B2 pot bearings

About us

B2 Sp. z o.o. was established in 2010. It deals with selecting, producing and installing bridge components such as:

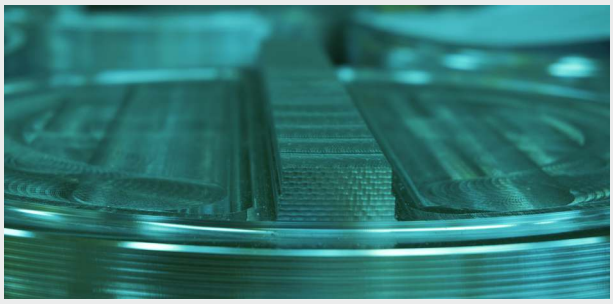
- modular expansion joint B2W, made of non-alloy steel (single seal and modular expansion joint)
- modular expansion joint made entirely of non-alloy or stainless steel (B2NS), or partly of non-alloy or stainless steel (B2NN) (single seal and modular expansion joint)
- finger expansion joint B2P
- pot bearings
- elastomeric bearings (including guide and restraint bearings)
- spherical bearings
- bridge cornice boards made of polymer concrete
- lifting structures, including bearings exchange

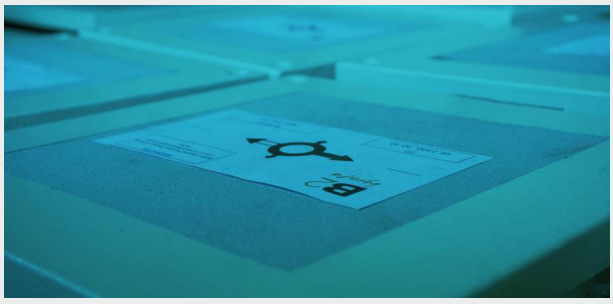
We are young company with well-experienced team. Bearings, expansion joints and cornice boards we deliver are made by the Polish production plants. They are of top quality, which is guaranteed by Production Control System.

B2 Sp. z o.o. has wide experience in supplying products both to the European Union and beyond its borders. Among others, we executed a delivery of expansion joints within the road connection between Zittau and Hradek by the Neisse River including connection to the Polish road network (road connection in Nysa Euroregion: Task II – part 3) and bridges in Göteborg, Olofström and Ludvika in Sweden and also bearings production for:

- Sweden (LKAB Ramp in Kiruna, Railway line Stenkumla-Dunsjö, Bridge over the Vindel River in Spöland, Bridge in Södertälje, Bridge in Norsborg)
- Norway (Harpe Bridge over Lågen River along E6 Frya-Vinstra highway)
- Lithuania (Road A1 Vilnius-Kaunas-Klaipeda, Road A5 Kaunas-Marijampolė-Suwalki, Akmena Bridge, pedestrian viaduct in Armino)
- Hungary (Bridge No. 61 along Budapest-Nagykanizsa E71 trunk road, Bridge No. M86 along Zalalövő bypass, railway bridge over Berettyó River, Miskolc northern bypass, railway bridge along Szolnok-Szajol railroad, bridges in Hódmezővásárhely)
- Turkey (Fen Lisesi Bridge in Ankara)
- Belgium (footbridge in Avelgem)

We cooperate with the biggest contractors in Poland and Europe such as Astaldi, Budimex/Ferrovial, Dragados, Metrostav, Mota-Engil Central Europe, Pannon Freyssinet, PORR, Salini Impregilo, Skanska, Strabag, Toto Construzioni Generali or ViaCon Baltic. We would appreciate cooperation with your company also!





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General information

Application

The pot bearings, produced by B2 are intended to be used in bridge structures or any other structure with comparable support condition where requirements on individual bearings are critical. The operating temperature of the usage is within a range from -40 °C to 50 °C.

Depending on type, the bearings are able to carry the following actions from the bridge deck: vertical force, horizontal forces (longitudinal and transversal), displacements (longitudinal and transversal), rotations (longitudinal and transversal). The pot bearings are the most often used type of support that is applied in bridge structures nowadays. The bearings produced by B2 are able to carry the maximal design vertical load up to **50 000 kN**.

Types

B2 company offers the following types of pot bearings:

- Fixed (FX)
- Guided sliding (GG)
- Free sliding (GL)

Construction

The construction of the pot bearing consists of the following main parts:

- sliding plate (in GL and GG bearings)
- piston
- elastomeric pad
- pot
- anchorage system

Additionally, the bearings are equipped with sealing elements which protect the crucial parts prone to dirt. The sliding surface is protected with a circumferential seal (around the PTFE) and the inner parts are protected with PCV external foam seal. Moreover, according to EN 1337 standard, the anti-extrusion internal sealing ring is placed between the elastomeric pad and the piston. Its main role is to prevent escape of the elastomer pad through the clearance between the pot wall and the piston when a compressive force is applied.

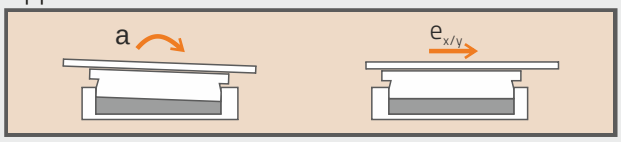


Fig. 1. Pot bearing under rotation and movement load

How does it work?

Vertical loads are transferred from the bridge deck to the support through the elements of the bearing: sliding plate, piston, elastomeric pad and pot. Horizontal loads are carried by the guide and piston and transmitted to the pot walls and the anchorage system. The displacements are allowed on the sliding surface – austenitic stainless steel on the sliding plate and PTFE placed in the piston. The PTFE disk has small round pockets on the surface for the lubrication grease to reduce friction and wear. Rotation is possible due to the nearly constant volume of the elastomer, which compressed by the piston behaves like a viscous liquid.

