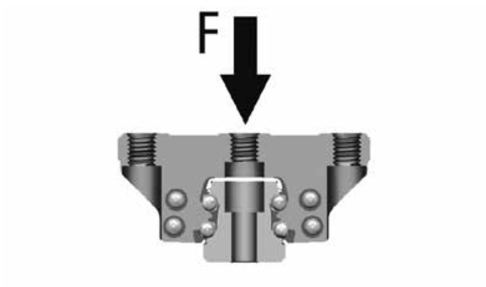
Example Applications

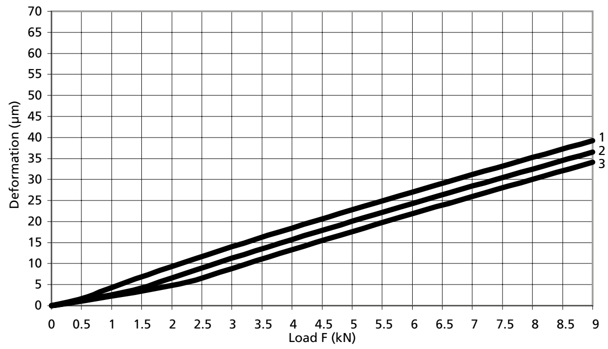
Preload	Clearance	.03C	.08 - .13C
Conditions	1. weak impact 2. 2 rails in pair 3. low accuracy 4. small resistance	1. cantilever 2. single rail 3. light load 4. high accuracy	1. strong impact 2. strong vibration 3. heavy machining
Applications	1. welding machine 2. chopping machine 3. feeding mechanism 4. tool change mechanism 5. ordinary XY table	1. NC lathe 2. EDM 3. precise XY table 4. ordinary Z-axis 5. industrial robot 6. PCB punching	1. machining centre 2. NC lathe and milling machine 3. feeding axis of grinder 4. tool feeding axis

Deflection vs. Applied Load

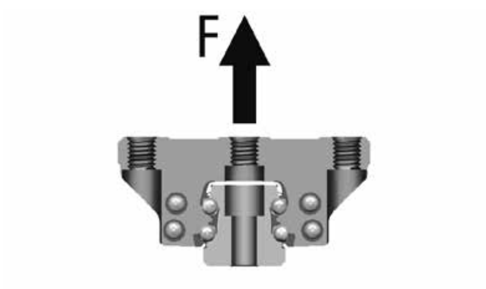
511 Style A, C, E
Size 15

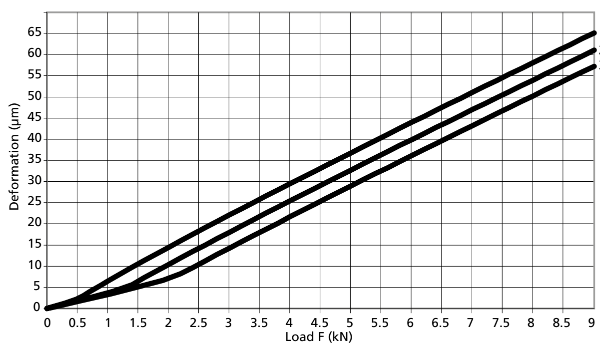
Compressive Load



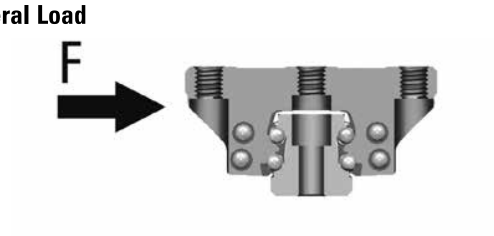


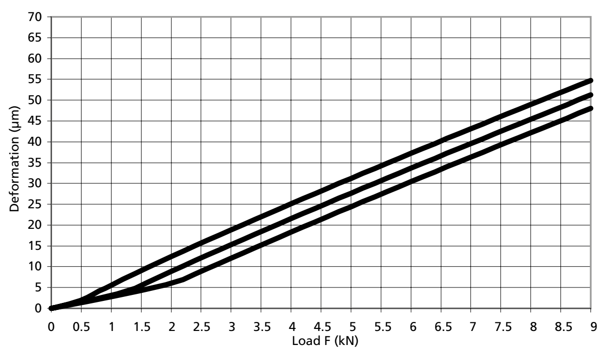
Tensile Load





Lateral Load





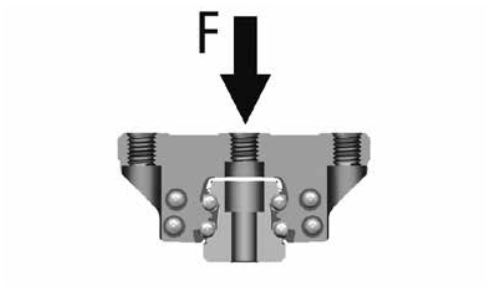
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

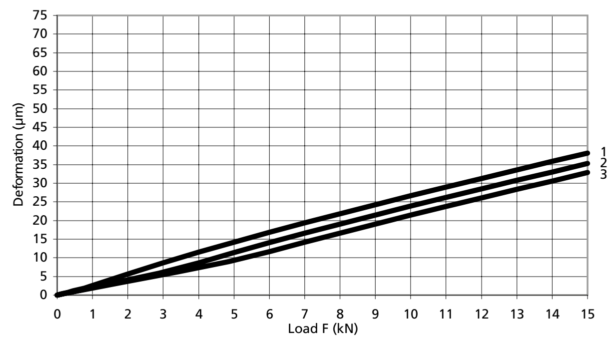
C = Dynamic load carrying capacity

Deflection vs. Applied Load

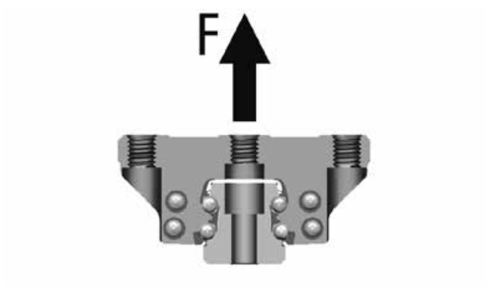
511 Style A, C, E
Size 20

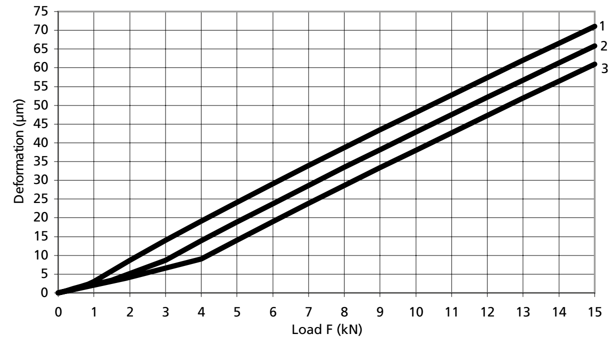
Compressive Load



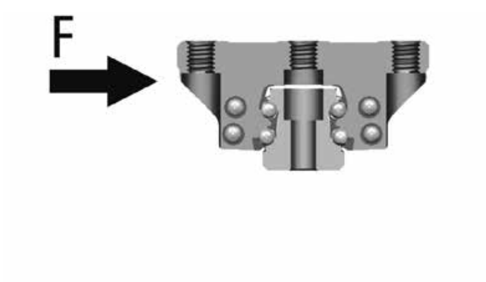


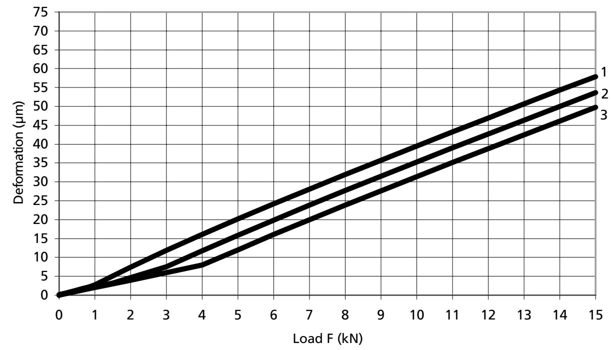
Tensile Load





Lateral Load





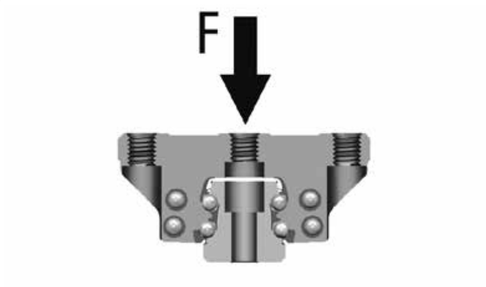
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

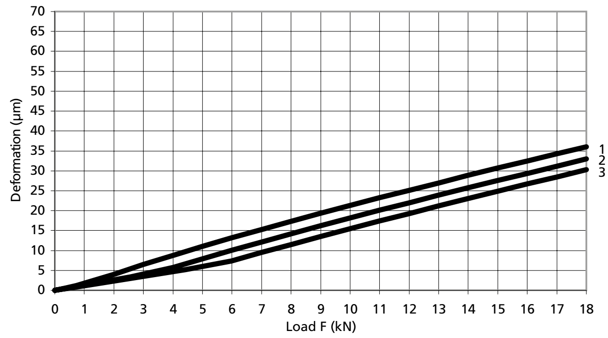
C = Dynamic load carrying capacity

Deflection vs. Applied Load

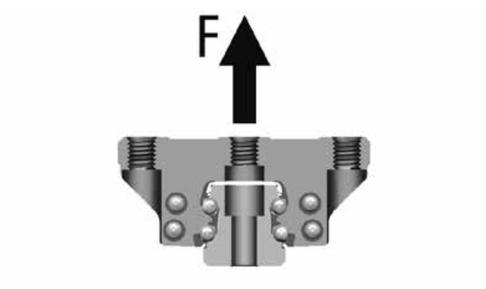
511 Style B, D, F
Size 20

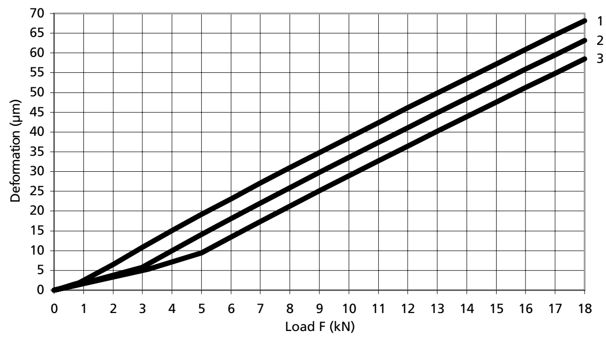
Compressive Load



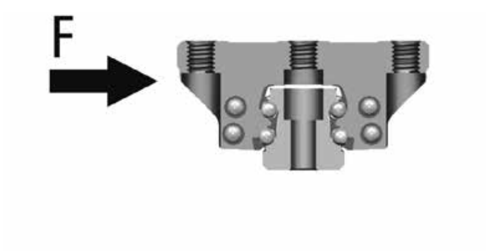


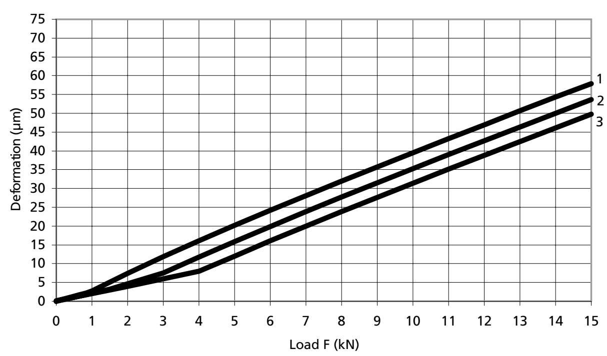
Tensile Load





Lateral Load





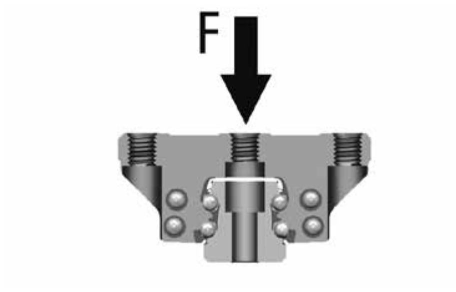
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

