English translation of German original “Technische Information”

TI-A10-EN-10/2014

Technical Information TI-A10

Safety Catchers

- ☑ high holding force by self-reinforcing clamping
- ☑ hydraulic or pneumatic actuation
- ☑ officially certified by DGUV as restraint device for presses, injection moulding machines, rubber and plastics machines

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

- ***“Technical Data Sheet TI-A11”*** (hydraulic PRESSURE versions: series KR, K)
- ***“Technical Data Sheet TI-A12”*** (pneumatic PRESSURE versions: series KRP)
- ***“Technical Data Sheet TI-A13”*** (hydraulic TENSILE versions: series KR/T, K/TA)
- ***“Technical Data Sheet TI-A14”*** (pneumatic TENSILE versions: series KRP/T)
- ***“Technical Data Sheet TI-A20”*** (spring bases for PRESSURE versions)
- ***“Technical Data Sheet TI-A21”*** (spring bases for TENSILE versions)
- ***“Technical Data Sheet TI-A30”*** (flanges for Safety Catchers and spring bases)

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

- ***“EC type-examination certificate TI-A40”***

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

- ***“Operating Manual BA-A11”*** *(hydraulic versions)*
- ***“Operating Manual BA-A12”*** *(pneumatic versions)*

Contents

1 Purpose

Safety Catchers 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 hydraulic or pneumatic pressure system. Safety Catchers 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.

SITEMA Safety Catchers release by applying hydraulic or pneumatic pressure and clamp at pressure loss. The kinetic energy of the falling mass is then used to generate the holding force.

2 Function

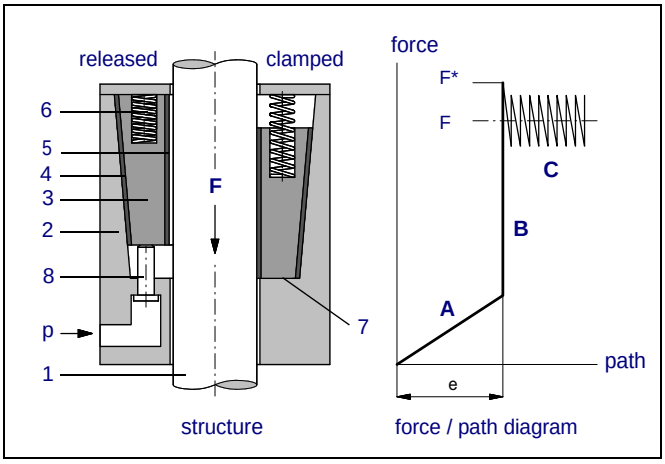


Fig. 1: Design principle

2.1 Clamping released

The piston rod (1) is surrounded by the housing (2) in which several wedged clamping jaws (3), each with one slide lining (4) and one brake lining (5), are assembled. When pressure (p) is applied to the plungers (8), the clamping jaws are held in a raised position so that the rod can move freely. The springs (6) are compressed in this position.

2.2 Secure the load

The Safety Catcher secures the load as soon as pressure is released from the plungers (8). Then the action of the springs causes the clamping jaws (3) to clamp the rod (1) firmly.

The clamping jaws will only cover a very small distance, until the radial play is eliminated and an equilibrium between the spring forces and the forces generated on the slide linings and brake linings is achieved.
At this point, the Safety Catcher has not yet taken the load.

2.3 Take the load

The clamping 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 jaws (3) are drawn into the clamping position at their stops (7) after having moved the distance "e" (approx. 5 to 15 mm, depending on the design). This movement is illustrated as phase **A** in the force/path diagram.

If the load is increased further (phase **B**), the rod remains in its position, independent of the load, until the static holding force F* is reached. As soon as this limit is exceeded, the Safety Catcher (phase **C**) generates a mean dynamic braking force F -- the holding force -- and thus dissipates the kinetic energy of the falling mass.

