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Spherical Joint

Spherical Joint

Spherical Plain Bearing

Double-slit outer-ring type SB

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Single-slit outer-ring type SA1

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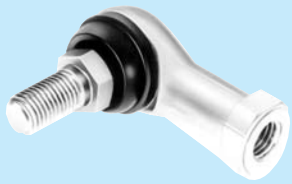
Link Ball®

AL



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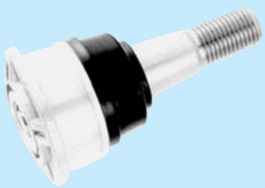

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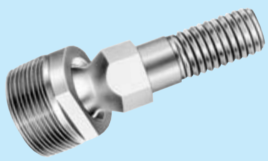
TBS



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Spherical Joint Contents

Note:
This Catalog provides basic information relating to THK linear motion and related products. The Catalog, including all information, charts, formulas, factors, accuracy standards, tolerances and applications recommendations contained herein, is only a starting point for the customer's selection of appropriate products, and may not apply in all intended applications. The Catalog is not a substitute for a proper application analysis conducted by an experienced, knowledgeable design engineer. Product selection should be based upon your specific application needs and conditions, which will vary greatly depending on many factors. No specific product application should be based solely on the information contained in this Catalog. All purchases of THK Products are subject to THK America's and the manufacturer's limited warranty. Customers should confirm independently that a contemplated application is safe, appropriate and effective.

Spherical Plain Bearing

1. Construction and Features

Spherical Plain Bearing types SB and SA1 are self-aligning plain bearings for heavy loads. The inner and outer rings consist of high-carbon chromium bearing steel, hardened, ground, phosphate-coated, and baked with molybdenum disulfide (MoS_2).

The Spherical Plain Bearing can bear large radial loads and bilateral-thrust loads. Moreover, as it is highly impact-resistant, this product is suitable for application to low-speed, heavy-load rocking components such as the cylinder crevices and hinges of various construction-work and civil-engineering machines, truck suspensions, and train bolster anchors.

Type SB

This constitutes the most popular series of its type in Japan. With wide spherical contact areas, type SB is suitable for use as a bearing for heavy loads. The outer ring is split at two points, enabling the inner ring to be accommodated.

Type SA1

This type is popular in Europe. The outer ring is split at one point (at two points in models with an inner diameter of 100 mm or greater). This type is narrower and thinner than type SB, and can therefore be used in small areas. Models with seals on both sides (SA1-UU) are also available. The seals are dust seals that are highly effective in contamination protection.

2. Accuracy Standards

The dimensional tolerances of the Spherical Plain Bearing are as shown in Table 1.

Table 1 Spherical-Plain-Bearing Accuracy

Unit: µm

Nominal ID (d) and OD (D), mm		ID (dm) tolerance		OD (Dm) tolerance		Tolerance for inner- or outer-ring width B1 or B	
Over	To (incl.)	Max.	Min.	Max.	Min.	Max.	Min.
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

Notes:
1. dm and Dm represent the arithmetic means of the maximum and minimum inner and outer diameters of the bearing measured at two points, respectively.
2. The tolerances for the inner- and outer-ring dimensions are values before surface treatment.
3. Outer-ring tolerances are values before splitting.
4. The tolerances for the inner- and outer-ring widths (B_1 and B) must be equal to one another, and are determined by the nominal inner-ring minor diameter.

3. Clearance

Table 2 presents the radial clearances of the Spherical Plain Bearing.

Table 2 Radial Clearance of the Spherical Plain Bearing

Unit: µm

Bearing ID d, mm		Radial clearance	
Over	To (incl.)	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

Notes:
1. Radial clearances are values before the outer ring is split.
2. Axial clearances are approximately twice the corresponding radial clearances.

4. Fit

The fit between the Spherical Plain Bearing and shaft or housing should be determined in accordance with the operating conditions. Table 3 gives recommended values.

Table 3 Recommended Fit

Operating conditions		Shaft	Housing
Inner-ring rotational load	Normal load	k6	H7
	Indeterminate load	m6	
Outer-ring rotational load	Normal load	g6	M7
	Indeterminate load	h6	N7

Notes:
1. When a clearance fit is applied to a shaft in an assembly, in order to rotate the inner ring, harden the shaft surface in advance.
2. Type N7 is recommended for light alloy housings.

Designing the shaft

When heavy loads must be borne by a clearance fit between the inner-ring minor circumference and shaft, the shaft hardness must be 58HRC or higher and the surface roughness 3.2 or less, as the shaft may otherwise slip on the ring circumference.

5. Choosing the Correct Type of Spherical Plain Bearing

The correct choice of Spherical Plain Bearing for your purpose of use depends on the operating conditions. Choose the correct type based on the basic dynamic load rating (C) and basic static load rating (C_0), as shown below.

Spherical Plain Bearing service life G

Use the basic dynamic load rating (C) to calculate the service life of the Spherical Plain Bearing when subjected to rocking motion under a load.

