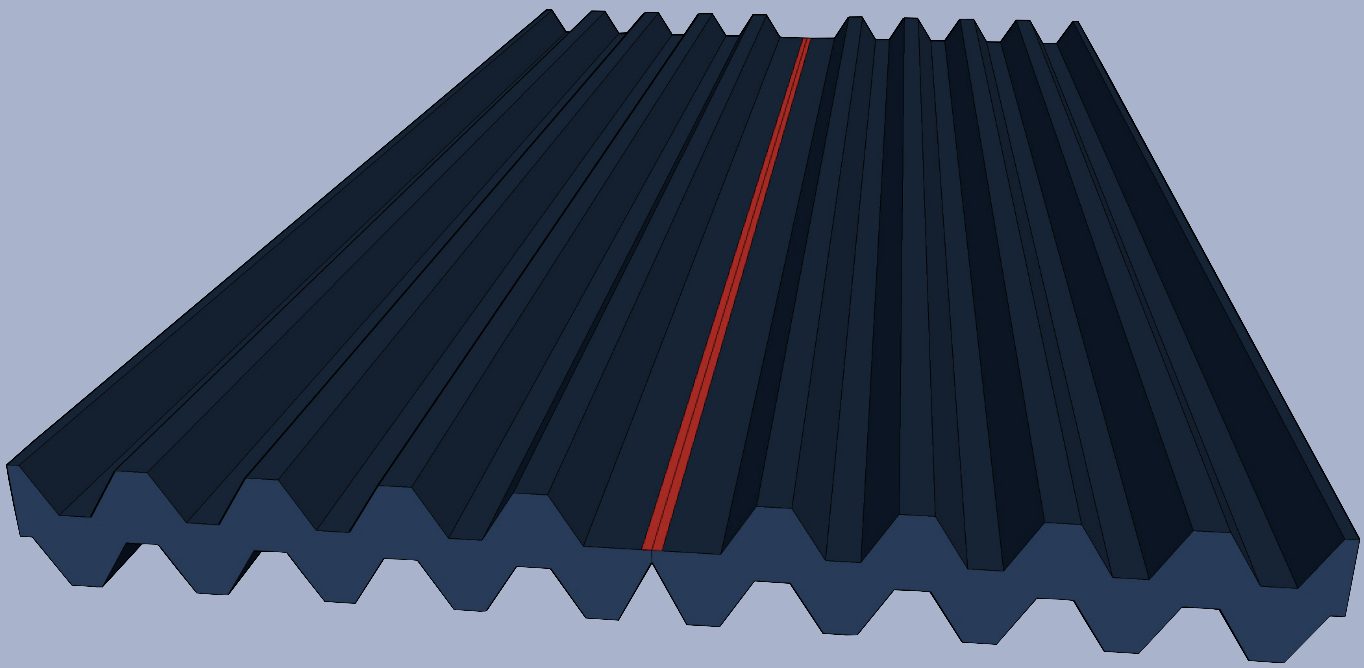
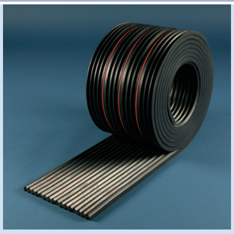
CALENBERG INGENIEURE

bi-Trapez Bearing®





High Sound Insulation with Spring Action Design

planmäßig elastisch lagern

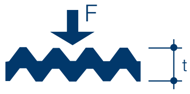
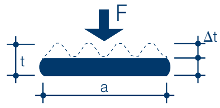
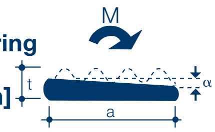
Design

Contents

Design loads, Design equations

Calenberg bi-Trapez Bearing®

Design for bearing class 2 according to DIN 4141 part 3

Thickness of bearing t [mm]	**5**	**10**	**15**	**20**
Allowable average compressive stress  **allow. σ_m [N/mm²]**	15,00	10,00	7,00	5,00
Existing deflection of bearing for allow. σ_m  **existing Δt [mm]**	2,20	4,50	7,00	9,50
Allowable horizontal shear deformation  **allow. u [mm]**	2,00	4,00	5,50	8,00
Horizontal force (restoring force) due to horizontal shear deformation  **allow. H [kN]**	allow. $H = c_s \cdot u \cdot A_E / 22500$ (See figure 6 and 7) – c_s = static shear stiffness [kN/mm] – u = existing horizontal displacement [mm] – A_E = plan area of bearing [mm²]			
Allowable angular rotation of the bearing  **allow. α [‰]; a [mm]**	$\frac{1500}{a}$	$\frac{3000}{a}$	$\frac{5000}{a}$	$\frac{6500}{a}$