2.4 Release clamping

The clamping is released by an upward movement of the rod through path "e", with a force corresponding to the load to be lifted. Thus the release operation is only possible if the drive is intact. An excess force (e.g. for breaking loose) is normally not required.

Applying pressure to the plungers at the same time moves the clamping jaws in the raised (e. g. released) position.

3 Design types

Depending on size and pressure fluid, there are different designs of SITEMA Safety Catchers: K, KR and KRP.

They are all identical as far as function and application are concerned.

Series K
This series has a number of small plungers to lift the clamping jaws. They are pressurized simultaneously by a common, annular groove.

Series KR
In this series the lifting function is ensured by a compact annular piston instead of the individual plungers used in series K. For reasons of design and cost, this solution is preferred to series K if used on rod diameters of less than 80 mm.

Series KRP
The KRP-series is the pneumatic option within the family of Safety Catchers.

Due to the self-reinforcing friction, the KRP series attains the same holding forces as the KR series regardless of the acting spring force or actuator force.

That's why the outer dimensions are equal to the ones of hydraulic KR series.

4 Control

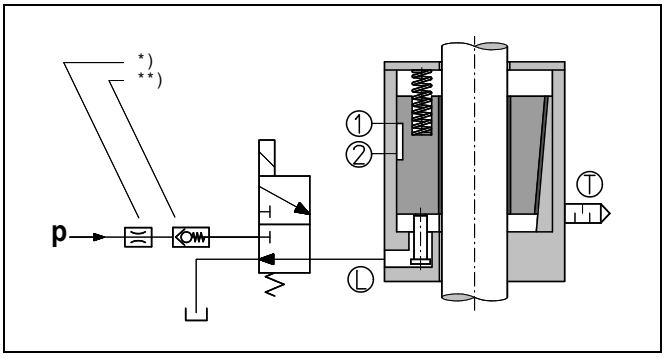


Fig. 2: Schematic circuit diagram

* In case impact noises due to excess pressure are audible when pressurizing the Safety Catcher, these can be suppressed by means of a flow control valve 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 ist **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 Catcher is required, the following preconditions must be met:

- short line distances
- fast valve response times
- appropriate control
- large valve and line cross-sections (esp. when actuated hydraulically)
- installation of a dump valve at L (when actuated pneumatically)

4.1 Pressure fluids

Safety Catchers mostly are hydraulically actuated. For smaller units, also pneumatic versions are available.

Hydraulic actuation:
Hydraulic oil (HLP) in accordance with DIN 51524-2 must be used as pressure fluid. Please consult SITEMA before using any other fluids.

Pneumatic actuation:
The compressed air must be dried and filtered. SITEMA recommends compressed air class 5-4-5 according to ISO 8573-1.

4.2 Actuation with a 3/2-way valve

In most applications an actuation as suggested in *Fig. 2* is used. During every operational cycle, the 3/2-way valve is actuated electrically and releases the Safety Catcher.

In all other operating conditions, as well as in case of power failure, emergency stop, etc., the Safety Catcher becomes effective, secures the rod and/or stops the load. In case the pressure line should fail, the load is secured in the same way.

If required e.g. in hydraulic lifts, the valve can also be controlled by a speed governor. In this case the safety catcher acts as a safety gear (braking mechanism).

4.3 Monitoring by proximity switches

Proximity switch 1 “load secured” indicates the secure state and is used to authorize entrance to the danger area. Switch 2 “clamping released” is used to activate the downward movement of the drive.

For an automatic detection of failures, both signals are compared. In case both switches indicate the same state - apart from a short overlapping period - a dysfunction is present.

5 Choosing the right type

The admissible load M is given for all types in the *“Technical Data Sheets TI-A11 to TI-A14”*. Normally (for vertical movement), the condition as below is to be fulfilled.

$$M \geq \frac{\text{moving weight}}{\text{number of safety catchers}}$$

The holding (braking) force for dry or hydraulic-oil wetted rods is not less than 2 x M, but will not exceed 3.5 x M (see also *Chapter 6 “Design and attachment of the rod”*).