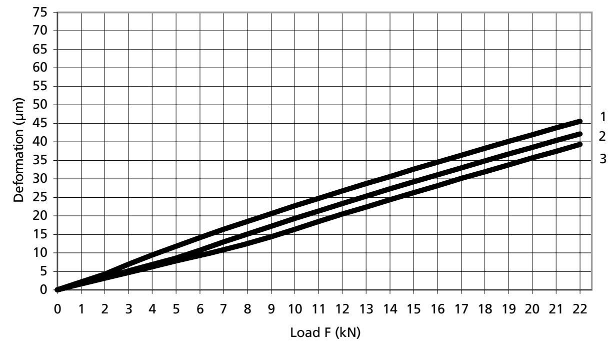
C = Dynamic load carrying capacity

Deflection vs. Applied Load

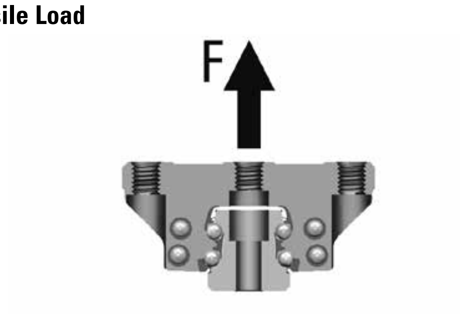
511 Style A,C,E
Size 25

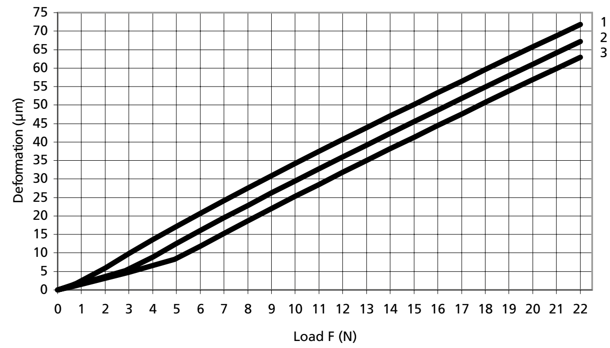
Compressive Load



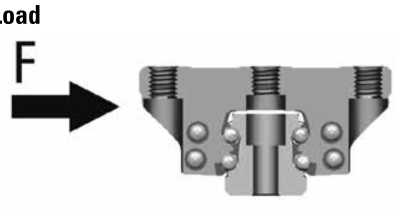


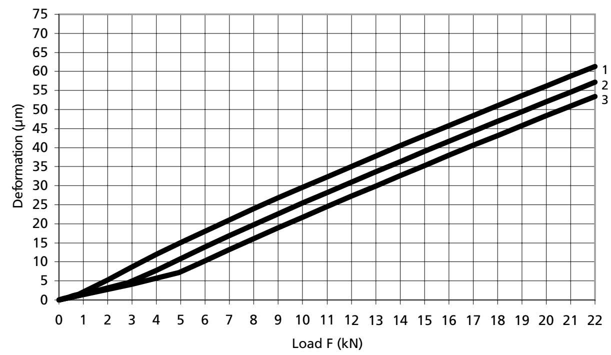
Tensile Load





Lateral Load





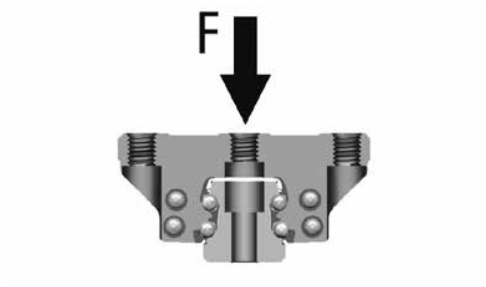
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

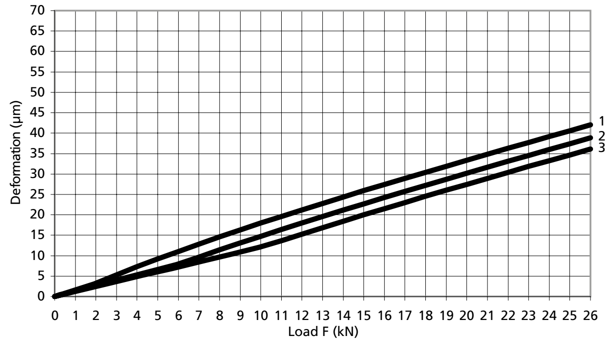
C = Dynamic load carrying capacity

Deflection vs. Applied Load

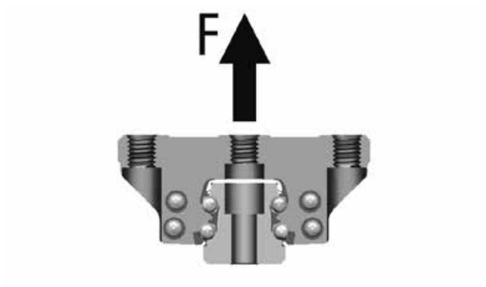
511 Style B, D, F
Size 25

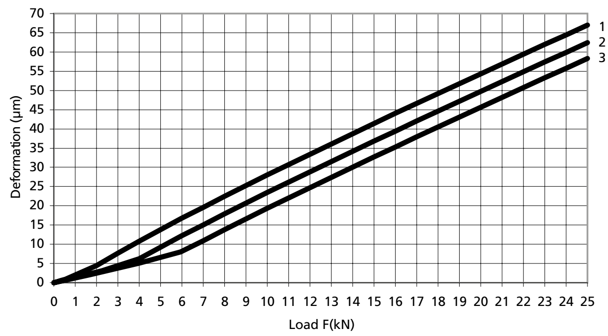
Compressive Load



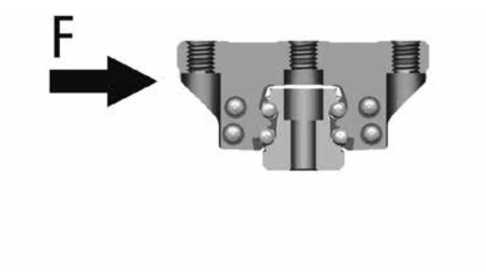


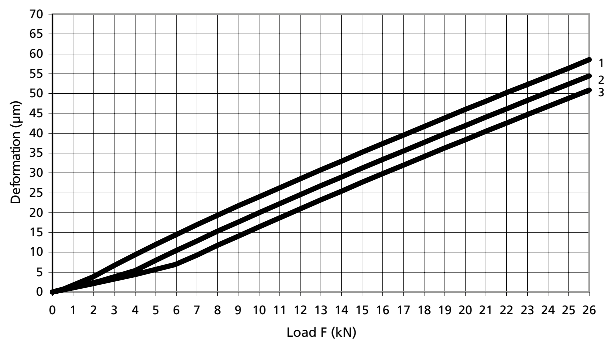
Tensile Load





Lateral Load





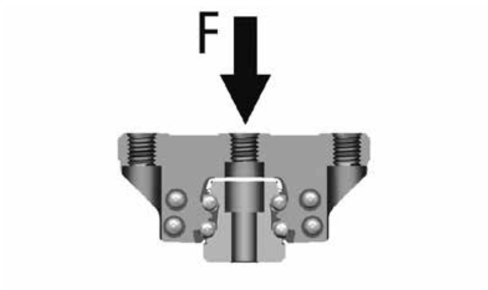
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

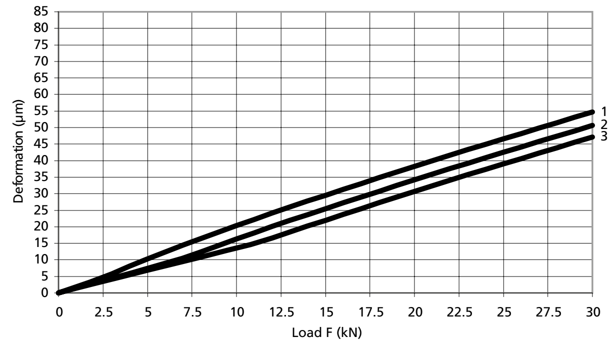
C = Dynamic load carrying capacity

Deflection vs. Applied Load

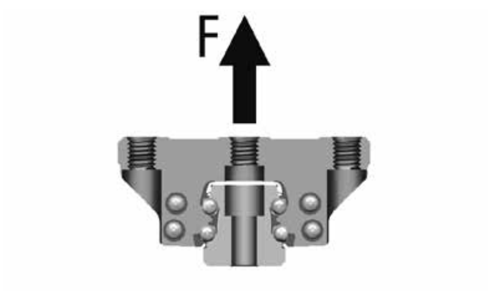
511 Style A,C,E
Size 30

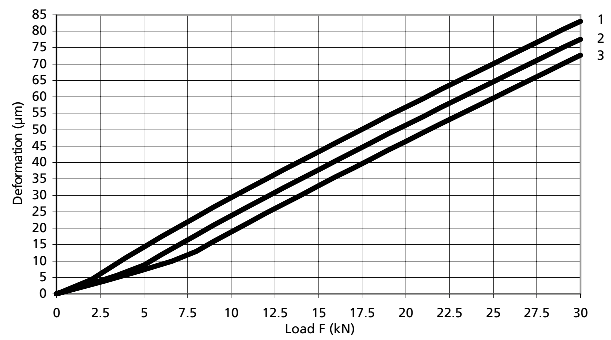
Compressive Load



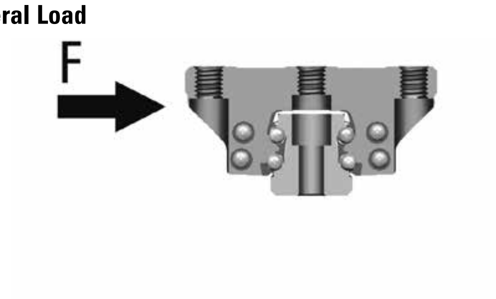


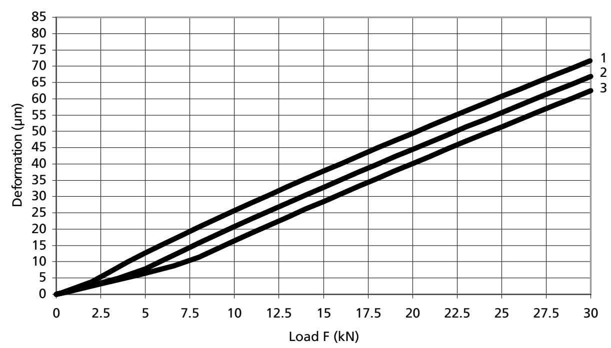
Tensile Load





Lateral Load





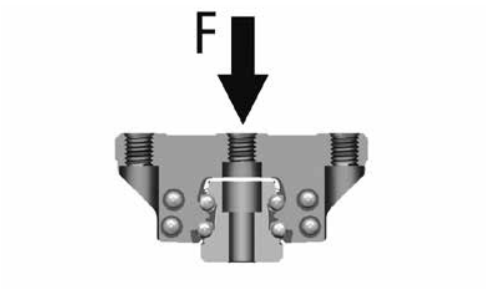
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

