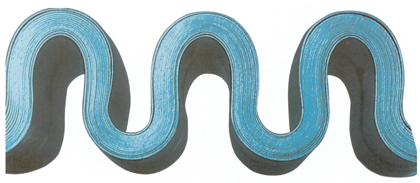
BOA® Group

Expansion Joints Guide Module 4a

- Lateral Expansion Joints General
- Standard Program (EFB)
- Installation Instructions

Expansion Joints Guide

Summary Module 4a



Elastomer Formed Bellows (EFB):

- several to multi-ply (2 to 16 layers)
- high flexibility
- short construction length
- low displacement forces
- big movement capacity
- small corrugation height
- vibration absorbing

1 Lateral Expansion Joints General

As for angular expansion joints, the function of the lateral expansion joint is based on angular rotation of the steel bellows. The expansion capacity depends on the construction length and the center-to-center distance of the bellows: The longer the length or the center-to-center distance of the bellows, the larger is the lateral expansion capacity (fig. 1).

A longer center-to-center distance results in lower displacement forces of the expansion joint. In contrast to angular expansion joints, lateral expansion joints are independent expansion systems, representing a complete two-pin system. Lateral expansion joints are usually installed with 50% prerestraint of the expansion capacity. Preferably the prerestraint should be made on the already completed hinge system. Considering the installation temperature, the prerestraint value may be taken from the prerestraint diagram 2 in section 3.3.

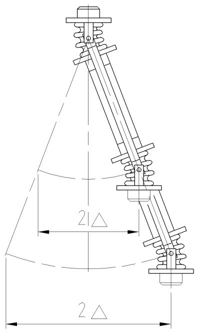


Fig. 1

Special characteristics of lateral expansion joints are:

- very low anchor loads, since the tie bars transfer the reaction forces from the internal pressure.
- larger expansion capacity is possible per expansion joint.
- reduced requirements on pipe guides.

Even swing hangers may be sufficient.

Depending on their expansion capacity, there is a distinction between two types of lateral expansion joints:

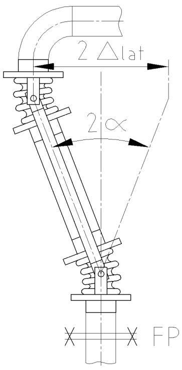


Fig. 2

Expansion joints with lateral expansion capacity in one plane

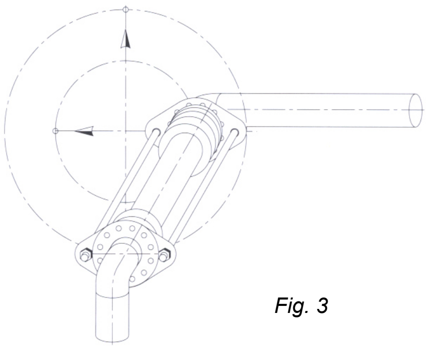


Fig. 3

Expansion joints with lateral expansion capacity in a circular plane

Types/ Design
Lateral expansion joint in spherical joint design, moving in a circular plane, are the simplest designs. In addition, for higher operating pressures, lateral expansion joints in universal joint execution or two gimbal expansion joints as hinge system are recommended, if expansion capacity in a circular plane is required. Lateral expansion joint moving in a circular plane are also suitable for compensating mechanical oscillations in pressure lines such as on pumps, compressors and other power machinery (fig. 4).

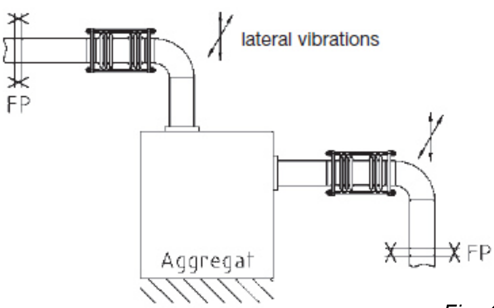


Fig. 4

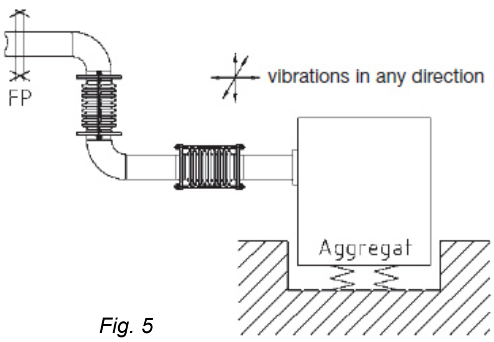


Fig. 5

If the machine is firmly mounted on a concrete base, usually installing a lateral expansion on the suction side and one on the pressure side is sufficient (fig. 4), for vacuum operation possibly with a tie rod on the suction side to compensate for traction and pressure. If, however, the machine is installed on a flexible foundation, three-dimensional movements occur in all directions. The same rule applies for installations in earthquake zones. In this case, an additional angular or lateral expansion must be installed (fig. 5).

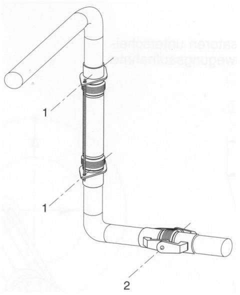


Fig. 6

One option is the installation of a three pin L-arc system layout, comprising one lateral and one angular expansion joint. To allow the elbow in the system performing tilting movements, the two expansion joints must work together, i.e. the imaginary connecting line (1) over the two tie rods is parallel to the bolt axis (2) of the angular expansion joint (fig. 6).

