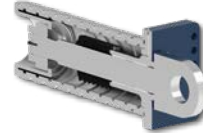


Damping Technology



Friction Springs



Industrial Buffers

EN 10.2022

Product Paper & Tech Paper





Machine Building



Aviation & Aerospace



Process Technology

Welcome

Your System Partner for Drive and Damping Technology

We say what we mean and mean what we say.

We see things from our customers' perspective.

We are considerate of our employees and their families as well as of our environment and society.

**Movement****Energy****Extraction**

RINGFEDER POWER TRANSMISSION is the international market leader in niche markets for drive and damping technology. We develop, manufacture and supply superior Shaft-Hub Connections, Damping Components, Couplings, Brake Systems and Bearing Housings for highest functionality and durability requirements in a wide range of technology sectors worldwide. Not only do we always provide our ambitious customers with competent advice based on over 100 years of experience and expertise, but also realize need-based, application-oriented solutions together with them that guarantee safe, failure-free and economic machine and plant operation – with our aspiration to be **Partner for Performance**.

Our customer promise for your specific use case:

- Excellent know-how for maximum performance and reliability
- Best cost-benefit ratio
- Short reaction times and high product availability



Quality & Expertise

One century of competence and experience

As pioneer and market leader for premium systems and components of drive and damping technology, we stand for outstanding professional competence, superior product and service quality as well as excellent customer focus. For your advantage, we consistently combine highest quality standards, continuous optimization and profound consulting – no matter how, where and when forces must be transmitted or damped.

Reliability & Trust

From the requirement to the optimum result

Whether customized special design or proven standard type, highly specific individual or holistic system solution: As a competent, professional and service-oriented partner, we support and accompany you from the initial clarification of your requirements to the successful completion of your purpose – and, of course, also beyond.



Your Projects, Our Drive

Anytime & Anywhere

Locally on-site for you worldwide

Thanks to national and international development, manufacturing and sales locations as well as a worldwide service and partner network, we are at your side around the globe directly and locally with qualified technical support and fast product availability – around the clock, seven days a week, of course also and particularly in urgent maintenance and repair cases.

Digital & Online

Always find the right information instantly

Discover the latest company and product information, download CAD models, brochures and data sheets, use our calculation and selection program for shaft-hub connections, arrange a video consultation appointment with one of our specialists and much more – quickly, easily, with no obligation and at any time. Convince yourself on our website at www.ringfeder.com.

RINGFEDER®

Damping Technology

Protecting People, Securing Structures

Slowing down moving masses in a quick, safe and precise manner: **RINGFEDER® Friction Springs and Industrial Buffers** are indispensable, maintenance-free safety components in all technology and industry sectors where suddenly occurring forces have to be taken up and kinetic energies must be absorbed, or when damping systems are required for enormous forces at relatively small dimensions – whether as customized special design or proven, readily available standard version.

As the pioneer of Friction Spring technology, RINGFEDER POWER TRANSMISSION has been the expert for more than 100 years for highly reliable premium products of damping technology, which – depending on requirement and application – absorb energies, act as overload protection and compensate for movements.

Friction Springs

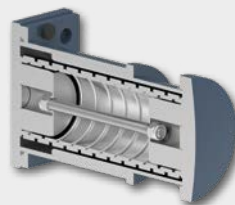
Complete spring columns consisting of precisely machined inner and outer rings



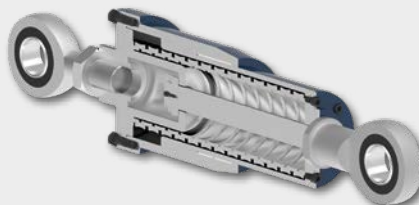
Industrial Buffers

Friction Springs as application-specific buffer versions

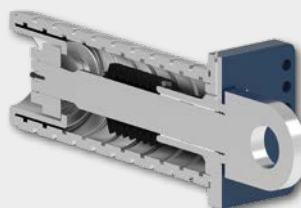
Buffer



Push-Pull Unit



Draw Gear



Overload Clutch



From a height of up to ten meters, very large, heavy pieces of steel scrap fall into this melting furnace in a steel plant. Thanks to the use of numerous draw gears based on RINGFEDER® Friction Springs, each with an absorption capacity of tens of thousands of joules, the resulting drop energy is effectively absorbed and the overall structure is thus safely protected against damage – and this without wear and maintenance during continuous furnace operation at temperatures of several thousand degrees Celsius.



RINGFEDER®

Friction Springs

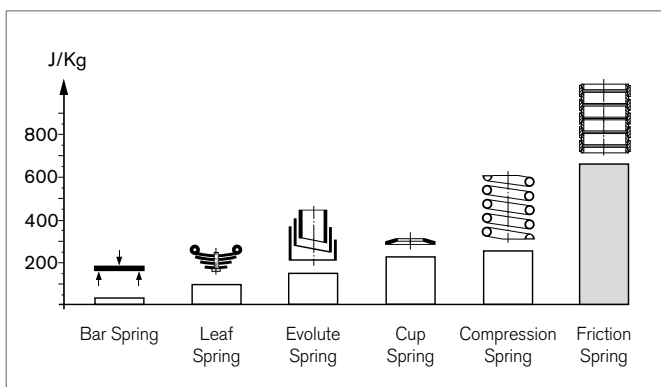
One Technology, Numerous Advantages

Compared to conventional damping solutions, RINGFEDER® Friction Springs have a variety of superior advantages:

- High spring work at low weight and volume
- High damping capability
- Spring work and damping effect independent from load speed
- Overload-safe in block position
- Maintenance-free and temperature-independent
- Parallel and serial arrangement of springs
- Individual designs for specific use cases

High spring work at low weight and volume

Since RINGFEDER® Friction Springs make full use of the spring material, dimensions and weight are reduced to a minimum. The decisive factor here is the spring work.



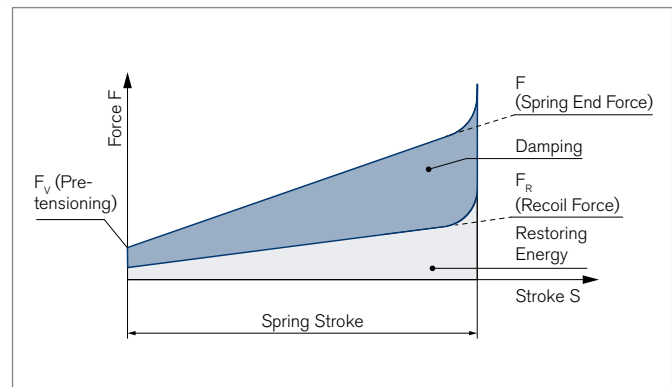
Weight utilization η of various springs

Disclaimer of liability

All technical details and notes are non-binding and cannot be used as a basis for legal claims. The user is obligated to determine whether the represented products meet his requirements. We reserve the right carry out modifications at any time in the interests of technical progress.

High damping capability

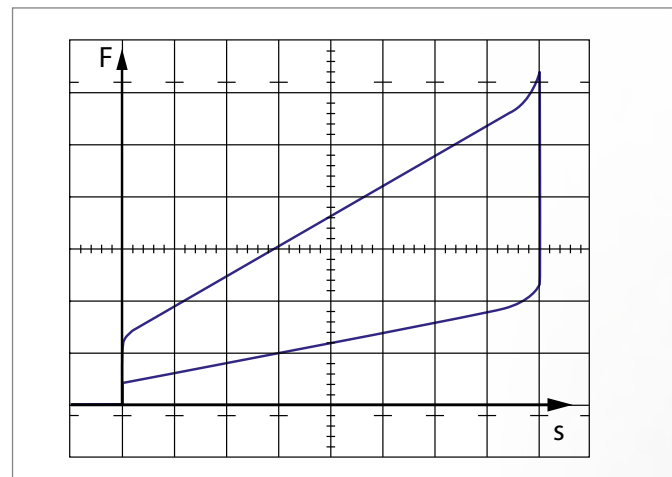
The damping of the RINGFEDER® Friction Springs is 66% as standard, which means that the energy introduced is quickly absorbed and resonance effects are completely suppressed. Variations in damping between 33% and 66% are possible by using other lubricants specific to the customer and application.