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

The bearing service life G is represented by the total number of rocking motions performed until normal operation is impossible as a result of the increased radial clearance and increased bearing temperature due to wear on the spherical sliding surface.

As the service life is affected by many factors, including the bearing material, the magnitude and direction of the load, lubrication, and sliding velocity, the equation shown below involves values set based on our years of experience. Therefore, a value obtained using this calculation can be used as a practical guideline.

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

where

- G : bearing service life (total number of rocking motion or revolutions)
- C : basic dynamic load rating (N)
- P : equivalent radial load (N)
- b_1 : load direction factor (see Table 4)
- b_2 : lubrication factor (see Table 4)
- b_3 : temperature factor (see Table 4)
- b_4 : dimension factor (see Fig. 1)
- b_5 : material factor (see Fig. 2)
- ø : sphere diameter (see the dimension table) (mm)
- b: rocking half angle (°) (For rotation, β = 90°)

Table 4

Type		b_1 Loading direction		b_2 Periodic greasing		b_3 Temperature °C		
		Fixed	Alter-nating	Not Applied	Applied	-30 +80	+ 80 +150	+150 +180
Spherical Plain Bearing	Seals not provided	1	5	0.08	1	1	1	0.7
	Seals provided	1	5	0.08	1	1	—	—

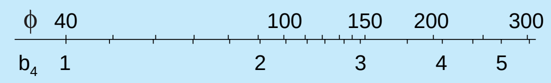


Fig. 1 Dimension Factor

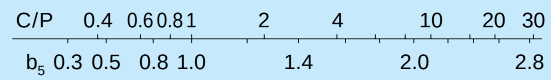


Fig. 2 Material Factor

Equivalent radial load

The Spherical Plain Bearing can bear radial and thrust loads simultaneously. If the magnitude and direction of loads applied are fixed, the equivalent radial load can be calculated using the following equation:

$$P = Fr + YFa$$

where

- P : equivalent radial load (N)
- Fr : radial load (N)
- Fa : thrust load (N)
- Y : thrust load factor (see Table 5)

Table 5 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

When the bearing is used under a static load or in light rocking motion, determine this based on the basic static load rating (C_0). The basic static load rating refers to the static load that can be applied without breaking the bearing or causing permanent set that hinders smooth operation.

Normally, the safety factor should be set to 3 or higher in consideration of the rigidity of the shaft and housing.

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

pV value

The permissible velocity at which the Spherical Plain Bearing can be used in normal operation varies with the load applied, lubrication conditions, and cooling performance. The recommended pV value for continuous operation under a load applied in a given direction is as follows:

$$pV \leqq 400\ N/mm^2 \bullet m/sec$$

When the operation is adiabatic or the loading direction varies, the generated heat on the sliding surfaces radiates more readily. Thus, the pV value can be even higher.

The contact-surface pressure (p) of the Spherical Plain Bearing can be calculated using the following equation:

$$p = \frac{P}{\phi \bullet B}$$

where

- p : contact-surface pressure (N/mm²)
- P : equivalent radial load (N)
- ø : sphere diameter (see the dimension table) (mm)
- B : outer-ring width (see the dimension table) (mm)

The sliding velocity (V) is given by:

$$V = \frac{\pi \bullet \phi \bullet \beta \bullet f}{90 \times 60}$$

where

- V : sliding velocity (mm/s)
- β : rocking half angle (°)
- f : number of rocking motion per minute (opm)

The sliding velocity in rocking motion can be up to 100 mm/s. If the motion is rotation and the lubrication conditions are favorable, it may be increased to as high as 300 mm/s.

Calculation example

Type SB25 is used where the bearing rotates 60 times per minute at an angle of 40° under a maximum fluctuating load of 1500 N. Under these conditions, let's assess whether the selected model is appropriate. If it is, we will calculate the service life of the model. In this calculation, we assume that the bearing temperature is +80°C or lower and that grease is replenished periodically.

First, let's calculate the pV value and determine whether the bearing size is acceptable.

Contact-surface pressure (p):

$$p = \frac{P}{\phi \bullet B} = \frac{1500}{36 \times 18} = 2.31\ N/mm^2$$

Sliding velocity (V):

$$V = \frac{\pi \bullet \phi \bullet \beta \bullet f}{90 \times 60} = \frac{3.14 \times 36 \times 20 \times 60}{90 \times 60}$$

$$= 25.12\ mm/sec$$

Hence, the pV value is as follows:

$$pV = 58.0\ N/mm^2 \bullet mm/sec$$

As both the pV value and sliding velocity (V) meet the present conditions, we can conclude that type SB25 is applicable.

Next, let's calculate the bearing service life (G):

$$pV = 58.0\ N/mm^2 \bullet mm/sec$$

6. Permissible Tilting Angle

The permissible tilting angle of the Spherical Plain Bearing is as specified in Table 6, depending on the shaft shape.

