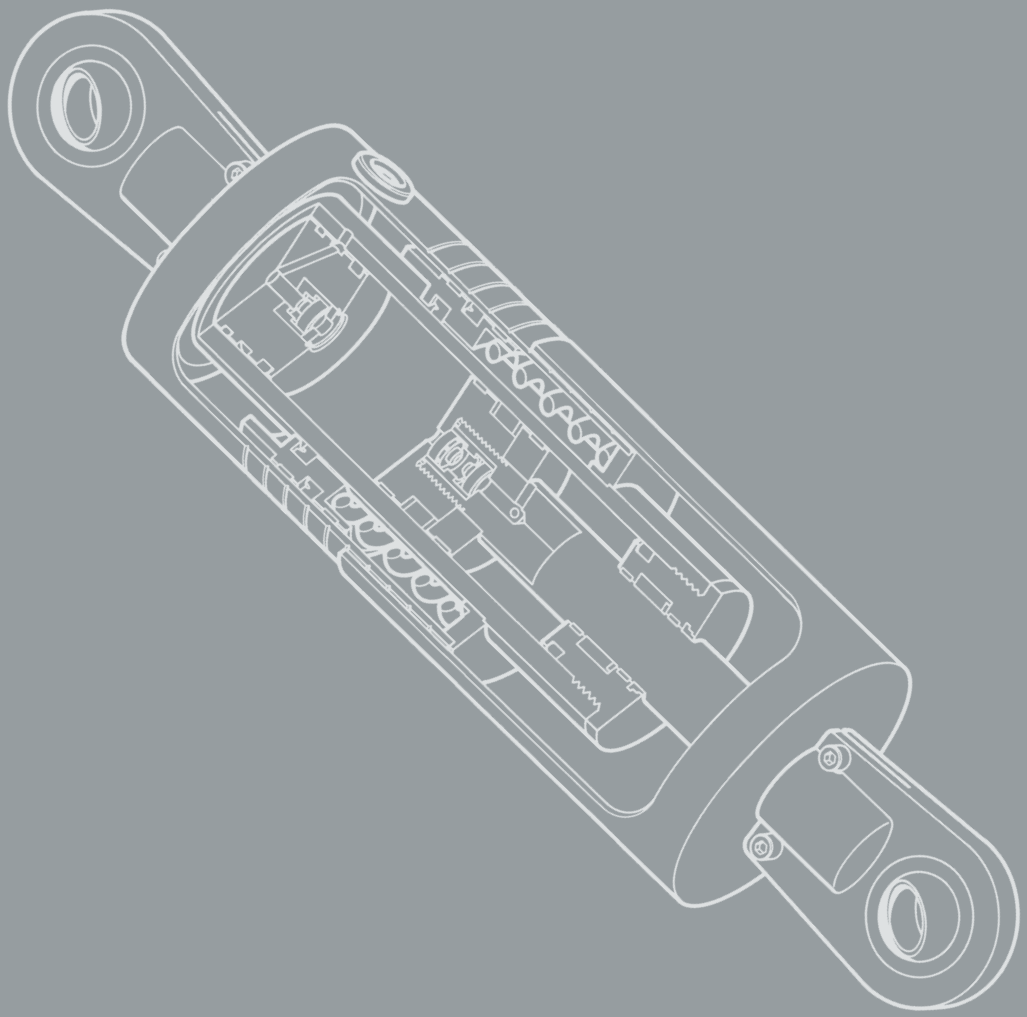
Snubbers, rigid struts, energy absorbers, viscoelastic dampers, dynamic clamps



3

SNUBBERS, RIGID STRUTS, ENERGY ABSORBERS, VISCOELASTIC DAMPERS, DYNAMIC CLAMPS

PRODUCT GROUP 3

LISEGA

Snubbers, rigid struts, energy absorbers, viscoelastic dampers, dynamic clamps

Contents **Page**

Field of application

To avoid unacceptable stresses and moments in the piping systems, unplanned deflections in the piping or other plant components must be prevented. Thermal displacement must, however, not be obstructed!

Dynamic events

Whenever unplanned dynamic events occur, the support components in LISEGA product group 3 have the task of protecting the piping or other affected parts from damage.

The unwanted jolting displacement of plant components can be caused by:

A. Internal events, for example:

- **start-up / shut-down**
- **pressure impacts from valve operations**
- **water hammer**
- **boiler detonations**
- **pipe rupture**

B. External events, for example:

- **wind loads**
- **seismic events**
- **aircraft crashes**
- **explosions**

Components affected can be:

- **pipe systems**
- **pumps**
- **valve assemblies**
- **pressure vessels**
- **steam generators**
- **boilers, heat exchangers**

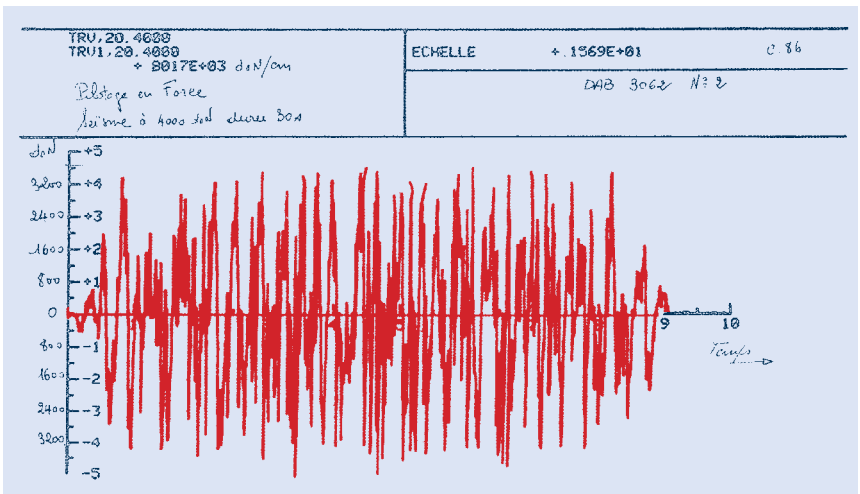


Diagram of an operating basis (O.E.B.)

Components in product group 3

For the absorption and transfer of dynamic load cases, specially designed supports are required. With product group 3, LISEGA provides a complete system in which all fields of application are covered by the corresponding ideal component. In this way the implementation of optimum concepts is possible for the user.

LISEGA product group 3 includes the following main products:

- **Snubbers, types 30 and 31**
- **Rigid struts, type 39**
- **Energy absorbers, type 32**
- **Viscoelastic dampers, type 3D**
- **Pipe whip restraints**

For proper implementation of the main components a complete range of connection possibilities is available:

- **Installation extensions, type 33**
- **Weld-on brackets, type 35**
- **Dynamic clamps, types 36 and 37**
- **Dynamic riser clamps, type 34**

The component connections are designed to be compatible with the LISEGA modular system and are subject to uniform calculation criteria. A **'table of permissible loads'** can be found on p. 0.6 of the **'technical specifications'**.

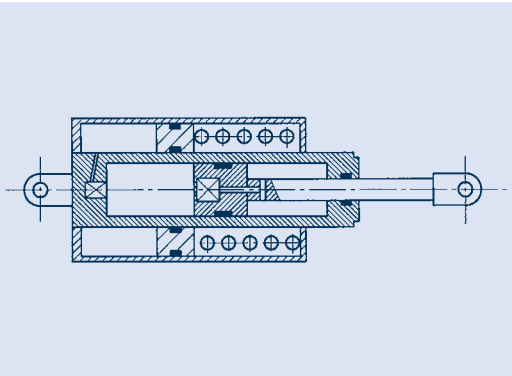
The stress analyses forming the basis correspond to the international guidelines and codes and are additionally supported by practical experiments and testing.

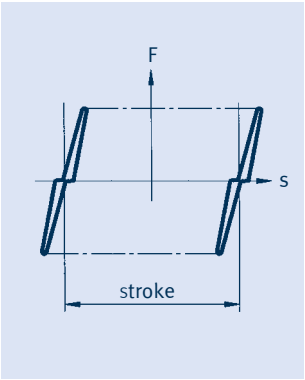
Design Report Summaries according to **ASME III NF** are available.

Main products

Snubbers type 30, 31

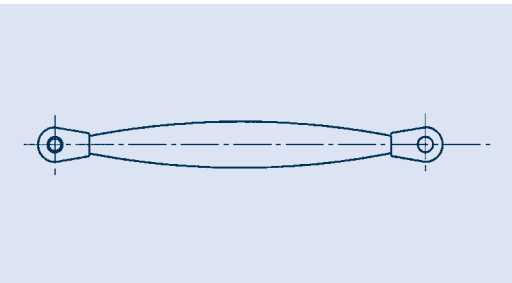
The use of snubbers is preferred in thermally operating plant components. In a dynamic event, snubbers provide an instantaneous, fixed, practically rigid connection between the component to be secured and the surrounding structure. In this way the dynamic energy from abrupt displacement can at once be transmitted and harmlessly dissipated. The thermal displacements during routine operation are not restricted.

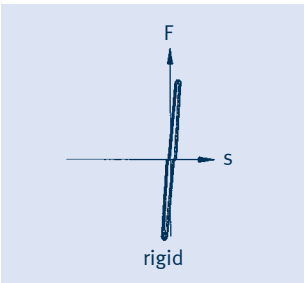




Rigid struts type 39

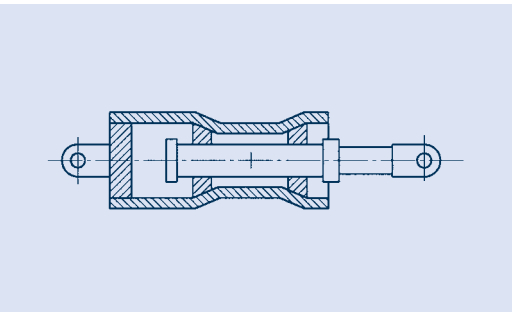
If operational displacements have to be restricted, e.g. in zero crossings, rigid struts are used. These components form rigid connections from connection point to connection point and do not permit movement of any kind in the axial direction. As they are fitted with articulated bearings they permit slight lateral displacement.

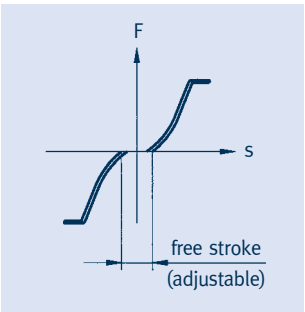




Energy absorbers type 32

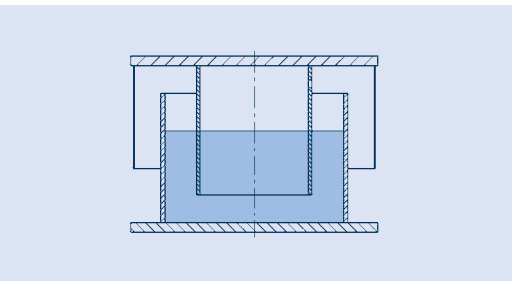
If only minor operational displacement is expected at the load application point, energy absorbers can be used. These components allow slight movements limited in the end positions by an adjustable gap. Any components affected are protected from overloading because, due to the design, the dynamic energy applied is transformed into plastic deformation of the absorber.

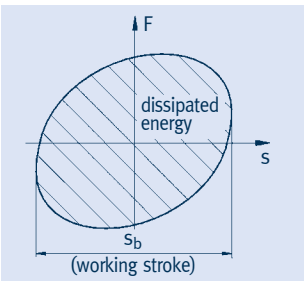




Viscoelastic dampers type 3D

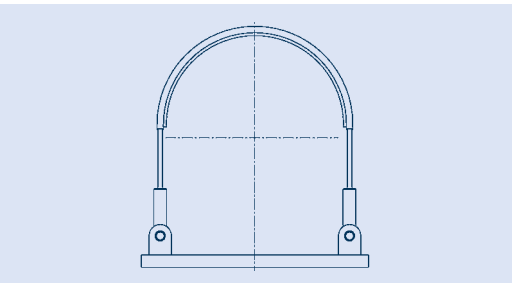
Dynamic loads from mechanical, hydrodynamic or other external events can seriously damage plant components and pipe systems. Viscoelastic dampers can absorb these vibrations and load peaks. A highly viscous fluid thereby absorbs the kinetic energy and so dampens any vibrations.

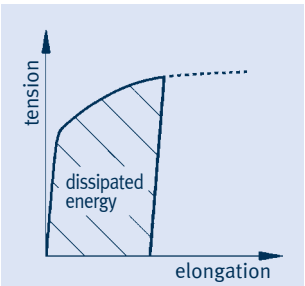




Pipe whip restraints

Pipe whip restraints are a specially designed pipe supports. In the event of a bursting pipe system, they will transform the suddenly released kinetic energy into plastic deformation and hold the pipe in a safe position. Any overloading of the steelwork is thereby prevented.





Instructions on use

The components in product group 3 are dynamically stressed. When using them, the following points must be observed for their effective functioning:

1. In the conception of **dynamic fixed points** the rigidity of the **whole system**, i.e. of all components in the support chain, must be taken into account.

2. In the selection of the sizes to be used, the **sum of all loads occurring** must be considered.

3. For given loads it must be clearly determined **beyond all doubt which design load** (H, HZ, HS and/or Level A, B, C, D) the data corresponds to. The **'table of permissible loads'** on p. 0.6 of the **'technical specifications'** must be observed.

4. The stroke length of snubbers should not be fully utilized. A **travel reserve of 10mm** in both directions is recommended.

5. When arranging components, **sufficient lateral freedom of movement** must be ensured so that no jamming occurs at the connections.

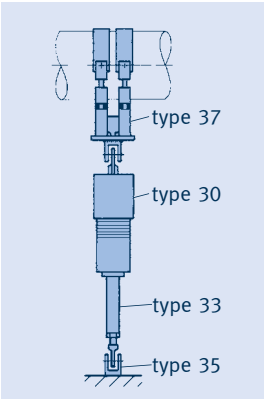
6. On **parallel arrangement of snubbers** it is recommended to take load reserves into account. Instead of 50% in each case, both snubbers should be designed to take at least 70% of the calculation load.

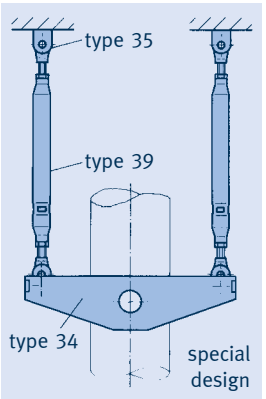
7. The **installation drawings** should clearly indicate the degree of freedom of possible angulation of the components.

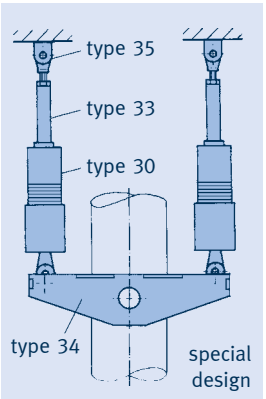
8. Any torque values necessary for threaded connections in the structural attachments should be indicated.

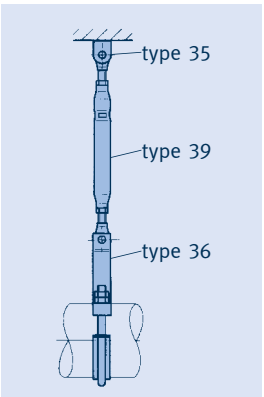
9. Before commissioning the plant, all support points should once again be **visually inspected**.

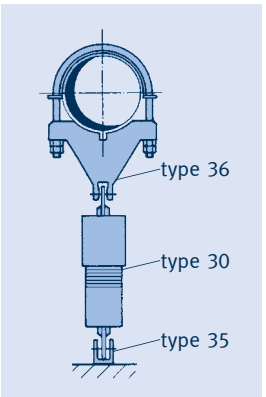
10. The **LISEGA instructions for commissioning** are to be observed, as well as inspection and maintenance recommendations.

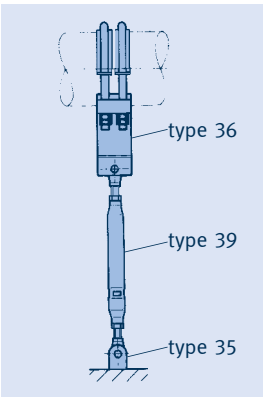


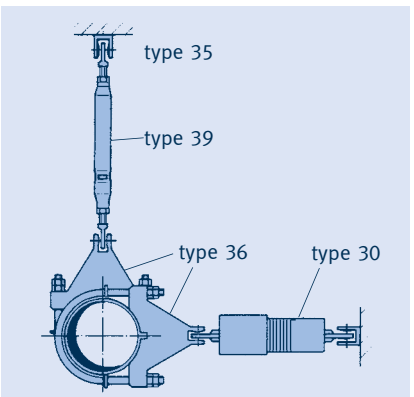


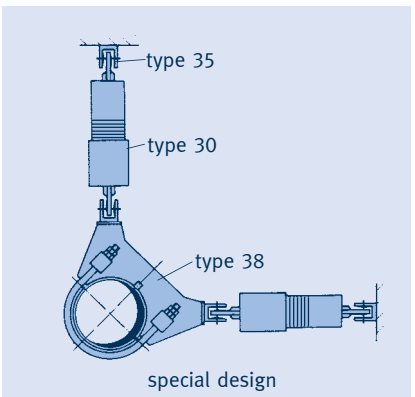


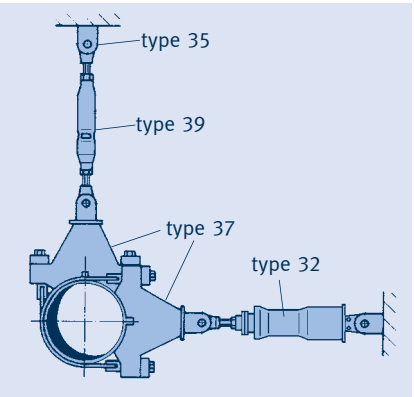


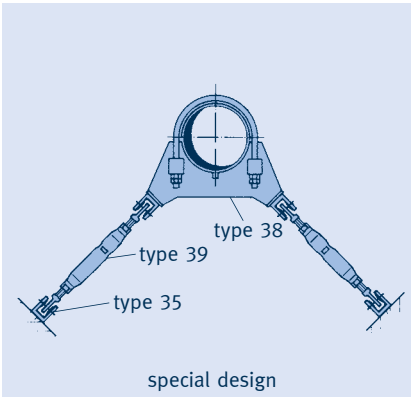












Snubbers Type 30, 31

LISEGA snubbers have stood the test of time in practical applications for well over four decades and have thereby proven their outstanding reliability. Extensive operational experience has, together with continuous further development, led to highly acclaimed state-of-the-art products and to worldwide market leadership.

Access to snuubbers after installation is almost always difficult and, due to possible danger to personnel from radiation when installed in nuclear power plants, is subject to stringent safety regulations. For this reason the most stringent demands are made on reliable, maintenance-free, continuous functionality.

For the reliable operational safety of snubbers, besides the function principle and whole design, the quality of critical components is crucial:

- **sealing systems**
- **piston and rod guides**
- **hydraulic fluid**
- **sliding surfaces**
- **corrosion-resistant materials**
- **corrosion-free interiors**
- **control valves**

The most common cause of failure in snubbers is usually premature wear and tear and corrosion. For this reason LISEGA snubbers are made of corrosion-resistant materials. In addition, any form of metallic contact within the unit is eliminated by the use of special guide bands.

Snubbers type 30

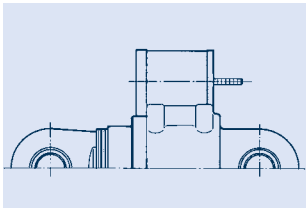
At LISEGA, sealing systems, guides and hydraulic fluid are certified by reliable qualification procedures to give at least 23 years of trouble-free operation under normal operating conditions in a nuclear power station.

The following quality features prove the superior functioning and long life of LISEGA snubbers:

- **corrosion-resistant materials**
- **special sealing systems**
- **vibration-resistant special guides**
- **pressurized hydraulic systems**
- **dynamic functional behavior**
- **exchangeable valves (type 31)**
- **tested and approved for min. 23 years maintenance-free operation**
- **60-year design life**
- **certified by suitability tests acc. to KTA 3205.3**
- **approvals acc. to ASME-NCA 3800**

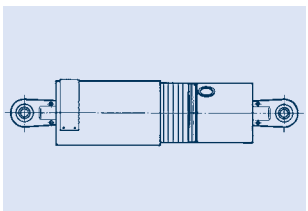
Final inspection of snubbers type 31

Design features
Snubbers Type 30, 31



Design features

The snubbers form a closed hydraulic system **without external bolted pressure fittings.** The individual parts of the units are connected **without welding** by precision fits and screw connections, and are mechanically secured.

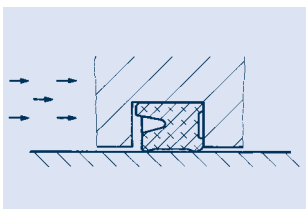


As a **protection against corrosion**, LISEGA snubbers are manufactured exclusively from **corrosion resistant materials**.
The connecting lugs are of carbon steel and protected with a galvanic coating.

The **guides on piston rods and pistons** are made of a special friction-resistant, non-metallic material.

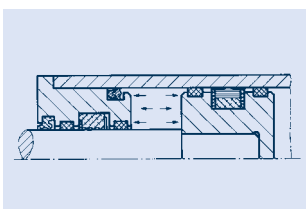
The **compensating reservoir** is sealed against the atmosphere by a preloaded piston so that slight **overpressure is maintained in the hydraulic system.** This ensures the permanent functioning of all seals and the positive feed of hydraulic fluid to the cylinder regardless of the installed orientation.

The **control valves** are vital for dynamic function. To achieve high functional accuracy the valve parameters have been optimized by extensive testing and special calculation models.



Seals

The decisive design features for long-lasting function are the sealing systems. Besides the hydraulic fluid and guide bands, they form part of the non-metallic materials and are therefore exposed to natural aging and wear.



The most important requirement for a long-lasting sealing effect is the choice of the correct sealing material. The crucial factor thereby is the seal's restitution behavior ('shape memory') or compression set, providing the lowest possible stress relaxation.

For optimum utilization of material properties the special shape of the seals is also important, while for final functional efficiency the best combination of the following features are critical:

- **thermal resistance**
- **radiation resistance**
- **resistance to wear, especially high-frequency vibrations**
- **good restitution behavior ('shape memory')**
- **good dry run characteristics**
- **limited tendency to diffusion in seal surfaces**
- **minimal transfer from static to sliding friction (stick-slip effect)**

A special mixture of **fluorelastomer VITON** has proved to offer the optimum solution here. In addition, the following prerequisites must be fulfilled to gain full benefit from the special characteristics:

- **special sealing geometry**
- **supporting composite materials**
- **optimum consistency (mixture proportions)**
- **optimized hardening**
- **precision of sliding surfaces**
- **design of the installation spaces for defined preloading of the seals**

Ordinary seals do not fulfill these demands in snubbers and have been shown to lead to premature failure. For this reason, as early as 1984 LISEGA, in collaboration with a renowned seal manufacturer, began to develop **specific sealing systems** that have since proved themselves in practice.

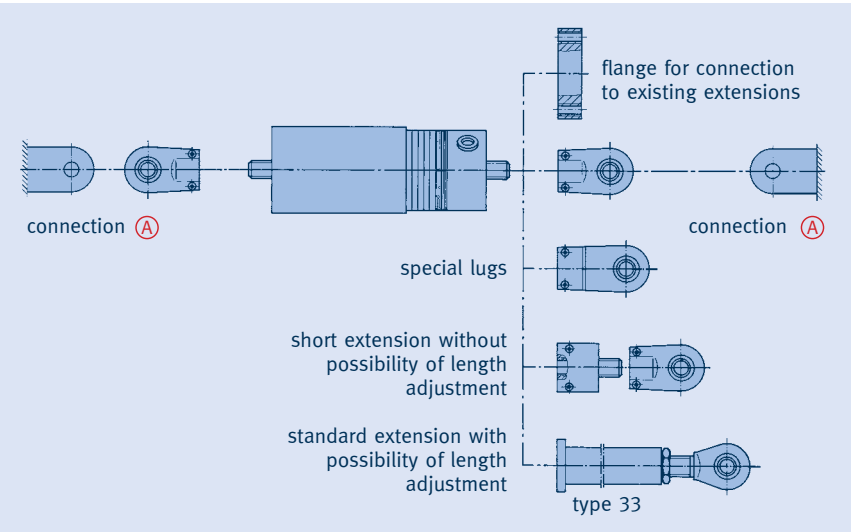
In 1992, after other successful certification procedures through artificial aging and long-term trials, a certification process for LISEGA snubbers was conducted on behalf of a European nuclear operator. The result: a **maintenance-free operating period of min. 23 years in nuclear applications was confirmed.**

Design features
Snubbers Type 30, 31

Type 30

Connection possibilities

A special range of connection components and adapters is available, so that in the event of an exchange the existing connections on site can still be used.



Ⓐ Connection possibilities: See bolt diameters of weld-on brackets type 35 or dynamic clamps in product group 3.

① Control valves to achieve greater functional accuracy (type 30: internal).

② Name plate with all technically relevant data.

③ Control indicators: The piston position of the snubbers can be read off on all sides via the scale rings on the snubber casing. A robust steel casing connected to the piston rod serves as an indicator and at the same time protects the piston rod from mechanical damage, pollution and radiant heat.

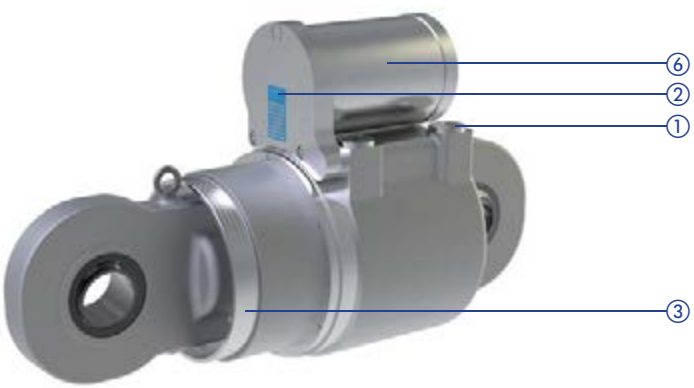
④ Connection lugs (carbon steel) galvanized (only type 30).

