

1.2 - Static characteristics

1.2.1 - Radial characteristics

The application of a radial force F_R causes an elastic eccentricity X by compression of the elastomer on one side and stretching of the other side.

The bush is characterised by the permissible radial static force and by the corresponding eccentricity.

In practice, the permissible radial static forces are estimated by taking the stress rate on the surface area S of the rectangle which represents the projection of part of the elastomer which is in contact with the internal tube.

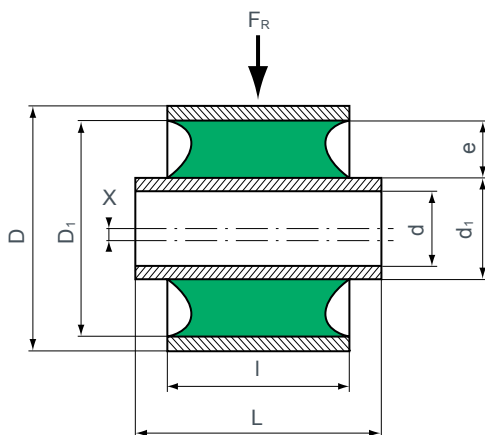
$$\text{Stress rate} = t = \frac{F_R}{S} = \frac{F_R}{d_1 \times l}$$

F_R in N
 d_1 and l in m
 t in N/m^2

The permissible stress is a function $\frac{l}{D}$ of the bush and of the specific properties of the elastomer.

It is clear that the permissible deformation for a given radial force will be linked in practice to the thickness of the elastomer.

$$e = \frac{D_1 - d_1}{2}$$



1.2.2 - Torsional characteristics

The application of a torque to the centre axis of revolution of a bush causes an angular displacement. This displacement produces a torsional reaction expressed in N.m.

The bush is characterised by its maximum torsion angle α and by the corresponding compensating torque.

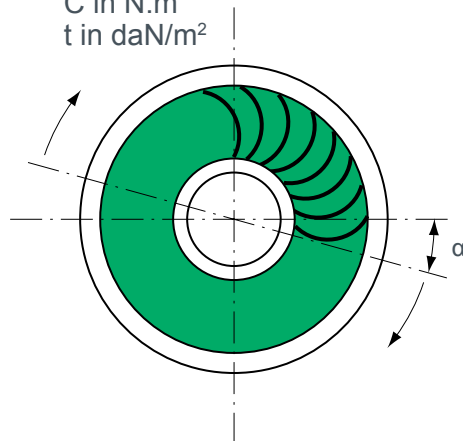
In practice, the permissible torsion angles are of the order of 20° to 30° . The maximum permissible static torque can be calculated on the basis of the stress rate at the point of contact between the internal tube and the elastomer.

$$C = t \times \pi \frac{d_1^2}{2} l$$

ou

$$C = \pi \frac{F_R d_1}{2} l$$

d_1 and l in m
 C in N.m
 t in daN/m^2



1.2.3 - Axial characteristics

When the external tube is fixed, the application of an axial force F_a on the internal tube will cause an elastic displacement “ y ” parallel to the axis of the bush, by shearing of the elastomer.

The bush is characterised by the permissible axial load and by the corresponding elastic displacement.

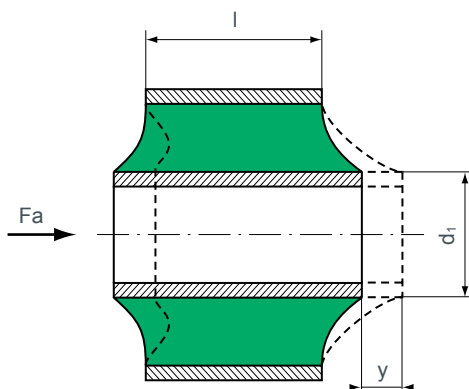
In practice, the permissible static axial loads are estimated by taking the stress rate at the internal tube.

$F_a = \pi \times d_1 \times l \times t$ where d_1 and l are in cm and F_a in daN and t is in daN/cm²

The permissible static deflection is a function of the radial thickness of the elastomer.

$$y = k \cdot \frac{D_1 - d_1}{2}$$

The axial breaking load of a bonded part is of the order of 10 times the permissible static load.