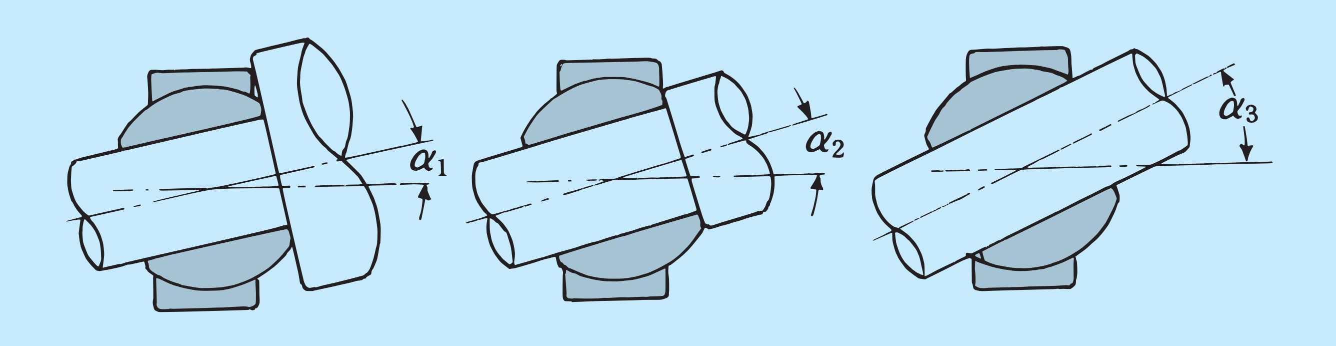


Table 6 Permissible Tilting Angle

Unit: °

Model No.	Permissible tilting angle		
	α_1	α_2	α_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
SB100	4	5	18
SB110	4	5	16
SB115	4	5	14
SB120	4	6	15
SB130	4	5	14
SB150	4	5	12

Unit: °

Model No.	Permissible tilting angle		
	α_1	α_2 Note)	α_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: Parentheses indicate values for models with seals.

7. Safety Design

Lubrication

The spherical sliding surfaces of the Spherical Plain Bearing are baked with a solid lubrication film of molybdenum disulfide. This method of lubrication enables operation for a relatively long period of time without oiling if the operation is motion under a static load, low-speed rocking motion, or intermittent rotation. Normally, however, it is necessary to replenish the grease at a given interval. For operation under a heavy load, consider providing lubrication using lithium soap-based grease containing molybdenum disulfide. The inner and outer rings of the Spherical Plain Bearing are provided with oil grooves to aid in the smooth flow of grease.

Greasing interval

The Spherical Plain Bearing is delivered with no grease applied, so be sure to feed an appropriate amount of grease following installation. It is recommended that the space around the bearing be filled with grease as well. In the initial stage following introduction, however, feed grease more frequently than normal so as to reduce friction and increase the service life.

The greasing interval depends on the magnitude of the load, the number of rocking motions, and other conditions. Refer to Table 7 as a guideline.

Table 7 Greasing Interval

Type of load	Minimum greasing interval
Unilateral load	G/40
Fluctuating load	G/180

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

Seal

For Spherical Plain Bearing type SA1, a special seal is available to prevent the entry of moisture and other harmful substances. This seal significantly elongates the bearing service life.

The seal for Spherical Plain Bearing type SA1 consists of oil-resistant synthetic rubber. Each seal has double lips that closely contact the inner ring. The material of the seal withstands a wide range of temperatures (from –30°C to +80°C), is wear-resistant, and has a long service life.

Extraordinarily severe conditions, such as the inclusion of sand and mud in the bearing, may shorten the seal service life. In such a case, it is recommended that the grease be periodically replenished.

Permissible operating temperature

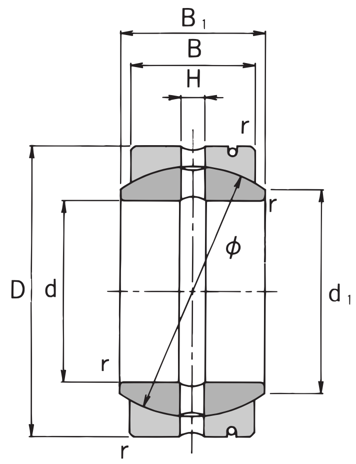
The permissible operating temperature of the Spherical Plain Bearing must be within the range of –30°C to +80°C, depending on the mat of the seal, as determined by the permissible operating temperature range of the grease used.

Installation

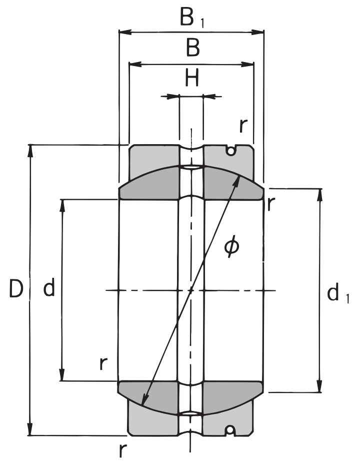
When installing the Spherical Plain Bearing, confirm the mounting direction to ensure that as little of a load as possible is exerted on the outer-ring slit.

Please note that it is not permissible to apply a thrust load only.