Damping and spring work

Spring work and damping effect independent from load speed

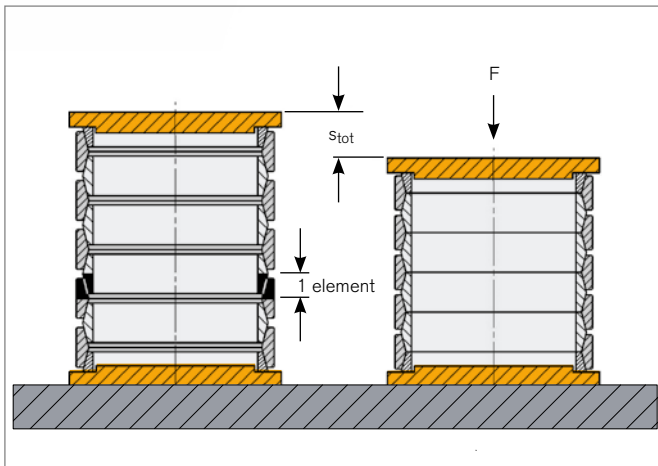
The force-stroke diagram of the RINGFEDER® Friction Spring applies for all operating conditions. In contrast to other damping systems, RINGFEDER® Friction Springs provide full spring work and damping effects even, when the load is applied extremely slowly or quickly.



Dynamic force-stroke diagram of a pretensioned RINGFEDER® Friction Spring

Overload-safe in block position

RINGFEDER® Friction Springs are generally designed to “block”, so it is therefore ensured that the admissible stresses cannot be exceeded and the RINGFEDER® Friction Springs will not be damaged.



Overload protection

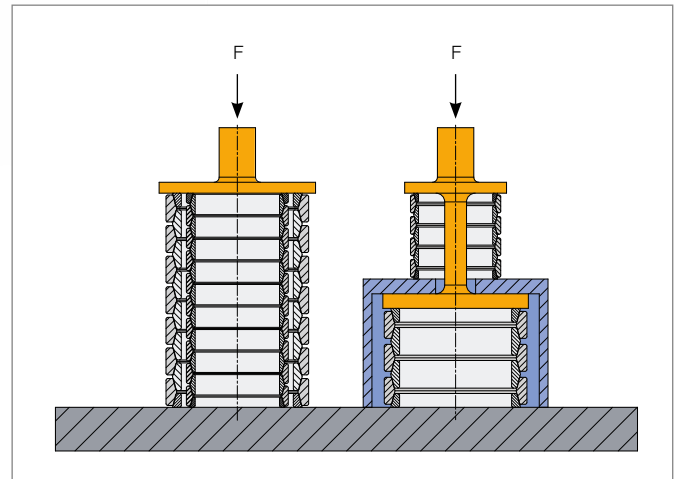
Maintenance-free and temperature-independent

With hydraulic dampers and springs made of synthetic material, the force-stroke diagram will be influenced by temperature fluctuations and inherent temperature rises. The characteristic curve of the RINGFEDER® Friction Spring, however, remain independent of these factors and can be used in the temperature range of -20 °C to +60 °C without the curve changing appreciably, as the inherent temperature rises of the spring due to the dampening effect have been taken into account. Please contact us for applications outside the named temperature range because changes will need to be made to the lubricants (-73 °C to +200 °C possible).

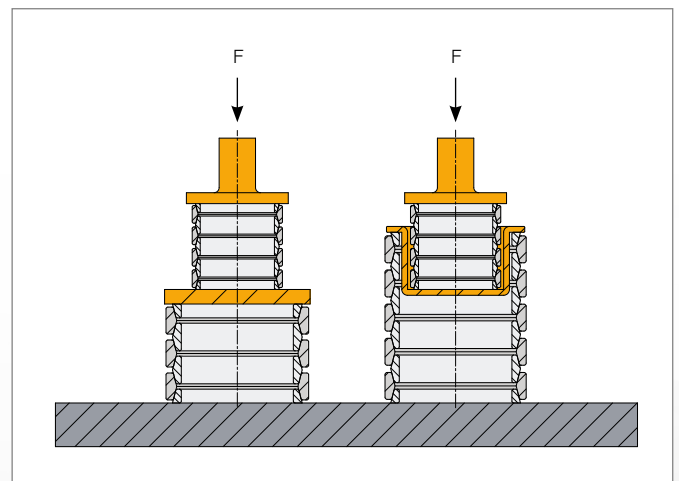
Basically, relubrication of the operating Friction Spring is **not required**. Use of other lubricants may even lead to spring failure.

Parallel and serial arrangement of springs

The geometry of the RINGFEDER® Friction Springs allows an optimum utilisation of the available mounting space due to a nested construction, using parallel and series spring arrangements.



Parallel arrangement for higher forces

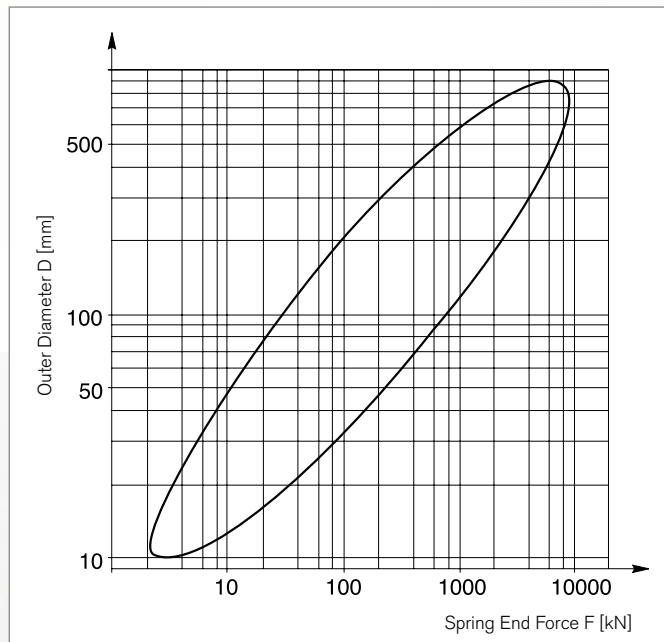


Serial arrangement for more spring travel

Structure of a Friction Spring

Individual designs for specific use cases

On top of the RINGFEDER® Friction Spring standard range (see table on page 13), we can offer customized solutions based on your specific requirements. The graph below shows the ratio of outer diameter to spring end force, which can be used to quickly see if an application is possible even though a standard spring is not available. The geometry of the RINGFEDER® Friction Spring allows an optimum utilisation of the available mounting space due to a nested construction, using parallel or serial spring arrangements.



