Preface

In addition to the specifications of the European Standard EN 1337, the VHFL Guideline 2 also includes manufacturer recommendations which are necessary for the planning and the execution of the installation of bridge bearings. The informations on the bearing drawings and the bearing installation details also have to be respected and considered. The specifications mentioned in EN 1337-11 [9] are also binding when installing the bearing. In the case of a bearing replacement, a bearing exchange concept shall be prepared. In case of difficult installation conditions (eg. steel connection at top/bottom) or when moving special bearings, an installation instruction should also be available.

The proper installation of bridge bearings is carried out by specially trained personnel. A specialist of the bearing manufacturer company should be present during installation of the “first bearing of its kind“.

Through a successful participation in a VHFL-MPA (Stuttgart, Germany) course "Specialist for the installation of bearings in structural engineering according to EN 1337", the specialist demonstrates the ability to install bearings in bridges and building structures. The performance scope of the bearing manufacturer for the installation supervision is regulated in the VHFL RiLi 1 [11]. The term "first bearing of its kind" is defined as follows:

- Bearings of a particular design, for example spherical bearings, horizontal force bearings
- Bearings, where horizontal forces are transferred to the structure by shear studs
- Bearings, where horizontal forces are transferred to the structure by friction
- Bearings connected to a steel (super-) structure
- Bearings which have a tension anchorage system

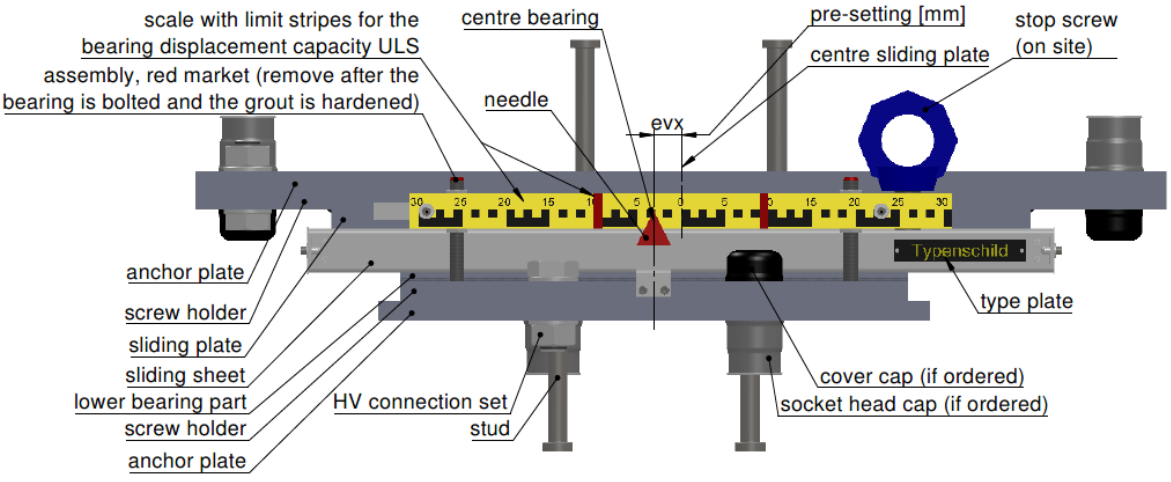


Figure 1: Relevant technical terms and components during bearing installation

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1 Bearing types and systems

The European Standard EN 1337-1, Table 1 [5] describes the most common types of bearings. In addition to the bearing number and the identification symbol, the respective degrees of freedom (forces, movements, rotations) are specified. In addition to that, the respective bearing types are represented schematically by the images 1a to 1f. The bearings are categorized as follows:

Type 1: Multidirectional rotatable bearings (For eg. No. 1.1 Elastomer bearing, No. 8.1 horizontal force bearing).

Type 2: Uniaxial rotatable bearings (For eg. No. 5.1 Linear rocker bearings, No. 6.1 Roller bearings).

Type 3: Spherical and cylindrical bearings, if the horizontal force is absorbed by the curved sliding surface (For eg. No. 3.2/3.4 and No. 7.1/7.2).

Type 4: Other bearings (For eg. No. 2.1 Pot bearing, fixed; No. 3.1 Spherical bearing, fixed).The bearing system is shown schematically in the bearing detail plan (Figure 2). For better orientation, the bearing shown in the bearing detail plan is marked separately in the bearing system. Furthermore, the structurale axes A and B (X-axis = bridge longitudinal direction) and the bearing rows 10 and 20 (Y-axis = bridge transverse direction), the north arrow, the arrangement of the bearing position indicator and the direction of the default setting are shown (if applicable).

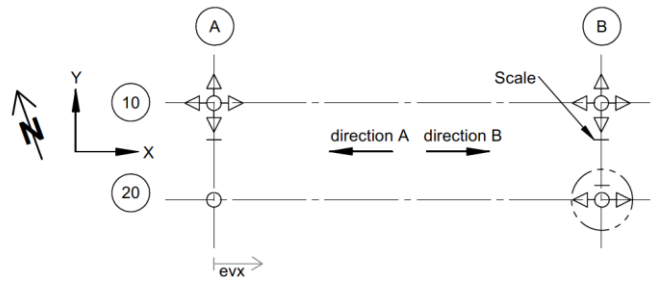


Figure 2: Example of a constraint-free bearing system with spherical bearings

2 Information for loading, delivery control and interim storage of bearings

Bearings are sensitive products, whose function can only be guaranteed by careful handling. Therefore they need to be unloaded from the delivery truck using a suitable hoisting device using approved lifting slings. Bearings should only be moved with suitable lifting slings at the points provided for this purpose (Figure 1). Sliding plates and bearing base parts are usually aligned parallel to each other in the production plant and connected with each other by auxiliary support structures with the help of color coded bolted connection. This arrangement is immovable and safe for transport. The parallelism between the bearing plates must be maintained until the bearing is installed. The bolted connection of the transport fixation (Figure 1) should not be removed before the bearing is firmly connected to the substructure and superstructure.