When used in safety-related applications, please pay special attention to the attachment to the DGUV certificate in *“EC type-examination certificate TI-A40”* (see in particular *pages 4 and 7*).

6 Design and attachment of the rod

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

- ISO tolerance field f7 or h6
- surface roughness: Rz = 1 to 4 µm
- 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 °

An additional hard chrome plating 20 +/- 10 µm, 800 – 1000 HV is recommended for protection from corrosion and a longer service life. The rod may not be lubricated with grease.

In practice, suitable and commercially available rods are:

Piston rods (ISO tolerance field f7) with

- basic material: yield strength min. 580 N/mm²
- hard chrome plating: 800 – 1100 HV min. 13 µm deep
- surface roughness: Ra 0.15 – 0.25 µm

The actual holding force of the Safety Catcher 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 Catcher.

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

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

7 Service life

To estimate the service life of SITEMA Safety Catchers, a distinction must be made between two different types of use:

1. Stress caused by securing the load

The stress caused when a stationary load is secured (see *Chapter 2.2 “Secure the load”*) is extremely low and can certainly be cycled millions of times.

2. Stress caused by taking the load

The radial forces and material stresses for which the unit is initially designed will occur only if the Safety Catcher takes the load (e. g. in the case of emergency braking, leakage, line break).

Occasional slippage of the rod through the closed clamping system will not reduce the Safety Catchers’ service life.

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 Catchers’ service life by considering the following points:

- Ensure that no radial 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.
- Clamp the rod when it is completely stopped.

8 Acceptance by Safety Authorities

SITEMA Safety Catchers have been tested and approved as safety devices for a number of different applications by

- TÜV (Technical Inspection Authority)
- National Offices for Occupational Safety and Health
- Berufsgenossenschaften (Accident Prevention & Insurance Associations)

Particularly, SITEMA Safety Catchers are certified with respect to the European Standard DIN EN 693 (Machine tools - Safety - Hydraulic presses) and DIN EN 692 (Mechanical presses) as mechanical restraint device to prevent gravity fall.

A copy of the EC type-examination certifications and additional information can be found in *“EC type-examination certificate TI-A40”*

9 Required risk assessment

It must be ensured that the dimensions and arrangement of a SITEMA Safety Catcher used in safety-relevant applications meet the requirements of the risk evaluation DIN EN ISO 12100:2011 and also comply with any further standards and regulations applicable for the intended use. The Safety Catcher 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.

10 Operating conditions

SITEMA Safety Catchers are designed to operate in normal clean and dry workshop atmosphere.

Heavy soiling conditions like grinding dust, chips, other liquids, etc. may require special protective measures. In such cases, please contact SITEMA.

The permissible surface temperature is 0 – 60°C.

11 Regular performance tests

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

Please check the operating manuals for further details: *“Operating Manual BA-A11” for* hydraulic standard versions and *“Operating Manual BA-A12”* for pneumatic standard versions.

12 Maintenance

The maintenance is limited to the regular performance tests.

Should the Safety Catchers 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 Safety Catchers must be immediately and professionally repaired by SITEMA.

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

13 Attachment

Overview of attachment options for PRESSURE and TENSILE versions

Safety Catchers can be integrated into the machine as **stationary** units or as **mobile** units travelling with the load to be secured.

When choosing the right series, consider the **load** that acts on the rod and the Safety Catcher.

In the case of **PRESSURE versions**, the load presses the Safety Catcher onto the machine frame. The load is transferred via the mounting surface of the Safety Catcher into the machine frame. PRESSURE versions are: **series KR, KRP, K**.

In the case of **TENSILE versions** the load pulls the Safety Catcher away from the machine frame. The tensile load is transferred via the attachment bolts into the machine frame.
TENSILE versions are: **series KR/T, KRP/T, K/T, K/TA** (T = tension).

