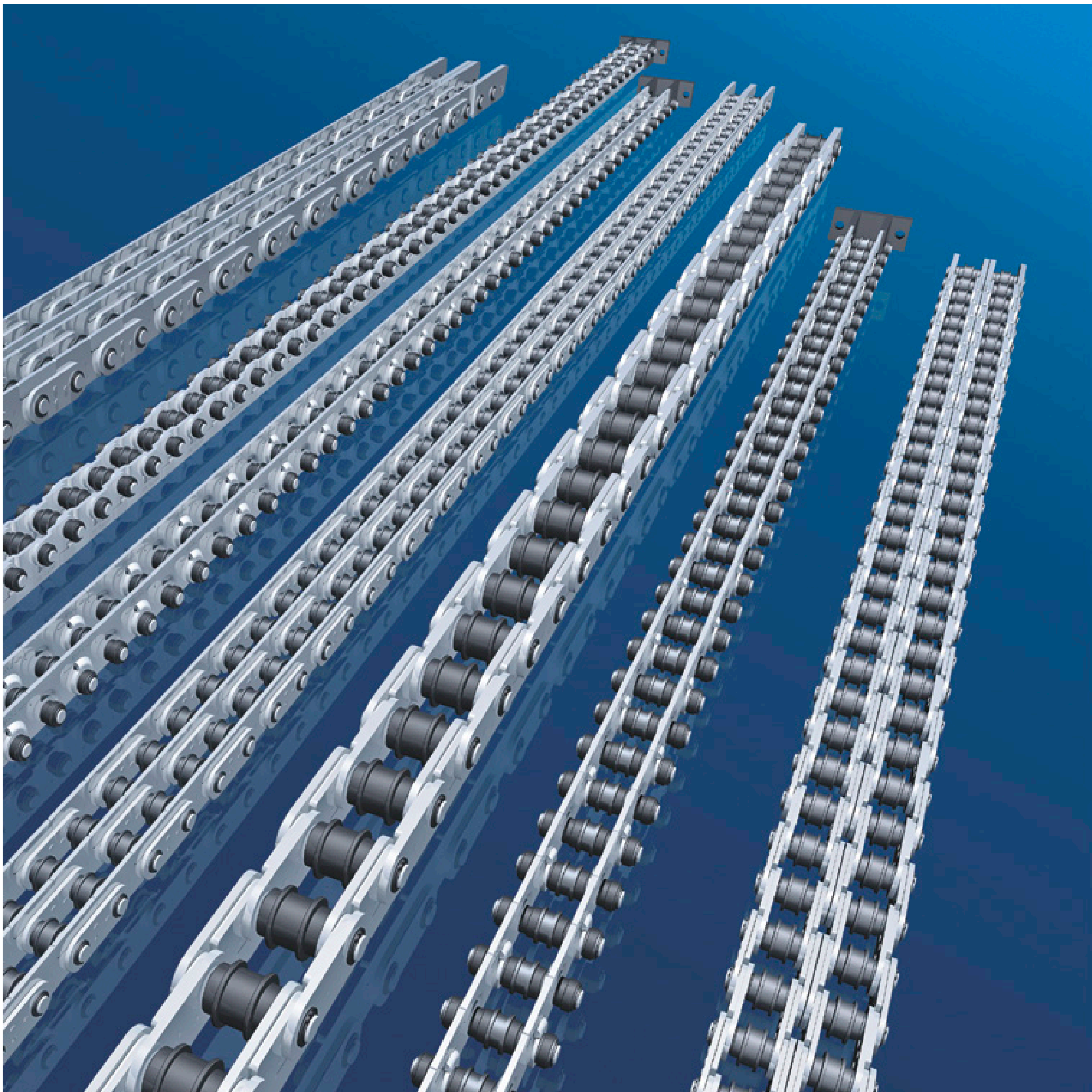
SERAPID
RIGID CHAIN TECHNOLOGY

RIGID CHAINS

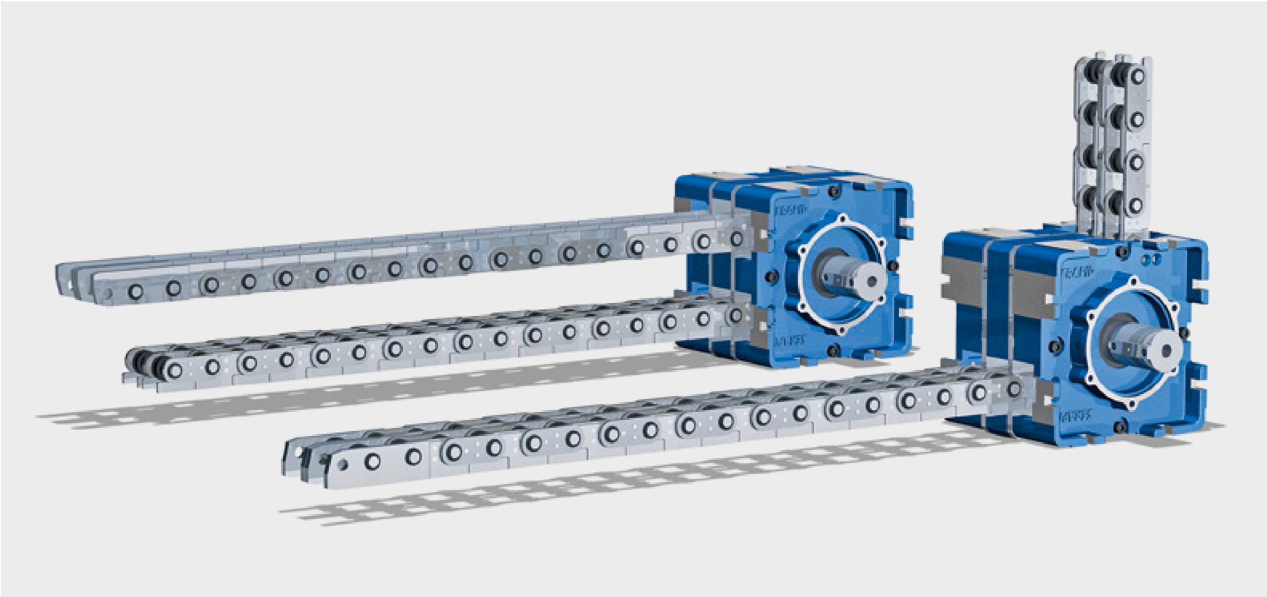
Mechanical actuators for horizontal load transfer