⑤ Inspection glass in the compensating reservoir / indicator bar. The fluid level of the reservoir is shown by the position of the reservoir piston. For type 30 the minimum level can be checked through the inspection glass; for type 31 there is a marked indicator bar at the base of the external compensating reservoir.

⑥ The reservoir is sealed against the atmosphere by means of a spring-loaded piston so that slight overpressure in the hydraulic system constantly keeps the seals under slight pressure (type 30: located inside).

✔ Non-corroding materials.

✔ Radiation-resistant, wear-resistant seals.



Type 31

For details of design and materials see **technical specifications** p. 0.1.

Mode of operation and function Snubbers Type 30, 31

In the event of an impact on the component to be secured, an instantaneous, practically rigid connection is to be made between the component and a fixed point on the surrounding structure.

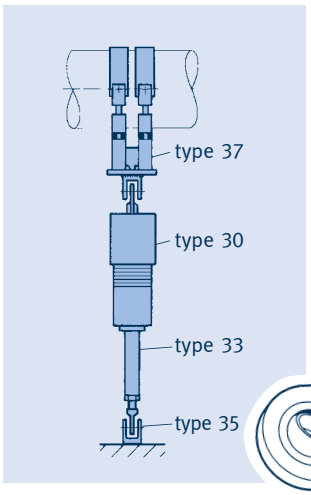
Function

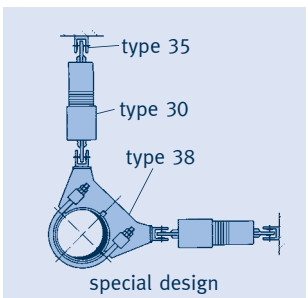
Control valves

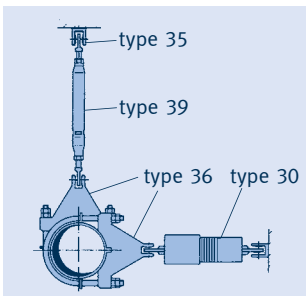
The function of the LISEGA hydraulic snubbers type 30 is controlled by a main control valve (B) positioned axially in the hydraulic piston (A). On slow displacement of the piston (≤ 2mm/s) the valve is held open by spring force and the hydraulic fluid can freely flow from one cylinder chamber into the other. On rapid piston displacement above a velocity limit (approx. >2mm/s), back pressure develops on the valve disk and closes the valve. The hydraulic flow is interrupted and the displacement blocked. Due to the compressibility of the hydraulic fluids, damaging load peaks are also prevented.

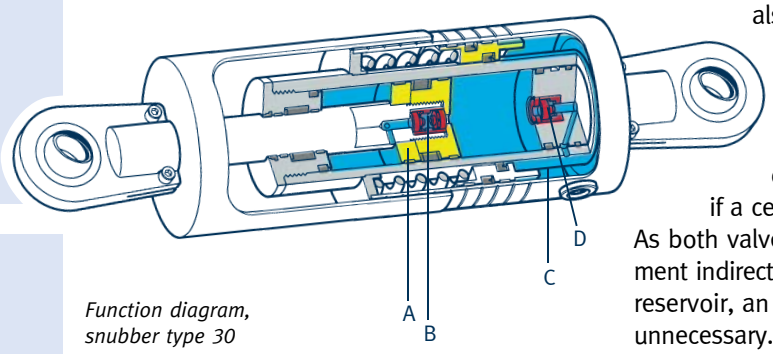
On displacement in pressure direction, the compensating valve (D) also closes almost synchronously with the piston valve.

If the pressure on the closed valve is reduced, e.g. by reversal of the displacement direction, the valve opens independently.









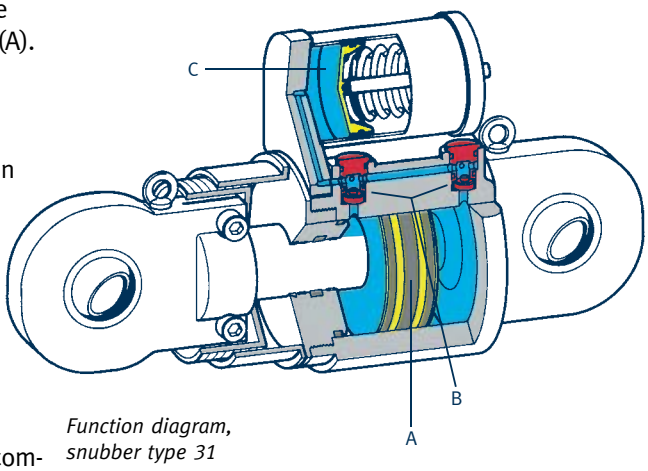
Function diagram, snubber type 30

Bypass

To prevent the valves from remaining in a blocked condition they are designed with a bypass system. This permits a gentle after-flow at continuous force and ensures the safe opening of the valves in both cylinder chambers through rapid pressure balance. The compensating valve works synchronously with the main valve in the same way.

Compensating reservoir

To balance the piston rod volume, as well as to change the volume of hydraulic fluid on change of temperature, volume compensation via a co-axially arranged compensating reservoir (C) takes place. The connection between reservoir chamber and the working cylinder is regulated by the compensating valve (D).



Function diagram, snubber type 31

Large bore design type 31

The mode of functioning of the LISEGA hydraulic snubbers type 31 is based in principle on the same concept as for type 30. The particularities of size require a different arrangement of the compensating reservoir (C). At the same time a different arrangement of the valves is also necessary. The valves (B) work similarly to those on type 30. Here too, the flow of hydraulic fluid in the respective direction of movement is interrupted by closure of the corresponding valve if a certain limit of velocity is exceeded. As both valves stand with the given arrangement indirect connection with the compensating reservoir, an additional compensating valve is unnecessary.

In-service testing

The valve system is designed to be replaceable, so that all the snubbers type 31 need not be removed for routine function testing. In this way, in the event of a recurrent test only the valve units are replaced by a previously certified valve assembly. A special shut-off device thereby prevents loss of fluid. The replaced valve assembly can subsequently be tested on a test snubber and prepared for future use. This design meet the intent of sub-component testing according to ASME OM Code, Subsection ISTD.

Function Tests
Snubbers type 30, 31

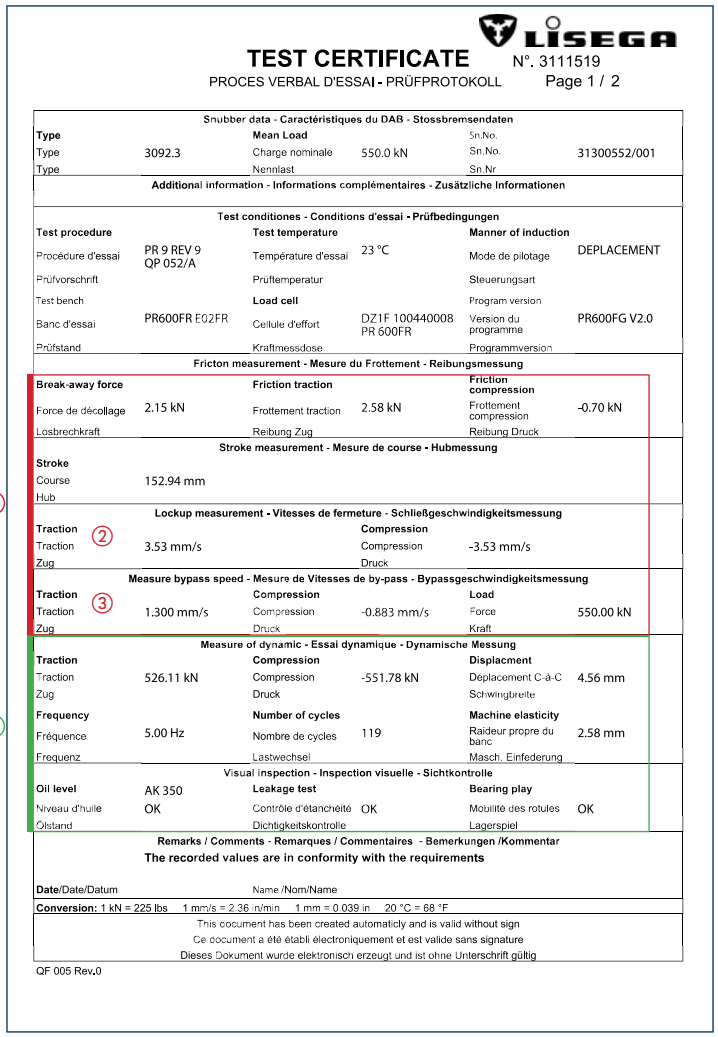
Especially stringent safety demands in the nuclear field require flawless proof of the function parameters for snubbers. This applies both to initial delivery inspection and to recurrent tests.

The LISEGA test technology is permanently improved in-house and complies with the most up-to-date technical standards. The test benches function as dynamic Hydropuls® units with optional force- or travel-controlled excitation. The frequency bands range from 0.5 – 30Hz, and the test loads from 0.5 up to 8600kN. For standard tests LISEGA has test facilities of its own manufacture in different factories and in various sizes. Mobile units are often used on site at customer request. The test facilities are used worldwide today and are operated by the customers' own personnel.

Variable test programs permit the testing of all snubber makes.

LISEGA test machines are also manufactured for customers.

All LISEGA test machinery is calibrated at regular intervals on the basis of DIN EN ISO 7500 with calibrated load cells and measurement amplifiers.



TEST CERTIFICATE N°. 3111519
PROCES VERBAL D'ESSAI - PRÜFPROTOKOLL Page 1 / 2

Snubber data - Caractéristiques du DAB - Stossbremsendaten

Type		Mean Load		Sn.No.	
Type	3092.3	Charge nominale	550.0 kN	Sn.No.	31300552/001
Type		Nennlast		Sn.Nr	

Additional information - Informations complémentaires - Zusätzliche Informationen

Test conditiones - Conditions d'essai - Prüfbedingungen

Test procedure		Test temperature		Manner of induction	
Procédure d'essai	PR 9 REV 9 QP 052/A	Température d'essai	23 °C	Mode de pilotage	DEPLACEMENT
Prüfvorschrift		Prüftemperatur		Steuerungsart	
Test bench		Load cell		Program version	
Banc d'essai	PR600FR E02FR	Cellule d'effort	DZ1F 100440008 PR 600FR	Version du programme	PR600FG V2.0
Prüfstand		Kraftmessdose		Programmversion	

Fricton measurement - Mesure du Frottement - Reibungsmessung

Break-away force		Friction traction		Friction compression	
Force de décollage	2.15 kN	Frottement traction	2.58 kN	Frottement compression	-0.70 kN
Losbrechkraft		Reibung Zug		Reibung Druck	

Stroke measurement - Mesure de course - Hubmessung

Stroke					
Course	152.94 mm				
Hub					

Lockup measurement - Vitesses de fermeture - Schließgeschwindigkeitsmessung

Traction ②				Compression	
Traction	3.53 mm/s			Compression	-3.53 mm/s
Zug				Druck	

Measure bypass speed - Mesure de Vitesses de by-pass - Bypassgeschwindigkeitsmessung

Traction ③		Compression		Load	
Traction	1.300 mm/s	Compression	-0.883 mm/s	Force	550.00 kN
Zug		Druck		Kraft	

Measure of dynamic - Essai dynamique - Dynamische Messung

Traction		Compression		Displacment	
Traction	526.11 kN	Compression	-551.78 kN	Déplacement C-à-C	4.56 mm
Zug		Druck		Schwingbreite	
Frequency		Number of cycles		Machine elasticity	
Fréquence	5.00 Hz	Nombre de cycles	119	Raideur propre du banc	2.58 mm
Frequenz		Lastwechsel		Masch. Einfederung	

Visual inspection - Inspection visuelle - Sichtkontrolle

Oil level	AK 350	Leakage test		Bearing play	
Niveau d'huile	OK	Contrôle d'étanchéité	OK	Mobilité des rotules	OK
Ölstand		Dichtigkeitskontrolle		Lagerspiel	

Remarks / Comments - Remarques / Commentaires - Bemerkungen /Kommentar
The recorded values are in conformity with the requirements

Date/Date/Datum Name /Nom/Name

Conversion: 1 kN = 225 lbs 1 mm/s = 2.36 in/min 1 mm = 0.039 in 20 °C = 68 °F

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QF 005 Rev.0

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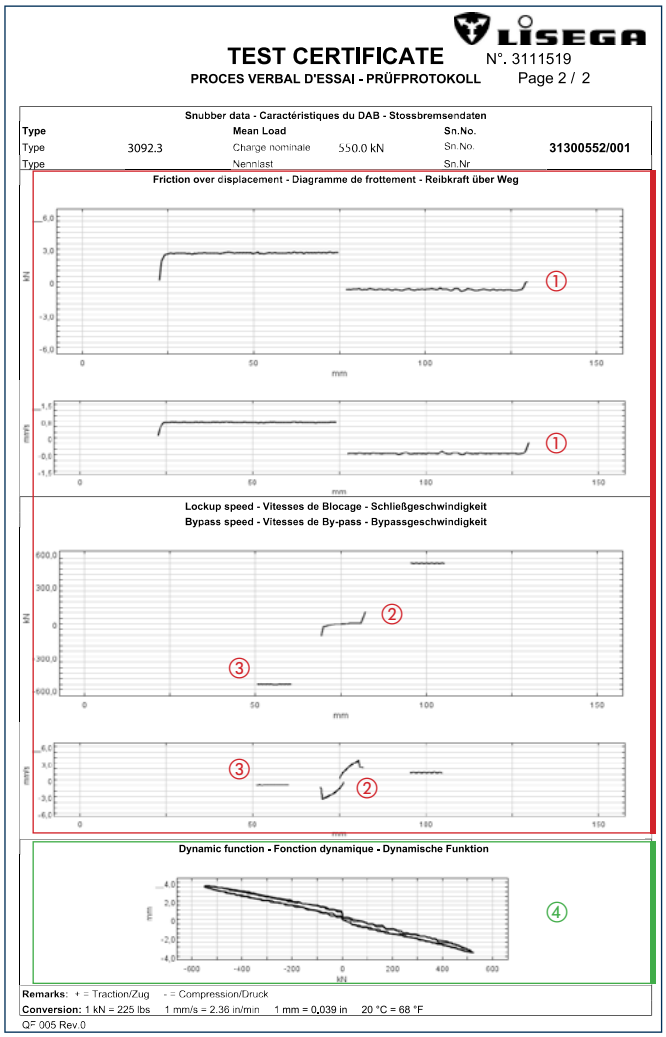
Inspection report with test diagrams page 1



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PROCES VERBAL D'ESSAI - PRÜFPROTOKOLL Page 2 / 2

Snubber data - Caractéristiques du DAB - Stossbremsendaten

Type		Mean Load		Sn.No.	
Type	3092.3	Charge nominale	550.0 kN	Sn.No.	31300552/001
Type		Nennlast		Sn.Nr	

Friction over displacement - Diagramme de frottement - Reibkraft über Weg

Lockup speed - Vitesses de Blocage - Schließgeschwindigkeit
Bypass speed - Vitesses de By-pass - Bypassgeschwindigkeit

Dynamic function - Fonction dynamique - Dynamische Funktion

Remarks: + = Traction/Zug - = Compression/Druck
Conversion: 1 kN = 225 lbs 1 mm/s = 2.36 in/min 1 mm = 0,039 in 20 °C = 68 °F
QF 005 Rev.0

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Inspection report with test diagrams page 2

Ⓐ **Quasi-static function tests**

① Friction measurement [kN]
② Lockup velocity [mm/s]
③ Bypass velocity [mm/s]

Ⓑ **Dynamic function tests**

④ Load and travel amplitude

Operational behavior Snubbers Type 30, 31

Operational behavior

On dynamic loading, LISEGA snubbers offer a constant, predictable, functional behavior subject to the load spectrum.

Specified function values

LISEGA snubbers comply, as a standard, with the following functional data. The values apply to alternating or dynamic loading.

The specified values correspond to the recognized international specifications and practical requirements. Observation of the values is certified and recorded during factory testing.

By means of design adaptation special parameters can be taken into account.

	type 30		type 31	
	travel range 8, 2, 9 ①	travel range 3 (stroke 300)	travel range 8 (stroke 100)	travel range 9 (stroke 200)
piston rod travel s_b at F_N, R_t ② and 1-35Hz	≤ 6mm	≤ 8mm	≤ 10mm	≤ 12mm
piston rod play s_a (lost motion)	≤ 0.5mm ④ up till load development on change in load direction			
lockup velocity at R_t ②	2-6mm/s			
bypass velocity at F_N und R_t ②	0.2-2mm/s ⑤			
maximum adjustment force ③	at F_N ≤ 8kN 2.5% F_N at F_N > 8kN largest value out of 200N or 1%F_N	largest value out of 300N or 1.5%F_N	1%F_N	

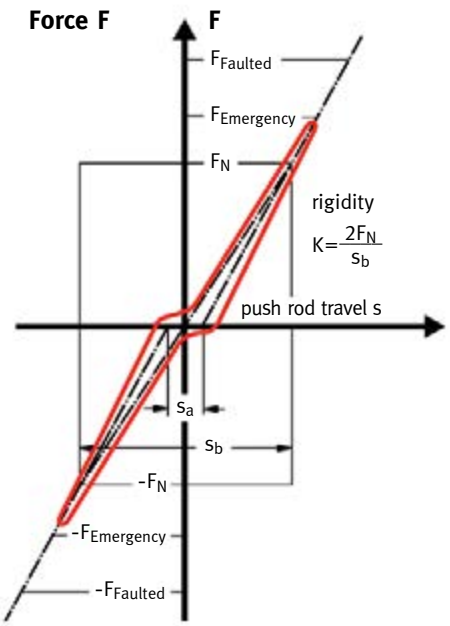
① Travel range 8≙100mm, travel range 2≙150mm, travel range 9≙200mm.

② R_t = room temperature (20°C ±2°C). At ambient temperatures of 150°C (short-term, max. 1hr) the push rod travel can increase by up to about 50% due to changed oil viscosity.

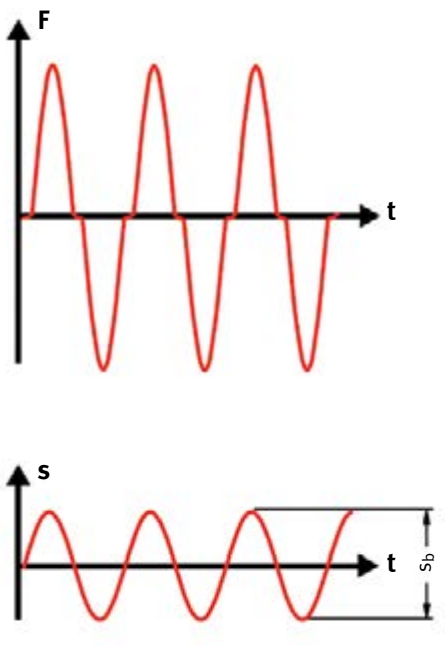
③ Measured at a displacement velocity of approx. 0.3mm/s. The resistance on startup (adhesive force) lies below 1.5 times the max. values. F_N = nom. load

④ If required, s_a can be increased to ≥ 0.5mm (KTA 3205.3).

⑤ Bypass velocity < 0.2mm on request.



Force – travel diagram



Force and travel amplitudes

2500kN test bench at LISEGA

Permissible loads Snubbers Type 30, 31

Operational demands

LISEGA hydraulic snubbers are designed as standard for the following operational demands. The specified values are certified by KTA suitability tests.

Other values can be agreed in exceptional cases by design adaptations.

Test facilities for snubbers in Zeven plant, Germany

loading due to ambient temperature	continuous operation	max. 80°C
	short-term max. 1h/temp. cycle max. 40h/year	max. 150°C
relative air humidity	at 10-150°C	100%
wet steam atmosphere	up to max. 150°C	X=1
energy dose	cumulative	10^5J/kg =10^5gray (=10^7rad)
ambient pressure	continuous operation	0.5-1 bar
	short-term	5 bar overload pressure

The values apply to the whole snubber, incl seals and hydraulic fluid. The data for the fluid are:

hydraulic fluid (silicon oil)	setting point	– 50°C
	flash point	> 300°C
	ignition point	≈ 500°C

Resistance to fatigue

Proof of operational durability is based on the following accumulated load cycles:

nominal load F_N	load cycle
10%	2,000,000
50%	100,000
80%	20,000
100% (Level A/B)	10,000
133% (Level C)	100
172% (Level D)	10

The load cycle figures correspond to an assumed maximum dynamic load capacity from diverse load events over a period of 40 years. They also comply to the requirements of the test programs of the KTA suitability tests performed. The test results certify that the snubbers endure these loads while maintaining their operational capability.

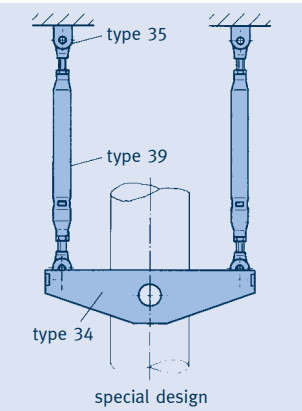
Due to their specially designed guides, the snubbers are extremely resilient to any continuous operational vibrations. This is proven by confirmed practical experience.

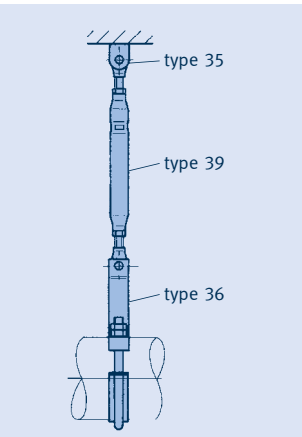
It should be taken into account that the number of possible active parameters, such as frequencies, amplitudes, forms of vibration, effective directions, as well as any possible simultanity, allow no uniform definition of permanent operational vibrations.

Special testing of snubbers type 31. Test load up to 8600kN.

Mode of operation and function
Rigid struts Type 39

In contemporary support concepts, rigid struts play an important role in the safe guiding of pipe systems. The reliable positioning of piping is a crucial factor in the operational safety and long life of the whole system.





Tasks

The LISEGA rigid struts type 39 provide a range of important functions for the operational safety of pipe systems:

- **Transmission of displacement from unplanned load events (see p. 3.1)**
- **Guiding of pipe systems for the control of planned thermal displacement direction**
- **Stabilization of flexible pipe systems by fixed so-called 'zero positions'**
- **Design of axial stops**

Mode of operation

Rigid struts perform as hinged rigid connections between pipe systems and structure. No resistance is offered to slight displacements in the pipe system around the angular displacement of the rigid struts. Movement axially to the rigid strut is not possible.

Design

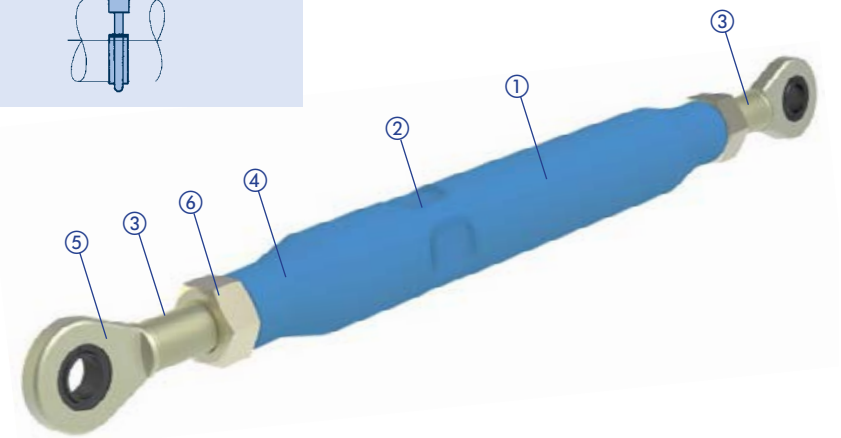
The rigid strut consists of a rigid body with a ball bushing joint for connection at each end. Attachment to the structure is made via a weld-on bracket type 35 and connection to the piping with dynamic clamps from product group 3. The selection tables for connecting components can be found on p. 3.22 or pp. 3.29 to 3.43.

Up to load group 8 the body consists of a tube tapered at the ends.

The shape corresponds to the flow of force and permits a favorable power / weight ratio. The connections are ball bushing joints acting as turnbuckles with right- and left-hand threads, permitting length adjustment within a range of 150mm or 300mm. Flat faces on the body of the tube allow the safe use of a wrench and so facilitate length adjustments in the installed condition.

The ball bushing joints are provided with fine threading to guarantee secure locking.

The bodies are produced in standard lengths and are available from stock. LISEGA rigid struts are suitability-tested according to KTA 3205.3 and designed in accordance with the ASME-BPV Code.



① surface with standard paint coating
② flat face for easy adjustment
③ length-adjustable with right-hand / left-hand threads
④ body with shaped ends, free of welding up to load group 8
⑤ galvanized ball bushing joints with fine thread
⑥ safe locking of ball bushing joints by means of fine threads and electro-galvanized lock nuts

Mode of operation and function
Energy absorber Type 32

Energy absorbers restrict dynamic deflections and transform forces above the nominal load into deformation energy. The steelwork is thus protected.

Mode of operation and function

The energy absorber functions by means of an adjustable free stroke to absorb thermal displacement. The adjustment of the free stroke can be carried out (for medium sizes) within a range of ± 25mm. In this range the pipe system can move freely without resistance.

Dynamic events, however, are limited in their movement by the use of stops. The forces arising are thereby led into the building structure up to the specified nominal load and, above that, transformed into deformation energy. Connected components are in this way protected in a controlled manner from overloading.