High-energy oscillations of very high frequencies, occurring due to strong turbulent flows caused by e.g. safety, reducing and quick closing valves, as well as oscillations caused by vibrating gas or liquid columns usually can not be compensated.

Guides, anchor points

To ensure an intended compensation of the pipeline expansion by a lateral expansion joint, the expansion mapping must be clearly defined using guide bearings or anchor points. Depending on the installation conditions, either guide bearings on both sides (fig. 7) or an immediate anchor point on one and a guide bearing on the other side shall be installed (fig. 8).

The pipe guides should fulfil the following requirements:

- take up the weight of the pipeline and the expansion joints
- guide the expanding pipeline in its longitudinal axis
- provide sufficient clearance s to assure that pipe movements not compensated by expansion joints, resulting both from the thermal expansion ΔL of the pipeline displacement L, and the arc height h (fig.7), can be compensated by the continuing pipeline without causing the guide to jam.

$$s \geq h + \Delta L$$

Guide bearings are not necessary for short-leg turbine house pipelines. The weight of the pipe legs must be absorbed by appropriate hangers in a way not to hinder the movement of the expansion joints.

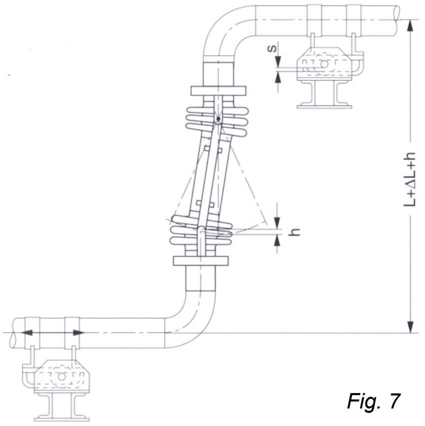


Fig. 7

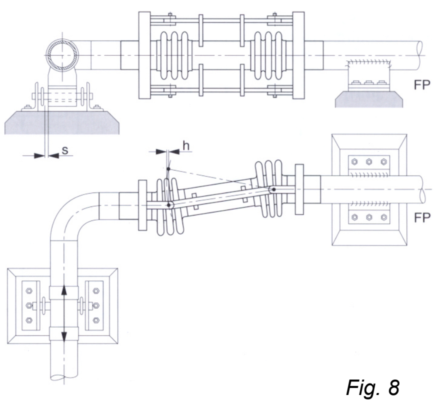


Fig. 8

1.1 System calculation

1.1.1 Lateral expansion joints for movement compensation in one plane

Due to the deflection of a lateral expansion a bending moment and a force occur, resulting from the bellows spring rate and the friction of the hinges. The anchor points are loaded by them. For longer pipe sections with several pipe guides between expansion joint and anchor point, the bending moment is wearing off almost completely until the connection points. The reaction forces resulting from the effective bellows area and the maximum operating pressure are absorbed by the hinge structure.

All formulae refer to a 50% prerestraint of the pipe movement Δ, i.e. the lateral expansion joint will be deflected by ±Δ/2. At 100% or 0% prerestraint, the amount of 2 x Δ must be put into the equation.

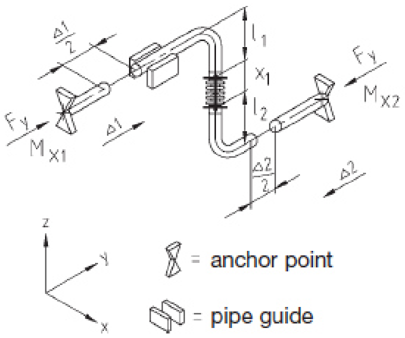


Fig. 9

Resulting movement

$$\Delta = \Delta_1 + \Delta_2$$

Admissible expansion capacity

Following the indications given in section 2.2 "Reduction", the admissible lateral expansion capacity $\pm\Delta_{adm}$ is calculated from the nominal lateral expansion capacity $\pm\Delta_{lat}$ as follows:

$$\pm\Delta_{adm} = \pm\Delta_{lat} \cdot K_\Delta (t_B) \cdot K_L$$

The occurring pipe movement $\pm \Delta/2$ must be less or equal to the admissible lateral expansion capacity $\pm \Delta_{adm}$:

$$\pm \Delta/2 \leq \pm \Delta_{adm}$$

Resulting arc height

At the maximum lateral deflection (Δ/2) to one side, due to the circular motion the vertical length of the expansion joint is shortened by the dimension h:

$$h = X_1 - \sqrt{(X_1^2 - 0.25 \cdot \Delta^2}$$

h	=	arc height [mm]
Δ	=	resulting movement of the pipeline [mm]
$\Delta_{1,2}$	=	movement of the pipeline sections 1 and 2 [mm]
Δ_{lat}	=	possible lateral movement of the expansion joint [mm]
K_Δ	=	reduction factor for expansion capacity [-]
X_1	=	center-to-center distance of the bellows [mm]
K_L	=	load cycle factor [-]

The arc height h and the uncompensated thermal expansion of the leg in the expansion joint's axis must be compensated for by sufficient clearance or by bending of the pipe legs.

