SITEMA
Expertise in Safety

TI-B10-EN-09/2015

Technical Information TI-B10
Safety Brakes

☑ high holding forces by self-intensifying clamping

☑ pneumatic releasing

☑ with DGUV approval for intended use "static holding of loads and forces"

For further information on technical data and optional accessories, please see:

- ***"Technical Data Sheet TI-B11"*** (overview of the types of the series KSP)
- ***"Technical Data Sheet TI-B20"*** (spring bases for Safety Brakes)

For information on the DGUV approval and EC type-examination, please see:

- ***"EC Type-examination Certificate TI-B40"***

A detailed description of control, mounting and performance test of the SITEMA Safety Brakes can be found in:

- ***"Operating Manual BA-B10"***

Contents

1 Purpose

Safety Brakes are used where protection of personnel and accident prevention must be achieved in connection with raised loads or tools in case of failure of load-bearing machine parts. This may e.g. be a leakage or breakdown of a pneumatic pressure system.

Safety Brakes catch falling masses infinitely variable at any position of the stroke, in a mechanically secure and absolutely reliable manner. The design principle of the self-reinforcing clamping ensures an extremely high safety level.

The following purposes are possible and permitted:

1. Static holding of loads and forces

The Safety Brake can be used as a mechanical restraint device for static loads.

For this static holding, the Safety Brake is certified according to the testing principle GS-HSM-02 of the DGUV (testing and certification body of the statutory accident insurance and prevention institution in Germany). For further information see *"EC Type-examination Certificate TI-B40"*, internet download: www.sitema.com.

2. Emergency braking

The Safety Brake can be used for emergency braking of a load in the load direction. The braking force in this direction is higher than the admissible load but limited to ensure that energy is absorbed in a defined manner.

"Emergency braking" is understood to mean a rarely occurring braking process that stops a machine movement in exceptional circumstances.

2 Function

2.1 Clamping released

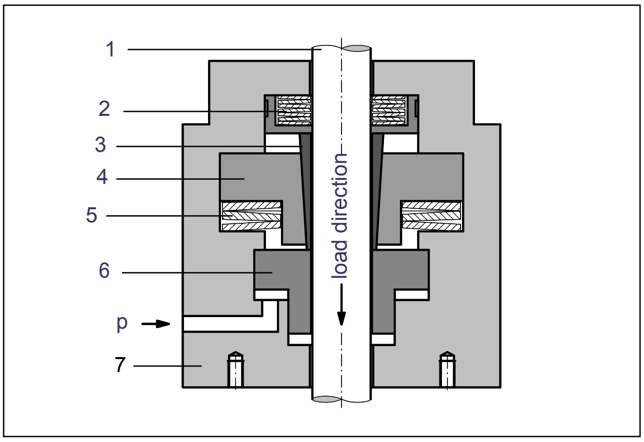

Fig. 1: Safety Brake in released condition (rod can move freely)

As shown in *Fig. 1*, the clamping rod (1) is surrounded by the housing (7). Inside the housing is the clamping system which consists of a conical clamping sleeve (3) with an outer cone moving within a clamping ring (4) with an inner cone. This whole clamping system is movable inside the housing (7) and pressed against the stop by the force of the force limit springs (5).

The annular piston (6) is pressurized (p) and keeps the clamping sleeve pressed against the set of disc springs (2) in released condition. The rod can move freely in both directions.

2.2 Static holding of the load

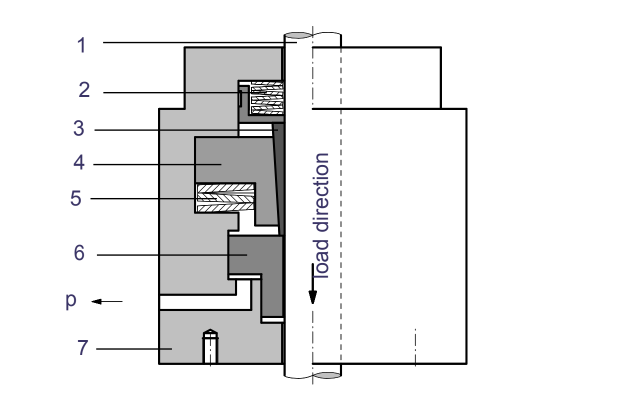

Fig. 2: Rod clamped, maximum load equals admissible load

2.2.1 Secure the load

The Safety Brake secures the load as soon as pressure is released from the annular piston (6). Then, the disc springs (2) push the clamping sleeve (3) into the cone of the housing, whereby an initial friction contact between rod and clamping sleeve is achieved (contact condition).

