



# Spherical Plain Bearing

**THK** General Catalog

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## Features of the Spherical Plain Bearing

### Structure and Features

Spherical Bearings models SB and SA1 are self-aligning plain bearings designed for heavy loads. The inner and outer rings of these models use high-carbon chromium bearing steel that is hardened and ground, are treated with phosphate coating, which is highly resistant to corrosion and wear, and seized with molybdenum disulfide ( $\text{MoS}_2$ ).

The Spherical Plain Bearing is capable of receiving a large radial load and thrust loads in both directions. Furthermore, because of its high resistance to impact loads, the Spherical Plain Bearing is optimal for low speed, heavy load rocking components such as the cylinder clevises or hinges of construction and civil-engineering machinery and the suspensions of trucks.

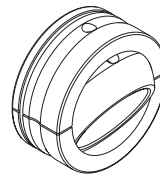
## Types of the Spherical Plain Bearing

### Types and Features

#### Model SB

The most popular type of Spherical Plain Bearing in Japan, model SB has wide spherical contact areas and is used as a bearing for heavy loads. The outer ring is split at two points, enabling the inner ring to be accommodated.

Specification Table⇒B-828

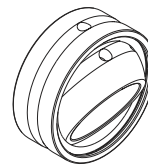


Model SB

#### Model SA1

This type of Spherical Plain Bearing is widely used in Europe. The outer ring is split at one point (outer rings with diameter of  $\phi 100$  or thicker are split at two points), and the width and thickness are smaller than model SB. Thus, this model can be used in small spaces. Types attached with highly dust-preventive dust seals on both ends (model SA1···UU) are also available.

Specification Table⇒B-830



Model SA1

## Selecting a Spherical Plain Bearing

When selecting a Spherical Plain Bearing, follow the instructions below while referring to the basic dynamic load rating (C) and the basic static load rating (C<sub>0</sub>) indicated in the corresponding specification table, as a measuring stick.

### [Spherical Plain Bearing Service Life G]

The basic dynamic load rating (C) is used to calculate the service life when the bearing oscillates under a load.

The basic dynamic load rating is calculated based on the contact surface pressure of the spherical sliding section.

The Spherical Plain Bearing service life G is expressed in the total number of rocking motions until it becomes impossible for the bearing to perform normal operation due to the increase in the radial clearance or in the temperature of the bearing as a result of wear on the spherical sliding section.

Since the bearing service life is affected by various factors such as the material of the bearing, magnitude and direction of the load, lubrication conditions and sliding speed, the calculated value can be used as an empirical, practical value.

$$G = b_1 \cdot b_2 \cdot b_3 \cdot b_4 \cdot b_5 \cdot \frac{3}{Da \cdot \beta} \cdot \frac{C}{P} \times 10^8$$

G : Bearing service life  
(total number of rocking motions or total number of revolutions)

C : Basic dynamic load rating (N)

P : Equivalent radial load (N)

b<sub>1</sub> : Load direction factor (see Table1)

b<sub>2</sub> : Lubrication factor (see Table1)

b<sub>3</sub> : Temperature factor (see Table1)

b<sub>4</sub> : Dimension factor (see Fig.1)

b<sub>5</sub> : Material factor (see Fig.2)

Da : Spherical diameter (mm)  
(see the specification table)

β : Oscillation half angle (degree)  
(for rotary motion, β=90°)

Table1

Type	b <sub>1</sub>		b <sub>2</sub>		b <sub>3</sub>		
	Load direction		Regular lubrication		Temperature °C		
	Fixed	Alternating	Not provided	Provided	-30 +80	+80 +150	+150 +180
Spherical Plain Bearing	With out seal	1	5	0.08	1	1	0.7
	With seal	1	5	0.08	1	—	—

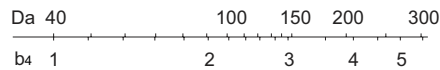


Fig.1 Dimension Factor

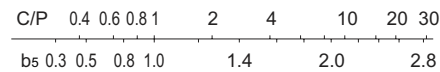


Fig.2 Material Factor

#### [Equivalent Radial Load]

The Spherical Plain Bearing is capable of receiving a radial load and a thrust load simultaneously. If the magnitude and direction of the load applied are constant, the equivalent radial load is obtained from the following equation.

$$P = Fr + YFa$$

P : Equivalent radial load (N)  
Fr : Radial load (N)  
Fa : Thrust load (N)  
Y : Thrust load factor (see Table2)

Table2 Thrust Load Factor

Fa/Fr ≤	0.1	0.2	0.3	0.4	0.5
Thrust load factor (Y)	0.8	1	1.5	2.5	3

#### [Static Safety Factor $f_s$ ]

If the Spherical Plain Bearing is to be used under a stationary load or in slight rocking motion, select a model using the basic static load rating ( $C_0$ ) as a guide. The basic static load rating refers to the stationary load that the bearing can receive without damaging the bearing and without causing permanent deformation that would prevent smooth motion.