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Product Description

bi-Trapez Bearings®:

- are unreinforced profiled elastomeric bearings, available in four thicknesses.
- provide high protection against structure-borne noise and vibration.
- are permanently elastic and flexible if structural elements are jammed.
- transmit little or no shear forces if structural elements move or are displaced.
- consist of quality controlled elastomer on the basis of Ethylene-Propylene-Dien-Terpolymer (EPDM) synthetic rubber.
- obtain high sound and vibration reduction indices due to the low compressive stiffness in the first loading phase up to a load of 1 N/mm^2.
- can be verified by calculations (compressive stresses, horizontal displacements and angular rotations).
- cause lower tensile shear forces than homogenous elastomeric bearings at the same load level and bearing thickness. Thereby the safety against concrete failure is increased (Figure 4).
- react like a soft spring when loaded (first loading phase). As the load increases the bearings deform and the stiffness increases (second loading phase). The load distribution below the bearing is parabolic.
- are designed according to DIN 4141 part 3, bearing class 2 and are verified by suitability tests carried out by an institute for material testing accredited by DIBT (German Institute for Building Technology).

Impact Sound Insulation

In buildings the transmission of impact sound is a particularly noticeable and unpleasant form of structure-borne noise. Sound is emitted in rooms below simply supported floor slabs, stairways, terraces etc. if they are excited by walking on the slabs.
The impact sound can effectively be reduced if the building components are elastically supported by bi-Trapez Bearings®.
Extensive measurements of elastically supported stairway landings in a building showed an improvement of impact sound insulation by 23 dB. Figure 5 shows which structure-borne sound reduction indices can be expected for different bearing thicknesses and a broad band excitation according to DIN 52210.
It is, however required, for the compressive stress to lie in a range from 0,3 to 0,7 N/mm^2. Furthermore, attention has to be paid to the fact that no rigid connection leads to secondary structure-borne noise transmission.

Text of Tender Document

Calenberg bi-Trapez Bearing®, unreinforced elastomeric bearing having on both sides trapezoidally profiled pressure contact areas, deliver and install.

Length:	.... mm
Width:	.... mm
Thickness:	.... mm
Quantity:	.... items
Price:	.... €/items or ....€/m

Calenberg bi-Trapez Bearing® impact sound stop stairway element for cast in-situ application with a cover on one side.

Type of element:	.... [I,L,Z]
Length:	.... 1 m
Thickness:	.... mm
Vertical load:	.... kN/m
Core width b_E:	.... mm
Element width:	.... mm
Quantity:	.... items or m
Price:	.... €/items or ....€/m

Supplier:
Calenberg Ingenieure GmbH
Am Knübel 2-4
31020 Salzhemmendorf
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Fax +49 (0) 51 53 / 94 00 - 49