Ratio of outer diameter to spring end force

A RINGFEDER® Friction Spring comprising **e** elements generally concludes with semi-rings. Its unclamped length L_0 is then (the values h_e , s_e , W_e that are necessary for the calculation can be found in the table on page 13):

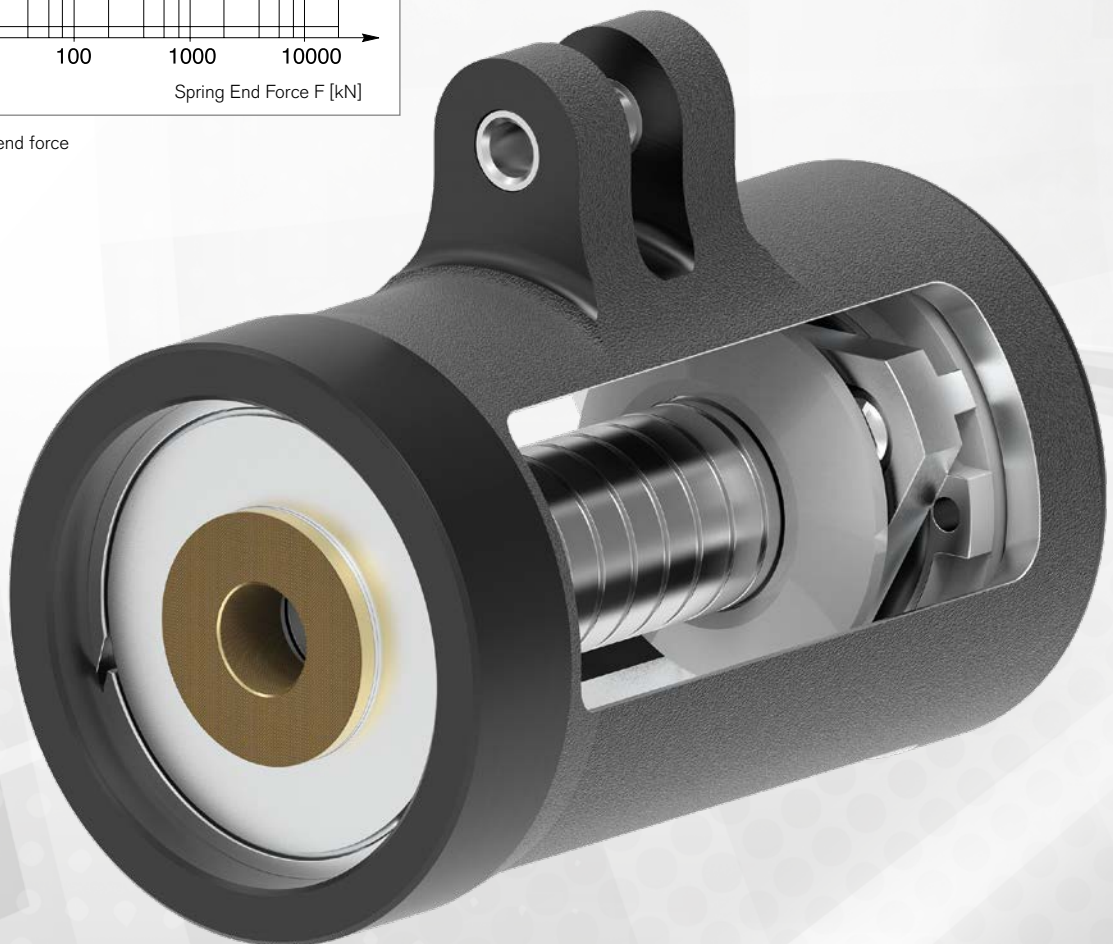
$$L_0 = e \cdot h_e$$

The total spring stroke can be calculated according to the equal:

$$s = e \cdot s_e$$

When eliminating the pretensioning force the spring work is given by:

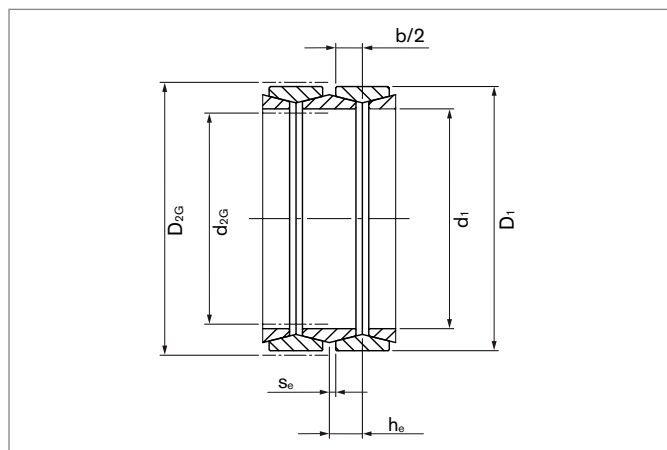
$$W = e \cdot W_e$$



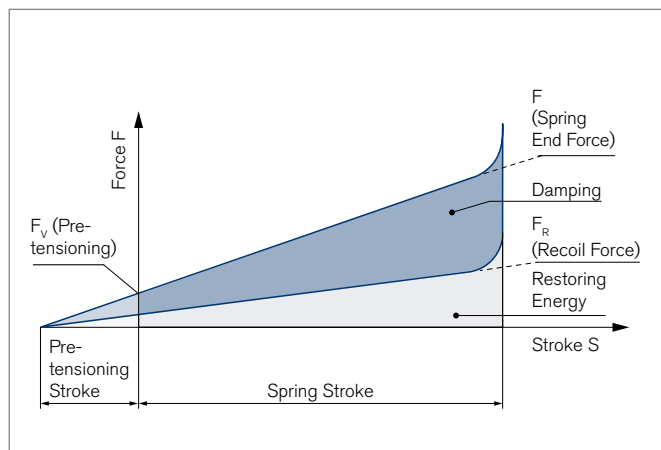
Thanks to their extremely low weight, highly compact design and resistance to very high and very low temperatures, RINGFEDER® Friction Springs are ideally suited for use in the aviation and aerospace industry. For example, they are applied in emergency exit doors of passenger aircrafts in the form of specially developed overload clutches with minimal dimensions, which ensure fast and safe opening of the exit doors in case of an emergency.



Selection and Installation Notes



Dimensions RINGFEDER® Friction Springs



Force-stroke diagram for one element

Pretensioning

RINGFEDER® Friction Springs have to be pretensioned with a minimum of 5%, preferably 10% of the total spring stroke. In order not to impair the lubricant film, the pretensioning force should not exceed 50%. Exceptions are possible after consultation.

Guiding

For RINGFEDER® Friction Springs, some form of guiding guide must be provided, either on the inner diameter (d_{2G}) or on the outer diameter (D_{2G}). Exceptions apply for short springs with a length $\leq 1,5 D_1$, in this case they need to be loaded between parallel thrust plates.

Lubrication

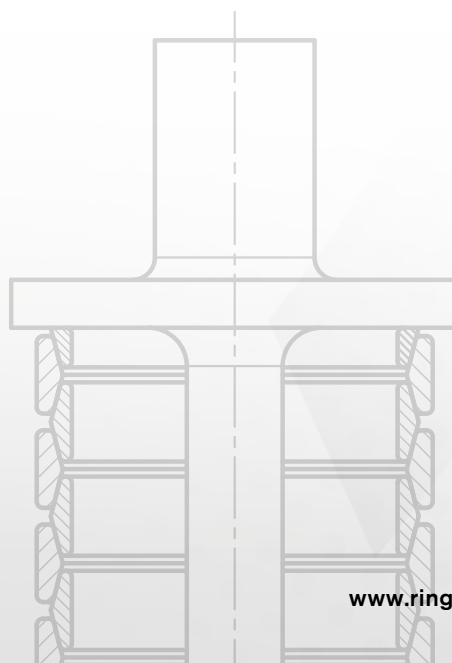
Only the special greases recommended by RINGFEDER® must be used for lubrication purposes, this is because the cone surfaces are under a high contact pressure. Generally, the grease provided with the spring is sufficient. Re-greasing is not required.

Observe the diagram

With Friction Springs the available spring work in J, i.e. the area under the loading-curve (upper curve), is of interest. If the spring is to be used as a tension device, the recoil curve has to be taken into account (lower curve). Of course, the lower curve can be increased by using a friction-reducing lubricant. For this, please let us have your specifications.

Sealing

RINGFEDER® Friction Springs must be installed protected from dirt and moisture in order not to compromise the lubricant film. Simple plain bearing guides are sufficient. Folding bellows are recommended in cases of heavy soiling and/or dampness development.



Force-stroke diagram

During the operation of the Friction Spring, two thirds of the input energy is dissipated as frictional heat. The recoil force F_R at any point on the diagram is approximately equal to one third of the relative

compressive force F . The capacity of the spring is represented by the total area shown below the load curve. The total energy absorption can be calculated by W_e multiplied by the number of elements.