Forces at connection points

$$F_X = C_r \cdot p + C_{lat} \cdot \frac{\Delta}{2} + g \cdot L \cdot \mu \cdot 10$$

F_X	=	displacement force in X-direction [N]
L	=	length of the pipeline [m]
g	=	weight per meter of the pipeline including medium and insulation [kg/m]
μ	=	friction coefficient [-]
Δ	=	resulting movement of the pipeline [mm]
C_{lat}	=	lateral spring rate [N/mm]
C_r	=	hinge friction (friction torque) [N/bar]
p	=	operating overpressure [bar]

Bending moments at connection points

$$M_{Y1} = F_X \cdot \frac{0.5 \cdot X_1 + l_1}{1000}$$

$$M_{Y2} = F_X \cdot \frac{0.5 \cdot X_1 + l_2}{1000}$$

$M_{Y1,2}$ = moments at connection points [Nm]
F_X = displacement force in X-direction [N]
X_1 = center-to-center distance of the bellows [mm]
$l_{1,2}$ = distance from bellow's center to connection point [mm]

1.1.2 Lateral expansion joint for movement compensation in a circular plane

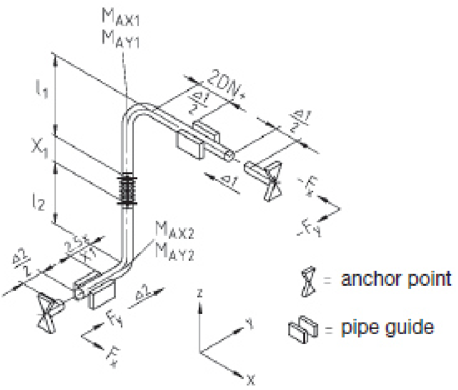


Fig. 10

All formulae refer to 50% prerestraint of the pipe movement Δ_1 und Δ_2, to compensate for, i.e. the lateral expansion joint will be deflected in both, the prerestrained and the operating position, by the resulting lateral expansion of $\pm \Delta/2$.

Resulting expansion

$$\Delta = \sqrt{\Delta_1^2 + \Delta_2^2}$$

Admissible expansion capacity
Following the indications given in section 2.2 "Reduction", the admissible lateral expansion capacity $\pm\Delta_{adm}$ is calculated from the nominal lateral expansion capacity $\pm \Delta_{lat}$ as follows:

$$\pm \Delta_{adm} = \pm \Delta_{lat} \cdot K_\Delta (t_B) \cdot K_L$$

The resulting pipe movement $\pm\Delta/2$ must be less or equal to the admissible lateral expansion capacity $\pm \Delta_{adm}$:

$$\pm \Delta/2 \leq \pm \Delta_{adm}$$

At 100% or 0% prerestraint the resulting pipeline movement Δ must be less or equal to Δ_{adm}:

$$\Delta \leq \Delta_{zul}$$

Resulting arc height
At the maximum lateral deflection ($\Delta/2$) to one side, due to the circular motion the vertical length of the expansion joint is shortened by the dimension h:

$$h = X_1 - \sqrt{(X_1^2 - 0.25 \cdot \Delta^2}$$

h = arc height [mm]
Δ = resulting movement of the pipeline [mm]
$\Delta_{1,2}$ = movement of pipeline sections 1 and 2 [mm]
Δ_{lat} = possible lateral movement of the expansion joint [mm]
K_{Δ} = reduction factor for expansion capacity [-]
X_1 = center-to-center distance of the bellows [mm]
K_L = load cycle factor [-]

At 100% or 0% prerestraint, the amount of 2 x Δ for h must be put into the equation.
The arc height h, and the uncompensated thermal expansion of the leg in the expansion joint's axis must be compensated for by sufficient clearance or by bending of the pipe legs.

Forces at connection points

$$F_X = C_r \cdot p + C_{lat} \cdot \frac{\Delta_1}{2} + g \cdot L \cdot \mu \cdot 10$$

$$F_Y = C_r \cdot p + C_{lat} \cdot \frac{\Delta_2}{2} + g \cdot L \cdot \mu \cdot 10$$

$F_{X,Y}$ = displacement force in X- and Y-direction [N]
L = length of pipeline [m]
g = weight per meter of the pipeline including medium and insulation [kg/m]
μ = friction coefficient [-]
$\Delta_{1,2}$ = resulting movement of the pipeline sections 1 and 2 [mm]
C_{lat} = lateral spring rate [N/mm]
C_r = hinge friction (friction torque) [N/bar]
p = operating overpressure [bar]

Bending moments at connection points

$$M_{X1} = F_Y \cdot \frac{0.5 \cdot X_1 + l_1}{1000}$$

$$M_{X2} = F_Y \cdot \frac{0.5 \cdot X_1 + l_2}{1000}$$

$$M_{Y1} = F_X \cdot \frac{0.5 \cdot X_1 + l_1}{1000}$$

$$M_{Y2} = F_X \cdot \frac{0.5 \cdot X_1 + l_2}{1000}$$

$M_{X,Y,1,2}$ = moments at connection points [Nm]
$F_{X,Y}$ = displacement force in X-direction [N]
X_1 = center-to-center distance of the bellows [mm]
$l_{1,2}$ = distance from bellow's center to connection point [mm]

If the system is 50% prerestrained, the bending moments and forces have different signs in the prerestrained position and operation position.

1.1.3 Lateral expansion joints in three pin hinge systems

In Module 3a "Angular Expansion Joints", different hinge systems are explained, each consisting of three angular expansion joints. If the distance between the hinges are small, due to restricted space conditions, it is often more economical to replace two angular expansion joints by a lateral expansion joint.