EN 1337-11 [9] specifies that the bearings must be checked for the following points immediately upon arrival at construction site:

- visible damage, particularly to the corrosion protection. The nature and extent of any damage shall be indicated together with details of any permissible remedial action on the bearing installation drawing,
- cleanliness,
- security of the transportation fixation,
- conformance to the installation and working drawings if this has not already been established by way of quality control or acceptance inspection,
- marking on the top surface of the bearing and on the type plate as well as marking of x- and y-axisand, if necessary, of presetting on the faces of upper and bottom part of the bearing, in addition identification of measuring points at rotating gap and eventually sliding gap,
- position of all means used to ensure the exact positioning and installation of the bearings, where specified,
- indicating device required for movable bearings in main direction of movement, where required,
- the magnitude and direction of presetting, if specified,
- possibility of readjustment, if provided
- temporary storage on site.

Unexpected changes or damages should be noted on the shipping documents and be immediately reported in written form to the bearing manufacturer. Bearings that are not installed immediately after the transport, must be stored on pallets at a suitable location and should be protected against mechanical damages, dirt, moisture and excessive heating. It is a must to ensure adequate ventilation in order to prevent condensation.

3 Bearing labelling

As shown in Figure 3, the X-axis (usually parallel to the longitudinal bridge axis) and the Y-axis (usually transverse to the bridge axis) are plotted for each bearing and by color markings on the upper side of the bearing. The front and long sides of bearing top and bottom part also marked. The black dashed line indicates the center of the respective bearing plate, while the left and right yellow dashed line is the optical marking. The distance between the red dashed line and the Y-axis corresponds to the pre-setting dimension.

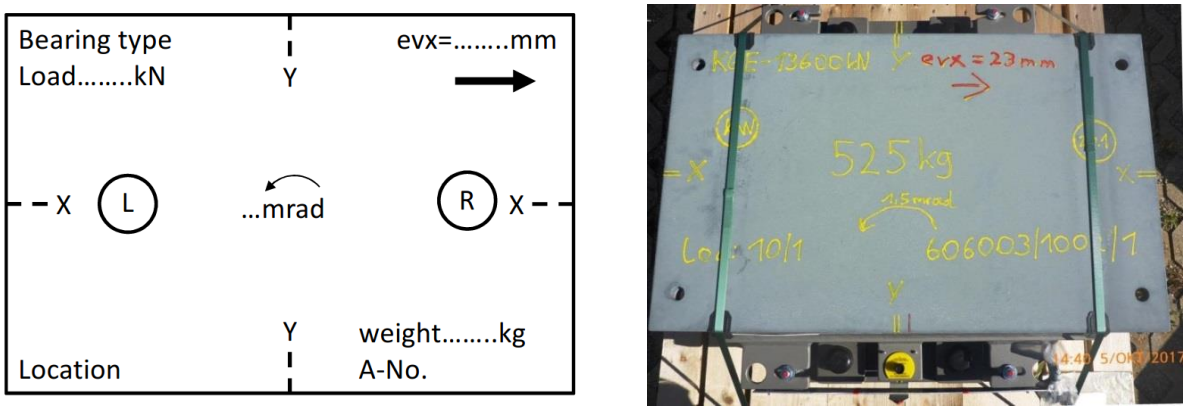


Figure 3: Bearing labelling in bearing detail plan (left) and on bearing (right)

All further details are given below, which are applied on the upper anchor / bearing plate.

- Bearing type according to EN 1337-1, Tabel 1 [5] with the maximum sustainable load [kN] in the ULS.
- If applicable, the direction and value of the pre-setting, evx [mm] in red text.
- If applicable, the direction and value of pre-rotation, ϕ [mrad].
- Location and weight [kg] of the entire bearing.
- Left and right neighbour axis (marked by circle).
- A-Nr. = Order number /sheet number /control card number (serial number)

4 Type plate

Bearings are generally identified by a type plate, which is usually located on the side of the bearing position indicator. An example of the type plate is shown in Figure 4. The layout is regulated by the notified certification body of DIBt (usually MPA Stuttgart, Germany), which as an independent third party determines the legal bearing identification with the EG certificate of conformity (CE mark).



Figure 4: Example of Type plate

The following information is given on the Type plate:

Type Bearing no. acc. EN 1337-1, Tab. 1 [5]

LOC Installation location

O-NO Order number

C-NO Control card number (serial number)

N_d max. vertical load in ULS

V_{xd}/V_{yd} max. horizontal load in ULS

v_{xd}/v_{yd} max. displacement in ULS

$\varphi_{xd}/\varphi_{xd}$ max. rotation in ULS

ST Fundamental technical rules for CE-Marking

YEAR Year of installation

5 Measuring plane on the bearing

Bearings are generally installed and aligned by using precision spirit levels (see also Figure 9 / 10 and sections 9 and 10). The measurement should be done in longitudinal, lateral and diagonal direction. The measurement plane (Figure 5) is an optional equipment to achieve a more precise result. It is considered as a reference surface to achieve the required installation accuracy. During installation of the bearing, a 2-axis precision spirit level (System MPA Stuttgart) is placed on top of it. The bearing is aligned horizontally using the two circular levels. The measuring plane usually is attached to the sliding part of the bearing or can be included in the lower anchor plate for example in case of elastomeric bearings. The measurement level is protected by a screwed protection cover, which is removed before each measurement and subsequently placed again after the measurement (Figure 5). The imprinted instructions always need to be observed and followed. The 2-axis precision spirit

level (System MPA Stuttgart) must be leveled with the measuring console at the front and sides and it should also touch the two protruding rear pins. The measuring plane must not have a deviation greater than 1 ‰ from the flat sliding surface (workshop setting tolerance). In case of elastomer bearings, the measuring plane can be formed by two adjustable measuring points each on the anchor plate or bearing plate in the direction of the main axis (Figure 6). If there is occurance that the measuring level has been damaged during transport, this must be reported immediately to the bearing manufacturer.

The measuring accuracy of the 2-axis precision spirit level is 0.6 ‰ (= 1 scale mark). After grouting the inclination error of the bearing must not exceed 3 ‰ (= 5 scale marks), 5 ‰ for elastomer bearings, plus the previously mentioned setting tolerance.

