INSTRUCTION MANUAL

Performance Line type 97

Installation and Operation

Document Number: 0100 78 00 92, rev B

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1 Safety precautions

1.1 General

KONI's hydraulic railway dampers are designed, developed and manufactured with state-of-the-art technologies in modern facilities. Our dampers are produced with great care and commitment to continuous quality control, utilising sophisticated quality techniques.

These instructions are intended to facilitate familiarization with the product and its use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always follow your company's safety requirements and applicable safety and health laws/regulations.

These instructions must be read prior to installing, operating and maintaining the dampers in any region worldwide. The dampers must not be put into service until all the conditions relating to safety, noted in the instructions, have been met. Failure to follow and apply the relevant user instructions is considered to be misuse. Personal injury, product damage, delay or failures caused by misuse are not covered by the KONI warranty.

1.2 Copyright

1.3 Safety

1.3.1 Marking

These user instructions contain a specific safety marking where non-observance of an instruction may cause danger. The specific safety marking is:

This symbol indicates safety instructions where non-compliance will involve risk to safe operation and personal safety and could damage the damper or train.

1.3.2 Personnel qualification and training

All personnel involved in the installation, inspection and maintenance of the damper must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skills, appropriate training and instructions must be provided. If required the customer may commission KONI to provide applicable training.

1.3.3 Safety action

This is a summary of conditions and actions to prevent injury to personnel and damage to the environment and to equipment.

Although the damper has a strong construction, it must be treated with care. The damper must never be dropped. When working with the dampers proper protective clothing must be worn, such as steel-capped shoes, working gloves and safety glasses. During cleaning, degreasing and blow-cleaning the damper or components, the inhalation of dust or degreasing fumes must be prevented.

The dampers contain oil. Please use caution and do not spill oil on the workshop floor as this may lead to dangerous situations. During the maintenance work you should always comply with your local health, safety and environmental regulations.

2 Storage Instruction

2.1 General

When the dampers are received, they should be inspected for damage or other signs of rough handling. Any damage found should be reported to the carrier immediately.

Any shortage and / or damage must be reported immediately to KONI.

Each damper has a unique serial number which can be found on the type plate. Check that this number corresponds with the sticker on the packing.

Do not drop dampers or damage dampers during handling.

2.2 Storage Conditions

Dampers should be stored in a horizontal position under normal industrial conditions. This means a dry (maximum humidity of 60%) and ventilated room with an ambient temperature between 0 ºC ~ 40ºC.

Furthermore the room should be ozone-free and protected from direct sunlight.

The shelf life of hydraulic dampers is 5 years.

If the shelf life is exceeded the dampers should be functionally checked at a KONI recognised service centre before use.

2.3 Recycling and end of product life

At the end of the service life of the damper, the relevant materials and parts should be recycled or disposed of by using an environmentally acceptable method and in accordance with local regulations.

KONI dampers contain components made of various types of steel, copper, rubber, plastic and contain a certain volume of mineral oil. The paint used on the dampers is generally water based without solvents, unless otherwise specified by the customer. The damper does not contain any dangerous substances.

Damper disposal can be realised through any of the following methods:

- Sending the dampers back to KONI
- Sending the dampers to a recognised and accredited disposal company
- Disassembling the damper at your own premises and sending parts to an accredited recycling or disposal company.

2.3.1 Sending the dampers back to KONI

The KONI address and the addresses of KONI recognised service centres can be found at the KONI website www.koni.com

2.3.2 Sending the dampers to a recognized disposal company

Disposal companies often are registered at the national government.

For local company names and addresses, please refer to the associated websites.

2.3.3 Disassembling the damper at your own premises

After disassembling, the parts and the oil must be disposed of according to the local regulations which comply with the separation and recycling processes available.

3 Damper Description

3.1 General description on Application

3.1.1 Primary vertical (axle box) dampers

These dampers control the vertical movements between axle box and bogie frame, in particular the motion of bogie bouncing on the axle boxes and more important, pitching of the bogie frame in relation to the axles. The latter is induced by irregularities in the track, rail joints and crossing. This causes the one end of the bogie frame to move down while the other moves upwards. Unless this motion is controlled, it can result in a serious wheel unloading with danger of derailment.

The primary vertical damper can be provided with a mechanical lift stop which provides the possibility to lift the bogie by means of the damper. The mechanical lift stop consists of a metal ring, mounted on the piston rod above the piston in order to safeguard the piston function. The maximum allowable static load is mentioned on the outline drawing and on the nameplate of the damper.

3.1.2 Secondary Vertical Dampers

The secondary vertical dampers control the vertical movements between car body and bogie frame, such as pitching. Correct damping is essential in relation to body mass and spring stiffness. Secondary vertical dampers, if widely spaced, will assist secondary springs to control rolling oscillations of the car body.