If lateral expansion joints in spherical joint or gimbal joint design are used, the armature of the lateral expansion in the system shall be arranged in a way to allow angular rotation towards the angular expansion joint (fig.11), e.g. spherical joint with angular expansion joint: The imaginary line connecting the two rods (1) must be parallel to the bolt axis (2) of the angular expansion joint.

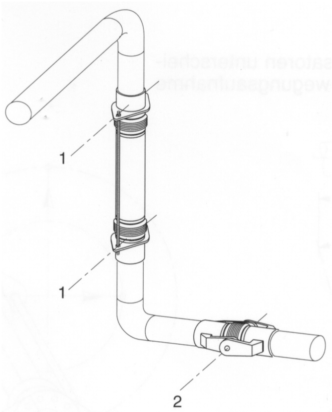


Fig. 11

In a three-pin hinge system, only lateral expansion joints with two tie rods are allowed. Three or more tie rods make angular rotation impossible.

In order to apply the equations of the three-pin hinge systems using a lateral expansion joint, the spring rates and displacement forces must be converted into equivalent bending strengths and displacement moments of two substitute angular expansion joints. The two substitute angular expansion joints then represent the lateral expansion joint in the calculation of the hinge system.

The following conversion only approximately applies to lateral expansion joints in spherical joint design, since the distance between the spherical joints do not coincide with the center-to-center distance. Please contact us if exact calculation is required.

The angular spring rate C_a of the substitute angular expansion joint is calculated by the lateral spring rate C_{lat} of the lateral expansion joint as follows:

$$C_a = C_{lat} \cdot X_1^2 \cdot \frac{\pi}{360} \cdot 10^{-3}$$

The angular hinge friction C_r of a substitute angular expansion joints is calculated from the lateral friction $C_{r(lat)}$ of the lateral expansion joint as follows:

$$C_r = C_{r(lat)} \cdot \frac{X_1}{2000}$$

The additional angular moment C_z of the substitute angular expansion joint is calculated from the additional lateral force $C_{z(lat)}$ of the lateral expansion joint as follows:

$$C_z = C_{z(lat)} \cdot X_1^2 \cdot \frac{\pi}{360} \cdot 10^{-3}$$

The admissible angular expansion capacity $\pm\alpha_{adm}$ of the substitute angular expansion joint is calculated from the admissible lateral expansion capacity $\pm\Delta_{adm}$ as follows:

$$\pm\alpha_{adm} = \pm \arcsin\left(\frac{\Delta_{adm}}{X_1}\right)$$

C_a = angular spring rate [Nm/°]
C_{lat} = lateral spring rate [N/mm]
C_r = hinge friction [Nm/bar]
$C_{r(lat)}$ = hinge friction (lateral) [N/bar]
C_z = additional moment from rotation and pressure [Nm/(bar°)]
$C_{z(lat)}$ = traction due to internal pressure and angulation [N/(bar mm)]
X_3 = center-to-center distance of the bellows [mm]

2 Standard Program BOA Lateral Expansion Joints (EFB)

2.1 General

Expansion joints manufactured by BOA AG Switzerland are formed in the elastomer process (EFB). The core element is the multi-ply metal bellows (2 to 16 layers) made of austenitic steel. Expansion joints produced by this method have a large expansion capacity and are very flexible. They are especially appropriate to compensate for thermal expansion and minor misalignment during installation. Their advantages are:

- BOA AG has over 70 years experience in manufacturing expansion joints
- multi-ply construction of the bellows, made of high-grade stainless steel (1.4571 and 1.4541), which means high resistance against ageing, temperature, UV-rays and most of aggressive media.
- very low spring rate due to the multi-ply construction of the bellows.
- large movements at short construction lengths
- due to reasonable stocks, various types in different sizes and pressure ranges are usually available at short time.

Inner sleeve
Inner sleeves protect the bellows and prevent it from being stimulated to oscillate by the fluid. The installation of an inner sleeve is recommended in the following cases:

- abrasive media
- large temperature variations
- flow rates **higher than approx. 8m/s for gaseous media**
- flow rates **higher than approx. 3m/s for liquid media**

When installing, the flow direction must be observed!

Design designation, example:
Type LFS16-50 = Lateral expansion joint for pressure range PN16 and total expansion capacity of 50mm (= ± 25mm). Decisive, however, is the value of the column "Nominal lateral expansion capacity" in the technical tables.

Lateral expansion joints usually must absorb large lateral movements /vibrations. Therefore, they are usually used without inner sleeve. An inner guide sleeve structure allowing large lateral movements inevitably leads to a strong constriction of the flow cross-section. The resulting local acceleration of the flow medium very often is not accepted. On request (extra charge) inner sleeves may be installed.
Of course expansion joints can be designed and manufactured specifically for other materials, pressure ranges and life cycles.

2.2 Reduction

2.2.1 Expansion capacity

NOTE (Hereinafter the term **load cycle** is used for full load change cycle.)
The maximum permissible expansion capacity is indicated on the expansion joint. It refers to 1000 load cycles (for expansion joints conforming to EC standards: 500 load cycles with safety factor 2). At higher load cycles, the expansion capacity must be reduced by the load cycle factor K_L according to table 1. For the accurate determination of the load factor K_L the following formula can be applied:

$$K_L = (1000 / N_{adm})^{0.29}$$

Load cycles N_{adm}	Load cycle factor K_L
1'000	1.00
2'000	0.82
3'000	0.73
5'000	0.63
10'000	0.51
30'000	0.37
50'000	0.32
100'000	0.26
200'000	0.22
1'000'000	0.14
25'000'000	0.05

Table 1

2.2.2 Temperature related movement and pressure reduction

NOTE
The admissible operating pressure is determined by the nominal pressure considering the reduction factor K_P according to tab. 2. At higher temperatures, the expansion capacity K_Δ has to be reduced according to the reduction factors.