Product Description

Edge Distances

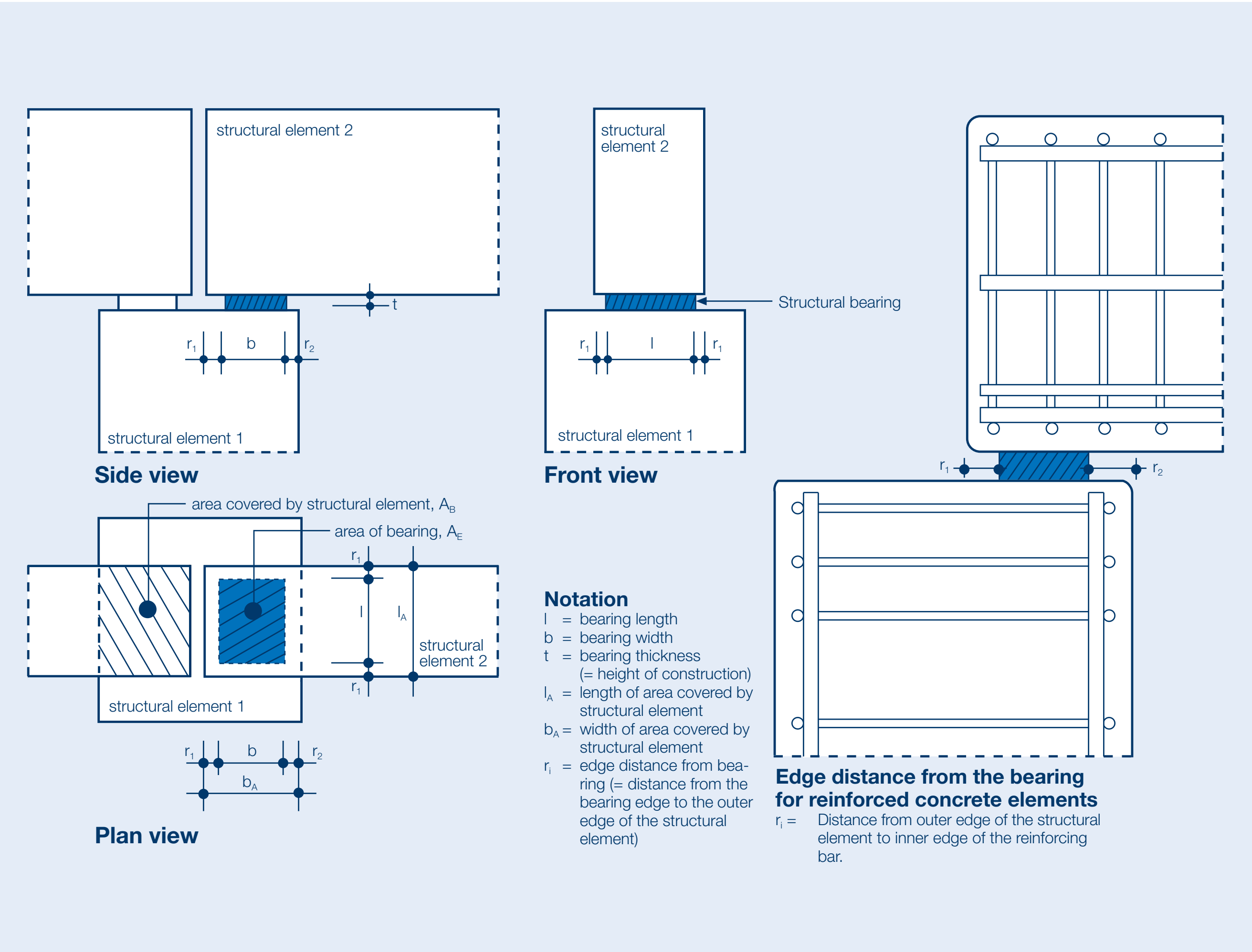

Figure 1. Maximum size of plan area of an elastomeric bearing for reinforced concrete construction (edge distance). For timber or steel elements the edge distance shall be at least 3 cm or 1,5 times the bearing thickness.