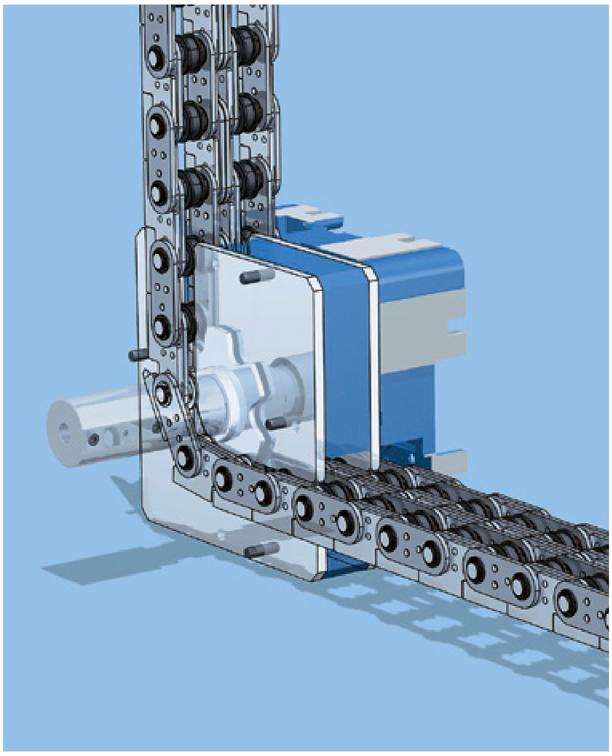
THE TECHNOLOGY OF THE RIGID CHAIN

The SERAPID Rigid Chain is a mechanical actuator moving loads with outstanding efficiency, at a rating between 80 and 90 %. In addition to their load capacity, accuracy and reliability, rigid chain drives are flexible to configure and require only a minimum of space. They can thus be used even in situations that are beyond the limits of other types of drives.

In contrast to spindle or rack-and-pinion drives, the transfer path can be kept clear as long as no load is being moved. In contrast to hydraulic cylinders, no withdrawal tunnels are required – and of course no oil. In contrast to a conventional chain, the rigid chain needs only one motor for bidirectional transfer.

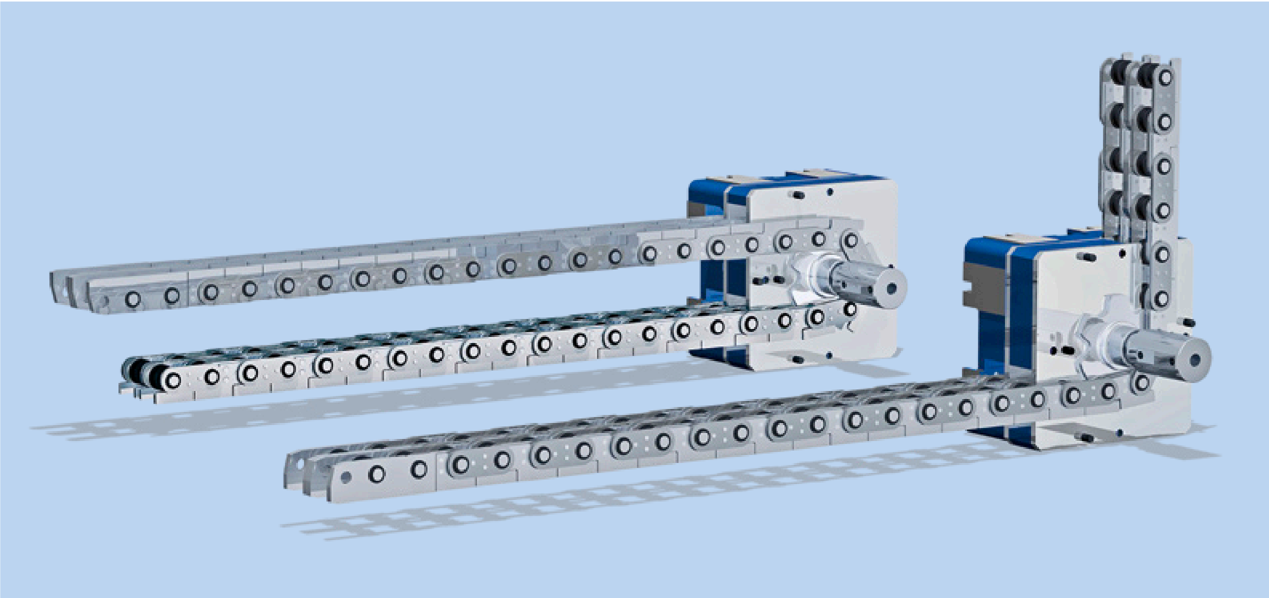


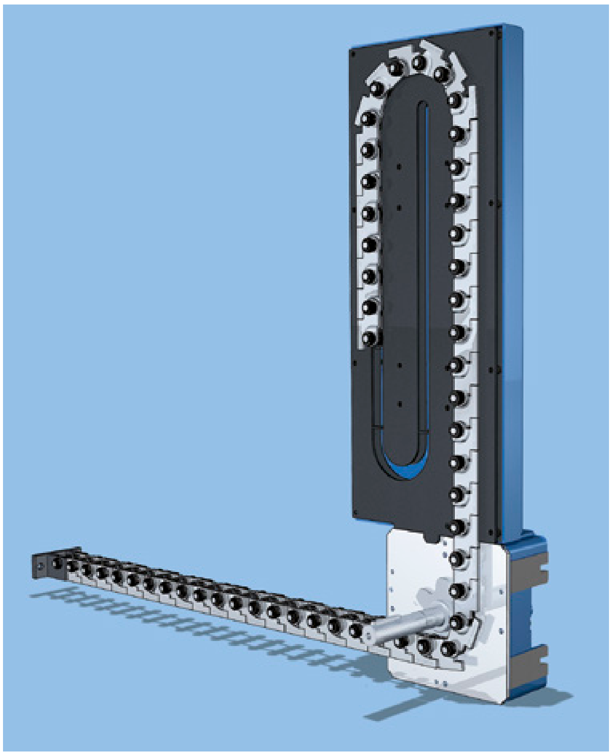
The chain return can be redirected by 180° so it is stored in parallel to the transfer path, normally beneath it. Alternatively, the return can be redirected by 90° so it is accommodated outside the transfer path, which is kept clear as long as no transfer is going on.