Stationary Safety Catcher

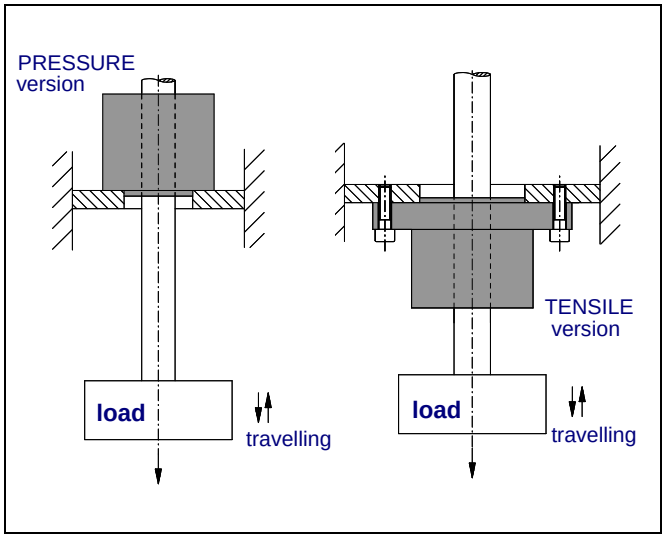


*Fig. 3: Attachment options for **stationary** Safety Catcher*

If the Safety Catcher is installed stationary, the load (e. g. the slide) is usually mobile.

To avoid side load on the rod,
*install either the Safety Catcher or the rod with a **floating** attachment.*
*For a floating attachment of the Safety Catcher, use a **mounting flange**.*

For further information on the different attachment options, please read
Chapter 13.1 “Attachment options for PRESSURE versions”
and
Chapter 13.2 “Attachment options for TENSILE versions”.

Mobile Safety Catcher

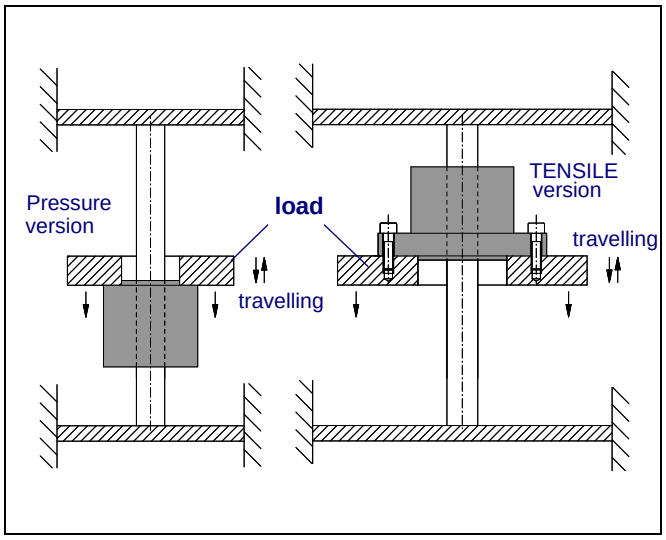


*Fig. 4: Attachment options for **mobile** Safety Catcher*

If the Safety Catcher is mobile and travels with the load (e. g. the slide), the rod is usually stationary.

To avoid side load on the rod,
*install either the Safety Catcher or the rod with a **floating** attachment.*
*For a floating attachment of the Safety Catcher, use a **mounting flange**.*

For further information on the different attachment options, please read
Chapter 13.1 “Attachment options for PRESSURE versions”
and
Chapter 13.2 “Attachment options for TENSILE versions”.

Remarks:
- The pictures above only show the technical principles of the attachment for SITEMA units. They are not intended as actual design drafts.
- The appropriate machine control of the unit, and the final testing of the design is always in the responsibilty of the machine builder .

13.1 Attachment options for PRESSURE versions

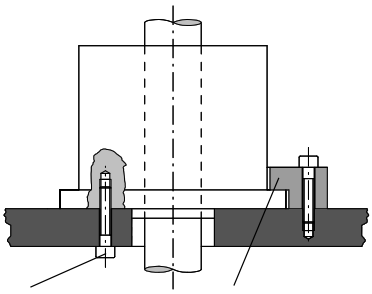
There are various ways to attach the Safety Catchers series KR, KRP and K.