3.1.3 Lateral Dampers

The lateral dampers are used to control lateral movements of the car body (both ends of the body moving in the same direction relative to the bogie) as well as body nosing oscillations (one end of the body moving opposite to the other). It is essential to ensure correct lateral damping as both an under and over damped secondary lateral suspension can induce excessive sway to the car body.

It is very important to carefully select the lateral damper rates in relation to the vertical and lateral suspension stiffness.

3.2 General working principles

The KONI railway damper is a hydraulic system: the resistance of the liquid flowing through valves and restrictions generates the damping force. The damper has a two-way function: damping force is generated through both inward and outward movement. In nearly all cases, the bump and rebound forces are basically equal; in other words, its characteristic is symmetrical.

3.2.1 Performance Line type 97 dampers

3.2.1.1 General technical data

Maximum damping force	15,000 N
Nominal velocity	0.1 m/s
Maximum velocity	1.5 m/s
Maximum damping rate	100 kNs/m
Maximum allowable ambient temperature in service	-40° +80°C (-50°C with special Arctic Pack)
Reservoir diameter	70 mm
Dust cover diameter	80 mm
Piston rod diameter	20 mm
Piston diameter	50 mm

3.2.1.2 *Construction*

The damper is constructed from a number of main components. Please refer to the general cross sectional drawing in Figure 3-1.

1. Dust cover
2. Reservoir tube seal nut
3. Rod oil seal
4. Reservoir tube seal
5. Piston rod guide
6. Piston rod
7. Cylinder tube
8. Upper valve set
9. Seal
10. Piston assembly
11. Lower valve set
12. Oil baffle
13. Reservoir tube
14. Foot valve assembly
15. Attachment

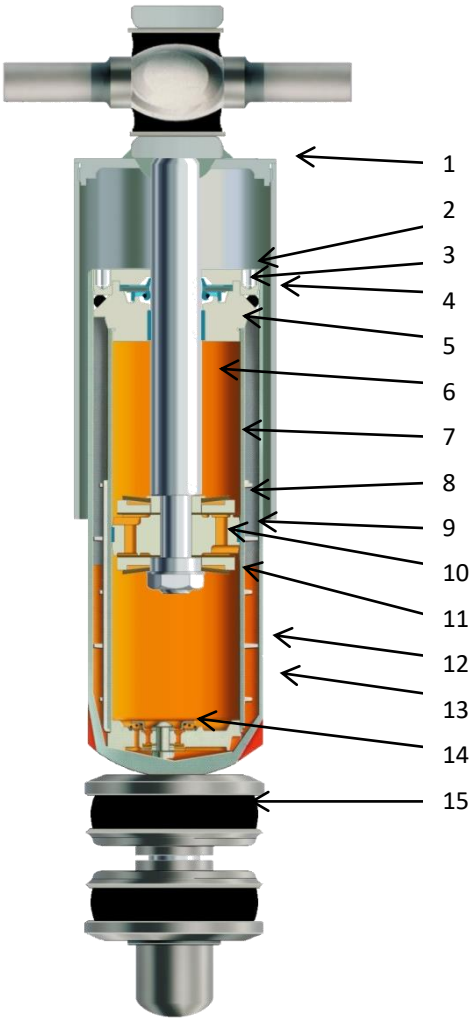


Figure 3-1 Cross sectional drawing

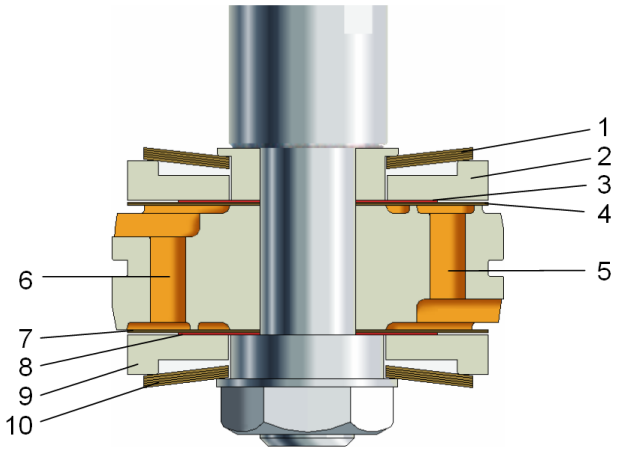
Not shown in the picture is the option to equip the damper with the so-called “Arctic Pack” or “Desert-Pack”, whereby a special rubber bellow fitted around the dust cover, protecting the damper against ingress of snow/ice/sand. This can be removed easily by loosening the hose clamp.

3.2.1.3 *Principle of damping*

There is a two-direction oil flow through the piston. The foot valve supplies the relatively small volume difference due to the piston rod volume. The construction of the damper is such that the damping force during the extension and compression stroke is symmetrical.

During the extension stroke the damping is performed by a package of valves below the piston, while during the compression stroke the package of valves on top of the piston, in cooperation with the foot valve, create the desired damping forces.

