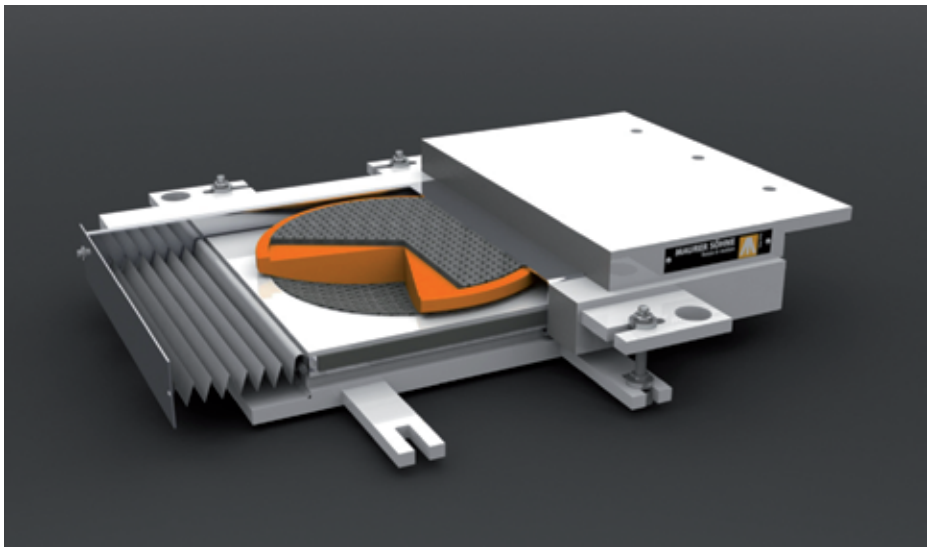
Structural Protection Systems

MAURER MSM®-spherical and cylindrical bearings

National Technical Approval

Approval no.:	Z-16.4-436
Valid until:	April 30, 2013



MAURER SÖHNE
forces in motion

Since 1876

National Technical Approval

Deutsches Institut für Bautechnik
ANSTALT DES ÖFFENTLICHEN RECHTS

Zulassungsstelle für Bauprodukte und Bauarten
Bautechnisches Prüfamt
Mitglied der Europäischen Organisation für
Technische Zulassungen EOTA und der Europäischen Union
für das Agrément im Bauwesen UEAtc

Tel.: +49 30 78730-0
Fax: +49 30 78730-320
E-Mail: dibt@dibt.de

Date: December 15, 2009

Ref. no.: I 32-1.16.4-12/09

Approval no.:

Z-16.4-436

valid until:

April 30, 2013

Applicant:

Maurer Söhne GmbH & Co. KG
Frankfurter Ring 193, 80807 München

Subject of approval:

MAURER – MSM® Spherical and Cylindrical Bearings

The subject of approval mentioned above is herewith nationally, technically approved.
This national technical approval contains 20 pages and 5 annexes.
This national technical approval replaces the national technical approval Nr. Z-16.4-436, dated October, 26th 2009. On April, 25th 2003 the subject has been approved for the first time.

"Translation of the original German version, not checked by Deutsches Institut für Bautechnik"

I. GENERAL PROVISIONS

1 With the National Technical Approval, the assessment of use and applicability of the subject of Approval has been demonstrated with reference to federal building regulations.

2 Provided that the national technical approval requires special knowledge and experience of people entrusted with the manufacture oft he construction products and construction systems in accordance with state regulations and § 17 clause 5 of the model building regulation, it shall be observed, that this knowledge and experience also may be proven by equivalent verifications of other member states of the European Union. This also applies, if applicable, for equivalent verifications submitted in the context of the convention about the European Economic Area (EEA) or other bilateral conventions.

3 The National Technical Approval does not replace the authorisations, approvals and certifications required by law for carrying out the building project.

4 The National Technical Approval is granted irrespective of the rights of third parties; in particular, private patent rights.

5 The manufacturer and seller of the subject of Approval are required to make available to the user or those applying the subject of Approval, irrespective of more extensive regulations contained in the section "Special Provisions", copies of the National Technical Approval and to point out that the National Technical Approval must be available at the place of use. If requested, those authorities concerned are to be presented with copies of the National Technical Approval.

6 The notice of the National Technical Approval may only be reproduced in full. Publication of only part of the document requires the prior agreement of the German Institute for Civil Engineering. Texts and drawings in advertising material may not contradict the National Technical Approval. Translations of the notice of the National Technical Approval must contain the remark "Translation of the original German version, not checked by Deutsches Institut für Bautechnik".

7 The National Technical Approval is granted until revoked. The provisions of the National Technical Approval may be subsequently supplemented and modified; in particular if required by new technical findings.

II. SPECIAL PROVISIONS

1 Subject of approval and field of application

The approved construction product consists of a bearing for bridges and building constructions that facilitates rotations and displacements of the superstructure by means of a plane and curved sliding surface, in using the sliding material MSM® (MAURER Sliding Material).

To the extent that in this General Approval no other definitions are made, the regulations for sliding elements as well as spherical and cylindrical bearings with PTFE according to DIN EN 1337-2:2004-07 and DIN EN 1337-7:2004-08 have to be applied, as well as the general regulations according to DIN EN 1337-1:2001-01, DIN EN 1337-9:1998-04, DIN EN 1337-10:2003-11 and DIN EN 1337-11:1998-04.

Sliding surfaces with a diameter of the circumscribing circle of single or multiple MSM® sheets less than 75 mm or greater than 1500 mm, or with effective bearing temperatures less than –50°C or greater than 70°C are outside the scope of this national technical approval.

The bearings are designed to accommodate the final service loads and shall not be used as temporary devices during construction (e.g. during incremental launch, or in de-piling of superstructures).

Spherical bearings generally act as multidirectional sliding point rocker bearings, cylindrical bearings as unidirectional sliding line rocker bearings. By using appropriate means (guides, restraints), the sliding movement can be limited and by this means the multidirectional movable bearing can be converted into an unidirectional movable bearing or a fixed bearing, its rotation capability however has to be ensured.

The subject of national technical approval is the bearing, including, if relevant, the necessary guides and restraints in accordance with the exemplary figure in Annex 1. As an alternative to the representation in Annex 1, the bearing may also be used upside down, i.e. with flat sliding surface lying below. The installation and equipment of bearings in Germany is regulated by a separate national technical approval or a single project based agreement.

The permissible combination of materials of the tribological systems (main sliding surfaces) adjacent to the convex plate (spherical or cylindrical element) consist of MSM® with stored silicone grease against

- austenitic steel for the flat sliding surface and
- austenitic steel, hard chrome or sliding alloy MSA® for the curved sliding surface.

MAURER MSM® spherical and cylindrical bearings are particularly suitable for soft structures with relatively large and frequent displacements caused by traffic, next for structures that employ fast sliding displacements of the bearings, like in bridges for high speed railways, as well as for regions of continuously low and/or high temperatures. Spherical and cylindrical parts made of sliding alloy MSA® are highly corrosion resistant.

The provisions made in this national technical approval are based on an assumed working life of the MAURER MSM® spherical and cylindrical bearing of 50 years in the absence of a specific verification in accordance with this approval. The assumed working life of the bearing is reduced to 10 years if composite material CM1 is used in guides.

2 Provisions fort he construction product

2.1 Properties and assembly

2.1.1 Materials

2.1.1.1 MSM®

MSM® is a sliding material made of UHMWPE (Ultra high molecular weight polyethylene). The list of components, the material characteristics as well as the tribological characteristics are with the supervising third party institute and the Deutsches Institut für Bautechnik.

In respect to the durability, long term sliding tests (see DIN EN 1337-2:2004-07, section D 6.2) were conducted with a total sliding distance of 50,000 m, a sliding velocity of 15 mm/s, and a contact pressure of 60 N/mm² , as well long term compression tests were conducted with a contact pressure of up to 200 N/mm². These tests showed that no remarkable wear and increase of the friction coefficients occurred, and the creep effect was greatly completed after 48 hours.

2.1.1.2 Composite material

As composite material for strips in guides CM1 in accordance with section 5.3.1 and 5.3.3 of DIN EN 1337-2:2004-07 shall be used.

2.1.1.3 Austenitic steel

Stainless steel with material number 1.4401 or 1.4404 in accordance with DIN EN 10088-4:2009-08 and finishing process 2B shall be used for austenitic steel sheets.

2.1.1.4 Hard chrome

Hard chromium-plated surfaces have to correspond to DIN EN 1337-2: 2004-07, section 5.5.

The hard chrome layer is not resistant to chlorine ions in an acid solution (e.g. in some industrial areas) and against fluorine ions and can, in the presence of solid particles in the air, be damaged in the course of time. In such cases, in addition to the measures in accordance with section 2.2.1.4, the hard chromium-plated surfaces shall be protected in a suitable manner.