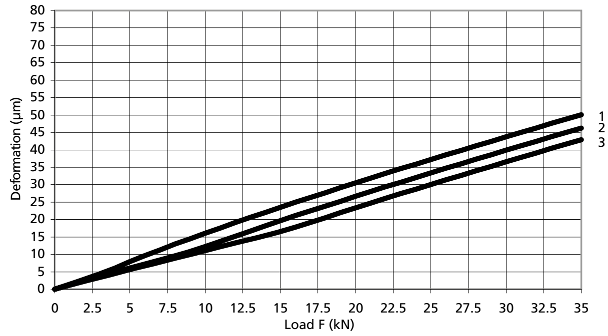
C = Dynamic load carrying capacity

Deflection vs. Applied Load

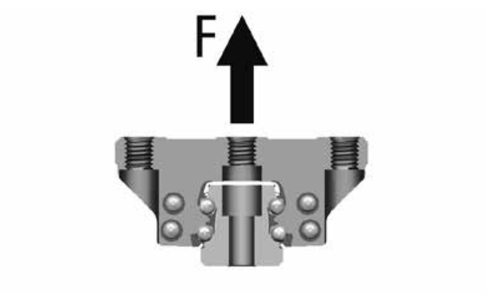
511 Style B, D, F
Size 30

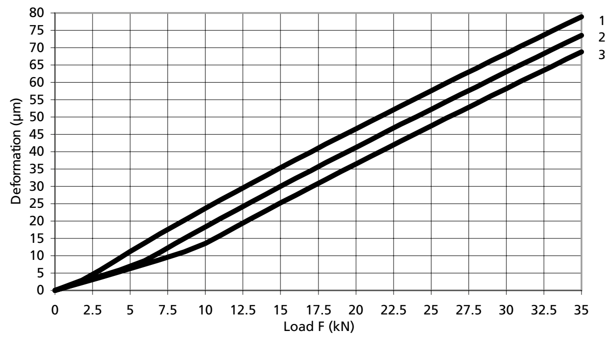
Compressive Load



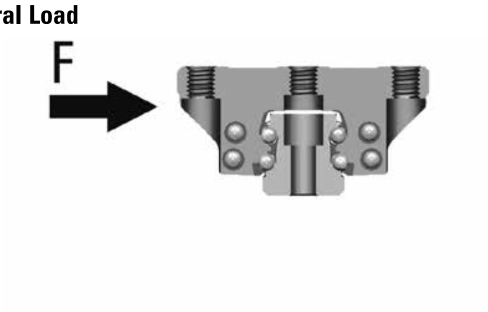


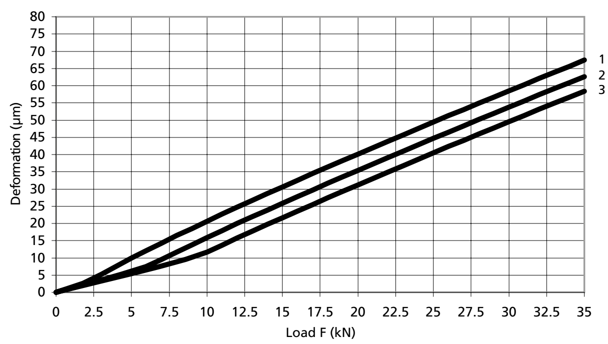
Tensile Load





Lateral Load





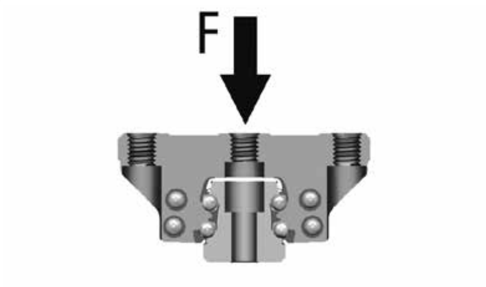
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

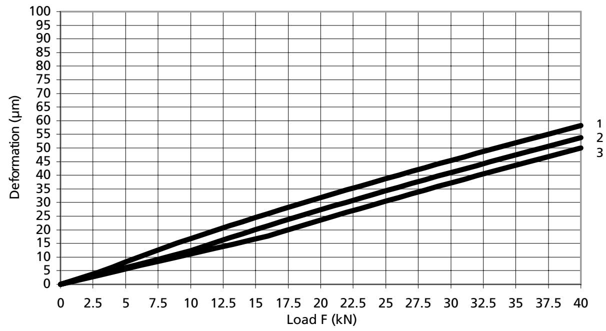
C = Dynamic load carrying capacity

Deflection vs. Applied Load

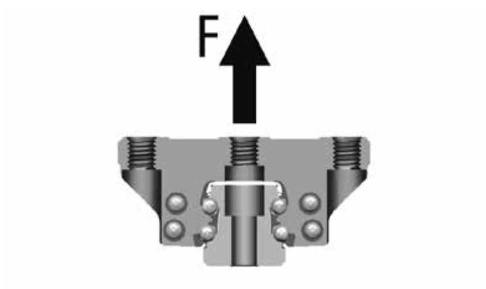
511 Style A,C,E
Size 35

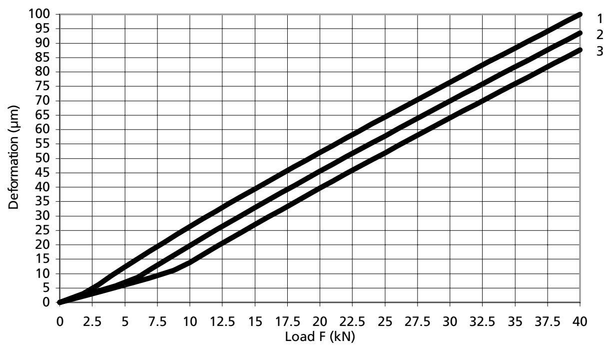
Compressive Load



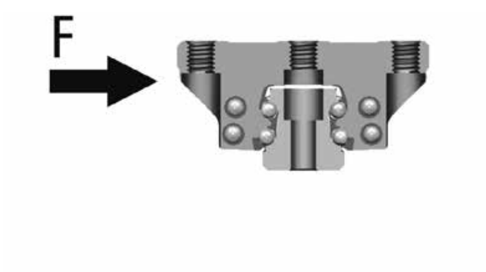


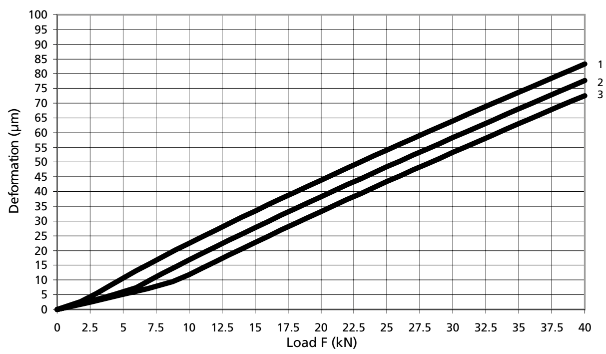
Tensile Load





Lateral Load





1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

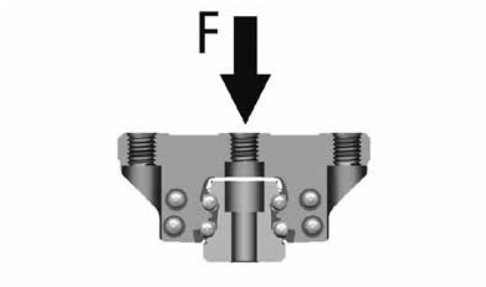
C = Dynamic load carrying capacity

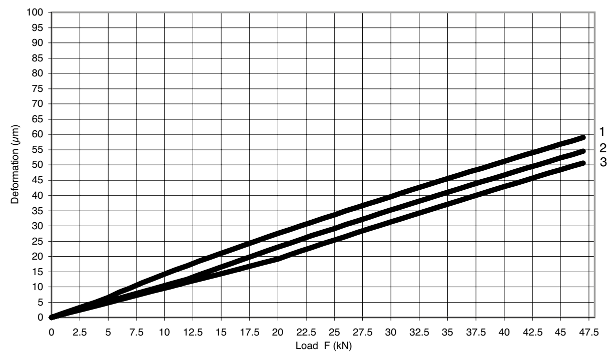
Engineering Guide

Deflection vs. Applied Load

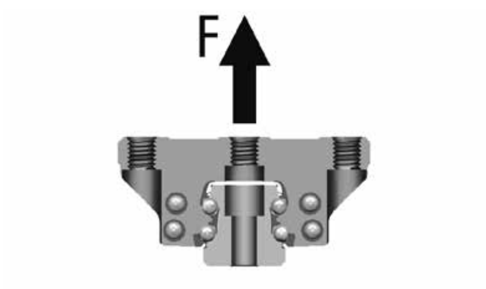
511 Style B, D, F
Size 35

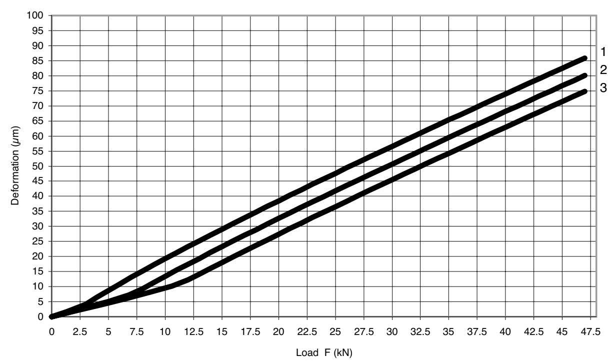
Compressive Load



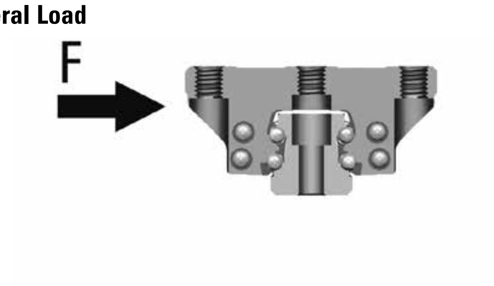


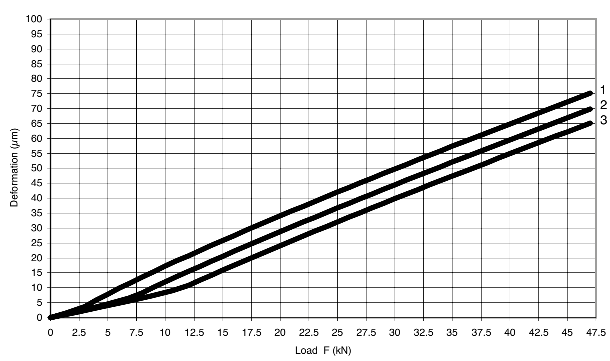
Tensile Load





Lateral Load





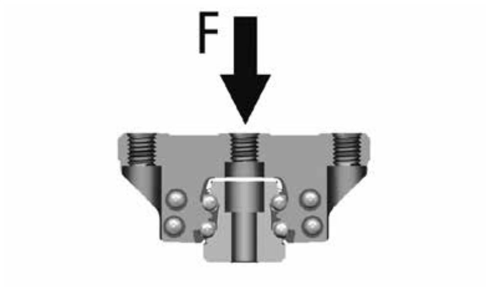
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