For this reason energy absorbers are ideal as protection:

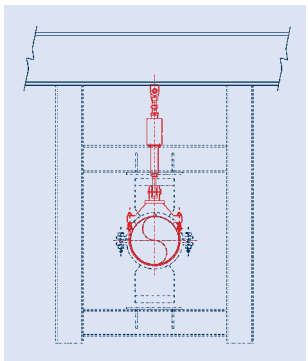
- **against water hammer**
- **as a substitute for complex framework constructions**
- **as whip restraints**

If such an event has occurred, the forward thrust of the disk affected can be read from the position of the indicator bar (G).

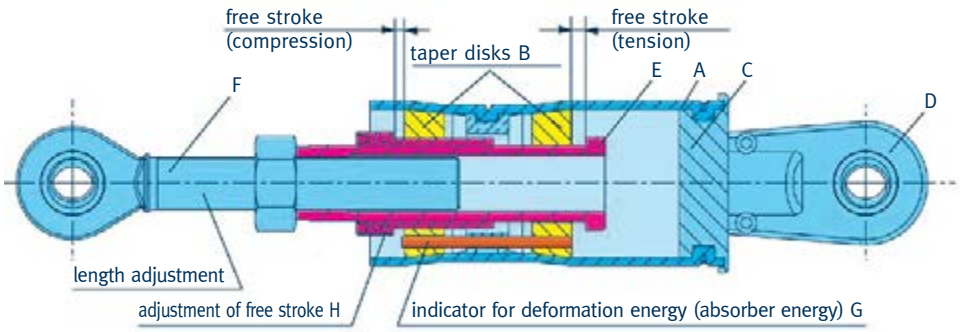
For further use of the energy absorber the free stroke on the adjustment device (H) only needs to be re-regulated for the new position. **Corresponding procedures can be repeated up to maximum deformation travel (s).** Further information is available on p. 3.23.

Installation

The energy absorbers are designed in accordance with the load group in product group 3 (dynamic components) and are correspondingly compatible in respect of loads and connections with the connection components in this product group. Please also note the instructions on p. 3.1.



Energy absorber, used instead of a double guide. In this way the framework can be avoided.



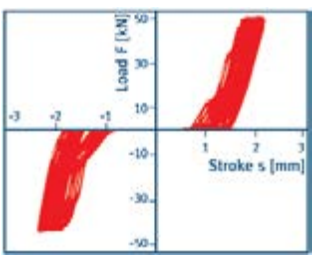
The design consists of an austenitic tubular casing (A) with defined size, into which taper disks (B) with defined force have been pressed. The tube is sealed with a fixed base (C) fitted with a connecting lug (D). The force transmission over the whole unit is made via the stops (E) and the push rod (F).

If a dynamic event exceeds the compression force of the taper disks, the taper disk affected is driven forward and widens the cover tube. In this way the excess force is diverted from the connection components by transformation into deformation energy.

Function certification

LISEGA energy absorbers have gone through an exhaustive test program to prove their functional reliability. In numerous dynamic and static stress tests, as well as load capacity tests, their safety has been clearly demonstrated.

Energy absorbers are maintenance-free during operation and require no in-service testing.



Measured force/travel path with oscillating loads > nominal load

Mode of operation and function Viscoelastic damper Type 3D

Dynamic loads from mechanical, hydrodynamic or external events can severely damage pipe systems and other plant components. Viscoelastic dampers can considerably reduce such vibrations.

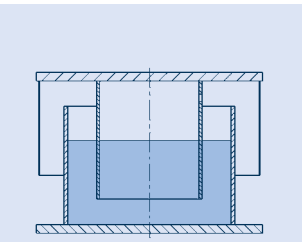
Vibrations occur through inner events from mechanical or hydrodynamic processes, or in the case of external events such as wind loads, traffic vibrations or earthquakes.

Unacceptable vibrations can thereby cause serious damage to pipe systems. By means of special components they must be protected. To avoid stresses in the whole system, displacements from thermal expansion in the piping system may only be minimally obstructed.

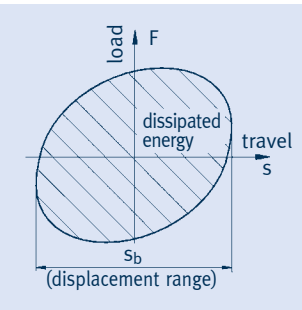
Viscoelastic dampers have proved in practice to offer reliable protection for pipe systems and installations. In particular, vibrations caused by sudden peak loads can be reduced to an acceptable level by such dampers.

The LISEGA viscoelastic damper consists of a casing filled with viscous fluid that allows relative displacement between the connecting plates and at the same time damps in all directions, dissipating the kinetic energy (transformed into heat).

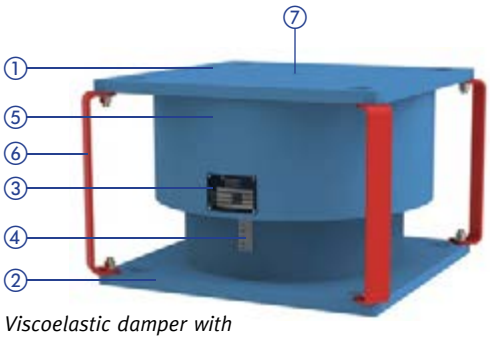
Viscoelastic dampers transmit only dynamic loads, not static ones. The reaction force of the damper is thereby proportional to the velocity and frequency of the vibrations. LISEGA offers fluids with varying damping characteristics in relation to application temperature and frequency.



Construction of the LISEGA viscoelastic damper



Hysteresis of a viscoelastic damper



Viscoelastic damper with transport brackets without offset

Viscoelastic damper with adjusted offset

①② connecting plates
③ name plate
④ position indicator
⑤ maintenance-free dust cover
⑥ transport brackets
⑦ inner connection thread M16 for transport purposes

- ✔ load range 2.5kN to 100kN
- ✔ frequency range up to 35Hz
- ✔ temperature range from – 10°C to 80°C
- ✔ travel range up to 50mm

Pipe whip restraints Type 3R

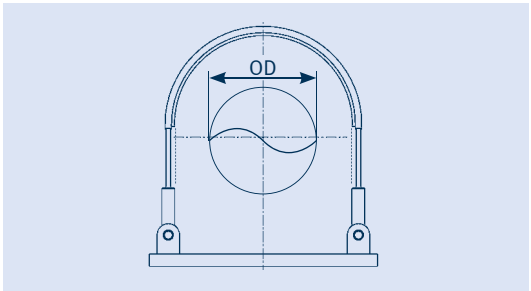
Pipe whip restraints

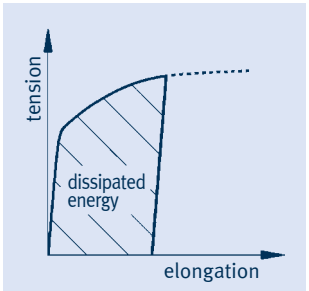
Special designs in the field of dynamic pipe supports are pipe whip restraints. Beside energy absorber type 32, a design type with round-steel U-bolts has proved widely successful, especially for large loads.

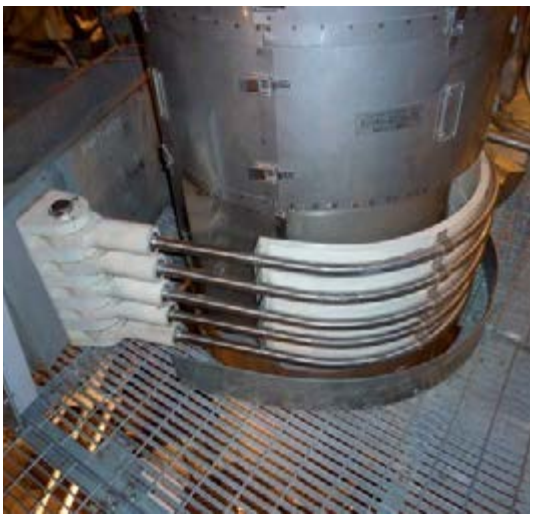
Pipe whip restraints are common in nuclear installations and are designed to instantaneously absorb the kinetic energy of bursting pipe systems in faulted conditions. For this, the elongation behavior of the surrounding steel U-bolts is utilized; these are designed to cope with the dynamic forces to be expected.

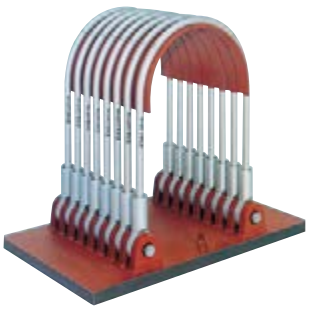
Pipe whip restraints are designed according to the customer's design parameters and manufactured by LISEGA as special components.

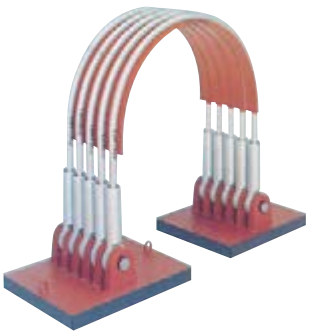
Pipe whip restraints are important as safety elements and are therefore subject to stringent quality requirements with regard to design and manufacture. As the result of countless deliveries to modern nuclear installations LISEGA has clearly proved its qualification for the supply of these components.

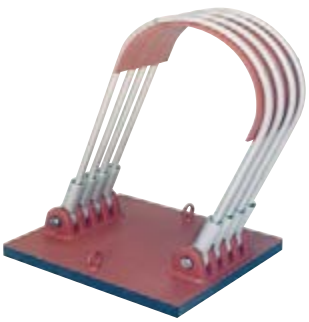






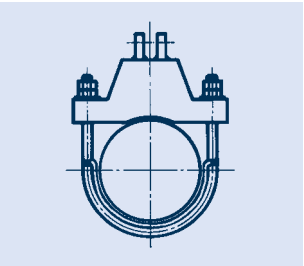




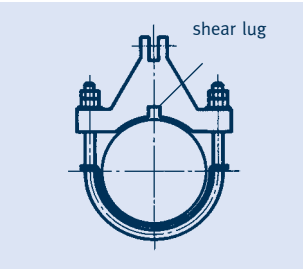


Mode of operation and function
Dynamic clamps Type 34, 36, 37

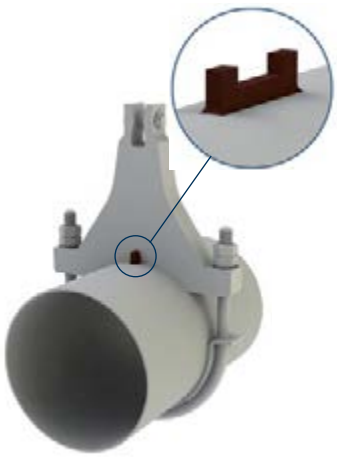
For the dynamic supports the pipe clamp design must also be carefully considered. Despite properly functioning main components (rigid struts, snubbers, energy absorbers) the functioning of the whole system can be seriously affected by faulty pipe clamps.



Friction-fit clamp (static)



Form-fit clamp (dynamic)



Type 36 with pipe whip restraints

Function

In the high temperature range and/or over a longer period of time, friction fit clamps cannot safely transmit dynamic loads, even with bolt pre-stressing, due to the creep strength behavior of the materials (long-term fatigue). Even over-sized bolts, which might under certain circumstances severely constrict the piping ('pipe squeezers'), are not solving the problem.

- **A typical fault is a clamp design that is too 'soft', so that the necessary stiffness rule is not achieved**
- **Attention must also be paid to connections to clamps free of play**
- **To prevent constraints, sufficient space must be ensured for lateral displacement in the event of pipe system movements**

To transmit dynamic loads, clamps are required that absorb dynamic forces and transmit them further. Dynamic forces are created by alternating loads; displacement can thereby result due to eccentrically applied forces. The dynamic clamp should therefore be form-fitted (shear lugs) to prevent contortion. In this way, defined, verifiable conditions are produced. Certification is the responsibility of the pipe system designer.

The shear lugs keep the dynamic clamps in the expected force direction and are practically unstressed. Lateral forces would not occur under dynamic load cases because friction forces between the pipe and the clamp insure the firm positioning.

Due to the minimal forces to be absorbed the weld seam stresses can be minimalized, despite the small shear lug sizes. As a rule they lie under 35% of the yield stress (creep strength) limit for load case H, in accordance with the permissible ASME or DIN values. From a table the LISEGA shear lugs can be selected on p. 3.44.

Dynamic clamps type 36, 37

To achieve the optimum solution in each case and at the same time the most favorable performance/weight ratios, LISEGA offers 4 standard designs.

The selection tables are classified according to pipe diameters. The type designation for the relevant clamp is found by way of the temperature ranges and permissible loads. After that the installation dimensions must be checked against the scale drawings. Special attention must be paid to the lug connections on the rigid struts, snubbers or energy absorbers. If the standard bolt connection d1 is not suitable, a different weld-on bracket type 35 can be supplied. The 'E' dimension of the clamp is changed according to the table below.

If the customer order does not show a particular modification of the layout, the bracket connection is fitted so that the main angulation range runs along the pipe axis.

Type 36 .. .1/2/3

Type 37 .. .1/2/3/4/5/6

Type 36 .. .4/5

Type 37 .. .7/8/9

theor. load group	max. load group of dynamic clamps							
	1, 2	3	4	5	6	7	8	9
	'E' dimension reduction ΔE							
1,2	0	4	10	20	45	60	85	125
3		0	6	16	41	56	81	121
4			0	10	35	50	75	115
5				0	25	40	65	105
6					0	15	40	80
7						0	25	65
8							0	40
9								0

Reduction of the E_{max} dimension for dynamic clamps type 36 and 37 on selection of a smaller connection than given in the column 'max. load group' in the selection tables.

Dynamic clamps as statically stressed clamps

The specified permissible loads (in the selection tables on pp. 3.29 to 3.43) are designed for dynamic operation with snubbers or rigid struts according to the load spectrum on p. 3.10.

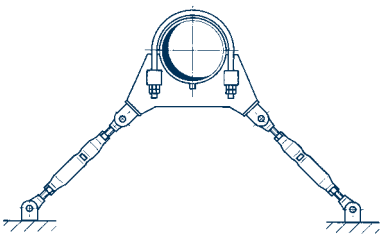
The dynamic clamps can also be exposed to permanent static stress. For this, the specified permissible stresses are reduced according to the following table:

pipe temperature	permiss. permanent tension stress
up to 350°C	100%
351°C – 450°C	100%
451°C – 500°C	80%
501°C – 510°C	80%
511°C – 530°C	65%
531°C – 560°C	55%
561°C – 580°C	65%
581°C – 600°C	60%

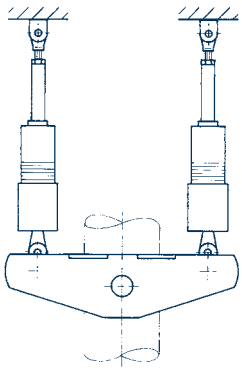
These specifications relate to the creep strength dependent on time in the 200,000 hr range at temperature ≥ 450°C.

Special designs

In some cases special designs are advisable in addition to the dynamic clamps type 36 and 37. In particular, for parallel and angulating arrangements, standardized design and calculation methods have been proved successful.

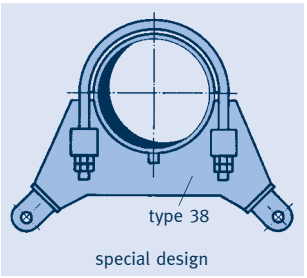


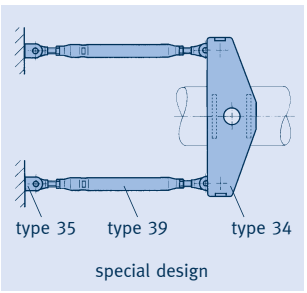
Special clamp for angulating arrangement

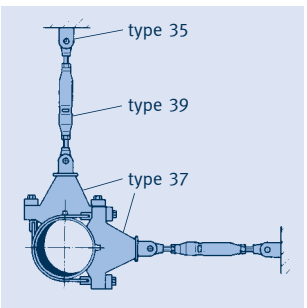


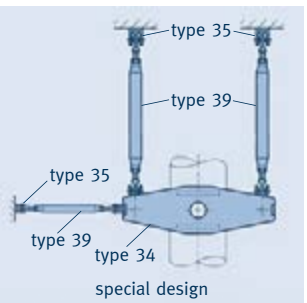
Dynamic axial clamp with snubbers

Special design type 37 with bolt of weld-on bracket in pipe axis direction







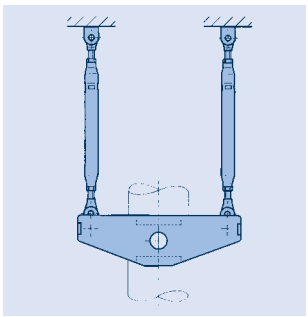


Horizontal axial stop with rigid strut type 39 and pipe clamp type 34 incl. spacer

Dynamic clamps Type 34

Dynamic stresses frequently arise in the direction of the pipe axis (e.g. from shock impacts or other forms of excitation). To absorb these loads the special dynamic clamp type 34 was developed.

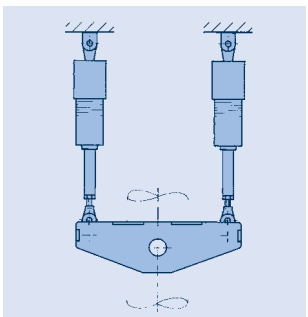
In vertically and horizontally running pipe systems, special clamps are being increasingly used for the defined determination of the pipe system positioning and also for the absorption of dynamic stresses in the direction of the pipe axis. The loads thereby occurring must be distributed via a form-fitting connection to the piping (trunnions). For this purpose LISEGA has developed the dynamic clamp type 34.



Type 34 as axial stop with spacer

Type 34

The basis of this design was the long time successful box-frame clamp type 46/48. The load distribution in dynamic clamp type 34 is effected by the use of reinforced cross-beams with weld-on brackets type 35 for connection to the dynamic main products type 30, 32, 39.



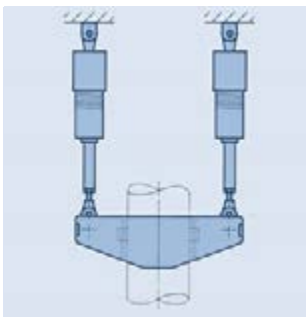
Type 34 with snubbers type 30 and trunnions

Design

For the design of the dynamic clamps type 34 the following parameters are required:

- **load (dynamic, static)**
- **pipe system temperature**
- **insulation thickness**
- **span width of the connections**
- **connection size and alignment of weld-on brackets type 35**
- **trunnion sizes**
- **trunnion tolerances**
- **position (horizontal/vertical)**
- **main components connected (type 30, 39, 32)**
- **twist restraint/recess dimensions if required**
- **spacer if required**

Due to the wide range of possible combinations and design parameters, dynamic clamps type 34 are designed individually on request.



Type 34 with rotated trunnion hole and snubber type 30

Type 34 with snubbers and position-securing devices

Securing positions

Position-securing measures ensure that the clamp cannot angle around the pipe (with the trunnion as pivot). The position-securing device is not dynamically stressed. It is either a recess in the trunnion socket-hole or additional plates.

Type 34 with recesses

Type 34 with additional plates

Horizontal axial stop with rigid struts type 39 and pipe clamp type 34

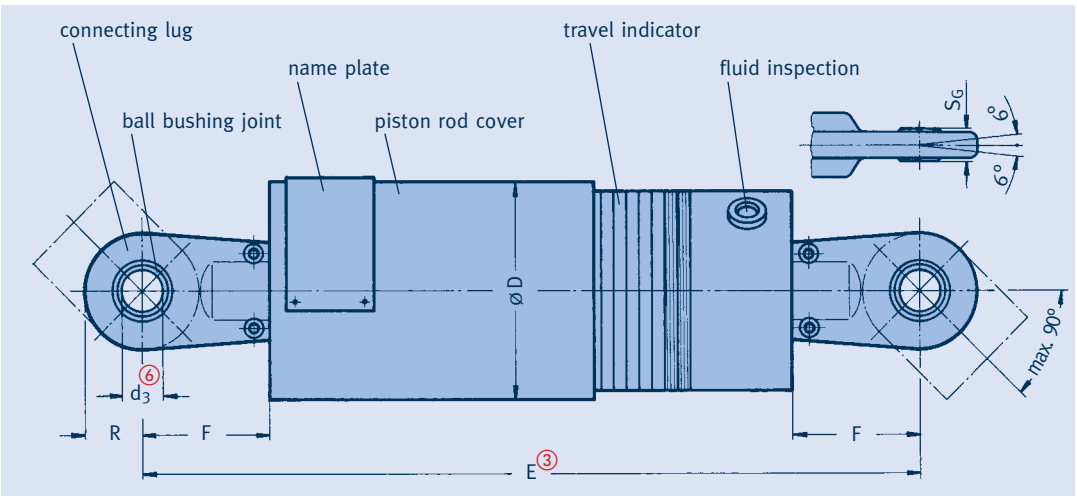
Pipe system secured with snubber type 30 on dynamic clamps type 36

Snubbers Type 30

Snubbers
type 30 18 16 to 30 03 12
Serial standard design.
Delivery from stock.

Only corrosion-resistant materials are used.

The connecting lugs attached by a connection thread (material P250GH, C45E+QT, S355J2, A668Cl. C/F, SA299) are galvanized.



type	nom. load [kN] ①	emergency Level C ②	stroke ⑤	ø D	ø d_3 ⑥	E ③ min	E ③ max	F ④	R	S_G	weight [kg]
30 18 16	3	4.0	100	54	10	220	320	18	15	9	1.9
30 38 16	8	10.6	100	70	12	315	415	50	20	10	4.3
30 39 16	8	10.6	200	70	12	410	610	50	20	10	5.7
30 42 16	18	23.9	150	85	15	395	545	58	22.5	12	8.3
30 43 16	18	23.9	300	85	15	545	845	58	22.5	12	12
30 52 13	46	61	150	135	20	445	595	65	30	16	20
30 53 13	46	61	300	135	20	595	895	65	30	16	29
30 62 16	100	141	150	170	30	535	685	100	45	22	37
30 63 16	100	141	300	170	30	685	985	100	45	22	51
30 72 16	200	267	150	200	50	615	765	130	60	35	61
30 73 16	200	267	300	200	50	765	1065	130	60	35	78
30 82 16	350	472	150	270	60	730	880	165	75	44	122
30 83 16	350	472	300	270	60	880	1180	165	75	44	147
30 92 13	550	735	150	300	70	760	910	165	105	49	175
30 93 13	550	735	300	300	70	910	1210	165	105	49	207
30 02 12	1000	1335	150	390	100	935	1085	240	147	70	390
30 03 12	1000	1335	300	390	100	1085	1385	240	147	70	460

Order details:
snubber type 30 .. ..
with 2 weld-on brackets type 35 .. ..
marking: ...

① See technical specifications, table: 'permissible loads' (p. 0.6) and 'welding of weld-on brackets' (p. 3.22).

② Usual design load for earthquakes and similar load cases. See also technical specifications on p. 0.6.

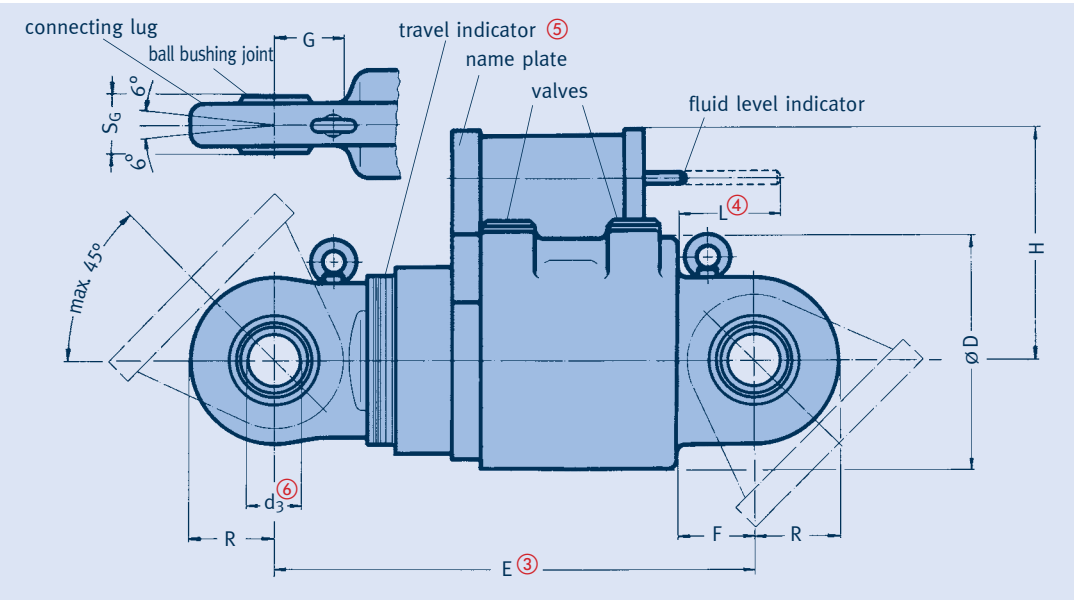
③ E_{min} = piston rod retracted
E_{max} = piston rod extended
To bridge greater installation lengths, extensions type 33 (p. 3.21) can be used.

④ On replacement of other makes, the connection dimensions such as pin diameters and lug lengths can be adapted to the connection designs already existing in the plant.

⑤ If required, snubbers with longer strokes can be supplied.

⑥ Connection possibilities: see bolt diameters of weld-on bracket type 35 or dynamic clamps in product group 3.

Snubbers Type 31



Snubbers type 31 98 16 to 31 58 16

Snubbers type 31 are specially conceived for the absorption of particularly heavy loads. They are mainly used in nuclear installations to secure steam generators and reactor codant pumps. Due to the normally very restricted installation space they are typically custom-built for the given conditions. The table on this page therefore serves as general orientation for initial planning.