In any case, it must be ensured that no side load can be induced due to tolerances in dimensions or angular alignment relative to other guiding means. If the Safety Catcher is directly mounted to a cylinder head, it usually is properly centered to the rod. In all other setups either the rod or the body of the catcher must not be rigidly fixed but mounted floating with enough radial clearance. Four basic options are illustrated below, using hydraulic presses as an example of application. They can be applied in other cases as well if the expression “slide” is replaced by the more general term “load”.

Suitable mounting flanges can be found in *“Technical Data Sheet TI-A30”*.

Stationary Safety Catcher

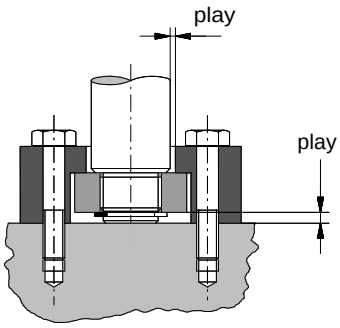
Stationary Safety Catcher **fixed** to the machine frame



1. Attachment with screws: possible for all series

2. Attachment with mounting flange: series KR and KRP

- rod floating on slide



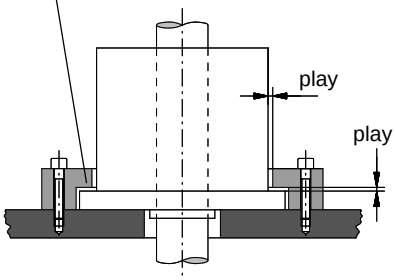
If the Safety Catcher is firmly bolted to the machine frame, the retaining rod must have sufficient play at its attachment, so that the lateral or tilting movements of the slide will not create lateral forces to the rod.

Fig. 5: Attachment option 1

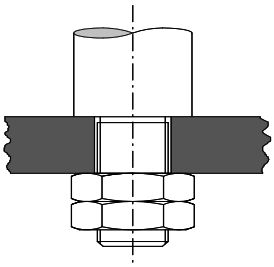
Stationary Safety Catcher

Stationary Safety Catcher with **floating** attachment to the machine frame

Attachment with mounting flange: series K, KR and KRP



- rod fixed to slide



The mounting flange as shown above is one of the common solutions for a mounting with radial play. Alternatively a spring base is recommended, which on top provides additional advantages as descibed in *“Technical Data Sheet TI-A20”*.

Both mounting options ensure that the Safety Catcher can move freely to compensate for lateral movements of the travelling rod.

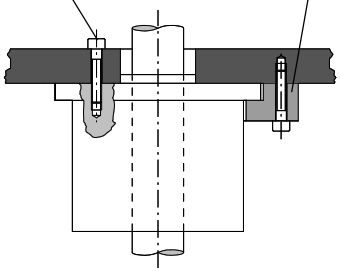
Fig. 6: Attachment option 2

Mobile Safety Catcher

Mobile Safety Catcher **fixed to slide - rod floating** on the machine frame

1. Attachment with screws: possible for all series

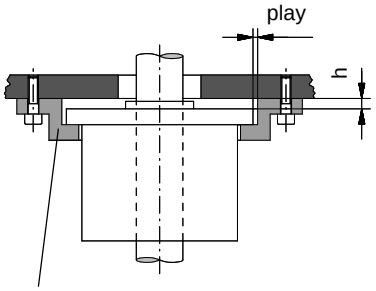
2. Attachment with mounting flange: series KR and KRP



If the mobile Safety Catcher is firmly fixed to the slide, the stationary rod must have a floating attachment, similar to option 1 (*Fig. 5*).

Fig. 7: Attachment option 3

Mobile Safety Catcher with **floating** attachment to the **slide - rod fixed** to the machine frame



Attachment with mounting flange: series KR and KRP

This is another application using a mounting flange. In addition, an axial play of h = approx. 5 to 10 mm is used, so that this design will perform the function of the spring base as well.