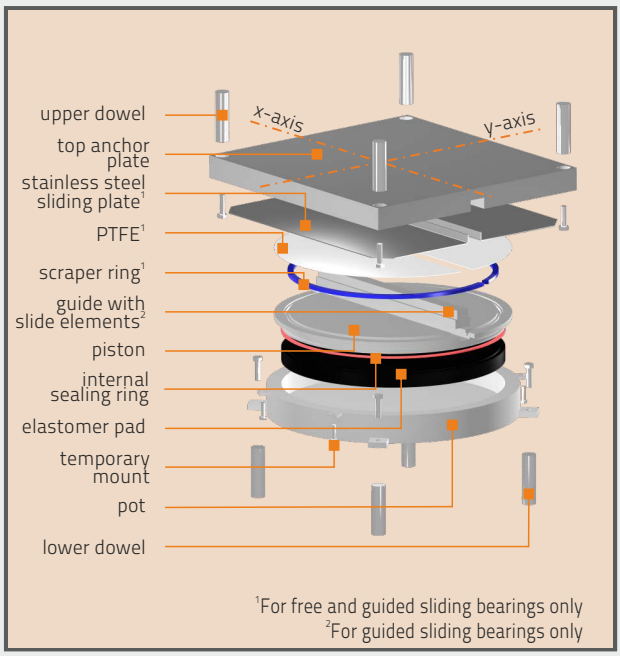


Fig. 2. Pot bearing elements

Advantages of B2 bridge bearings

The characteristics of B2 pot bearings are mainly: high load capacity, small dimensions, simplicity in installation and in further maintenance and technical inspections.

Location of the manufactory and Factory Production Control

Our bearings are produced in Wschowa in Poland. We use modern CNC machines which allow us to manufacture the steel elements with high quality and high accuracy of dimensions. The factory is liable to Factory Production Control according to EN 1337. The inspection is conducted by the representative of the notified body twice a year.

Placing on a market

The procedures of placing the construction products on the market are regulated by Regulation (EU) No. 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, which has been obligatory since 1st July 2013. Each construction product, which is covered by harmonised standards (EN) or European Technical Approvals (ETA) must fulfill the requirements included in this regulation. In case of the bridge bearings, the only reference document is the harmonized standard EN 1337: "Structural Bearings", which consists of 11 parts. The fifth part – EN 1335-5 – refers to the pot bearings.

The bearings which are to be used in bridge structures or any other structure with comparable support condition where requirements on individual bearings are critical need to be supervised under attestation of conformity system "1". In this system of conformity with the reference document (EN or ETA) it is necessary to have Certificate of Constancy of Performance (CoCoP) issued by the notified body and Declaration of Performance (DoP), which is drawn up by the manufacturer. Owing to these evaluation system the customers cannot demand any other additional documents that would provide any supplementary information on the construction product that they purchase. The manufacturers are obliged to report every documents, technical data (including results of the tests) exclusively to the proper authorities or control body.

The B2 attaches the Declaration of Performance to each batch according to the sample presented in Annex III to Regulation 305/2011 with the further updates.

Commercial terms and conditions

The documentation may be expected to be done within 5-7 days as a standard. The fabrication time of each batch of bearings should not exceed 4-6 weeks since getting the confirmation of the drawings. The shipping to Sweden takes approximately 1 week. The invoice which will be issued immediately after the delivery of the bearings should be paid within 30 days.

Warranty

The B2 provides a five-year warranty on produced bearings. Do not confuse this with a period of use which is specified in EN 1990, Table 2.1. Also please note that the bearings shall be properly transported and installed. In the case of mechanical damage caused by improper use of bearings, the warranty expires. Special attention should be paid to protect bearings against any work under the superstructure (painting, sandblasting, etc.).

To the designers

Construction of the bearings

■ Fixed pot bearing (FX)

The FX type bearing accommodates following loads transferred from superstructure: F_z, F_x, F_y, a (see definitions of symbols in Table 3). Fixed bearing consists of piston, elastomeric pad, pot and dowels (see Fig. 3).

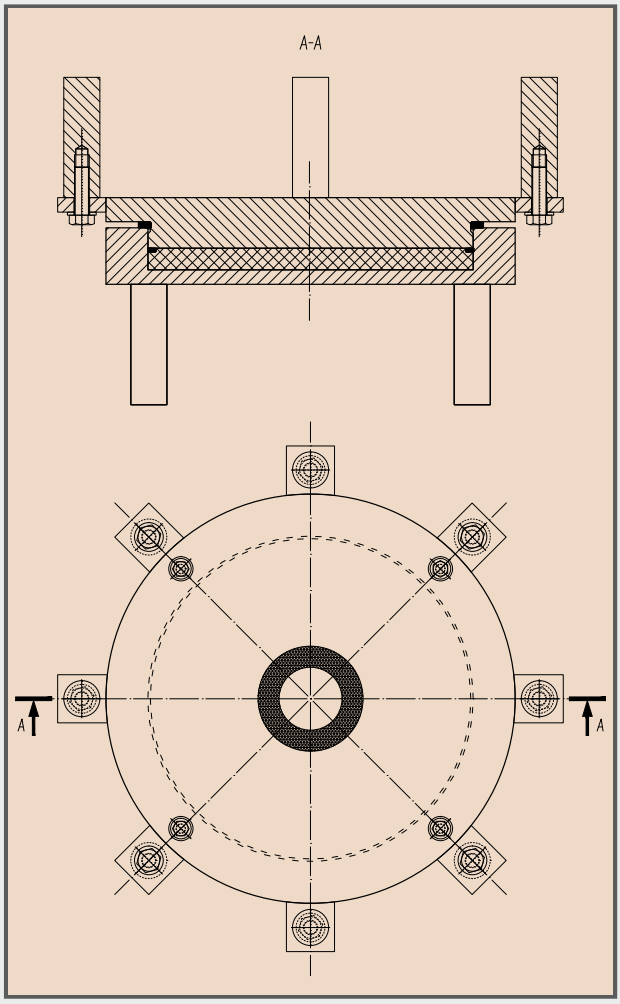


Fig. 3. Cross section and top view of fixed pot bearing

■ Guided sliding pot bearing (GG)