At this point, the Safety Brake secures the load but has not yet taken the load.

2.2.2 Take the load

The holding force, however, is not built up until the rod has been moved by the load. Due to the self-reinforcing static friction at the rod, the clamping systems contracts. As long as the acting force does not exceed the admissible load M, the movement of the rod is very small, typically under 0.5 mm. The position of the clamping ring remains in its original position, because the pre-tension V of the force limit springs (5) is somewhat larger than M.

2.3 Emergency braking: braking the load dynamically

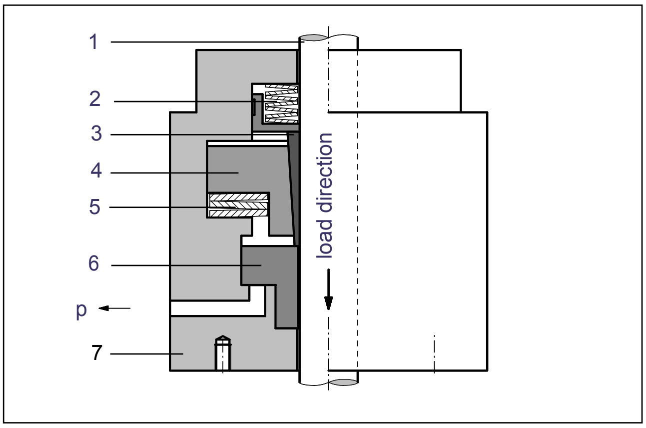

Fig. 3: Rod clamped, overload due to dynamic braking. The dynamic braking force is substantially larger than the admissible load.

If a moving mass has to be stopped, the kinetic energy has to be dissipated by friction. For the clamping system, this means that the dynamic forces become much higher than the static forces.

If the load exceeds the pre-tension V of the force limit springs (5), the whole package of clamping sleeve (3), clamping ring (4) and annular piston (6) moves together with the rod until it gets to the mechanical stop after approx. 2 mm. The force limit springs (5) then bounce slightly, without being fully tensioned. After this point, the clamping force of the clamping sleeve cannot increase.

The slipping force for the rod is thus limited and calculable, lying between 2 and 3.5 times the admissible load M. The resulting deceleration (if load is equivalent to M) is thus between g (gravitational acceleration) and 2.5 g.

The shaded area under the force-path curve in *Fig. 4* represents the dissipated energy.

After stopping, the force limit springs (5) will again raise the load by a small amount.

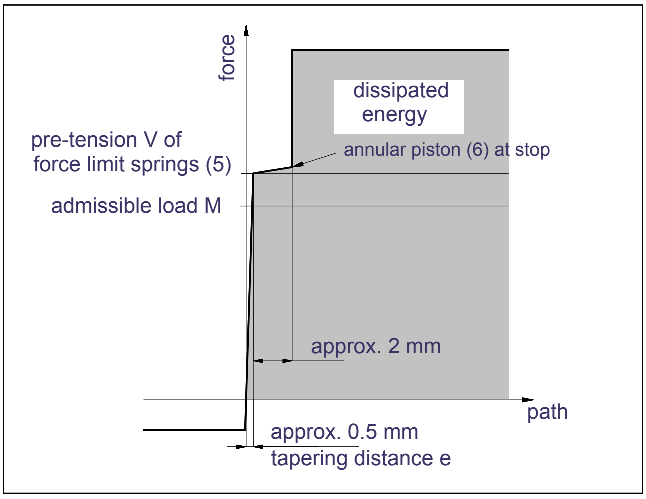

Fig. 4: Force-path diagram

2.4 Release the clamping

To release the clamping after securing the load (see *Chapter 2.2.1 "Secure the load"*), it is sufficient to apply the operating pressure to pressure port L.

To release the clamping after taking up the load (see *Chapter 2.2.2 "Take the load"*) or braking, the rod must additionally be moved back in opposite direction to the load direction (travelling back the tapering distance e) with a force corresponding the load. Thus providing the safety advantage that the clamping can generally only be released as far as the hoist drive is intact and controlled. An excess force (e.g. for breaking loose) is normally not required.

Applying pressure to the annular piston at the same time moves the clamping system in the raised (e. g. released) position.

However this advantage does not necessarily apply to small loads with a simultaneously high release pressure (for details see minimal loads F6 in *"Technical Data Sheet TI-B11"*).

2.4.1 Movement in opposite direction

To move the rod in opposite direction, pressure port L is usually pressurized and the clamping released so that the rod can move freely.

In exceptional cases, a momentary movement in opposite direction while the rod is clamped (without release pressure at L) is possible. The holding force then achieves approx. 15 - 20 % of M.