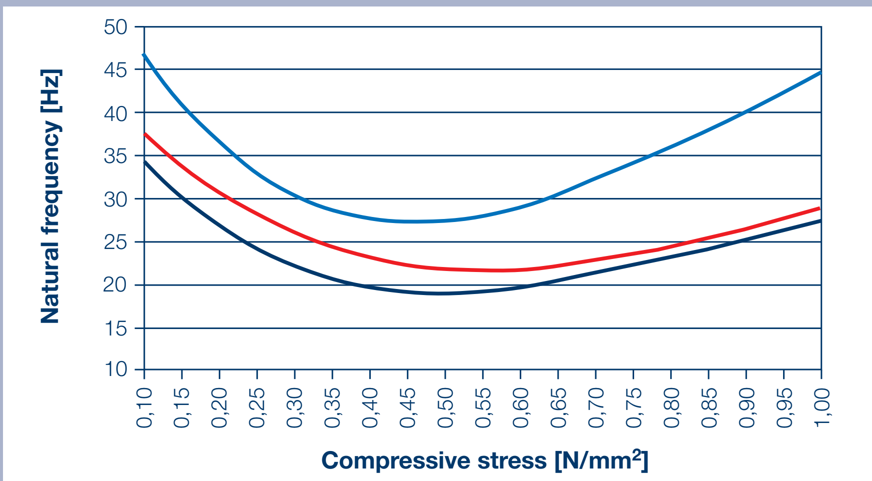

Figure 2. Natural frequencies

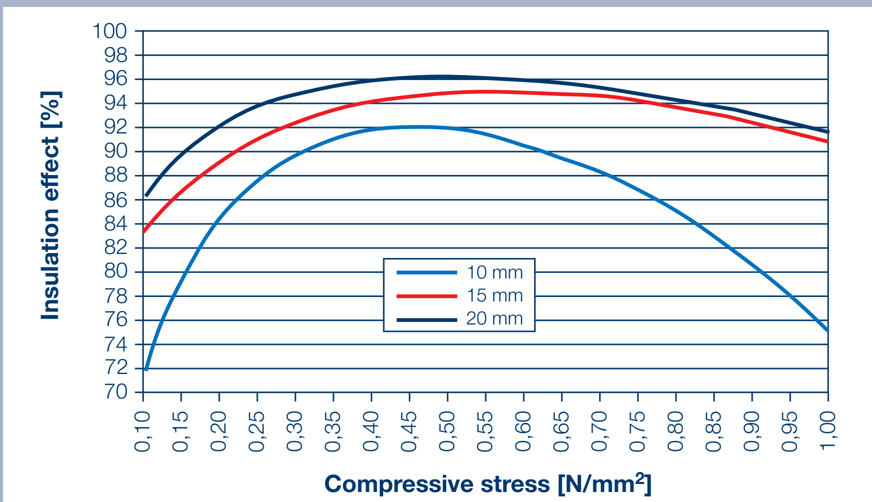

Figure 3. Insulation effect

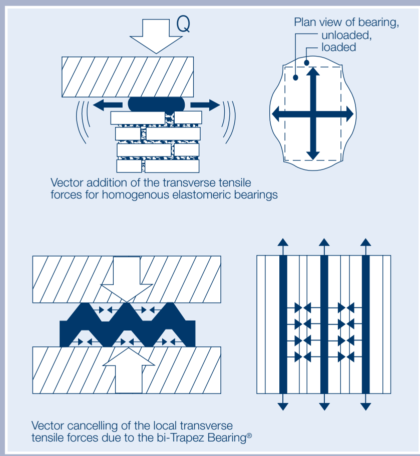

Figure 4. Effect of transverse tensile forces

Dynamic Deflection and Damping

If periodic loads act on an elastomeric bearing the dynamic reactions have to be considered in the calculation.

The dynamic spring stiffness of the elastomeric springs is always larger than the static spring stiffness.

The degree of damping ϑ of bi-Trapez Bearings® is with 0,08 high enough so that in the case of resonance no dangerous peaks will occur.

Natural Frequency

Structure-borne Noise Insulation

In the case of resonance i.e. when natural and excitation frequency are equal, the frequency amplification cannot be more than six fold. Total failure is not to be expected. In case of impact action the elastically supported structural element steadies quickly due to damping.

Vibration Protection and Structure-borne Noise Insulation

With the growing environmental awareness the problems associated with vibration and structure-borne noise insulation have gained in importance substantially during the last years.

Legislation gives reference values as to what can reasonably be accepted regarding vibration and noise.
To meet these requirements it is necessary to separate the hard-walled structural elements made of concrete, brick, timber and metal by elastic pads so as to prevent the propagation and transmission in the structure.
If bi-Trapez Bearings® are used as elastic pads in the abutting joints of construction members significant shielding from annoying excitation frequency can be achieved. A precise determination of a numerical value for structure-borne noise insulation is difficult as apart from the excitation frequencies that are to be shielded off vibrating masses and the structural geometry have to be considered.

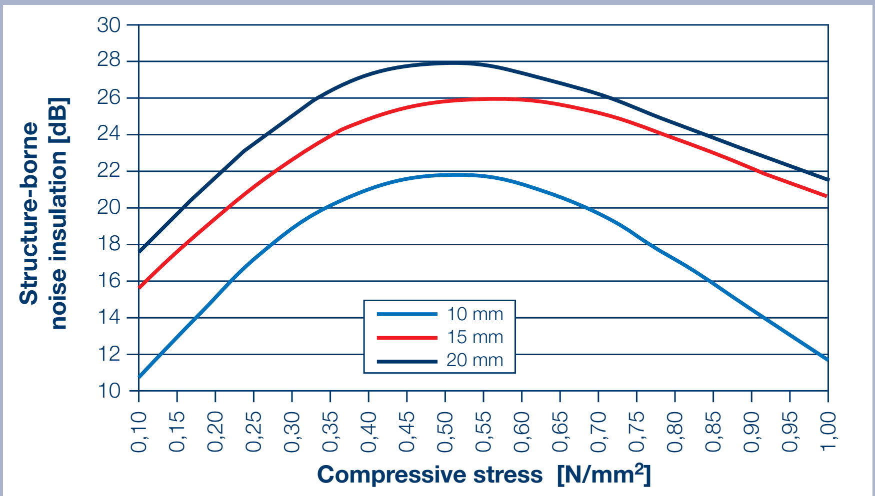

Figure 5. Structure-borne noise insulation

The situation is easier if the application can be ascribed to the equivalent system of a linear single degree of freedom system as is normally the case in practice. Under these conditions it is possible to show how bi-Trapez Bearings® reduce periodic excitations as well as impact loads such that only residual disturbance forces are transmitted. The ratio of the natural frequency f_o to the existing excitation frequencies f is significant for the level of structure-borne noise insulation. For building construction the noise insulation measures cover the frequency range from 100 Hz to 3200 Hz.