The assembly of the piston components is shown in Figure 3-2:



1 Tension valves bump
2 Tension washer bump
3 Support washer bump
4 Main valves bump
5 Bump oil channel
6 Rebound oil channel
7 Main valves rebound
8 Support washer rebound
9 Tension washer rebound
10 Tension valves rebound

Figure 3-2 Piston assembly

By variation of the components used, a damper characteristic can be created to suit the customer requirements. This characteristic can be defined both in the linear normal operation area, as well as in the blow-off area at high damper speeds.

In the following figures, the various operating modes of the piston moving in rebound direction are shown. The operation in bump is similar and is therefore not further described.

Depending on the imposed damping speeds, the valve system of the piston operates as follows:

Low damper speeds
At low piston speeds, the damper force is created by the oil flow through an orifice between the main valve and the piston.
Please refer to Figure 3-3.

Medium damping speeds (normal damping area)
At medium piston speeds, the main valves bend around the support washer. The created damping force has a linear characteristic.
Please refer to Figure 3-4.

High damping speeds
At high piston speeds, the tension washer is pushed down against the pretension of the tension springs. This enables the main valves to open completely and by this providing for the blow–off function of the damper.
Please refer to Figure 3-5.

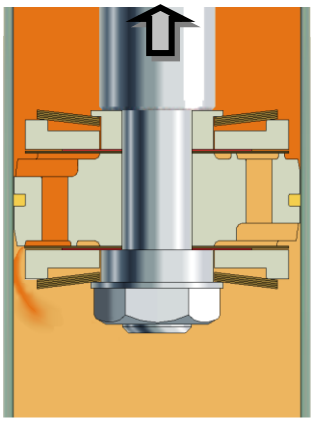


Figure 3-3 Low damping speeds

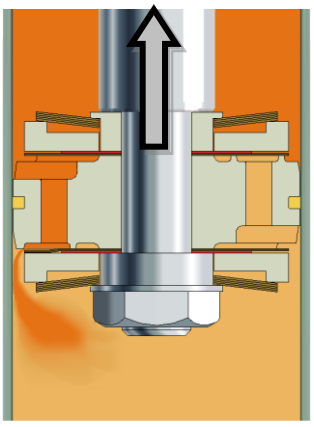


Figure 3-4 Medium damping speeds

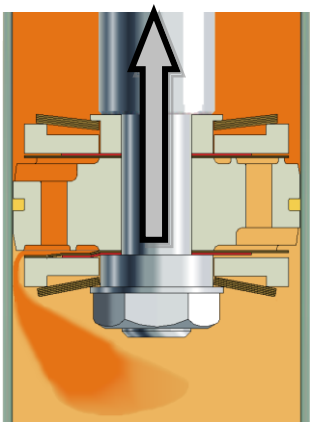


Figure 3-5 High damping speeds

3.3 Nameplate information

Every damper has a nameplate that provides information about the damper. The nameplate is located on the dust cover. In addition, the damper type number and serial number are also rolled in the reservoir tube.

When ordering spare parts, please always communicate the following damper information:

- Damper type
- Serial number
- Item numbers of the required parts

See Parts List for item numbers.

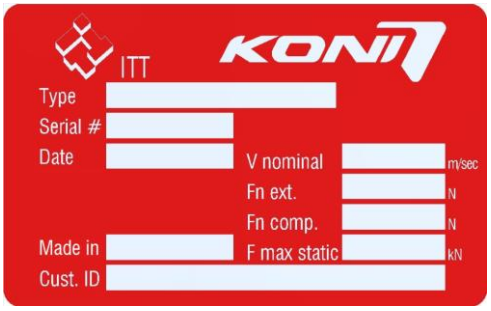


Figure 3-6 Damper nameplate

Table 3-1 Explanation of the nameplate

Nameplate field	**Explanation**
Type	Damper type
Serial #	Serial number of the damper
Date	Production date
V nominal	Nominal test speed
Fn ext	Nominal damping force in rebound at V nominal
Fn comp	Nominal damping force in compression at V nominal
F max static	Maximum static extension load (Lift Stop)
Made in	Indicates production location: NL – OB: Netherlands – Oud-Beijerland CZ – OS: Czech Republic – Ostrava CN – WX: China – Wuxi Or blank, with “Assembled in USA” above it for Hebron
Cust. ID	Customer damper identification

4 Installation

4.1 Mounting and priming Instruction

Before mounting a damper or a damper batch, take a sample and verify that the shelf life is not exceeded and the damper is in good visual condition.

Visual check points:

- Check the rubber of the attachments for cracks
- Check the damper for oil leakage and dents or other damages
- Check if the piston rod can rotate freely

Although the damper is self-priming in service; we advise to prime the dampers before mounting. Priming can be done by hand or by using a damper testing machine.

Priming instruction (using machine):

1. Mount the damper in vertical position, with the dust cover on top, at the testing machine
2. Press the piston rod to the minimum length
3. Pull the piston rod to the maximum length.
4. Repeat step 2 + 3 for 4 times.
5. Press the piston rod to the mounting length.