Under normal operating conditions, pressure port L must always be pressurized to release the clamping during movement in opposite direction. Proximity switch 2 signals "clamping released".

2.4.2 Movement in load direction during normal operation

During normal operation, movements in load direction are only possible when and as long as the clamping is released. The Safety Brake's operating conditions are monitored by proximity switches. For normal movements in load direction, signal 2 "clamping released" is active. It is therefore imperative that this signal be processed accordingly in the control unit.

3 Control

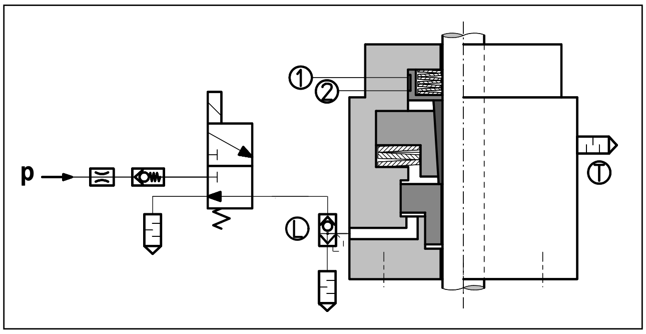

Fig. 5: Schematic diagram of pneumatic circuit

* In case impact noises due to excess pressure are audible when pressurizing the Safety Brake, these can be suppressed by means of a flow control valve (throttle) in the p-line.

** In case the pressure is not sufficiently constant (e.g. pressure drop at the beginning of a downward stroke), we recommend a check valve in the p-connection of the valve.

⚠ WARNING!

Risk due to slowed discharge of pressure medium!

Slowed discharge of the pressure medium may cause a dangerous situation. The clamping locks with a time delay.

- Make sure that the discharge of the pressure medium from pressure port L is **not** impaired by any additional components.
- Route all connection lines without any kinks.
- If there is any danger of kinking, take appropriate precautions (protective tube, thicker hose, etc.).

If a particular quick response time of the Safety Brake is required, the following preconditions must be met:

- installation of a dump valve at L
- short line distances
- fast valve response times
- appropriate control

3.1 Pressure fluid

The compressed air must be dried and filtered. SITEMA recommends compressed air according to ISO 8573-1:2010 [7:4:4].

3.2 Activation using 3/2-way valve

In most applications an actuation as suggested in *Fig. 5* is used.

During every operational cycle, the 3/2-way valve is actuated electrically and releases the Safety Brake.

In all other operational conditions, as well as in cases of power failure, pressure line breakage, emergency stop, etc. the Safety Brake becomes effective, secures the rod and/or stops the load. If necessary the valve can also be switched by another safety signal, e.g. speeding, contouring error, etc.

3.3 Monitoring by proximity switches

Proximity switch 1 "load secured" signals the secure state and is used to authorize entrance to the danger area.

Proximity switch 2 "clamping released" is used to activate the downward movement (in load direction) of the drive.

For automatic detection of failures both signals are compared. In case both switches indicate the same state - apart from minor overlapping periods - there is a defect present.