Due to the soft spring characteristics high structure-borne noise insulation indices are reached in the compressive stress area of up to 1 N/mm².

As can be seen from Figure 3 an insulation effect of 90 % is already possible for excitation frequencies of 100 Hz. The structure-borne noise insulation is about 20 dB. Excitation frequencies of more than 100 Hz are shielded off to a much larger extent.

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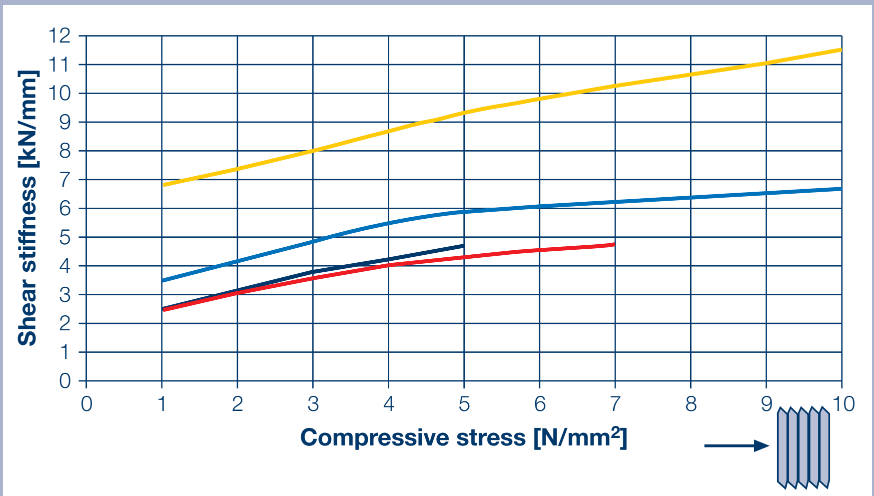


Figure 6: Shear stiffness at right angle to the profile

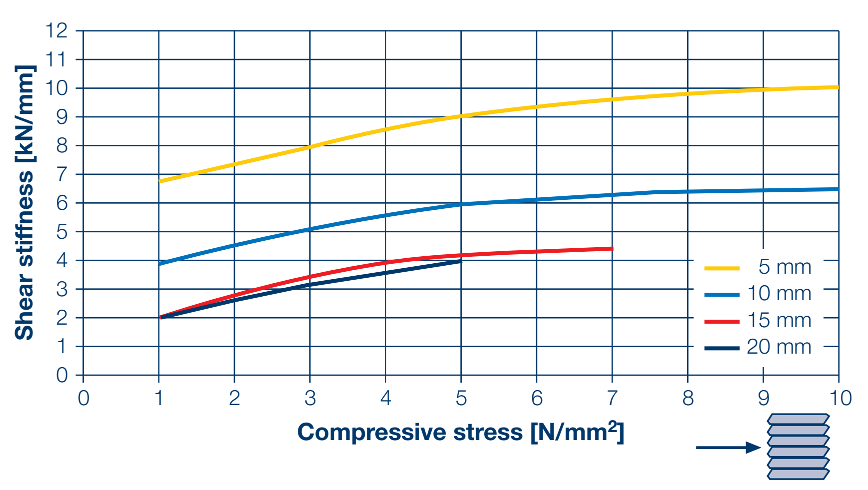


Figure 7: Shear stiffness parallel to the profile

Installation Details

In **precast construction** the bi-Trapez Bearings® are laid centrally on the support area with no special installation measures. For concrete elements the edge distance to the outer edge of the element has to be at least 2,5 cm and the reinforcement shall extend at least as far as the bearing area. Likewise the chamfer edges of the structure elements have to be considered when determining the edge distance.

For **in-situ construction** the gaps and joints around the bi-Trapez Bearing® have to be filled in such way that no concrete can penetrate. A rigid connection has to be avoided and the spring action of the bearing has to be guaranteed at all times.

A full fitted element can be delivered on request (see page 10).