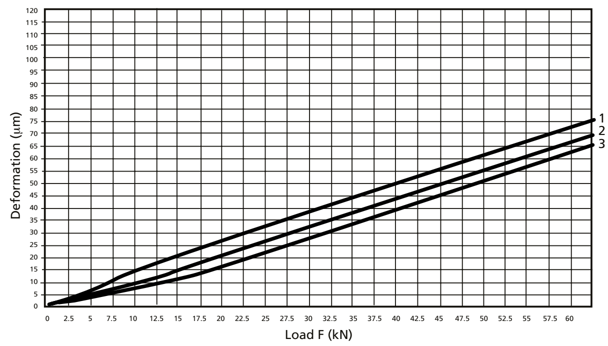
C = Dynamic load carrying capacity

Deflection vs. Applied Load

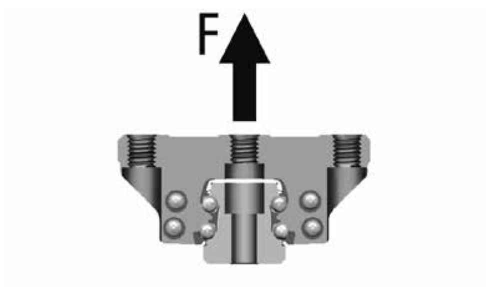
511 Style A,C,E
Size 45

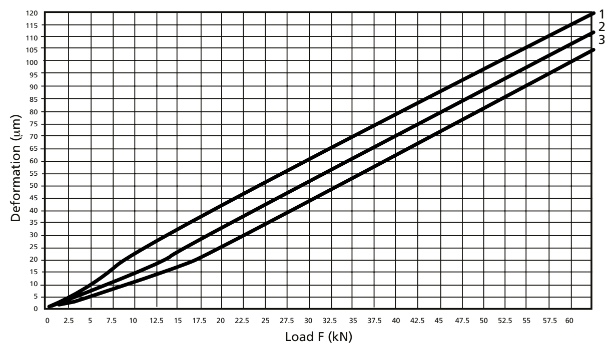
Compressive Load



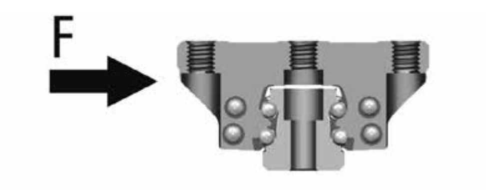


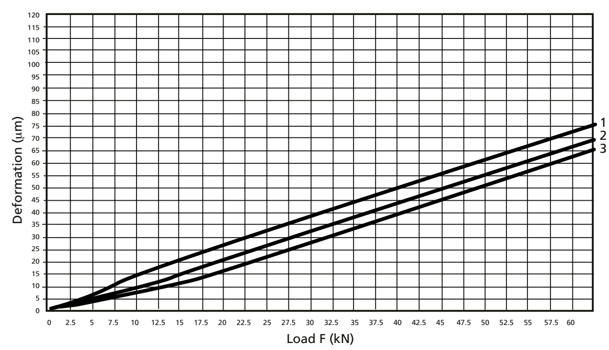
Tensile Load





Lateral Load





1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

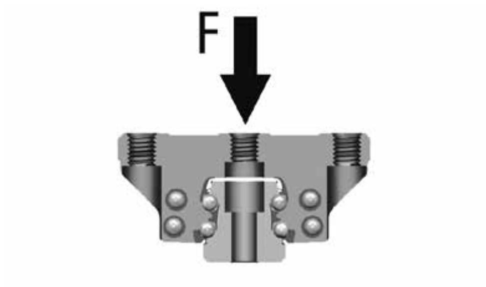
C = Dynamic load carrying capacity

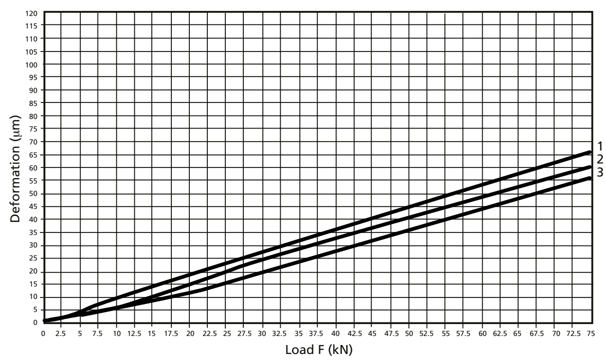
Engineering Guide

Deflection vs. Applied Load

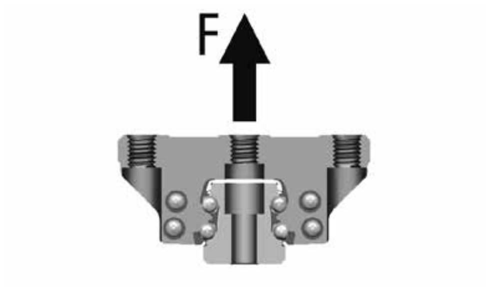
511 Style B, D, F
Size 45

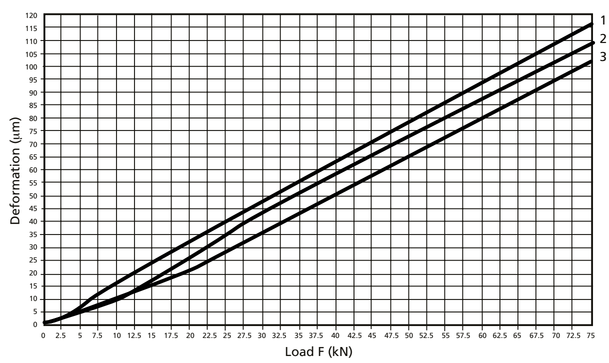
Compressive Load



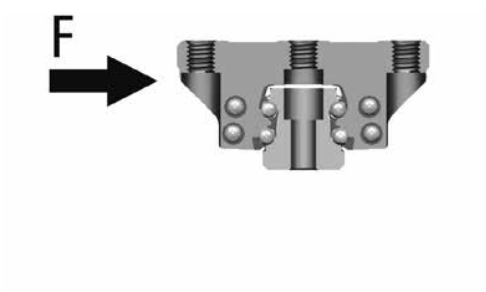


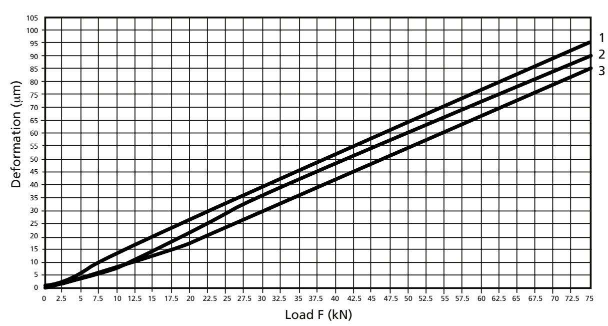
Tensile Load





Lateral Load





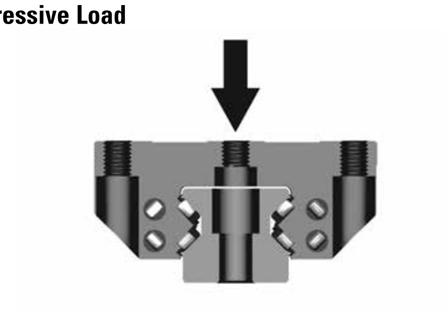
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

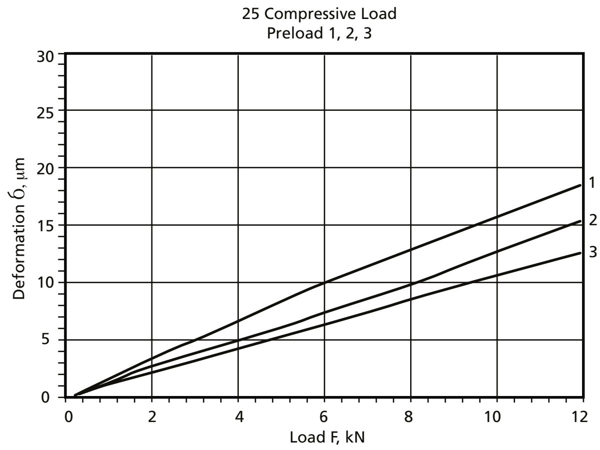
C = Dynamic load carrying capacity

Deflection vs. Applied Load

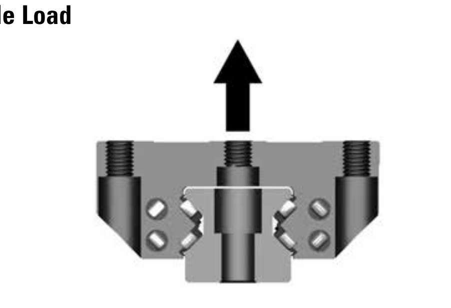
512 Style A and C
Size 25

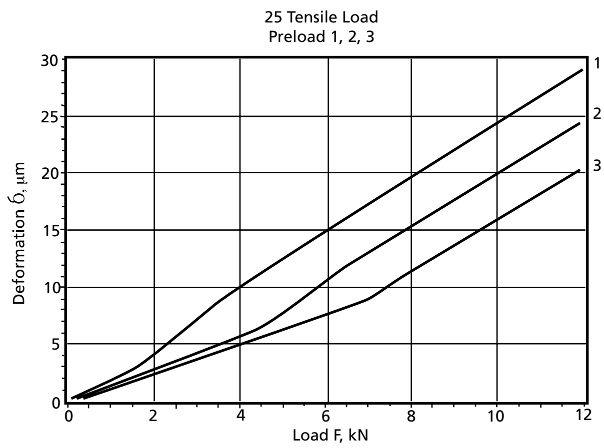
Compressive Load



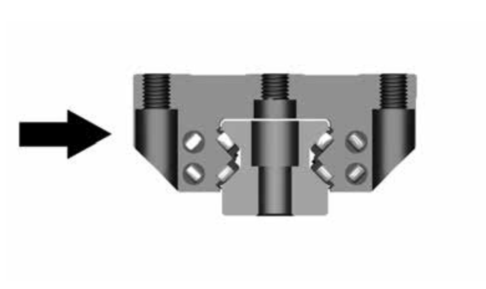


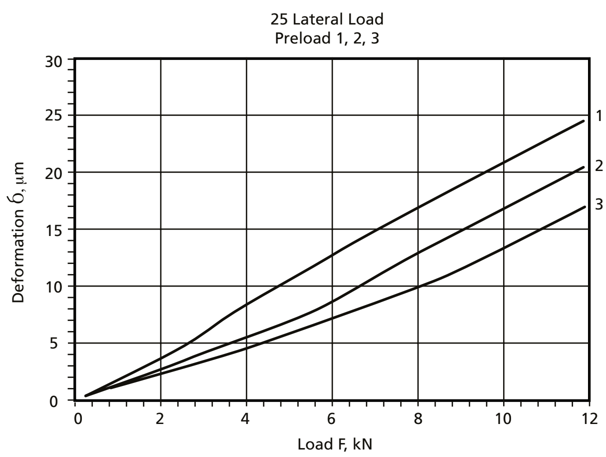
Tensile Load





Lateral Load





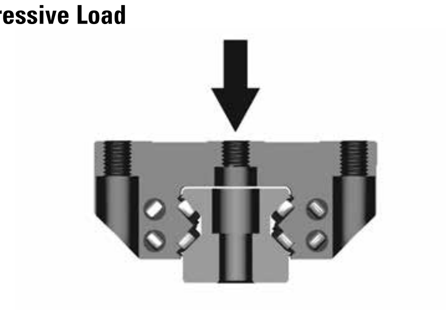
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