The GG type bearing accommodates following loads transferred from superstructure: F_z, F_y, e_x, a. Guided sliding bearing consists of sliding plate with austenitic sheet, piston with PTFE sheet, guide with sliding material, elastomeric pad, pot and dowels (see Fig. 4).

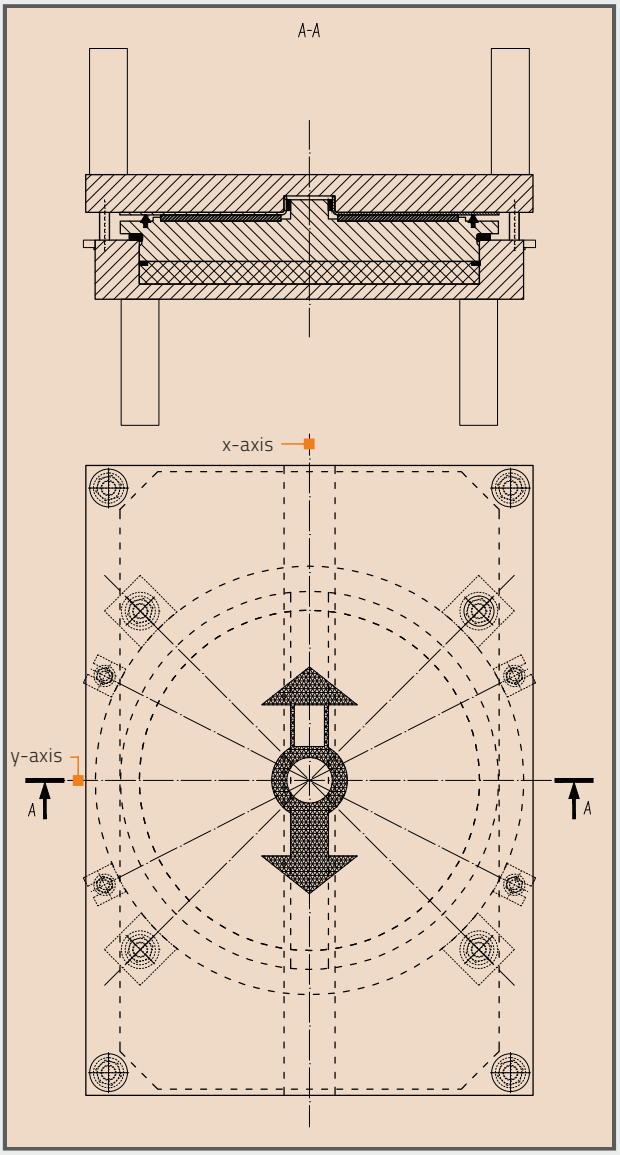


Fig. 4. Cross section and top view of guided sliding pot bearing

■ Free sliding pot bearing (GL)

The GL type bearing accommodates following loads transferred from superstructure: F_z, e_x, e_y, a. Free sliding bearing consists of sliding plate with austenitic sheet, piston with PTFE sheet, elastomeric pad, pot and dowels - if required (see Fig. 5).

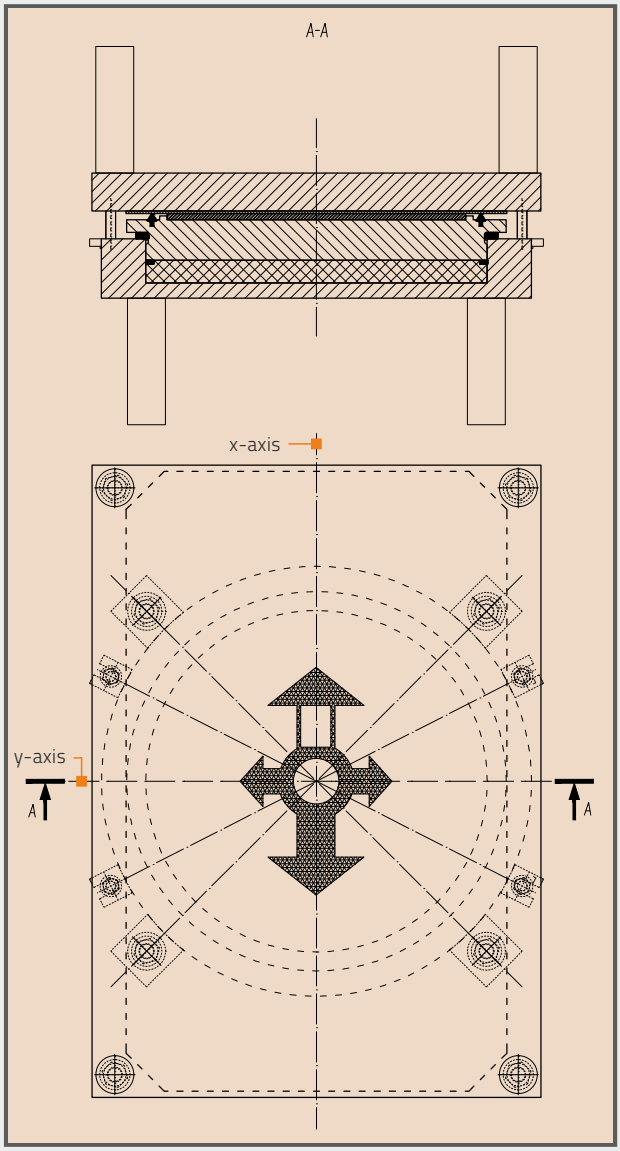


Fig. 5. Cross section and top view of free sliding pot bearing

Material data

Table 1.