3.4 Proposal for the logic integration of the Safety Brake in the machine control system

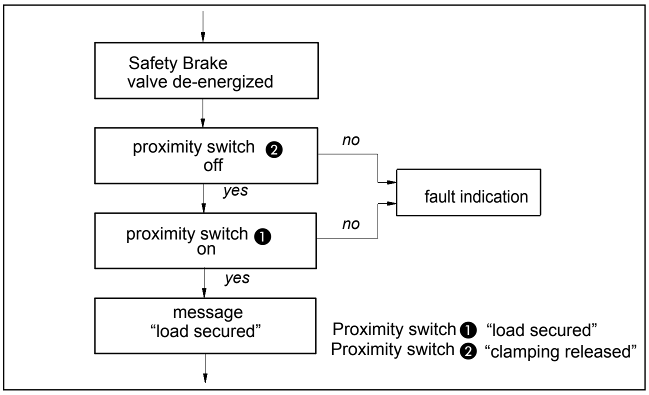

Fig. 6: Secure load

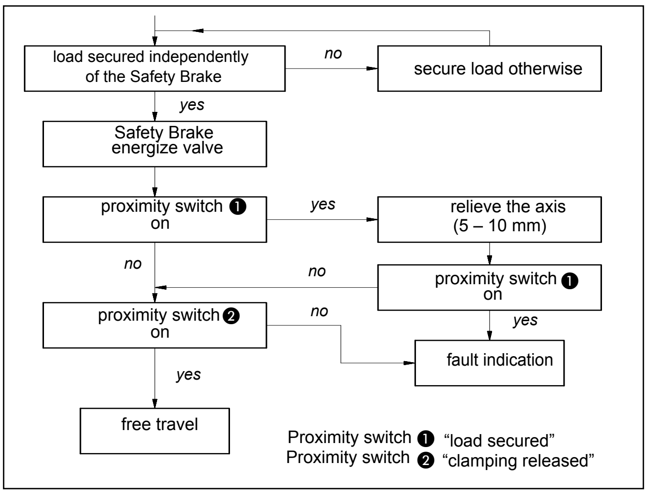

Fig. 7: Release load

4 Choosing the right type

The admissible load M is stated for all types in the *"Technical Data Sheet TI-B11"*. Normally (for vertical movement), the condition as below is to be fulfilled:

$$M \geq \frac{\textit{moving weight}}{\textit{number of Safety Brakes}}$$

The holding (braking) force for dry running or hydraulic-oil wetted rods is not less than 2 x M, but will not exceed 3.5 x M (see also *Chapter 5 "Design and attachment of the rod"*).

When used in safety-related applications, please pay special attention to the information in the attachment to the **DGUV certificate** in *"EC type-examination certificate TI-B40"*.

5 Design and attachment of the rod

The Safety Brake will operate correctly only if the rod has a suitable surface:

- ISO tolerance field f7 or h6
- induction hardened min. HRC 56, surface hardening depth:
  ø up to 30 mm: min. 1 mm
  ø over 30 mm: min. 1.5 mm
- surface roughness: Rz = 1 to 4 µm (Ra 0.15 - 0.3 µm)
- protection against corrosion, e.g. hard chromium plating: 20 ±10 µm, 800 – 1 000 HV
- lead-in chamfer, rounded:
  ø 18 mm up to ø 80 mm: min. 4 x 30 °
  ø over 80 mm up to ø 180 mm: min. 5 x 30 °
  ø over 180 mm up to ø 380 mm: min. 7 x 30 °

Often, the following standard rods fulfill the above mentioned requirements and can then be used:

- piston rods (ISO tolerance field f7), hard chrome plated
- rods for linear ball bearings (ISO tolerance field h6)

The rod may not be lubricated with grease.

The actual holding force of the Safety Brake is higher than the **admissible load (M)** indicated in the data sheets and drawings but will not be higher than 3.5 times this value. Therefore, all **fixation elements** carrying the load (rod, its attachment, etc.) have to be dimensioned for at least **3.5 x M**. This maximum force can occur at emergency braking and also if, in case of control errors, the full driving force is exerted against the Safety Brake.

In case of overload, the rod will slip. This does normally not cause any damage to the rod or the Safety Brake.

Generally, the basic rod material needs to have sufficient yield strength. In the case of compression-loaded rods, sufficient buckling resistance must be assured.

6 Service life

To estimate the service life, a distinction must be made between 3 different types of use:

1. Stress when securing the load

When securing a stationary load (see *Chapter 2.2.1 "Secure the load"*), the occurring material stresses are negligible and can be withstood millions of times over.

2. Stress when taking the load

When taking up the load (see *Chapter 2.2.2 "Take the load"*, for example in the event of leakage or a line break*)*, the Safety Brake may reach the maximum holding force. The design forces and material stresses then occur. The rod does not slip when this happens.

3. Stress when emergency braking

The Safety Brake can withstand braking processes with slipping rod from several hundred times to a few thousand times.

For a longer service life, the following operating conditions should be avoided:

- frequent dynamic braking
- incorrect operation of the (press)cylinder with the clamp engaged
- driving the rod against the load direction without applying pressure simultaneously

Based on the results of fatigue tests, it can be assumed that under usual operating conditions (type of use 1 and occasionally type of use 2), the holding force will not drop below the nominal value after several years in use. Even after lots of clamping cycles, no relevant changes in the diameter or surface quality will be observed on the clamping rod either.

Additionally, you can extend the Safety Brake's service life by considering the following points:

- Ensure that no transverse forces or side loads due to misalignment act on the rod.
- Use a rod with a finish that is not too rough.
- Protect the housing from penetration of corrosive substances and dirt.
- Only use dried compressed air, see *Chapter 3.1 "Pressure fluid"*.
- Clamp the rod only when it is completely stopped. Ensure the correct sequencing of the operational states by programming the control adequately.

7 DGUV Test certification

SITEMA Safety Brakes have been certified by DGUV Test for installation in the following machines (for clamping from a standstill):

- hydraulic presses (according to EN 693)
- mechanical presses (according to EN 692)
- injection moulding machines (according to EN 201)
- rubber and plastics machines (according to EN 289)
- hydraulic press brakes (according to EN 12622)

You can find the **DGUV Test Certificate** (EC type-examination certificate) and further information in *"EC type-examination certificate TI-B40"*.