2.1.1.5 Lubricant

Silicon grease in accordance with DIN EN 1337-2:2004-7, section 5.8 shall be used as lubricant for sliding surfaces .

2.1.1.6 Steel

For bearing components made of steel in accordance with sections 2.1.2.3 to 2.1.2.6, construction products in accordance with construction regulation list A part 1 shall be selected in accordance with their intended use and their welding suitability. If the load-bearing capacity of a bearing component shall be proven (cf. section 2.1.3.7), then DIN 18 800-1:2008-11, section 4.1 applies for the selection of the steel grade. For the use in bridges DIN Fachbericht 103:2009, section II-3 shall be applied. Particular railway regulations shall be considered for bearings in railway bridges, e. g. DBS 918002-02.

The tolerance of rectangularity and inclination for thermally cut steel plates shall comply with range 4 in accordance with section 7.2.2 of EN ISO 9013:2003, the average roughness depth with range 3 in accordance with section 7.2.3 of EN ISO 9013:2003 as well as the dimension tolerance with class 2 in accordance with section 8 of EN ISO 9013:2003. Hardness increase due to flame cutting shall be taken down before sand blasting. The hardness increase shall not show shining surfaces and the minimum roughness depth R_{y5i} shall be 40 µm.

2.1.1.7 Sliding alloy

Sliding alloy MSA® with special surface treatment may be used as an alternative to steel in accordance with section 2.1.1.6 for spherical and cylindrical elements in accordance with section 2.1.2.5. The list of components, the surface treatment procedure, the material characteristics as well as the tribological characteristics are with the supervising third party institute and the Deutsches Institut für Bautechnik.

As given in DIN EN 1337-2:2004-07 it is supposed, that the maximum accumulated sliding path in the curved surface is 20 % of the path in the flat sliding surface. Thus a design sliding path of 10 km is specified. In respect to the durability, long term sliding tests (see DIN EN 1337-2:2004-07, section D 6.2) were conducted with a total sliding distance of 10,000 m, a sliding velocity of 15 mm/s, and a contact pressure of 60 N/mm². These tests showed that no remarkable wear and increase of the friction coefficients occurred. The corrosion resistance has been verified in accordance with DIN EN 1337-9:1998-04.

2.1.1.8 Fasteners

Fasteners in accordance with DIN-Fachbericht 103:2009-03 as well as DIN 18800-7:2008-11 shall be used.

2.1.1.9 Adhesive for bonding austenitic steel sheets

The main function of the adhesive is to join austenitic steel sheets to the backing plate in such a way that shear is transmitted without relative movement.

The adhesive shall comply with DIN EN 1337-2:2004-07, section 5.9 and annex J.

2.1.2 Constructional design, dimensional limits, tolerances

2.1.2.1 MSM® - Elements

2.1.2.1.1 General

MSM® - Elements are circular or rectangular sheets in main sliding surfaces or rectangular stripes in guides.

With regard to facilitate an equal pressure distribution in the curved sliding surface, the following geometrical condition shall be observed:

$$\frac{R}{L_2} \geq 1{,}0 \text{ for spherical bearings and}$$

$$\frac{R}{a} \geq 0{,}82 \text{ for cylindrical bearings}$$

2.1.2.1.2 MSM® - Sheets

MSM® sheets may, in accordance with Annex 4, be composed of separately recessed sections. If so, a subdivision into maximally four sections in the flat sliding surface and two sections in the cylindrical curved sliding surface similar in form may be effected. In the spherical curved sliding surface, with L_2 > 1,200 mm, a subdivision into two concentric sections is permitted, of which the outer section may be subdivided once more into maximally four equal subsections butted together.

The small bar dimension B of the inner concentric section may not be less than 1,000 mm, and that of the other sections may not be less than 50 mm. The distance C between the chambers may not exceed 10 mm.

Dimples (lubricating pockets) shall be provided in the MSM® sheets, in accordance with Annex 4, for storing lubricant. For pressures due to permanent loads of less than 5 N/mm2, the dimples can be dispensed with.

The protrusion h and the thickness t of the MSM® sheet (see Annex 3) shall correspond to the following conditions:

$$h = 2{,}5 + \frac{L_{(1,2)}}{3000} \qquad [mm]$$

$$2{,}65\ h \le t \le 10 \qquad [mm]$$

The limiting conditions mentioned above may be replaced by those applicable for PTFE-sheets according to DIN EN 1337-2:2004-07, if the existing pressure in MSM® does not exceed the maximum permissible pressure of PTFE.

The tolerance range for h may be for $L_{(1,2)} \le 1{,}200$ mm ± 0.2 mm, for $L_{(1,2)} > 1{,}200$ mm the range is ± 0.3 mm. The aforementioned condition for h applies for an unloaded bearing provided with a protective coating against corrosion in the area of the measurement points, in accordance with section 2.2.1.7.

The tolerance range for t is $^{+0,3}_{-0,0}$ mm if $L_{(1,2)} \le 1200$ mm, and $^{+0,4}_{-0,0}$ mm if $L_{(1,2)} > 1200$ mm.

2.1.2.1.3 MSM® - Strips

MSM® - Strips in guides do not have any dimples, their width a must be at least 15 mm. For the protrusion h and for the thickness t, the following limiting dimensions have to be observed:

$$h = 3{,}0 \pm 0{,}2 \qquad [mm]$$

$$8 \le t \le 10 \qquad [mm]$$

The limiting conditions mentioned above may be replaced by those stipulated in DIN EN 1337-2:2004-07, if the maximum permissible pressure in PTFE guides are not exceeded.

For the modified shape factor S, the following condition has to be observed:

$$S = \frac{A_{MSM}}{u \cdot h} \cdot \frac{t - h}{h} > 4$$

Whereby:

A_{MSM} compressed (undeformed) surface, see Annex 4

u perimeter, see Annex 4

If necessary, several, individually recessed sheets shall be arranged according to the aforementioned principles.

2.1.2.2 Strips made of composite material

Strips made of composite material must be at least 10 mm wide.

2.1.2.3 Austenitic steel sheet

The contact surface shall be grinded and, if required, be polished.

After the surface treatment the average roughness depth R_{y5i} in accordance with EN ISO 4287:1998 shall not exceed 1 µm and the surface hardness shall be in the range of 150 HV1 to 220 HV1 in accordance with EN ISO 6507-2:2005.

Austenitic steel sheets which have been welded on or fully bonded must be at least 1.5 mm thick and those which have been mechanically fixed must be at least 2.5 mm thick.

2.1.2.4 Sliding plate

The thickness of the flat sliding plate in relation to the plate diagonal D_{LP} shall be at least 0.04 x D_{LP}, however, at least 10 mm.

The tolerance in relation to the flatness of the sliding plate, in accordance with DIN ISO 1101:2008-08 is 0.0003 x D_{LP}. Local unflatness in the region of the adjacent MSM®

sheet – referred to a measurement length of the dimension $L_{(1)}$ – shall not exceed 0.0003 x $L_{(1)}$ or 0.2 mm. The larger value is decisive.

The requirements mentioned above must be fulfilled for both sides of the sliding plate, if anchoring or shim plates or a steel superstructure is connected, otherwise this holds only on the side of the austenitic steel sheet. With reference to the dimension $L_{(1)}$, please refer to Annex 4.

2.1.2.5 Spherical and cylindrical element, concave backing plate

The upper edge of the recess for integrating a sheet or a strip made of MSM® shall be formed with sharp edges. The radius at the root of the recess shall not exceed 1 mm (cf. Annex 3).

The recess for the curved MSM® sheet may be arranged in the spherical as well as cylindrical element or in the concave backing plate.

The inside dimension of the recess shall be selected such that the MSM® element can be fitted in, as intended, without clearance – if necessary, following prior cooling. A gap which may possibly occur between the side of the recess and the MSM® element may only occur partially and at ambient temperature shall not exceed the values listed in table 1.

Table 1: Maximum gap width

Dimension L or B in mm	gap in mm
≤ 50	≤ 0,3
> 50 ≤ 600	≤ 0,6
> 600 ≤ 1.200	≤ 0,9
> 1.200 ≤ 1.500	≤ 1,2

L and B are the minimum dimensions of the individually recessed MSM®-element according to Annex 4.

The edge of the MSM® backing plate for the flat MSM® sheet is, if necessary, to be processed such that an edge of the backing plate of around 10 mm width and $3^{+0,1}_{-0,0}$ mm height remains (cf. Annex 3). If the edge is not wider than 15 mm at any point, then processing can be dispensed with.

The smallest thickness min t_p of the concave backing plate must be at least 10 mm (Annex 2).