Type SB

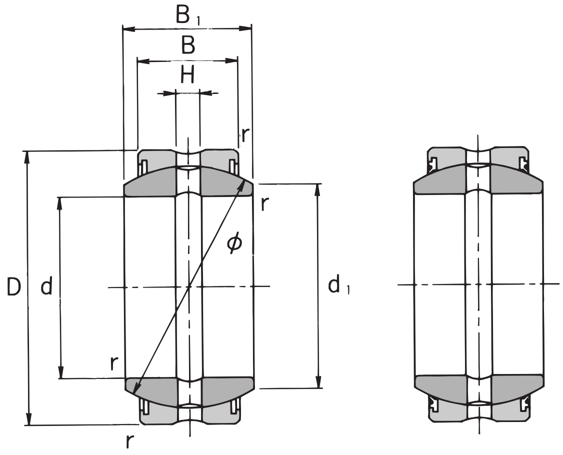


Model No.	Major daimensions mm								Basic load rating		Mass
	ID d	OD D	Outer-ring width B	Inner-ring width B_1	d_1	ϕ	H	r	C kN	C_0 kN	kg
SB 12	12	22	9	11	14	18	1.5	0.5	3.82	95.3	0.019
SB 15	15	26	11	13	17.5	22	2.5	0.5	5.69	142	0.028
SB 20	20	32	14	16	23	28	2.5	0.5	9.22	230	0.053
SB 22	22	37	16	19	25.5	32	2.5	0.5	12.1	301	0.085
SB 25	25	42	18	21	29	36	4	0.5	15.3	381	0.116
SB 30	30	50	23	27	36	45	4	1	24.3	609	0.225
SB 35	35	55	26	30	40	50	4	1	30.6	765	0.3
SB 40	40	62	28	33	44	55	4	1	36.3	906	0.375
SB 45	45	72	31	36	50.5	62	6	1	45.2	1130	0.6
SB 50	50	80	36	42	58.5	72	6	1	61.0	1530	0.87
SB 55	55	90	40	47	64.5	80	6	1	75.3	1880	1.26
SB 60	60	100	45	53	72.5	90	6	1	95.3	2380	1.7
SB 65	65	105	47	55	76	94	6	1	104	2600	2.05



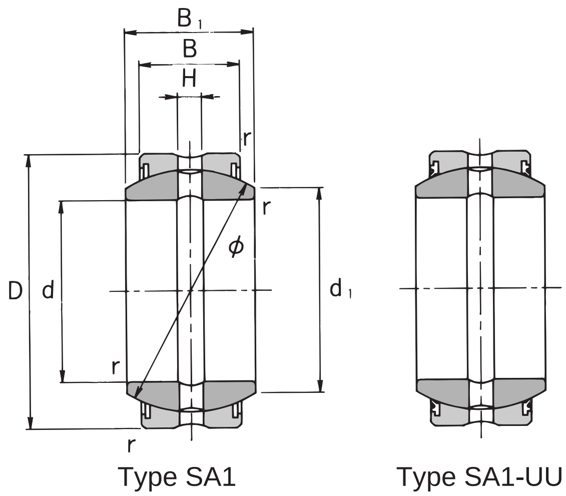
Model No.	Major daimensions mm								Basic load rating		Mass
	ID d	OD D	Outer-ring width B	Inner-ring width B_1	d_1	ϕ	H	r	C kN	C_0 kN	kg
SB 70	70	110	50	58	81.5	100	8	1	118	2940	2.22
SB 75	75	120	55	64	89.5	110	8	1	142	3560	3.02
SB 80	80	130	60	70	97.5	120	8	1	170	4240	3.98
SB 85	85	135	63	74	100.5	125	8	1	185	4640	4.29
SB 90	90	140	65	76	105.5	130	8	1	199	4970	4.71
SB 95	95	150	70	82	113.5	140	8	1	230	5760	6.05
SB 100	100	160	75	88	121.5	150	10	1.5	265	6620	7.42
SB 110	110	170	80	93	130	160	10	1.5	301	7530	8.55
SB 115	115	180	85	98	132.5	165	10	1.5	330	8250	10.3
SB 120	120	190	90	105	140	175	10	1.5	371	9260	12.4
SB 130	130	200	95	110	148.5	185	10	1.5	414	10300	13.8
SB 150	150	220	105	120	166	205	10	1.5	507	12600	17.0