Reduction factors [1] for pressure [K_P] and expansion capacity [K_Δ]		
Temperature °C	K_P	K_Δ
-10...20	1.00	1.00
50	0.92	0.97
100	0.87	0.94
150	0.83	0.92
200	0.79	0.90
250	0.74	0.88
300	0.67	0.86
350	0.60	0.85
400	0.53	0.84

Table 2

[1] linear interpolation for intermediate values

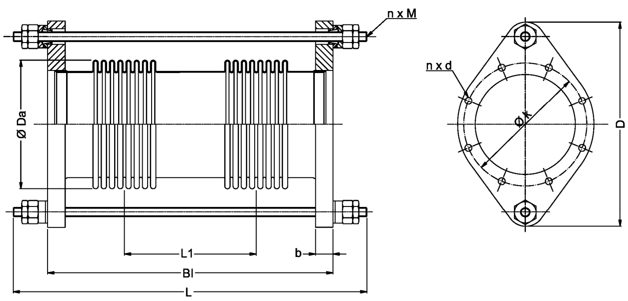
2.3 Lateral expansion joints

2.3.1 Lateral expansion joints with flanges

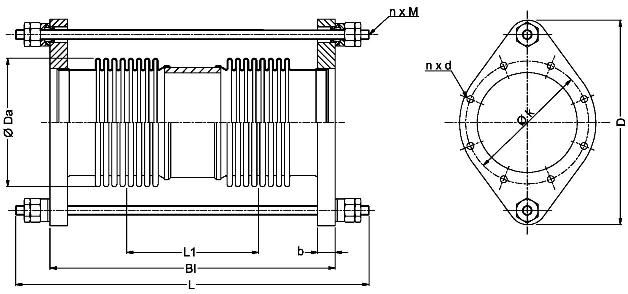
2.3.1.1 Type LFS

- Expansion joints of type LFS are equipped with **flanges firmly welded onto the bellows**.
- As a standard, expansion joints of type LFS are manufactured in nominal diameters from DN 40 until DN 1000 mm and in pressure ranges of PN 6,10, 16, 25 and 40.
- High-grade, low-friction hinge system with tie rods made of carbon steel and with ball joints.
- As a standard, flanges are made of carbon steel and are primer coated.
- The variant with particularly large lateral movement (Design II) is equipped with an intermediate tube made of carbon steel.
- The design type I or II is indicated in the last column of the standard tables (see fig.).

Design I
Lateral expansion joint with integrated intermediate tube



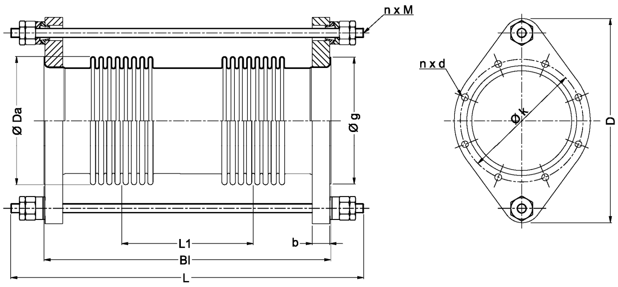
Design II
Lateral expansion joint with attached intermediate tube



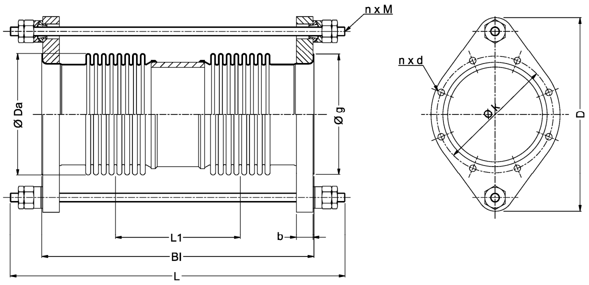
2.3.1.2 Type LFB

- Expansion joints of type LFB are equipped **with movable, collared flanges**. The inside medium is only in contact with the austenitic bellows material.
- As a standard, expansion joints of type LFB are manufactured in nominal diameters from DN 40 until DN 300 mm and in pressure ranges of PN 6, 10, 16 and 25.
- As a standard, flanges are made of carbon steel and are primer coated.
- High-grade, low-friction hinge system with tie rods made of carbon steel and with ball joints.
- The variant with particularly large lateral movement (Design II) is equipped with an intermediate tube made of carbon steel.
- The design type I or II is indicated in the last column of the standard tables (see fig.).