The flat base of the recess and the underside of the concave backing plate of the bearing must likewise fulfil the requirements regarding flatness specified in section 2.1.2.4.

In the region of the curved sliding surface, for local deviations from the spherical or cylindrical shape of the sliding surface and the base of the recess, section 2.1.2.4 applies in the general sense. The quality of the osculation is additionally determined by the magnitude of the unintended deviation of the radii of the sphere from one another. For the purpose of limiting this deviation, the difference Δx from the measured depth gauges of the spherical or cylindrical sections of the spherical or cylindrical elements and the concave backing plate of the bearing, the following condition applies:

$\Delta x \leq 0{,}20$ mm and

$\Delta x \leq 0{,}0003 \cdot L_{(2)}$, the larger value is decisive

2.1.2.6 Guides, restraints

For guides, MSM® / austenitic steel or composite material / austenitic steel and for restraints as well as guide rings even steel / steel combinations are permitted as material combinations for the sliding surfaces.

Deviant from the requirements given in DIN EN 1337-2:2004-07, the sliding combination steel / steel in guides may be used under following conditions:

- rotation around the main axes of the contact surface not larger than 0,005 rad for flat and 0,01 rad for curved contact surfaces;
- Movements not larger than ±50 mm in the case of road bridges;
- Movement length (Distance from fixed to the guided bearing) not larger than 25 m in the case of railway bridges;
- Radius of curvature of the structure not less than 50 m.

The afore mentioned movement limiting values are valid for the design values for movements in accordance with DIN-Fachbericht 101:2009-03 or series of standards DIN 1055.

When using MSM® strips, these shall be completely recessed and bonded in the backing plate of the bearing or the key in the general sense in accordance with section 2.1.2.5, whereby the lining of the recess shall be around 10 mm wide on the narrow sides. On the longitudinal side, the width of the lining should not be less than 5 mm. For the inner dimension of the recess, respectively for the clearance between the edge of the recess and the MSM®-element, section 2.1.2.5 applies in the general sense.

The arithmetical edge pressure of the MSM® strip, which is produced by the nonparallelism on rotation around the horizontal axis, may not exceed 0.25 mm in relation to the width of the strip. When exceeding this limiting value under the characteristic combination of actions acc. to DIN EN 1990:2002-10 an additional rotation element (rocker strip) must be arranged (cf. Annex 1, pos. 7).

In case of using composite material, in order to accommodate the rotations around the vertical axis without strain, a guide ring made of steel has to be provided (Annex 5, pos. 6). The strip made of composite material shall be bonded to the guide ring, and additionally mechanically secured at least at the front side.

The contact surfaces of the material combinations steel / steel shall be designed such that a seizing up or jamming is prevented.

2.1.2.7 Tolerances

The permissible deviation of the total bearing height h_L is 3 % of the construction height but not less than 5 mm and not more than 10 mm.

Dimensions with no tolerance indication shall be executed with class "coarse" in accordance with DIN ISO 2768-1:1991-06.

The bearing clearance given in DIN EN 1337-1:2001-02, 7.1 shall be verified on the bearing in new condition.

2.1.3 Load-bearing capacity and stability

2.1.3.1 General

When verifying the stability of the bearing, all forces acting from the structure as well as the resistance to displacement and rotation of the bearing resulting from its movements shall be taken into account.

The design values for loads and movements of the structures shall be determined under consideration of Annex O of DIN-Fachbericht 101:2009-03 or DIN 1055-100:2001-03.

When verifying the ultimate and serviceability limit state of the bearing the design values in accordance with DIN-Fachbericht 101:2009-03 or the series of DIN 1055 as well as the resistance to displacement and rotation of the bearing due to movements shall be taken into account.

In the absence of regulations in DIN-Fachbericht 102:2009-03 or 103:2009-03, DIN 18800-1:2008-11 and DIN 1045:2008-08 as well as in this national technical approval the partial safety coefficients γ_m recommended in the standard series DIN EN 1337 shall be used.

For the intended absorption or reduction of external, horizontal forces, frictional resistance of sliding surfaces shall not be taken into account.

For the determination of movements (displacements, rotations) DIN EN 1337-1:2001-02 shall be applied. In so far as this affects the design of the bearing, the movements shall be increased according to section 5 of this standard.

2.1.3.2 Verification of the assumed working life

The assumed working life of structural bearings with sliding elements mainly depends on wear in the sliding surface due to movements combined with loads. The durability of the sliding material additionally depends on the sliding velocity and the effective bearing temperature. Thus the respective case of application influences the working life to be expected.

Structural bearings with sliding elements made of PTFE in accordance with DIN EN 1337-2:2004-07 shall show a minimum working life of 10 years according to table 2.1 of DIN EN 1990:2002-10 (category 2 of design working life).

The assumed working life shall be determined by means of data to be provided by the structural engineer using the following formulae:

$$AWL[\text{Years}] = \frac{c \cdot S_T}{S_{Ay,D}[\text{m}]}$$

$$S_{Ay,d} = n_V \times \Delta d_d + s_{Y,var}; \qquad S_{A,d} = S_{Ay,d} \times AWL$$

AWL	assumed working life
$S_{A,d}$	design value of the accumulated sliding path in the flat main sliding surface
$S_{Ay,d}$	design value of the yearly accumulated sliding path in the flat main sliding surface
n_v	number of vehicles per year
Δd_d	total sliding path of the single load cycle
c	($c \geq 1$) Correction coefficient for the difference between the slide path due to constant amplitude in tests and the slide path due to real movements with variable amplitude caused by the traffic
$s_{Y,var}$	accumulated movements per year due to variable actions other than traffic, e.g. temperature, wind etc..
S_T	accumulated slide path in test
$S_{T,PTFE}$	accumulated slide path according to table D.2 of DIN EN 1337-2:2004-07 ($S_{T,PTFE}$ = 10.000 m)
$S_{T,D1}$	accumulated slide path for MSM® in the initial type test in accordance with this national technical approval ($S_{T,D1}$ = 50.000 m)

In this respect Δd_d is determined using an appropriate single load spectrum.

The assumed working life of 50 years of MSM® Spherical and Cylindrical Bearings is based on the assumption of a maximum accumulated slide path of c x 50.000 m and a maximum average velocity of 15 mm/sec in the main sliding surface (for PTFE in accordance with DIN EN 1337-2:2004-07 c x 10.000 m and 2 mm/sec applies) and may be determined as follows:

$$AWL = AWL_{PTFE} \cdot \frac{S_{T,D1}}{S_{T,PTFE}} = 10 \cdot \frac{50.000}{10.000} = 50 \text{ Years}$$

2.1.3.3 Friction coefficients

For sliding elements combined with dimpled and lubricated MSM® sheets used in zones where the minimum effective bearing temperature doesn't fall below $T_{o,min}$, the coefficient of friction μ_{max} is determined as a function of the average pressure σ_p (MPa) in accordance with table 2.

In guides and restraints the friction coefficients μ_{max} given in table 3 hold independent from contact pressure.

Contact surfaces in guides with steel to steel contact shall be machined to a surface roughness $R_z \leq 6{,}3$ µm in accordance with DIN EN ISO 4288:1998-04.

Table 2: Coefficient of friction μ_{max} of dimpled and lubricated MSM® sheets

$T_{o,min}$	$S_{A,d} \leq$ c x 50.000 m
-35 °C	$0{,}020 \leq \mu_{max} = \frac{1{,}6}{15+\sigma_p} \leq 0{,}08$
-50 °C	$0{,}027 \leq \mu_{max} = \frac{2{,}8}{30+\sigma_p} \leq 0{,}08$
-5 °C	$0{,}015 \leq \mu_{max} = \frac{1{,}2}{15+\sigma_p} \leq 0{,}06$

Table 3: Coefficient of friction μ_{max} of MSM® in guides

$T_{o,min}$	$S_{A,d} \leq$ c x 10.000 m	$S_{A,d} \leq$ c x 2.000 m
Material combination MSM® / austenitic steel		
-35 °C	μ_{max} = 0,10	-
-50 °C	μ_{max} = 0,12	-
-5 °C	μ_{max} = 0,07	-
Material combination composite material / austenitic steel		
-35 °C	-	μ_{max} = 0,20
Material combination steel / steel in restraints and guide rings		
-50 °C	μ_{max} = 0,20	
Material combination steel / steel in guides		
-50 °C	μ_{max} = 1,00	

2.1.3.4 Eccentricities

When performing the structural analysis for MSM® sheets, the anchorage elements and the adjacent structural members, the eccentricities of the normal force N_{Sd}, which are caused by friction forces, the horizontal forces as well as the rotated state of the bearing have to be considered acc. to DIN EN 1337-7:2004-08, Annex A.