The rigid chain operates by deploying its links into an expanding bar under forward thrust. Each link has an extension, the so-called "shoulder", which is form-fitting and force-locking with the shoulders of its neighboring links. Inside the drive housing, links are aligned exactly one after another by driving them through a guiding channel between two steel plates.

The interlocking of the links makes the chain rigid and blocks bending. However, on the other side of the articulation point, the passive, unused portion of the chain remains flexible. On withdrawal it can be redirected to return below the transfer path, or it can be coiled into a compact package that is stored in a magazine entirely outside the working area.





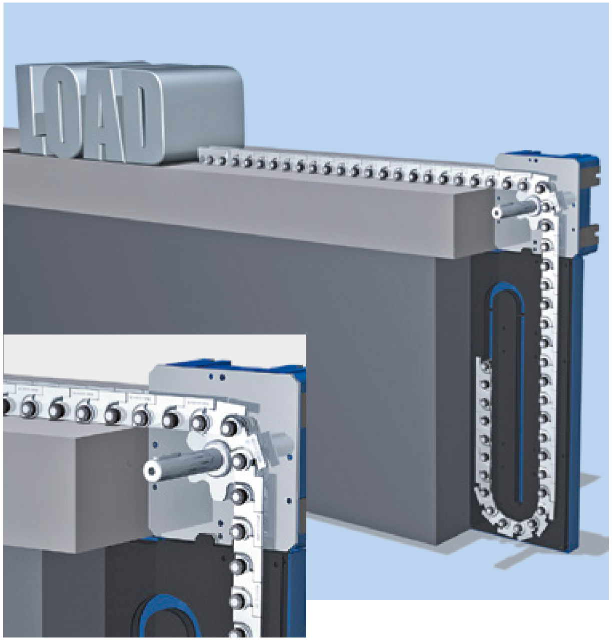
With the 90° redirection the chain return is moved into a storage magazine that can be selected according to available space. In this configuration the rigid chain operates telescopically from a minimum footprint.

See more ... page

OPERATING MODES OF THE RIGID CHAIN

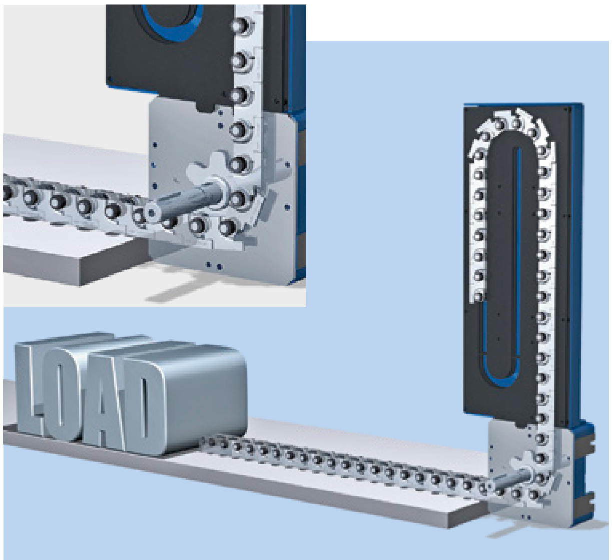
Operating without guides

For best performance over longer strokes the rigid chain has to be used with guides. However, with strokes up to 5 meters, it may also be used unguided, providing that the load is guided. Capacities of each chain type are specified relative to stroke on pp 8 – 9. There are two ways of using the chain without guides: with shoulders pointing up, or with shoulders down on the worktop.



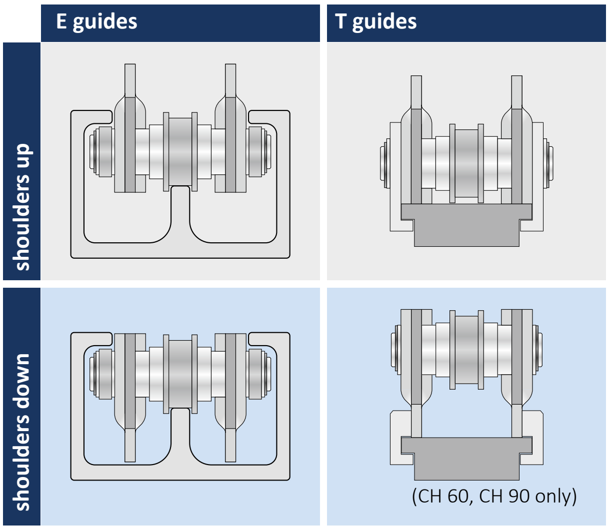
Shoulders up: The impact of the thrust force may cause the chain to bend upwards, in the coiling direction. Use above 3 m of stroke is not recommended. The chain return is stored below the transfer path.

Shoulders down: In shoulder-down orientation the chain is kept rigid by its own weight. In addition, the shoulders are supported by contact with the worktop. As a result, the chain runs stabler than with shoulders up. Use above 5 m of stroke is still not recommended. The chain return is stored above the transfer path.



Operating with guides

Guides stabilize the chain so its full capacity is available over any distance, regardless of whether it is used with shoulders up or down.