The body and connecting lugs are made of high-tensile stainless steel castings.

type	nom. load [kN]①	emergency Level C②	stroke ⑤	ø D	ø d_3 ⑥	E③ min	E③ max	F	G	H	L_{max} ④	R	S_G	weight [kg]
31 98 16	550	735	100	240	70	620	720	95	90	310	115	105	49	152
31 99 16	550	735	200	240	70	735	935	95	90	310	145	105	49	181
31 08 16	1000	1335	100	330	100	765	865	120	110	385	145	140	70	285
31 09 16	1000	1335	200	330	100	880	1080	120	110	385	200	140	70	338
31 28 16	2000	2660	100	440	120	870	970	160	155	450	150	160	85	648
31 38 16	3000	4000	100	540	140	1020	1120	190	180	620	100	200	90	968
31 48 16	4000	5320	100	580	160	1050	1150	205	200	585	255	245	105	1300
31 58 16	5000	6650	100	630	180	1140	1240	230	220	670	205	290	105	1750

Order details:
snubber type 31 .. ..
marking: ...

① See technical specifications, table: 'permissible loads' (p. 0.6) and 'welding of weld-on brackets' (p. 3.22).

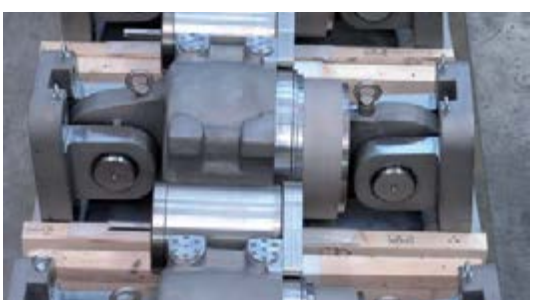
② Usual design load for earthquakes and similar load cases. See also technical specifications on p. 0.6.

③ E_{min} = piston rod retracted
E_{max} = piston rod extended

④ L_{max} at 80°C

⑤ Design of travel indicator for travel range 8 (100mm stroke).

⑥ Connection possibilities: see bolt diameters of weld-on brackets type 35 or dynamic clamps in product group 3



Snubber type 31 in special configuration

LISEGA snubbers type 31 are fitted with exchangeable valves for in-service tests on site.

Installation extensions Type 33

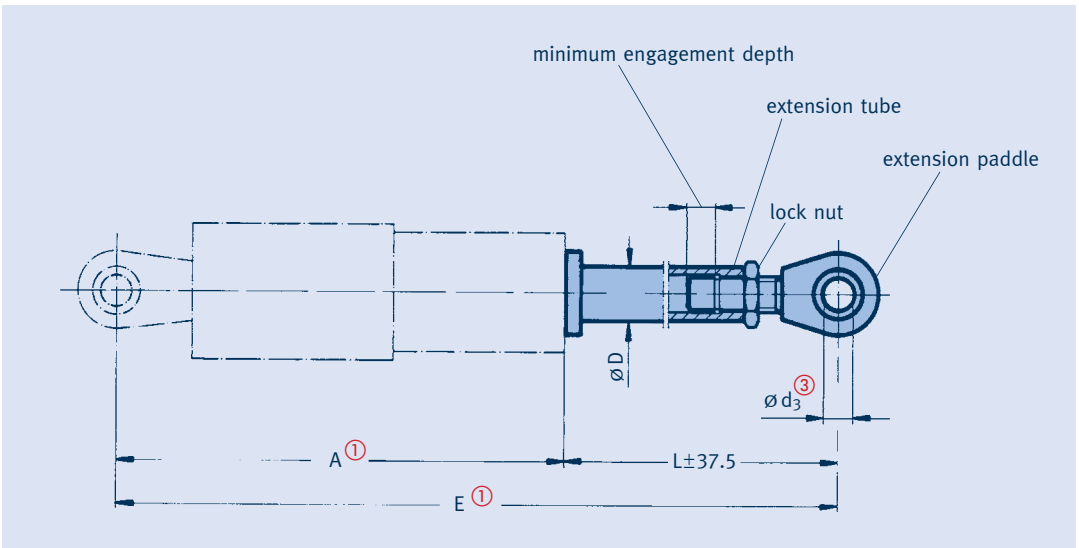
Installation extensions type 33 18 18 to 33 03 12
Serial standard design.

Type 33 extensions are used if greater installation lengths are required.

Connection to the snubber or energy absorber is made at the cylinder base. By means of serially-produced screw connections the change over easily be made from standard connecting lugs to extensions. This also applies to special connections, which are particularly useful when exchanging other makes, as in this way the connections on site can still be used. Further connection possibilities can be found on p. 3.6.

Material:
body P355NH

extension paddle P250GH
C45E+QT
S355J2



type	nom. load [kN]	snubber stroke	A ①	ø d_3 ③	D max	E ①② min	E ①② max	L±37.5 ② min	L±37.5 ② max	weight [kg] L_{min}	weight [kg] +per 100mm
33 18 18	3	100	240	10	25	445	760	205	520	0.80	0.39
33 38 18	8	100	315	12	30	515	760	200	445	1.00	0.55
33 39 18	8	200	460	12	30	660	690	200	230	1.00	0.55
33 42 18	18	150	412	15	35	617	1175	205	763	1.60	0.75
33 43 18	18	300	635	15	35	840	930	205	295	1.60	0.75
33 52 13	46	150	455	20	49	720	1405	265	950	3.70	0.73
33 53 13	46	300	680	20	49	945	1180	265	500	3.70	0.73
33 62 18	100	150	510	30	64	780	1900	270	1390	6.00	2.00
33 63 18	100	300	735	30	64	1005	1700	270	965	6.00	2.00
33 72 18	200	150	560	50	83	875	2415	315	1855	12.00	3.20
33 73 18	200	300	785	50	83	1100	2040	315	1255	12.00	3.20
33 82 18	350	150	640	60	102	1030	2400	390	1760	22.50	4.75
33 83 18	350	300	865	60	102	1255	2320	390	1455	22.50	4.75
33 92 13	550	150	670	70	115 127	1155 1671	1670 2870	485 1001	1000 2200	41.00 44.50	5.50 7.20
33 93 13	550	300	895	70	115 127	1380 1696	1695 2795	485 801	800 1900	41.00 44.50	5.50 7.20
33 02 12	1000	150	770	100	160	1415	2300	645	1530	92.00	9.50
33 03 12	1000	300	995	100	160	1640	2325	645	1330	92.00	9.50

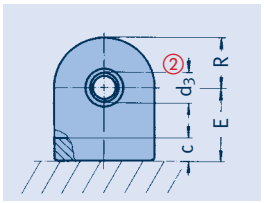
Order details:
installation extension
type 33 .. ..
L = ...mm for
hydr. snubber
or energy absorber

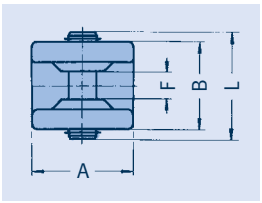
① For middle piston position.

② Installation dimensions larger than 'E' max. possible on load reduction. Smaller 'L' dimensions can also be supplied without adjustment possibility.

③ Connection possibilities: see bolt diameters of weld-on brackets type 35 or dynamic clamps in product group 3.

Weld-on brackets Type 35





Weld-on brackets type 35 19 13 to 35 20 19
Serial standard design.

This component is designed for connection of snubbers type 30 and 31, energy absorbers type 32 and for rigid struts type 39, 16, 20 and 27 and provides for attachment to the structure.

The brackets are made of the easily weldable material S355J2 and the precision-fit connecting bolts are of non-corroding material.

Order details:
weld-on bracket
type 35 .. ..

type	nom. load [kN]①	A	B	C	ø$d_3$②	E	F	L	R	weight [kg]
35 19 13	3	25	32	12	10	30	9.5	42	13	0.2
35 29 13	4	25	32	12	10	30	9.5	42	13	0.2
35 39 13	8	30	37	12	12	34	10.5	46	15	0.3
35 49 13	18	35	43	13	15	40	12.5	52	18	0.5
35 59 19	46	54	54	15	20	50	16.5	65	27	1.0
35 69 19	100	90	79	23	30	75	22.5	95	45	3.7
35 79 19	200	110	100	25	50	90	35.5	115	55	7.9
35 89 19	350	150	130	34	60	115	45	160	75	17.0
35 99 11	550	180	230	40	70	155	50	220	80	41.0
35 09 13	1000	390	310	58	100	212	72	305	100	132.0
35 20 19	2000	520	320	65	120	245	87	320	135	215.0

① See technical specifications, table 'permissible loads' (p. 0.6) and 'welding of weld-on brackets' (as shown below).

② Fit: H7 f8.

■ **If required, weld-on / bolt-on brackets in larger sizes are suppliable**

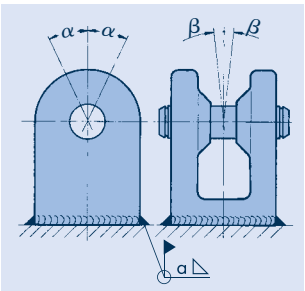
type	a α=15° β= 6°	a α=30° β= 6°	a α=45° β= 6°
35 19 13	3.0	3.0	3.0
35 29 13	3.0	3.0	3.0
35 39 13	3.0	3.0	3.0
35 49 13	3.0	4.0	5.0
35 59 19	5.5	7.0	8.0
35 69 19	7.5	9.5	11.0
35 79 19	10.5	13.5	15.5
35 89 19	14.5	18.0	21.0
35 99 11	15.0	20.0	23.0
35 09 13	14.0	17.0	19.0
35 20 19	23.0	–	–

Weld-on brackets should always be arranged so that the max. angulation results in the direction of the greatest thermal expansion during operation ($\sphericalangle\alpha$). The lateral deflection is restricted to $\pm 6°$ ($\sphericalangle\beta$). Misalignment of the weld-on brackets should be avoided due to the restricted possibility of movement caused.

The minimum weld seam thickness **'a'** for weld-on brackets type 35 is dependent on the angulations α and β. In the calculations a permissible stress of 90N/mm² in Load Case H was assumed.

On increasing the angulation α to 90°, the permissible loads are reduced by approx. 15% on constant weld seam thickness (a at α = 45°).

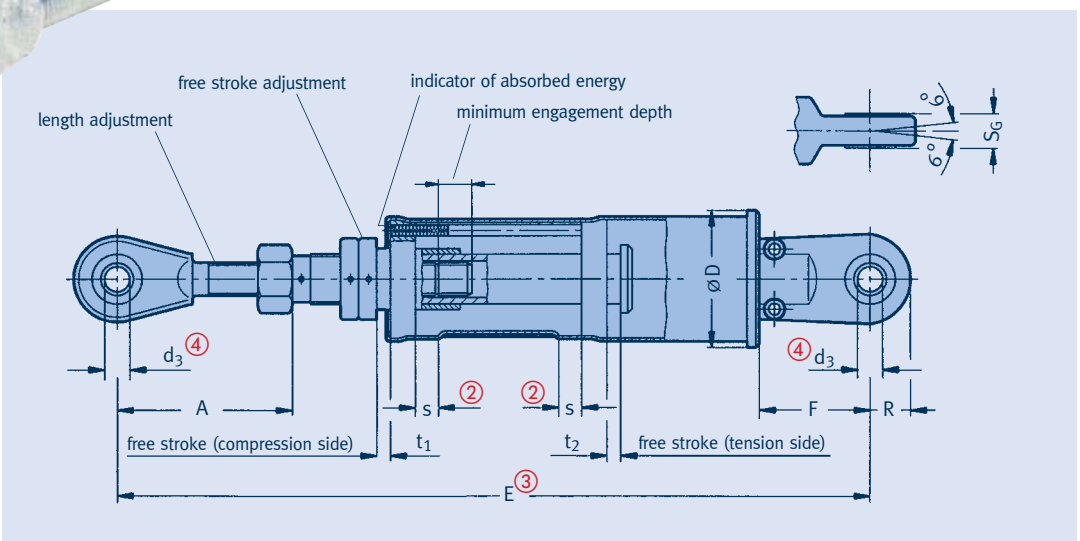
The basis for the permissible loads is provided by the relevant load table (**'technical specifications'**, p. 0.5).



Max. angulation type 35

Energy absorber Type 32

Energy absorber
type 32 18 16 to 32 92 16
Serial standard design.



① If the nominal load is exceeded, the increasing force and displacement are transformed into deformation energy.

② Max. deformation travel in compression and tension directions.

③ 'E' dimensions on middle position of the free strokes t_1/t_2 and length adjustment 'A' dimension. If t_2 changes, the 'E' dimension is correspondingly reduced or increased.

④ Connection possibilities: see bolt diameters of weld-on brackets Type 35 or dynamic clamps in Product Group 3.

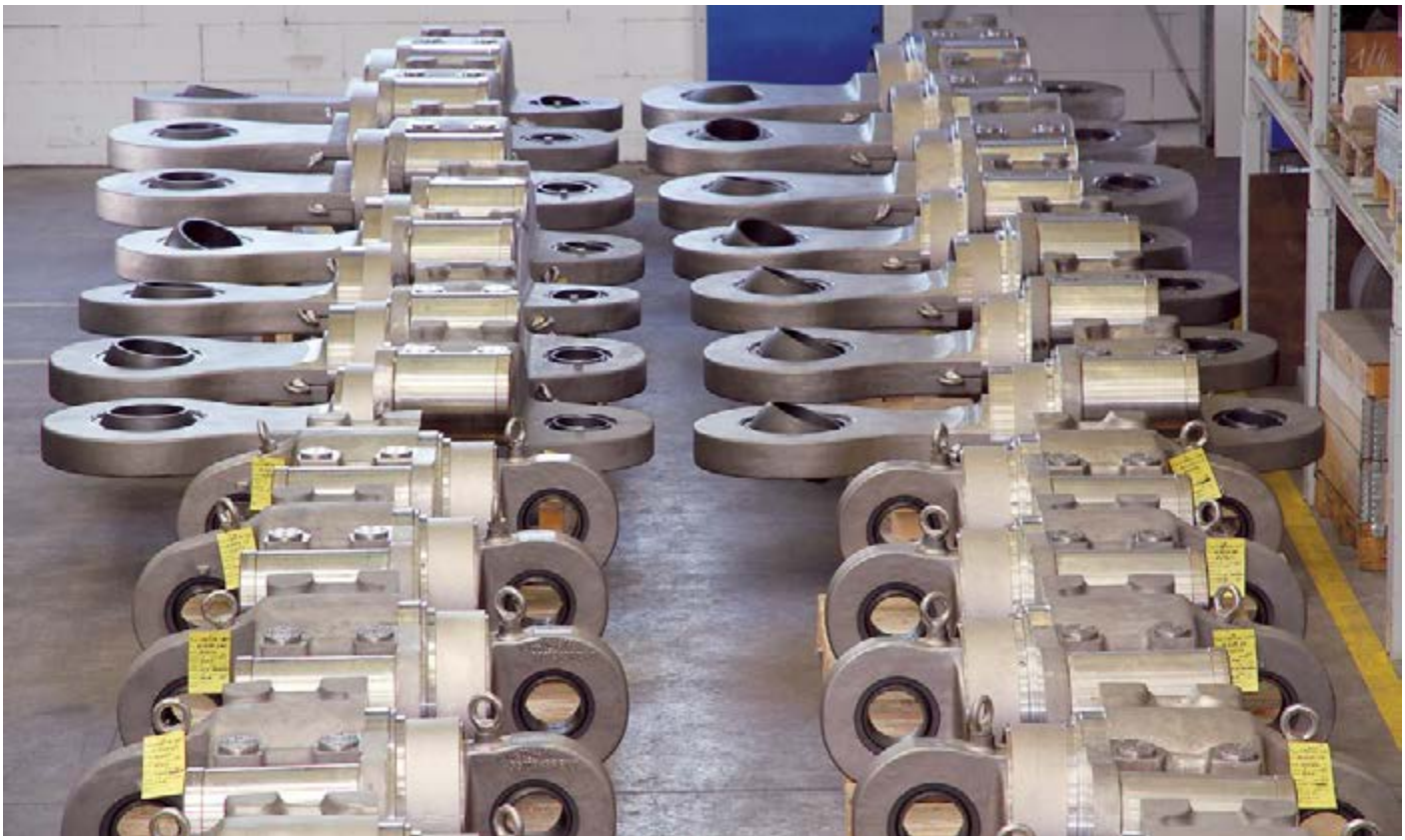
type	nom. load [kN]①	s②	t_1	t_2	ø D	ø d_3 ④	E③	A	F	R	S_G	weight [kg]
32 18 16	3	5.0	0-20	0-20	56	10	300	85 ± 50	18	15	9	0.8
32 38 16	8	5.0	0-22	0-22	60	12	355	95 ± 50	50	20	10	1.8
32 42 16	18	5.0	0-25	0-25	80	15	440	125 ± 75	58	22.5	12	3.6
32 52 16	46	5.0	0-25	0-25	115	20	490	150 ± 75	65	30	16	11.5
32 62 16	100	6.5	0-25	0-25	130	30	575	165 ± 75	100	45	22	18.5
32 72 16	200	9.5	0-28	0-28	195	50	715	175 ± 75	130	60	35	47.0
32 82 16	350	12.5	0-30	0-30	250	60	945	225 ± 75	165	75	44	105.0
32 92 16	550	on request										

Individual application

The standard designs shown in the table above represents only part of the suppliable range. The products can be adapted by LISEGA to the particular requirements of the user.

This applies especially to those cases where loads and strokes exceed standard parameters.

Order details:
energy absorber
type 32 .. 16
t_1 = ...mm, t_2 = ...mm
marking: ...

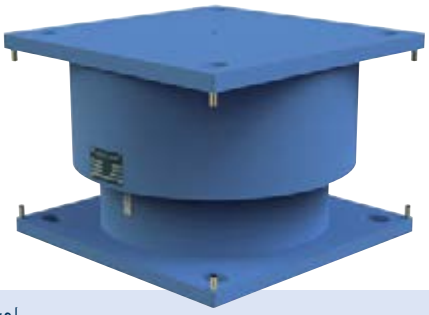


Snubbers type 31 prior to delivery

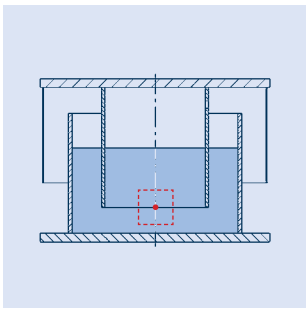
Type 31

Commissioning of type 30

Viscoelastic damper Type 3D .. 44-D



Viscoelastic damper type 3D 03 44-D to 3D H1 44-D



= working range round the mid-position

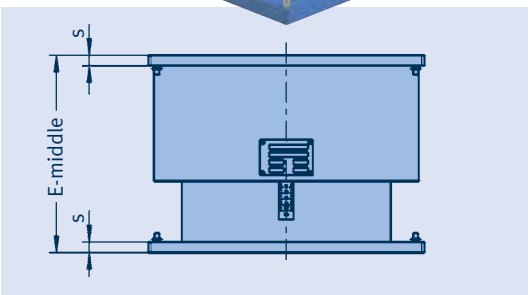
Selection and dimensions

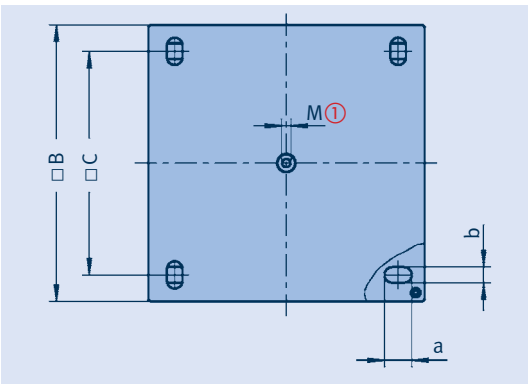
When selecting viscoelastic dampers attention should be paid to the **temperature existing on site**. These dampers are available for application temperatures ranging from 20°C to 80°C, whereby the various damping media cover a temperature range of 10°C in each case. **For this reason the correct selection of application temperature is important.**

The choice of damper size depends on the nominal load. The offset in horizontal and vertical directions must be considered for the cold load position. For LISEGA dampers in the 44-D series this amounts in each case to ± 40mm in horizontal/vertical directions.

Operation of the damper in mid-position should be aimed at. To achieve the necessary damping resistance the viscoelastic dampers should operate in the range ± 20mm from the mid-position. Before any start-up the dampers are to be preheated to operating temperature.

- **load range: 2.5kN up to 100kN**
- **frequency range: up to 35Hz**
- **temperature range: 20°C up to 80°C (in 10°C stages)**
- **offset (cold position) to mid-position: up to ± 40mm (horizontal/vertical)**





The table values are minimum values at ordered working temperature. At lower temperatures the damping resistance increases. If required, the equivalent stiffness (kN/mm) can be given in vertical and horizontal directions.

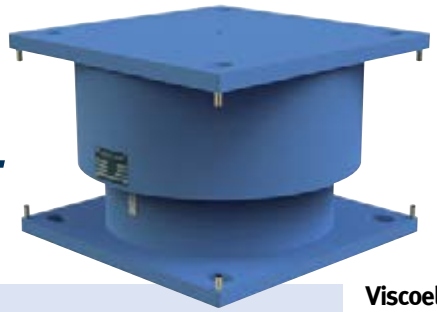
① Inner thread for transport ring screw.

Order details:
viscoelastic damper
type 3D .. 44-D
marking: ...
nominal load: ...kN
offset: ...
x: ...mm, y: ...mm, z: ...mm
operating temperature: ...°C

type	nom. load [kN]	E	□B	□C	s	a	b	M①	weight [kg]
3D 03 44-D	2.5	240	270	215	8	34	14	–	16
3D 05 44-D	5	240	290	230	8	34	14	–	19
3D 10 44-D	10	240	340	270	10	38	18	M16	31
3D 20 44-D	20	280	390	320	12	42	22	M16	51
3D 30 44-D	30	320	440	350	15	46	26	M16	84
3D 40 44-D	40	335	470	380	18	46	26	M16	109
3D 60 44-D	60	350	510	410	20	53	33	M16	149
3D 80 44-D	80	390	535	430	25	59	39	M16	191
3D H1 44-D	100	405	580	460	30	59	39	M16	246

type	nom. load [kN]	vertical damping resistance [kNs/m] 5 [Hz]	10 [Hz]	15 [Hz]	20 [Hz]	25 [Hz]	30 [Hz]	35 [Hz]	horizontal damping resistance [kNs/m] 5 [Hz]	10 [Hz]	15 [Hz]	20 [Hz]	25 [Hz]	30 [Hz]	35 [Hz]
3D 03 44-D	2.5	15.7	12.0	10.2	9.1	8.3	7.7	7.3	14.0	10.8	8.6	7.0	6.0	5.4	5.1
3D 05 44-D	5	27.8	21.1	18.0	16.0	14.7	13.7	12.9	23.7	18.3	14.6	12.0	10.2	9.1	8.6
3D 10 44-D	10	47.3	36.0	30.7	27.4	25.0	23.3	21.9	37.4	28.8	22.9	18.9	16.1	14.4	13.6
3D 20 44-D	20	89.3	67.9	57.9	51.6	47.3	44.0	41.4	94.0	72.5	57.8	47.5	40.6	36.3	34.2
3D 30 44-D	30	143.9	109.4	93.2	83.2	76.2	70.9	66.7	148.7	114.5	91.5	75.1	64.2	57.4	54.1
3D 40 44-D	40	162.7	123.7	105.4	94.1	86.1	80.1	75.4	229.9	177.1	141.2	116.2	99.2	88.7	83.6
3D 60 44-D	60	189.4	144.0	122.7	109.5	100.3	93.3	87.8	293.0	225.8	180.0	148.1	126.5	113.1	106.6
3D 80 44-D	80	229.9	174.8	148.9	132.9	121.7	113.2	106.5	367.3	283.0	225.6	185.6	158.5	141.8	133.7
3D H1 44-D	100	340.2	258.7	220.4	196.7	180.1	167.6	157.7	554.1	427.0	340.4	280.0	239.2	214.0	201.7

Viscoelastic dampers Type 3D .. 33-L, 3D .. 55-L



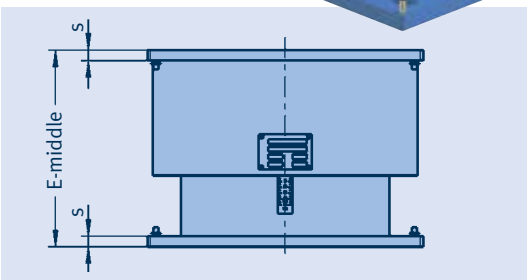
Selection and dimensions

When selecting viscoelastic dampers the **temperature on site** is important. Series 3D .. ..-L is designed for use in a temperature range from -10°C up to +40°C. In this temperature range the damper functions with relatively constant characteristics. The values were determined for a temperature of 20°C.

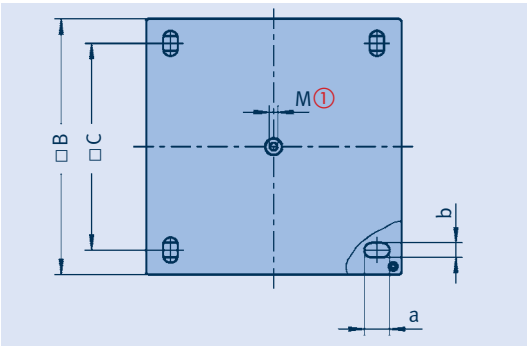
The choice of damper size depends on the nominal load. The offset in horizontal and vertical directions must be taken into account for the cold load position. For LISEGA dampers in the 33-L and 55-L series it amounts to ± 30mm and ± 50mm respectively in horizontal / vertical directions.