In general, set the safety factor at three or greater taking into account the rigidity of the shaft and the housing.

$$f_s = \frac{C_0}{P} \geq 3$$

$f_s$  : Static safety factor  
 $C_0$  : Basic static load rating  
P : Equivalent radial load

## Point of Selection

### Selecting a Spherical Plain Bearing

#### [pV Value]

The permissible sliding speed at which the Spherical Plain Bearing can be used varies depending on the load, lubrication conditions and cooling status. The recommended pV value for continuous motion under a load applied in a constant direction is calculated as follows.

$$pV \leq 400 \text{ N/mm}^2 \cdot \text{mm/sec}$$

If the Spherical Plain Bearing performs adiabatic operation or the load direction changes, the heat produced on the sliding surface easily radiates. Therefore, it is possible to set a higher pV value.

The contact surface pressure (p) of the Spherical Plain Bearing is obtained from the following equation.

$$p = \frac{P}{D_a \cdot B}$$

p	: Contact surface pressure	(N/mm <sup>2</sup> )
P	: Equivalent radial load	(N)
D <sub>a</sub>	: Spherical diameter (see the specification table)	(mm)
B	: Outer ring width (see the specification table)	(mm)

The sliding speed is calculated as follows.

$$V = \frac{\pi \cdot D_a \cdot \beta \cdot f}{90 \times 60}$$

V	: Sliding speed	(mm/sec)
β	: Oscillation half angle	(degree)
f	: Number of rocking motions per minute	(min <sup>-1</sup> )

The Spherical Plain Bearing can be used at sliding speed of up to 100 mm/sec in oscillating motion, or up to 300 mm/sec in rotary motion in favorable lubrication status.

#### [Example of Calculating a pV Value]

Assuming that model SB25 is used in a location where the shaft rotates 60 turns per minute at an angle of 40° (oscillation half angle : 20°) and the maximum varying load of 1,500 N is applied, determine whether the model number is appropriate and calculate the service life under these conditions. Assume that the bearing temperature is +80 °C or less and the product is regularly provided with sufficient lubrication. Calculate the pV value and examine if the bearing size is appropriate.

The contact surface pressure (p) is calculated as follows.

$$p = \frac{P}{D_a \cdot B} = \frac{1500}{36 \times 18} = 2.31 \text{ N/mm}^2 \quad \left( \begin{array}{l} B: \text{outer ring width of model SB25} = 18 \\ D_a: \text{spherical diameter of model SB25} = 36 \end{array} \right)$$

The sliding speed (V) is obtained from the following equation.

$$V = \frac{\pi \cdot D_a \cdot \beta \cdot f}{90 \times 60} = \frac{3.14 \times 36 \times \left(\frac{40}{2}\right) \times 60}{90 \times 60} = 25.12 \text{ mm/sec}$$

The pV value is calculated as follows.

pV=58.0N/mm<sup>2</sup>·mm/sec

Since both the pV value and the sliding speed (V) meet the requirements, model SB25 can be used.

Next, calculate the service life of the bearing (G) as follows.

$$G = b_1 \cdot b_2 \cdot b_3 \cdot b_4 \cdot b_5 \cdot \frac{3}{D_a \cdot \beta} \cdot \frac{C}{P} \times 10^8$$

$$= 5 \times 1 \times 1 \times 1 \times 2.2 \times \frac{3}{36 \times 20} \times \frac{15300}{1500} \times 10^8 = 4.7 \times 10^7 \text{ (min}^{-1}\text{)}$$

## Accuracy Standards

The dimensional tolerances of the Spherical Plain Bearing are defined as indicated in Table3.