Component	Application	Material	Standard
pot, piston	FX, GG, GL	S355 J0	EN 10025
sliding plate	GG, GL	S355 J0	EN 10025
guide	GG	S355 J0	EN 10025
elastomer pad	FX, GG, GL	NR (Natural Rubber)	ISO 6446, ISO 37, ISO 188
internal sealing ring preventing the extrusion of the elastomeric pad	FX, GG, GL	CuZn39Pb3 or carbon filled PTFE	EN 12164 ISO 1183, EN ISO 527-2, EN ISO 527-1, EN ISO 2039-1
austenitic steel sheet	GG, GL	1.4401+2B	EN 10088-2
PTFE sheet	GG, GL	polytetrafluoroethylene	EN 1337-2, EN ISO 1183, EN ISO 527-1 and -3, EN ISO 2039-1
anchoring screws	FX, GG, GL*	class 10.9	ISO 898-1

* if required

Bearings with variable static scheme

If there is such a need due to the structure's construction technology, the use of bearings with variable static scheme is possible. For example from fixed bearing to guided sliding or free sliding.

Table 2.

Step 1	Step 2
free sliding (GL)	guided sliding (GG)
fixed (FX)	free sliding (GL)
fixed (FX)	guided sliding (GG)

Negative vertical load

In case of negative vertical load (F_z < 0 kN) occurrence a bearing must be secured to prevent unwanted separation of the sliding elements. Such B2 bearing is marked with UL symbol.

NOTE Bearings that accommodate uplifting forces **are not CE marked**, as the issue of negative vertical force is beyond the scope of EN 1337. In this case it is necessary to prepare an individual design, which shall be approved by the designer of the bridge.

Principles of bearing selection

■ Data needed to design bearings according to EN 1337

In order to perform an appropriate selection of pot bearings following information are essential **(ULS)**:

Table 3.

Mark	Unit	Parameter
$F_{z\,max}$	kN	maximum vertical load (ULS)
$F_{z\,min}$	kN	minimum vertical load (ULS)
$F_{x\,max}$	kN	maximum horizontal load along the x-axis (ULS)
$F_{y\,max}$	kN	maximum horizontal load along the y-axis (ULS)
e_x	mm	total range of displacement along the x-axis
e_y	mm	total range of displacement along the y-axis
e_{vx}	mm	total presetting along the x-axis
e_{vy}	mm	total presetting along the y-axis
α_1	rad	rotation angle due to permanent actions
α_{2min}	rad	negative rotation angle due to variable loads
α_{2max}	rad	positive rotation angle due to variable loads

■ Restraint moment

Total restraint moment (M_T) can be calculated using formula:

$$M_T = M_{Fxy} + M_{emax} + M_{mmax}$$

where:

$$M_{Fxy} = F_{xy} \times e_2 \text{ [Nmm]}$$

M_{Fxy} - moment due to horizontal force
F_{xy} - maximum horizontal force (vectorial sum of $F_{x\,max}$ and $F_{y\,max}$)
e_2 - distance between the point of action of the horizontal force at the pot wall and the lower edge of the bearing

$$M_{emax} = 32 \times d^3 \times (F_0 + (F_1 \times \alpha_1) + (F_2 \times \alpha_{2max})) \text{ [Nmm]}$$

M_{emax} - restraint moment from the elastomer pad
d - elastomer pad diameter
α_1, α_{2max} - see definition in Table 3 and Fig. 6
F_0, F_1, F_2 - restraint moment factors determined by individual test for each bearings manufacturer

The coefficients of restraint moment for B2 bearings obtained during the tests performed according to EN 1337 are:
F_0 = 0,01
F_1 = 0,34
F_2 = 4,59

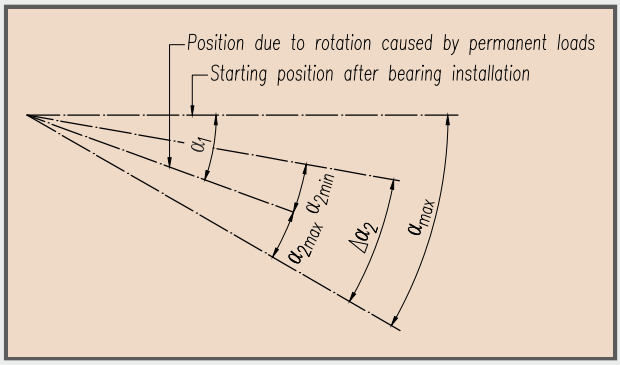


Fig. 6. Types of elastomer pad rotation angles

$$M_{mmax} = 0{,}2 \times F_{xy} \times d \text{ [Nmm]}$$

M_{mmax} - moment caused by friction at the pot/piston contact surface
F_{xy}, d - see above

M_{emax} and M_{mmax} can be added up as the vectorial sum, but straightforward addition is more safe.