2.1.3.5 MSM® sheets (Main sliding surfaces)

Concerning minimum dimensions, see section 2.1.2.1.2.

Sheets made of MSM® shall be designed such that under the fundamental combination of actions acc. EN 1990:2002-10 the following condition is observed:

$$N_{sd} \leq \frac{f_k}{\gamma_m} \cdot A_r$$

Values for f_k and γ_m shall be taken from table 4.

Table 4: Characteristic values of contact pressure of sliding materials

Maximum effective bearing temperature $T_{o,max}$ [°C]		MSM®			Composite Material
		≤ 35	48	70	<48
Charakteristic contact pressure f_k [MPa]	Main sliding surface dead loads and variable loads	180	135	90	200
	Guides variable loads				
	Guides dead loads effects of temperature, shrinkage and creep	60	45	30	
Partial safety coefficient γ_m		1,4			

The characteristic contact pressure of MSM® depends on the maximum effective bearing temperature $T_{o,max}$. Values for $T_{o,max} \leq 35$ °C, $T_{o,max} = 48$ °C and $T_{o,max} = 70$ °C are given in table 4. For bearings with a maximum effective bearing temperature between 35°C and 70°C the characteristic contact pressure shall be determined by linear interpolation oft he afore mentioned values.

A_r stands for the reduced contact area of the sliding surface without subtracting the dimples. In the centre of gravity of this area the design value of the normal force N_{sd} acts with its total eccentricity e according to section 2.1.3.4. A_r shall be calculated on the base of the theory of plasticity as well as under the assumption of a rectangular stress block (see Annex A of DIN EN 1337-2:2004-07 and Annex B of DIN EN 1337-7:2004-08).

Under the characteristic combination of actions acc. to EN 1990:2002-10 it has to be shown that when considering the total eccentricity e, for the contact pressure holds $\sigma_p \geq 0$. Thereby it has to be assumed a linear elastic behaviour of the sliding material, with the backing plates to be stiff. This condition is observed for spherical bearings if

$$e \leq \frac{L}{8}.$$

2.1.3.6 Strips of MSM® or composite material (sliding surfaces in guides)

With reference to minimal dimensions, see section 2.1.2.1.3 and 2.1.2.2.

The strips have to be designed such that under the fundamental combination of actions acc. to EN 1990:2002-10, the following condition is observed:

$$V_{Sd} \leq \frac{f_k}{\gamma_m} \cdot A$$

Values for f_k and γ_m shall be taken from table 4.

For the determination of the contact pressure the forces that act perpendicular to the sliding surface can be considered to act centrally (average pressure).

2.1.3.7 Austenitic steel sheet

Length and width of the austenitic steel sheet are a function of the design sliding path resulting from the total movements under the fundamental combination of actions acc. to EN 1990:2002-10 (see section 2.1.3.1).

2.1.3.8 Stability of bearing components made of steel

The stability of steel components is, as far as is necessary, to be verified in each individual case in accordance with DIN Fachbericht 103:2009-03 or DIN 18 800-1:2008-11.

2.1.3.9 Sliding plate and lower bearing part (backing plates)

The sliding plates are designed in a sufficient way, if in the serviceability limit state a functional sliding clearance and a sufficiently constant distribution of the MSM® contact pressure is ensured. This is the case, when under the characteristic combination of actions acc. to EN 1990:2002-10 the sum of maximum relative deformations Δw of the sliding plate or the lower part of the bearing referred to the dimension $L_{(1,2)}$ of the MSM® sheet is not larger than

$$\Delta w \le h\left(0{,}45 - k'\sqrt{h/L}\right) \quad \text{with} \quad 0 \le k' \le 1 \quad \text{and} \quad k' = 0{,}022\,(\sigma_{MSM}[\text{MPa}] - 45)$$

where σ_{MSM} is the average pressure in the sliding surface under the characteristic combination of actions and k' is a sliding material dependent stiffness coefficient.

It must also be verified that the associated stress due to bending does not exceed the elastic limit.

If the bearing plate serves the function of transferring internal forces from guides, then stability in accordance with section 2.1.3.8 also has to be demonstrated.

The mechanical model for verification the relative deformation and the associated bending stress shall include the effects of all the bearing components which have a significant influence on these deformations including the adjacent structural members and their short and long-term elastic properties. In this model the following assumptions shall be made:

- central load
- Notional design modulus of elasticity of the sliding material MSM®: 900 MPa
- The total thickness t_{MSM} of MSM® sheets
- Notional design Poisson's ratio of MSM® = 0,44
- in the case of adjacent structural members of massive construction: linear reduction of the elastic modulus of concrete or mortar from the edge to the centre of the backing plate by 20%.

The convex plate (spherical or cylindrical element) can be supposed as a rigid body.

If needed – for example, in the case of large sliding plates not supported in the construction state – the deformation component resulting from the not yet cured concrete stress shall also be taken into account.

Instead of a precise calculation, the maximum relative deformation Δw may be calculated in using the following approximative equation:

$$\Delta w = 0{,}55 \cdot \frac{1}{L_{(1,2)}} \cdot \kappa_b \cdot \alpha_b \cdot \kappa_p \cdot \alpha_p$$

with the factors

$\kappa_b = 1{,}1 + (1{,}7 - 0{,}85 \cdot L_p/L_{(1,2)})\,(2 - L_p/L_o)$ wenn $L_o \le L_p \le 2\,L_o$

$\kappa_b = 1{,}1$ wenn $L_p > 2\,L_o$

$$\alpha_b = \frac{N_G}{E_{b,red}} + \frac{N_Q}{E_b}$$

$$\kappa_p = 0{,}30 + 0{,}55 \cdot L_p/L_{(1,2)}$$

$$\alpha_p = \left(\frac{L_{(1,2)}}{L_{(1,2)} + 2 \cdot t_p} \right)^2 \cdot \left(\frac{3L_o}{L_p} \right)^{0,4}$$

The abbreviations stand for

L_o reference diameter = 300 mm

L_p diameter of the backing plate

$L_{(1,2)}$ dimension of the MSM® sheet according to Annex 4

t_p thickness of the backing plate respectively the lower part of the bearing

the concave bearing plate (lower part of the bearing) may be arithmetically replaced by a plate with a constant thickness $t_p = mint_p + 0,6\ (maxt_p - mint_p)$.

N_G normal force due to permanent actions with creep effects

N_Q normal force due to variable actions

E_b modulus of elasticity of concrete

$E_{b,red}$ reduced modulus of elasticity of concrete for determining the creep caused by N_G ($E_{b,red} \cong 1/3\ E_b$)

This approximative solution applies for bearing plates which are connected with components made of concrete belonging to the strength class C 20/25 or higher, whereby additional proofs of stresses are unnecessary if at least concrete and steel belonging to the strength classes C 25/30 and S355 are used. If materials with a lower strength are used, the proof of stresses in the bearing plates can only be omitted when the relative deformation Δw does not exceed the following limiting values:

$0,90 \cdot h\ (0,45 - 2 \cdot \sqrt{h/L_{(1,2)}})$ when using concrete belonging to the strength class C 20/25,

$0,67 \cdot h\ (0,45 - 2 \cdot \sqrt{h/L_{(1,2)}})$ when using steel belonging to the strength class S235,

$0,60 \cdot h\ (0,45 - 2 \cdot \sqrt{h/L_{(1,2)}})$ when using both concrete C 20/25 and steel S235.

For bearing plates with locally reduced sections and for those that serve to transmit section forces from guides, the stresses are, however, to be calculated for verification of the elastic condition or the stability (see above).

The preceding approximative solution may also be used for rectangular sliding plates with the sides $a \leq b$, if they are idealised to circular plates with a diameter $L_p = 1,13 \cdot a$.

2.1.3.10 Restraints

If, in the case of fixed bearings, the horizontal forces are adopted by ring-shaped restraints, then the distribution of the contact pressure can be assumed to be parabolic over half the circumference. For the calculation of the contact areas DIN EN 1337 5:2005-07, Section 6.2.3 applies.

2.2 Manufacturing, packing, transport, storage and labelling

2.2.1 Manufacturing

2.2.1.1 Suitability of the factory

The parts of the bearing made of steel may only be welded in factories that possess a manufacturer qualification for construction components of class D in accordance with DIN 18 800-7:2008-11.

2.2.1.2 Fixing of the austenitic steel sheet

The austenitic steel sheet is to be connected with the sliding plate by welding, using a continuous weld, by full surface bonding or by mechanical fasteners. Curved sheets may also be peripheral recessed with a recess depth of half the thickness of the sheet. By

taking appropriate measures, it should be ensured that the austenitic steel sheet tightly contacts over the whole area of the sliding plate (avoiding the inclusion of air). The regulations for connection manners given in DIN EN 1337-2:2004-02, section 7.2 shall be considered.