Type	Type old	Diagram				Dimensions			Guiding		Gw_e
		F	s_e	W_e	h_e	D_1	d_1	$b/2$	D_{2G}	d_{2G}	
		kN	mm	Joule	mm	mm	mm	mm	mm	mm	kg
01800	1201	5	0,4	1,0	2,2	18,1	14,4	1,8	18,7	13,9	0,002
02500	1202	9	0,6	2,7	3,1	25,0	20,8	2,5	25,9	20,1	0,004
03200	1203	14	0,8	5,6	4,0	32,0	27,0	3,2	33,1	26,1	0,007
03800	1204	20	0,9	9,0	4,7	38,0	31,7	3,8	39,3	30,6	0,012
04200	1205	26	1,0	13,0	5,2	42,2	34,6	4,2	43,6	33,4	0,018
04800	1206	34	1,1	18,7	5,9	48,2	39,4	4,8	49,8	38,1	0,026
05500	1207	40	1,3	26,0	6,8	55,0	46,0	5,5	56,7	44,5	0,035
06300	1208	54	1,4	37,8	7,7	63,0	51,9	6,3	64,9	50,3	0,056
07000	1209	65	1,6	52,0	8,6	70,0	58,2	7,0	72,1	56,4	0,074
08000	1310	83	1,8	75,0	9,8	80,0	67,0	8,0	83,0	64,0	0,105
09000	1311	100	2,0	100,0	11,0	90,0	75,5	9,0	93,0	73,0	0,145
10000	1312	125	2,2	138,0	12,2	100,0	84,0	10,0	103,0	81,0	0,203
12400	1314	200	2,6	260,0	15,0	124,0	102,0	12,4	128,0	98,0	0,408
13000	1313	160	2,6	208,0	15,0	130,0	111,5	12,4	134,0	108,0	0,376
14000	1315	250	3,0	375,0	17,0	140,0	116,0	14,0	144,0	112,0	0,568
16600 *	1316	350	3,7	648,0	20,0	166,0	134,0	16,0	170,0	130,0	0,869
19600	1318	600	4,4	1320,0	23,4	194,0	155,0	19,0	199,0	150,0	1,676
20000	1317	510	3,9	995,0	22,4	198,0	162,0	18,5	203,0	157,0	1,570
22000	1319	720	4,4	1584,0	26,4	220,0	174,0	22,0	225,0	169,0	2,573
26200	1320	860	4,8	2064,0	25,8	262,0	208,0	21,0	268,0	202,0	3,415
30000	1221	1000	5,8	2900,0	35,8	300,0	250,0	30,0	306,0	245,0	5,510
32000	1222	1200	6,2	3720,0	38,2	320,0	263,0	32,0	326,0	258,0	7,060
35000	1223	1400	6,6	4620,0	41,6	350,0	288,0	35,0	356,0	283,0	9,180
40000	1224	1800	7,6	6840,0	47,6	400,0	330,0	40,0	407,0	324,0	13,560

* For type 1316 a separate stroke limitation has to be provided

Explanations to table

F = Spring end force

s_e = Spring stroke for one element

W_e = Energy absorption of one element

h_e = Length of one element

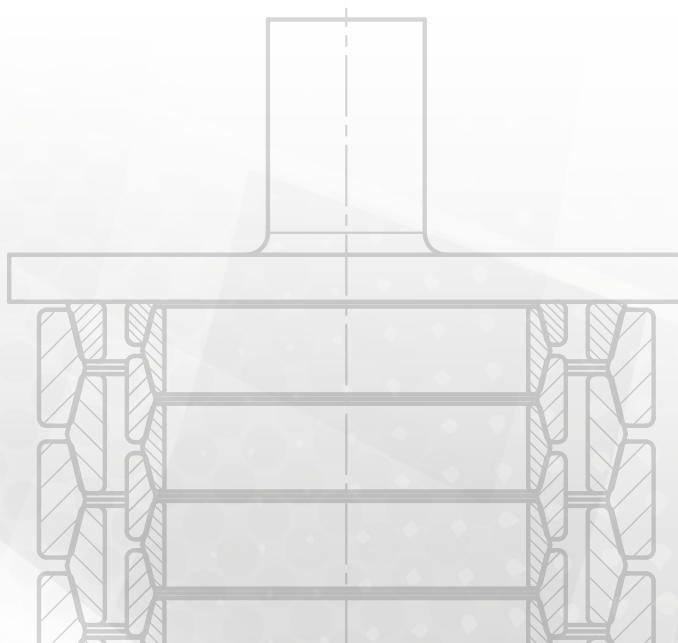
D_1, d_1 = Outer and inner diameter

$b/2$ = Half length of the ring

D_{2G} = Outer guiding diameter

d_{2G} = Inner guiding diameter

Gw_e = Weight of one element



Application Example

Figures 1 and 2 show a RINGFEDER® Friction Spring of type 20000, which consists of 8 outer rings, 7 inner rings and 2 half inner rings. It is pretensioned with 200 kN to a length of 334 mm. With these values it has a maximum stroke of 38 mm and a capacity

of 13400 Joule. The requirement is to absorb a maximum energy of 6000 Joule.

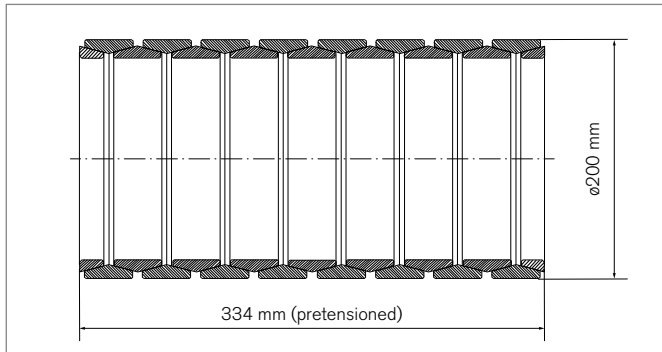


Figure 1

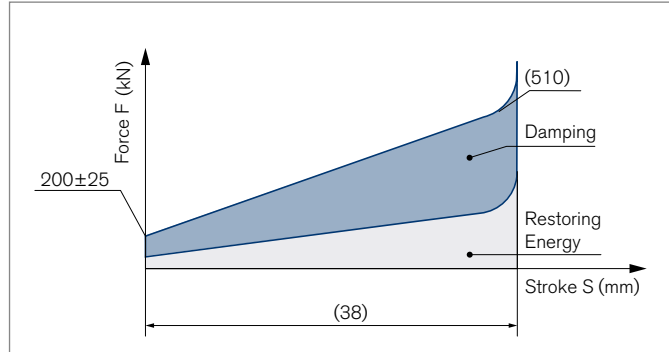


Figure 2

Diagram 1: When the RINGFEDER® Friction Spring receives an impact force, it compresses by 21 mm and absorbs 6000 Joule (=66%) from which 4000 Joule are converted to heat. After the compression, the RINGFEDER® Friction Spring discharges back by the same 21 mm due to a reaction force and there are 2000 Joule which has to be absorbed.

Diagram 2: The impacting body strikes again on the RINGFEDER® Friction Spring with the remaining 2000 Joule and compress it by 8,5 mm. After the compression, the buffer springs back by the same 8,5 mm due to the reaction force. Based on the fact that the friction not only occurs between the rings of the friction spring but in the whole system, the complete 6000 Joule are now absorbed and the system comes to rest.