Marks of B2 bearings

Scheme 1.

Foundation

To calculate thickness of the non-reinforced mortar bed (H_M) and local pressure in the foundation (F_{Rdu}) see formulas according to EN 1337-11 and EN 1992-1-1 (see Fig. 7):

$$H_M = \frac{0{,}1 \times A_M}{2p\sqrt{A_M}p} + 15 \text{ mm} \le 50 \text{ mm}$$

$$A_{c0} = p\left(\sqrt{\frac{A_M}{p}} + H_M\right)^2 [\text{mm}^2]$$

$$F_{Rdu} = A_{c0} \cdot f_{cd}\sqrt{\frac{A_{c1}}{A_{c0}}} \le 3\, A_{c0} \cdot f_{cd} [\text{N}]$$

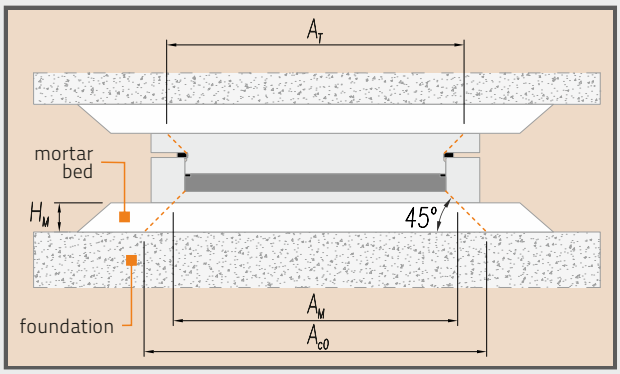


Fig. 7. Bearing mortar and foundation

In order to know A_M and A_T please contact us.

Coefficient of friction

The coefficient of friction given in Table 4 shall be used for verification of the bearing and the structure in which it is incorporated.

Table 4.

s_p	≤ 5	10	20	≥ 30
m_k	0,08	0,06	0,04	0,03

Intermediate values can be obtained by linear interpolation or by using this formula:

$$m_{max} = \frac{1{,}2}{\sqrt{10 + s_p}}$$

where:
m_{max} - coefficient of friction
s_p - PTFE contact pressure [MPa]
To calculate s_p please use A_p (PTFE disc area) given in bearing's drawing.

NOTE Table 4 and the formula above are only for dimpled lubricated PTFE and for mating austenitic steel and hard chromium. These values shall not be applied in the presence of high dynamic actions which may occur for instance in seismic zones. The effects of friction shall not be used to relieve the effects of externally applied horizontal loads.

Corrosion protection

Corrosion protection is presented on the technical drawings of the bearings. Standard system includes preparing the ground surface to grade Sa 3 and 4 layers showed in Table 5. Thickness of layers could be adapted to local requirements.

Table 5.

No.	layer	min. thickness
1	metal spraying	80 mm
2	sealing layer	30 mm
3	intermediate coat based on epoxy resin containing micaceous iron oxide	120 mm
4	topcoat based on polyurethane	80 mm

Dust protection

The sliding surface of the B2 bearings is protected against dust which might cause a quicker excessive wear as a result. To perform a proper protection the triangular circumferential seal is used as a standard (see Picture 1). If it is necessary and additional outer elastomeric skirt might be added as an option.

Picture 1.

Examples of bearing systems

Bearings can be arranged at abutments and piers under the superstructure. Due to high local vertical and horizontal forces the substructure must be properly designed to withstand the designed loads. The layout of the bearings should correspond to the structural analysis of the whole structure and should be designed considering the behavior and mechanics of the substructure (i.e. settlement, stiffness).

Bearings should be arranged in the structure in a way that allows to avoid torsional deflections and allow the structure to expand freely according to change of temperature and any other rheological effects that may occur.

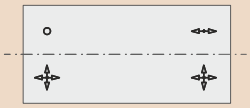
There are a few methods of arranging the bearings, in each of them it should be taken into account that the bearing system must correspond to the expansion joints movements.

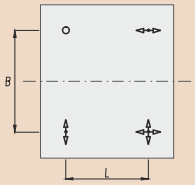
Symbols of the bearings

Scheme 3.

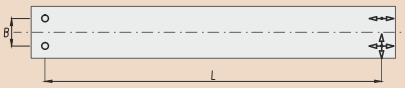
FX	GG	GL
Fixed bearing	Guided sliding bearing	Free sliding bearing

One span



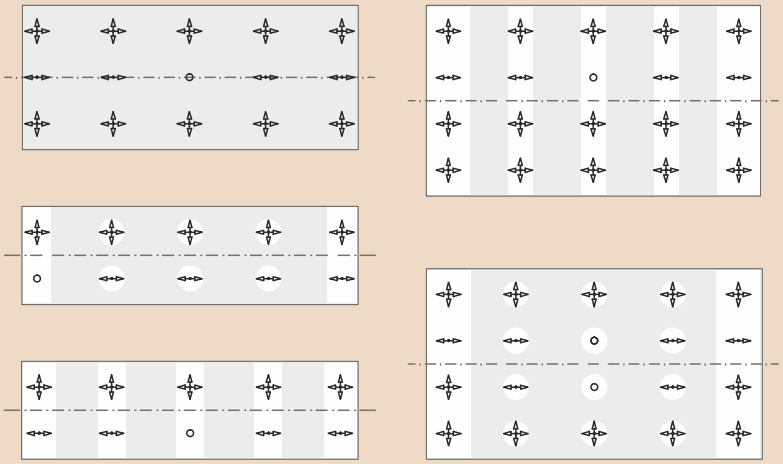


Wide span (B/L > 2)