2.2.1.3 Lubrication

The sliding surfaces of MSM® elements are to be cleaned immediately prior to assembly of the bearing and are to be provided with lubricant, in accordance with section 2.1.1.5. MSM® sheets shall be lubricated in such a manner that the lubricant dimples are filled. MSM® strips in the guides shall receive an initial lubrication, by rubbing the sliding surfaces with lubricant and removing the excess lubricant.

2.2.1.4 Protection against corrosion and contamination

All parts made of not corrosion resistant materials shall be protected. Requirements for the corrosion protection are given in DIN EN 1337-9:1998-04. If different materials are combined, the effect of electrolytic corrosion shall be considered. The recess surfaces of the MSM® backing plate shall only be provided with the basic coating (coating thickness 20 to 100 µm). Spherical or cylindrical elements made of MSA® do not need an additional corrosion protection. In the case of bolted austenitic steel sheets, the surface of the sliding plate contacting the austenitic steel sheet is also to be protected against corrosion, using appropriate measures.

For corrosion protection and coating materials the respective actual version of ZTV-ING, part 4 applies.

Depending on the kind of contact surface the following corrosion protection coatings are required:

- Contact surface steel - concrete

  The contact surface shall not be coated. The 5 cm to 7 cm wide margin of the steel surface is provided with the full corrosion protection coating.

- Contact surface steel - steel

  In case of slip resistant connections the contact surface between bearing plates made of steel shall be protected by an at least 40 µm thick layer of slip resistant coating. If the contact surface is fully coated, horizontal forces cannot be transmitted due to friction (see section 5.2 of DIN EN 1337-1:2001-02).

The sliding surfaces shall not receive a coating.

On assembly, attention should be paid that no dust and no foreign particles reach the sliding surfaces. They are to be protected in a suitable manner against contamination. The sliding surface protection must be easily separable for the purpose of inspection.

2.2.1.5 Connecting the components of the bearing

For the assessment of irregularity of welding class B in accordance with DIN EN ISO 5817:2006-10 applies. The welding suitability of the used materials shall be proven.

Welding seams not loaded after activation of the bearing welding class C in accordance with DIN EN ISO 5817:2006-10 applies.

In case of bolted connections with small clearance (see DIN 18800-7:2008-11) it may happen, that the bolt cannot be fully inserted in the bolt hole due to the rounded transition from the screw to the bolt head. This shall be avoided e.g. using washers.

At the prestressing side of bolts in either case washers shall be used.

2.2.1.6 Presetting

A presetting depending on the specific structure and the installation temperature ensures the extensively regular starting position after the construction phase.

With reference to modifications to the presetting at the construction site, DIN EN 1337-11:1998-04, Section 6.1 applies.

2.2.1.7 Measuring points

For the adjustment of the bearing in accordance with DIN EN 1337-11:1998 a measuring surface or an equivalent device shall be arranged on the sliding element.

The deviation from parallelism of the measuring surface and the flat sliding surface shall not exceed 1 ‰.

After installation and completion of the superstructure the sliding element shall not deviate more than 3 ‰ from the regular position in accordance with section 6.5 of DIN EN 1337-11:1998.

2.2.2 Packaging, transport, storage

The stipulations according to DIN EN 1337-1:2001-02, section 7.4 and DIN EN 1337-11:1998-04 apply.

2.2.3 Labelling

The bearing must be labelled by the manufacturer with the conformity mark (Ü mark) in accordance with the conformity mark ordinances of the federal states. The mark may only be applied when the prerequisites, in accordance with section 2.3, concerning the attestation of conformity are fulfilled.

The bearing is additionally to be provided, in accordance with DIN EN 1337-1:2001-02, with a marking label made of plastic which, if applicable, is to be fixed in position on the side of the movement indicator.

2.3 Conformity evaluation

2.3.1 General

The attestation of conformity of the bearing with the regulations of this national technical approval must be implemented for each production facility with a conformity certificate on the basis of factory production control, and regular third party control, including the initial type testing of the bearing according to the following stipulations.

For the granting of a conformity certificate and for third party control, including the product tests to be carried out in this connection, the manufacturer of the bearing is required to call in an approved certification body, as well as a third party approved for the purpose of control.

The manufacturer by marking the bearing with the conformity label (Ü mark) with reference to the intended use shall give the declaration of granting of the conformity certificate.

The certification body is required to give the German Institute for Civil Engineering a copy of the conformity certificate granted by it, for information.

In addition, the German Institute for Civil Engineering shall be given a copy of the initial inspection report for information.

2.3.2 Factory production control

In each production facility, a factory production control is to be set up and implemented. Factory production control refers to the continuous surveillance of production carried out by the manufacturer by which means it is ensured that the construction products produced by it fulfil the regulations of this national technical approval.

The factory production control should at least include the measures listed below:

- Description and examination of the basic material and the components:

  For each delivery of material, it has to be checked by means of test certificates according section 2.4 that the material corresponds to the stipulations made in section 2.1 as well as to the respective standards, and to the material characteristics that are deposited at the Deutsches Institut für Bautechnik and the third party control body. In addition, the dimensional tolerance of each MSM® element has to be verified according section 2.1.2.1.2. at the hand of the sticker

(see section 2.4.2). Further, at each component made of steel, the tolerances have to be verified according sections 2.1.2.4 and 2.1.2.5 and for MSA® the confidentially deposited surface properties shall be verified.

The ferroxyl test at hard chromium plated surfaces has to be conducted for each delivery once, at one component. For each component it has to be verified that the remaining requirements and the geometrical requirements comply to section 2.1.2.5.

- Proofs and tests that have to be conducted at the completed construction product:

  For each manufactured bearing it has to be verified conformity of the bearing with the requirements of this national technical approval and the contents in the execution drawings. In particular the requirements in respect to the parallellity of the sliding surfaces and the clearance have to be observed.

The results of the factory production control are to be recorded and evaluated. The records must at least contain the following details:

- designation of the construction product or the raw material and the components
- the type of control and testing
- date of production and the testing of the construction product or the raw material or the components
- the results of the controls and tests and, if applicable, a comparison with the requirements
- signature of the person responsible for factory production control.

The records must be kept in safe keeping for at least 5 years and are to be presented to the responsible body for third party control. They are to be presented on request to the German Institute for Civil Engineering and to the Federal States Building Supervisory Board.

In the event of inadequate test results, the necessary measures needed for elimination of the defect shall be immediately taken. Construction products which do not fulfil the stipulations shall be handled in such a manner that confusions with conforming products is excluded. After elimination of the defects, provided that this is technically possible and is necessary for demonstrating the elimination of the defect, the relevant tests shall be repeated.

2.3.3 Third party control

In the case of continuous production, in each production facility for the bearing, the factory production control is to be monitored on a regular basis by a third party control body, at least four times a year. In the case of non-continuous production, the third party control is to be carried out following notification of the manufacturer.

Within the framework of the third party control, an initial inspection of the bearing shall be carried out, samples shall be taken and to check. Samples for the purpose of random sample tests may also be taken. The sampling and tests are the duty, in each case, of the authorised body.

The initial inspection shall consider all tests and controls as per Section 2.3.2.

The results of certification and third party control are to be kept in safe keeping for at least five years. They are to be presented on request by the certification authority or the monitoring authority, respectively, to the German Institute for Civil Engineering.

If the provisions of this national technical approval and/or the specifications of the control plan deposited at the Deutsche Institut für Bautechnik are not any longer fulfilled, the certification body shall withdraw the conformity certificate and immediately inform the Deutsche Institut für Bautechnik.

2.4 Testing certificates

2.4.1 General

The conformity of the properties of the components and materials used for the production of the bearings with the specifications of this national technical approval shall be demonstrated by test certificates, in accordance with EN 10204:2005-01 corresponding with the conditions below. In so far as acceptance test certificates 3.2, in accordance with DIN EN 10204:2005-01, are intended, these must be issued by a recognised testing authority, in accordance with section 2.3.1.