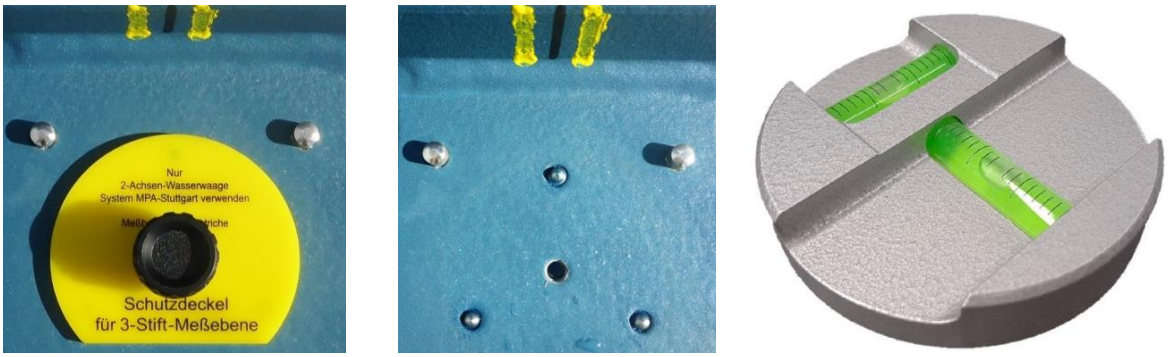


Figure 5: Measuring plane (with/without Protection cover), 2-Axial precision spirit level [www.roeckle.com]

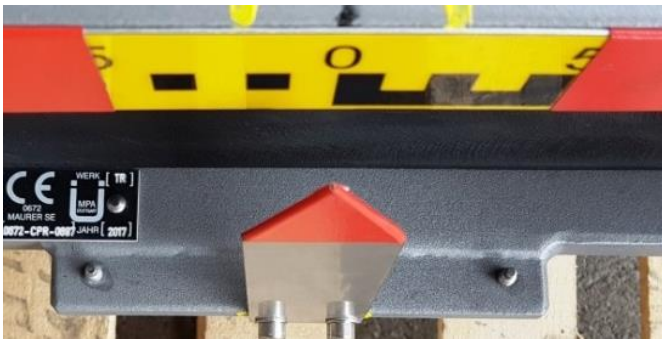


Figure 6: Two-point measuring plane integrated in anchor plate, top view of elastomer bearing

6 Sliding and tilting gap measuring points

The most important parameters for assessing the bearing function are the sliding and tilting gaps. The first measurement is made in the manufacturing plant just before the shipment. These values are documented in the bearing specific control card. The measuring points whose positions are specified in Lag 2 to Lag 5 and Lag 7 [10] are marked on the bearing as follows:

a) Sliding gap/Protrusion: Punch mark and color marking on the spherical cap or pot lid edge or on the edge of the sliding material support in the case of elastomer slide bearings.
b) Tilting gap: Red dotted points on the front sides of the bottom part of spherical bearings or colored marking on the pot lid edge (not required for elastomer slide bearings)

The change in the sliding material thickness at non-measurable sliding gaps, for example at fixed spherical bearings, can be detected approximately via auxiliary measurements (decrease in the average of the tilting gap along the circumference).

The bearing manufacutrer recommend that for bearings with sliding gaps ≤ 1 mm a shorter inspection interval shall be scheduled. For gap widths ≤ 0.2 mm, the sliding material must be replaced immediately. For guide bearings and restaint bearings, the horizontal gap must be ≤ 2 mm (EN 1337-8 [7]).

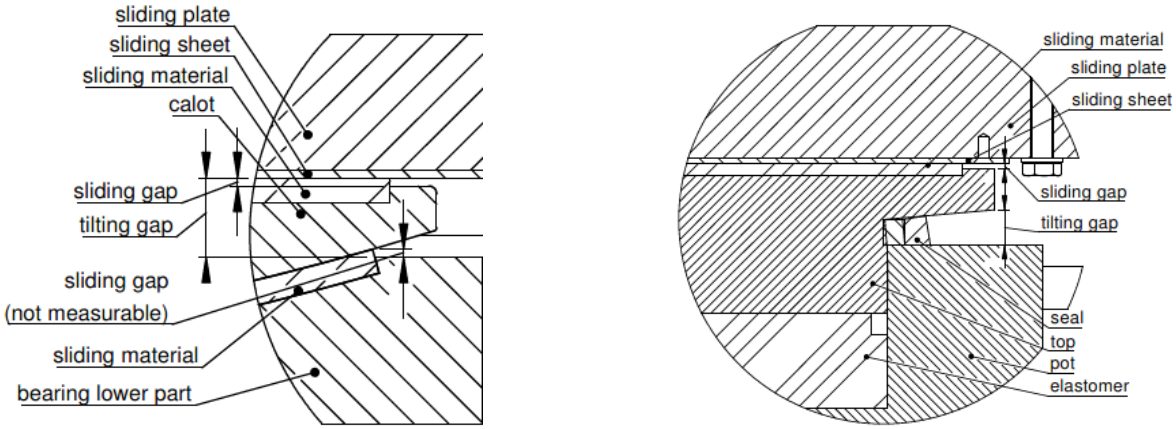


Figure 7: Sliding and tilting gap measuring points at the spherical bearing (left) and pot bearing (right)

7 Bearing position indicator and presettings

The bearing position indicator (Figure 8) is an optinal equipment, to visualize the longitudinal movement of the bearing. On the weather resistant and high contrast scale, the permissible bearing end position which corresponds to the maximum calculated displacement is marked separately. The design, alignment and mounting of the pointer and measuring strip on the bridge bearing are given by Lag 1 [10].

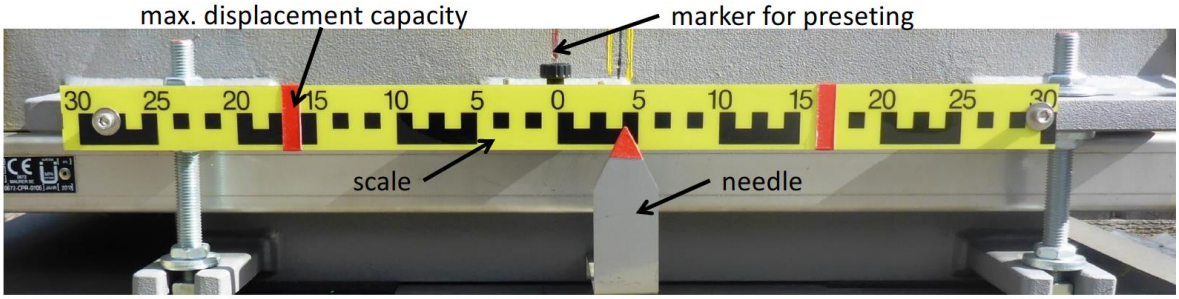


Figure 8: Bearing position indicator acc. Lag 1 [10]

If the installation temperature is not indicated for the particular project, then the value of T_0 = 10°C is recommended as default in DIN EN 1991-1-5 [3]. The respective national annex specifies the values of the minimum / maximum outdoor air temperature. The structural engineer determines with the safety margin dT_0, whether the bearing setting only applies to the set-up temperature T_0 or to a temperature range of $T_0 \pm dT_0$°C.