Type SA1



Type SA1　　Type SA1-UU

Model No.		Major daimensions mm							Basic load rating		Mass
Standard type	Seal-provided type	ID d	OD D	Outer-ring width B	Inner-ring width B_1	d_1	ϕ	r	C kN	C_0 kN	kg
SA1 12	SA1 12 UU	12	22	7	10	15	18	0.5	2.94	74.1	0.017
SA1 15	SA1 15 UU	15	26	9	12	18.4	22	0.5	4.70	117	0.032
SA1 17	SA1 17 UU	17	30	10	14	20.7	25	0.5	5.88	147	0.049
SA1 20	SA1 20 UU	20	35	12	16	24.2	29	0.5	8.23	205	0.065
SA1 25	SA1 25 UU	25	42	16	20	29.3	35.5	0.5	13.3	334	0.115
SA1 30	SA1 30 UU	30	47	18	22	34.2	40.7	0.5	17.3	431	0.16
SA1 35	SA1 35 UU	35	55	20	25	39.8	47	1	22.1	553	0.258
SA1 40	SA1 40 UU	40	62	22	28	45	53	1	27.5	686	0.315
SA1 45	SA1 45 UU	45	68	25	32	50.8	60	1	35.3	882	0.413
SA1 50	SA1 50 UU	50	75	28	35	56	66	1	43.5	1090	0.56
SA1 60	SA1 60 UU	60	90	36	44	66.8	80	1.5	67.7	1700	1.1
SA1 70	SA1 70 UU	70	105	40	49	77.9	92	1.5	86.6	2170	1.54



Model No.		Major daimensions mm							Basic load rating		Mass
Standard type	Seal-provided type	ID d	OD D	Outer-ring width B	Inner-ring width B_1	d_1	ϕ	r	C kN	C_0 kN	kg
SA1 80	SA1 80 UU	80	120	45	55	89.4	105	1.5	111	2780	2.29
SA1 90	SA1 90 UU	90	130	50	60	98.1	115	2	135	3380	2.84
SA1 100	SA1 100 UU	100	150	55	70	109.5	130	2	169	4210	4.43
SA1 110	SA1 110 UU	110	160	55	70	121.2	140	2	181	4530	4.94
SA1 120	SA1 120 UU	120	180	70	85	135.6	160	2	264	6590	8.12
SA1 140	SA1 140 UU	140	210	70	90	155.9	180	3	296	7410	11.3
SA1 160	SA1 160 UU	160	230	80	105	170.2	200	3	376	9410	14.4
SA1 180	SA1 180 UU	180	260	80	105	199	225	3	424	10600	18.9
SA1 200	SA1 200 UU	200	290	100	130	213.5	250	3	588	14700	28.1
SA1 220	SA1 220 UU	220	320	100	135	239.6	275	3.5	647	16200	36.1
SA1 240	SA1 240 UU	240	340	100	140	265.3	300	3.5	706	17600	40.4

Note: • In model numbers 100 and above, the outer ring is separable.

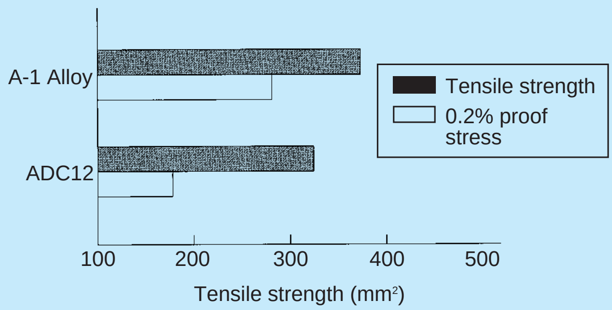
1. Types and Features

The THK Link Ball is produced by a unique process: with a steel ball used for the precision bearing as the core, the holder is die-cast into a spherical shape, then the shank is specially welded to the holder. This manufacturing process is advantageous in that the mirror surface of the steel ball can be exactly duplicated on the holder spherical interior, and that high lubrication performance is achieved due to the grease pockets provided at the top and bottom of the spherical section, over the entire surface of which the ball and holder contact one another. High lubrication performance results in high wear resistance.

High-Strength Aluminum Alloy Series

A-1 Alloy, a high-strength aluminum alloy developed for the Link Ball, has approximately twice the proof stress (yield strength) of the ordinary aluminum die-cast material ADC12. A-1 Alloy's high strength and wear resistance can be compared to those of the high-strength zinc alloy.

The specific gravity of A-1 Alloy is less than half that of the high-strength zinc alloy. In other words, Link Ball types AJ and AL made of this new alloy are ideal for auto parts that must be lightweight and high in strength, and have high corrosion and wear resistance.



Comparison of Tensile Strength and Proof Stress between ADC12 and THK A-1 Alloy

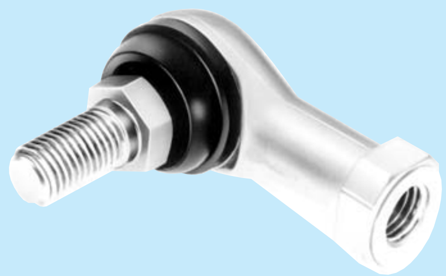
Link Ball Type AJ

The holder is assembled on the same axis as that of the ball shank, which consists of a precision steel ball and an externally threaded shaft.

The grease pockets provided at the top and bottom of the spherical section provide high lubrication performance, resulting in high wear resistance.

As the holder is made of A-1 Alloy, type AJ is advantageous for automobile suspensions that must be lightweight and high in strength.

Link Ball Type AL



The holder is assembled at a right angle with the ball shank, which consists of a precision steel ball and an externally threaded shaft.