2.4.2 MSM® elements

The following material properties – per each lot (max. 500 kg) – shall be attested with test certificate 3.2:

- density at 3 samples, test in accordance with DIN EN ISO 1183-1:2004-05, DIN EN ISO 1183-2:2004-10; DIN EN ISO 1183-3:2000-05,
- Young's modulus (23±2°C) at 5 samples, test in accordance with DIN EN ISO 527-1:1996 04 and DIN EN ISO 527-3:2003-07,
- yield strength (23±2°C) at 5 samples, test in accordance with DIN EN ISO 527-1:1996-04 and DIN EN ISO 527-3:2003-07
- tensile strength (23±2°C) at 5 samples, test in accordance with DIN EN ISO 527-1:1996-04 and DIN EN ISO 527-3:2003-07
- elongation at break (23±2°C) at 5 samples, test in accordance with DIN EN ISO 527-1:1996-04 and DIN EN ISO 527-3:2003-07
- ball hardness (60 sec, totally 10 imprints at least at 3 samples), test in accordance with DIN EN ISO 2039-1:2003-06
- friction coefficients from phase 1 of the program for sliding friction tests acc. DIN EN 1337-2:2004-07, Annex D, Table D.2 and D.3. The sliding friction test has to be conducted using hard chrome (R_{zDIN} app. 3 µm) as mating partner and "constant"**) lubricant according to section 2.1.1.5.
- Melting temperature and enthalpy at 1 sample, test in accordance with DIN EN ISO 11357:1997-11

In addition to the tests to be recorded with test certificates, the dispatching party shall verify the dimensions at ambient temperature of each element according to the specifications of the bearing manufacturer and section 2.1.2.1. The test results L, B, t and Δt shall be recorded on a sticker.

2.4.3 Composite material CM1

With certificate 3.2 shall be attested:

Per each coil

- Adhesion of the surface layer in respect to the requirements acc. 2.1.1.2.
- Friction coefficients, evaluation acc. DIN EN 1337-2:2004-07, 4.2.1 by means of short term sliding friction tests
- The sliding friction test may be limited to the low temperature program test type E according to DIN EN 1337-2:2004-07, Table D.1. The test shall be conducted with austenitic steel acc. section 2.1.1.3, and with a one-time lubrication made of "constant"** lubricant acc. section 2.1.1.5.

With certificate 3.1 shall be attested:

Per each coil

- material characteristic acc. section 2.1.1.2 except the adhesion.

2.4.4 Austenitic steel sheets

With certificate 3.1 acc. DIN EN 10204:2005-01 shall be attested:

Per each coil

- The results of the tests according to DIN EN 10088-4:2009-08.

2.4.5 Lubricant

With certificate 3.2 acc. DIN EN 10204:2005-01 shall be attested:

Per each lot (500 kg)

- IR-spectre to verify that the lubricant is in conformity to the lubricant that was used for the initial test of the sliding bearing.
- Friction coefficients according DIN EN 1337-2:2004-07, 5.8.3, determined by means of short term sliding friction tests. Mating partners to be used are "constant" PTFE or "constant" MSM® (sheets with impressed dimples) against hard chrome (R_{zDIN} app. 3 µm).

With certificate 3.1 acc. DIN EN 10204:2005-01 shall be attested:

Per each lot (app. 500 kg)

- Material characteristics acc. DIN EN 1337-2:2004-07, 5.8.2, Table 8.

2.4.6 Steel products

With certificate 3.1 acc. DIN EN 10204:2005-01 shall be attested:

- The results of the tests according to the appropriate technical specifications.

2.4.7 MSA®

The test results in accordance with the control plan deposited at the Deutsche Institut für Bautechnik shall be attested with certificate 3.1 acc. DIN EN 10204:2005-01.

3 Provisions for layout and design of the structure

3.1 Layout

The information required for the issue of the bearing installation drawing in accordance with section 4 of DIN EN 1337-11:1998-04 and the bearing plan in accordance with DIN EN 1337-1:2001-02 shall be taken from the drawings of the bearings.

3.2 Design

DIN-Fachbericht 101:2009-03 shall be considered for the design.

Anchoring and fastening elements shall be designed taking into account the actions and the resulting reaction forces relevant for the design of the bearings.

The load introduction area shall be designed and, if required, be reinforced, in the case of concrete structures, using fissure tension reinforcement or, in the case of steel structures, by means of metal bracing plates. Under the condition that a bigger load distribution angle cannot be justified in consideration of the characteristics of the adjacent components, materials, and structural members, the area to be assumed for the calculation of the partial area compression and that results due to load distribution within the bearing plates can be determined by an angle of a maximum of 45°.

Strains produced by resistance of the bearing, due to displacement and rotation are to be traced further into the adjacent structural members.

For the determination of the range of application, the effective bearing temperature in accordance with the standard series DIN EN 1337 shall be taken as the minimum and maximum air temperature in accordance with chapter V, section 6.3.1.3 of DIN-Fachbericht 101:2009-03. In the absence of a more precise determination in accordance with chapter V, section 6.3.1.3.2 of DIN-Fachbericht 101:2009-03 the minimum and

maximum effective bearing temperature may be assumed to be -24 °C and +37 °C respectively.

The bearing clearance given in DIN EN 1337-1:2001-02, 7.1 shall be verified on the complete bearing in new condition.

The stability of structural elements made of steel shall be verified in accordance with DIN-Fachbericht 103:2009-03.

3.3 Flatness

The surfaces of the adjacent structural elements must fulfil the requirements specified in section 2.1.2.4 concerning the flatness of the sliding plate. If necessary, compensatory layers, e.g. mortar must be laid between the bearing and the adjacent structural elements.

4 Regulations regarding the execution (installation)

4.1 Documents

On the delivery of the bearings to the construction site, in addition to the notice of approval the installation guidelines of the bearing manufacturer, the bearing plan in accordance with DIN 1337-1:2001-02, section 8 and the bearing installation drawing in accordance with DIN EN 1337-11:1998-04, section 4 shall be available.

4.2 Installation oft he bearing

On mounting the bearing, the stipulations of DIN EN 1337-11:1998-04, section 6 shall be observed.

The mounting of at least the first bearing of its kind in a structure must be supervised by a specialist of the manufacturer of the bearing. Additional regulations for road bridges are given in ZTV-ING, section 4 and for railway bridges in DB-Richtlinie 804.

The bearing shall be adjusted horizontally on the measuring surface acc. section 2.2.1.7 in accordance with the bearing installation drawing, using a measuring device with a precision of at least 0.6 ‰.

The deviation of regular inclination shall not exceed 3 ‰ after setting the mortar joints.

4.3 Mortar joints

The strength of the joint mortar shall at least correspond to that of concrete of the adjacent structure or the stability requirements respectively. Further, DIN EN 1337-11:1998-04, section 6.6 applies.

4.4 Records

The records, in accordance with DIN EN 1337-11:1998-04, section 7, are to be kept in the construction files.

5 Provisions regarding use, upkeep and maintenance

Controls are to be carried out on a regular basis in accordance with DIN EN 1337-10:2003-11 on the bearings of the finished structure during use, in particular the sliding clearance between the austenitic steel sheet or the lining and the MSM® backing plate, its evenness over the extent of the MSM® sheet (as far as possible), the condition of the exposed areas of sliding surfaces for accommodating vertical and horizontal loads (e.g. unevenness in the austenitic steel sheet, defects in fixing, damage due to corrosion, etc.) and the displacement as well as the rotation position are to be checked and recorded. The air temperature measured during the control is likewise to be documented.

In the case of a sliding clearance > 1 mm, the bearing shall be considered as being functional with regard to its displacement ant rotational capability in the longer term. In the case of narrower clearances, more frequent controls shall be undertaken. The same applies in relation to the camber in the austenitic steel sheet area in the order of more than 1 mm.

If contact between the steel MSM® backing plate and the mating surface is established, the bearing is considered to be non-functional.

Dr.-Ing. Kathage

Certified

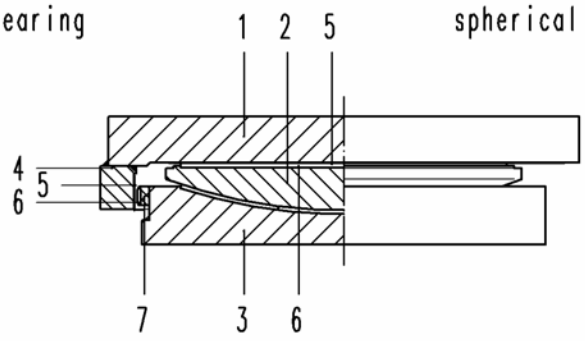
Ines Hoppe

MAURER MSM®-spherical and cylindrical bearings

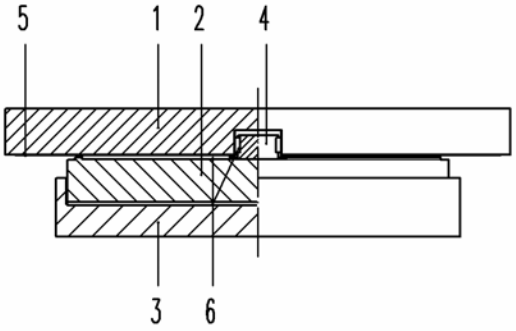
(Examples, displayed, if required, including guides)

unidirectional movable
spherical bearing

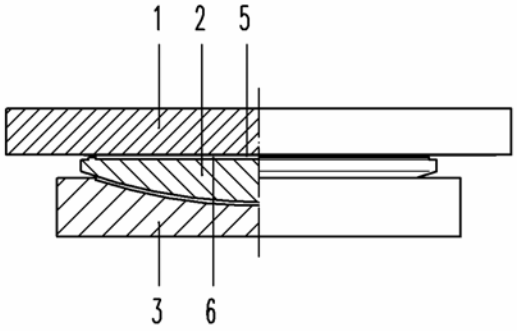
multidirectional movable
spherical bearing



unidirectional movable
cylindrical bearing
(longitudinal cross section)



multidirectional movable
cylindrical bearing
(transversal cross section)