Note :

A Prestressed bush which is not fully bonded must not be subjected to a static axial load.

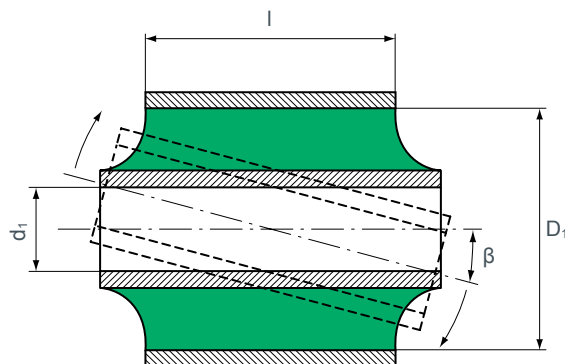
1.2.4 - Conical characteristics

The application of a torque whose axis is perpendicular to the axis of rotation of the bush will cause an angular deformation β .

This deformation will in turn produce a compensating elastic torque expressed in N.m.

The bush is characterised by the permissible conical angle and by the corresponding compensating torque.

In practice, the permissible conical angles are of the order of a few degrees. They vary greatly with the slenderness ratio $\frac{l}{D}$ of the part.

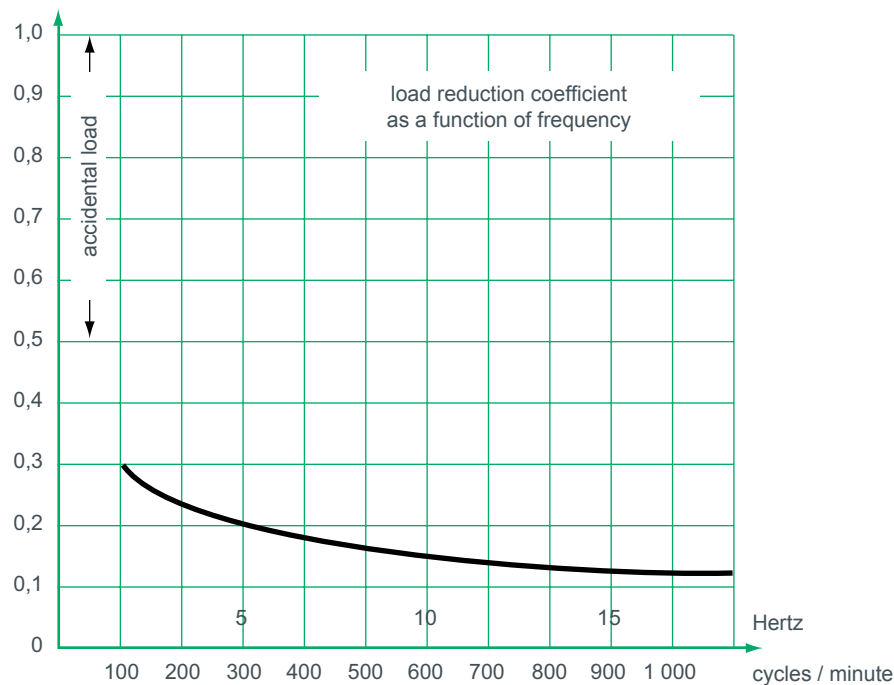


1.3 - DYNAMIC CHARACTERISTICS

1.3.1 - Dynamic loads

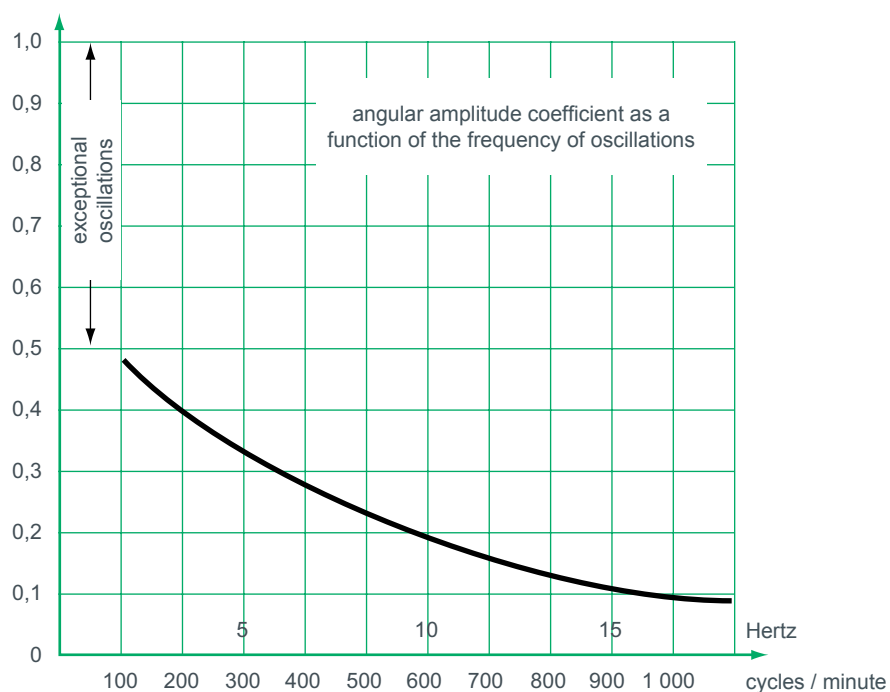
For dynamic loads, the following corrections must be added to the static loads provided in the catalogue :

- for infrequent forces of very short duration (shocks), the loads can be doubled;
- in the case of continuing periodic forces, the loads must be multiplied by a reduction coefficient λ which is a function of the frequency of the forces.