The procedure can also be done in horizontal position for lateral dampers. It is most effective however when done in vertical position.

Depending on the setting of the damper (force levels), it may be possible to prime by hand.
Priming instruction (by hand):

1. Position the damper in vertical position with the dust cover side up.
2. Hold damper by placing two feet over the silentbloc end and pull with two hands on upper silentbloc until damper reaches maximum length.
3. Compress damper by pushing by hand to minimum length.
4. Repeat this action 2 + 3 another 4 times.
5. Press the piston rod to the mounting length.

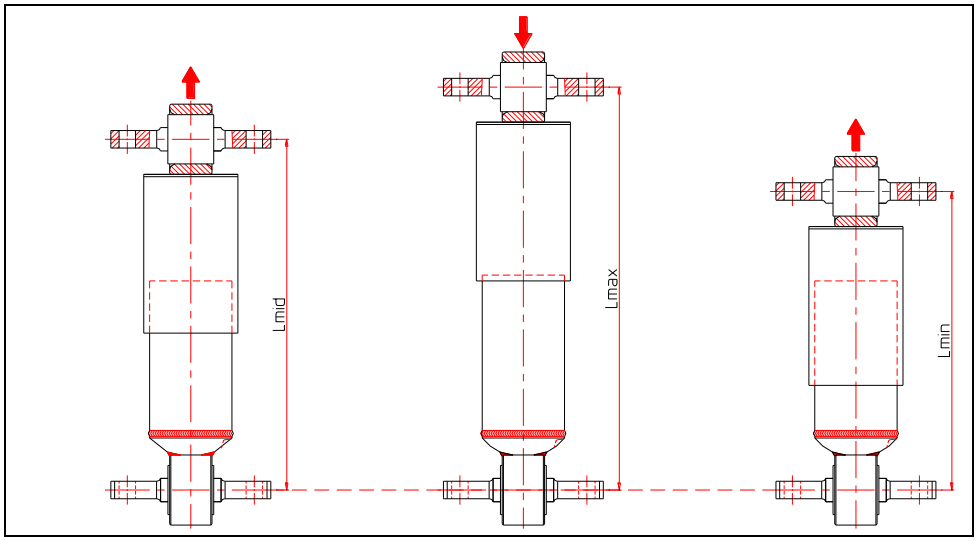


Figure 4-1 Priming positions

After these priming actions keep the dampers in vertical position until they are mounted on the bogie.

4.1.1 Primary Vertical

For the primary vertical dampers no special priming actions are required.

Mounting

The damper has to be mounted in a vertical position. The attachments must be bolted to the bracket and tightened to the right mounting torque.

Make sure that the attachments are mounted without an angular pre-stress as this could have a negative influence on the service life of these rubbers.

4.1.2 Secondary Horizontal (Lateral)

Before mounting the lateral type 97-dampers, we advise to prime the damper. After these priming actions keep the dampers in vertical position until they are mounted on the bogie.

Mounting

The damper has to be placed in a horizontal position under a positive angle. The attachments must be bolted to the bracket and tightened to the right mounting torque.

Make sure the attachments are mounted without an angular pre-stress as this could have a negative influence on the service life of these silentblocs.

The top of the damper is marked with a single deep groove, as shown in Figure 4-2, while an indication decal identifies the bottom of the damper, see Figure 4-3.

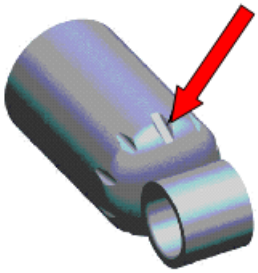


Figure 4-2: Typical top marking

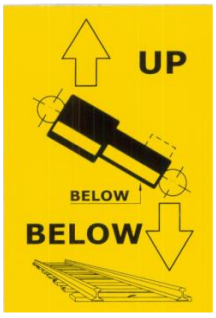


Figure 4-3: Below decal

5 Operation

5.1 Planned inspection and replacement schedule

We advise the periodical inspection and replacement of the dampers in accordance with Figure 5-1. These values are however indications and can vary by application and contractual agreement.

Frequency	Maintenance action	Chapter
Monthly	Visual inspection of the dampers	5.2
1.200.000 km Or 6 years in service	Replacement of the dampers	4

Figure 5-1; Maintenance schedule

5.2 Visual inspection

5.2.1 General

The dampers are exposed to dirt and oil from outside sources due to the operating environment. Road dirt accumulation covering the entire outer surface of the damper is normal and will have no adverse effects on the damper's performance.

5.2.2 Inspection for oil leakage

Inspection on new dampers

Sometimes new KONI railway dampers can appear to show a little oil loss during the first service period and as a result are suspected of leakage. In almost all cases this is assembly lubricant which has nothing to do with oil leakage.