1 Sliding plate
2 Spherical/Cylindrical part (convex plate)
3 Bottom plate (concave backing plate)
4 Guiding key
5 Austenitic steel sheet
6 MSM®- sheet or strip
7 Rocker strip

Applicant	Content of drawing	Annex 1
MAURER SÖHNE Frankfurter Ring 193 80807 München/Germany phone +49 89/32394-0 fax +49 89/32394-329	MAURER MSM®-spherical and cylindrical bearings (cross view and section)	to the National Technical Approval No. Z-16.4-436 of December 15, 2009 Deutsches Institut für Bautechnik

MAURER MSM®-spherical and cylindrical bearings (Pos. acc. annex)

Permissible variants of sliding surfaces

Fig.1

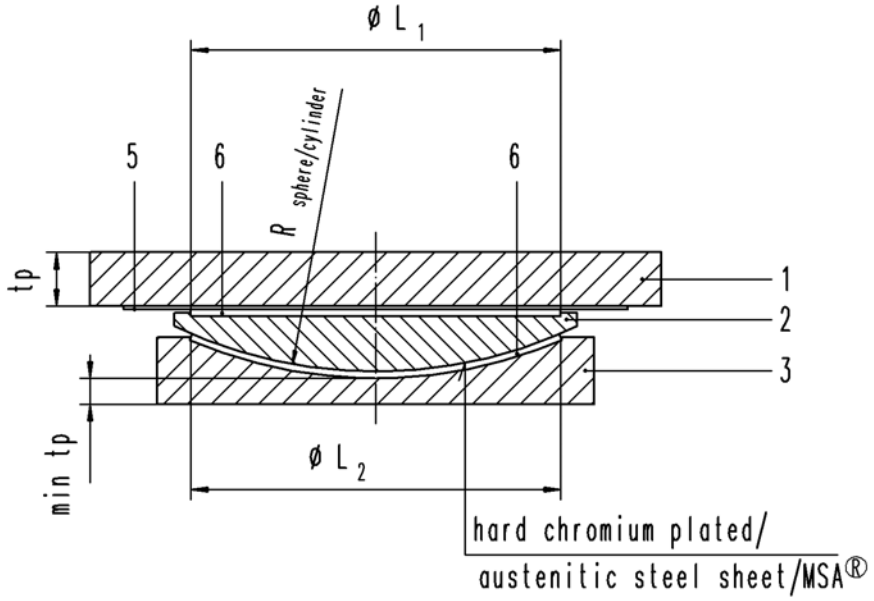
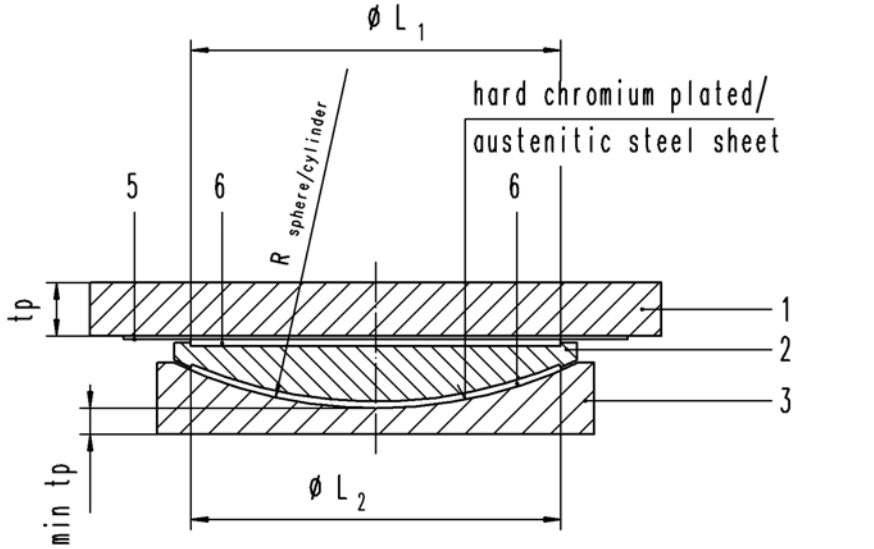


Fig.2



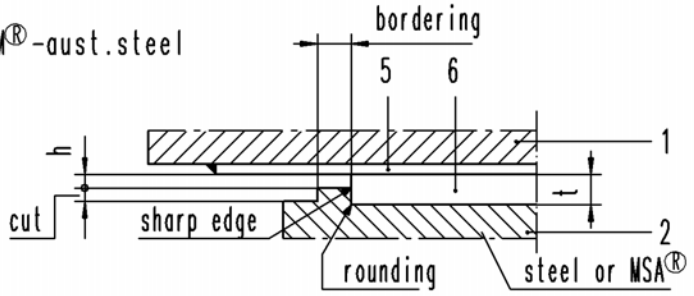
Applicant	Content of drawing	Annex 2
MAURER SÖHNE Frankfurter Ring 193 80807 München/Germany phone +49 89/32394-0 fax +49 89/32394-329	MAURER MSM®-spherical and cylindrical bearings (variants of sliding surfaces)	to the National Technical Approval No. Z-16.4-436 of December 15, 2009 Deutsches Institut für Bautechnik

Cross section of the sliding surfaces (Pos. acc. annex)

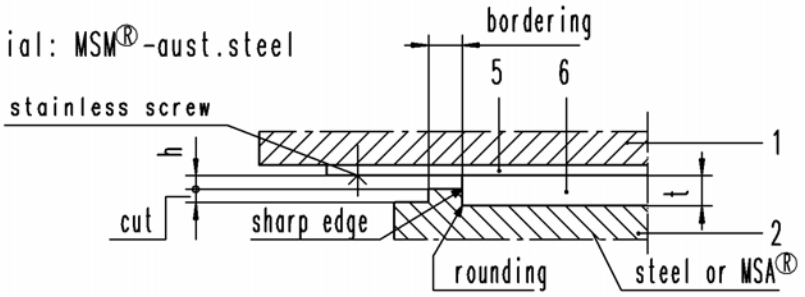
(h = clearance, t = MSM® thickness)

Flat sliding surface

Combination of material: MSM®-aust.steel
(continuously welded around)

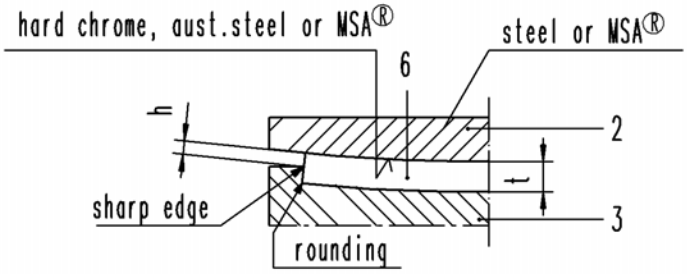


Combination of material: MSM®-aust.steel
(bolted)

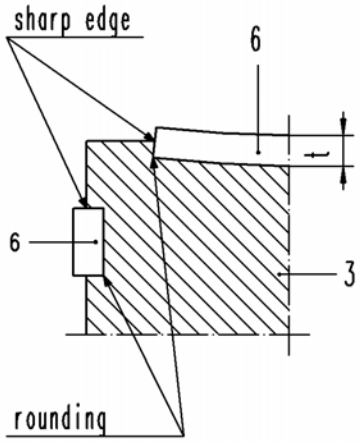


Curved sliding surface

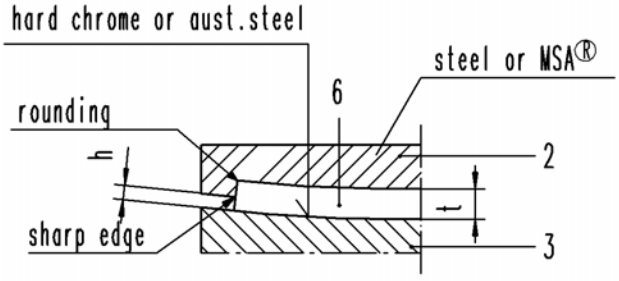
Combination of material: MSM®-hard chrome, aust.steel or MSA®