Narrow span (B/L < 0,15)

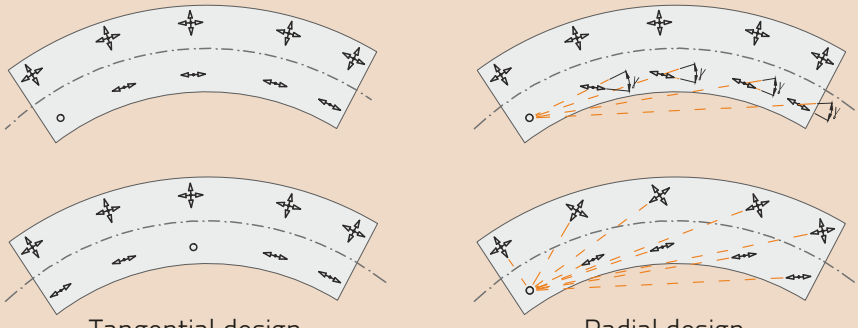
Several spans (straight bridges)



There are many ways to set the layout of bearings for bridge structures. One of the fundamental principles of the EN 1337 is that there should be only one bearing carrying horizontal force for one support. In case when there is more than one bearing restraining movement in any direction on a support (e.g. FX and GG) then each of them must be designed to withstand 100% of horizontal force that occurs on the support.

Supports:
pillar
wall or abutment

Several spans (curved bridges)

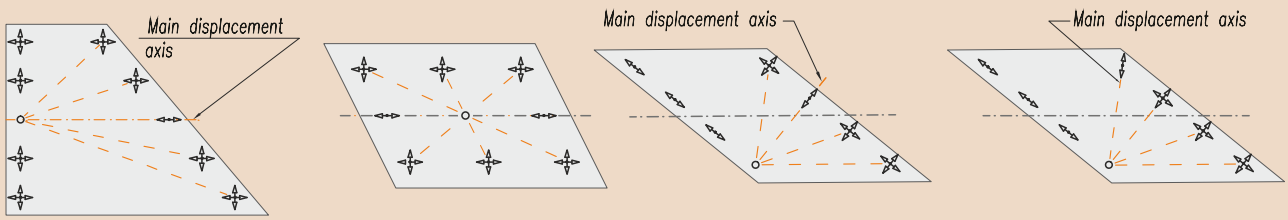


Tangential design

Radial design

The curved bridges with continuous girders may have the bearings system in two different types: tangential and radial.

One and several spans (skewed bridges)



It is strongly advised to take a proper attention to the bearings in light skewed bridges where the uplifting may appear. The uplifting of the bearing is not covered by the EN 1337 standard.

Presetting

Presetting shall be applied in case of (see Fig. 8):

- installation at a temperature other than specified in the National Annex to EN 1991-1-5
- occurrence of displacements due to shrinkage and creep of concrete
- occurrence of elastic shortening in prestressed structures

In the first two cases, the presetting value is usually small so it can be incorporated in the nominal movement capacity of the bearing. Additionally B2 pot bearings have increased range of movement by ±20 mm according to EN 1337-1.

In case of prestressed bridges it is recommended to provide supplier with presetting values, whose task is to overcome the effects of elastic shortening and rheological effects. Lack of presetting before installation may cause a malfunction of the bearing during its operational time.

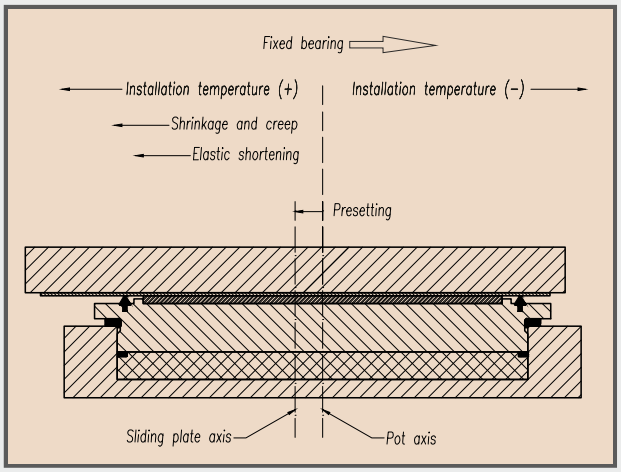


Fig. 8. Bearing presetting components

NOTE It should be taken into account that if the presetting is not applied before post-tensioning it may cause a malfunction of the bearing during its exploitation.

Anchoring

Bearing anchoring serves to transfer horizontal forces from the superstructure to the support. There are two most frequently used methods: through steel dowels or bonding.

The standard pot bearings are equipped with upper and lower steel dowels. Their number and diameter depend on the horizontal design load.

Where the position of a bearing or part of bearing is maintained completely or partially by friction its safety against sliding shall be checked at the ULS in acc. with the following formula:

$$V_{Sd} \le V_{Rd} = (\mu_k / \gamma_k) \times N_{Sd} + V_{pd} \text{ [N]}$$

where:
V_{Sd} - design shear force resulting from the actions
V_{Rd}# design value of shear resistance
N_{sd} - design force acting normal to the joint in conjunction with V_{Sd}
V_{pd} - design strength of any fixing device in accordance with European standards or European Technical Assessment
μ_k - characteristic value of the friction coefficient given in Table 6
γ_k - partial safety factor for friction given in Table 6

Table 6.

	for steel on steel	for steel on concrete
μ_k	0,4	0,6
γ_k	2,0	1,2

NOTE In the case of dynamically stressed structures where extreme load fluctuations can occur, e.g. railway bridges and earthquakes, the horizontal forces shall not be resisted by friction. In these cases $\gamma_k = 0$.