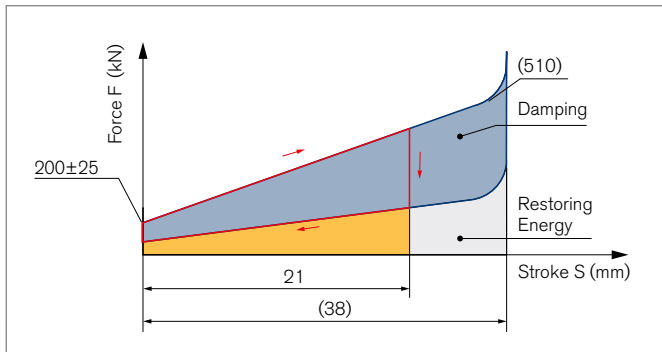


Diagram 1

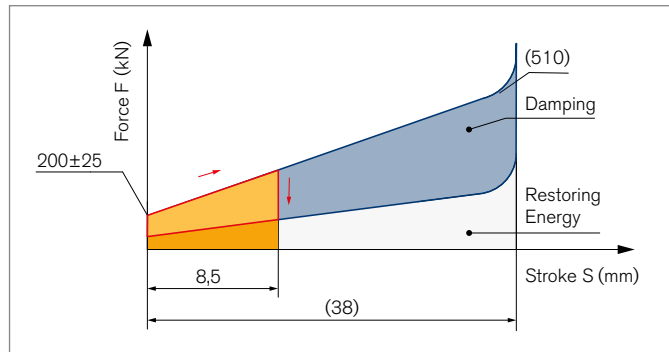
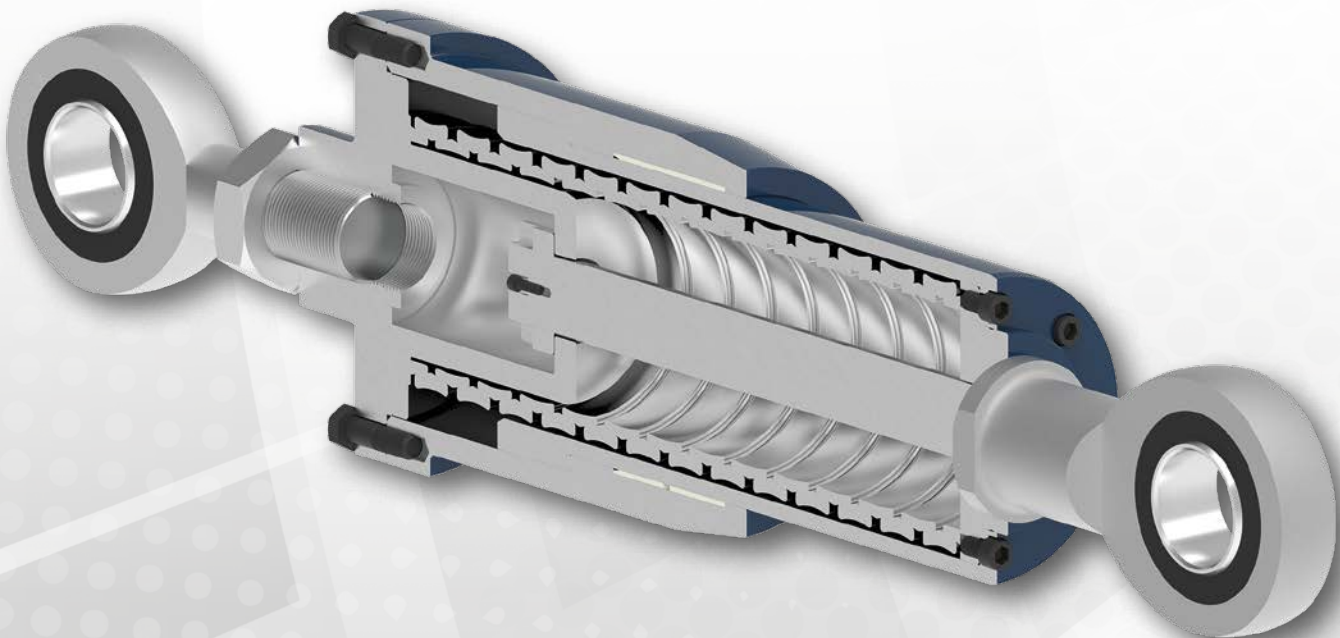


Diagram 2

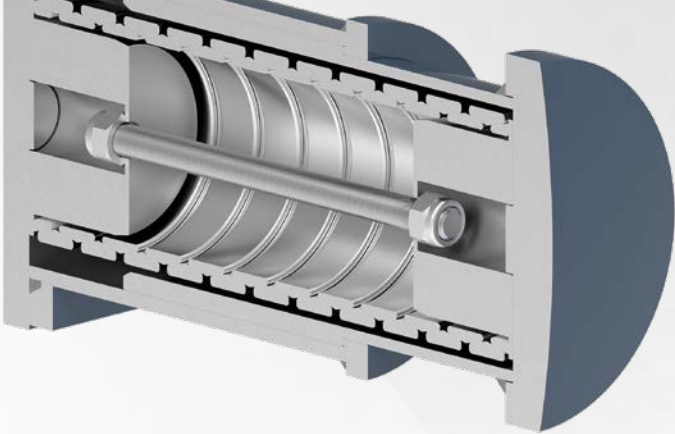


Tall, slender structures in exposed locations, e.g. the television and radio antenna system on the Brocken mountain in Saxony-Anhalt, Germany, are subject to strong lateral oscillations induced by prevailing winds, threatening the existence of the entire building. RINGFEDER® Friction Springs in the form of special push-pull units effectively compensate movements of this kind and thus act as powerful vibration dampers or absorbers, providing highly reliable protection for chimneys, skyscrapers, antennas, etc.



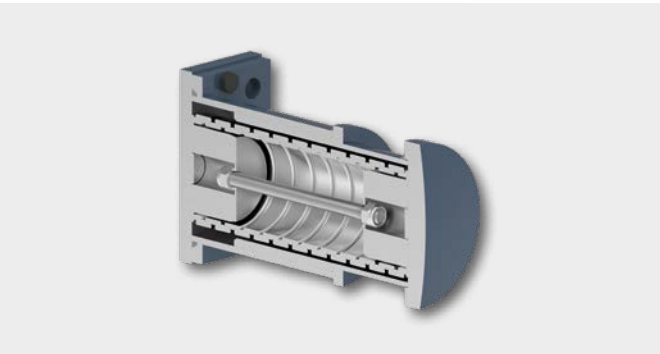
RINGFEDER®

Industrial Buffers



In addition to sole spring columns, RINGFEDER® Friction Springs are also available as complete, application- and customer-specific buffer versions in various shapes and sizes for diverse use cases, e.g. in mechanical engineering, in raw material extraction and processing, or in the aviation and aerospace industry. A selection of common buffer types can be obtained from the table on page 17.

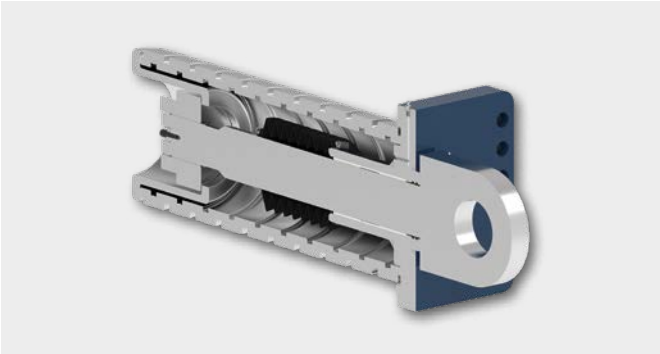
Common designs include push-pull units as highly effective vibration dampers or absorbers, and slipping clutches for reliable protection against overloads.