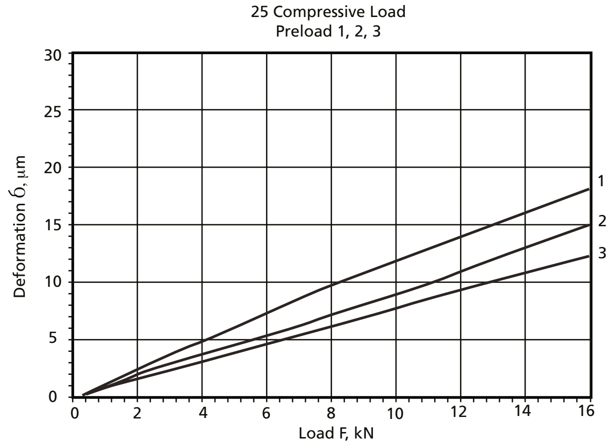
C = Dynamic load carrying capacity

Deflection vs. Applied Load

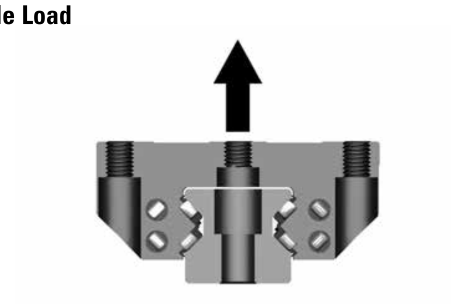
512 Style B and D
Size 25

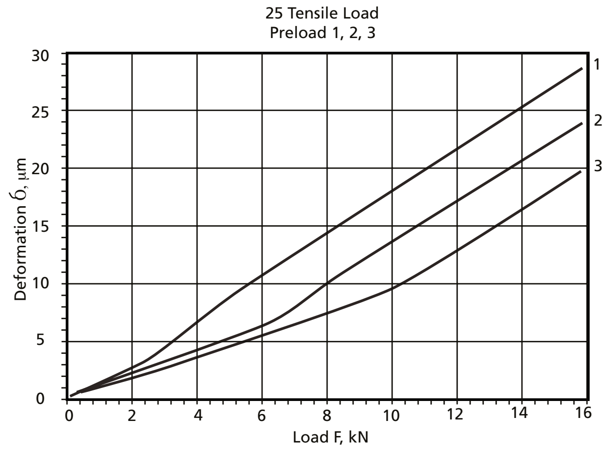
Compressive Load



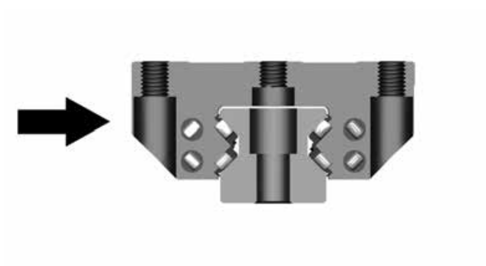


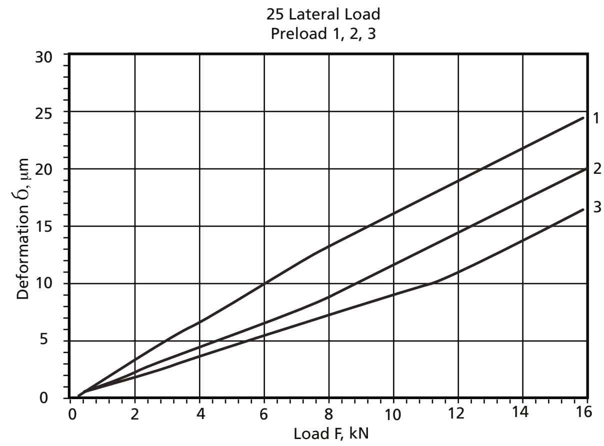
Tensile Load





Lateral Load





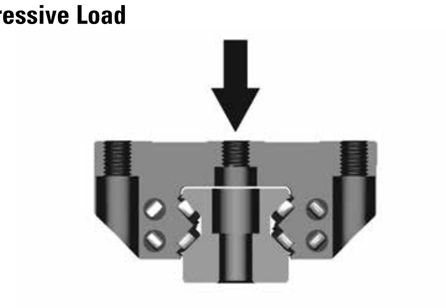
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

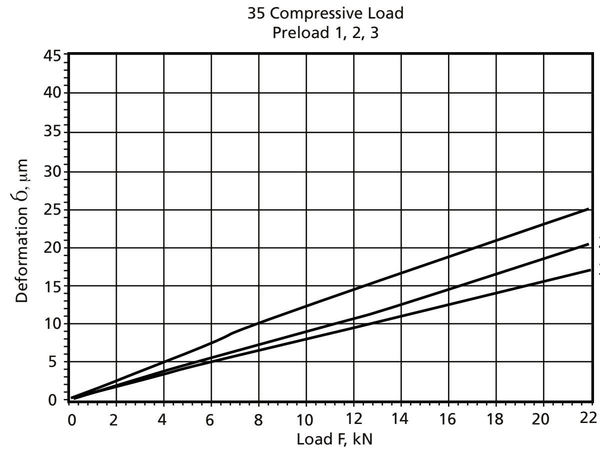
C = Dynamic load carrying capacity

Deflection vs. Applied Load

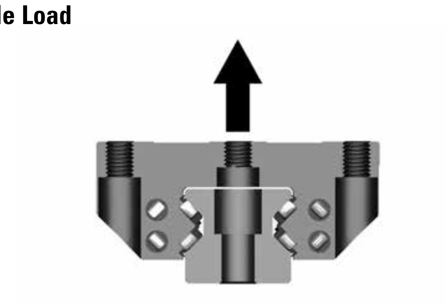
512 Style A and C
Size 35

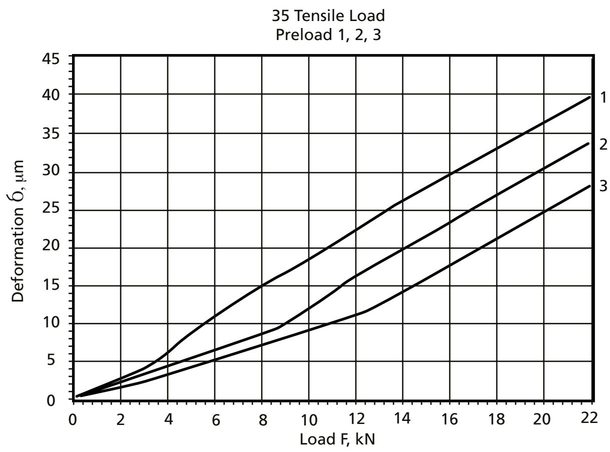
Compressive Load



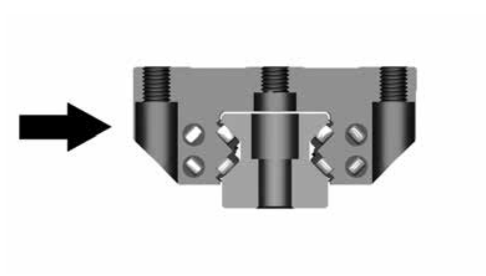


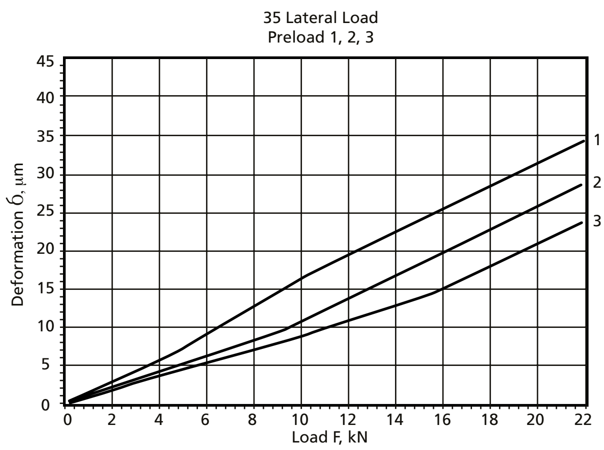
Tensile Load





Lateral Load





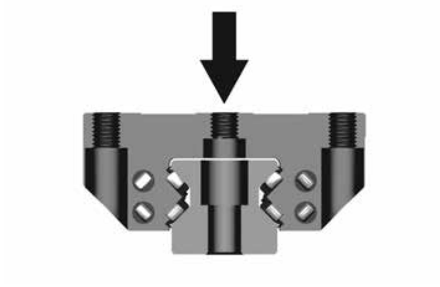
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

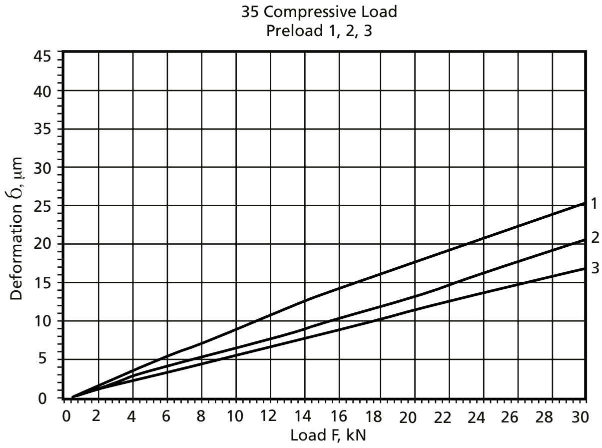
C = Dynamic load carrying capacity

Deflection vs. Applied Load

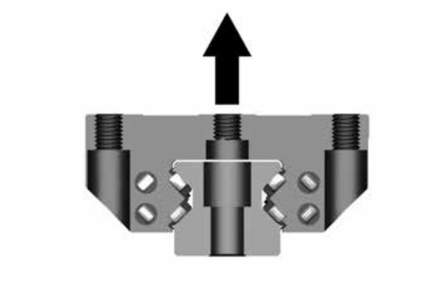
512 Style B and D
Size 35

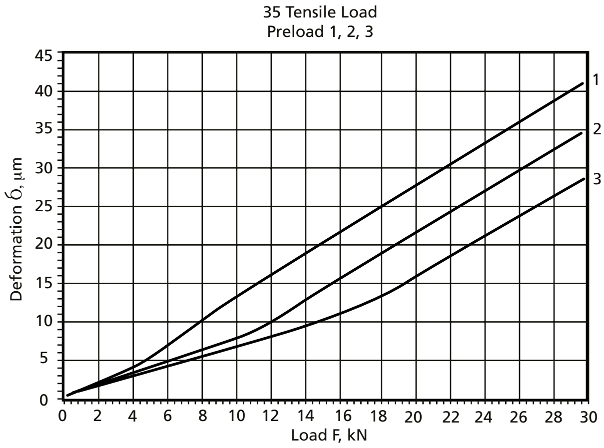
Compressive Load



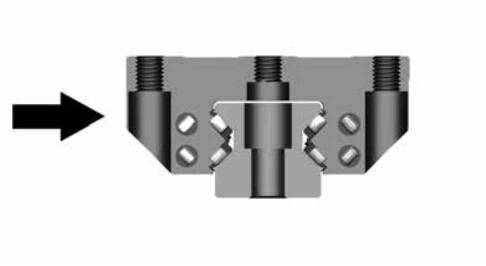


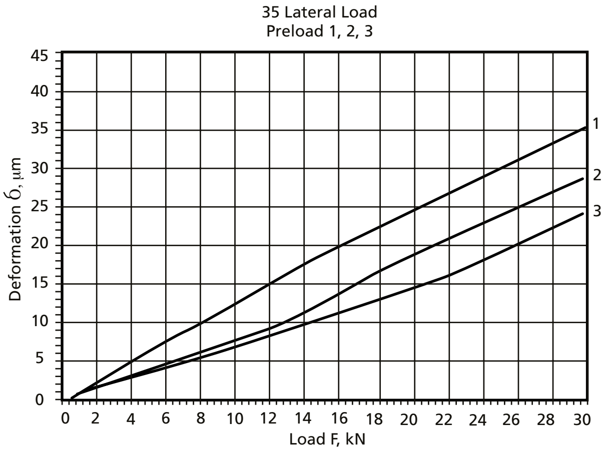
Tensile Load





Lateral Load





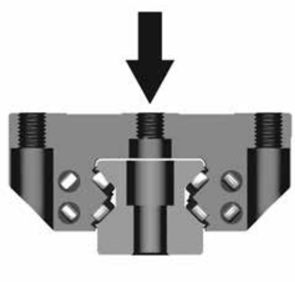
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