Design I
Lateral expansion joint with integrated intermediate tube



Design II
Lateral expansion joint with attached intermediate tube



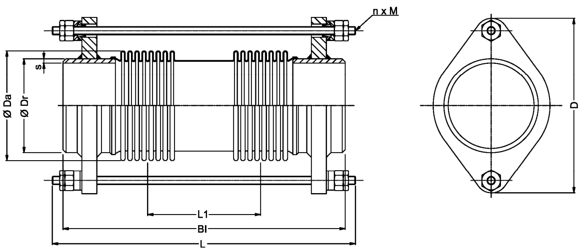
2.3.2 Lateral expansion joint with weld ends

2.3.2.1 Type LW

- **The bellows and weld ends** of expansion joints of type LW are **tightly welded**.
- As a standard, expansion joints of type LW are manufactured in nominal diameters from DN 40 until DN 1000 mm and in pressure ranges of PN 6, 10, 16, 25 and 40.
- High-grade, low-friction hinge system with tie rods made of carbon steel and with ball joints.
- As a standard, weld ends and flanges are made of carbon steel and are primer coated.
- The variant with particularly large lateral movement (Design II) is equipped with an intermediate tube made of carbon steel.
- The design type I or II is indicated in the last column of the standard tables (see fig.).

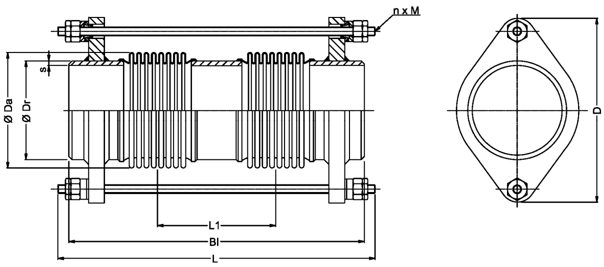
Design I

Lateral expansion joint with integrated intermediate tube



Design II

Lateral expansion joint with attached intermediate tube



3 Installation Instructions Lateral Expansion Joints

3.1 General safety recommendations

Prior to installation and start-up, installation and start-up instructions must be read and observed. Installation, start-up and maintenance work shall only be performed by **qualified and authorized staff.**

Maintenance
Lateral expansion joints are maintenance free.

CAUTION
Prior to disassembly and maintenance, the system must be
- depressurized,
- cooled down,
- emptied.

Otherwise there is a risk of accident!

Transport, packaging and storage
- The consignment must be checked for completeness upon receipt.
- Any transport damage must be reported to the carrier and the manufacturer.
- At an intermediate storage we recommend to use the original packaging.

Admissible ambient conditions for storage and transport:
- ambient temperature - 4°C to +70 °C
- relative humidity up to 95%.

Lateral expansion joints must be protected against wetness, humidity, dirt, shocks and damage.

Warranty
A warranty claim requires professional installation and start-up in accordance with installation and start-up instructions. The necessary installation, start-up and maintenance work must be performed by qualified and authorized staff.

Operating pressure
NOTE
- The permissible operating pressure results in the nominal pressure considering the reduction factors given in section 2.2 "Reduction".
- At higher temperatures, the expansion capacity has to be reduced according to the reduction factors (see section 2.2).

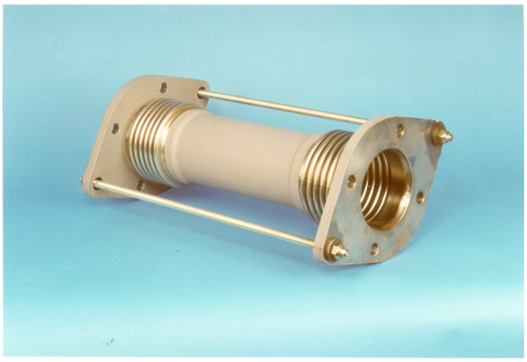
Start-up and check
Before starting-up check if
- the pipeline is installed with sufficient inclination to avoid water pockets
- there is sufficient drainage
- pipe anchors and pipe supports/ guides are firmly installed prior to filling and pressure testing the system
- the expansion joint is not stressed by torsion
- the flow direction has been observed for expansion joints with inner sleeves
- the steel bellows is free of dirt, welding, plaster or mortar splatters or any other soiling; clean if necessary
- all screwed connections are tightened properly
- the general due diligence requirements to avoid corrosion damage are observed, such as water treatment, or prevention of galvanic corrosion in copper and galvanized pipes.

Insulation
Expansion joints may be insulated exactly as the pipeline.
- If no coating is provided, protect the bellows by means of a slidable metal sleeve to avoid insulation material dropping into the convolutions.
- If the expansion joint is to be placed under plaster, a protective cover is essential. This ensures the bellows' function, protects against soiling and avoids contact with structure materials.

.
Improper operation
- The limits given in the technical data of the standard range must not be exceeded.
- Swinging suspensions adjacent to expansion joints are not permitted.
- Do not clean the newly installed pipeline by blowing it with steam to avoid water hammers and unacceptable vibration stimulating of the bellows.

System start-up
CAUTION
- During pressure testing and operation, the allowable test pressure or operating pressure defined for the expansion joint must not be exceeded.
- Excessive pressure peaks as a consequence of valves closing too abruptly, water hammers etc. are not permitted.
- Avoid contact with aggressive media.
- The start-up of steam lines must be performed such that the condensate has time to drain off.

3.2 Lateral expansion joints



Description of lateral expansion joints and their application fields
Lateral expansion joints work in the same way angular expansion joints do, utilizing the angular rotation of the steel bellows. They are also suitable for limited installation space. The expansion capacity depends on the construction length of the bellows and their center-to-center distance. The longer the distance between the bellows, the larger is the lateral expansion capacity (fig. 12).

A longer center-to-center distance also results in lower displacement forces of the expansion joint.

A lateral expansion joints is an independent expansion system representing a complete two-pin hinge system.