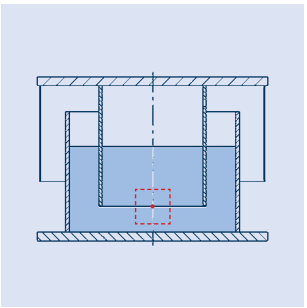
Operation of the damper in mid-position should be aimed at. To achieve the necessary damping resistance the viscoelastic dampers should be positioned in the range ± 20mm from the mid-position during operation. The dampers do not need to be preheated to operating temperature before start-up.

The table values are minimum values at 20°C. At lower temperatures the damping resistance increases. If required, the equivalent stiffness (kN/mm) can be given in vertical and horizontal directions.



Viscoelastic dampers type 3D 05 33-L to 3D 50 55-L





⬚ = working range round the mid-position

- **load range: 2.5kN up to 50kN**
- **frequency range: up to 35Hz**
- **temperature range: – 10°C up to + 40°C**
- **offset (cold position) to mid-position: up to ± 30mm (type 30 .. 33L) up to ± 40mm (type 30 .. 55L) (horizontal/vertical)**

type	nom. load [kN]	E	□B	□C	s	a	b	M①	weight [kg]
3D 05 33-L	5	270	260	195	10	38	18	M16	21
3D 10 33-L	10	270	295	230	10	38	18	M16	30
3D 15 33-L	15	280	335	265	15	42	22	M16	48
3D 25 33-L	25	290	425	340	20	46	26	M16	106
3D 40 33-L	40	300	540	440	25	53	33	M16	193
3D 50 33-L	50	380	590	480	30	59	39	M16	288

type	nom. load [kN]	E	□B	□C	s	a	b	M①	weight [kg]
3D 05 55-L	5	390	325	260	10	38	18	M16	39
3D 10 55-L	10	390	360	290	10	42	22	M16	49
3D 15 55-L	15	410	420	345	20	46	26	M16	107
3D 25 55-L	25	410	525	420	20	46	26	M16	158
3D 40 55-L	40	490	590	470	25	53	33	M16	282
3D 50 55-L	50	500	730	590	30	59	39	M16	489

① Inner thread for transport ring bolt

Order details:
viscoelastic damper
type 3D .. ..
marking: ...
nominal load: ...kN
offset: ...
x: ...mm, y: ...mm z: ...mm
operating temperature: ...°C

type	nom. load [kN]	vertical damping resistance [kNs/m] 5 [Hz]	10 [Hz]	15 [Hz]	20 [Hz]	25 [Hz]	30 [Hz]	35 [Hz]	horizontal damping resistance [kNs/m] 5 [Hz]	10 [Hz]	15 [Hz]	20 [Hz]	25 [Hz]	30 [Hz]	35 [Hz]
3D 05 ..-L	5	9.6	7.3	6.3	5.6	5.1	4.8	4.5	11.0	8.2	7.0	6.2	5.6	5.2	4.9
3D 10 ..-L	10	18.6	14.1	12.1	10.8	9.9	9.2	8.7	22.8	17.1	14.5	12.9	11.8	10.9	10.2
3D 15 ..-L	15	28.2	21.5	18.4	16.4	15.1	14.0	13.2	38.9	29.3	24.8	22.0	20.1	18.6	17.5
3D 25 ..-L	25	52.2	39.8	34.0	30.4	27.8	25.9	24.4	95.0	71.5	60.5	53.8	49.1	45.5	42.8
3D 40 ..-L	40	98.0	74.8	63.8	57.0	52.3	48.7	45.8	206.4	155.3	131.5	116.9	106.7	99.0	92.9
3D 50 ..-L	50	166.0	126.7	108.1	96.7	88.6	82.5	77.7	416.4	313.4	265.4	235.9	215.2	199.7	187.5

Rigid struts Type 39

Selection

When selecting rigid struts from the below tables, these points must be noted:

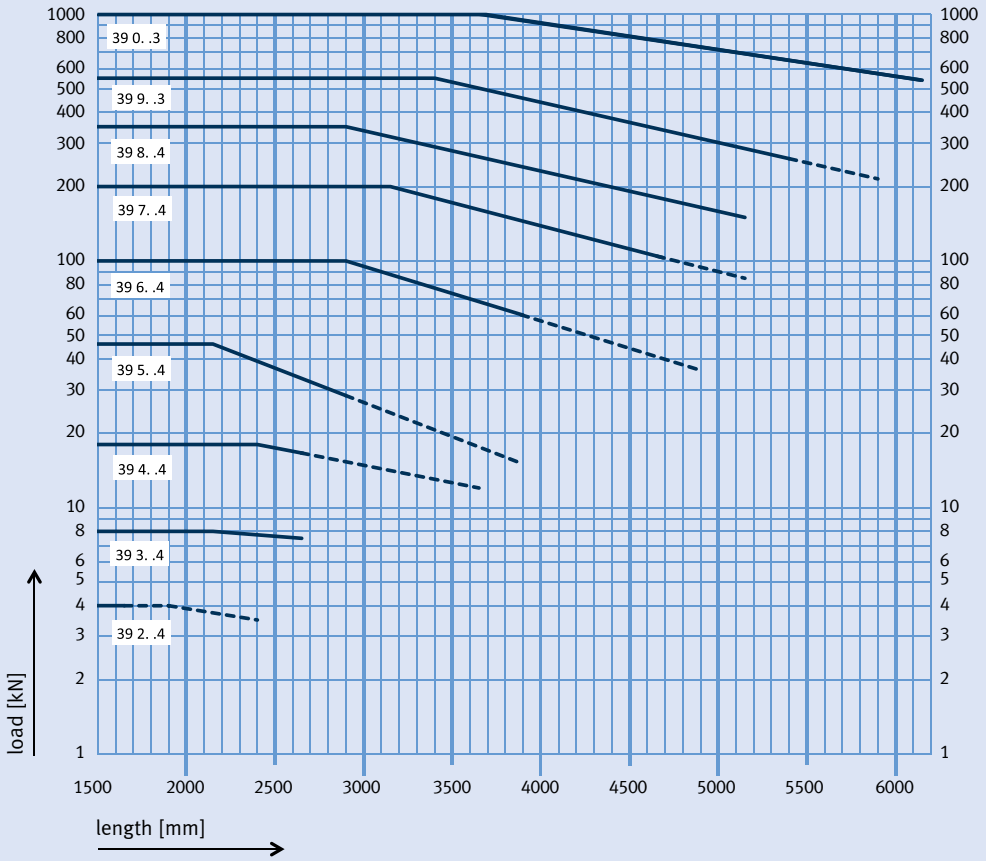
1. The specified operating load must be covered by the nominal load.
2. The load group is determined at the same time by the nominal load.
3. The adjustment range available for the rigid struts is given for the specified installation length.
4. The weight is specified at the intersection between load group and adjustment range. If the intersection lies below the red boundary line, it is a matter of an extended length with reduced load that must be checked in the diagram on p. 3.28 for agreement with the specified operating load.
5. When ordering, the type designation is to be completed at the 3rd place by entering the load group number.

Permissible loads and weights

			nominal load [kN]										nominal load [kN]	
			4	8	18	46	100	200	350				550	1000
			load group ①										load group ①	
type ①	adjustment range	'E' middle	2	3	4	5	6	7	8	type	adjustment range	'E' middle	9	0
			weight [kg]										weight [kg]	
39 .0 34	300 - 450	375	1.4	2.2	2.3					39 .0 83	800 - 950	875	71	
39 .0 44	400 - 550	475	1.9	2.9	3.0	7.0	7.6			39 .0 93	900 - 1050	975	77	
39 .0 54	500 - 650	575	2.3	3.6	3.7	8.5	9.1	15.9		39 .1 03	1000 - 1150	1075	82	172
39 .0 74	600 - 900	750	2.4	3.4	4.9	8.8	13	22		39 .1 13	1100 - 1250	1175		182
39 .0 84	750 - 900	825							40	39 .1 23	1200 - 1350	1275		192
39 .1 04	850 - 1150	1000	3.3	4.5	6.5	11	17	28	47	39 .1 33	1300 - 1450	1375		231
39 .1 24	1100 - 1400	1250	4.1	5.5	8.0	13	21	34	57	39 .1 23	1100 - 1400	1250	88	
39 .1 54	1350 - 1650	1500	4.9	6.6	10	14	25	40	67	39 .1 53	1350 - 1650	1500	121	247
39 .1 74	1600 - 1900	1750	(5.8)	7.6	11	16	29	46	77	39 .1 73	1600 - 1900	1750	139	270
39 .2 04	1850 - 2150	2000	(6.6)	12.5	13	18	33	52	86	39 .2 03	1850 - 2150	2000	157	294
39 .2 24	2100 - 2400	2250	(7.4)	14.1	15	20	37	58	96	39 .2 23	2100 - 2400	2250	175	350
39 .2 54	2350 - 2650	2500		15.7	16	22	41	65	106	39 .2 53	2350 - 2650	2500	193	379
39 .2 74	2600 - 2900	2750			(18)	24	45	71	115	39 .2 73	2600 - 2900	2750	211	409
39 .3 04	2850 - 3150	3000			(19)	(26)	49	77	125	39 .3 03	2850 - 3150	3000	229	438
39 .3 24	3100 - 3400	3250			(21)	(28)	53	83	135	39 .3 23	3100 - 3400	3250	247	467
39 .3 54	3350 - 3650	3500			(23)	(30)	57	89	144	39 .3 53	3350 - 3650	3500	265	497
39 .3 74	3600 - 3900	3750				(31)	61	95	154	39 .3 73	3600 - 3900	3750	283	526
39 .4 04	3850 - 4150	4000					(65)	101	164	39 .4 03	3850 - 4150	4000	301	555
39 .4 24	4100 - 4400	4250					(69)	107	174	39 .4 23	4100 - 4400	4250	319	585
39 .4 54	4350 - 4650	4500					(73)	113	183	39 .4 53	4350 - 4650	4500	337	614
39 .4 74	4600 - 4900	4750					(77)	(119)	193	39 .4 73	4600 - 4900	4750	355	644
39 .5 04	4850 - 5150	5000						(126)	203	39 .5 03	4850 - 5150	5000	372	673
										39 .5 23	5100 - 5400	5250	390	702
reduced loads for overlength (below red line) see diagram on p. 3.28										39 .5 53	5350 - 5650	5500	(408)	732
slenderness ratio λ ≤ 150, for greater lengths the slenderness ratio can range between										39 .5 73	5600 - 5900	5750	(426)	761
150 and 200; the weight of these rigid struts is given in brackets.										39 .6 03	5850 - 6150	6000		790

① The type designation is to be completed in the 3rd place with the load group.

Load diagram for extended lengths

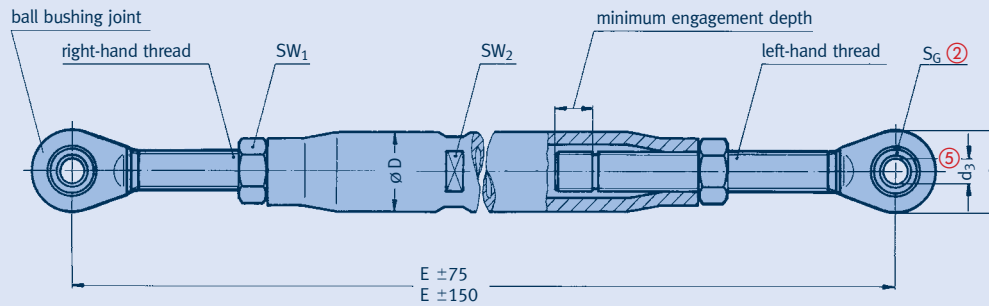


doted line: slenderness ratio: 150 ≤ λ ≤ 200

The diagram on the left shows the reduced load values against nominal load that must be taken into account for extended lengths.

Material:

body	P235GH
	P355NH
strut paddle	P250GH
	C45E+QT
	S355J2
	42CrMo4+QT



type ③	nom. load [kN]	A	ø D	ø d3 ⑤	E ④ min	E max	SW1	SW2	SG ②
39 2. .4	4	30	(30) 38	10	300	1900	27	(27) 32	9
39 3. .4	8	38	(40) 43/57	12	300	2150	32	(32) 36/46	10
39 4. .4	18	45	(40) 57	15	300	2400	36	(32) 46	12
39 5. .4	46	60	61	20	400	2150	60	50	16
39 6. .4	100	82	(60) 83	30	400	2900	60	(50) 70	22
39 7. .4	200	120	(75) 102	50	500	3150	70/75	(60) 85	35
39 8. .4	350	150	115	60	750	2900	95	100	44
39 9. .3	550	210	115/127	70	800	3400	110	100/110	49
39 0. .3	1000	293	159/169	100	1000	3650	155	135/145	70

① Minimum engagement depth on the ball bushing joint marked by an undercut.

② Ball bushing width.

③ The type designation is to be completed by the length index (4th and 5th places in the type designation, p. 3.27).

④ Due to their design, the rigid struts have freely variable adjustment, with right-hand / left-hand threads, similar to a turnbuckle. Shorter installation lengths for rigid struts are possible as special designs.

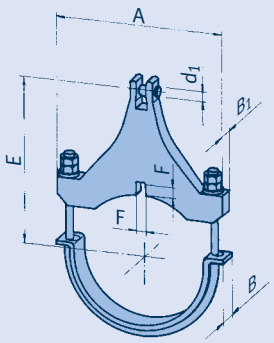
⑤ Connection possibilities: see bolt diameters of weld-on brackets type 35 or dynamic clamps type 36 / 37 in product group 3.

(...) Values in brackets: up to E_{max} = 650mm.

Depending on load group and length the struts are subject to alternative manufacturing technoloies which may result in designs different to the shown.

Order details:
rigid strut type 39 .. ..

Dynamic clamps
Selection overview OD 33.7 – OD 88.9



type 36 .. .1

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

OD 33.7 (ND 25)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 03 11	4.0	4.0	4.0								10	110	75	50	20	9	2	0.9
36 03 21			4.0	4.0	4.0						10	155	75	50	20	9	2	1.1
36 03 31					4.0	4.0	4.0	3.2			10	160	75	50	20	9	2	1.1
36 03 41								4.0	3.2	2.4	10	160	75	50	20	9	2	1.1

OD 42.4 (ND 32)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 04 11	8.0	8.0	8.0								12	130	85	50	20	9	3	1.2
36 04 21			7.2	6.3	5.8						12	175	85	50	20	9	3	1.4
36 04 31					4.0	4.0	4.0	3.1			10	175	85	50	20	9	2	1.3
36 04 41								4.0	3.3	2.5	10	175	85	50	20	9	2	1.3

OD 48.3 (ND 40)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 05 11	8.0	8.0	7.9								12	130	90	50	20	9	3	1.2
36 05 21			7.2	6.3	5.9						12	175	90	50	20	9	3	1.5
36 05 31					4.0	4.0	4.0	3.2			10	175	90	50	20	9	2	1.4
36 05 41								4.0	3.2	2.4	10	175	90	50	20	9	2	1.4

OD 60.3 (ND 50)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 06 11	16	15	12								15	150	110	50	25	9	4	1.9
36 06 21			8.0	8.0	8.0						12	190	110	50	25	9	3	2.2
36 06 31					8.0	8.0	7.9	5.1			12	195	110	50	25	9	3	2.2
36 06 41								6.5	5.3	3.8	12	195	110	50	25	9	3	2.2

OD 73.0 (ND 65)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 07 11	16	14	13								15	160	120	50	25	9	4	2.2
36 07 21			8.0	8.0	8.0						12	210	120	50	25	9	3	2.7
36 07 31					8.0	8.0	7.6	4.9			12	215	120	50	25	9	3	2.6
36 07 41								6.3	5.1	3.8	12	215	120	50	25	9	3	2.6

OD 76.1 (ND 65)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 08 11	16	14	13								15	160	125	50	25	9	4	2.2
36 08 21			8.0	8.0	8.0						12	210	125	50	25	9	3	2.7
36 08 31					8.0	8.0	7.6	4.9			12	215	125	50	25	9	3	2.7
36 08 41								6.3	5.1	3.8	12	215	125	50	25	9	3	2.7

OD 88.9 (ND 80)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 09 11	27	24	22								20	185	150	50	30	11	5	3.8
36 09 21			18	18	18						15	230	150	50	30	11	4	4.4
36 09 31					17	17	15	9.8			15	235	150	50	30	11	4	4.3
36 09 41								12	10	7.2	15	235	150	50	30	11	4	4.3

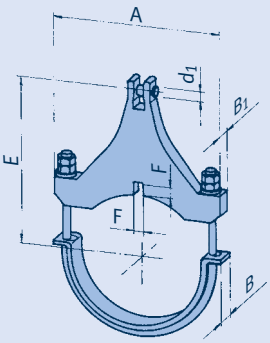
Dynamic clamps
Selection overview OD 108.0 – OD 159.0

OD 108.0 (ND 100)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 10 11	32	29	26								20	205	165	50	35	11	5	5.0
36 10 21			18	18	18						15	265	165	50	35	11	4	6.2
36 10 31					16	16	14	9.1			15	270	165	50	30	11	4	5.3
36 10 41								11	9.3	6.8	15	270	165	50	30	11	4	5.3

OD 114.3 (ND 100)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 11 11	31	29	26								20	210	175	50	35	11	5	5.1
36 11 21			18	18	18						15	270	175	50	35	11	4	6.5
36 11 24	46	46	46	46	42						20	280	175	100	60	13	5	12.3
36 11 31					16	16	13	9.0			15	280	175	50	30	11	4	5.5
36 11 34					41	41	35	22			20	290	175	100	60	13	5	12.4
36 11 41								11	9.1	6.8	15	280	175	50	30	11	4	5.6
36 11 44								28	21	14	20	290	175	100	60	13	5	12.4



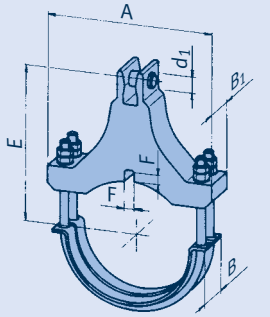
type 36 .. .1

OD 133.0 (ND 125)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 13 11	31	28	26								20	225	190	50	35	11	5	5.8
36 13 21			18	18	17						15	275	190	50	30	11	4	6.3
36 13 24	46	46	46	46	43						20	285	190	100	60	13	5	13.5
36 13 31					16	16	13	9.1			15	285	190	50	30	11	4	6.1
36 13 34					42	41	35	22			20	295	190	100	60	13	5	13.7
36 13 41								11	8.5	6.5	15	285	190	50	30	11	4	6.1
36 13 44								29	23	16	20	295	190	100	60	13	5	13.7

OD 139.7 (ND 125)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 14 11	31	28	26								20	230	200	50	35	11	5	6.1
36 14 21			18	18	16						15	285	200	50	30	11	4	6.7
36 14 24	60	55	50	43	40						30	320	200	100	60	13	6	16.9
36 14 31					16	16	13	8.9			15	295	200	50	30	11	4	6.4
36 14 34			46	45	41	40	34	22			20	305	200	100	60	13	5	14.5
36 14 41								11	8.5	6.5	15	295	200	50	30	11	4	6.4
36 14 44								29	23	16	20	305	200	100	60	13	5	14.5



type 36 .. .4

OD 159.0 (ND 150)

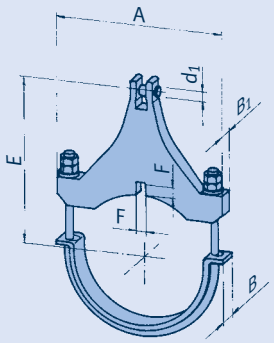
type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 16 11	30	28	25								20	245	220	50	35	11	5	6.8
36 16 21			18	18	16						15	300	220	50	30	11	4	7.5
36 16 24	59	54	49	43	40						30	335	220	100	60	13	6	18.7
36 16 31					16	15	13	8.8			15	310	220	50	30	11	4	7.2
36 16 34			46	44	41	40	34	22			20	320	220	100	60	13	5	16.2
36 16 41								11	8.8	6.7	15	310	220	50	30	11	4	7.2
36 16 44								28	23	17	20	320	220	100	60	13	5	16.2

① Calculation of intermediate values: linear interpolation.

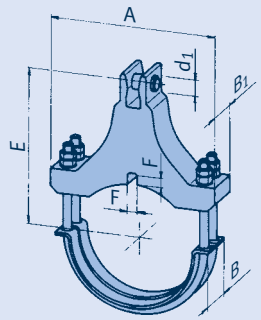
② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

Dynamic clamps
Selection overview OD 168.3 – OD 219.1



type 36 .. .1/2



type 36 .. .4

OD 168.3 (ND 150)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
36 17 11	29	26	24								20	270	230	50	35	11	5	7.7
36 17 12	50	46	36								30	270	240	50	45	11	6	11.4
36 17 21			18	17	16						15	315	230	50	30	11	4	8.1
36 17 22			35	29	28						20	315	240	50	40	11	5	11.0
36 17 24	59	54	49	43	40						30	340	230	100	60	13	6	19.5
36 17 31					16	15	13	8.6			15	320	230	50	30	11	4	7.7
36 17 32					18	18	18	14			15	320	240	50	40	11	4	10.4
36 17 34	100	95	87	76	70	69	58	38			30	345	240	100	80	16	6	26.8
36 17 41								11	9	6.8	15	320	230	50	30	11	4	7.7
36 17 42								16	13	9.8	15	320	240	50	40	11	4	10.4
36 17 44								49	40	29	30	345	240	100	80	16	6	26.9

OD 193.7 (ND 175)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
36 19 11	50	46	41								30	285	265	50	45	11	6	12.7
36 19 12	65	59	54								30	285	275	50	45	13	6	14.1
36 19 21			33	29	27						20	355	265	50	40	11	5	13.3
36 19 22			52	45	42						30	355	275	50	45	13	6	18.0
36 19 24	100	95	87	76	70						30	355	265	100	80	13	6	29.8
36 19 31					18	18	18	14			15	350	265	50	40	11	4	12.3
36 19 32					39	39	34	23			20	350	275	50	45	13	5	15.5
36 19 34					68	67	57	37			30	375	265	100	80	16	6	31.1
36 19 41								17	13	10	15	350	265	50	40	11	4	12.4
36 19 42								25	20	15	20	350	275	50	45	13	5	15.5
36 19 44								47	38	29	30	375	265	100	80	16	6	31.1

OD 219.1 (ND 200)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
36 22 11	49	45	41								30	310	290	50	45	11	6	14.4
36 22 12	65	59	55								30	310	300	50	45	13	6	16.0
36 22 21			32	28	26						20	385	290	50	40	11	5	14.2
36 22 22			50	44	41						30	385	300	50	45	13	6	20.2
36 22 24	100	93	85	74	68						30	385	290	100	80	13	6	34.1
36 22 31					18	18	18	14			15	370	290	50	40	11	4	12.3
36 22 32					40	40	35	22			20	370	300	50	45	13	5	16.4
36 22 34					67	66	56	36			30	395	290	100	80	16	6	34.7
36 22 41								17	13	10	15	370	290	50	40	11	4	12.3
36 22 42								26	20	15	20	370	300	50	45	13	5	16.4
36 22 44								47	38	28	30	395	290	100	80	16	6	34.7

① Calculation of intermediate values: linear interpolation.