Assembly lubricants (greases) are yellow, black or white in colour, and can easily be distinguished from the red hydraulic damping fluid. When the damper is new, the assembly lubricant may cause a slightly moist piston rod or damper body. If this occurs, simply wipe off the excess oil and return the damper to service. If a new damper has red oil droplets, the damper should not be installed but returned under warranty.

Figure 5-2; KONI damper oil Fluid-A

For a long service life, it is necessary for the rod oil seal to remain lubricated. The continuous inward and outward movement of the piston rod may cause oil “sweat” from the rod oil seal. This loss of oil can be recognized by the outside of the damper being slightly moist and dirty. However, there should not be any droplets of oil clinging to the damper. A slight oil sweating will not affect the damping force and such a damper may remain in service.

Even in the case of a real leakage, the damping forces will not be reduced abruptly, but very slowly, pending on the amount of oil that is left in the damper. However, when red droplets of oil are clearly formed on the damper body, it is advised to remove the damper from the train and replace it.

5.2.3 Roadmap for oil leakage

The following steps can be helpful to identify a real leakage problem of a suspicious damper.

1 Exclude an external source of oil (or another fluid)
The external source could be wheel lubrication systems, gear boxes, hydraulic brakes during servicing or when being maintained, detergents, etc.

a) Check the upper damper tube (also "dust cover")
If the upper part of the damper (with larger diameter) is polluted on its outside with fluid, it could not come from the damper itself.

b) Compare with corresponding dampers of other bogies / wheelsets
It is also an indication for external sources, when there are significant differences between comparable dampers of bogies or wheelsets (e.g. no wheel lubrication at the second axle).

When no external source can be seen, please follow the next steps.

2 *Clean the damper housing*
The surface of the damper has to be freed completely from all dirt/moisture. For this action the damper should be dismounted from the bogie, pulled to its max. length and then cleaned. After cleaning, the damper should be mounted to the bogie again. As an alternative action the oiled area can be marked at its lower edge on the lower damper tube, for instance with a felt pen. When the damper is then installed again and inspected after a certain period, it will be possible to see if the oiled area has been extended.

3 *Operate the train with cleaned damper*

4 *Check the cleaned damper*
Please check the damper after a period, which can last from a week up to the next maintenance period in the workshop. If the surface of the lower damper tube is now oiled and really wet over a wide range, or when even oil drops are visible (or the marked area is considerably extended) it is an indication of a leakage problem of the damper and the damper should be returned.

In addition to the above, the following criteria can also be used during the visual inspection of the dampers:

Visual appearance	Action	Picture
<u>Dirt</u> Normal contamination caused by the operating environment of the dampers is harmless. If a damper has a damp film over the whole body (including the dust cover), it is very probable that this is the result of an outside source of oil or dirt. In this case the damper can remain in service.	None	 *Figure 5-3; Dirt*

Visual appearance	Action	Picture
<u>Sweating</u> For a long service life, it is necessary for the rod oil seal to remain lubricated. The continuous inward and outward movement of the piston rod may cause oil “sweat” from the rod oil seal. This loss of oil can be recognized by the outside of the damper being slightly moist and dirty. However, there should not be any droplets of oil clinging to the damper. A slight oil sweating will not affect the damping force and this damper may remain in service.	None	 *Figure 5-4; Sweating*

Visual appearance	Action	Picture
<u>Oil drops</u> A true oil leakage becomes apparent by a damp surface, which usually covers a large part of the reservoir tube. Isolated oil drop formation is possible. When wiping the damper with a paper cloth, clear oil stains are visible.	Replacement / Overhaul	 *Figure 5-5; Leakage*

5.2.4 Attachments

It is important to visually check the condition of all rubber attachments. Worn or deteriorated rubber parts may adversely affect the damper's performance and cause internal damage to the damper.

While inspecting the bushings, it is advised to examine the welds between the eye and the damper body. The welds should show no evidence of cracking or deterioration.

5.2.4.1 Pin attachments

The pin attachments do not have to be removed in the following cases

Small damages to the surface of the rubber are not affecting the service life.

The pin attachment should be removed in the following cases

Pin rubbers should be replaced when the rubber develops a cut or a split. Furthermore the centring seats should be free of any damage.

5.2.4.2 Rubber bushings

The rubber bushings do not have to be removed in the following cases

Small damages to the surface of the rubber are not affecting the service life.

The rubber bushing should be removed in the following cases

Rubber bushings should be replaced when the rubber develops a cut or a split. Special attention should be paid to the position of the bushings. They should never be further from the centre of the eye than a maximum of 5 mm (Figure 5-6).

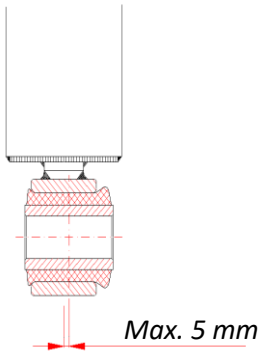


Figure 5-6; Bushing position

5.2.4.3 Silent blocks

The silentbloc do not have to be removed in the following cases

During service of the damper the rubber attachments are subject to wear. The wear is normal and if the rubber part has only developed small cracks on the surface, no action is required. The function of the silentbloc is secured mainly by the internal bonding of the rubber to the metal part. Small damages to the surface of the rubber are not affecting the service life. Please refer to below pictures.