For bearings subjected to horizontal forces (FX and GG) it is always recommended to use anchoring system. Anchoring of free sliding bearing (GL) can be omitted if from the formula above comes out that the friction caused by the minimum vertical force (design value) is sufficient to protect the bearing from slipping. Bonding is used when technological reasons don't allow usage of anchors (i.e. bridge structures erected by the incremental launching method). Or in case if the erection technology assumes installation of the bearings after post-tensioning.

For steel bridges screws are used as anchoring system. There are two methods for fixing the bearing in such a case:

1) with fixing screws in the upper wedge plate, which is welded to the underside of the steel structure (see Fig. 9)
2) with fixing screws in the superstructure, usually on the bottom flange of the girder or box (see Fig. 10)

Solution 1) is recommended due to the easy installation and one plane of the shear in bolt.

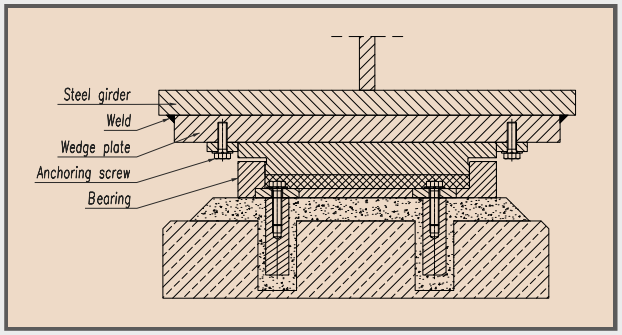


Fig. 9. Anchoring system with fixing screws in the wedge plate

In the method 2) a thinner upper plate can be used but it requires the implementation of two times the number of holes and the use of longer bolts.

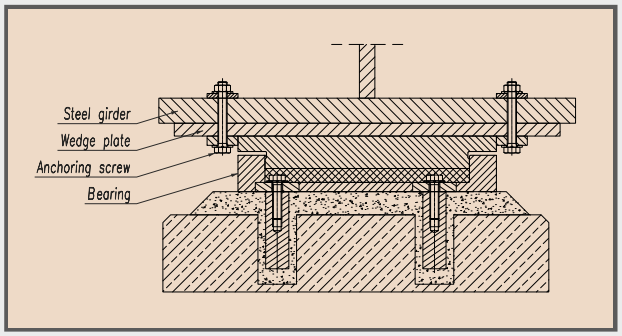


Fig. 10. Anchoring system with fixing screws through the lower flange of steel girder

To the contractors

Labelling

Each bearing can be identified by stickers placed on the top of upper plate and the labels fixed to the outer side of the pot. The information contained on them are shown in Fig. 11-14.

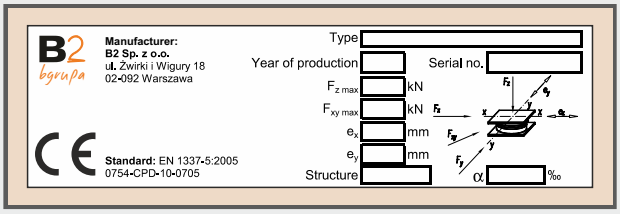


Fig. 11. B2 bearing label

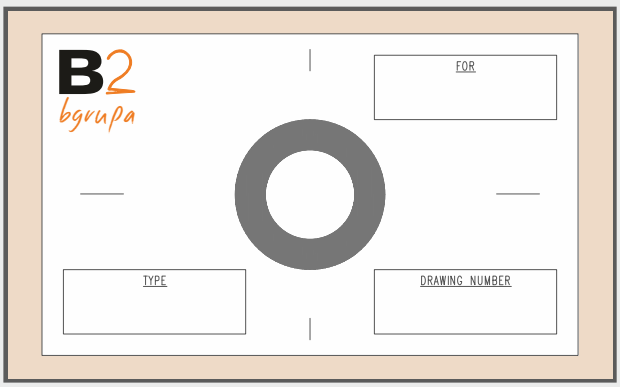


Fig. 12. FX bearing sticker

NOTE Empty arrows shown in Fig. 11 and 12 are particularly important for correct installation of bearings with presetting.

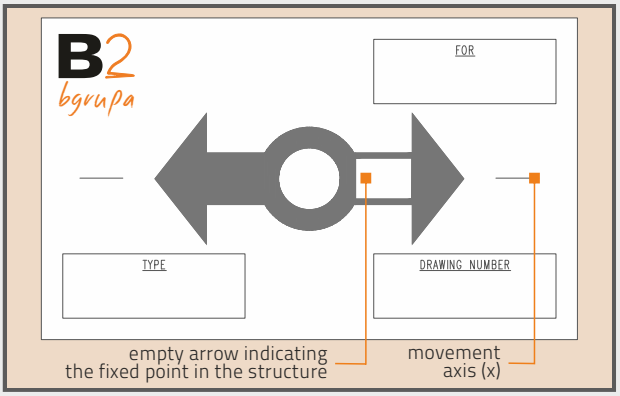


Fig. 13. GG bearing sticker

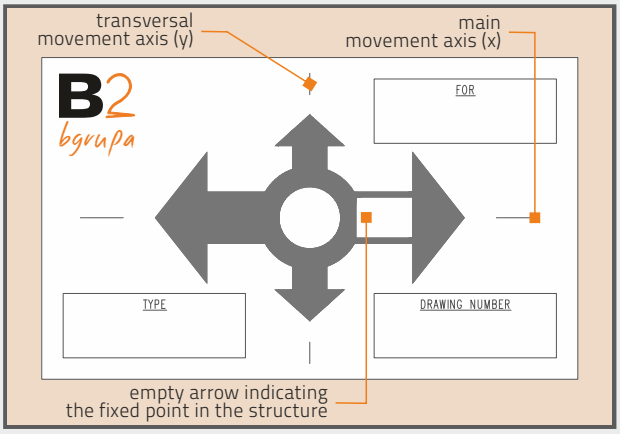


Fig. 14. GL bearing sticker

Packing

The bearings are placed on pallets, making their transportation easy. Each batch is secured with separators (see Picture 2) and a protective foil.