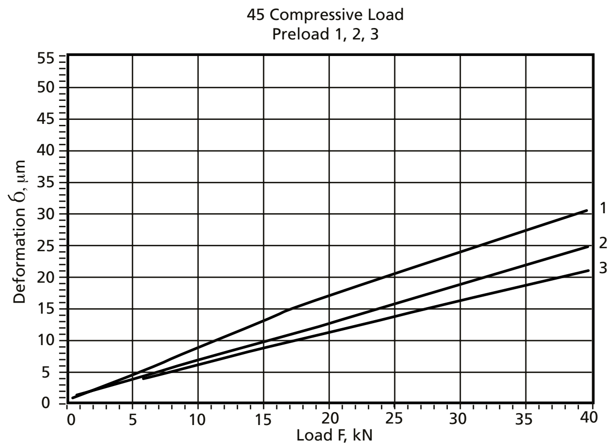
C = Dynamic load carrying capacity

Deflection vs. Applied Load

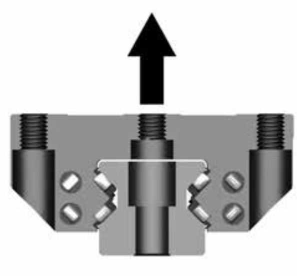
512 Style A and C
Size 45

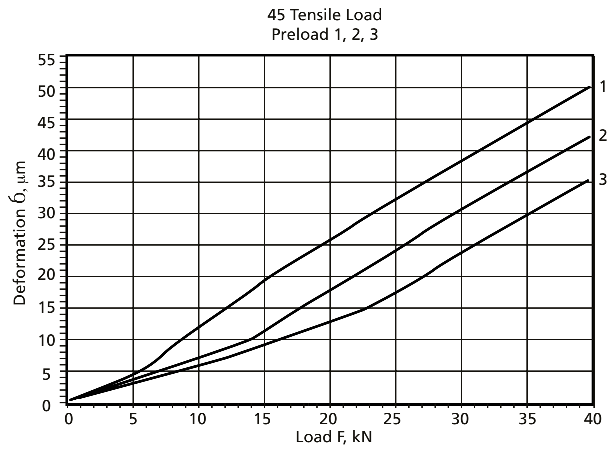
Compressive Load



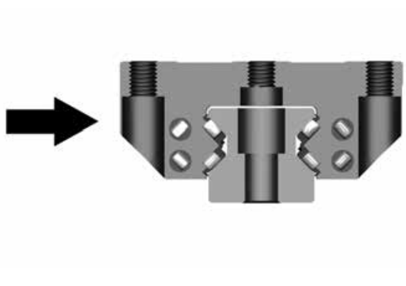


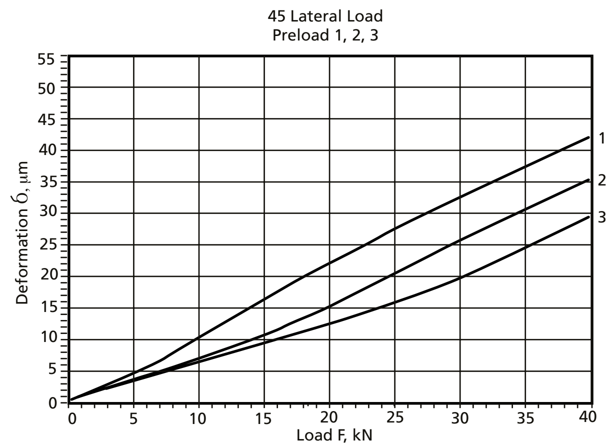
Tensile Load





Lateral Load





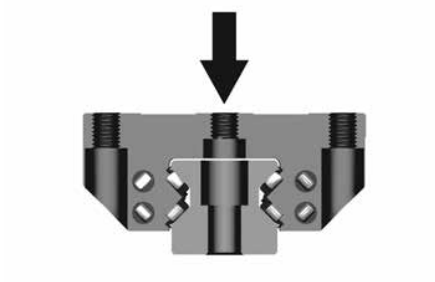
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

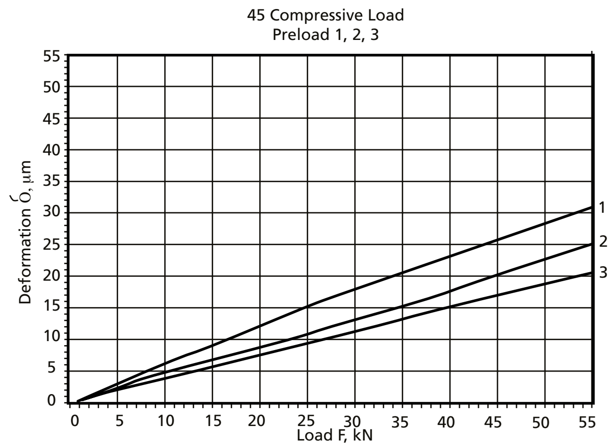
C = Dynamic load carrying capacity

Deflection vs. Applied Load

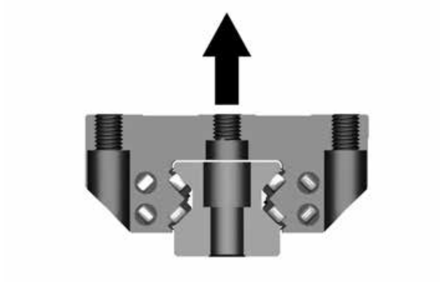
512 Style B and D
Size 45

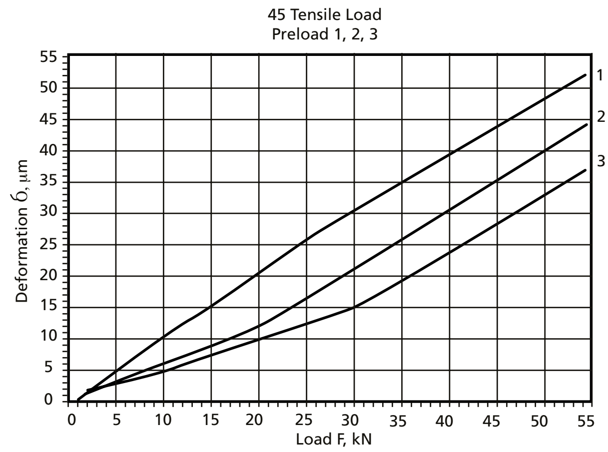
Compressive Load



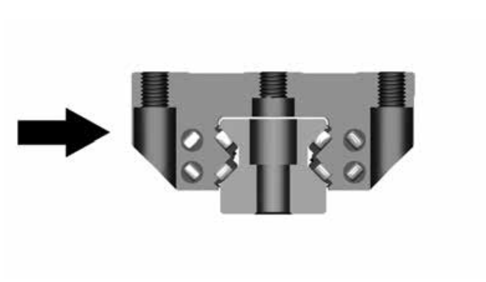


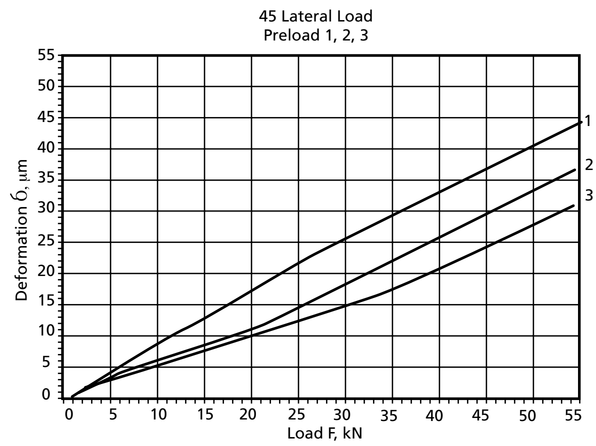
Tensile Load





Lateral Load





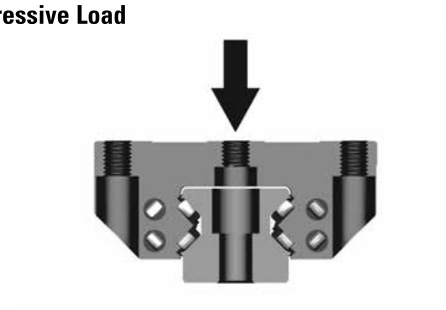
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

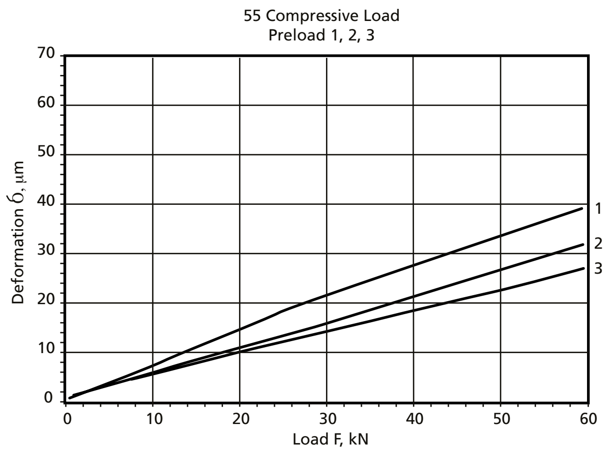
C = Dynamic load carrying capacity

Deflection vs. Applied Load

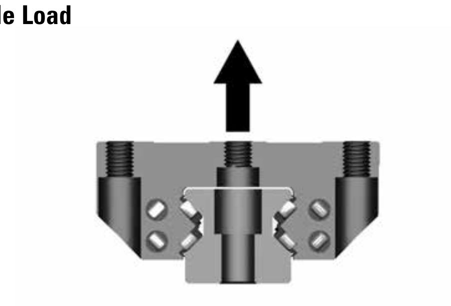
512 Style A and C
Size 55

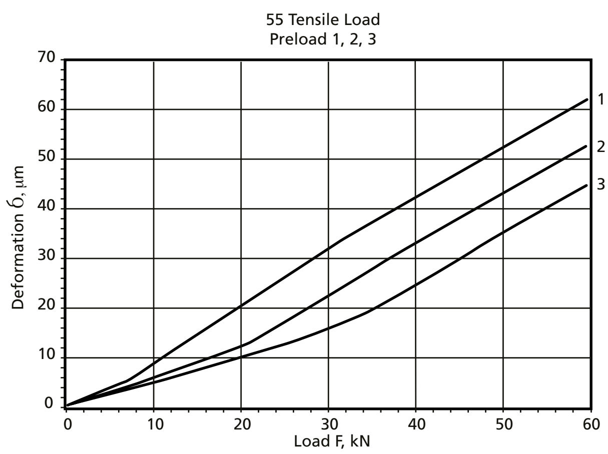
Compressive Load



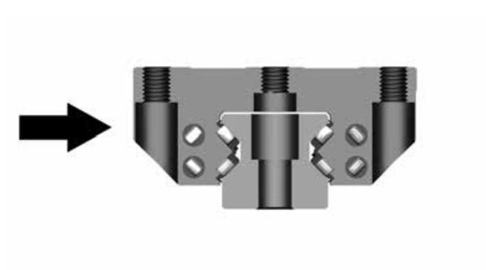


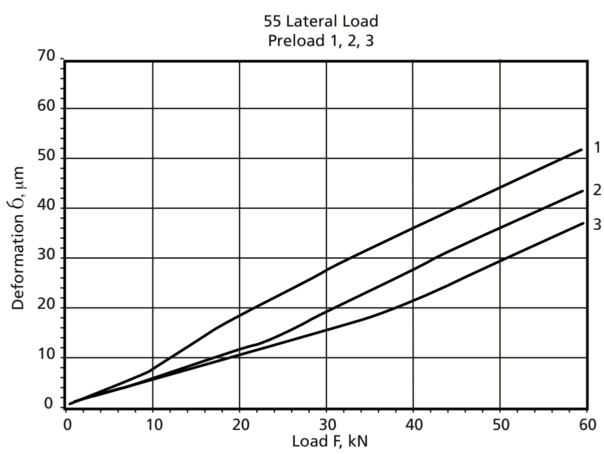
Tensile Load





Lateral Load





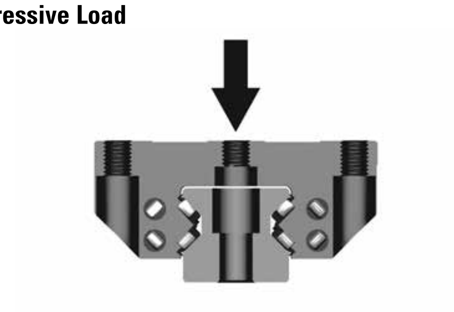
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