1.3.2 - Torsional amplitudes

The torsion amplitudes provided in the catalogue must be multiplied by a reduction coefficient μ which is a function of the frequency of the oscillations.



2 - PRINCIPAL TYPES OF FLEXIBLE BUSHES

2.1 - Simple bushes

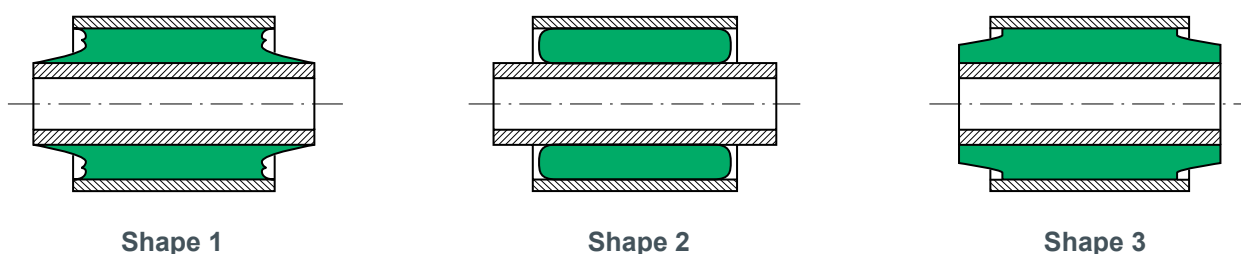
FLEXIBLOC (fig. 1) - FULLY BONDED

This is a bush made up of 2 concentric tubes between which of elastomer is bonded. Under the effect of external forces or torques, the relative movement of the tubes will cause an elastic deformation of the elastomer. By consulting the service conditions, a bush should be chosen which will remain within its elastic operational limits.

SILENTBLOC (fig. 2) - PRESTRESSED

This is a bush made up of 2 concentric tubes between which a ring of "adhérite®" elastomer is inserted by force. Under the effect of external forces or torques, the relative movement of the tubes will cause an elastic deformation of the elastomer. Above a certain value the adhereite will slide in the tubes.