The grease pockets provided at the top and bottom of the spherical section provide high lubrication performance, resulting in high wear resistance.

As the holder is also made of the same A-1 Alloy as used for type AJ, the weight of type AL has been substantially reduced.

High-Strength Zinc Alloy Series

Link Ball Type BL

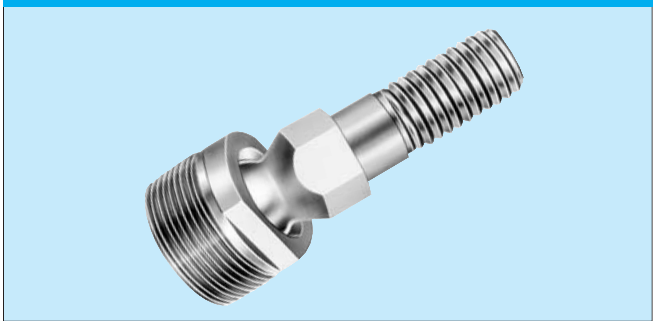
High-strength zinc alloy is used for the holder, which is assembled at a right angle with the ball shank.

The grease pockets provided at the top and bottom of the spherical section provide high lubrication performance, thus high wear resistance.

Link Ball Type RBL

Grease is sealed in the boot. This design provides high lubrication performance, resulting in high wear resistance.

Type TBS



The thread worked by rolling on the outer-ring exterior aids in mounting to the housing. Simply tightening the bolts securely fastens the Link Ball unit to the housing.

Since the sphere covers a large area, a large axial load can be applied.

2. Construction and Features

Unique manufacturing process

To produce the Link Ball, the holder is first die-cast using a precision bearing ball as the core. The shank or yoke is then specially welded to the holder thus obtained. As this unique manufacturing process allows the mirror surface of the steel ball to be duplicated on the holder spherical interior, thereby making it possible for the holder sphere and ball to contact one another over their entire surface. This results in high wear resistance and smooth movement free from clearance.

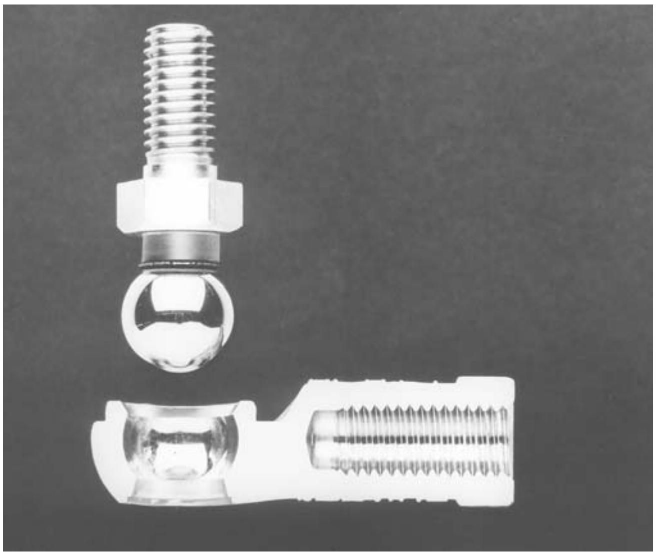
High-strength aluminum alloy has been developed for use as the holder material. In addition to high-strength zinc alloy, the performance of which has already been proven in actual use, this new material used for holders forms a new line-up of Link Balls that can meet the need for use in lightweight auto parts, as well as in conventional applications.

Compact design

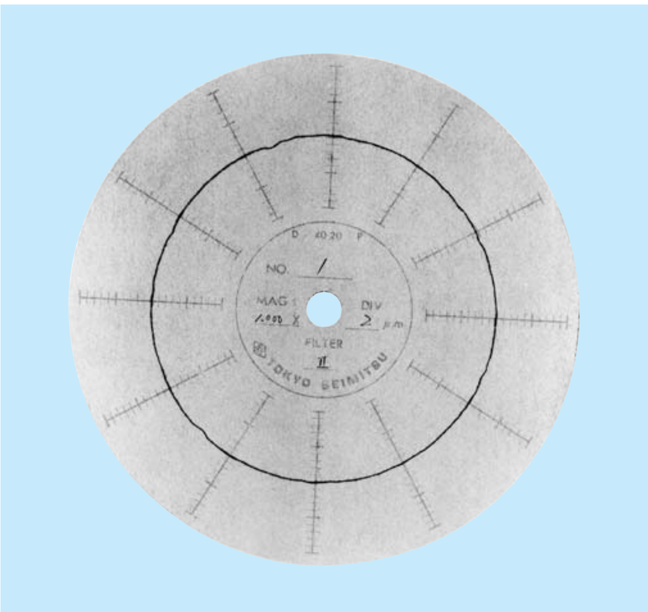
Type AL is designed to strike a subtle balance: the required strength is maintained, but it is remarkably compact. As the Link Ball is lightweight due to the synergy effect with A-1 Alloy, it is ideal for use in automobile stabilizer connecting rods, transmission controls, and the like.