Picture 2.

Unloading and storage

During unloading an appropriate carefulness must be provided to prevent damage of the bearings. They should be kept in a dry and well-ventilated place. All B2 pot bearings are equipped with necessary dowels and screws shown in the technical drawings.

A threaded hole in the center of the upper plate of a bearing enables the transfer of bearing to support using a suspension hook.

Installation

■ Preparation of bearing seat

During the concreting of bearing seat proper recesses shall be left within the seat where lower anchors of bearing will be mounted. All data (diameter and location of anchors) are placed in the drawing documentation of bearings. The width of the recesses should be larger than the diameter of the anchor of at least 5 cm, and a depth greater than the length of the dowels at least 3-5 cm.

Seats should be grained and axes X and Y applied before mounting of bearings.

■ Mortar bed arrangement

Positioning of bearings in the horizontal plane is done by using alignment screws which adjust the correct height of the upper plates and horizontality arranged in the bearing seat. After checking the correctness of the setting of the bearing by land surveyor a mortar bed casting shall be proceeded.

Water and impurities from anchor recesses must be removed before the installation of bearings. Mortar should be arranged by gravity infusion always from one corner of the formwork. Make sure the mortar is compacted and there is no air void that may cause a failure of the bearing in the future.

A mortar bed needs to be cured for at least 24 hours after installation e.g. by covering with wet geotextile.

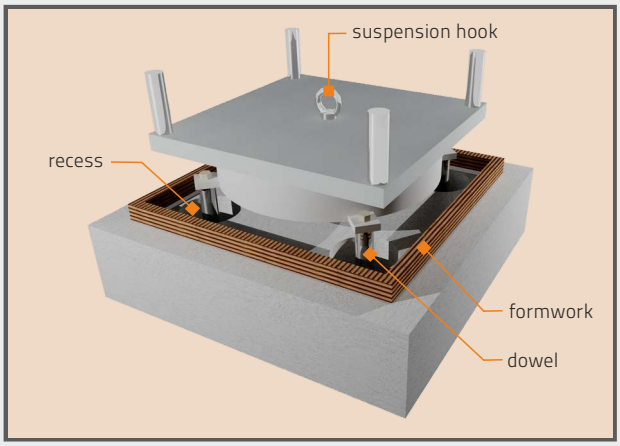


Fig. 15. Bearing installation

■ Installation in temperature below 5 °C

In case of mounting bearings in temperature below 5 °C the bearing seat should be heated by heating tents.

For proper mortar bed setting the heating should start 8 hours before the installation and last at least 24 hours after.

■ Where to pay a special attention

The upper plates of bearings are attached to the pot by temporary screws which prevent uncontrolled displacement or rotation. Temporary fixing must be removed soon after the bearing starts to work (when the substructure and superstructure are connected via the bearing). In FX type of bearing a brass temporary screws are used. Their removal is not necessary since the rotation of the bearing itself will cut them down.

Presetting should be applied in the manufactory. In exceptional situations they can be made on site. In this case a proper care must be provided in order to protect the sliding surface from dirt and PTFE sheet from displacement.

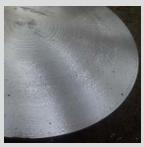
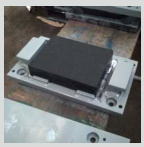
■ Control

Following elements will be subjected to quality control during the execution of the works:

- positioning of the bearing in terms of location on the support
- stabilization of the bearings before casting mortar bed
- check of the positioning of bearings in terms of coordinates (axes) and elevation (height) by surveying services
- check of the expiration date of materials for mortar bed
- making the mortar bed according to the manufacturer recommendations
- position control of bearings after setting of mortar by the surveying services

■ Summary

The B2 bearings are designed for each bridge individually. It allows to apply bearings which are the most suitable for design loads in the particular bridge. To receive an offer please feel free to contact our office via **biuro@bgrupa.pl**. To make the choice of the bearings easy please attach a full information necessary to design the bearing plan, as listed in Table 3. Additionally, please provide us with information about the construction of sub- and superstructure, what would make it easier to design the connection between the bearing and the structure.

B2 bgrupa




B2 reference projects

S7 expressway, part B: Ostróda Ring Road, part C1 Ostróda-Rychnowo (Poland)
210 pcs. of pot bearings with max vertical load 26000 kN
76 pcs. of elastomeric, guide and restraint bearings

A4 highway from Tarnów to Rzeszów (Poland)
428 pcs. of pot bearings with max vertical load 13470 kN

A1 highway from Stryków to Tuszyn (Poland)
293 pcs. of pot bearings

Nowolazurowa Street, Warsaw (Poland)
80 pcs. of pot bearings
62 pcs. of elastomeric, guide and restraint bearings

S8 expressway from Wrocław to Łódź (Poland)
961 pcs. of pot bearings
86 pcs. of elastomeric, guide and restraint bearings

S8 expressway, Grota-Roweckiego Bridge, Warsaw (Poland)
32 pcs. of pot bearings with max vertical load 27400 kN
32 pcs. of elastomeric, guide and restraint bearings

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