Buffer



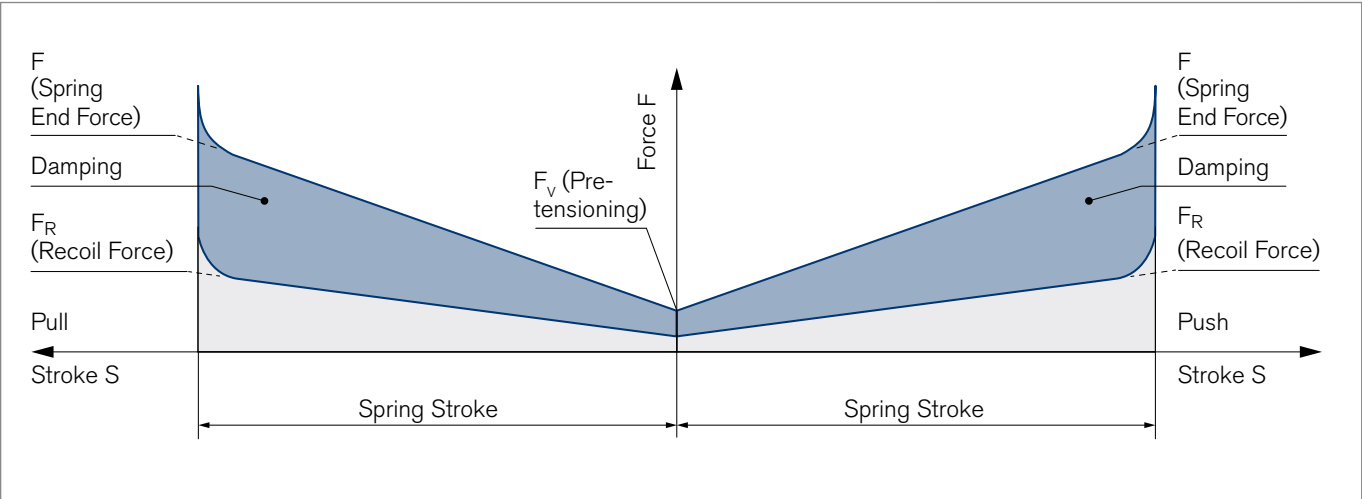
Push-Pull Unit



Draw Gear



Overload Clutch



Force-stroke diagram for a push-pull unit

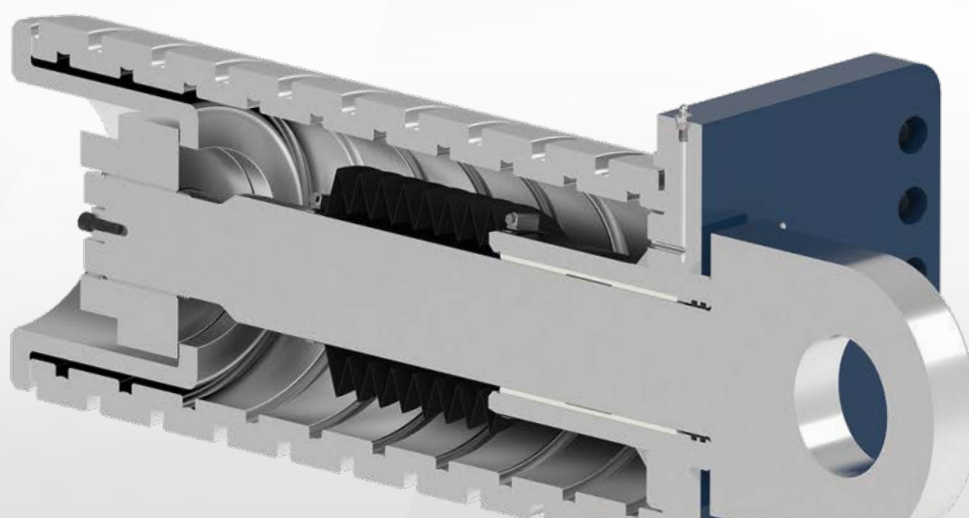
Size	Type	Diagram				Buffer Dimensions									Gw	Fitting			
		F _V	F	s	W	L	I _S	D	D _B	D _C	D _P	F _K	L _N	b		d _b	D _E	t	
		kN		mm	J	mm									kg	mm			
1	06300	6	54	27	820	202	107	112	150	102	80	27	145	10	100	18	104	15	
2				37	1100	262	156							12					
3				55	1640	374	225							17					
4				64	1900	434	293							19					
5				74	2200	494	293							20					
6	08000	7	83	33	1500	230	125	122	200	114	96	27	160	13	110	18	117	15	
7				46	2050	306	170							16					
8				66	2950	428	258							23					
9				79	3550	505	355							26					
10				92	4150	582	360							28					
11	10000	10	125	45	3000	300	165	142	250	133	114	31	185	22	130	23	135	20	
12				61	4100	397	230							26					
13				89	6000	571	350							37					
14				105	7050	667	470							42					
15				121	8150	763	470							45					
16	12400	20	200	51	5600	366	216	178	250	165	142	34	215	39	155	23	167	20	
17				65	7150	454	275							45					
18				102	11200	696	456							64					
19				116	12800	784	574							75					
20				130	14300	872	550							78					
21	16600	10	350	75	13900	500	328	235	370	219	184	46	270	85	200	27	222	25	
22				95	17500	630	450							105					
23				140	25900	880	657							145					
24				165	30500	1040	690							160					
25				190	35000	1200	850							165					
27	19600	20	600	105	32000	620	-	-	-	-	-	-	153	-	26	-	-		

Explanations to table

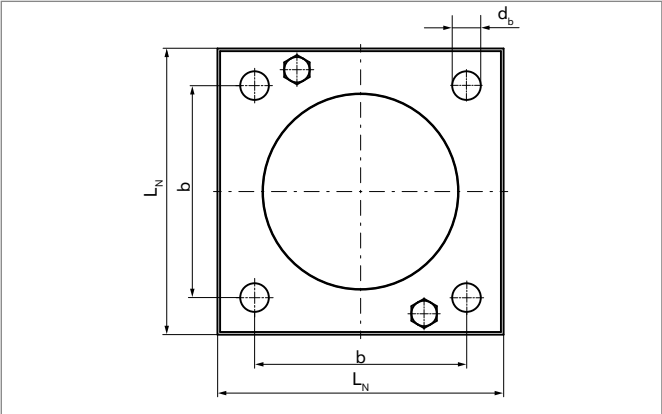
F_V = Pretensioning force
F = Spring end force
s = Spring stroke
W = Spring work
L = Total length
l_S = Submerged length

D = Outer diameter
D_B = Flapper diameter
D_C = Case diameter
D_P = Plunger diameter
F_K = Flange thickness
L_N = Flange width

Gw = Weight
b = Distance between flange bore
d_b = Diameter of through holes
D_E = Guiding diameter
t = Wall thickness

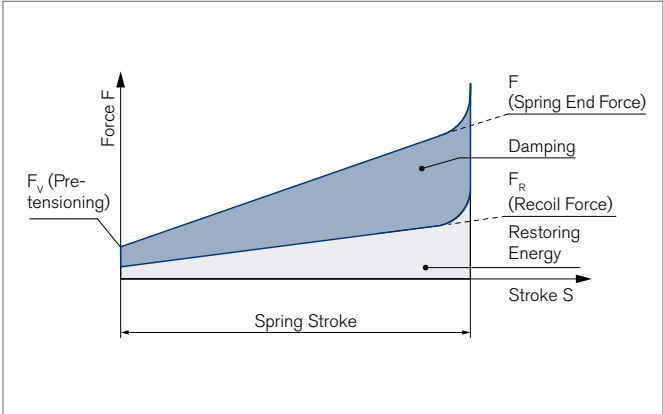


Buffers with RINGFEDER® Friction Springs



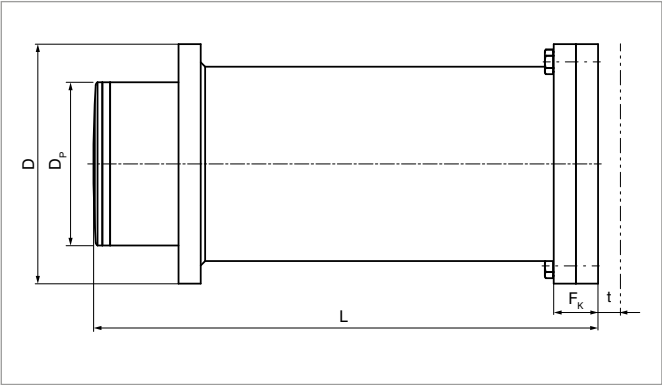
Typical hole pattern

The buffer types shown in extracts on the previous page are standard delivered in one of the following 4 designs. These buffers are suitable for operation temperatures from -20 °C to +60 °C. Above that, modifications allow an extended temperature range from