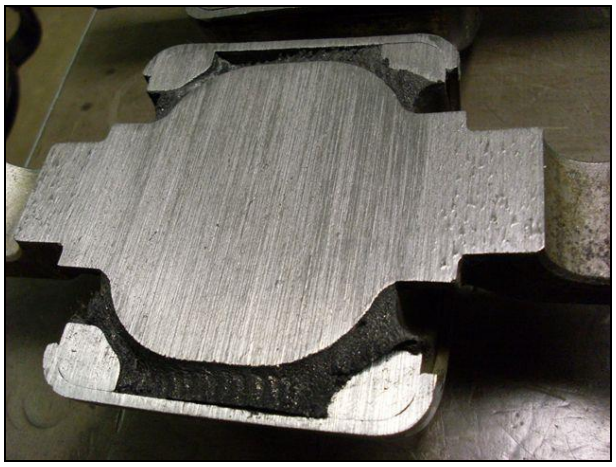


Figure 5-7; Bonding of the internal rubber

Figure 5-8; Acceptable surface cracks

The silentbloc should be removed in the following cases

Silentblocs should be replaced when the rubber develops a cut or a split. If the silent bloc has only developed small cracks on the surface of the rubber, no action is necessary.

If the rubber is deteriorated or the pin is loose in the rubber, the damper must be removed and the silentbloc replaced.

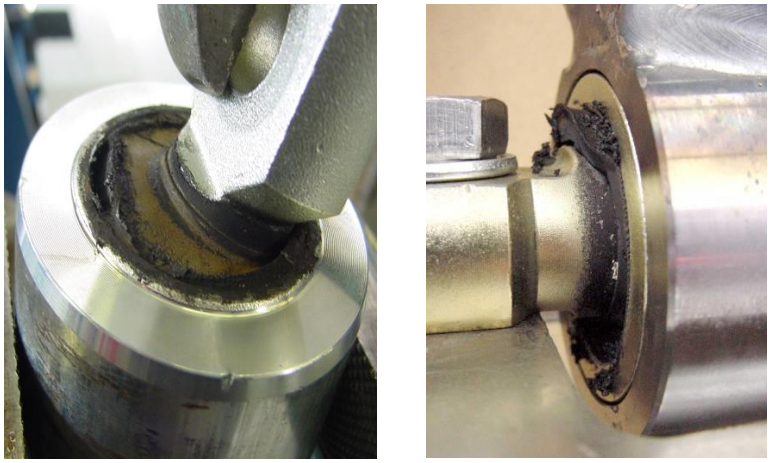


Figure 5-9; Examples of worn bushings

Guideline for replacement of silentblocs

Phenomenon	***Criteria***		***Action***
Cracks in rubber	Depth of crack	Max. 8mm	Replace attachment
	Surface cracks	Only a visual issue	No action required
De-bonding of metal and rubber	De-bonding	Max 10% of the total rubber	Replace attachment
Rubber deterioration	Pulverized rubber	Max. 10% of the total rubber	Replace attachment
Creeping of rubber	Bulging outwards	Max 12 mm from origin	Replace attachment
	Loose collar	Only a cosmetic issue	No action required

5.3 Replacement of attachments

5.3.1 Pin attachment

In case of pin attachments the rubbers or centring seats can simply be replaced without the requirement of special tools, see Figure 5-10.

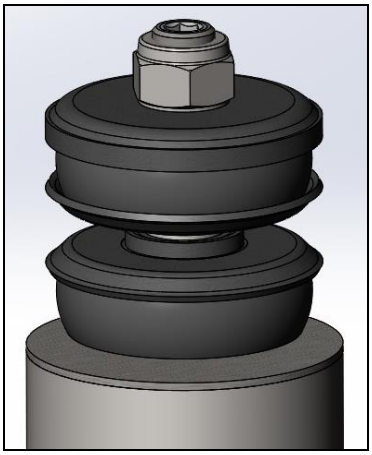


Figure 5-10; Pin attachment

5.3.2 Rubber bushing

5.3.2.1 Rubber block with a separate bush or trunnion

1. Remove the old rubber with bush or trunnion and clean the eye.
2. Immerse the new rubber in hot soapy water of about 60°C.
3. Place the eye on a suitable tool (Figure 5-11/1).
4. Place the rubber over the eye and press it in. If necessary, a plastic or wooden hammer can be used. The rubber must be pressed in so far that the collar of the rubber projects above the bottom side of the eye (Figure 5-11/2).
5. Rotate the damper 180° around the longitudinal axis and place the eye back on the tool (Figure 5-11/3).
6. Heat the assembly cone and the bush or trunnion to be mounted to about 60°C. Place the assembly cone in the rubber and the bush on the cone (Figure 5-11/4) or place the trunnion in the rubber and the assembly cone on the trunnion (Figure 5-11/5).
7. Press the bush or trunnion into the rubber as quickly as possible.
8. When the rubber has been pressed through the eye too far, the damper must be rotated to press it back in the centre.