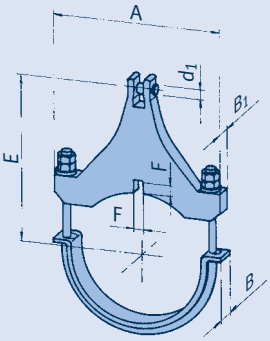
② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

Dynamic clamps
Selection overview OD 244.5 – OD 273.0

OD 244.5 (ND 225)

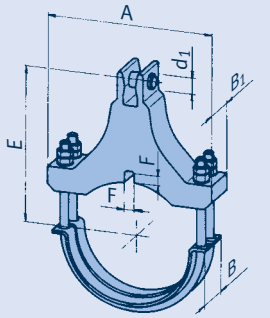
type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 24 11	49	45	41								30	320	315	50	45	11	6	15.3
36 24 12	65	59	53								30	320	330	50	45	13	6	17.0
36 24 21			32	28	26						20	400	315	50	40	11	5	15.3
36 24 22			50	44	40						30	400	330	50	45	13	6	21.6
36 24 24	100	92	85	74	68						30	400	315	100	80	13	6	36.0
36 24 25	149	137	125	109	100						50	415	330	100	90	16	7	49.2
36 24 31					18	18	18	14			15	395	315	50	40	11	4	13.7
36 24 32					37	37	33	22			20	395	330	50	45	13	5	17.9
36 24 34					63	62	55	36			30	420	315	100	80	16	6	36.6
36 24 35					95	93	83	54			30	420	330	100	90	16	6	44.3
36 24 41								18	14	10	15	395	315	50	40	11	4	13.7
36 24 42								24	18	13	20	395	330	50	45	13	5	17.9
36 24 44								44	34	26	30	420	315	100	80	16	6	36.6
36 24 45								66	52	38	30	420	330	100	90	16	6	44.3



type 36 .. .1/2

OD 267.0 (ND 250)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 26 11	49	44	41								30	335	340	50	45	11	6	16.5
36 26 12	65	59	54								30	335	350	50	45	13	6	18.2
36 26 21			32	28	26						20	410	340	50	40	11	5	16.0
36 26 22			50	44	40						30	410	350	50	45	13	6	22.2
36 26 24	100	93	85	74	68						30	410	340	100	80	13	6	37.3
36 26 25	150	137	125	109	101						50	425	350	100	90	16	7	51.0
36 26 31					18	18	18	14			15	410	340	50	40	11	4	14.4
36 26 32					38	38	34	22			20	410	350	50	45	13	5	18.8
36 26 34					66	64	55	35			30	435	340	100	80	16	6	38.3
36 26 35					97	96	83	54			30	435	350	100	90	16	6	46.5
36 26 41								18	14	11	15	410	340	50	40	11	4	14.4
36 26 42								25	19	15	20	410	350	50	45	13	5	18.9
36 26 44								46	36	27	30	435	340	100	80	16	6	38.3
36 26 45								68	53	40	30	435	350	100	90	16	6	46.5



type 36 .. .4/5

OD 273.0 (ND 250)

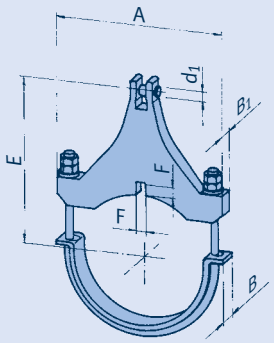
type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 27 11	48	44	40								30	345	345	50	45	11	6	17.2
36 27 12	65	59	54								30	345	355	50	45	13	6	18.9
36 27 14	110	101	88								50	360	345	100	80	13	7	34.9
36 27 15	165	151	130								50	360	355	100	90	16	7	42.4
36 27 21			32	27	25						20	420	345	50	40	11	5	16.5
36 27 22			50	43	40						30	420	355	50	45	13	6	22.8
36 27 24			84	73	67						30	420	345	100	80	13	6	38.4
36 27 25			124	108	100						50	435	355	100	90	16	7	52.5
36 27 31					18	18	18	13			15	435	345	50	40	11	4	15.4
36 27 32					37	37	32	21			20	435	355	50	45	13	5	20.1
36 27 34					63	62	53	34			30	460	345	100	80	16	6	41.5
36 27 35					95	94	81	52			30	460	355	100	90	16	6	49.5
36 27 41								17	14	10	15	435	345	50	40	11	4	15.4
36 27 42								24	18	13	20	435	355	50	45	13	5	20.1
36 27 44								44	36	27	30	460	345	100	80	16	6	41.5
36 27 45								67	52	38	30	460	355	100	90	16	6	49.5

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

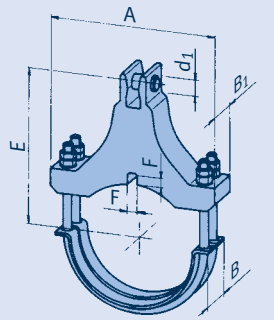
Dynamic clamps
Selection overview OD 323.9 – OD 355.6



type 36 .. .1/2/3

OD 323.9 (ND 300)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 32 11	44	40	37								20	380	400	60	40	11	5	20
36 32 12	65	59	56								30	380	415	60	45	13	6	24
36 32 13	100	100	88								30	380	430	60	60	13	6	34
36 32 14	163	149	137								50	395	415	120	90	16	7	52
36 32 15	200	200	177								50	395	430	120	120	16	7	72
36 32 21			31	27	25						20	450	400	60	40	11	5	21
36 32 22			49	43	40						30	450	415	60	45	13	6	28
36 32 23			88	73	69						30	450	430	60	60	13	6	38
36 32 24			123	107	99						50	465	415	120	90	16	7	61
36 32 25			186	172	165						50	465	430	120	120	21	7	86
36 32 31					18	18	18	13			15	450	400	60	40	11	4	20
36 32 32					38	38	32	21			20	470	415	60	45	13	5	25
36 32 33					71	70	59	38			30	470	430	60	60	13	6	39
36 32 34					98	97	82	53			30	470	415	120	90	16	6	56
36 32 35					157	155	145	94			50	485	430	120	120	21	7	85
36 32 41								17	14	11	15	450	400	60	40	11	4	19
36 32 42								25	19	15	20	470	415	60	45	13	5	25
36 32 43								48	37	27	30	470	430	60	60	13	6	39
36 32 44								69	56	42	30	470	415	120	90	16	6	56
36 32 45								117	91	71	50	485	430	120	120	21	7	85



type 36 .. .4/5

OD 355.6 (ND 350)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 36 11	44	40	37								20	395	435	60	40	11	5	22
36 36 12	65	59	56								30	395	445	60	45	13	6	26
36 36 13	100	100	96								30	395	465	60	60	13	6	36
36 36 14	165	151	138								50	410	445	120	90	16	7	56
36 36 15	200	200	193								50	410	465	120	120	16	7	77
36 36 21			30	26	24						20	480	435	60	40	11	5	22
36 36 22			48	42	39						30	480	445	60	45	13	6	30
36 36 23			89	74	71						30	480	465	60	60	13	6	42
36 36 24			121	105	97						50	495	445	120	90	16	7	66
36 36 25			186	172	165						50	495	465	120	120	21	7	93
36 36 31					18	18	18	13			15	475	435	60	40	11	4	21
36 36 32					38	37	31	20			20	495	445	60	45	13	5	27
36 36 33					70	69	59	38			30	495	465	60	60	13	6	41
36 36 34					97	96	81	53			30	495	445	120	90	16	6	61
36 36 35		200	200	175	164	162	143	93			50	510	465	120	120	21	7	91
36 36 41								17	13	10	15	475	435	60	40	11	4	21
36 36 42								26	20	16	20	495	445	60	45	13	5	27
36 36 43								49	39	28	30	495	465	60	60	13	6	42
36 36 44								68	55	41	30	495	445	120	90	16	6	61
36 36 45								119	95	73	50	510	465	120	120	21	7	91

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

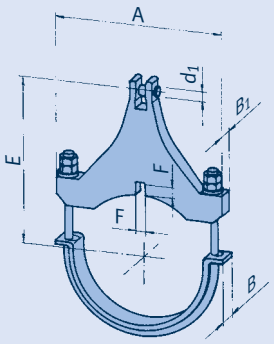
Dynamic clamps
Selection overview OD 368.0 – OD 406.4

OD 368.0 (ND 350)

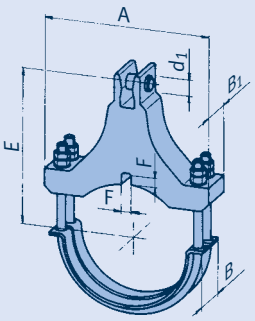
type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 37 11	44	41	37								20	400	445	60	40	11	5	22
36 37 12	65	59	56								30	400	455	60	45	13	6	26
36 37 13	100	100	99								30	400	475	60	60	13	6	36
36 37 14	166	151	139								50	415	455	120	90	16	7	57
36 37 15	279	256	181								60	440	475	120	120	16	8	88
36 37 21			31	27	24						20	485	445	60	40	11	5	23
36 37 22			48	42	39						30	485	455	60	45	13	6	31
36 37 23			89	76	72						30	485	475	60	60	13	6	42
36 37 24			121	105	97						50	500	455	120	90	16	7	67
36 37 25			186	168	159						50	500	475	120	120	21	7	94
36 37 31					18	18	18	13			15	480	445	60	40	11	4	22
36 37 32					38	37	31	20			20	500	455	60	45	13	5	28
36 37 33					70	69	59	38			30	500	475	60	60	13	6	42
36 37 34					97	96	81	53			30	500	455	120	90	16	6	62
36 37 35		200	200	178	167	165	143	93			50	515	475	120	120	21	7	92
36 37 41								17	14	11	15	480	445	60	40	11	4	23
36 37 42								23	18	14	20	500	455	60	45	13	5	27
36 37 43								49	39	29	30	500	475	60	60	13	6	42
36 37 44								68	55	41	30	500	455	120	90	16	6	62
36 37 45								120	97	73	50	515	475	120	120	21	7	93

OD 406.4 (ND 400)

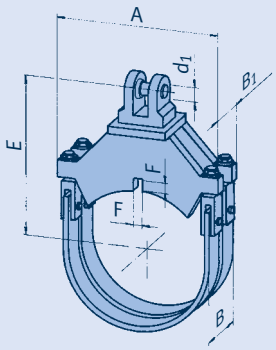
type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
36 41 11	43	40	36								20	430	485	60	40	11	5	24
36 41 12	65	59	54								30	430	495	60	45	13	6	29
36 41 13	100	100	100								30	430	515	60	60	13	6	40
36 41 14	163	150	137								50	445	495	120	90	16	7	64
36 41 15	277	253	232								60	470	515	120	120	21	8	98
36 41 21			30	26	24						20	510	485	60	40	11	5	25
36 41 22			48	41	38						30	510	495	60	45	13	6	34
36 41 23			89	77	71						30	510	515	60	60	13	6	46
36 41 24			120	105	97						50	525	495	120	90	16	7	73
36 41 25			186	172	165						50	525	515	120	120	21	7	104
37 41 27	350	338	290	244	229						60	580	490	310	230	21	8	187
36 41 31					18	18	18	13			15	510	485	60	40	11	4	24
36 41 32					37	36	31	20			20	530	495	60	45	13	5	30
36 41 33					69	68	58	37			30	530	515	60	60	13	6	46
36 41 34					96	94	80	52			30	530	495	120	90	16	6	67
36 41 35					164	162	142	92			50	545	515	120	120	21	7	99
37 41 37					226	223	215	161			60	600	490	310	230	21	8	191
36 41 41								17	14	10	15	510	485	60	40	11	4	23
36 41 42								25	19	15	20	530	495	60	45	13	5	30
36 41 43								48	39	29	30	530	515	60	60	13	6	46
36 41 44								67	55	41	30	530	495	120	90	16	6	67
36 41 45								118	96	72	50	545	515	120	120	21	7	101
37 41 47		307	291	266	250	247	231	161	126	94	60	600	490	310	230	21	8	191



type 36 .. .1/2/3



type 36 .. .4/5



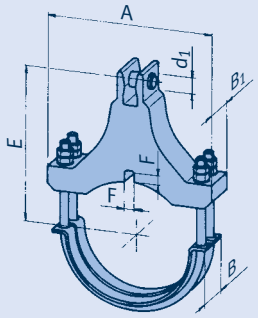
type 37 .. .7

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

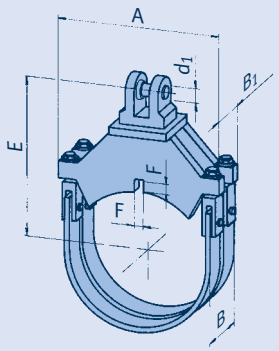
Dynamic clamps
Selection overview OD 419.0 – OD 457.2



type 36 .. .4/5

OD 419.0 (ND 400)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d1 ②	Emax ②	A	B	B1	F ③	max load gr. ②	wt. [kg]
36 42 11	43	39	36								20	440	495	60	40	11	5	25
36 42 12	65	59	55								30	440	510	60	45	13	6	30
36 42 13	100	100	100								30	440	525	60	60	13	6	42
36 42 14	163	149	136								50	455	510	120	90	16	7	66
36 42 15	276	253	231								60	480	525	120	120	21	8	101
36 42 21			29	26	24						20	530	495	60	40	11	5	26
36 42 22			47	40	37						30	530	510	60	45	13	6	35
36 42 23			87	76	70						30	530	525	60	60	13	6	48
36 42 24			118	103	95						50	545	510	120	90	16	7	76
36 42 25			186	172	165						50	545	525	120	120	21	7	108
37 42 27	350	336	289	243	228						60	595	500	310	230	21	8	192
36 42 31					18	18	18	13			15	520	495	60	40	11	4	25
36 42 32					37	36	31	20			20	540	510	60	45	13	5	31
36 42 33					69	68	57	37			30	540	525	60	60	13	6	48
36 42 34					95	93	79	51			30	545	510	120	90	16	6	69
36 42 35					158	156	140	91			50	560	525	120	120	21	7	102
37 42 37					226	224	215	161			60	605	500	310	230	21	8	194
36 42 41								17	14	10	15	520	495	60	40	11	4	24
36 42 42								25	21	15	20	540	510	60	45	13	5	31
36 42 43								48	39	29	30	540	525	60	60	13	6	47
36 42 44								66	54	40	30	545	510	120	90	16	6	69
36 42 45								117	93	69	50	560	525	120	120	21	7	104
37 42 47		307	291	266	250	247	231	161	126	94	60	605	500	310	230	21	8	194



type 37 .. .7/8

OD 457.2 (ND 450)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d1 ②	Emax ②	A	B	B1	F ③	max load gr. ②	wt. [kg]
36 46 11	42	38	35								20	470	535	60	40	13	5	29
36 46 12	65	59	55								30	470	545	60	45	13	6	34
36 46 13	100	100	100								30	470	565	60	60	13	6	47
36 46 14	160	147	134								50	485	545	120	90	16	7	72
36 46 15	273	250	229								60	510	565	120	120	21	8	111
36 46 21			29	26	24						20	550	535	60	40	13	5	29
36 46 22			46	40	37						30	550	545	60	45	13	6	38
36 46 23			87	76	70						30	550	565	60	60	13	6	52
36 46 24			115	100	92						50	585	545	120	90	16	7	84
36 46 25			186	172	165						50	585	565	120	120	21	7	118
37 46 27	350	336	289	242	228						60	615	540	310	230	21	8	203
36 46 31					18	18	18	13			15	550	535	60	40	13	4	27
36 46 32					36	35	30	19			20	570	545	60	45	13	5	35
36 46 33					68	66	56	37			30	570	565	60	60	13	6	52
36 46 34					93	92	78	51			30	575	545	120	90	16	6	74
36 46 35					166	163	139	90			50	590	565	120	120	21	7	114
37 46 37					225	222	214	160			60	635	540	310	230	21	8	208
37 46 38	550	504	433	364	342	337	321	223			70	675	550	340	250	26	9	294
36 46 41								16	13	10	15	550	535	60	40	13	4	26
36 46 42								25	20	15	20	570	545	60	45	13	5	34
36 46 43								47	38	29	30	570	565	60	60	13	6	52
36 46 44								65	53	40	30	575	545	120	90	16	6	75
36 46 45								116	94	70	50	590	565	120	120	21	7	115
37 46 47								160	125	94	60	635	540	310	230	21	8	208
37 46 48								223	170	125	70	675	550	340	250	26	9	294

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

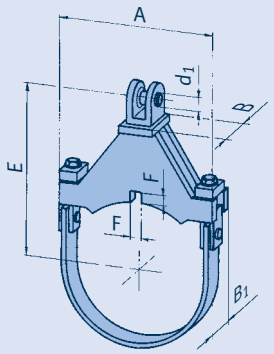
Dynamic clamps
Selection overview OD 508.0 – OD 558.8

OD 508.0 (ND 500)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 51 11	82	62	45								30	515	595	170	130	13	6	43
37 51 12	133	101	73								50	530	620	170	136	13	7	66
37 51 13	182	142	108								60	560	640	230	180	16	8	105
37 51 14	269	206	153								70	600	660	330	260	21	9	187
37 51 17	365	294	213								70	600	590	320	230	21	9	213
37 51 21			69	58	54						30	595	575	140	104	13	6	41
37 51 22			95	80	75						50	620	590	170	130	13	7	66
37 51 23			131	110	104						50	620	605	180	136	16	7	90
37 51 24			213	179	168						60	650	625	240	180	21	8	150
37 51 25			235	197	184						60	650	635	240	190	21	8	181
37 51 26	350	314	269	227	212						60	650	670	250	190	21	8	200
37 51 28	550	520	446	375	352						70	650	605	340	250	26	9	298
37 51 31					53	52	45	31			30	625	580	140	104	13	6	42
37 51 32					75	74	71	49			30	625	600	170	130	13	6	63
37 51 33					102	101	95	72			50	640	600	180	136	16	7	92
37 51 34					166	164	156	109			60	665	640	230	180	21	8	148
37 51 35					183	180	170	132			60	665	640	240	190	26	8	182
37 51 38					340	336	319	222			70	710	605	340	250	26	9	318
37 51 41								31	24	18	30	625	580	145	104	13	6	42
37 51 42								50	39	29	30	625	600	170	130	13	6	63
37 51 43								74	58	43	30	625	600	180	140	16	6	92
37 51 44								110	84	62	50	640	640	235	180	21	7	138
37 51 45								134	105	77	50	640	640	240	190	26	7	173
37 51 48	550	535	488	447	430	427	394	275	215	158	70	710	625	395	290	26	9	397

OD 558.8 (ND 550)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 56 11	81	62	44								30	550	645	170	130	13	6	47
37 56 12	133	100	72								50	565	670	170	136	13	7	70
37 56 13	181	142	108								60	595	690	230	180	16	8	111
37 56 14	269	206	153								70	635	705	330	260	21	9	195
37 56 17	365	295	213								70	635	645	320	230	21	9	228
37 56 21			67	57	53						30	640	630	140	104	13	6	45
37 56 22			94	79	74						50	655	640	170	130	13	7	70
37 56 23			131	110	103						50	655	655	180	136	16	7	96
37 56 24			212	178	167						60	680	675	240	180	21	8	157
37 56 25			234	197	184						60	680	685	240	190	21	8	190
37 56 26	350	313	269	226	211						60	680	720	250	190	21	8	210
37 56 28	550	504	433	364	342						70	725	655	340	250	26	9	337
37 56 31					53	52	45	31			30	650	630	140	104	13	6	46
37 56 32					75	74	72	49			30	650	650	170	130	13	6	67
37 56 33					102	101	95	72			50	665	650	180	136	16	7	96
37 56 34					166	164	155	108			60	695	690	230	180	21	8	154
37 56 35					182	180	170	132			60	695	690	240	190	21	8	191
37 56 38					340	336	319	222			70	735	655	340	250	26	9	334
37 56 39	550	550	485	408	382	377	355	276			70	735	665	400	290	26	9	410
37 56 41								31	24	18	30	650	630	145	104	13	6	46
37 56 42								50	39	29	30	650	650	170	130	13	6	67
37 56 43								72	57	42	50	665	650	180	136	16	7	100
37 56 44								108	82	61	60	695	690	235	180	21	8	154
37 56 45								132	103	76	60	695	690	240	190	21	8	191
37 56 48								222	169	125	70	735	655	340	250	26	9	334
37 56 49		550	537	473	443	437	396	276	216	159	70	735	665	400	290	26	9	410

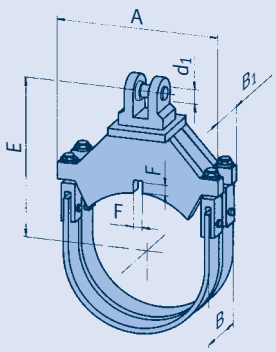


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

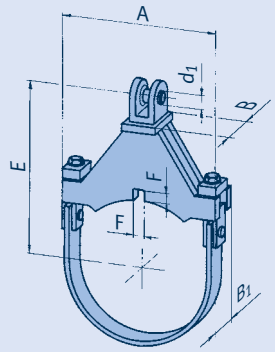
② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15).
Fit: H7 f8.

③ Shear lug dimensions:
F minus 1mm;
B_1 plus 2mm
(see p. 3.44).



type 37 .. .7/8/9

Dynamic clamps
Selection overview OD 609.6 – OD 660.4

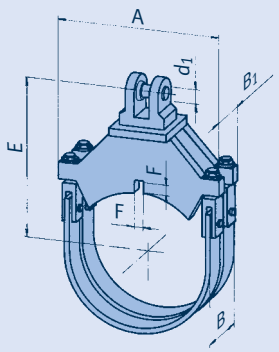


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15).
Fit: H7 f8.

③ Shear lug dimensions:
F minus 1mm;
B_1 plus 2mm
(see p. 3.44).



type 37 .. .7/8/9

OD 609.6 (ND 600)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
37 61 11	82	62	45								30	575	700	170	130	16	6	50
37 61 12	128	101	73								50	590	720	180	136	16	7	73
37 61 13	182	143	108								60	620	740	230	180	16	8	115
37 61 14	272	206	155								70	660	760	330	260	16	9	199
37 61 17	368	297	214								70	660	695	320	230	21	9	239
37 61 18	543	412	297								70	660	705	335	250	21	9	299
37 61 21			67	57	53						30	670	680	140	104	16	6	49
37 61 22			94	79	75						50	685	690	170	130	16	7	75
37 61 23			131	110	103						50	685	705	180	136	16	7	101
37 61 24			211	177	167						60	715	725	240	180	21	8	166
37 61 25			233	196	183						60	715	735	240	190	21	8	199
37 61 26			268	225	211						60	715	770	250	190	21	8	220
37 61 28	550	501	430	362	340						70	760	705	340	250	26	9	359
37 61 31					52	52	45	30			30	685	680	140	104	16	6	50
37 61 32					75	74	71	49			30	685	700	170	130	16	6	72
37 61 33					102	100	95	72			50	700	700	180	136	16	7	101
37 61 34					164	163	154	108			60	730	740	230	180	21	8	163
37 61 35					181	179	170	131			60	730	740	240	190	21	8	201
37 61 38					338	334	317	221			70	770	705	340	250	26	9	357
37 61 39	550	550	483	406	380	375	355	275			70	770	720	400	290	26	9	438
37 61 41								31	24	18	30	685	680	145	104	16	6	50
37 61 42								50	39	29	30	685	700	170	130	16	6	72
37 61 43								72	56	42	50	700	700	180	136	16	7	106
37 61 44								108	82	60	60	730	740	235	180	21	8	163
37 61 45								131	102	75	60	730	740	240	190	21	8	201
37 61 48		550	533	471	440	435	394	275	214	158	70	770	720	400	290	26	9	438
37 61 49						427	416	346	268	209	70	770	730	435	340	26	9	510

OD 660.4 (ND 650)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
37 66 11	82	62	45								30	605	750	170	130	16	6	51
37 66 12	127	101	73								50	620	770	185	136	16	7	78
37 66 13	182	143	109								60	650	790	230	180	16	8	120
37 66 14	272	206	155								70	690	810	330	260	16	9	207
37 66 17	369	298	215								70	690	745	320	230	21	9	252
37 66 18	545	413	298								70	690	755	335	250	21	9	316
37 66 21			69	58	55						30	700	730	145	110	16	6	56
37 66 22			96	81	76						50	715	745	175	136	16	7	86
37 66 23			131	110	103						50	715	760	180	136	16	7	105
37 66 24			211	177	166						60	750	775	240	180	21	8	175
37 66 25			233	196	183						60	750	785	240	190	21	8	209
37 66 26			267	225	210						60	750	820	250	190	21	8	231
37 66 28	550	500	429	361	339						70	790	755	340	250	26	9	382
37 66 31					54	53	46	31			30	715	730	145	110	16	6	57
37 66 32					76	75	73	50			30	715	755	175	136	16	6	84
37 66 33					102	101	95	72			50	730	755	180	136	16	7	106
37 66 34					166	164	155	108			60	755	790	230	180	21	8	171
37 66 35					182	180	170	132			60	755	790	240	190	21	8	209
37 66 38					338	334	317	221			70	795	755	340	250	26	9	377
37 66 39	550	550	483	406	380	375	355	275			70	795	770	400	290	26	9	460
37 66 41								32	25	18	30	715	730	145	110	16	6	57
37 66 42								51	39	30	30	715	755	180	136	16	6	89
37 66 43								72	56	42	50	730	755	180	136	16	7	111
37 66 44								108	82	61	60	755	790	235	180	21	8	171
37 66 45								132	103	76	60	755	790	240	190	21	8	209
37 66 48		535	488	447	430	427	394	275	215	158	70	795	770	400	290	26	9	460
37 66 49						427	416	346	268	209	70	795	780	435	340	26	9	536

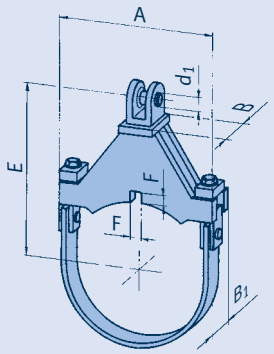
Dynamic clamps
Selection overview OD 711.2 – OD 762.0

OD 711.2 (ND 700)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 71 11	82	62	45								30	635	800	170	130	16	6	54
37 71 12	126	101	73								50	650	825	190	136	16	7	83
37 71 13	182	143	109								60	680	840	230	180	16	8	127
37 71 14	272	206	156								70	720	860	330	260	16	9	213
37 71 15	328	253	186								70	720	880	355	260	21	9	245
37 71 18	546	414	299								70	720	810	335	250	21	9	331
37 71 21			69	58	55						30	725	780	145	110	16	6	59
37 71 22			96	81	76						50	745	795	175	136	16	7	87
37 71 23			131	110	103						50	745	810	180	136	16	7	111
37 71 24			213	179	168						60	770	830	240	180	21	8	178
37 71 25			235	198	185						60	770	840	240	190	21	8	217
37 71 26			270	227	213						60	770	875	250	190	21	8	240
37 71 28	550	503	432	363	341						70	815	810	340	250	26	9	396
37 71 31					54	53	46	31			30	740	780	145	110	16	6	59
37 71 32					76	75	73	50			30	740	805	175	136	16	6	89
37 71 33					102	101	95	73			50	755	805	180	136	16	7	112
37 71 34					167	165	156	109			60	780	845	230	180	21	8	175
37 71 35					183	181	170	133			60	780	845	240	190	21	8	217
37 71 38					338	334	317	221			70	825	810	340	250	26	9	394
37 71 39	550	550	484	407	381	376	355	275			70	825	820	400	290	26	9	483
37 71 41								32	25	18	30	740	780	145	110	16	6	59
37 71 42								51	40	30	30	740	805	180	136	16	6	94
37 71 43								73	57	43	50	755	805	180	136	16	7	117
37 71 44								109	83	61	60	780	845	235	180	21	8	175
37 71 45								133	103	76	60	780	845	240	190	21	8	217
37 71 48		550	550	486	455	449	407	284	222	163	70	785	820	400	290	26	9	458
37 71 49						427	416	347	269	210	70	825	835	435	340	26	9	567

OD 762.0 (ND 750)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 76 11	82	62	44								30	665	850	170	130	16	6	58
37 76 12	126	101	73								50	680	875	190	136	16	7	85
37 76 13	182	143	109								60	710	895	235	180	16	8	133
37 76 14	285	216	156								70	750	910	330	260	16	9	226
37 76 15	329	251	187								70	750	930	345	260	21	9	249
37 76 16	407	308	233								70	750	935	370	260	21	9	276
37 76 18	547	414	299								70	750	860	335	250	21	9	349
37 76 21			69	57	54						30	760	835	145	110	16	6	63
37 76 22			96	81	76						50	775	845	175	136	16	7	92
37 76 23			131	110	103						50	775	860	180	136	16	7	117
37 76 24			213	179	168						60	800	880	240	180	21	8	186
37 76 26			271	228	213						60	800	925	250	190	21	8	249
37 76 28	550	504	433	364	342						70	845	860	340	250	26	9	417
37 76 31					54	53	46	31			30	765	835	145	110	16	6	63
37 76 32					77	76	73	51			30	765	855	175	136	16	6	89
37 76 33					103	102	95	73			50	780	855	180	136	16	7	117
37 76 34					168	166	157	110			60	805	895	230	180	21	8	182
37 76 35					185	182	170	133			60	805	895	240	190	21	8	225
37 76 38					341	336	320	223			70	850	860	340	250	26	9	411
37 76 39	550	550	487	410	383	378	355	277			70	850	870	400	290	26	9	504
37 76 41								32	25	18	30	765	835	145	110	16	6	63
37 76 42								52	40	30	30	765	855	180	140	16	6	94
37 76 43								74	58	43	50	780	855	180	140	16	7	123
37 76 44								110	83	61	60	805	895	235	180	21	8	182
37 76 45								133	104	77	60	805	895	240	190	21	8	225
37 76 48		550	538	475	444	439	398	277	216	160	70	850	870	400	290	26	9	504
37 76 49						427	416	349	271	211	70	850	885	435	340	26	9	582

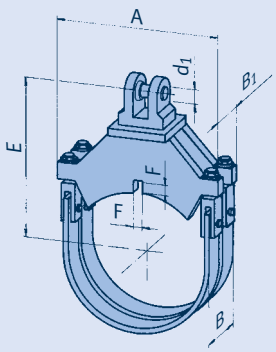


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

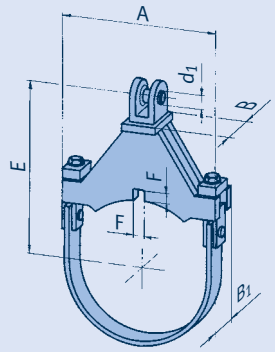
② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15).
Fit: H7 f8.