Based on the movement values mentioned in the bearing specification, the bearing manufacturer checks whether individual bearings need to be preset at the factory. For this purpose, the upper bearing plate (sliding plate) is moved towards the bearing base. The direction of this shift from the center position is indicated by a red arrow on the top of the bearing (see also Figure 3). In the bearing detail plan, the value and the direction of the default setting are listed in the bearing identification label. If the sliding plate position only applies to the set-up temperature T_0, then the correction value [mm/K] determined by the structural engineer to take account of the actual installation temperature at site is noted in the bearing detail and bearing installation plan.

The members of VHFL recommend that presettings changes may only be made by a specialist from the bearing manufacturer or at least under his supervision. In order to carry out a presetting deviating from the bearing installation plan, a written instruction by the design engineer and/or the responsible construction authorities is required.

8 Bearings with anchor plates and high strength prestressed bolted connections

If high strength prestressed bolts are tightened at the head of the bolts, there must be a manufacturer specific procedure that ensures that, the same high strength prestressed bolt set is approved to be pretensioned four times. The procedural instruction is part of the European Standard EN1090-2, 8.5 [4].

9 General instructions for the installation of bearings

In addition to this VHFL Guideline 2, the requirements of EN 1337-11 [9] must also be taken into consideration.

The bearings should to be installed in accordance with the specifications of the bearing installation plan (dimensions, ground levels and positions, inclinations, lateral and longitudinal position, material quality of the bearing joint, pre-setting). They have to be adjusted exactly according to the position and direction in the layout as well as the height and slope in the elevation. Temporary supports shall be used to adjust the position of the bearing. The temporary supports under bearing plates shall be compressible under design loading (to avoid hard spots) if not removed once the bedding material has reached the required strength.

Unless considered in the design of the structure and the bearings, the bearing shall be located so that its position does not deviate more than 3 mm (value is recommended by VHFL acc. prEN 1337-1) from its nominal position in any direction.

Bearing usually are installed horizontally. A deviation from the horizontal X and Y axis should not exceed 3 ‰ and 5 ‰ for elastomer bearings after casting. For sloped bridges, the structural engineer may prefer the bearings to be aligned in parallel to the local gradient. In any case,

-the sliding plate and the lower part of the bearing shall be parallel (such that the gradient is not accommodated by the rotational element of the bridges)

-the alignement of the bearings must match the alignement forseen by the structural engineer

The X-axis marked on the upper bearing plate must match with the displacement direction specified in the bearing installation plan. The maximum deviation from the nominal displacement direction in plane shall not exceed 3 ‰.

The direction of the pre-setting (red arrow on the upper bearing plate) has to be checked .

10 Measuring instruments, tools and material requirements for bearing installation

The company commissioned with the bearing installation has to install the bearings under consideration of the respective installation conditions. The following measuring devices, tools and materials should also be available (see also Annex 2).

a) Horizontal alignment
- 2-axis precision spirit level d=80 mm (measuring accuracy: 1 scale=0.6 mm/m, measuring range: 5 divisions = 3mm/m),
- Precision spirit level for control measurements on machined and milled bearing plates (l ≥ 200 mm, measuring accuracy ≤ 0.3 mm/m),
- Allen wrench for M6 and M8 for removing the bearing position indicator (if required),

b) Tilt and slide gap measurement
- 1 mirror with light on a flexible holder,
- 1 set of telescopic gauges 8 to 12.7 mm, 12.7 to 19 mm, 19 to 32 mm,
- 1 set of feeler gauges from 0.1 to 2 mm, each at least 300 mm long,
- 1 vernier calliper up to 150 mm,
- 1 precision measuring tape 2 m long,
- 1 forehead torch/flashlight,
- Angle wrench 6KT for M6 (SW 10) and M8 (SW 13) for removing the sliding surface protection (if required).

c) Mortar pouring
- compulsory mixer with tub and measuring cup with 1 litre capacity,
- 2 to 3 small plastic buckets, if required, rope to pull up the plastic bucket on the pillar
- large plastic funnel for hose d ≥ 30 mm,
- smooth, transparent plastic hose, d ≥ 30 mm,
- PE foil and adhesive tape to protect the bearings against pollution during casting and flat scraper/ scraper to remove concrete residues,
- shuttering wood with fastening elements,
- crowbar with suitable support for setting up the bearings on the axes of coordinates using a small steel angle,
- for venting the mortar joint at least 2 aluminum or steel strips (about 2m long, cross section 25 mm x 1.5 - 3 mm) and 1 to 2 metal chain strands (chain link length/width/ diameter = 30/10/3 mm),
- mortar system with associated product data sheet including processing information and if necessary, further product specific tools.

d) Motar press
   - compulsory mixer with tub and measuring cup with 1 litre capacity,
   - stopper iron, 2 slide in plates, trowel,
   - shuttering wood with fastening elements,
   - PE foil and adhesive tape to protect the bearings against pollution during casting as well as flat scrapers for removing concrete residues,
   - mortar system with associated product data sheet including processing information and if necessary, further product specific tools.

e) Coating material
   - For repairing the corrosion protection, the appropriate coating materials, associated tools and cleaning utensils must be present.

11 Connection of the bearings to the substructure and superstructure

11.1 General Information

According to EN 1337-11 [9], the unreinforced mortar joint must be 2 cm to 5 cm thick. Additionally, the layer thickness must not be less than 3 times the largest grain diameter of the additive. It must at least correspond to very low shrinkage class and early strength class in case of cementitious mortar. It's recommended that only grout with a certificate of conformity may be used.

Before applying a cement bound mortar, the concrete base must be saturated with water for several hours. Thereby no water is removed from the thin mortar layer during the set up process. Then the non-bound water should be removed before grouting, so as not to exceed the manufacturer's predefined maximum water level.