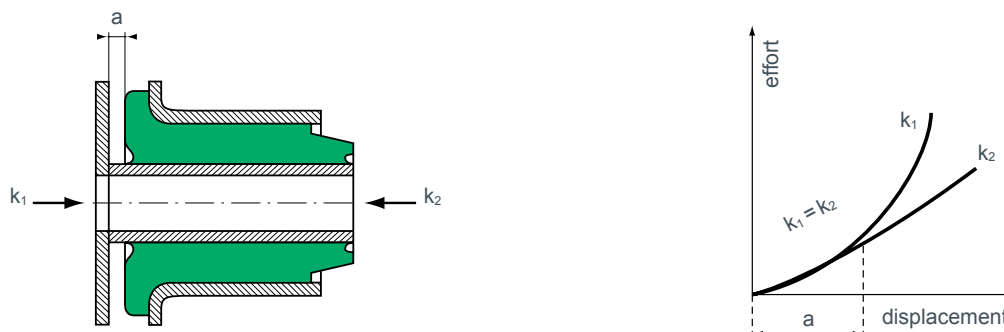
These simple bushes are considered to have lateral stops (shape. 3) when the elastomer protrudes from the external tube in the form of a support surface with various profiles.



The lateral stop only comes into operation when the bush is forced off centre by a radial load. This causes the stop to protrude, thus ensuring an "anti-noise" role at the limit of axial movement.

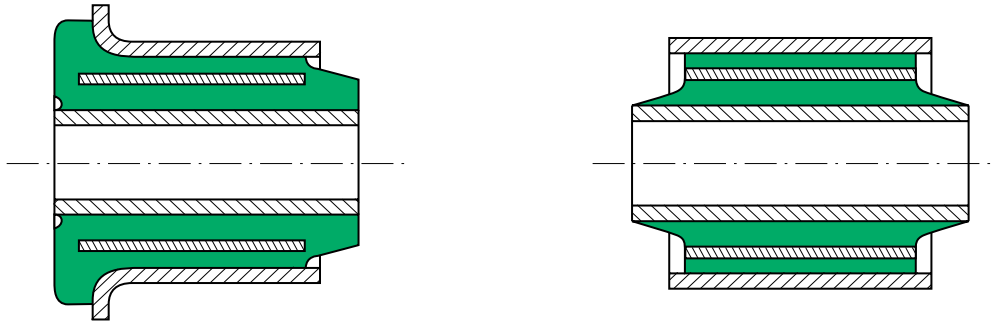
2.2 - Flanged bushes

In this type of bush, one of the tubes is flanged.



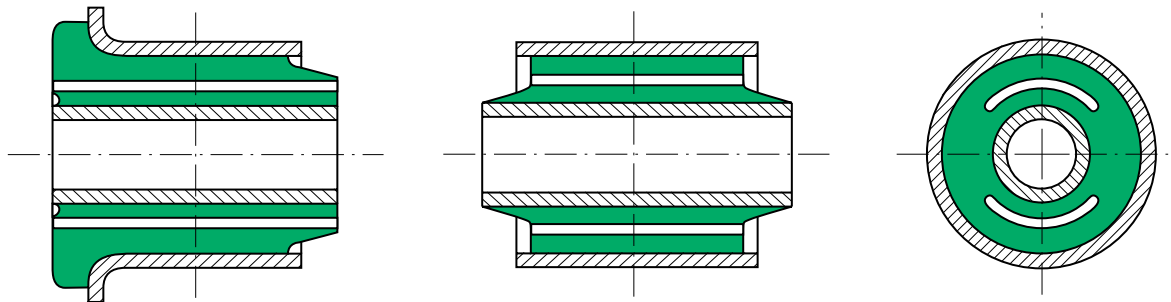
The rigidity k_1 is equal to k_2 if the travel is less than "a", and it becomes greater than k_2 when the travel is greater than "a".

2.3 - Laminated bushes



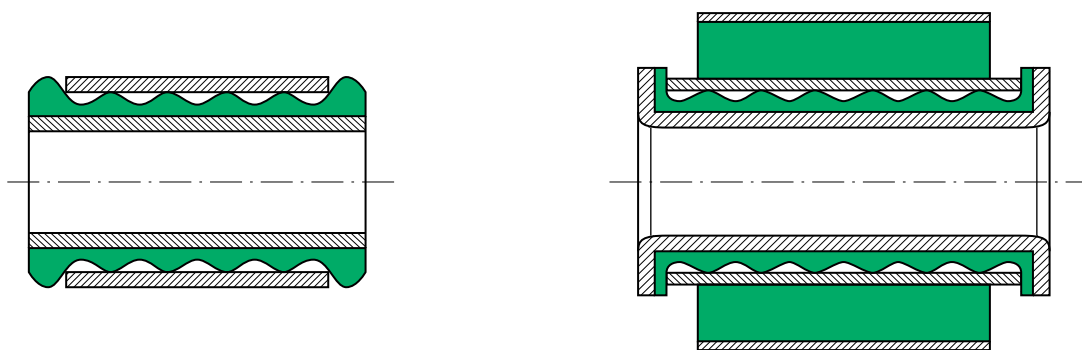
This type of bush has a thin metallic tube between the internal tube and the external tube. The object is to have a higher stiffness radially while keeping practically the same stiffness in torsion. The lamination of a bush also helps to decrease the work rate of the elastomer under high radial loads.