③ Shear lug dimensions:
F minus 1mm;
B_1 plus 2mm
(see p. 3.44).



type 37 .. .8/9

Dynamic clamps
Selection overview OD 812.8 – OD 863.6

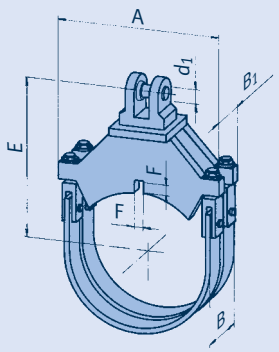


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15).
Fit: H7 f8.

③ Shear lug dimensions:
F minus 1mm;
B_1 plus 2mm
(see p. 3.44).



type 37 .. .8/9

OD 812.8 (ND 800)

type	permissible load [kN] 100	250	350	450	500	510	530	560	580	600°C	d_1	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
37 81 11	76	59	42								30	700	905	170	130	16	6	60
37 81 12	126	100	72								50	715	925	185	136	16	7	90
37 81 13	183	143	108								60	745	950	235	180	16	8	135
37 81 14	284	215	155								70	785	960	330	260	16	9	235
37 81 15	328	248	186								70	785	985	345	260	21	9	258
37 81 16	399	307	233								70	785	985	370	260	21	9	286
37 81 18	545	413	298								70	785	910	335	250	21	9	372
37 81 21			69	58	54						30	790	885	145	110	16	6	67
37 81 22			96	81	76						50	805	895	175	136	16	7	101
37 81 23			131	110	103						50	805	910	180	136	16	7	123
37 81 24			214	180	169						60	830	930	240	180	21	8	195
37 81 26			271	228	213						60	830	975	250	190	21	8	261
37 81 28	550	505	434	365	343						70	875	910	340	250	26	9	440
37 81 31					54	54	46	32			30	790	885	145	110	16	6	66
37 81 32					77	76	74	51			30	790	905	175	136	16	6	98
37 81 33					103	102	95	71			50	805	905	180	136	16	7	121
37 81 34					169	167	158	107			60	830	945	230	180	21	8	191
37 81 35					186	183	170	134			60	830	945	240	190	21	8	234
37 81 38					343	338	321	224			70	875	910	340	250	26	9	432
37 81 39	550	550	490	412	385	381	360	279			70	875	920	400	290	26	9	523
37 81 41								32	25	19	30	790	885	145	110	16	6	66
37 81 42								52	40	30	30	790	905	180	140	16	6	104
37 81 43								74	58	43	50	805	905	180	140	16	7	127
37 81 44								110	84	62	60	830	945	250	180	21	8	193
37 81 45								134	105	77	60	830	945	270	190	21	8	236
37 81 48		550	541	478	447	441	400	279	217	160	70	875	920	400	290	26	9	523
37 81 49						427	416	351	273	213	70	875	935	435	340	26	9	612

OD 863.6 (ND 850)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
37 86 11	79	61	43								30	725	955	155	130	16	6	66
37 86 12	125	100	72								50	740	980	170	136	16	7	101
37 86 13	179	143	109								60	770	990	215	180	16	8	145
37 86 14	277	216	156								70	810	1015	295	260	16	9	243
37 86 15	317	248	187								70	810	1035	295	260	21	9	273
37 86 16	387	307	233								70	815	1040	305	260	21	9	304
37 86 18	518	415	300								70	810	965	335	250	21	9	393
37 86 21			69	58	55						30	815	935	145	110	16	6	72
37 86 22			96	81	76						50	830	950	180	136	16	7	113
37 86 23			132	111	104						50	830	965	200	136	16	7	136
37 86 24			215	181	170						60	855	985	260	180	21	8	211
37 86 26			273	229	214						60	855	1030	240	190	21	8	286
37 86 28	550	509	437	367	345						70	900	965	340	250	26	9	474
37 86 31					55	54	47	32			30	815	935	145	110	16	6	70
37 86 32					77	76	74	51			30	815	960	180	136	16	6	109
37 86 33					104	103	95	72			50	830	960	180	136	16	7	133
37 86 34					170	168	159	110			60	855	1000	235	180	21	8	207
37 86 35					187	184	170	135			60	855	1000	235	190	21	8	255
37 86 38					345	341	323	225			70	900	965	340	250	26	9	465
37 86 39	550	550	493	415	388	383	360	281			70	900	975	400	290	26	9	564
37 86 41								32	25	19	30	815	935	145	110	16	6	70
37 86 42								52	41	31	30	815	960	180	140	16	6	116
37 86 43								74	58	44	50	830	960	180	140	16	7	140
37 86 44								111	84	62	60	855	1000	250	180	21	8	207
37 86 45								135	105	78	60	855	1000	270	190	21	8	255
37 86 48		550	545	481	450	444	403	281	219	162	70	900	975	400	290	26	9	566
37 86 49						427	416	353	274	214	70	900	990	435	340	26	9	659

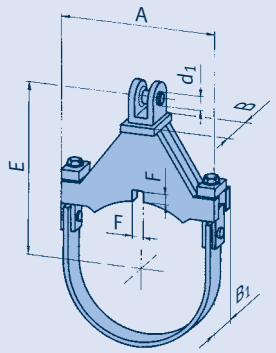
Dynamic clamps
Selection overview OD 914.4 – OD 965.2

OD 914.4 (ND 900)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 91 11	75	61	43								30	760	1005	180	130	16	6	69
37 91 12	121	100	72								50	775	1030	185	136	16	7	100
37 91 13	181	143	108								60	805	1045	250	180	16	8	146
37 91 14	285	216	156								70	845	1065	330	260	16	9	245
37 91 15	329	248	186								70	845	1085	365	260	21	9	275
37 91 16	400	301	233								70	845	1090	390	260	21	9	306
37 91 18	544	413	299								70	845	1015	335	250	21	9	394
37 91 21			69	58	55						30	840	985	145	110	16	6	72
37 91 22			97	81	77						50	855	1000	175	136	16	7	112
37 91 23			132	111	104						50	855	1015	220	136	16	7	137
37 91 24			216	181	170						60	880	1035	240	180	21	8	213
37 91 26			274	230	215						60	880	1080	250	190	21	8	288
37 91 28	550	511	438	368	346						70	925	1015	340	250	26	9	478
37 91 29	550	550	495	416	390						70	925	1025	400	290	26	9	574
37 91 31					54	53	46	32			30	850	985	145	110	16	6	73
37 91 32					77	76	74	51			30	850	1010	175	136	16	6	110
37 91 33					103	102	95	68			50	865	1010	180	136	16	7	134
37 91 34					170	168	156	97			60	880	1050	230	180	21	8	206
37 91 35					187	185	170	135			60	880	1050	240	190	21	8	258
37 91 38					343	339	322	225			70	935	1015	340	250	26	9	475
37 91 39					387	382	360	280			70	935	1025	400	290	26	9	579
37 91 41								32	25	18	30	850	985	145	110	16	6	73
37 91 42								52	40	30	30	850	1010	180	140	16	6	117
37 91 43								74	58	43	50	865	1010	180	140	16	7	141
37 91 44								111	84	62	60	880	1050	260	180	21	8	208
37 91 45								135	106	78	60	880	1050	320	190	21	8	264
37 91 48		550	544	479	449	443	402	280	219	161	70	935	1025	400	290	26	9	579
37 91 49						427	416	353	274	214	70	935	1040	435	340	26	9	680

OD 965.2 (ND 950)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 97 11	75	58	41								30	785	1055	155	130	16	6	72
37 97 12	128	103	74								50	800	1080	180	150	16	7	112
37 97 13	181	146	111								60	830	1090	230	195	16	8	163
37 97 14	277	216	156								70	870	1115	295	260	16	9	262
37 97 15	328	249	187								70	870	1135	290	260	21	9	296
37 97 16	387	324	234								70	870	1140	295	260	21	9	353
37 97 18	518	415	300								70	870	1065	335	250	21	9	430
37 97 21			69	59	55						30	865	1040	145	110	16	6	81
37 97 22			100	84	79						50	880	1060	180	146	16	7	118
37 97 23			144	119	113						50	880	1080	225	186	16	7	152
37 97 24			225	186	177						60	905	1090	250	205	21	8	231
37 97 26			295	247	232						60	905	1130	300	250	21	8	308
37 97 28	550	513	440	370	348						70	950	1065	340	250	26	9	512
37 97 29	550	550	498	418	391						70	950	1075	400	290	26	9	603
37 97 31					51	51	48	33			30	875	1040	145	120	16	6	81
37 97 32					79	78	76	52			30	875	1060	180	146	16	6	115
37 97 33					115	113	105	67			50	890	1080	225	186	16	7	151
37 97 34					170	168	166	98			60	905	1105	240	205	21	8	224
37 97 35					202	199	185	140			60	905	1125	295	250	21	8	293
37 97 38					345	341	324	226			70	960	1065	340	250	26	9	510
37 97 39		550	512	431	403	398	380	292			70	960	1075	440	330	26	9	613
37 97 41								33	26	19	30	875	1040	145	120	16	6	81
37 97 42								53	41	31	30	875	1080	180	150	16	6	124
37 97 43								82	64	48	50	890	1080	225	190	16	7	159
37 97 44								115	88	65	60	905	1100	240	205	21	8	221
37 97 45								146	114	84	60	905	1120	295	250	21	8	288
37 97 48		550	546	482	450	445	403	281	220	162	70	960	1075	400	290	26	9	608
37 97 49						427	416	354	275	215	70	960	1090	435	340	26	9	690

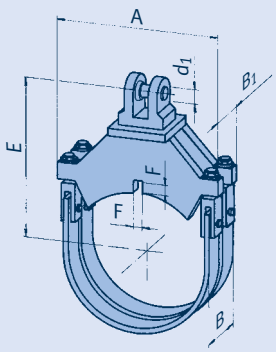


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

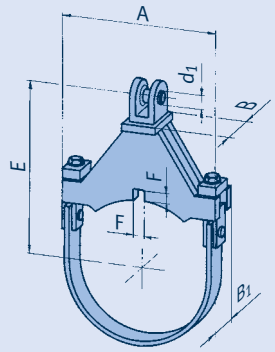
② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15).
Fit: H7 f8.

③ Shear lug dimensions:
F minus 1mm;
B_1 plus 2mm
(see p. 3.44).



type 37 .. .8/9

Dynamic clamps
Selection overview OD 1016 – OD 1067

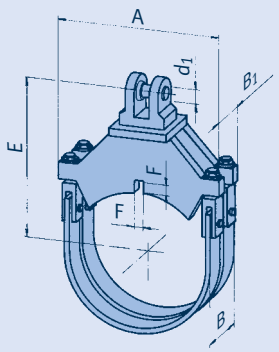


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).



type 37 .. .8/9

OD 1016 (ND 1000)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
37 T0 11	77	59	42								30	810	1110	165	130	16	6	76
37 T0 12	120	102	74								50	825	1130	180	150	16	7	111
37 T0 13	182	142	111								60	855	1140	230	195	16	8	166
37 T0 14	281	217	157								70	895	1165	295	260	16	9	267
37 T0 15	323	250	188								70	895	1185	295	260	21	9	298
37 T0 16	387	328	237								70	895	1190	305	270	21	9	359
37 T0 18	518	416	301								70	895	1115	335	250	21	9	435
37 T0 21			70	59	55						30	890	1090	145	110	16	6	82
37 T0 22			100	84	79						50	905	1110	180	146	16	7	117
37 T0 23			141	117	111						50	905	1130	225	186	16	7	155
37 T0 24			225	187	177						60	930	1140	250	205	21	8	236
37 T0 26			290	240	228						60	930	1180	300	250	21	8	324
37 T0 28	550	515	442	371	349						70	975	1115	340	250	26	9	519
37 T0 29	550	550	499	420	393						70	975	1125	400	290	26	9	606
37 T0 31					52	51	48	33			30	900	1090	145	120	16	6	81
37 T0 32					79	78	76	52			30	900	1110	180	146	16	6	113
37 T0 33					115	114	106	66			50	915	1130	225	186	16	7	154
37 T0 34					171	169	167	103			60	930	1155	240	205	21	8	226
37 T0 35					203	200	185	137			60	930	1175	295	250	21	8	295
37 T0 38					346	342	325	226			70	985	1115	340	250	26	9	513
37 T0 39		550	514	433	405	400	380	293			70	985	1125	440	330	26	9	620
37 T0 41								33	26	19	30	900	1090	145	120	16	6	81
37 T0 42								53	42	31	30	900	1130	180	150	16	6	122
37 T0 43								82	64	48	50	915	1130	225	190	16	7	159
37 T0 44								116	88	65	60	930	1150	240	205	21	8	225
37 T0 45								147	114	84	60	930	1170	295	250	21	8	288
37 T0 48		550	548	484	452	447	405	282	220	163	70	985	1125	400	290	26	9	614
37 T0 49						427	416	356	276	216	70	985	1140	435	340	26	9	726

OD 1067 (ND 1050)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load ② gr.	wt. [kg]
37 T1 11	76	59	42								30	835	1160	165	130	16	6	86
37 T1 12	120	100	75								50	850	1185	180	150	16	7	121
37 T1 13	182	141	111								60	880	1190	230	195	16	8	179
37 T1 14	281	218	157								70	920	1220	295	260	16	9	282
37 T1 15	323	254	187								70	930	1240	295	260	21	9	318
37 T1 16	387	327	236								70	930	1245	305	270	21	9	362
37 T1 18	518	417	302								70	920	1170	335	250	21	9	470
37 T1 21			70	59	55						30	915	1140	145	110	16	6	88
37 T1 22			100	84	79						50	930	1165	180	146	16	7	127
37 T1 23			144	119	113						50	930	1185	225	186	16	7	166
37 T1 24			226	187	177						60	955	1195	250	205	21	8	251
37 T1 26			289	239	227						60	955	1235	300	250	21	8	342
37 T1 28	550	516	443	373	350						70	1000	1170	340	250	26	9	559
37 T1 29	550	550	501	421	394						70	1000	1180	400	290	26	9	655
37 T1 31					52	51	48	33			30	925	1140	145	120	16	6	88
37 T1 32					80	79	76	53			30	925	1165	180	146	16	6	123
37 T1 33					115	114	105	66			50	940	1185	225	186	16	7	165
37 T1 34					171	169	168	98			60	955	1210	240	205	21	8	243
37 T1 35					203	201	186	137			60	955	1230	295	250	21	8	317
37 T1 38					348	343	326	227			70	1010	1170	340	250	26	9	550
37 T1 39		550	516	434	406	401	382	293			70	1010	1180	440	330	26	9	664
37 T1 41								33	26	19	30	925	1140	145	120	16	6	88
37 T1 42								53	42	31	30	925	1185	180	150	16	6	134
37 T1 43								82	64	48	50	940	1185	225	190	16	7	170
37 T1 44								116	89	65	60	955	1205	240	205	21	8	240
37 T1 45								147	115	85	60	955	1225	290	250	21	8	308
37 T1 48			550	485	454	448	407	283	221	163	70	1010	1180	400	290	26	9	659
37 T1 49						427	416	357	277	216	70	1010	1195	435	340	26	9	770

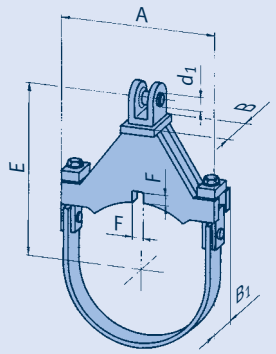
Dynamic clamps
Selection overview OD 1118 – OD 1168

OD 1118 (ND 1100)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 T2 11	77	59	42								30	860	1210	165	130	16	6	86
37 T2 12	120	100	75								50	875	1235	180	150	16	7	127
37 T2 13	186	138	109								60	905	1240	235	195	16	8	180
37 T2 14	281	217	158								70	945	1270	295	260	16	9	290
37 T2 15	323	254	188								70	955	1290	295	260	21	9	321
37 T2 16	387	326	239								70	955	1295	310	280	21	9	403
37 T2 18	518	414	303								70	945	1220	335	250	21	9	472
37 T2 21			70	59	55						30	940	1190	145	110	16	6	87
37 T2 22			100	82	78						50	955	1215	180	146	16	7	126
37 T2 23			148	121	114						50	955	1235	230	190	16	7	174
37 T2 24			227	191	179						60	980	1245	250	205	21	8	256
37 T2 26			294	243	231						60	980	1285	300	250	21	8	347
37 T2 28	550	518	445	374	351						70	1025	1220	340	250	26	9	557
37 T2 29	550	550	503	423	395						70	1025	1230	400	290	26	9	656
37 T2 31					52	51	48	33			30	950	1190	145	120	16	6	86
37 T2 32					80	79	76	52			30	950	1215	180	146	16	6	122
37 T2 33					116	114	106	67			50	965	1235	225	186	16	7	169
37 T2 34					172	170	168	98			60	980	1260	240	205	21	8	247
37 T2 35					204	201	185	139			60	980	1280	295	250	21	8	323
37 T2 38					349	344	327	228			70	1035	1220	340	250	26	9	553
37 T2 39		550	518	436	408	402	382	293			70	1035	1230	440	330	26	9	668
37 T2 41								34	26	19	30	950	1190	145	120	16	6	88
37 T2 42								54	42	31	30	950	1235	180	150	16	6	131
37 T2 43								80	62	47	50	965	1235	225	190	16	7	169
37 T2 44								116	89	65	60	980	1255	240	205	21	8	243
37 T2 45								148	115	85	60	980	1275	295	250	21	8	312
37 T2 48			550	487	456	450	408	284	222	164	70	1035	1230	400	290	26	9	664
37 T2 49						427	416	358	278	217	70	1035	1245	435	340	26	9	773

OD 1168 (ND 1150)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 T3 11	75	58	41								30	885	1260	165	130	16	6	93
37 T3 12	120	98	75								50	900	1285	180	150	16	7	127
37 T3 13	181	139	111								60	930	1295	235	195	16	8	194
37 T3 14	279	219	158								70	970	1320	295	260	16	9	295
37 T3 15	323	254	188								70	980	1340	295	260	21	9	342
37 T3 16	387	326	239								70	980	1345	310	280	21	9	414
37 T3 18	518	420	303								70	970	1270	335	250	21	9	495
37 T3 21			70	59	56						30	965	1240	145	110	16	6	94
37 T3 22			101	85	80						50	980	1265	180	146	16	7	138
37 T3 23			149	121	114						50	980	1285	230	190	16	7	186
37 T3 24			227	189	179						60	1005	1295	250	205	21	8	272
37 T3 26			293	242	230						60	1005	1335	300	250	21	8	369
37 T3 28	550	519	446	375	352						70	1050	1270	340	250	26	9	563
37 T3 29	550	550	504	424	397						70	1050	1280	400	290	26	9	654
37 T3 31					52	51	48	33			30	975	1240	145	120	16	6	94
37 T3 32					80	79	77	53			30	975	1265	180	146	16	6	133
37 T3 33					116	115	107	66			50	990	1285	225	186	16	7	180
37 T3 34					172	170	169	98			60	1005	1310	240	205	21	8	264
37 T3 35					205	202	186	138			60	1005	1330	295	250	21	8	342
37 T3 38					350	345	328	229			70	1060	1270	340	250	26	9	594
37 T3 39		550	520	437	409	404	383	293			70	1060	1280	440	330	26	9	667
37 T3 41								34	26	19	30	975	1240	145	120	16	6	94
37 T3 42								54	42	32	30	975	1285	180	150	16	6	144
37 T3 43								80	62	47	50	990	1285	225	190	16	7	182
37 T3 44								117	89	66	60	1005	1305	240	205	21	8	260
37 T3 45								148	115	85	60	1005	1325	295	250	21	8	333
37 T3 48			550	488	457	451	409	285	222	164	70	1060	1280	400	290	26	9	661
37 T3 49						427	416	359	279	218	70	1060	1295	435	340	26	9	831

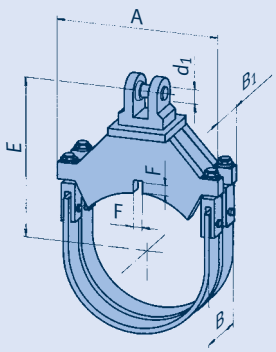


type 37 .. .1/2/3/4/5/6

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15).
Fit: H7 f8.

③ Shear lug dimensions:
F minus 1mm;
B_1 plus 2mm
(see p. 3.44).

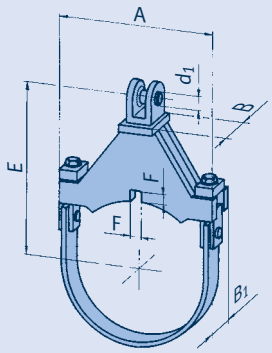


type 37 .. .8/9

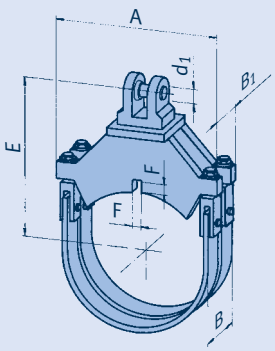
Dynamic clamps
Selection overview OD 1219

OD 1219 (ND 1200)

type	permissible load [kN] ① 100	250	350	450	500	510	530	560	580	600°C	d_1 ②	E_{max} ②	A	B	B_1	F ③	max load gr. ②	wt. [kg]
37 T4 11	74	56	40								30	910	1315	165	130	16	6	93
37 T4 12	122	99	75								50	925	1335	180	150	16	7	136
37 T4 13	183	137	108								60	955	1345	235	195	16	8	195
37 T4 14	281	217	159								70	995	1370	295	260	16	9	310
37 T4 15	323	254	189								70	1005	1390	295	265	21	9	362
37 T4 16	387	322	240								70	1005	1395	310	280	21	9	415
37 T4 18	518	415	304								70	995	1320	335	250	21	9	530
37 T4 21			67	55	52						30	990	1295	145	110	16	6	94
37 T4 22			101	84	80						50	1005	1315	180	146	16	7	139
37 T4 23			147	121	115						50	1005	1335	230	190	16	7	186
37 T4 24			228	189	179						60	1030	1345	250	205	21	8	275
37 T4 26			293	242	230						60	1030	1385	300	250	21	8	373
37 T4 28	550	521	447	376	353						70	1075	1320	340	250	26	9	607
37 T4 29		550	505	425	398						70	1075	1330	400	290	26	9	708
37 T4 31					52	51	49	31			30	1000	1295	145	120	16	6	92
37 T4 32					80	79	77	52			30	1000	1315	180	146	16	6	134
37 T4 33					116	115	107	66			50	1015	1335	225	186	16	7	183
37 T4 34					173	171	169	98			60	1030	1360	240	205	21	8	267
37 T4 35					206	204	188	139			60	1030	1380	295	255	21	8	364
37 T4 38					350	346	329	229			70	1085	1320	340	250	26	9	596
37 T4 39		550	521	438	410	405	385	293			70	1085	1330	440	330	26	9	718
37 T4 41								34	26	19	30	1000	1295	145	120	16	6	94
37 T4 42								54	42	32	30	1000	1335	180	150	16	6	142
37 T4 43								78	60	45	50	1015	1335	225	190	16	7	183
37 T4 44								117	89	66	60	1030	1355	240	205	21	8	263
37 T4 45								148	116	85	60	1030	1375	295	250	21	8	337
37 T4 48			550	490	458	452	410	286	223	165	70	1085	1330	400	290	26	9	712
37 T4 49						427	416	361	280	218	70	1085	1345	435	340	26	9	831



type 37 .. .1/2/3/4/5/6



type 37 .. .8/9

① Calculation of intermediate values: linear interpolation.

② The connection load group is to be specified when ordering. On selection of a smaller load group than that shown in the table, the 'E' dimensions of the clamp are reduced (see table on p. 3.15). Fit: H7 f8.

③ Shear lug dimensions: F minus 1mm; B_1 plus 2mm (see p. 3.44).