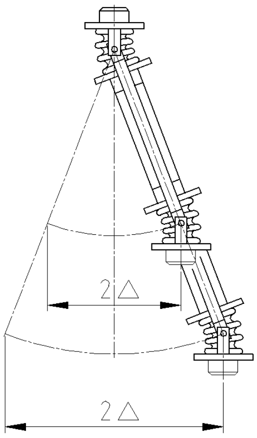


Fig. 12

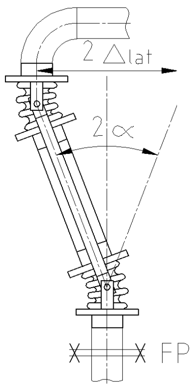
Special characteristics:

- very low anchor loads as the tie bars restrain the pressure thrust resulting from internal pressure
- less demanding regarding pipe supports/ guides

Even swing hangers may be acceptable.

Depending on the expansion capacity, there are two types of lateral expansion joints:

- expansion joints with lateral expansion capacity in one plane
- expansion joints with lateral expansion capacity in a circular plane



Movement from one direction is possible

Fig. 13

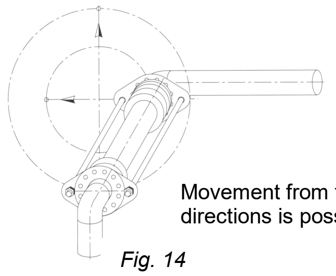

Movement from two directions is possible

Fig. 14

Type overview

Lateral expansion joints	Connection type
LW	1
LFS	2
LFB	5

Table 3

Connection type:
1 weld end
2 flange, welded
5 flange, flared (collared)

Admissible operating temperature:
for standard design: maximum 300°C

3.3 Installation advice

Assembly

- Anchor points and pipe guides must be firmly installed before filling and pressure testing the system.
- Expansion joints must be installed without being subject to torsion.
- The steel bellows must be protected against damage and dirt (e.g. welding, plaster or mortar splatter).
- Steam pipelines should be installed in such a way that water hammers are avoided. This can be achieved by adequate drainage, insulation, by preventing water pockets and by sufficient inclination of the line.
- Observe the flow direction while installing expansion joints with inner sleeves.
- Avoid the installation of expansion joints in the immediate vicinity of pressure reducers, hot steam coolers and shut-down valves, if high-frequency oscillations are expected due to turbulence. Otherwise special measures must be installed (e.g. thick-walled sleeves, perforated disks, calming sections etc.).
- If high frequency vibrations or turbulence or high flow speed are expected, we recommend the installation of expansion joints with inner sleeve.
- Inner sleeves are also recommended for expansion joints with DN ≥ 150, if the flow speed of air, gas or steam media exceeds 8 m/s, or 3 m/s in case of liquid media.

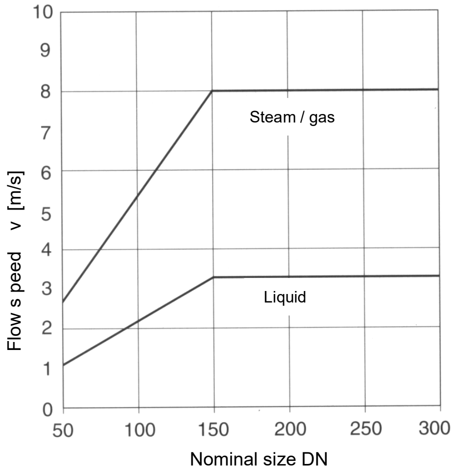


Diagram 1

Pipe guides, pipe supports

- When installing lateral expansion joints (fig. 15), which can take up lateral expansion only in one plane, pay attention to consistency between the direction of the pipe expansion and the movement capability of the expansion joints (perpendicular to the bolt axis). The nominal lateral expansion capacity can be taken from Module 4c. Lateral expansion joints have no special demands on guide supports. For short-leg boiler and turbine room pipelines guide bearing is not necessary.
- The weight of the pipeline (including medium and insulation) and all wind and additional loads must be absorbed by suitable pipe hangers or supports. Movements of the expansion joint must not be hindered!
- Long pipe sections before and after the lateral expansion joint need a guide support.

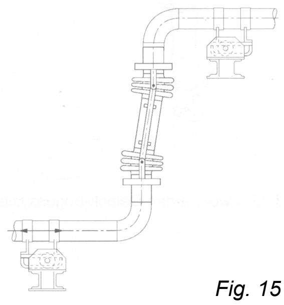


Fig. 15

Anchor points

- Only one lateral expansion joint is allowed between two anchor points. The anchor points must absorb the inherent resistance of the expansion joint, resulting from the bending resistance of the bellows and the pin friction of the hinge supports as well as the frictional forces of the guides/supports.

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NOTE

Pipe guides with excessive frictional resistance resulting from a too high surface pressure, dirt or corrosion deposits may block and cause considerable pressure peaks in the pipeline, its anchors and connections.

Vibration compensation with lateral expansion joints
Lateral expansion joints in spherical hinge design are suitable for compensating mechanical oscillations in pressure lines laterally in circular plane, such as for pumps, compressors and other power machinery (fig. 16). If the machine is securely mounted on a concrete base, in most cases the installation of a lateral expansion joint is sufficient. However, if the machine is mounted on a flexible foundation, two lateral expansion joints making a 90° L-arc system are to be provided (fig. 17) in order to compensate for the all-around vibrations. Immediately behind the expansion joint, an anchor point independent from the flexible foundation is required!