Fig. 8: Attachment option 4

13.2 Attachment options for TENSILE versions

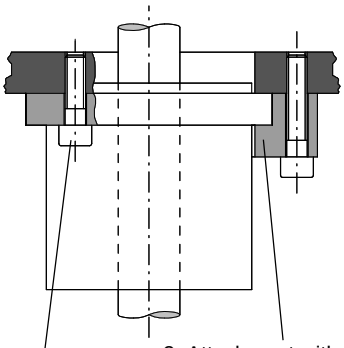
There are various ways to attach the Safety Catchers series KR/T, KRP/T and K/T, K/TA.

In any case, it must be ensured that no side load can be induced due to tolerances in dimensions or angular alignment relative to other guiding means. If the Safety Catcher is directly mounted to a cylinder head, it usually is properly centered to the rod. In all other setups either the rod or the body of the catcher must not be rigidly fixed but mounted floating with enough radial play. Three basic options are illustrated below, using hydraulic presses as an example of application. They can be applied in other cases as well if the expression “slide” is replaced by the more general term “load”.

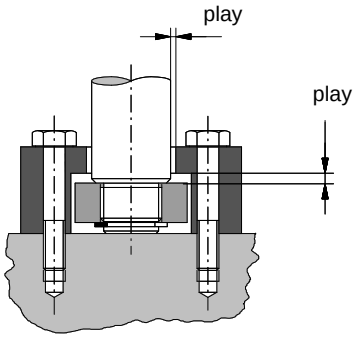
Suitable attachment flanges can be found in *“Technical Data Sheet TI-A30”*.

Stationary Safety Catcher

Stationary Safety Catcher **fixed** to the machine frame



- rod floating on slide

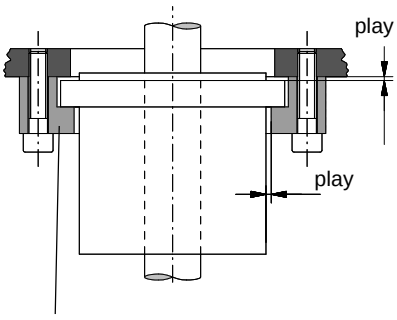


If the Safety Catcher is firmly bolted to the machine frame, the retaining rod must have sufficient play at its attachment, so that the lateral or tilting movements of the slide will not create lateral forces to the rod.

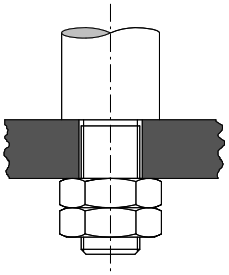
Fig. 9: Attachment option 5

Stationary Safety Catcher

Stationary Safety Catcher with **floating** attachment to the machine frame



- rod fixed to slide



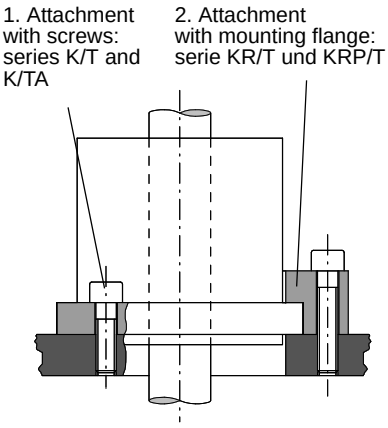
The mounting with a flange as shown above is one of the common solutions for a mounting with radial play. Alternatively a spring base can be recommended, which on top is providing other advantages.

Both mounting versions make sure that the Safety Catcher can move freely in order to compensate for lateral movements of the travelling rod.

Fig. 10: Attachment option 6

Mobile Safety Catcher

Mobile Safety Catcher **fixed to slide - rod floating** on the machine frame



If the mobile Safety Catcher is firmly fixed to the slide, the stationary rod must have a floating attachment, similar to option 5 (*Fig. 9*).

Fig. 11: Attachment option 7