Shear Stiffnesses

Deflection

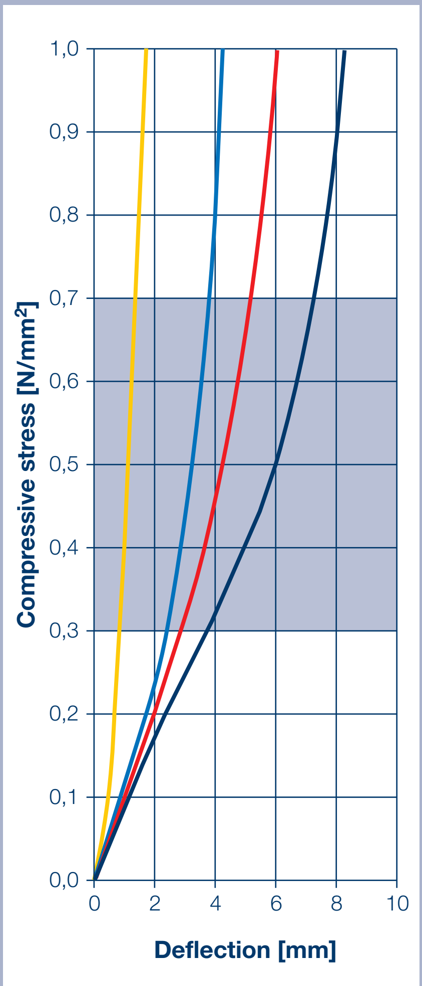


Figure 8: Deflection of bearing in the lower compressive stress range relevant for structure-borne noise, orientation diagram

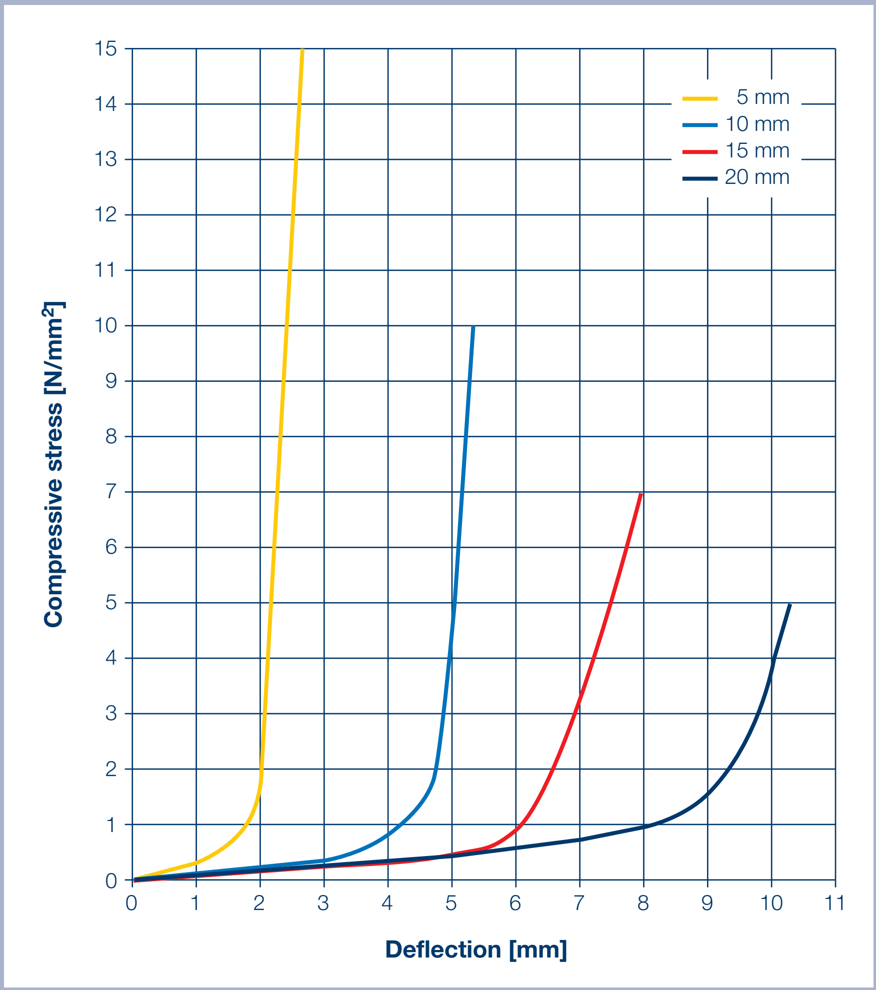


Figure 9: Deflection of bearing, orientation diagram

References
(a selection)

- BWM, Leipzig
- Audi, Ingolstadt
- Riem Arcaden, Munich
- Hundertwasser House Waldspirale, Darmstadt
- Porcelain Factory, Meißen
- Atomic Power Station Biblis

- WDR Cologne – Lindenstraße –
- Congress Centre Am Funkturm, Berlin
- Institute for Marine Science, Kiel