2.4 - Void bushes



A void bush is designed to have radial stiffness which are very different at 90° to each other. The difference in rigidity is governed by the size of the voids, which may or may not run the whole length of the bush.

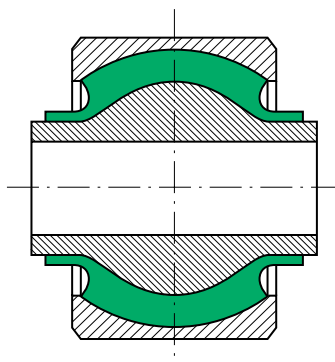
2.5 - Pivot bushes



FLUIDBLOC :

This type of bush is intended to offer minimum resistance to torsion. The elastomer is bonded to only one of the armatures, and a suitable permanent lubricant ensures the lubrication between the elastomer and the second armature ensures a very low torsional resistance. Seals are provided at each end to prevent the lubricant from coming out and stop impurities from getting in. Resistance to axial force is provided by a flange in the elastomer which bears against the side of the outer sleeve, the force being transmitted by a lateral washer.

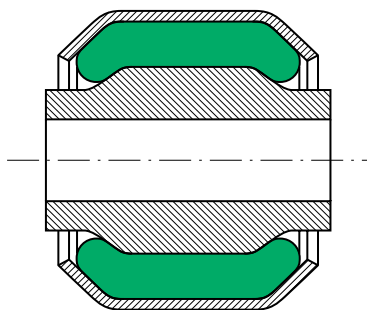
2.6 - Spherical bushes



SPHERIFLEX :

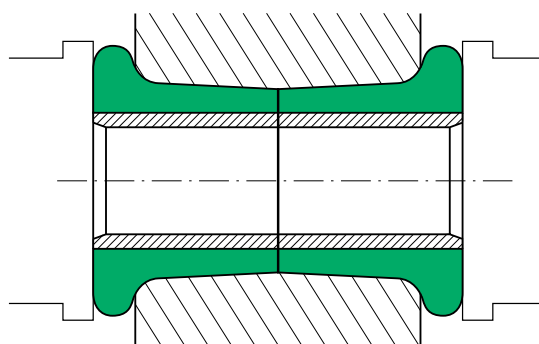
In this bush, the outer sleeve and centre axis are spherical, which enables the bush to resist relatively high radial and axial loads and to obtain a circular rigidity which is independent of the axis of rotation.

2.7 - Other bushes



“SILENTBLOC®” with turned down sides :

For the same dimensions, this type of bush provides a radial load capacity which is superior to that of the classic “silentbloc®”. In addition, versions of relatively short length permit conical movement more easily (reduced torque and increased angle).



CONICAL BUSH :

This takes the form of a rubber sleeve whose external surface is a truncated, and which surrounds a cylindrical internal part to which it adheres strongly by high radial expansion.

Assembly in pair, in a housing made up of two truncated cones placed small end to small end.

By axial pressure, a high compression is created which ensures the external adherence of the rubber and causes lateral cushions to form at each end of the housing. These cushions ensure resistance to axial forces.

3 - OUTER SLEEVE AND CENTRE AXIS

3.1 - Materials used

In general, the outer sleeve and centre axis of flexible bushes are made of :

- Mild steel or polyamide for the external outer sleeve.
- Medium carbon steel for the centre axis.