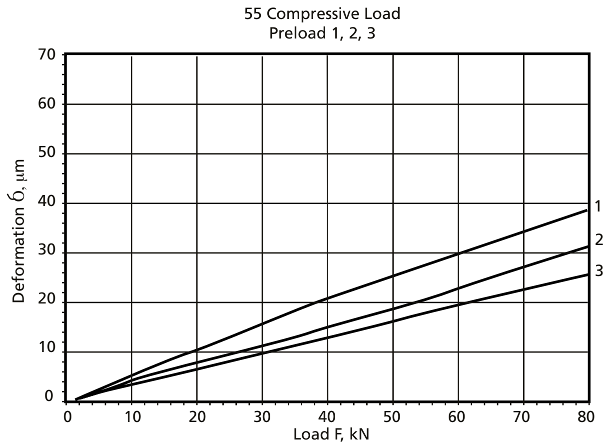
C = Dynamic load carrying capacity

Deflection vs. Applied Load

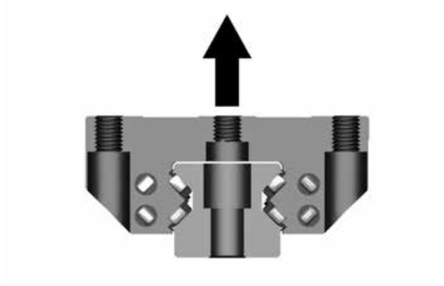
512 Style B and D
Size 55

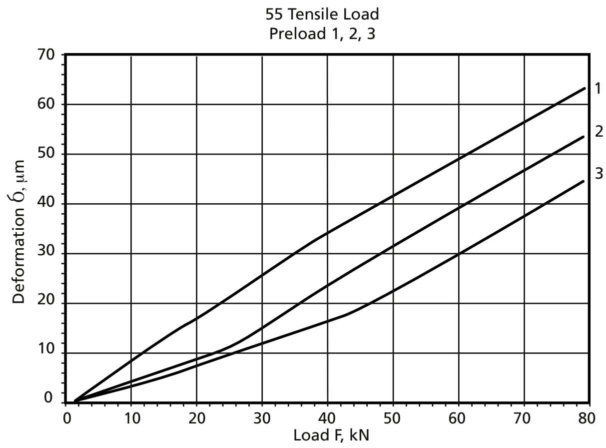
Compressive Load



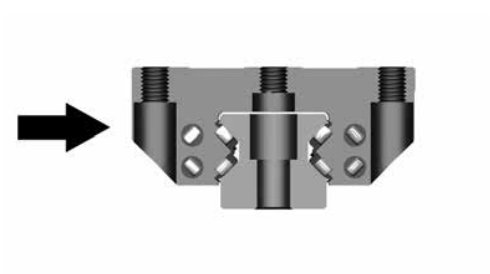


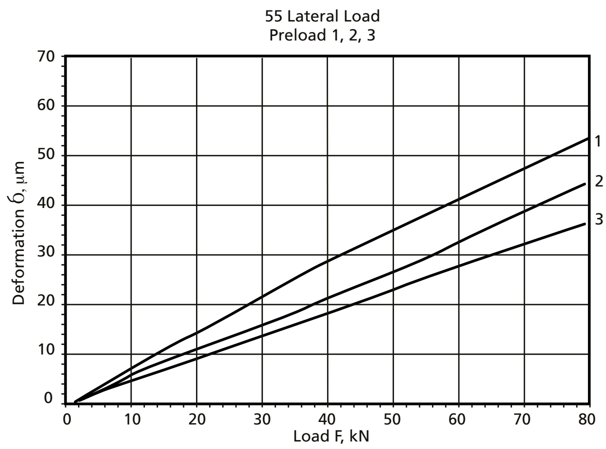
Tensile Load





Lateral Load





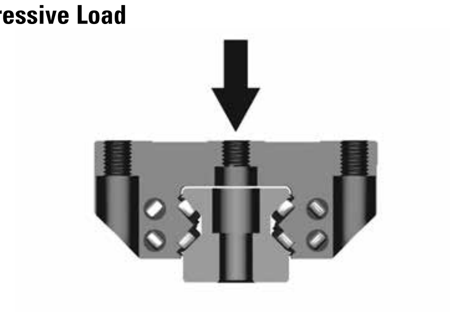
1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

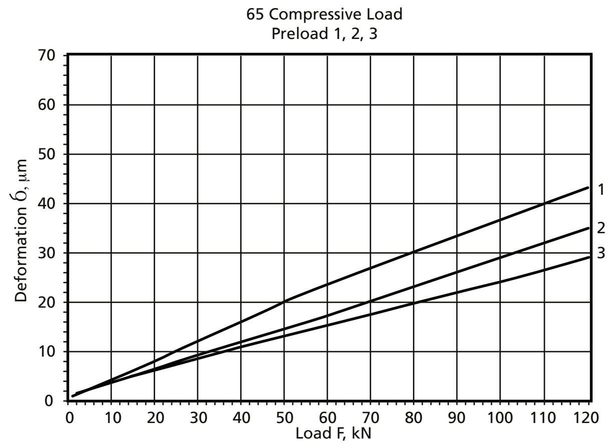
C = Dynamic load carrying capacity

Deflection vs. Applied Load

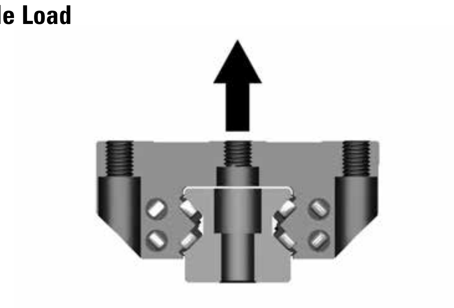
512 Style A and C
Size 65

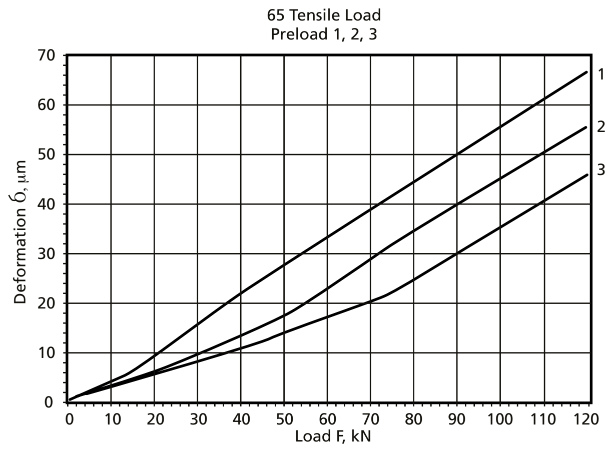
Compressive Load



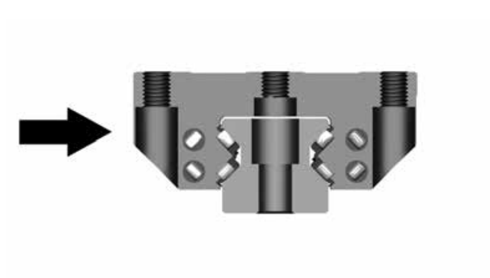


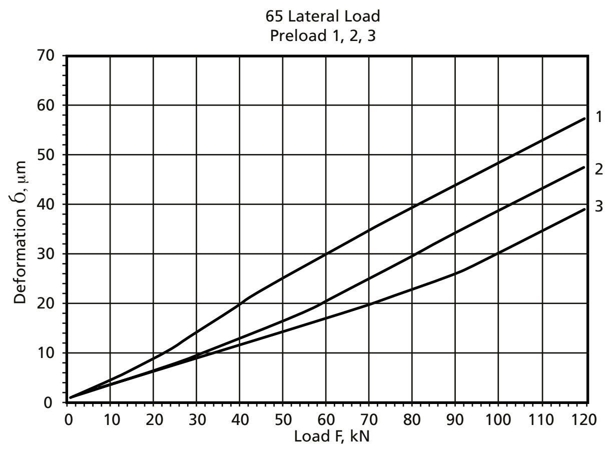
Tensile Load





Lateral Load





1. Preload 3% of C
2. Preload 8% of C
3. Preload 13% of C

C = Dynamic load carrying capacity

Actuation Force

The force required to actuate a linear guide (FA) has four basic components:

1. Frictional resistance (F_f)
2. Intrinsic resistance (D_{int})
3. Inertia of the moving components ($F_{inertia}$)
4. Viscose drag of the lubrication (D_l)

$$F_A = F_f + D_{int} + F_{inertia} + D_l$$

Frictional Resistance

Rolling Element Guides
Friction occurs in rolling element guides as a result of slipping of the rolling elements on the raceways. The frictional resistance can be calculated by means of the following equation:

$$F_f = \mu \times F_i$$

Where:
μ = coefficient of friction (dependent upon type of guide type, rolling element type and load)
F_i = force internal to the linear guide

The following table lists the coefficient of friction for different types of guides:

Profile Rail	
Ball Type	Roller Type
0.002 - 0.003	0.001 - 0.002

The value for the coefficient of friction is a function of the applied load. The coefficient of friction increases as load is applied. This is due to the increased contact area between the rolling elements and races.

The force internal to the linear guide is equal to the external force (F_{ext}) applied to the linear guide in non-preloaded guides, and preloaded guides loaded beyond 3 times the preload value (F_p).

$$F_i = F_{ext}$$

For preloaded guides loaded below a level of 3 times the preload value (F_p), the internal force can be approximated with the following equation:

$$F_i = 2F_p + 1/3\ F_{ext}$$

Intrinsic Resistance

The intrinsic resistance is the measured actuation force required to move the guide at a constant velocity, without lubrication, regardless of load. It consists of the seal drag (larger component) and force required to circulate the rolling elements (smaller component). The intrinsic resistance can be assumed to be a constant for linear guides carrying more than 5% of their dynamic load rating (C). For guides loaded below that value, the force required to circulate the rolling elements will increase.

The following chart shows the intrinsic resistance, D_{int}, for different types and sizes of linear guides.

Inertia of Moving Components
Inertia is directly related to the mass and acceleration by the following equation:

$F_{inertia}$ **= Ma**

Viscose Drag of the Lubrication
The viscose drag of the lubricant is dependent upon the viscosity of the lubricant selected.

Preload
Preload of the assembly has an effect on intrinsic resistance, the greater the preload the greater the intrinsic resistance to move the guide.

500 Series Ball Profile Rail

Size D_{int} (N)	Carriage Style A, C D_{int} (N)		Carriage Style B, D D_{int} (N)	
Preload	**0.03C**	**0.13C**	**0.03C**	**0.13C**
15	7	15	8	14
20	10	16	11	18
25	13	22	14	22
30	16	26	19	30
35	23	37	25	41
45	27	44	30	49

Values for lubricant oil VG 68, speed 0.1 m/s

500 Series Roller Profile Rail

Size	Carriage Style A, C D_{int} (N)	Carriage Style B, D D_{int} (N)
25	17	18
35	35	51
45	53	60
55	98	124
65	—	170

Value for 0.13 C Preload, lubricant oil VG68, speed 0.1 m/s

Lubrication

Lubrication provides protection against wear, corrosion, heat, and friction. Application-specific variables, such as load, speed, and environmental conditions, determine the most suitable lubricant and lubrication schedule for that specific application.