If epoxy resin or a metal polymer is used, the application restrictions of the technical sheets must be followed. The manufacturer's specifications must be strictly adhered, since the mixing ratio of 2 component systems significantly affects the functionality. This also applies to the available gap height, which can be seen in the approval.

If reaction resin mortar is used between two steel sheets of a slip resistant high strength bolted connection, the calculated coefficient of friction must be verifiably proven, taking creep and shrinkage behaviour into account. Mortar joints with thicknesses over 5 cm must be reinforced. The bearing capacity of reinforced mortar joints shall be verified in accordance with DIN EN 1992 [4].

Irrespective of the type of grouting material, the product specific processing instructions of the manufacturer must be followed. To ensure the coefficient of friction between the structure and the bearing, which has been verified by standards or official tests, the grouting surfaces must be free of grease and oil (especially formwork oil) and additionally the bearing plates must be uncoated, zink flame sprayed or coated with zinc silicat. (EN 1337-1 [5]).

11.2 Concrete Substructures / Grouting

If the bearings are accurately offset and aligned (see also section 9), they are either grouted or plugged depending on the type of mortar specified in the bearing installation plan.

a) Underpouring

If the bearing pedestal is completed upto normal upper edge, the mortar joint in bearings with anchoring elements should be filled with a high quality and sufficiently free flowing mortar (Figure 10).The grout is slowly introduced into the formwork via a transparent plastic hose in conjunction with a funnel. **Special attention must be paid for the adequate ventilation. No air bubbles are allowed.** For this purpose, metal chains are inserted in the casting direction at a distance of about 20 cm and alternately pulled back and forth during the casting process. There are sometimes straps with cross-section 25 mm x 1.5-3 mm, diagonally placed to the flow direction sting in the casting compound, so that the air can leak and for exceptionally larde bearings, air holes are recommended (Figure 9). When the joint is filled (about 1 cm above the lower edge of the bearings), the chains and straps need to be carefully removed.



Figure 9: Underpouring of bearing, anchor plate with air outlet holes (left) and spherical fixed bearing (right)

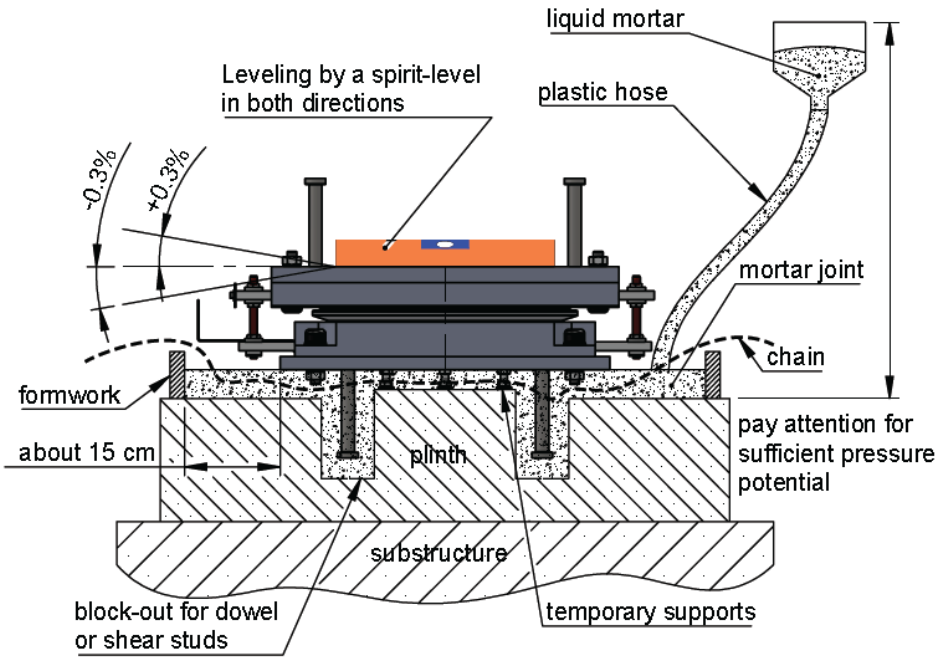


Figure 10: Preparation of the mortar joint to the concrete substructure (schematic)

b) Underplugging

Packing mortar exhibits a stiff consistency. In the case of large bearings, undercoating is carried out against a wooden strip in the middle, which is wedged in the longitudinal direction underneath the bottom part of the bearing. If the cavity is half filled, the wooden strip is removed and the mortar is plugged against the mass already applied. Particularly in warm weather and with large containers, it is advisable to process the mortar in partial quantities.

Another possibility is to work with two men and two darning irons. The mortar is pushed inside from one side upto the centre of the bearing and held against the other side with a darning iron. This process is repeated as often as necessary until the material filled inside offers sufficient resistance in order to plug the remaining joint towards the outer edges without any opposite. This procedure should only be used by appropriately trained personnel.

In case of small bearing plates, grouting from one side against a joint opening closed on three sides is a proven reliable option.

Irrespective of the method chosen, the contact pressure of the darning iron must always be high enough to ensure that no cavities remain in the mortar bed.

11.3 Concrete superstructures

If the bearing connects directly to a precast superstructure member, see 11.2

Usually the superstructure is concreted directly onto the bearing, whereby the forwork is brought as close as possible to the bearing. In order to avoid moistening the bearing with cement slurry, the remaining gap between the formwork and the upper bearing plate must be sealed e.g. using polyurethane foam. The insertion of a foil is not permitted. If necessary, precautions must be taken to ensure that the bearing always remains in position even if the formwork expands due to temperature. The possibility of loosening the bolts of the auxiliary support structure marked in red on time must also be taken into account. Ensure that the auxillary support elements are accessible and can be disconnected on the the bearing is firmly connected to both the sub- and the superstructure, i.e. the concrete or mortar is extensively hardened. The “activation” of the sliding bearing should be confirmed by the structural engineer, as there are several exceptions. For example:

- In case of prestressed concrete bridges, the bolted connections must be removed before the prestressing tendons are tensioned
- In case of change / relocation of the fixed point during construction, auxillary support elements may be desired to remain fastened beyond the firm connection of the bearing to sub- and superstructure

In case of bearings with high torsional resistance (pot bearings, elastomeric bearings with sliding elements), it is possible to replace the metallic bolts or threaded rods of the auxiliary support structure with plastic fasteners (e.g. polyamide). But it is feasible only after the bearing has been offset and aligned. If this is intended, then the instructions on the bearing detail plans must be strictly followed. In this case, accessibility before stripping the formwork does not have to be guaranteed, as the plastic bolted connection already fails under low load. After stripping the formwork, all plastic residues remaining on the bearing must be removed.