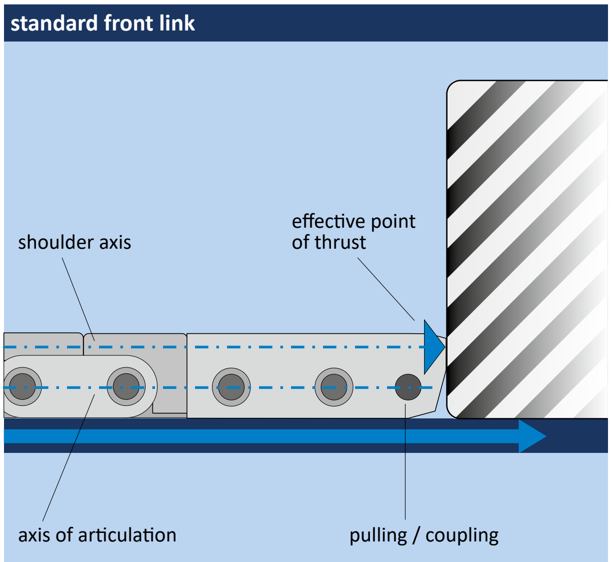


Guiding

There are two standard ways of guiding the rigid chain: inside E-profile rails or on flat T-shaped tracks. With E-guiding, additional rollers prop up the chain against the inner walls of the rail. As the chain is partially or totally sunk into the rail, the load has to run on another level, either beneath or above. With T-guiding, the chain is kept on the top surface of the rail by lateral grippers mounted on every fourth or fifth link. The T guides take up only a small space and allow the load to run on the same level as the chain. This makes them a very cost-effective solution.

Applying force

The drive pinions apply the thrust force to the presently rearmost link of the straight active chain. At the load side, the front link shifts the point of thrust from the axis of articulation to the axis of the chain shoulders. This creates a moment which locks the shoulders against each other, making the chain a rigid bar. Thus, the shoulder axis of the chain links is used for pushing, while the pulling is done on the axis of articulation.



Attaching the load

For strictly pushing operations, it is unnecessary in many cases to fix the load to the chain. Provided the load moves on a defined path, contact with the chain’s front link is enough. If the load’s course is not stable enough or the load is to be pulled as well, a coupling device will be required.

The chain’s front link has a pushing point and a coupling point. (See above.) The latter is situated on the pulling axis and can be used to install a hook that engages automatically with an interface mounted to the load. Two parallel chains can be combined by means of a pushing bar. Like a single front link, it can be equipped with automatic or semi-automatic hooks for pulling.

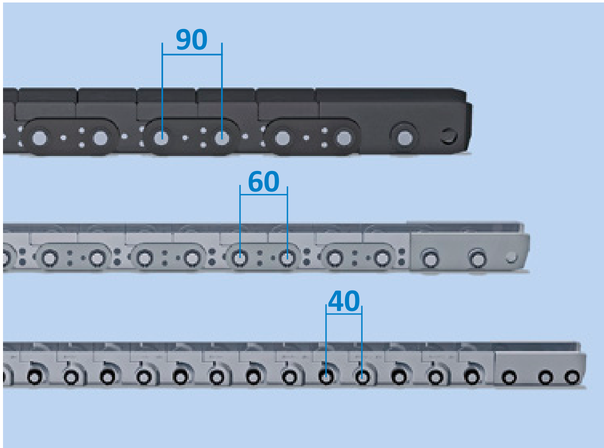
A force-shifting device is required when E-shaped guides are used, since in this case the load is conveyed at a height level different from that of the chain itself. The device shifts the point of thrust to the level of the load, compensates parallel divergences and introduces the force without momentum.

TYPOLOGY OF THE RIGID CHAIN

The range of rigid chains includes standard types from 5,000 N to 16,000 N maximum capacity (per single chain). Special versions allow for even higher forces. The individual chain types differ chiefly in size and structure. Further, some types are suitable for guiding. The corresponding features differentiating the chain types are listed below.

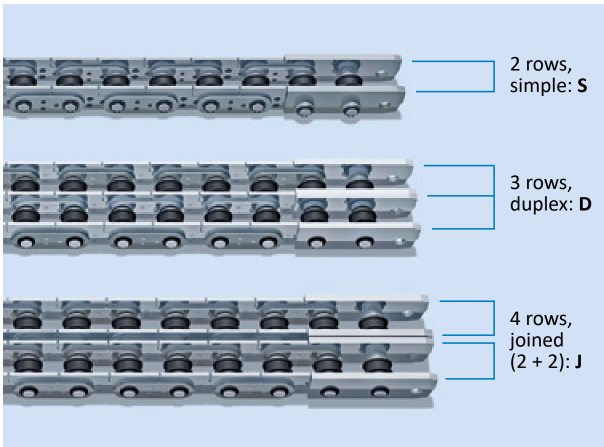
Size according to chain pitch

Size is determined by the pitch of the chain, ie the length of each link, measured between two consecutive cross axes. Standard pitches are **40, 60 or 90 mm.** These numbers appear in the type designations, eg **CH 40.**



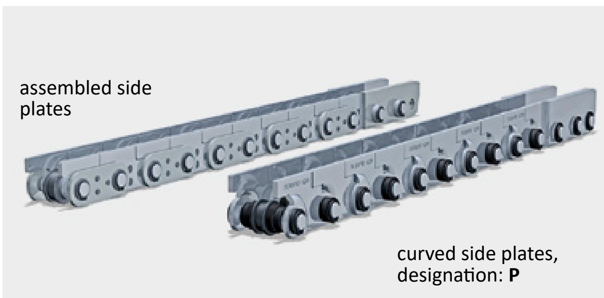
Structure, number of rows

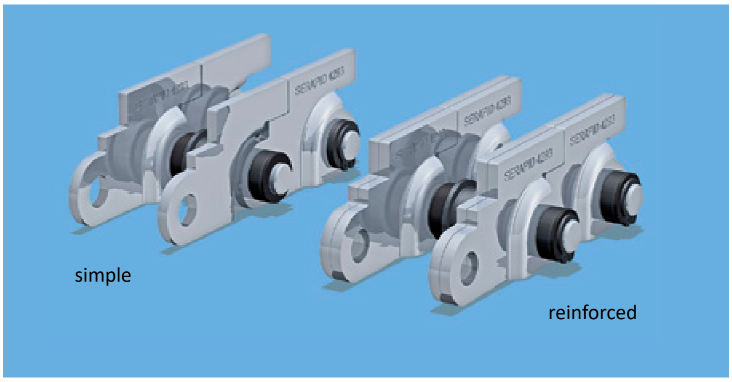
A simple chain has two rows of link plates and thus two rows of shoulders. The duplex version has three rows, the joined version has four. Designations are as follows: **S = simple, D = duplex, J = joined.**