Table3 Accuracy of the Spherical Plain Bearing

Unit:  $\mu\text{m}$

Nominal dimension of the inner diameter (d) and outer diameter (D) (mm)		Tolerance in inner diameter (dm)		Tolerance in outer diameter (Dm)		Tolerance of the inner outer ring in width (B <sub>i</sub> , B <sub>o</sub> )	
Above	Or less	Upper	Lower	Upper	Lower	Upper	Lower
10	18	0	-8	—	—	0	-120
18	30	0	-10	0	-9	0	-120
30	50	0	-12	0	-11	0	-120
50	80	0	-15	0	-13	0	-150
80	120	0	-20	0	-15	0	-200
120	150	0	-25	0	-18	0	-250
150	180	0	-25	0	-25	0	-250
180	250	0	-30	0	-30	0	-300
250	315	—	—	0	-35	0	-350
315	400	—	—	0	-40	0	-400

Note1) "dm" and "Dm" represent the arithmetic averages of the maximum and minimum diameters obtained in measuring the inner and outer diameters at two points.

Note2) The dimensional tolerances of the inner and outer diameters are the values before they are surface treated.

Note3) The dimensional tolerance of the outer ring is the value before it is split.

Note4) Tolerances of the inner and outer diameters in width (B<sub>i</sub>, B<sub>o</sub>) are assumed to be equal, and obtained from the nominal dimension of the inner diameter of the inner ring.

## Radial Clearance

Table4 shows radial clearances of the Spherical Plain Bearing.

Table4 Radial Clearances of the Spherical Plain Bearing

Unit:  $\mu\text{m}$

Bearing inner diameter (d) (mm)		Radial clearance	
Above	Or less	Min.	Max.
—	17	70	125
17	30	75	140
30	50	85	150
50	65	90	160
65	80	95	170
80	100	100	185
100	120	110	200
120	150	120	215
150	240	130	230

Note1) The radial clearance indicates the value before the outer ring is split.

Note2) The axial clearance is approximately twice the radial clearance.

**Point of Selection**

Radial Clearance

Spherical Plain Bearing



## Fit

The fitting between the Spherical Plain Bearing and the shaft or the housing is selected according to the conditions. Table1 shows recommended values.

Table1 Recommended Fitting Values

Service condition		Shaft	Housing
Inner ring rotational load	Normal load	k6	H7
	Indeterminate load	m6	H7
Outer ring rotational load	Normal load	g6	M7
	Indeterminate load	h6	N7

Note1) If the product is to be installed so that the inner ring rotates and the fitting with the shaft is to be clearance fitting, harden the surface of the shaft in advance.

Note2) "N7" is recommended for light alloy housings.

### [Shaft Designing]

If the inner ring is to be fit onto the shaft in loose fitting and the product is to be used under a heavy load, the shaft may slip on the inner circumference of the inner ring. To prevent the slippage, the shaft hardness must be 58 HRC or higher and the surface roughness must be 0.80 a or below.

## Permissible Tilt Angles

The permissible tilt angle of the Spherical Plain Bearing varies according to the shaft shape as indicated in Table2.

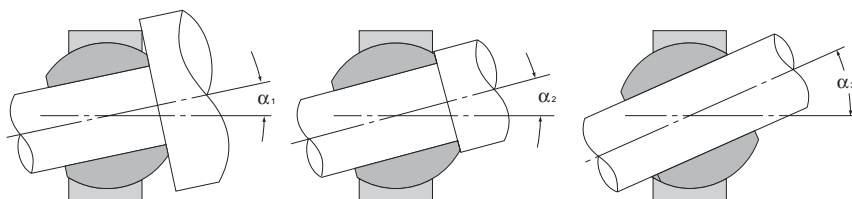


Table2 Permissible Tilt Angles  
Unit: degree

Unit: degree

Model No.	Permissible tilt angles		
	$\alpha_1$	$\alpha_2$	$\alpha_3$
SB 12	5	7	18
SB 15	4	6	18
SB 20	3	4	14
SB 22	4	6	16
SB 25	4	5	16
SB 30	4	6	17
SB 35	4	5	14
SB 40	4	6	12
SB 45	4	5	13
SB 50	4	5	16
SB 55	4	6	16
SB 60	4	6	18
SB 65	4	5	16
SB 70	4	5	15
SB 75	4	5	18
SB 80	4	5	18
SB 85	4	6	16
SB 90	4	5	16
SB 95	4	5	17
SB 100	4	5	18
SB 110	4	5	16
SB 115	4	5	14
SB 120	4	6	15
SB 130	4	5	14
SB 150	4	5	12