11.4 Steel superstructures

Generally bridge bearings are installed horizontally considering the maximum permissible inclination error (refer chapter 5). For this reason, a permanent inclination of the superstructure must either be mathematically taken into account and the bearings are pre-rotated or the wedge shaped gap between the bearing and the steel superstructure must be compensated (see also section 9). Along with this, the flatness tolerance of the steel contact surfaces (bridge bearing and steel superstructure) specified in EN 1337-2 [6] must not be exceeded for plain bearings 0.0003 x D_{LP} or 0.2 mm (D_{LP} = diagonal of the bearing plate) and for elastomer bearings 0.003 x D_E or 1 mm (D_E = diagonal of elastomer bearing).

If the horizontal steel superstructure has the required flatness (**Variant 1**, Figure 11) the bearings can be bolted to the superstructure. Then it can be lowered to the final target position and then the lower grouting joints can be prepared. For bearings with a lower anchor plate, sufficiently large recesses must be provided in the bearing base to accomodate shear studs. Before grouting, the bearings must be carefully supported with set screws and the bolted connections of the auxiliary support structure must be loosened slightly (approx. 1/2 turn) so that the superstructure movements are absorbed more easily during the setting process. It is crucial to ensure that the bearing parts do not lift apart during the hardening of the grout and that the bearing is held exactly in position. Once the required compressive strength has been reached, the superstructure can be set down on the bearings. The bearings must be released directly after this.

In principle, the procedure described above can also be applied to **Variant 2** (Figure 11) whereby the non-parallelism between the bridge bearing and the steel superstructure must be compensated by means of a wedge plate. For this purpose, it is recommended that the allowance is considered at several points per each installation location. If necessary, use wedge washers to screw the bearing with a wedge plate to a heavily torsioned superstructure. (see also DIN EN 1090-2 [1])

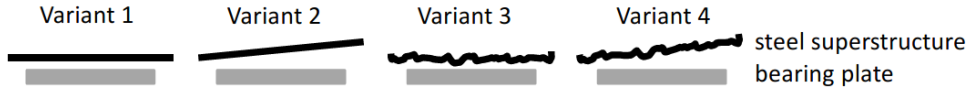


Figure 11: Typical variants of the bearing installation on steel superstructure

If the connecting surfaces on the steel superstructure do not have the required flatness tolerance (**Variant 3/4**, Figure 11), then the superstructure is placed in the set position on auxiliary supports/presses after loading or inserting and the bearings on the base are moved in accordance with the instructions in chapter 9. Even if the transmission of the horizontal force through the frictional resistance is ensured, the following connection options are available.

A) <u>Elastomer bearings without anchoring means (horizontal force is transmitted via the friction resistance of the mortar joint)</u>

The clear distance between the upper edge of the bearing base and the lower edge of the steel superstructure in the desired position must be planned in such a way that a mortar joint with a respective height of 2 cm to 5 cm can be executed below as well as above the bearing. The gaps of the moved bearing can be poured or plugged, whereas it is advisable to start with the lower one first.

The comments of the previous subchapters 11.1 and 11.2 apply, in particular to the notes on producing the bubble free mortar contact surface. Once they have reached the required compressive strength, the presses are relieved and the superstructure is set down on the bearings and the auxiliary support structures are loosened.

B) Bearing with mortar joint and bolted connection to the steel superstructure

The clear distance between the upper edge of the bearing base and the lower edge of the steel superstructure in the desired position must be planned in such a way that a mortar joint with a height of 2 cm to 5 cm can be prepared under the bearings and the gap width dependent on the material (cement, synthetic resin or metal poylmer) can be prepared above the bearings. It is also recommended that, the lining plate (possibly wedge shaped) with an average thickness of at least 18 mm is inserted between the bearing plate and the steel superstructure so that the contact joint is not damaged when the bearing is exchanged.

The bearings are installed as follows:

- In first step, the wedge plate is first separated from the bearing. According to the manufacturer's instructions, either a filler (e.g. MM1018 or similar) is applied in an x-shaped manner and then pressed onto the steel superstructure with screws, or the wedge plate is screwed to the steel superstructure in the desired position, shuttered and the remaining gap is completely filled with a grouting/injection system. In both cases, the wedge plate is horizontally aligned with a machine spirit level (chapter 10).
- Bearings without wedge plates are bolted completely to the steel superstructure and the mortar system dependent gap dimension is adjusted. The bearing is then shuttered horizontally with the 2-axis spirit level and the remaining cavity is completely filled.
- The bearing must be cleaned immediately from squeezed out filler material or pouring grout.
- Once the filler material has hardened, conitnue in the same way as for variant 1.

C) Bearing with mortar joint and weld seam connection for steel superstructure

The clear distance between the upper edge of the bearing base and the lower edge of the superstructure must be prepared as described in section B1. A lining plate should also be used.

The bearings are installed as follows:

- After the bearing has been moved offset and aligned using temporary supports, a steel frame is welded to the steel superstructure on site. The size of the frame must be designed and dimensioned, in order to fit around the upper bearing plate with at least 10 mm clearance.
- The gaps between the bearing and the structure are shuttered and the lower joint is prepared as described in subsection 11.2. Thereafter, the upper joint is grouted by the filling and vent holes provided on the steel superstructure.

Alternative 1

- If there is a bracket/pin on the steel superstructure for shear force transmission, it is recommended that the filler plate bolted to the bearing is trough-shaped. The webs later serve as the formwork or shuttering. After the lower bearing joint has been produced as described in subchapter 11.2 the trough is cast and a full surface frictional connection in horizontal and vertical direction to the steel superstructure is executed.

- Once the mortar has reached the required compressive strength, the jacks are relieved, the superstructure is placed on the bearings and the auxiliary support structures are loosened.