Make of side plates

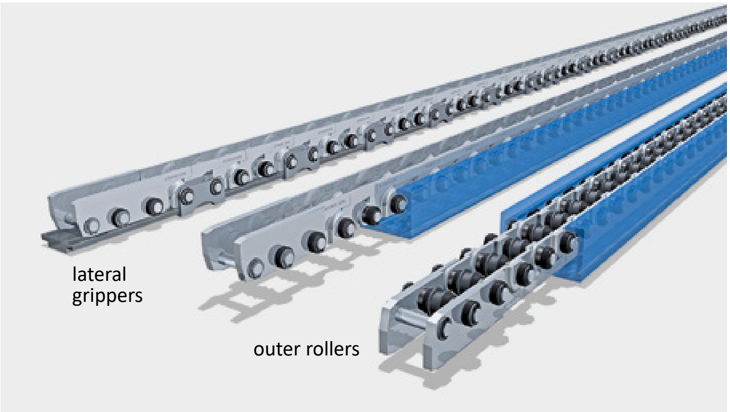
The links' shoulders are aligned exactly one behind the other while the side plates are connected by the axes. This can be achieved in one of two ways: The side plates can either be curved at one end, or they can be assembled by riveting together two component plates. Curved links are indicated with a **P.**





Reinforcement through doubled side plates

Curved links can be reinforced simply by assembling two mirroring side plates together. Reinforced links are indicated with an **R** in the chain-type designation.



Type of guiding

There are two versions of guidable chains. (See section Guiding, p 5.) The version with outer rollers (used with E-shaped guides) is indicated with a **G,** the version with lateral grippers (used with T-shaped guides) with a **C.** The G-type is also used without guiding as it allows two additional drive pinions. (See below.)

model	pitch	structure	make	reinforced	guiding
CH 40PS 2000	40	simple	curved	no	no
CH 40PSR 2000	40	simple	curved	yes	no
CH 40PSC 2000	40	simple	curved	no	grippers
CH 40PSG 2000	40	simple	curved	no	rollers
CH 60PS 2000	60	simple	curved	no	no
CH 60PSR 2000	60	simple	curved	yes	no
CH 60PSG 2000	60	simple	curved	no	rollers
CH 60S	60	simple	assembled	–	no
CH 60SC	60	simple	assembled	–	grippers
CH 60SG	60	simple	assembled	–	rollers
CH 60D	60	duplex	assembled	–	no
CH 60DC	60	duplex	assembled	–	grippers
CH 60DG	60	duplex	assembled	–	rollers
CH 60J	60	joined	assembled	–	no
CH 60JG	60	joined	assembled	–	rollers
CH 90S	90	simple	assembled	–	no
CH 90SC	90	simple	assembled	–	grippers
CH 90SG	90	simple	assembled	–	rollers
CH 90D	90	duplex	assembled	–	no
CH 90DC	90	duplex	assembled	–	grippers
CH 90DG	90	duplex	assembled	–	rollers
CH 90J	90	joined	assembled	–	no
CH 90JG	90	joined	assembled	–	rollers

The standard types of the horizontal SERAPID chain are classified in the table on the left. Types are listed in ascending order according to capacity.

Number of drive pinions

A simple chain with no outer rollers is driven by two pinions that engage to the left and right of the central rollers. Accordingly, the duplex and joined types are driven by four pinions. In addition to that, the G-types allow two more pinions, engaging with their outer rollers. With more pinions the thrust is distributed over more target points, and higher forces are possible. Thus, among types that otherwise have the same features, the G-type can transmit the highest force. The SG type allows four pinions; the DG and JG types allow the maximum of six pinions.