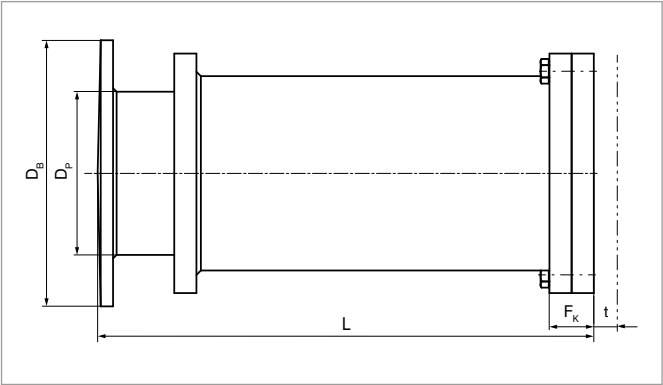


Typical friction spring diagram

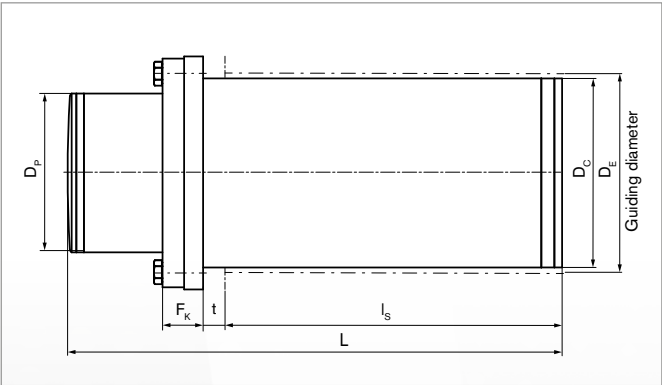
-73 °C to +200 °C. Customized requirements with respect to geometrical and technical special solutions on request.



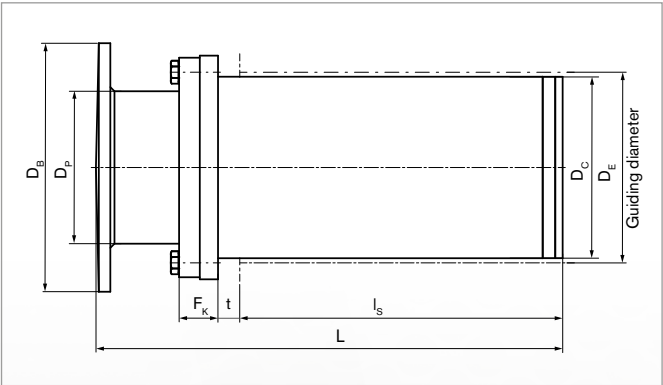
Buffer without flapper and with end flange



Buffer with flapper and end flange

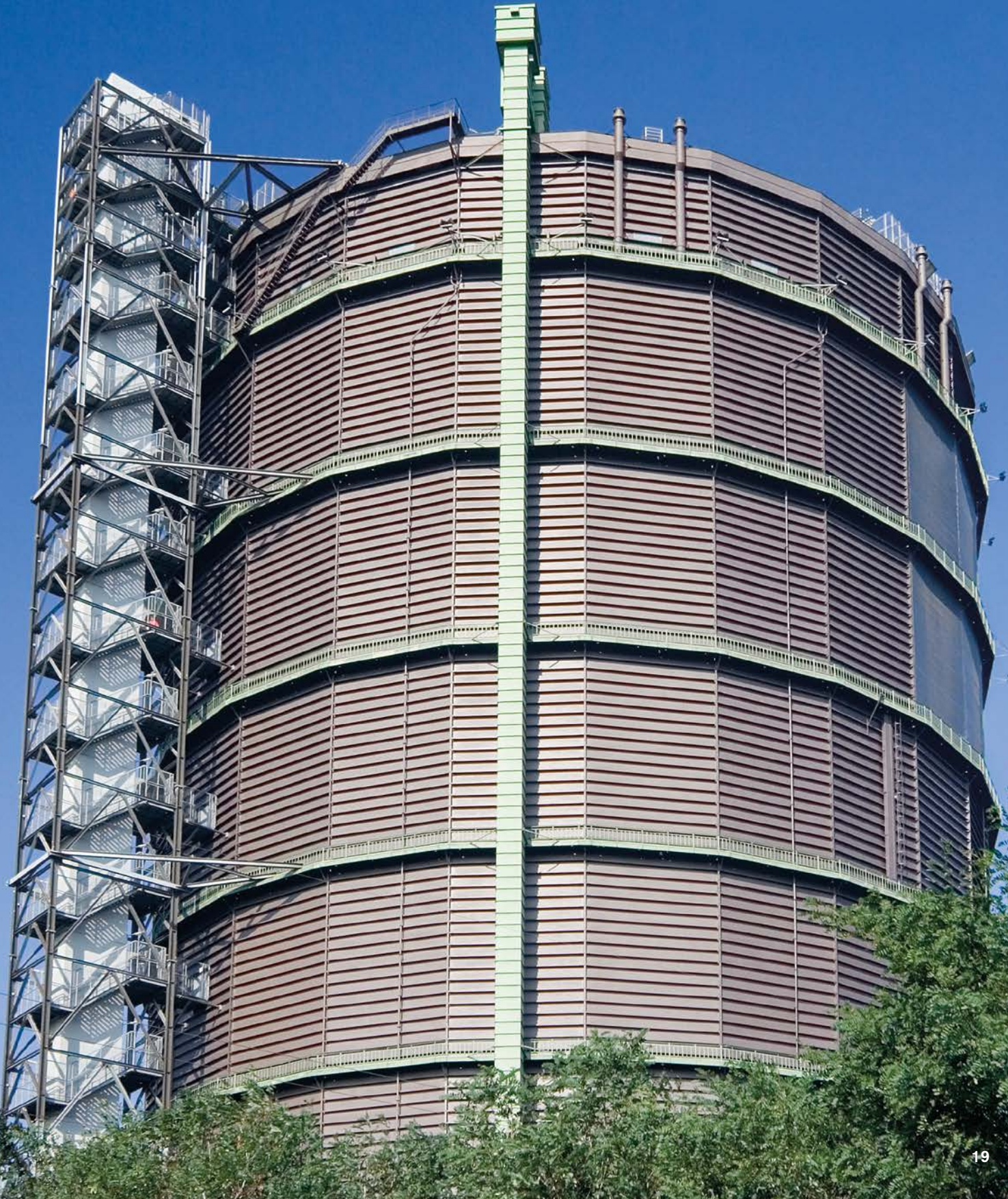


Buffer without flapper and with central flange



Buffer with flapper and central flange

Friction Spring technology is also predestined for use in case of large masses and low load speeds: In gasometers, used for storing and stockpiling high volumes of all kinds of gases, maintenance-free industrial buffers with RINGFEDER® Friction Springs reliably equalize movements of the outer casing caused by pressure variations and thus prevent damages, e.g. due to cracks, with potentially catastrophic consequences.