  Alternative 2

  - A filler plate (wedge shaped if applicable) is welded all around to the steel superstructure, leaving a gap of ≤ 10 mm in the vertical direction. Metal polymer (e.g. MM1018 or similar) is injected into the cavity. Due to the high requirements of material processing and the venting mechanism, the injection of the material should only be carried out by trained personnel. Once the filling material has hardened, the bearing is bolted to the lining plate via a blind hole connection. The further procedure is the same as for variant 1.

Spontaneous individual customised solutions, which are easy and necessary during replacement of a bearing are permissible. This solution must be agreed by the company carrying out the construction work, the planning office, the test engineer and the bearing manufacturer. It should also be documented in a bearing replacement manual. Figure 12 / Figure 13 / Figure 14 show examples of the possible connections to the steel superstructure.



Figure 12: Grouting to the concrete substructure, welding to the steel superstructure

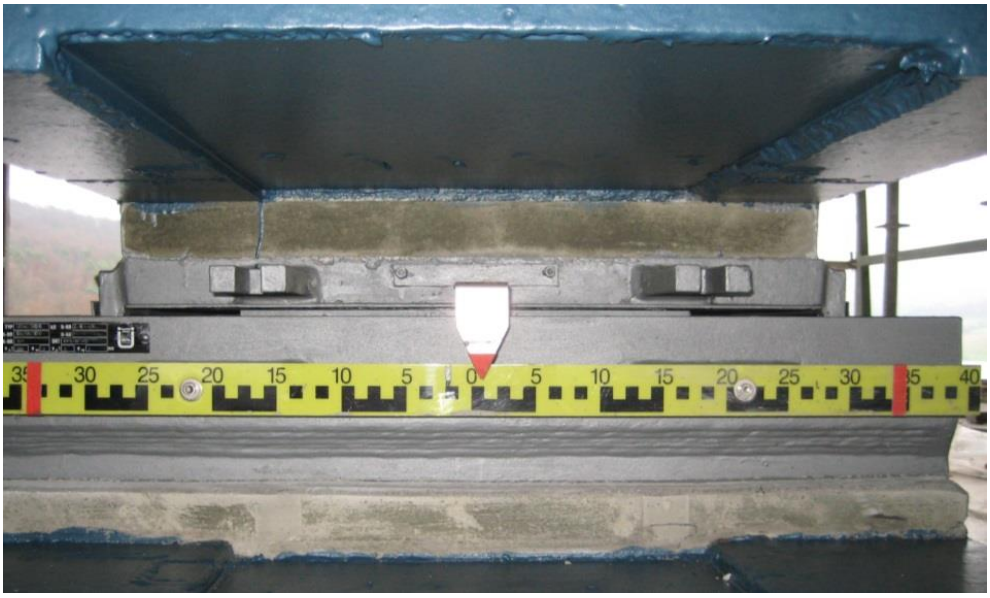


Figure 13: Grouting to steel substructure, grouting to steel superstructure



Figure 14: Grouting to the concrete substructure, bolted connection to the steel superstructure

12 Concreting load

In case of a widely cantilevered sliding plate which results from a large presetting or a wide bearing movement capacity, the bearing can tilt and/or the concreting load from fresh concrete can bend the upper bearing plates. In this case, the site management must ensure that the sliding plate is sufficiently supported against the structure, whereby the supports are to be arranged under the temporary support plates in case of bearings without anchor plates and under the bolt retainers in case of bearings with anchor plates. A support directly under the stainless steel sliding plate is only allowed after consulation with the bearing manufacturer. Primitive wooden supports are not permitted.

13 Release of the bearings

If the bearing is firmly connected to the substructure and superstructure, before prestressing the colour marked bolts of the auxiliary support structures must be loosened and any remaining free tapped holes must be closed with sealing plugs. This process has to be done immediately after hardening of the mortar joints. This procedure is not necessary, if the auxiliary support structures are provided with polyamide bolt after the installation. If there are fixed adjusting bolts on the bearing, check again whether these have been torqued back and relieved. If the bearings have been aligned by temporary supports for example with conical clamping washers or set screw tappets these remain in the structure.

14 Commissioning of the bearings

After removal of the shuttering or formwork, the bearings must be cleaned and any damage to the corrosion protection must be repaired. Information on the possibilities of corrosion protection repair can be found in ISO 12944 and must be consulted with the bearing manufacturer. Since sliding materials or elastomer components can be easily damaged, all cleaning and repair work (e.g. grinding) must be carried out very carefully. It is generally forbidden to work with compressed air, fire, fuels or chemical agents in the vicinity of a bridge bearing. If blasting work is carried out next to the bearing, the entire bearing must be protected from blasting material.

15 Bearing installation report

Templates for bearing installation reports are provided in Annex 1 and in DIN 1337-11 [9]. It is mostly possible to adapt or supplement the forms to the respective installation situation.

If the bearing manufacturer supervises the complete installation process, then the respective specialist will mention the notes in the lines "Before installation" and "Installation" and will confirm in the line "Remarks" the instruction of the executing installation company in the correct installation of the bearing. All other bearing records of the previously instructed bearing type are filled in by the local site management independently, unless otherwise agreed contractually.

16 Initial measurement

The initial measurement (commissioning inspection) at the beginning of the bearing’s service life) has to be arranged by the contractor. He is free to appoint a specialist of the bearing manufacturer or a third party supervising body. The client carries out corresponding measurements during the first inspection of the structure in accordance with the main inspection. For these measurements, the horizontal position at the measuring plane of the bearings shall be checked, the sliding and tilting gaps shall be measured at the marked points and the displacement as a function of the mean structural temperature . The results of the zero measurement shall be documented in the respective files. For this reason, text fields are already reserved in the bearing protocol document. The required test and measuring equipment and tools (Annex 2) as well as any scaffolding required must be provided by the contractor.

17 List of references

[1] DIN EN 1090-2 (2018-09) Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures.

[2] DIN EN 1990/NA/A1 (2012-08) Basis of structural design.

[3] DIN EN 1991-1-5 (2010-12) Actions on structures – Part 1-5: General actions – Thermal actions.

[4] DIN EN 1992-1 (2011-01) Design of concrete structures – Part 1-1: General rules and rules for buildings.

[5] EN 1337-1 (2001-02) Structural bearings – Part 1: General design rules.

[6] EN 1337-2 (2004-07) Structural bearings – Part 2: Sliding elements.