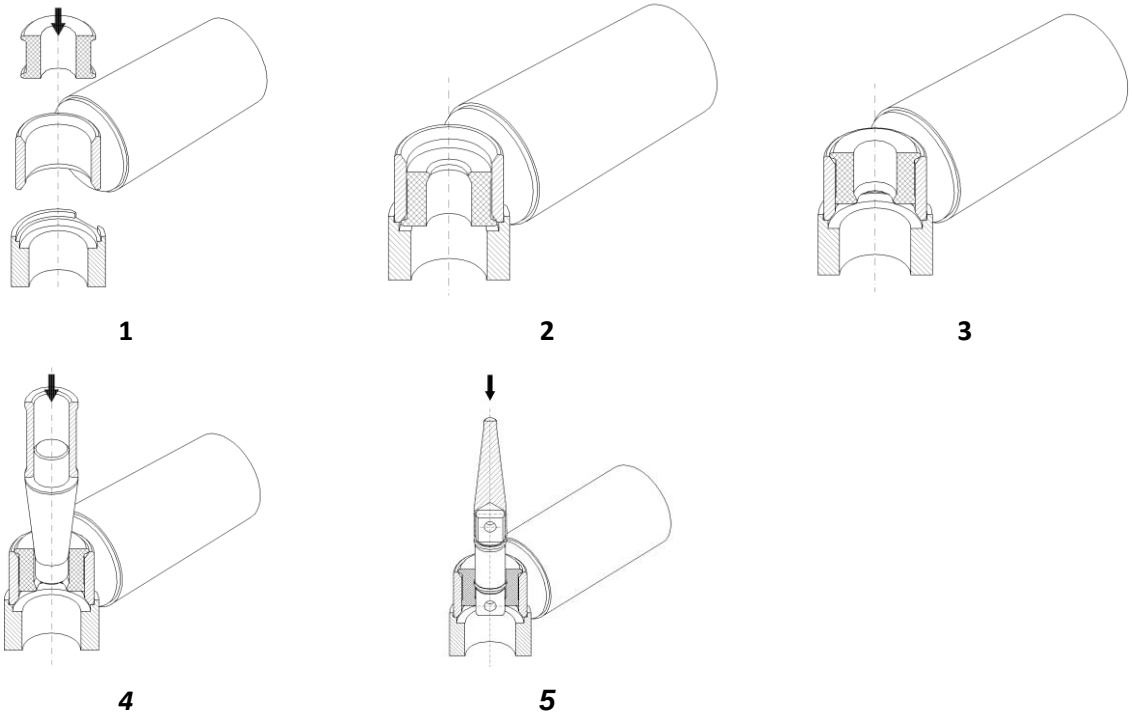
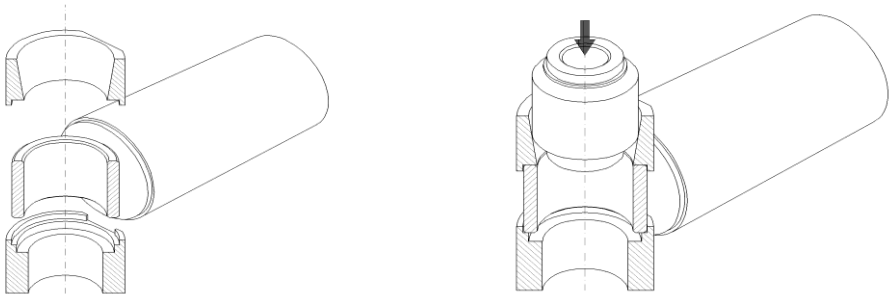


Figure 5-11 Replacement of rubber blocks

5.3.2.2 Rubber bloc with a vulcanized bush or trunnion

1. Remove the old rubber bloc and clean and degrease the eye and the rubber bloc.
2. Place the damper eye on a suitable tool (Figure 5-12/1).
3. Apply locking agent Loctite 601 to the inside of the eye and the outside of the rubber bloc.
4. Place the guiding tool on the eye (Figure 5-12/1)
5. Place the rubber bloc into the guiding tool (Figure 5-12/2)
6. Press the rubber bloc into the eye and press it in about 5 mm too far.
7. Rotate the damper 180° around its longitudinal axis and press the rubber bloc back into the middle.

Make sure you always press on the metal part of the bush.



1 ***2***

Figure 5-12 Replacement of vulcanized rubber blocks

5.3.3 Silentblocs

In case of a worn silentbloc, the complete part has to be removed from the damper eye. Since these attachments are locked in the eye by means of a press fitting and/or Loctite, they can only be removed or assembled by means of a tool set and a press (Figure 5-13, Figure 5-14).