RINGFEDER®

Earthquake Protection

Friction Springs will increasingly be a part of future constructions for the protection of residential buildings as well as installations for electricity transmission, e.g. high voltage switches or so called Wall Bushings. Not all damage that a significant earthquake will cause can be avoided, but with RINGFEDER® Friction Springs there is a high probability that a building will sustain an earthquake, such as those that occurred in Christchurch in 2010 and 2011, and still be

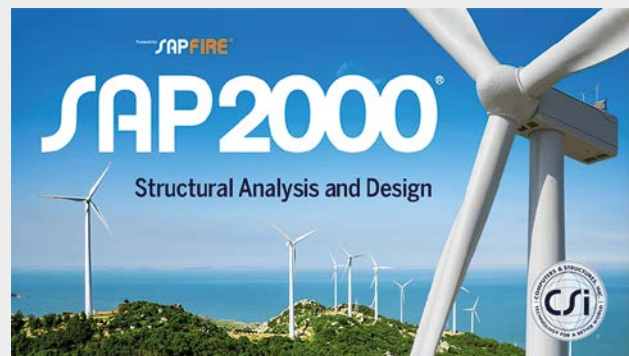
habitable. There are already buildings in New Zealand equipped with RINGFEDER® Friction Springs that have been tested in practice. For example, the Te Puni Village student residence was already completed when an earthquake occurred on July 21, 2013 with an intensity of 6.5 on the Moment Magnitude Scale and aftershocks with a magnitude of 5.8. The building withstood the quakes without major damage.

Advantages

- 1. Longevity** – RINGFEDER® Friction Springs are designed to last through many cycles and remain reusable. If one of the rings in a RINGFEDER® Friction Spring breaks, it will lose some spring travel and the stiffness will increase slightly, but it will continue to work. The end force and damping capability are unaffected. For comparison, if a coil spring or a disc spring breaks, this means a total loss of function and there is no longer any protection.
- 2. Damping** – With our RINGFEDER® Standard Grease F-S1, 2/3 of the induced energy is consumed. If less damping is required, a customized solution can be used to achieve reduced damping of up to approx. 1/3 of the injected energy. This is a simple solution to purposefully modify the characteristics of the Friction Spring. In certain seismic applications, a higher force is required to release the spring in order to move the structure back to its vertical position.
- 3. Fire and High Temperature** – Friction Springs are made of special spring steel and are covered with grease. In the event of a fire, rubber products will be destroyed, but Friction Springs will withstand the fire and the accompanying temperatures. They only need to be re-greased.
- 4. Recoil Force** – Thanks to the always application-specific design of the Friction Spring, the optimum recoil force is achieved for a particular use case. This can be realized, for example, by using a different grease, increasing the outer diameter or changing the taper angle. With conventional springs, this possibility does not exist.
- 5. Reusability** – Friction Springs can be reused after a seismic event. They are designed to withstand many load cycles while maintaining their beneficial functionality and performance. Friction Springs are wear- and maintenance-free.
- 6. Speed** – Friction Springs react faster to applied forces than all other spring types.
- 7. Installation Space** – For a given diameter, Friction Springs provide the largest spring forces in comparison to other spring types.


Software Integration of RINGFEDER® Friction Springs

Friction Springs are an integral part of the SAP2000® Software for Structural Analysis and Design of buildings, developed and distributed by „Computers and Structures, Inc.“. Founded in 1975, the California-based company develops software for structural analysis of buildings of various shapes, sizes and functions. The ETABS® software was used, for example, for the mathematical modeling of the currently tallest building in the world, the Burj Khalifa in Dubai, in order to simulate and analyze influencing factors such as gravity, wind and earthquake events.



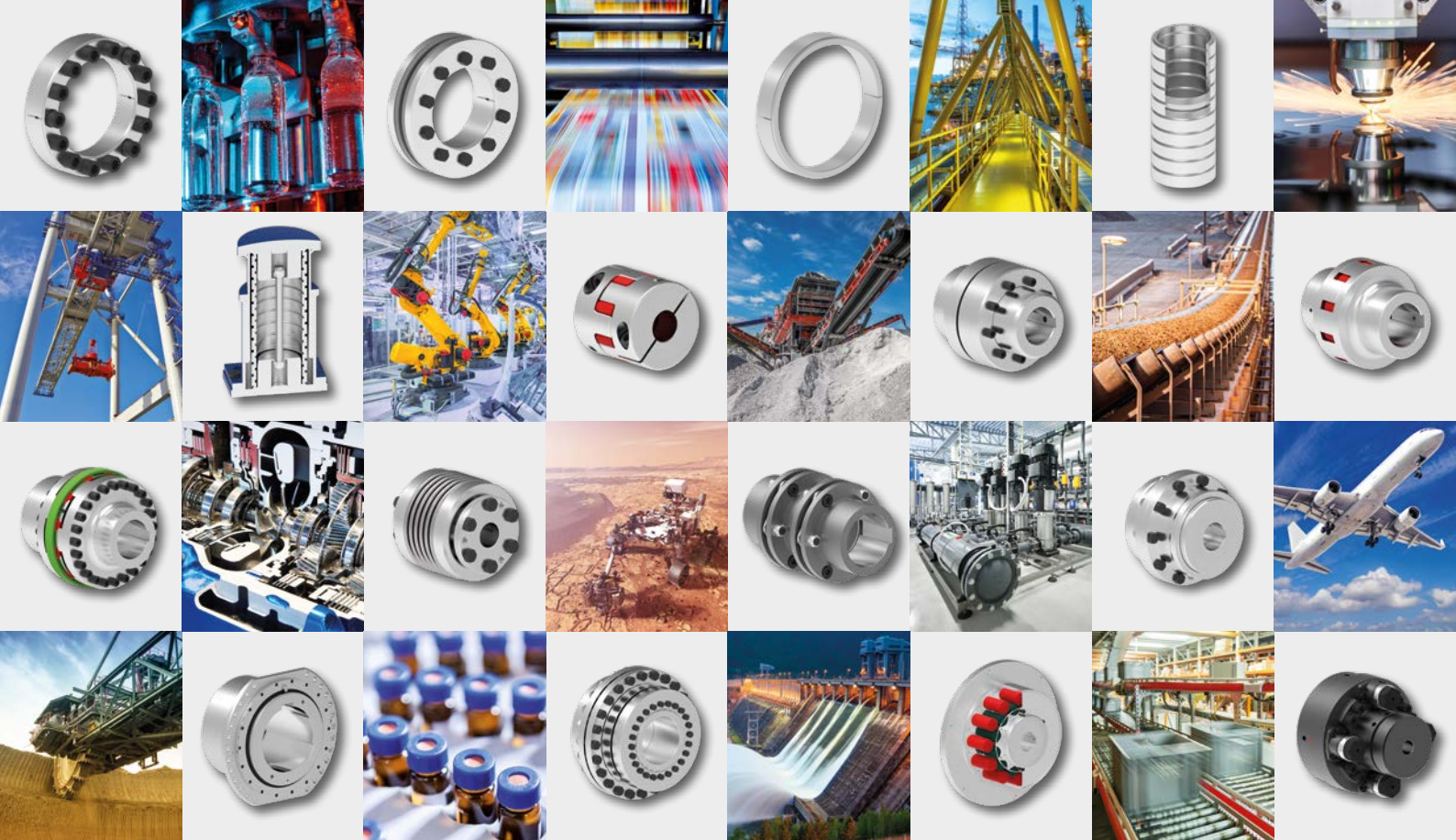
For safe protection against earthquake damages, the steel support frame of the Te Puni Village student residence in New Zealand's capital Wellington is equipped with RINGFEDER® Friction Springs. These operate in conjunction with special sliding hinge joints, which are located between the supports and traverses of the frame. By applying the Friction Spring technology, a self-centering sliding hinge joint is created that gives the building flexibility and reliably balances ground accelerations occurring in the event of an earthquake. The energy induced is absorbed and the building is also moved back to its initial position.





Whether as cross bracing to maximize ultimate loads, as base isolation for decoupling from the foundation, or for shear walls, RINGFEDER® Friction Springs serve as a highly effective, maintenance- and wear-free protection system against earthquake damage in buildings and other critical infrastructure. In the event of an earthquake, they absorb the occurring energy and, through their restoring force, ensure a safe so-called “Re-Centering” of the structure back to its original position.





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