Sphericity: 0.001 mm

On the ball-shank sphere, the sphericity of the bearing steel ball is accurately duplicated. This minimizes the clearance between the spherical section and ball, and provides smooth movement. As a result, the link motion can be controlled easily and a smooth feel can be provided.

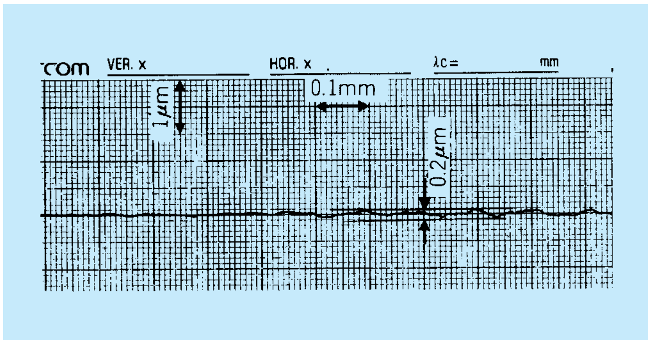


Cutaway Sample of Type BL Sphere

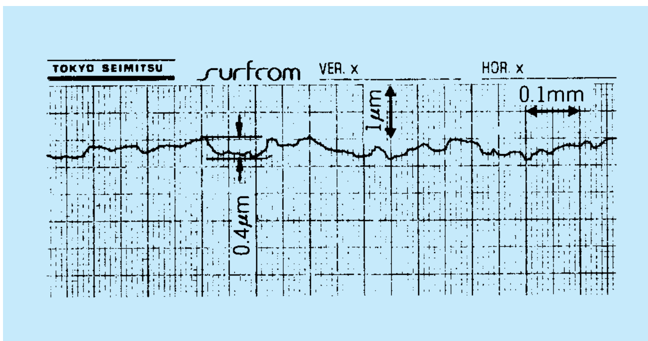


Sphericity: 0.001 mm

Sphericity of the Ball-Shank Sphere



Ball-Shank-Sphere Surface Roughness



Holder-Sphere Surface Roughness

Two types of holder material

In types AJ and AL the holder is made of A-1 Alloy, a lightweight and wear-resistant high-strength aluminum alloy newly developed for use in the Link Ball.

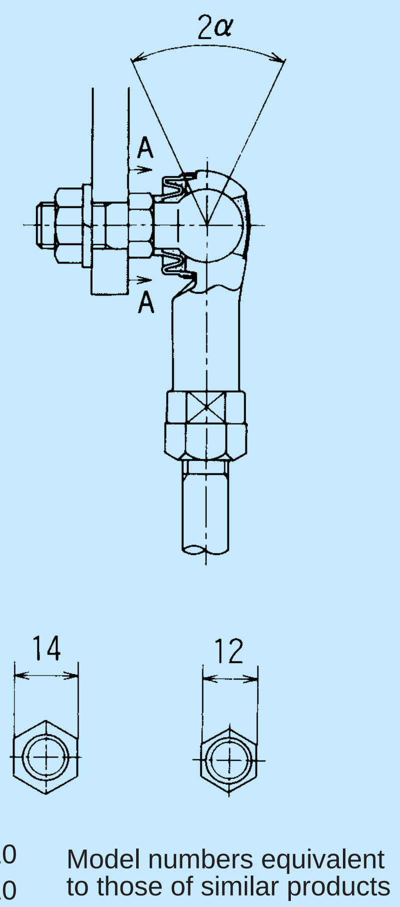
Types BL and RBL consist of conventional high-strength zinc alloy, which has a proven record in actual use.

High lubrication performance

As grease is sealed in types AJ, AL, and BL, as well as models with a boot, these products provide high lubrication performance and are therefore highly wear-resistant.

Large-hexagonal-bolt seat

The hexagonal-bolt seat is machined to the same tolerance as those of the small hexagonal bolts, in accordance with automobile industrial standards. Thus, tightening a bolt does not cause the shank bearing surface to sink and ensures stable link motion.



A-A cross section

Wrench Size

Lightweight yet high in strength

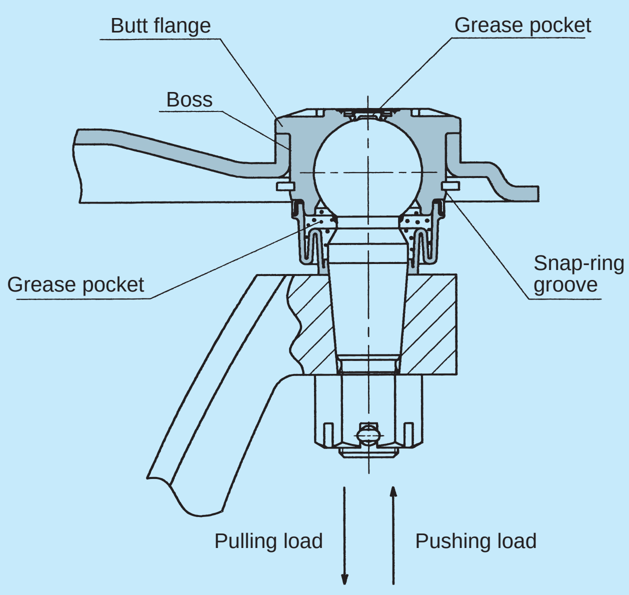
A-1 Alloy features the advantages of aluminum, in that it is lightweight and features high corrosion resistance, and also provides mechanical strength approximately twice that of the ordinary aluminum die-cast material ADC12, making it virtually identical to high-strength zinc alloy in terms of performance.