The reason for the difference has to do with the method of fixation onto the internal armature, which is usually done by forcing from one end. The armature must therefore be both strong and not too thin, to avoid buckling.

3.2 - Protection during storage

To avoid corrosion of the steel parts, the parts are protected by a layer of phosphate which gives them a grey appearance, the whole being protected by a layer of oil.

To ease removal of fixing bolts, the internal tubes are also protected on the interior by a layer of phosphate. This protection is good for storage, but it does not constitute a "tropicalised" protection, nor is it intended to resist saline mist.

3.3 - Length tolerances

- Length L (internal tube) : ± 0.1 mm
- Length l (external tube) : JS 15, according to NF E02 100-1 and NF E02 100-2

- Longitudinal overhang : $\frac{L - l}{2} \pm 0,4$ mm

3.4 - Diameter tolerances

On the internal diameter d : H10

d (mm)	3 to 6	6 to 10	10 to 18	18 to 30	30 to 50
H10	+ 0,048 + 0	+ 0,058 + 0	+ 0,070 + 0	+ 0,084 + 0	+ 0,1 + 0

On the external diameter D :

D ≤ 25 (mm)	25 < D ≤ 40 (mm)	D > 40 (mm)
+ 0,05 + 0	+ 0,1 + 0	+ 0,15 + 0

Recommended tolerance for fitting into a bored hole : boring D : N9 :

D (mm)	10 to 18	18 to 30	30 to 50	50 to 80	80 to 120
N9	- 0 - 0,043	- 0 - 0,052	- 0 - 0,062	- 0 - 0,074	- 0 - 0,087

4 - THE SELECTION OF A FLEXIBLE BUSH

In order to specify a bush correctly for a given application, the following criteria must be determined :

Basic data

For each of the 4 characteristics of the part (axial, radial, torsion or conical), the following values must be taken into account :

- the maximum static values (of force and/or of deflection) to which the part is subjected;
- the maximum dynamic values and their frequencies.

Fundamental parameters

Depending on the application, determine from the basic data the major fundamental parameter(s) which govern the choice of the bush to be used.

Dimensions

The fundamental parameters enable you to consult the catalogue for the range of dimensions of various bushes.

Stiffness

The final selection of the bush will depend on the required stiffness for the application. In particular, length, diameter and the thickness of the elastomer required for the desired bush will be determined.

Environmental conditions

Most of our standard bushes are in natural rubber. This has been chosen because of its good dynamic qualities.

In normal conditions of use, the types of rubber used guarantee a good life and limit creep in particular.

The following conditions of use are considered abnormal :

- temperatures above 70° C;
- prolonged contact with aggressive fluids;
- aggressive environments, such as oil or petrol;
- prolonged contact with acids or alkalis;
- aggressive atmospheres (e.g. ozone, chlorine).

Use in this conditions can accelerated ageing of the bushes, and cause the degradation or even the destruction of the rubber. An abnormally aggressive environment can, in particular, increase the deformation of the bush (by creep).

Flexible bushes can be made with special elastomers which are capable of surviving the abnormal conditions mentioned above and enabling the bushes to perform well.

Our technical services are at your disposal to reply to your questions about the properties of our various elastomers.

5 - AN EXAMPLE OF A SELECTION

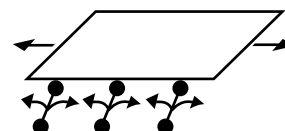
For the bushes of a vibrating carpet.

Weight : 120 daN. Number of fixing points : 6

Angle of movement : $\pm 2^\circ$. Frequency: 600 cycles/mn = 10 Hz

Radial load per bush : ± 20 daN (evenly loaded).

Amplitude reduction coefficient at 10 Hz : $m = 0.18$. Torsion angle : $\frac{2^\circ}{0.18} = 11^\circ$



In this case, the axial and conical parameters are not of major importance in the selection of the bushes. Since the fixing diameter of the connecting rods is 10 mm, we would select reference 561 205 from the bush catalogue.

$d = 10$ mm $D = 22$ mm $L = 17$ mm $l = 15$ mm Radial load = 40 daN

Maximum torsion angle = 25°

Therefore, for the given application we would use : 12 Flexibloc 561205 bushes.