- Reichstag Plenary Hall, Berlin
- Residence Embassy Qatar, Berlin
- Chinese Embassy, Bonn
- Hessian Parliament, Wiesbaden

- Olympic Stadium, Berlin
- Signal-Iduna-Stadium, Dortmund
- Bobsleigh Run, Oberhof

- Hotel de France, Isle of Jersey
- Veterinary University, Vienna
- Ice Stadium, Vienna
- Natural History Museum, Vienna
- Airport, Vienna
- Music Centre, Moscow
- Bolschoi Theatre, Moscow
- Kuwait Airways, Jumbo Hangars, Kuwait
- Moda-NCO-Housing; Riyadh, Saudi Arabia

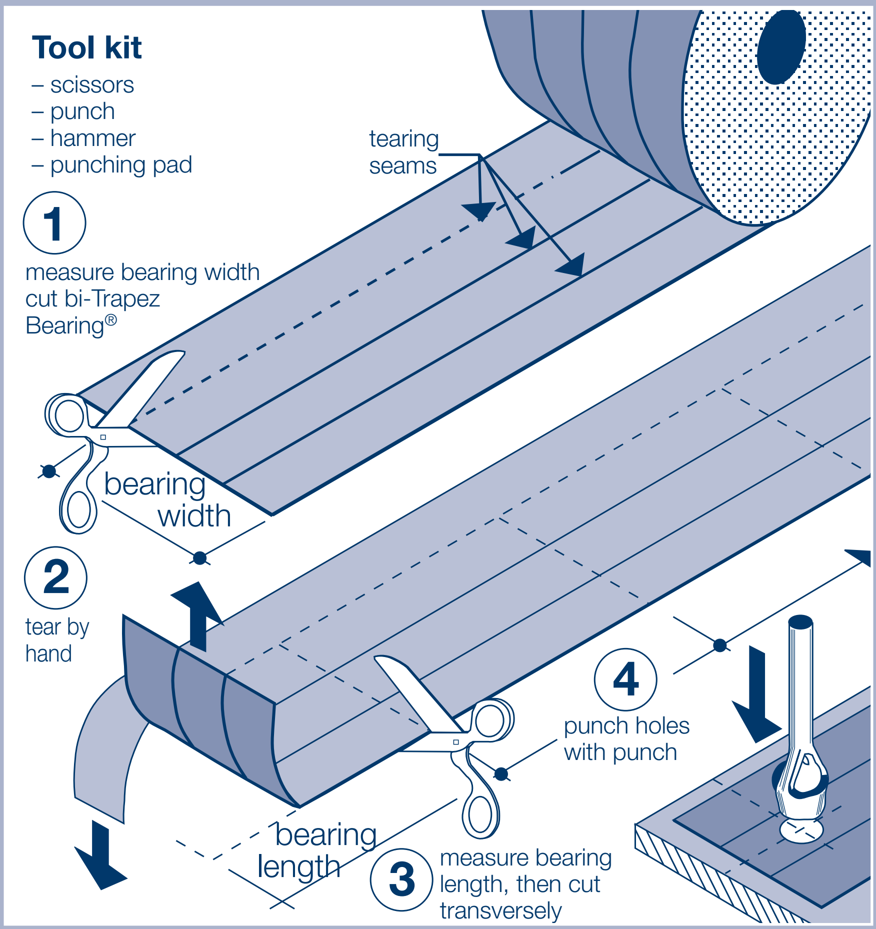


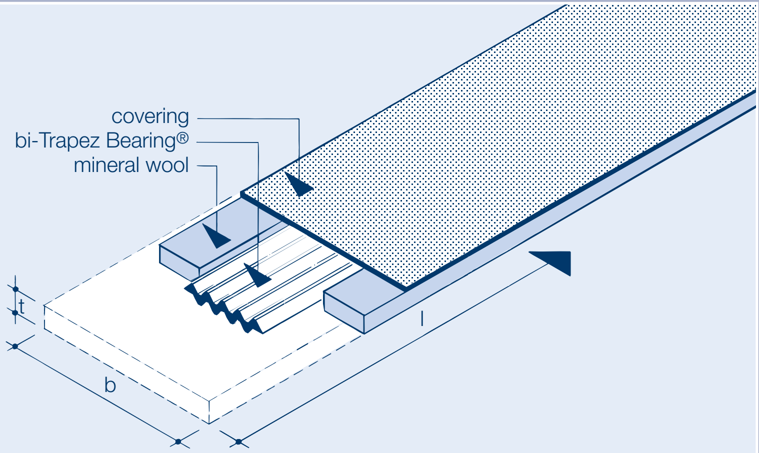
Figure 10. On site cutting from a roll of Calenberg bi-Trapez Bearings®