Model No.	Permissible tilt angles		
	$\alpha_1$	$\alpha_2$ <sup>Note</sup>	$\alpha_3$
SA1 12	8	11 (6)	25
SA1 15	6	8 (5)	18
SA1 17	7	10 (7)	23
SA1 20	6	9 (6)	21
SA1 25	6	7 (4)	18
SA1 30	4	6 (4)	16
SA1 35	5	6 (4)	16
SA1 40	5	7 (4)	16
SA1 45	6	7 (4)	16
SA1 50	5	6 (4)	15
SA1 60	5	6 (3)	14
SA1 70	5	6 (4)	14
SA1 80	4	6 (4)	14
SA1 90	4	5 (3)	12
SA1 100	5	7 (5)	14
SA1 110	5	6 (4)	15
SA1 120	4	6 (4)	15
SA1 140	5	7 (5)	16
SA1 160	6	8 (6)	13
SA1 180	5	6 (5)	16
SA1 200	6	7 (6)	13
SA1 220	6	8 (6)	15
SA1 240	6	8 (6)	17

Note) The values in the parentheses apply to types attached with a seal.

## Installation

- (1) Do not use the product in the manner that the permissible tilting angle is exceeded since doing so may damage the product.
- (2) The Spherical Plain Bearing is designed for use under a radial load. Do not use the product if the trust load component or the load component in the thrust direction exceeds 50% of the resultant force consisting of the radial load and the thrust load.
- (3) When installing the Spherical Plain Bearing, pay attention to the mounting orientation so that the slit of the outer ring receives a minimum load.

### [Temperature Range]

The permissible temperature range of the Spherical Plain Bearing is limited between -30°C and 80°C depending on the seal material and determined by the permissible temperature range of the grease used.

## Lubrication

The spherical sliding surface of the Spherical Plain Bearing is seized with a solid lubricant film of molybdenum disulfide. This enables the Spherical Plain Bearing to be used over a relatively long period without further lubrication under a static load, in low-speed rocking motion or in intermittent rotary motion. However, it is generally necessary to replenish grease on a regular basis. If a heavy load is applied, consider using lithium soap group grease containing molybdenum disulfide. The inner and outer rings of the Spherical Plain Bearing have greasing holes as a means to facilitate the flow of the lubricant inside the bearing.

### [Lubrication Interval]

Since the Spherical Plain Bearing is delivered without being applied with a lubricant, it is necessary to replenish an appropriate amount of grease after installing the Spherical Plain Bearing. We recommend filling grease also to the space surrounding the Spherical Plain Bearing. It is also recommendable to shorten the lubrication interval in the start-up period in order to lighten the initial wear and extend the service life.

The lubrication interval varies according to the magnitude of the load, frequency of the vibrations and other conditions. Provide lubrication while referring to the values in Table1 as a guide.

Table1 Lubrication Interval

Type of load	Required minimum lubrication interval
Unilateral load	G/ 40
Fluctuating load	G/ 180

G: Service life of the bearing (total number of rocking motions or total number of revolutions)

## Contamination Protection

Spherical Bearing model SA1 is provided with a seal designed to prevent humidity or other deleterious material from entering the bearing. This seal is effective in increasing the service life of the bearing. The seal for Spherical Bearing model SA1 is made of oil-resistant synthetic rubber and has double lips as the sealing element. These lips closely contact the spherical inner ring. The seal can be used within the temperature range between  $-30^{\circ}\text{C}$  and  $80^{\circ}\text{C}$ , and is highly resistant to wear and capable of operating for a long period of time. If the product is used in an environment where sand or soil matter may enter the bearing, the service life of the seal is shortened. We recommend lubricating the product on a regular basis.



### [Handling]

- (1) When installing model SA1 or model SB, they must not be disassembled before installation.
- (2) Dropping or hitting the Spherical Plain Bearing may damage it.  
Giving an impact to it could also cause damage to its function even if the product looks intact.

### [Lubrication]

- (1) For details of the lubrication, see A-918.
- (2) Do not mix lubricants of different physical properties.

### [Precautions on Use]

- (1) When using the product in locations exposed to vibrations or an impact load or in a special environment such as a clean room, vacuum and low/high temperature, contact THK in advance.
- (2) Entrance of foreign material such as dust between the outer and inner rings may cause damage or functional loss. Prevent foreign material, such as dust and cutting chips, from entering the product.

### [Storage]

When storing the Spherical Plain Bearing, avoid high temperature, low temperature and high humidity.