Shear lugs
Type 3L

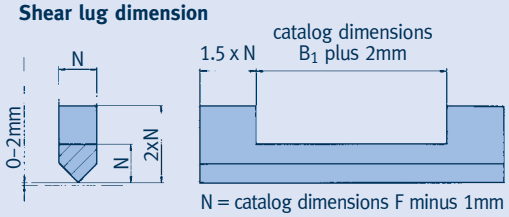
The shear lugs secure the position of the dynamic clamps in the expected direction of force and are practically unstressed. Even in a load case, friction forces from the pipe-clamp-contact ensure firm positioning. Lateral forces are negligable.

Due to the minimal forces to be absorbed, the weld seam stresses can be kept at a low level, despite the small dimensions of the shear lugs. As a rule they lie under 35% of the yield strength or creep stress limit for Load Case H according to the permissible ASME or DIN values.

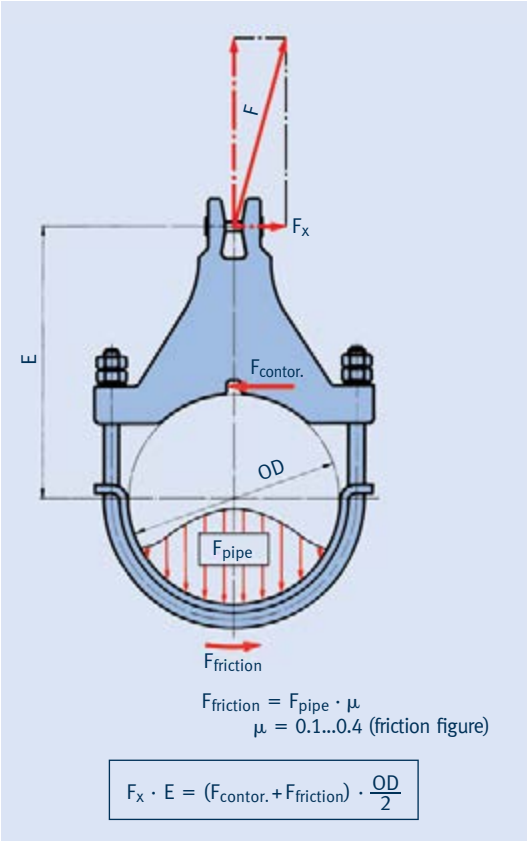
Selection

The selection of suitable shear lugs is made after selection of the dynamic clamp and the corresponding dimensions F and B1 according to the selection tables of dynamic clamps on pages 3.29 – 3.43

Shear lug dimension

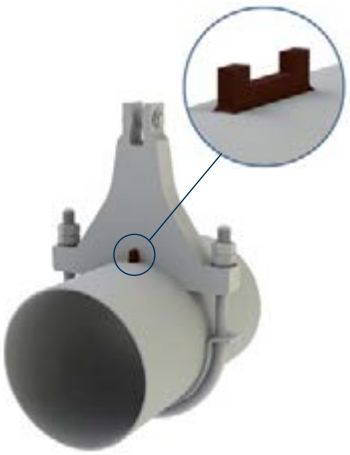


The specified materials for the shear lugs are materials delivered from stock and delivered at short notice. The customer is responsible for the suitability of the pipe material on hand and for the weld seam sizes.



Force distribution in a dynamic clamp with shear lug

To secure dynamic clamps type 36/37 against misalignment due to compressive stress and off-axis load applications, LISEGA offers standardized shear lugs.



type number									
1st place	2nd place	3rd place	4th place	5th place	6th place		7th place	8rd place	material①
3	L	.	.	.	.	—	0	1	S235JR
						—	0	2	S355J2
		3rd – 6th places of pipe dampers				—	0	3	16Mo3
		type numbers e.g.: 36 22 31				—	0	4	13CrMo4-5
		2	**2**	**3**	**1**	—	0	5	10CrMo9-10
						—	0	6	X10CrMoVNb9-1

① Different materials on request.

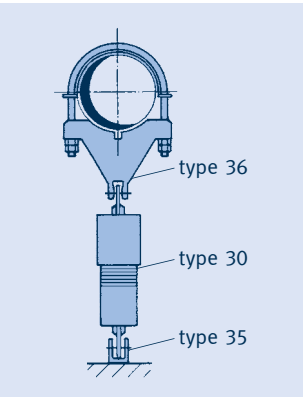
Order details:
shear lug
type 3L .. .. - ..

Order example

For shear lug on a pipe clamp type 36 22 31 for a pipe made from material 13CrMo4-5:
Order number 3L 22 31-04

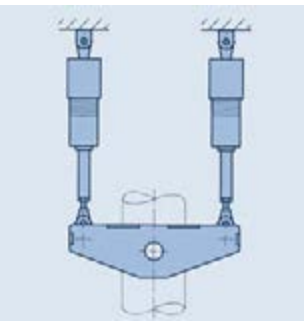
Installation and operating instructions Type 30

Snubbers are precision components of crucial importance for safety. Correspondingly, great care must be taken when dealing with them. Attention to the following points in these instructions is the prerequisite for their proper functioning.



Typical installation situation for type 30

① name plate
② piston rod casing
③ sight glass
④ travel indicator
⑤ connecting lug



Hanger with snubber type 30 and dynamic clamp type 34 with position-securing plates

1 Transport and storage

LISEGA snubbers are high-precision components of great relevance for safety that must be treated with special care during transport, storage, unpacking and handling before and after installation.

Snubbers and their ancillary components must be stored in enclosed spaces. They must be protected from dirt and damage. It is recommended that they should be left in their original packaging until installation. Any transport damage incurred or damage caused during their handling on installation must be reported at once to the manufacturer.

Snubbers are not suitable in any way as substitutes for steps or ladders. Before work such as sand blasting, welding, painting etc. is carried out in the close vicinity of a snubber, the snubber must be dismantled and removed or protected.

2 Delivery condition

The shock absorbers are supplied as fully operational components including hydraulic fluid. On type 30 the connecting lugs are bolted on one side to the base of the shock absorber and on the other to the piston rod and secured with locking bolts.

LISEGA shock absorbers are manufactured entirely of non-rusting materials. They therefore require no additional surface treatment. The threaded connecting lugs are galvanized and white chromatized.

Weld-on brackets type 35 are supplied separately with the appropriate bolts. The surface protection hereby consists of a weldable primer.

For shipment the type 30 shock absorbers are packed singly with retracted pistons in suitable crates.

Name plate type 30

Stamped on the name plate are:

- **type designation**
- **nominal load**
- **theoretical travel**
- **description of hydraulic fluid**
- **serial number**
- **order number**
- **marking and ident. number, if required**

3 Installation

The snubbers must be inspected for damage before installation. It must also be ensured that the connecting lugs are firmly attached. The connection components on site and the connecting brackets must be fully welded.

The arrangement of the connection brackets must always be selected so that the maximum deflection angle is in the direction of the greatest operational heat expansion. The lateral displacement is restricted to a maximum of ± 6°. Misalignment of the connection brackets should be prevented, due to the limited possibility of movement.

Any welding at the connections or in their vicinity should take place before installation of the snubbers.

For installation, the type 30 snubbers are to be brought to the required installation dimension (dimension from connection bolt to connection bolt) by extending the piston rods to the necessary installation dimension.

To avoid undesirable blockage of the snubber the rods must be extended slowly, smoothly and below lock-up velocity. The piston rod of the smaller snubbers can be shifted manually. The dead weight of the large-bore snubbers can also be utilized by suspending the snubber from the connecting lug of the piston rod.

The snubbers can be installed in any orientation. The piston rod should be connected to the heat-conducting component so that any radiated heat can be dissipated through the protective casing. When a snubber extension is used, the exetension should be connected to the heat source.

The snubbers should be installed in such way that the sight glasses for fluid checks are easily visible from the maintenance walkway.

Connections between components must be form-fit for load actuation. Pin connections in the flow of force must be trakt fit sufficiently.

If after installation of the snubber welding work on the connections has to be carried out, care must be taken that no welding current passes through the snubber.

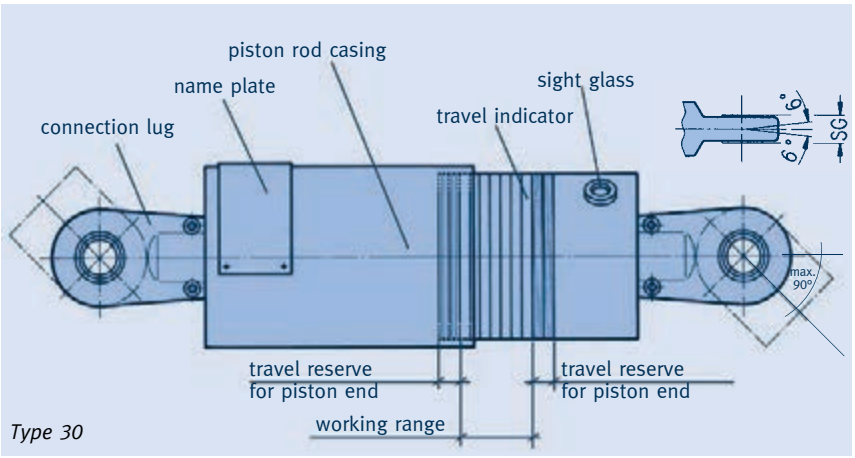
After assembly of a complete system the subsequent inspection of every point of application is recommended:

A. Inspection of all connection points for force- and form-fitting attachment (locking- bolts on the connection lugs, securing of all boltings at connections).

B. Inspection of the installation position for freedom of movement on expansion. Care must be taken that the connection lugs in the connection brackets remain freely movable and that the piston cannot run into the end of snubber travel.

A travel reserve of min. 10 mm at the end positions is recommended for the piston position. The position can be read off the travel indicator.

Before commissioning of the plant a final visual inspection of all snubbers and their installation positions is recommended.



Type 30

4 Inspection and maintenance

Under normal operating conditions the snubbers are designed to function trouble-free for the maximum lifespan of a plant. To maintain the operating capacity of the snubbers at all times preventive maintenance is recommended. For this, see p. 47, 'Maintenance recommendations'.


Support of a vertical pipe system section by type 30 snubbers with extension type 33 and dynamic clamp type 34.

Installation and operating instructions Maintenance recommendations snubbers

Snubbers are crucially important components for the safety of a plant. They serve to protect the piping systems and other components from dynamic overloading from unplanned load cases. As these events occur unpredictably, the full functional safety of the snubbers at all times must be guaranteed.

Under normal operating conditions the service life of the snubbers is designed to match the maximum operational life (60 years) of a plant. The seals and hydraulic fluid should be exchanged at least once during this period, at the latest after 23 years.

Under certain conditions of use (extreme loading), premature aging or increased mechanical wear cannot be excluded. In accordance with the stringent demands concerning reliability, preventive maintenance is recommended. The performance of maintenance work is the responsibility of the plant operator.

Measures

1. **Regular inspection –**
   Visual inspection once a year

2. **Extended testing –**
   Function test, at the latest after 12 years of operation

Implementation

The inspection and maintenance work must be carried out by specially trained personnel.

If required, this work can be performed by specially trained LISEGA service technicians. Fully certified testing facilities are available for dynamic function tests – these mobile test benches can be brought to the plant.

1 Regular inspection

The regular inspection consists of a visual check and should be carried out once a year on all components installed. The first inspection should be directly before commissioning.

In the course of this inspection not only the snubbers but also the installation situation and surrounding conditions must be controlled. The procedure should be carried out with a checklist containing the following information:

- **all positions to be inspected, with details of their locations.**
- **planned, operation-related displacements in connections**
- **special ambient or operational conditions**
- **maintenance measures previously carried out**

Test bench for snubbers

The following points are to be checked at the installation position:

- **name plate data, for conformity with check list**
- **connections at attachment points for force-fitting**
- **freedom of movement for the snubbers on operational deflections**
- **position of piston rod for sufficient stroke, incl. travel reserve (min. 10mm)**
- **external condition for possible signs of damage or leakage**
- **immediate surroundings for any indications of unusual operational stresses, e.g. increased temperature**
- **inspection glass for fluid level**

As long as the reservoir piston is not visible in inspection glass there is sufficient fluid reserve in the reservoir. If the reservoir piston is visible a leakage of fluid must be assumed.

Observations and conclusions must be recorded on the checklist and if necessary supplemented by recommendations for corrective measures.

2 Extended inspection
A supplementary inspection is carried out after an operational period of 12 years in which a small selection of the snubbers installed (min. 2 units per type) are subjected to an additional function test.

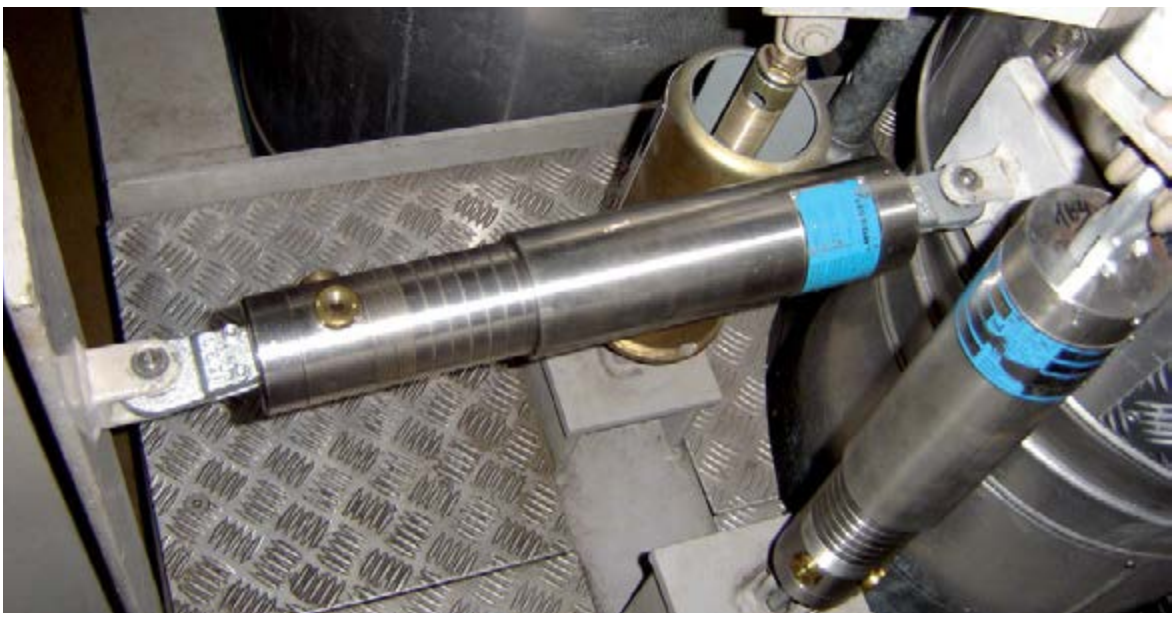
After successful testing the snubbers can be re-installed. If any anomalies in behavior are noted, the components in question should be dismantled and the condition of the functionally important individual units examined. The plant management is responsible for any necessary corrective measures and for their documentation.

The scope of the inspections and the selection of the snubbers to be tested should be agreed on between the plant management and the service engineer involved. The different forms of stress (temperature, radiation, loads, operational vibrations) should receive particular attention.

The time-point and scope of the next extended inspection is to be determined on the basis of the recorded test findings.

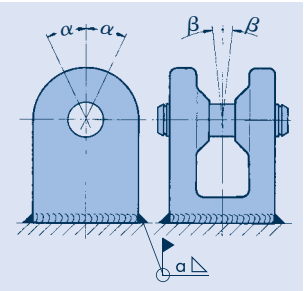
It is recommended that, after 23 years of operation at the latest, the seals and hydraulic fluid should be exchanged. After the professional execution of this work, the use of original LISEGA spare parts, and successful function testing, the snubbers can go into operation for a further 23 years.

Securing pipe systems with snubbers type 30



Use of snubbers type 30

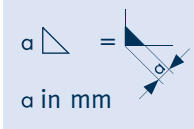
Installation and operating instructions Type 35



Max. angulation of type 35

type	a α=15° β= 6°	a α=30° β= 6°	a α=45° β= 6°
35 19 13	3.0	3.0	3.0
35 29 13	3.0	3.0	3.0
35 39 13	3.0	3.0	3.0
35 49 13	3.0	4.0	5.0
35 59 19	5.5	7.0	8.0
35 69 19	7.5	9.5	11.0
35 79 19	10.5	13.5	15.5
35 89 19	14.5	18.0	21.0
35 99 11	15.0	20.0	23.0
35 09 13	14.0	17.0	19.0
35 20 19	23.0	–	–

Explanation of weld seam symbols:



1 Delivery condition

LISEGA weld-on brackets type 35 are supplied painted and with fitted bolts. The surface protection hereby consists of a weldable primer, unless otherwise noted.

2 Installation

The connection components and connecting brackets on site must be fully welded.

The arrangement of the weld-on brackets should always be so arranged that the max. angulation is in the direction of the operational thermal expansion ($\sphericalangle \alpha$). The lateral displacement is restricted to max. ± 6° ($\sphericalangle \beta$). Any misalignment of the weld-on brackets should be prevented due to the hereby limited freedom of movement.

Welding at the connecting components or in their immediate vicinity should be carried out before installation of the snubbers, rigid struts, etc.

The following procedure is recommended for the welding of the brackets:

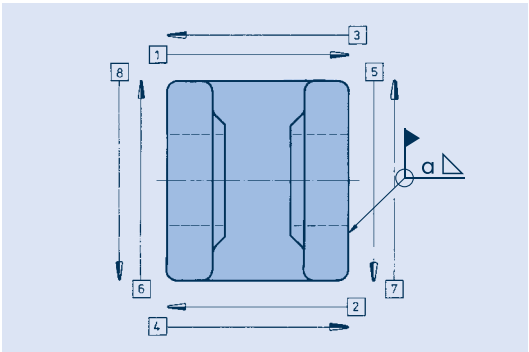
The minimum weld seam thickness 'a' for weld-on brackets type 35 depends on the angulations α and β. In the calculation a permissible stress of 90N/mm² in load case H was the basis.

On an increase in the angulation α to 90° the permissible stresses are reduced by approx. 15% at constant weld seam thickness (a min. at α = 45°).

The relevant load table (**"technical specifications"** p. 0.5) applies for the permissible stresses.

Welding procedure

1. Remove bolts from weld-on bracket
2. Preheat weld-on bracket from type 35 79 19 and above to appr. 100°C
3. Use base electrodes
4. Apply the weld seam in layers to avoid welding distortion.
   Welding sequence: see below
5. Allow the weld-on bracket to cool down to 100°C after every layer



Note: Welding must be carried out only by qualified personnel and is to be supervised by the technical department.

3 Surface protection

After completion of the attachment, the primer surface of the weld-on brackets can be painted. It is urgently advised to do this **before** installation of the snubber.

Installation and operating instructions Type 3D

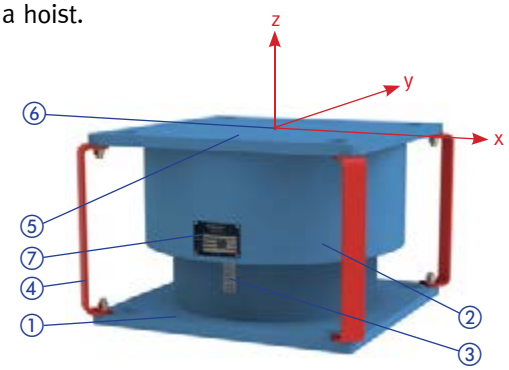
1 Transport and storage

Care must be taken during transport that the viscoelastic damper type 3D is always in upright position to avoid any leakage of the damping medium. When storing in the open the dampers are to be protected from dirt and water.

2 Delivery condition

LISEGA viscoelastic dampers are delivered preset to cold condition (offset). This is ensured by the transport brackets, which keep the offset position fixed in place between the upper and lower sections of the damper. If not ordered otherwise the blocking position (offset position x = 0, y = 0, z = 0) is supplied.

For a weight greater than 20kg, an M16 inner thread of limited engagement depth is located in the upper connection plate for attachment to a hoist.



① lower connection plate
② casing
③ position indicator
④ transport bracket
⑤ upper connection plate
⑥ connection thread M16 for hoist
⑦ name plate

The following information is stamped on the name plate:

- **type**
- **serial and commission number**
- **nominal load**
- **operating temperature**
- **ident. number**

3 Installation

For installation, attention must be paid to the information in the installation instructions for the pipe systems. The LISEGA viscoelastic damper, which is supplied with installation load (cold load) is transported to the place of assembly in an upright position. A force-fitting connection of the upper and lower connection plates is made to the pipe system and steelwork. For this, the transport brackets must be removed. The screw torque values can be found in the table at the side.

4 Commissioning

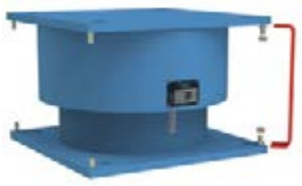
For types 3D.. ..-D it is recommended that the plant should be started up slowly so that the dampers can adjust to operating temperatures, otherwise strong reaction forces could develop that exceed the specified nominal loads. If required, the dampers could be brought to operational temperature by means of supplementary heating. During commissioning the relative position of the upper and lower connection plates changes to hot load position, as calculated beforehand.

During operation the damper should function roughly in middle position, otherwise the dynamic characteristics of the damper change. If the middle position in the tolerance range is not reached the calculations are to be reviewed.

5 Inspection and maintenance

LISEGA viscoelastic dampers are in principle free of maintenance, but a annual visual inspection is recommended. For revision purposes the transport brackets can be attached again.

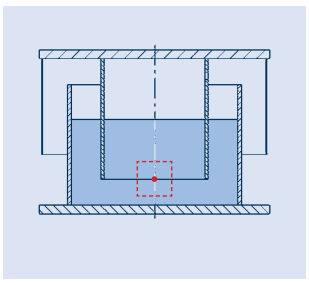
Name plate type 3D



Removal of transport brackets

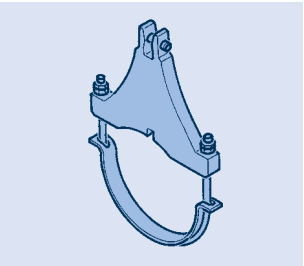
thread size	screw torque values * [Nm] 4.6	5.6
M 12	29	39
M 16	71	95
M 20	138	184
M 24	235	315
M 30	475	635
M 36	1080	1440

** Values acc. to VDI 2230 Appendix A, friction value μ = 0.14*

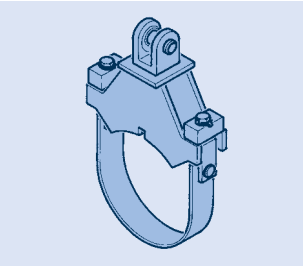


= *Working range of type 3D at the middle position*

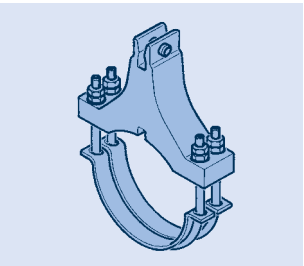
Installation and operating instructions Type 36, 37



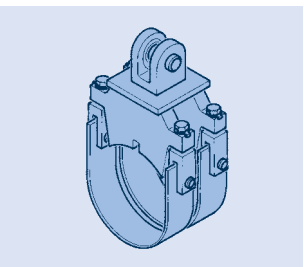
Type 36 .. .1/2/3



Type 37 .. .1/2/3/4/5/6



Type 36 .. .4/5



Type 37 .. .7/8/9

1 Transport and storage

Care must be taken that the dynamic clamps are not damaged during transport. It is recommended that the components are only stored in dry, enclosed spaces. If storage in the open is unavoidable, the clamps must be protected from dirt and water.

2 Delivery condition

LISEGA dynamic clamps are supplied with all the necessary boltings for installation. For reasons of dispatch optimization the clamps may be delivered partially assembled.

Shear lugs

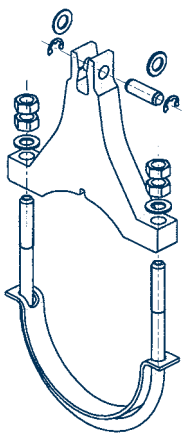
In order to avoid any kind of twist of the clamp it is recommended that shear lugs be fitted. See also p. 3.44 on this.

The dimensions of the recesses for the shear lugs can be found in the selection tables for dynamic clamps on pp. 3.29 – 3.43.

3 Installation

Type 36

This design consists of a massive upper section with integrated connecting bracket and, depending on the load range, with one or two U-bolts and a shim plate.



For installation the pre-assembled U-bolts must be removed. The upper part, fitted with a lug recess, is seated on the shear lug. The U-bolt is inserted from the opposite side together with the shim plate and at first only loosely screwed. The position of the clamp is to be checked again for proper alignment. The bolts can then be tightened and locked.

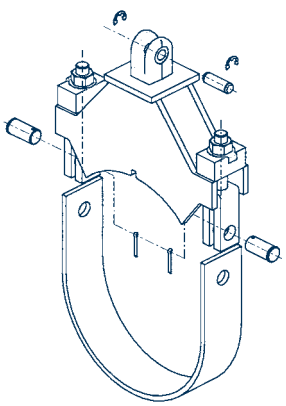
Type 37

This design is the heavy duty version for large pipe diameters and heavy loads.

As a rule, type 35, the weld-on bracket suitable for the load, is already welded on. If the bracket is delivered separatly at customer request, the welding instructions on p. 3.16 are to be followed when welding.

The counterpart to the upper section of the clamp consists, depending on the load, of one or two flat steel straps which are connected by bolts to the upper section for transport.

For installation the flat steel straps must be removed by loosening the bolt connections. The upper part with the lug recess is seated on the shear lug. From the opposite side the flat steel strap is inserted into the bolt-on clevis and fastened with the bolts, which are then locked with splints.



The position of the clamp must be checked once again for proper alignment. The bolts can then be firmly tightened. To avoid unintentional loosening the hexagon nuts on the bolts must be locked with tab washers.