Cutting

bi-Trapez Impact Sound Stop

Bearing design for precast concrete construction

bi-Trapez Bearing®, strip type



Bearing design for in-situ concrete construction

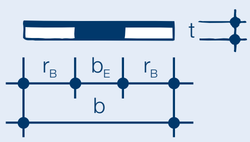
bi-Trapez Bearing®, strip type, embedded in mineral wool sensitive to compression with covering on top

Standard length = 1 m

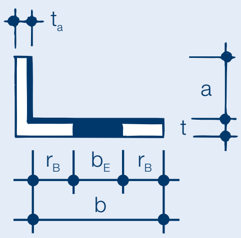
Notation

l = total length
b = total width
t = total thickness
a = upper (vertical) leg length
c = lower (vertical) leg length
t_a = upper (vertical) leg thickness
t_c = lower (vertical) leg thickness
b_E = bi-Trapez Bearing® width
r_B = edge distance

Cross section I



Cross section L



Cross section Z

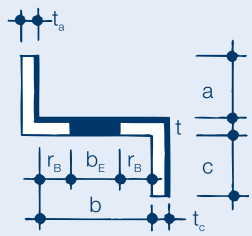


Figure 11: Types of cross sections and designations

bi-Trapez Impact Sound Stop Impact sound insulation element for use in staircases					
Bearing thickness [mm]	Bearing width* b_E [mm]	Effective vertical load F [kN/m]	Impact sound insulation index according to DIN 52210 part 4 for the compression stress range of **0,3** to **0,7** N/mm² [dB]	Insulation effect [%]	Deflection [mm]
10	50	15 – 35	23	87	2,3 – 3,8
	100	30 – 70	23	87	2,3 – 3,8
15	50	15 – 35	27	91	2,8 – 5,5
	100	30 – 70	27	91	2,8 – 5,5
20	100	30 – 70	28	93	3,8 – 7,4

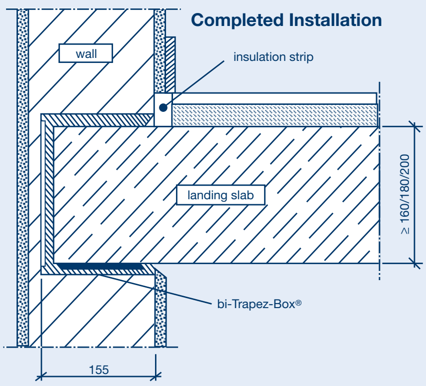
* Bearing can be provided in different widths (custom made product)

bi-Trapez-Box®

For support of staircase landings

Dimensions and technical details see data sheet bi-Trapez-Box®

Cast in-situ type can be delivered on request



bi-Trapez-Box®

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Sizes

Test Certificates, Suitability Testing

- Standard building authority approval no. P-849.0554/1 of the Institute for Material Science, Hanover; July 2000
- Fire safety assessment no. 3799/7357-AR; assessment of Calenberg elastomeric bearings regarding classification into the fire resistance class F 90 or F 120 according to DIN 4102 part 2 (issued 9/1977); Accredited Testing Authority for Civil Engineering at the Institute for Construction Materials, Reinforced Concrete Construction and Fire Protection, Technical University Braunschweig; March 2005
- Research report no. 2729/1054 and expert opinion no. 2729/1054-1; Measurement of natural frequencies as a function of compressive stress of the structure-borne noise isolation according to DIN 52 221 and of the impact sound insulation according to DIN 52 210 part 1; July 1994

Fire Behaviour

For all applications of elastomeric bearings which have to comply with fire protection requirements the fire safety assessment no. 3799/7357-AR- of the Technical University of Braunschweig applies. It specifies minimum dimensions and other measures in accordance with the specifications of DIN 4102-2, Brandverhalten von Baustoffen und Bauteilen (Fire behaviour of construction materials and components), 1977-09.

Sizes, Delivery Types

No.	Thickness [mm]	Cross section geometry	Tearing seams	Roll sizes	m²
Roll types					
1	5		3	20 m x 20 cm	4
2	5		5	20 m x 30 cm	6
3	10		2	10 m x 15 cm	1,5
4	10		3	10 m x 20 cm	2
5	15		2	10 m x 15 cm	1,5
6	15		3	10 m x 20 cm	2
7	20		1	10 m x 20 cm	2
Cut					
8	All thicknesses	Calenberg bi-Trapez Bearing®, cut to size for application			

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