[7] EN 1337-8 (2008-01) Structural bearings – Part 8: Gide bearings and Restraint bearings.

[8] EN 1337-10 (2003-11) Structural bearings – Part 10: Inspection und maintenance.

[9] EN 1337-11 (1998-04) Structural bearings – Part 11: Transport, storage und installation.

[10] Richtzeichnungen für Ingenieurbauten RiZ-ING (2015-12), Lag 1 – 11, Federal Ministry of Transport and Digital Infrastructure, Germany.

[11] VHFL RiLi 1 (2010-11) Leistungsumfang des Lagerherstellers bei der Einbauaufsicht Lager.

Products recommended by the VHFL for bearing grouting

Product name; Manufacturer homepage

Contact surface Steel-Steel (liquid/pasty)

MM1018FL/MM1018P; http://diamant-polymer.de/

Contact surface Steel-Concrete (grouting mortar, pouring)

PARGEL V1/50; www.pagel.com

Silikal R17; www.silikal.de,

Contact surface Steel-Concrete (grouting mortar, press)

PARGEL V14/40; www.pagel.com

BETEC 340; www.bcr.at

Annex 1: Bearing Protocol

Bearing Protocol							**Page**
Structure/ Project							**Structure number**
Customer							
Contractor							**Structure name**
☐ **first assembly** [1] ☐ **replacement** [1] ☐ **adjustment** [1]							
Manufacturer:							
Order-No.:				specialist (name):			
Bearing-/Bearing laying plan-No.:				present at (date):			
Bearing Type:				DIN EN 1337-part: ETA-No.:			
application of approval		monitoring					
Mortar Manufacturer,suitability test and processing references							
Manufacturer specific of mortar joint => a) bottom layer:				b) top layer:			
1		Installation location (support no./alignment) as per drawing					
2	Prior to Installation	Bearing type (acc. to EN 1337-1)					
3		Vertical load capacity N_d in [kN]					
4		Horizontal load capicity V_{xd} / V_{yd} in [kN]		/	/	/	/
5		Displacement capacity $V_x \pm$ / $V_y \pm$ in [mm] [2])		/	/	/	/
6		Preset $ev_x \pm$ / $ev_y \pm$ in [mm] [2])		/	/	/	/
7		Bearing Drawing no. / sheet no.		/	/	/	/
8		Date of delivery					
9		Correctly off loaded, properly supported and covered					
10		Proper marking on upper face of bearing					
11		display apparatus in place					
12		Proper labelling of bearing					
13		leveling with measuring plane or spirit level					
14		Proper protection against corrosion					
15		Correct temporary clamping devices					
16		Proper installation location as per line 1					
17		Lift overhang date / time		/	/	/	/
18		Cleanness of mortar contact surface					
19	Installation	Direction and size of preset in mm [2])					
20		Deviation from horizontal in [mm / m] (longitudinal / transverse) [3])		/	/	/	/
21		Application of mortar Date	Time (from/to)	/	/	/	/
22		Shade air temperature / strucutral temperature [°C]		/	/	/	/
23		Thickness of mortar joints in mm (u)= non reinforced, (b)= reinforced	upper / lower	/	/	/	/

Bearing Protocol

Page	
Structure/ Project	**Structure number**
Customer	
Contractor	**Structure name**

☐ **first assembly** [1] ☐ **replacement** [1] ☐ **adjustment** [1]

24	Start of function	Initial loading of the bearing Date / time	/	/	/	/
25		Temporary clamping devices released / removed	/	/	/	/
26		Protection of sliding surfaces in place				
27		Cleanliness, condition of support				
28	Initial measurements	Date / Time of initial measurements	/	/	/	/
29		Shade air temperature/structural temperature in °C	/	/	/	/
30		Deviation from horizontal [mm / m] (longitudinal / transverse) [3,4])	/	/	/	/
31		Displacement in [mm] proper orientation Vx ±/Vy ± in [mm] [2])	/	/	/	/
32		Guide clearance in millimet (max / min)	/	/	/	/
33		Tilting clearance in millimetre (max / min)	/	/	/	/

34 Remarks or other information:[5])

NOTE: Bearing should not be adjusted by means of the levelling screws

description details: [1] to mark with a cross; [2] + fixed point away, must be defined in the absence of constructive [3] with signs of twist acc. to DIN EN 1337-1 chart 1; [4] at loaded bearing by twisting the measured level values correspond to the actual deviation result do not correspond to the actual deviation; [5] e. g. on construction stages temporary fixed point change, sketch about respect points in line 20 and 30

Draw up:	Seen:
Place	Place
Date	Date
Contractor	Costumer

Annex 2: Shifting and testing of bridge bearings - test/measurement equipment

The following testing/measuring equipment and tools have proved to be necessary or helpful for the professional shifting and testing of bridge bearings.

Test and measurement equipment

Tilting and sliding gap measurement
- Feeler gauge sets, e.g. in the lengths 300 / 500
- Telescopic gauge sets, e.g. with measuring ranges from 5 to 30 mm
- Vernier calipers up to 150 mm (digital)

Bearing position
- Depth gauge
- Angles
- Metal ruler

Horizontal Alignment
- 2-Axis-Precision Spirit Level (System MPA Stuttgart; www.roeckle.com)
  Measuring accuracy: 1 Graduation Line = 0.6 mm/m
  Measurement range: 5 Graduation Line = 3 mm/m
- Tripod and measuring plate for 2-axis precision spirit level
- Inclination measuring instrument /Machine spirit level 0.3 mm/m

Other
- Contact Thermometer
- Coating thickness measurement device
- Straightedge, For e.g. in the lengths 200/300/500 mm
- Precision measurement tape

Tools
- Torch (with spare batteries)
- Mirror
- Set of open-end wrenches (matched to stock)
- Set of hexagon socket wrench
- Set of socket spanners or ring ratchet wrenches
- Set of screwdrivers
- Scraper

Miscellaneous
- Cleaning agent/Solvent/Clothes
- Clipboard
- Bearing Drawings / Bearing Transfer Plans / Bearing End Control Cards
- Protocol templates
- Writing things
- Robust container for test/measuring equipment and tools
- Rope for transporting the container to the installation site (if necessary)
- Handgloves
- Safety helm
- Safety footwear and goggles
- Hearing protection