OPERATING RANGES OF UNGUIDED RIGID CHAINS

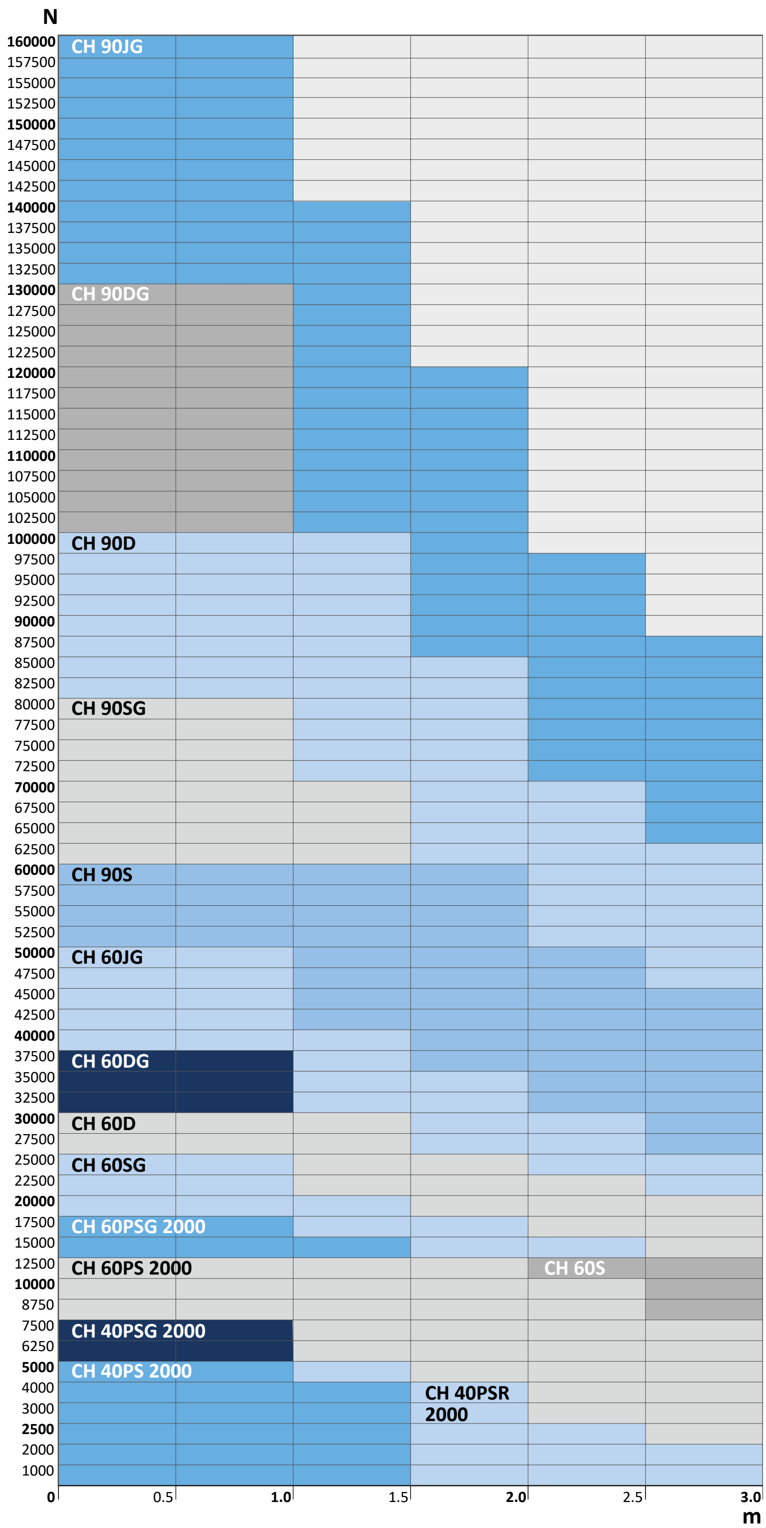
The two diagrams on the right show the recommended application ranges for each type of the standard horizontal SERAPID chain, used without guides. With shoulders up the maximum force can be used on strokes between 1 and 2 m, depending on the type of chain. With shoulder down strokes between 1.5 and 4 m are possible. The specification is subject to the following conditions:

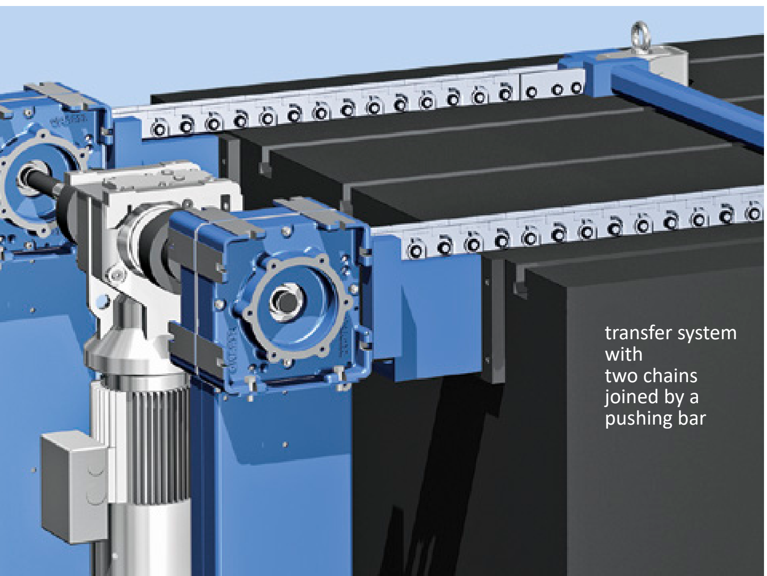
- speed: 150 mm/s
- duty: < 10 cycles / day
- no shock loads
- temperature: < 200 °C
- periodic lubrication

Guided chains can transmit the maximum force over practically any length. The C-type guided chains, with grippers, are not listed. Their capacity is equal to the corresponding unguided type – only without limitation on stroke length. Unguided chains should only be used for strokes up to 3 m with shoulders up, and up to 5 m with shoulders down.

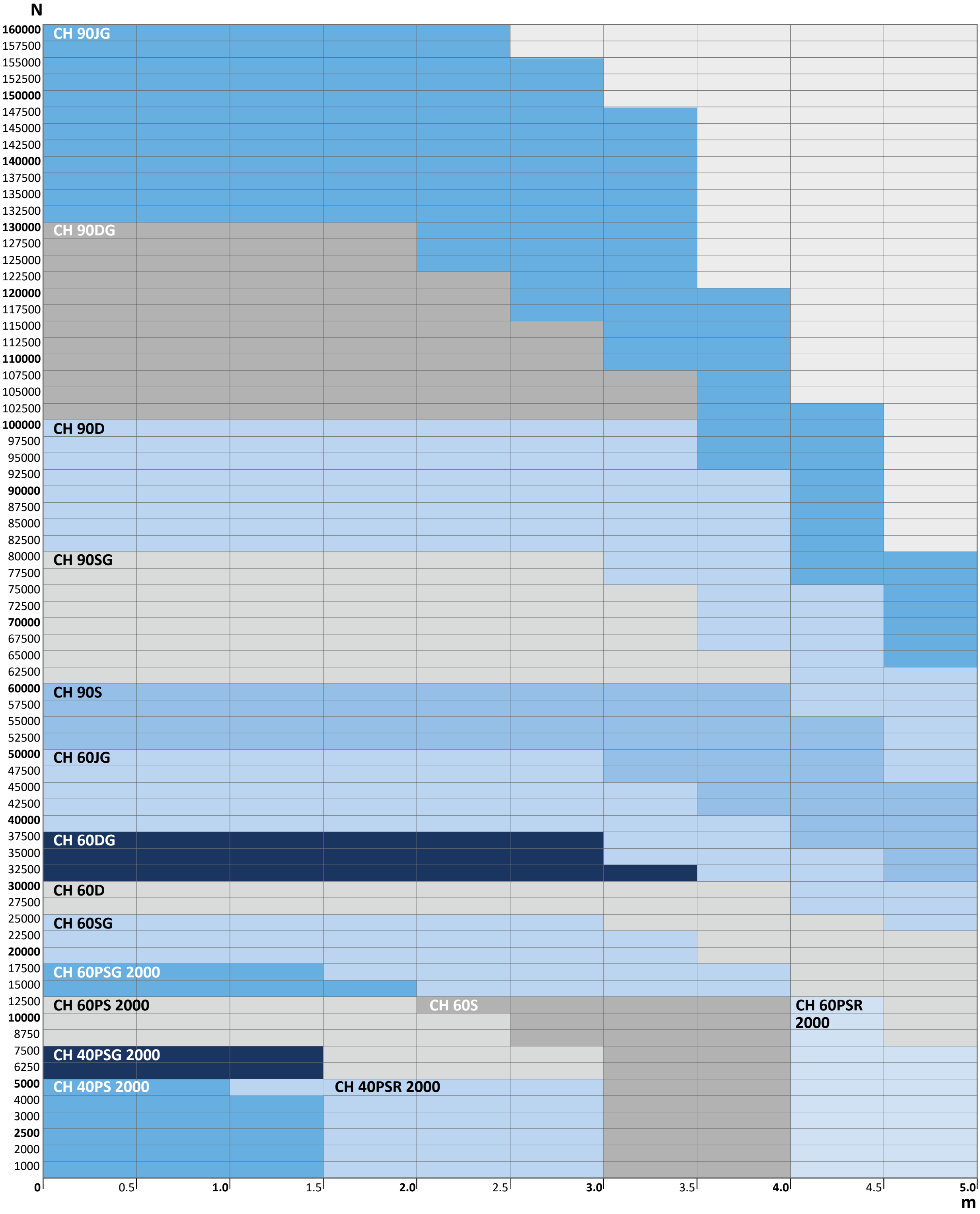
If your application does not fall within these general specifications, consult SERAPID engineering for your special solution.