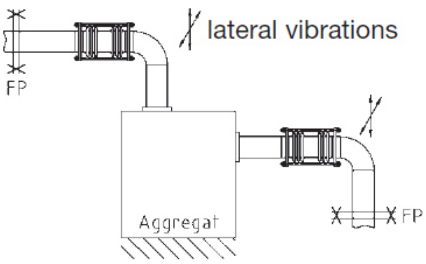


Fig. 16

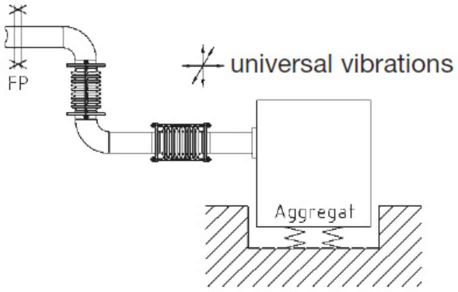


Fig. 17

Install the expansion joint as close as possible to the vibrating unit.
Installation without prerestraint!

CAUTION
In general, vibrations of very high frequency due to strong turbulent flows, such as those occurring after safety, reducing and shut-down valves, as well as vibrations caused by vibrating gas or liquid columns can not be compensated.

Prerestraint
Lateral expansion joints are usually installed with 50% prerestraint of their expansion capacity. It is advisable to carry out prerestraining on the completely installed system.

- While prerestraining, consider the installation temperature of the pipeline, particularly for above ground level pipelines.
- If the installation temperature differs from the lowest design temperature, reduce the prerestraint in accordance with the prerestraint diagram 2

Prerestraint diagram

Example to diagram 2
Hinge system for a pipeline measuring 140 m in length:
Lowest temperature is -7°C.
Highest temperature is +293°C.
The maximum anticipated thermal movement equals 500 mm at the temperature difference of 300°C.
The hinge system or expansion joint shall be prerestrained by 50% of the pipelines expansion = 250mm (i.e. acting in opposite direction of the pipeline movement).
While installing, pay special attention to the correct restraining. Temperature while installing shall not be -7°C but +20°C. This results in a thermal expansion of the pipeline of 45 mm (see diagram 2). This amount must be subtracted from the original prerestraint value of the hinge system or expansion joint: 250 – 45 = 205 mm.
The prerestraint diagram (2) allows determining the prerestraint value directly without calculation:

1. Temperature difference between installation temperature and lowest temperature: +20°C – (-7°C) = 27°C.

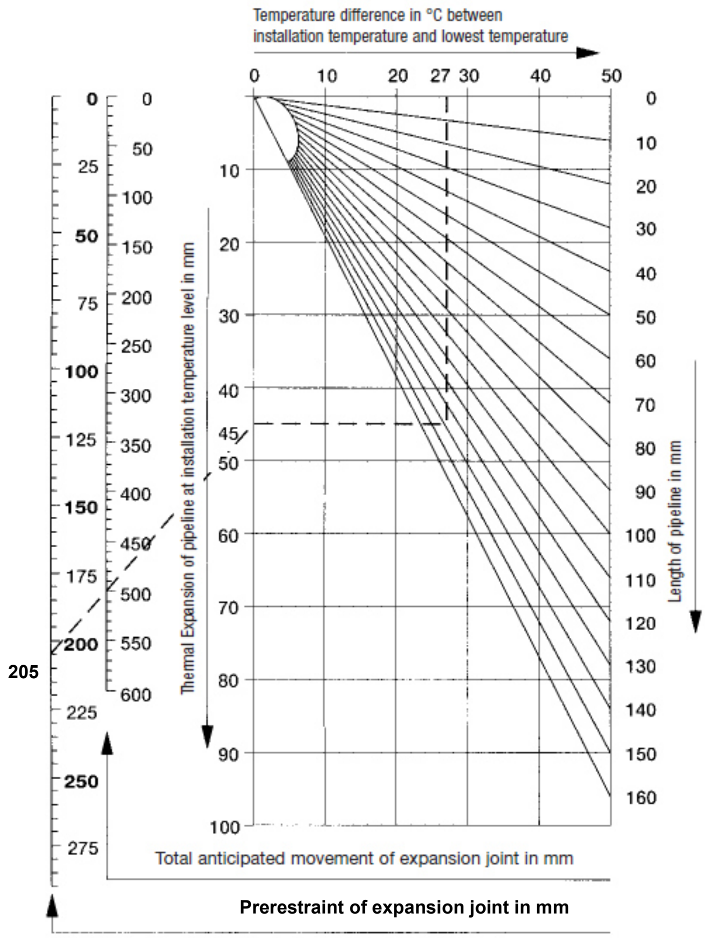
2. Length of pipeline to be compensated for: 140 m

3. Draw a vertical line from the "27°C" point towards the beam coming from "0 - 140m".

4. Draw a horizontal line from this intersection to the line "Thermal expansion of pipeline in mm"; the result is, as stated above, 45 mm.

5. Draw a straight line from the "45 mm" point to "Total anticipated movement", this equals 500 mm, and go further to "Prerestraint of hinge system/ expansion joint in mm".

The intersection shows a prerestraint of 205 mm. This is the value by which the hinge system must be prerestrained during installation.



valid for steel pipelines made of St 35

Diagram 2

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