MSM®-Recess



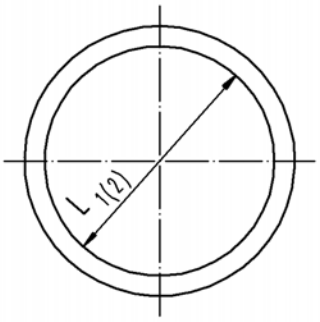
Combination of material: MSM®-hard chrome



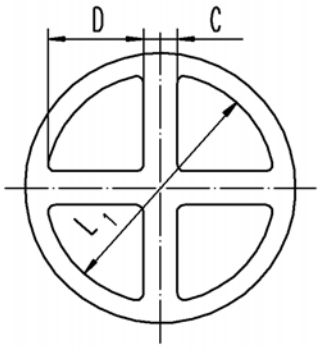
Applicant	Content of drawing	
MAURER SÖHNE Frankfurter Ring 193 80807 München/Germany phone +49 89/32394-0 fax +49 89/32394-329	MAURER MSM®-spherical and cylindrical bearings (cross sections of the sliding surfaces)	Annex 3 to the National Technical Approval No. Z-16.4-436 of December 15, 2009 Deutsches Institut für Bautechnik

Design of the MSM®-surfaces (Examples, Dimensions in mm)

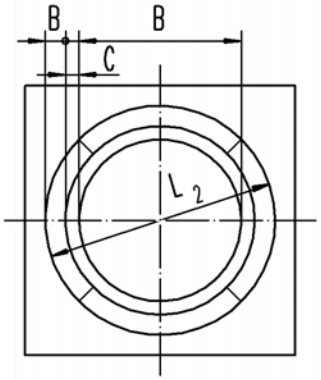
Flat and spherical sliding surface



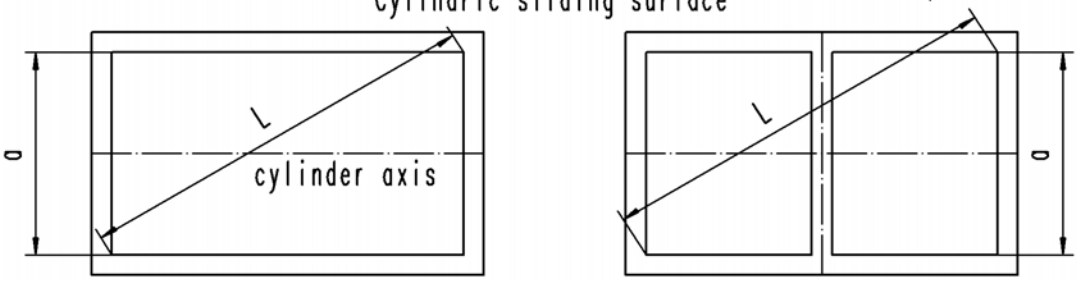
Flat sliding surface



Spherical sliding surface



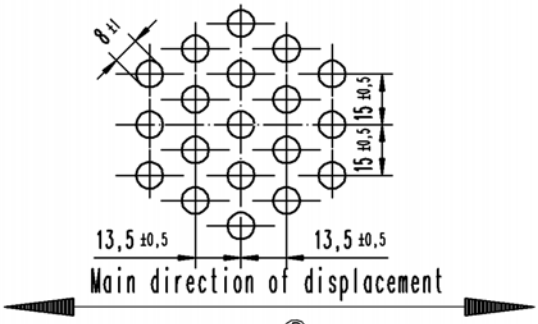
Cylindric sliding surface



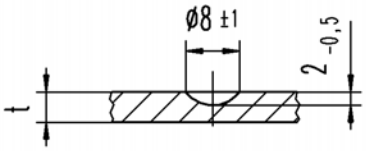
Storing of the lubricant in accordance with the sketches below

Design of the dimples

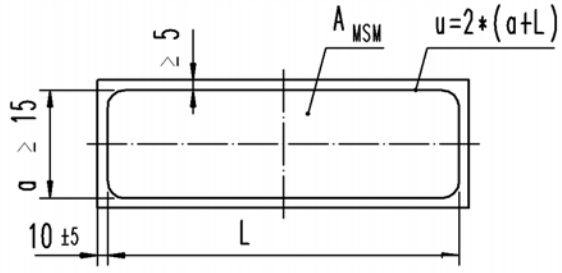
Top view on the dimples (Dimensions in mm)

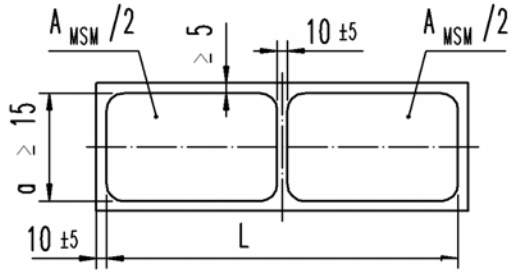


Cross section of a dimple



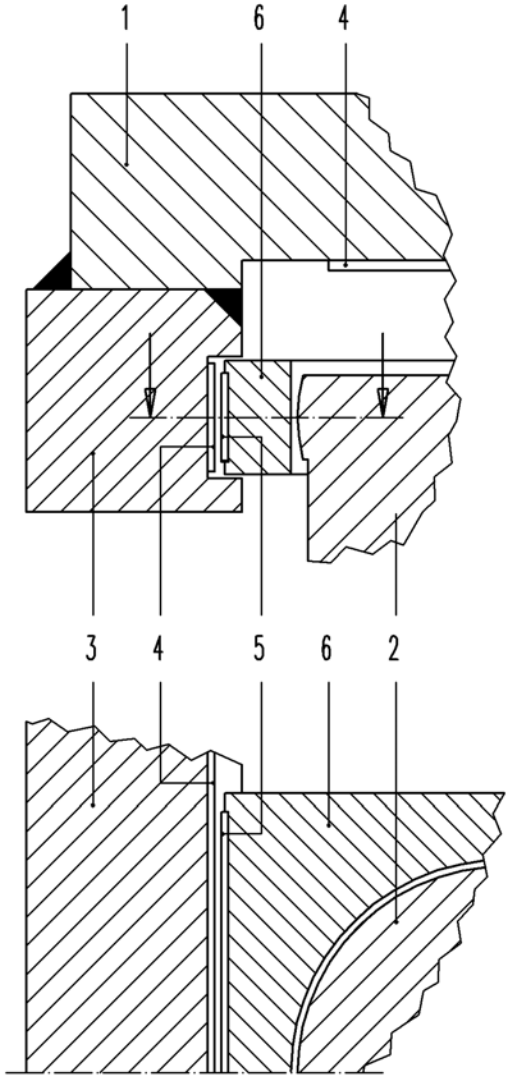
Design of MSM®-strips





Applicant	Content of drawing	Annex 4
MAURER SÖHNE Frankfurter Ring 193 80807 München/Germany phone +49 89/32394-0 fax +49 89/32394-329	MAURER MSM®-spherical and cylindrical bearings (design of the MSM®-elements and design of dimples)	to the National Technical Approval No. Z-16.4-436 of December 15, 2009 Deutsches Institut für Bautechnik

Cross section of the guide with strips made of composite material



1 Sliding plate
2 Bottom plate
3 Guiding key
4 Austenitic steel sheet
5 Composite material, alternatively MSM®
6 Guide ring

Applicant
MAURER SÖHNE
Frankfurter Ring 193
80807 München/Germany
phone +49 89/32394-0
fax +49 89/32394-329

Content of drawing
MAURER MSM®-spherical and cylindrical bearings (cross sections of the guide with strips made of composite material, alternatively-MSM®)

Annex 5
to the National Technical Approval
No. Z-16.4-436 of December 15, 2009
Deutsches Institut für Bautechnik

Maurer Söhne head office
Frankfurter Ring 193, 80807 Munich/Germany
P.O. Box 44 01 45, 80750 Munich/Germany
phone: +49 89 32394-0
fax: +49 89 32394-306
ba@maurer-soehne.de
www.maurer-soehne.com

Maurer Söhne branch office
Zum Holzplatz 2, 44536 Lünen/Germany
P.O. Box 63 40, 44520 Lünen/Germany
phone: +49 231 43401-0
fax: +49 231 43401-11
info@nd.maurer-soehne.de

Maurer Söhne subsidiary
Kamenzer Str. 53, 02994 Bernsdorf/Germany
P.O. Box 55, 02992 Bernsdorf/Germany
phone: +49 35723 237-0
fax: +49 35723 237-20
info@bd.maurer-soehne.de