shoulders up




transfer system with two chains joined by a pushing bar

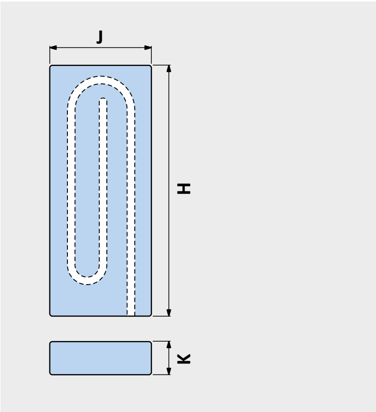
shoulders down



STORING THE RIGID CHAIN

Chain magazines

Our standard magazines cover the types CH 40 ..., CH 60S ..., CH 60D ... and CH 60J ... up to a stroke of 5 meters. For all other types and stroke lengths the magazines are made to specifications.



Magazine positions

There are four possible mounting positions for the standard magazines as shown on the right. Note that the position of the magazine determines the orientation of the chain shoulders. (See p 4.)

Storing in guide rails

Besides magazines, the E-shaped guide rails may also be used for storage, especially when individual configurations are required. Using housings with no drive shafts, 90° or 180° redirections can be realized and arranged freely. The length of the rails is also unlimited. For example, the chain return may be moved up a wall, and even across the ceiling, while the transfer path runs on the ground.

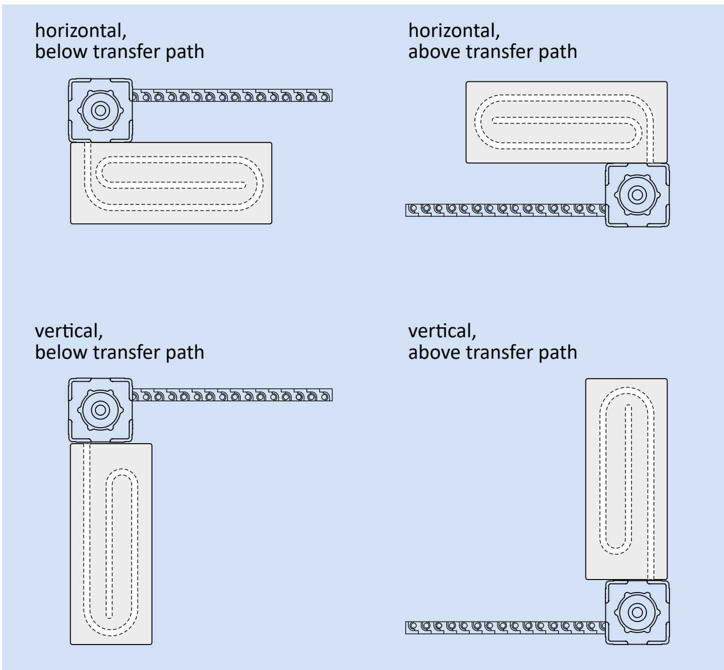
standard magazines for CH 40 chains

stroke	2 tracks		3 tracks		5 tracks		2/3/5 tr.
	H	J	H	J	H	J	K
500	400	190					85
1000	650	190					85
1500	900	190					85
2000	1150	190	800	260	535	400	85
3000			1135	260	735	400	85
4000			1470	260	935	400	85
5000			1800	260	1135	400	85

standard magazines for CH 60S, 60D and 60J chains

stroke	2 tracks		3 tracks		5 tracks		2/3/5 tracks		
	H	J	H	J	H	J	K		
							60S	60D	60J
1000	690	265					110	145	160
2000	1190	265	840				110	145	160
3000	1690	265	1175	360	840	555	110	145	160
4000	2190	265	1505	360	1040	555	110	145	160
5000	2690	265	1840	360	2205	555	110	145	160

All dimensions in mm.



CALCULATING THE THRUST FORCE

The total force (Ft) to be applied to the chain is the sum of friction force (Ff), acceleration or deceleration force (Fa) and external forces (Fe):

Ft = Ff + Fa + Fe [N]

The friction force is calculated as

Ff = W x µ [N]

where W is the load's weight force and m the friction factor, depending on surface properties, rolling or sliding devices etc. The following values account for the most frequent situations:

- steel on steel, dry: µ = 0.3
- steel on steel, lubricated: µ= 0.12
- steel on plastic (PE/HD): µ = 0.25
- gray cast iron on gray cast iron: µ = 0.3
- wood on metal: µ= 0.7
- roller wheels: µ = 0.07
- roller bars: µ = 0.025
- caterpillar-type rollers: µ = 0.07

Acceleration, deceleration and shock loads (eg through mechanical stops) have to be accounted for individually.