Thomson's general lubricant recommendation for linear guides is a grade 2 grease. A maximum of one year or 100 km, whichever comes first, between applications of lubricant is recommended. A grease with an extreme pressure additive should be used for guides loaded beyond 50 of their dynamic load rating (C). Oil can also be used and is recommended in applications where the bearings experience high speeds. Use the uppermost lubrication port on oil-lubricated bearings that are vertically oriented to ensure gravity-assisted lubricant dispersal.

Linear guide products are supplied with a light coating of preservative oil. This preservative oil is for storage purposes only and is not recommended as lubrication for the bearing.

Lubrication Procedure
For best lubrication dispersal, the carriage should be moved on the rail while applying lubricant to ensure circulation to all internal bearing surfaces. It is not possible to over lubricate the bearings, as excess lubricant will merely exit the carriage under the seals.

Recommended initial volumes of lubricant for 500 Series bearings are shown in the tables. The recommended volume for relubrication is 1/2 the initial volume.

Short Stroke
In the case of a stroke less than 2X´s the carriage length, two lubrication connections are recommended, one at each end to ensure adequate lubrication to the entire ball or roller track.

Oil Reservoir
The oil reservoir is supplied from the factory ready for installation (filled with oil). Relubrication is dependent upon many factors such as speeds, temperature, cleanliness, etc. The following is a guideline for relubrication. (It is recommended to relubricate every 12 months.)

The oil reservoir is filled in the factory with Kluber Lamora D220 oil. If relubricating with different oil it is the responsibility of the user to determine oil compatibility. The recommended refill quantity is shown in the table.

Initial Grease Volume for 500 Series Ball Bearings

Size	Carriage Style A, C, E (cm^3)	Carriage Style B, D, F (cm^3)
15	0.9	—
20	1.7	2.1
25	2.8	3.5
30	4.7	5.8
35	6.6	8.1
45	12.6	15.6

Initial Grease Volume for 500 Series Roller Bearings

Size	Carriage Style A, C (cm^3)	Carriage Style B, D (cm^3)
25	1.9	2.2
35	2.9	3.7
45	5.3	6.6
55	10.6	10.6
65	—	18.9

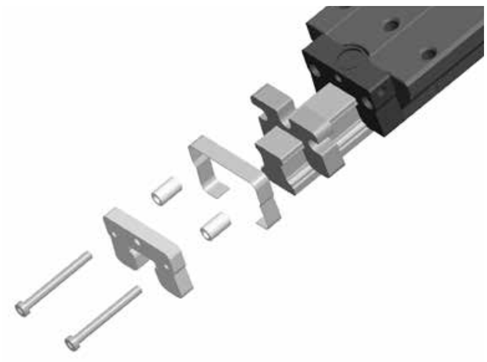
Oil Reservoir Refill Quantity

Size	500 Series Ball 5310W Oil (cm^3)	500 Series Roller 5320W Oil Qty (cm^3)
15	0.5	—
20	1.4	—
25	2.4	2.2
30	2.9	—
35	5.	6
45	10.9	11
55	—	19
65	—	43

Relubrication

Size	15	20	25	30	35	45	55	65
Travel Distance	2500 km					5000 km		

Self-Lubricating Profile Rail Lube Block



The self-lubricating Lube Block option offers maintenance free operation and enhanced protection for a broad range of applications. It offers:

- Reduced system cost by eliminating the need for designing, purchasing, and installing expensive lubrication systems.
- Environmentally friendly operation.
- Increased bearing life by offering enhanced protection.

Design
The self-lubricating option utilizes self-lubricating attachments at both ends of the carriage and includes an initial EP2 grease pack of the carriage. The self-lubricating attachments consist of a section of oil saturated polymer actively compressed by a contact spring, inside a double lip seal.

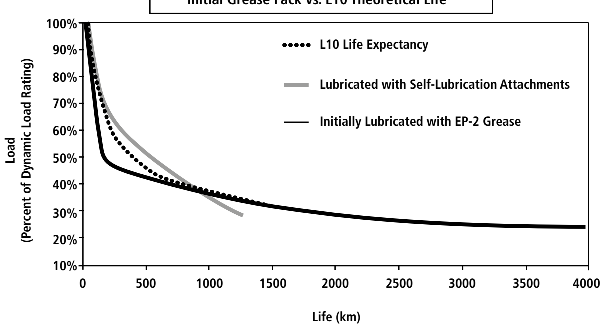
A contact spring assures continuous contact with the rail, releasing oil as the carriage moves. This ensures a film of lubricant between the rolling elements and races. When the carriage is at rest, oil is re-absorbed by the polymer.

Performance
The design has incorporated a proven oil-saturated polymer used for over 10 years to lubricate radial bearings. This method of lubrication has a successful track record in applications ranging from food processing to automotive assembly.

The graph below shows the theoretical L10 life expectancy and actual test results for the following two methods of lubrication:

1. Bearing with self-lubricating attachments only.
2. Bearing initially packed with EP2 grease only.

Life Expectancy with Self-Lubricating Option and Initial Grease Pack vs. L10 Theoretical Life

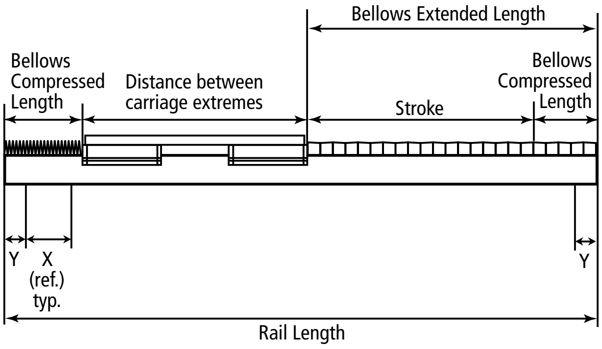


Testing Parameters
Stroke: 500 mm
Speed: 0,6 m/s

This chart illustrates how using the self-lubricating option, which combines the self-lubricating attachments and initial grease pack, will enable the bearing to achieve the L10 life expectancy under all loading condition. Note that for travel lives exceeding 30,000 km, recharging or replacing of the self-lubricating polymer is recommended.

Calculations for Bellow Cover Extended Length & Rail Length

Given the Stroke and Distance Between Carriage Extremes:
Way Cover Extended Length (mm) = Stroke (mm) / (1-CR). After dividing, round number up to the next increment of 5 mm. This value is used as the length in the way cover part number when ordering.



The Way Cover Extended Length will be cut to next vee at the factory.

Way Cover Compressed Length (mm) =
Way Cover Extended Length (mm) - Stroke (mm).

Rail Length = Compressed Length + Extended Length + Distance Between Carriage Extremes.

Example:
Product: 500 Series Ball Linear Guide Size 35

Stroke Length = 200 mm
Distance Between Carriage Extremes = 520 mm
Bellows Type = Walk-On
CR = 0.19 for size 35 500 Series Ball Walk-on type bellows
Way Cover Extended Length = Stroke /
(1-CR) = 200 mm / (1-0.19) = 200 mm / .81 = 246.91 mm

Round up to next increment of 5 mm, therefore,
Way Cover Extended Length = 250 mm
Way Cover Compressed Length = Way Cover Extended Length - Stroke = 250 mm - 200 mm = 50 mm
Rail Length = Compressed Length + Extended Length + Distance Between Carriage Extremes = 50 mm + 250 mm + 520 mm = 820 mm

Butt Joint Specifications Sheet

Specification Sheet for the Butting of Rails
A butt joint will be require for rail lengths longer than the maximum shown in the chart below. If a butt joint is required, the 1st and 2nd rail lengths must each be less than the maximum shown. The “Y1” and “Y2” dimensions must be between the minimum and maximum shown below to avoid cutting into a mounting hole. The standard “Z” dimension should be used for best performance.

Linear Guide Product	Size	“X” dim	Standard “Z” dim	Minimum “Y” dim	Maximum “Y” dim	Fastener size	Maximum length without a joint
500 Series Ball	15	60	60	8	52	M4	1 500
500 Series Ball	20	60	60	8	52	M5	3 000
500 Series Ball	25	60	60	8	52	M5	6 000
500 Series Ball	30	80	80	10	70	M8	6 000
500 Series Ball	35	80	80	10	70	M8	6 000
500 Series Ball	45	105	105	13	92	M12	6 000
500 Series Roller	25	30	30	8	22	M6	6 000
500 Series Roller	35	40	40	10	30	M8	6 000
500 Series Roller	45	52.5	52.5	13	39.5	M12	6 000
500 Series Roller	55	60	60	15	45	M14	6 000
500 Series Roller	65	75	75	17	58	M16	6 000

All dimensions in mm.

Unit Conversion Table

Quantity	Conventional		SI Unit	Conversion Factors
	Inch Unit	Metric Unit (MKS)		
Length	Inch **in**	Meter **m**	Metre **m**	1 in = 25.4 mm 1 mm = 0.03937 in 1 m = 3.2808 ft 1 ft = 0.3048 m
Area	Square Inch **in^2**	Square Meter **m^2**	Square Metre **m^2**	1 in^2 = 6.4516 cm^2 1 cm^2 = 0.155 in^2 1 m^2 = 10.764 ft^2 1 ft^2 = 0.092903 m^2
Mass	Pound **lb_m**	Kilogram **kg**	Kilogram **kg**	1 lb_m = 0.45359237 kg 1 kg = 2.2046 lb
Force	Pound Force **lb_f**	Kilogram Force **kg_f**	Newton **N**	1 lb_f = 0.45359237 kg_f 1 lb_f = 4.44822 N 1 kg_f = 2.2046 lb_f 1 kg_f = 9.80665 N 1 N = 0.1019716 kg_f 1 N = 0.224809 lb_f
Stress or Pressure	Pounds per Square Inch **lb_f/in^2**	Kilograms per Square Meter **kg_f/m^2**	Pascal **Pa**	1 MPa = 10^6 N/m^2 = N/mm^2 1 kPa = 10^3 N/m^2 1 lb_f/in^2 = 0.070307 kg_f/cm^2 1 lb_f/in^2 = 7.0307 x 10^{-4} kg_f/mm^2 1 lb_f/in^2 = 6.8947 x 10^{-3} N/mm^2 (MPa) 1 kg_f/cm^2 = 14.2233 lb_f/in^2 1 kg_f/cm^2 = 9.80665 x 10^{-2} N/mm^2 (MPa)
Torque or Work	Inch Pounds **lb_f-in**	Kilogram Meters **kg_f-m**	Newton-Metres **Nm**	1 lb_f-in = 1.1521 kg_f-cm 1 kg_f-cm = 0.8679 lb_f-in 1 lb_f-in = 0.1129848 Nm 1 kg_f-m = 9.80665 Nm 1 kg_f-cm = 9.80665 x 10^{-2} Nm 1 Nm = 8.85 lb_f-in 1 Nm = 10.19716 kg_f-cm
Power	Foot Pound per Minute **lb_f-ft/min**	Force per Second **kg_f-m/s**	Newton Metre per Second **Nm/s**	1 kW = 1000 Nm/s 1 kW = 60,000 Nm/s 1 kW = 44,220 lb_f-ft/min 1 kW = 1.341 hp 1 hp = 75 kg_f-m/s 1 hp = 44,741 Nm/min 1 hp = 33,000 lb_f-ft/min 1 hp = 0.7457 kW
Velocity	Feet per Second **ft/s**	Meters per Second **m/s**	Metres per Second **m/s**	1 ft/sec = 0.3048 m/s 1 in/sec = 2.54 cm/s 1 ft/sec = 0.00508 m/s 1 mile/hr = 0.44704 m/s 1 km/hr = 0.27777 m/s 1 mile/hr = 1.609344 km/hr
Acceleration	Feet per Second Squared **ft/s^2**	Meters per Second Squared **m/s^2**	Metres per Second Squared **m/s^2**	1 ft/s^2 = 0.3048 m/s^2