8 Required risk assessment

It must be ensured that the dimensions and arrangement of a Safety Brake used in safety-relevant applications meet the requirements of the risk evaluation EN ISO 12100:2010 and also comply with any further standards and regulations applicable for the intended use. The Safety Brake alone principally cannot form a complete safety solution. It is however suitable to be part of such a solution. Furthermore, all attachments and fixations have to be dimensioned correspondingly. This is generally the duty of the system manufacturer and the user.

9 Operating conditions

The immediate environment of the Safety Brake in its standard version must be dry and clean. Environmental contamination such as grease, dirt, grinding dust, chips may require special protective measures. Liquids such as coolants, conservation agents and other liquids or chemicals inside the housing may reduce the holding force. It is particularly important not to apply any grease on the rod surface.

- The machine manufacturer must take appropriate measures to ensure that contamination cannot enter the interior of the housing.
- In case of doubt, please contact SITEMA.

The permitted surface temperature is 0°C to 60°C.

10 Regular performance tests

The Safety Brake must be functionally checked at regular intervals. Regular checking is the only way to ensure that the Safety Brake will operate safely in the long run.

Please see the *operating manual* for further details.

11 Maintenance

The maintenance is limited to the regular performance tests.

Should the Klemmeinheiten cease to comply with the required characteristics, the safety for working with the machine or system may no longer be given. In this case the Klemmeinheiten must be immediately and professionally repaired by SITEMA.

The Klemmeinheiten are safety components. Any repair or refurbishing must be carried out by SITEMA. SITEMA cannot take any responsibility for repairs by another party.

12 Attachment

The Safety Brake may be integrated into the machine as a **stationary** component or as a movable component **moving with the load**.

When configuring the layout, attention must be paid to how the **load** acts on the rod and to the Safety Brake particularly.

The Safety Brake KSP is a **pressure version**. When under load, the load pushes the Safety Brake onto the machine part. The load is transmitted into the machine via the mounting surface of the Safety Brake.

ℹ *All fixation elements carrying the load (rod, its attachment, etc.) have to be dimensioned for the maximum load of at least 3.5 x admissible load M, see also Chapter 5 "Design and attachment of the rod".*

ℹ *To avoid side load (constraint forces) on the rod, install either the Safety Brake or the rod with a **floating** attachment.*
*For a floating attachment of the Safety Brake, use a **spring base**, see also "Technical Data Sheet TI-B20".*

12.1 Stationary Safety Brake

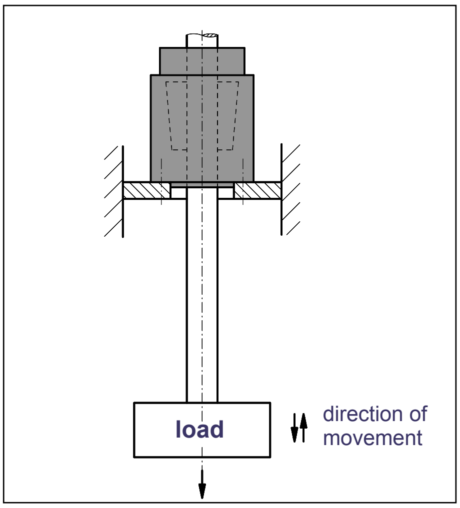

Fig. 8: Attachment of stationary Safety Brake

If the Safety Brake is installed stationary, the load is usually movable.

12.2 Safety Brake moves along with the load

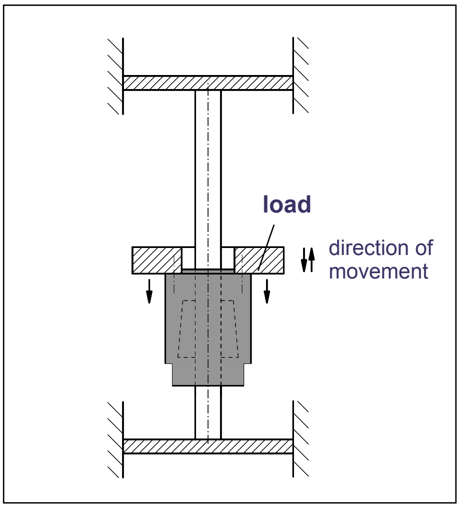

Fig. 9: Attachment of movable Safety Brake

If the Safety Brake is movable and travels with the load, the rod is usually stationary.