MOTORIZATION OF THE RIGID CHAIN

A rigid-chain system can be driven electrically, pneumatically or hydraulically. The drive shaft dimensions are found in the data sheet for each chain type.

To calculate the motor power required, the drive moment and revolutions per minute [rpm] must be known. The drive moment M is calculated on the basis of the total thrust force:

$$\mathbf{M = \frac{Ft \times 10^{-3} \times p}{0.8} \ [Nm]}$$

where Ft is the total of all forces in effect [N], p is the pitch of the chain [mm] and 0.8 is the system efficiency rate.

The number of drive revolutions, R, is calculated on the basis of required speed:

$$\mathbf{R = \frac{\vec{S}}{6 \times 10^{-3} \times p} \ [rpm]}$$

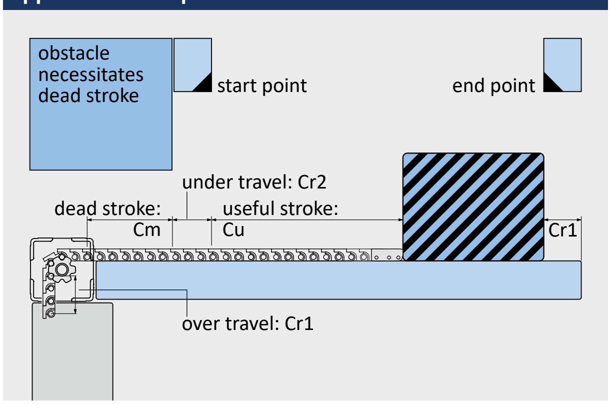
where $\vec{S}$ is the motion speed [m/min] and p is the pitch of the chain [mm]. The required output power P is obtained with the formula:

$$\mathbf{P = \frac{M \times R}{9550} \ [kW]}$$

Ft	total force [N]
Ff	friction force [N]
Fa	acceleration / deceleration force [N]
Fe	external forces [N]
W	weight force [N/m²]
µ	friction factor
M	drive moment [Nm]
p	pitch of chain [mm]
R	drive revolutions [rpm]
$\vec{S}$	transfer speed [m/min]
P	output power [kW]
L	chain length [links]
Ct	total stroke [mm]
Cu	useful stroke [mm]
Cr1	over travel [mm]
Cr2	under travel [mm]
Cm	dead stroke [mm]

CHAIN LENGTH

application example



The length of the chain (L) is normally specified by the number of links. First, the total stroke Ct (useful stroke plus dead stroke, plus over and under travel, if any) is divided by the chain pitch. Two links are subtracted for the front link. Then four links are added; these must stay on the pinions. If necessary, the result is rounded to the next higher integer.

$$\mathbf{Ct = Cm + Cr2 + Cu + Cr1 \ [mm]}$$

$$\mathbf{L = \frac{Ct}{p} - 2 + 4 \ [links]}$$

MAINTENANCE

Other than lubrication, our chains require no special maintenance. For duty cycles up to 1 per hour lubrication is required only occasionally. For up to 10 duty cycles per hour, periodic lubrication is required – once a week to once a month, depending on application. Heavy-duty applications, with high cycling rates and/or high motion speeds, require more frequent lubrication or a permanent lubrication system.

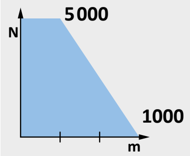
MATERIALS

Standard material for our chains is semi-hard carbon steel, suitable for ambient temperatures of up to 200 °C. For high-temperature applications, eg loading of furnaces, the chain can be made of HT steel. For corrosive environments, the chain can be made of stainless steel, or its surfaces can be coated appropriately.

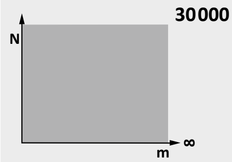
Notes on our rigid-chain data sheets

Our data sheets provide technical drawings for all chains, drive housings and guides. For every chain, a small diagram indicates the most important performance data. In these diagrams, a slanted edge on the right shows the decrease in capacity, with increasing stroke length, and thus stands for unguided use. In contrast, a straight edge shows constant capacity over the entire stroke and thus stands for guided use.

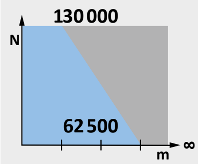
The diagram on the right is for an unguided chain. The capacity is 5000 N up to 1 m of stroke and 1000 N at 3 m with shoulders up.



This diagram is for a chain that can only be used with guides, that is, a chain with lateral grippers. There is no slant, since the chain maintains its capacity over any stroke length.



This diagram is for a chain that can be used guided and unguided, that is, a chain with outer rollers. The left portion shows performance without, the right one with guides.



SERAPID
RIGID CHAIN TECHNOLOGY

www.serapid.com

SERAPID Ltd
Elm Farm Park, Great Green, Thurston,
Bury St Edmunds | IP31 3SH England
+44 (0)1359 233335
info-uk@serapid.com

SERAPID France
ZI Louis Delaporte, Zone Bleue, Voie F
F-76370 Rouxmesnil-Bouteilles | France
+33 (0)2 32 06 35 60
info-fr@serapid.com

SERAPID Deutschland GmbH
Wilhelm-Frank-Straße 30
D-97980 Bad Mergentheim | Deutschland
+49 (0)7931 9647-0
info-de@serapid.com

SERAPID USA INC.
34100 Mound Road
Sterling Heights MI 48310 | USA
+1 586 274 0774
info-us@serapid.com

SERAPID Italy Office | +39 01 18 00 35 44 | info-it@serapid.com · SERAPID China Office | +86 185 1215 0303 | info-cn@serapid.com
SERAPID Mexico Office / LATAM | +52 1 442 4 900 701 | info-mx@serapid.com