Figure 5-13; Pressing adapter set

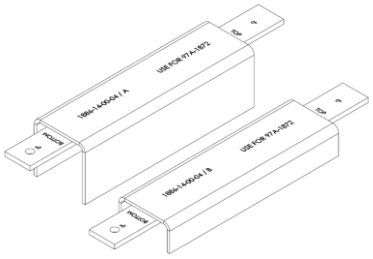


Figure 5-14; Auxiliary tooling set

Silentbloc removal

1. Place the eye of the damper on the big support tool.
2. Now place the smaller tool with the smaller diameter down, on the metal part of the silentbloc, and apply pressure.(Figure 5-15/1)

   Be careful only to apply pressure on the metal part of the silentbloc, and not on the eye of the damper.
3. The block will now be pressed out of the eye.

Silentbloc assembly

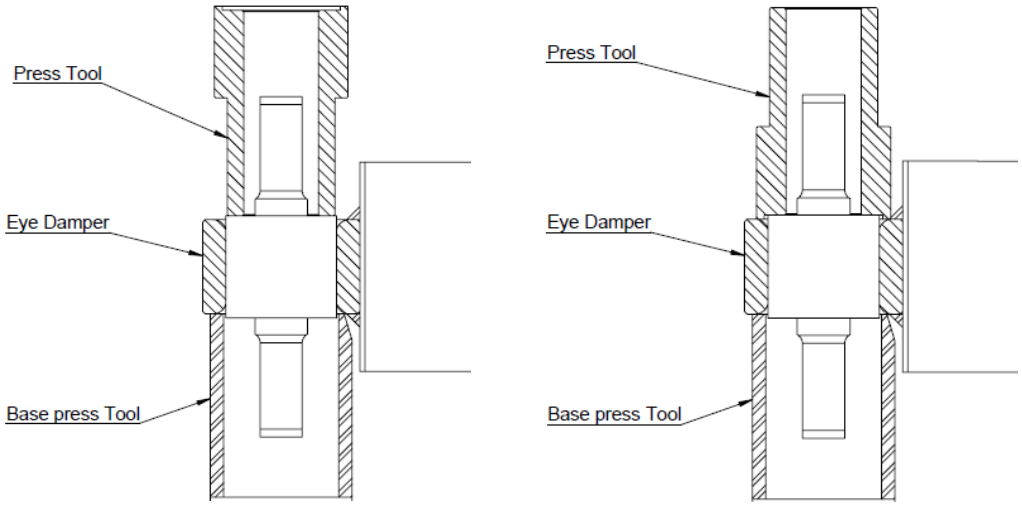
1. Place the eye of the damper on the big support tool.
2. Apply Loctite 601 to the attachment and the eye.

Place the silentbloc onto the eye, and use the high version of the auxiliary tooling to verify the orientation of the silentbloc, according to the damper (Figure 5-16)

3. Now place the smaller tool with the bigger diameter down, on the metal part of the silentbloc, and apply pressure. (Figure 5-15/2)

   Be careful only to put pressure on the metal part of the silentbloc.
4. The silentbloc will now be pressed into the eye.

Use the low auxiliary tool to check the angle after pressing it in. (Figure 5-17)



1 - Pressing out silentbloc 2 - Pressing in the silentbloc

Figure 5-15; Replacement of silentblocs

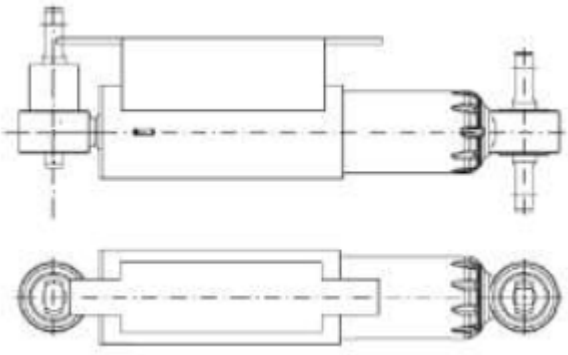


Figure 5-16: Auxiliary tool "High"

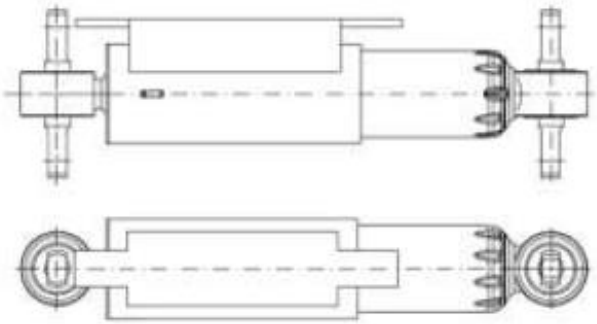


Figure 5-17: Auxiliary tool "Low"