Boot to prevent the entry of muddy water

Even in an atmosphere subjected to muddy water, the boot, which accurately reproduces the shank movement, prevents water, mud, and other impurities from contacting the spherical surface. The Link Ball therefore has been in actual use for outdoor applications and auto parts installed under the chassis. For details, see the muddy-water durability test data (pages H-26 and H-28).

Simple mounting procedures

As the exterior of type AJ comprises a boss, butt flange, and snap ring, mounting can be performed simply by making a hole in a part with which the device is to be mated. Insert it into the hole and put the snap ring in place. The holder assembly is ready for use. The THK Link Ball therefore saves man-hours.



Type-AJ Sample Assembly

3. Selecting the Appropriate Link Ball

Permissible load P

The yield strength given in the dimension table indicates the mechanical strength of a bearing. For types AL, BL, and RBL it indicates the strength against a load applied in a direction perpendicular to the ball-shank axis, and for types AJ and RBI it indicates the strength against a load applied to the holder in the axial direction of the ball shank or yoke.

In consideration of the type of load and the corresponding safety factor (f_s), determine the correct model number for your purpose of use.

Table 1 Safety Factor (f_s)

Type of load	f_s lower limit
Constant unilateral load	2 ~ 3
Fluctuating unilateral load	3 ~ 5
Fluctuating-direction load	5 ~ 8

In consideration of the type of load and required mechanical strength, select the appropriate bearing using the following equation:

$$P \leqq \frac{P_k}{f_s} \quad \cdots\cdots(1)$$

where

P	: permissible load	(N)
P_k	: yield strength	(N)
f_s	: Safety Factor	(Table 1)

Dynamic-load-carrying capability C_d

The dynamic-load-carrying capability (C_d) refers to the limit load that can be applied to the Link Ball without causing seizure of the spherical section during rotation or rocking motion. The approximate dynamic-load-carrying capability can be calculated using the following equation based on the value for static-load-carrying capability (C_s)* presented in the dimension tables:

$$C_d = \frac{C_s}{\sqrt[3]{n}} \quad \cdots\cdots(2)$$

where

C_d	: dynamic-load-carrying capability	(N)
C_s	: static-load-carrying capability	(N)
n	: number of revolutions per minute	(min^{-1} or rpm)

When determining the type of bearing to be used, make sure your system meets both the requirements for the permissible load obtained from equation (1), and the dynamic-load-carrying capability obtained from equation (2).

*Note: The static-load-carrying capability (C_s) is obtained as a product of the projected area of the spherical section multiplied by the corresponding permissible surface pressure, and is used when calculating the dynamic-load-carrying capability, as in the present case.

4. Safety Design

Permissible tilting angle

The permissible tilting angle of each model number is given in the respective dimension table.

Note: Using the Link Ball with a tilt of greater than the permissible tilting angle may seriously damage the holder and boot. Therefore, always use the Link Ball within the range of permissible tilting angles.

Operating temperature

When the Link Ball is used at temperatures above 80°C or subjected to impact at low temperatures, the safety factor for the holder strength must be reconsidered. In such a case, please contact us. For details, see the durability test results at high and low temperatures (page H-28).

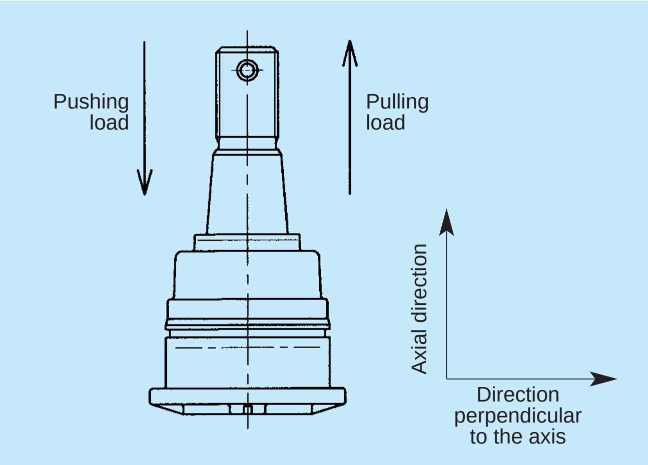
Link Ball is proven for temperatures from –40 to +140°C in commercial use as the ball joint in the truck transmission control.

Definitions of loading directions

There are two directions of the load applied to the Link Ball. Regardless of the shape of the Link Ball, the direction parallel to the ball-shank axis is called the axial direction, and that perpendicular is called the direction perpendicular to the axis.

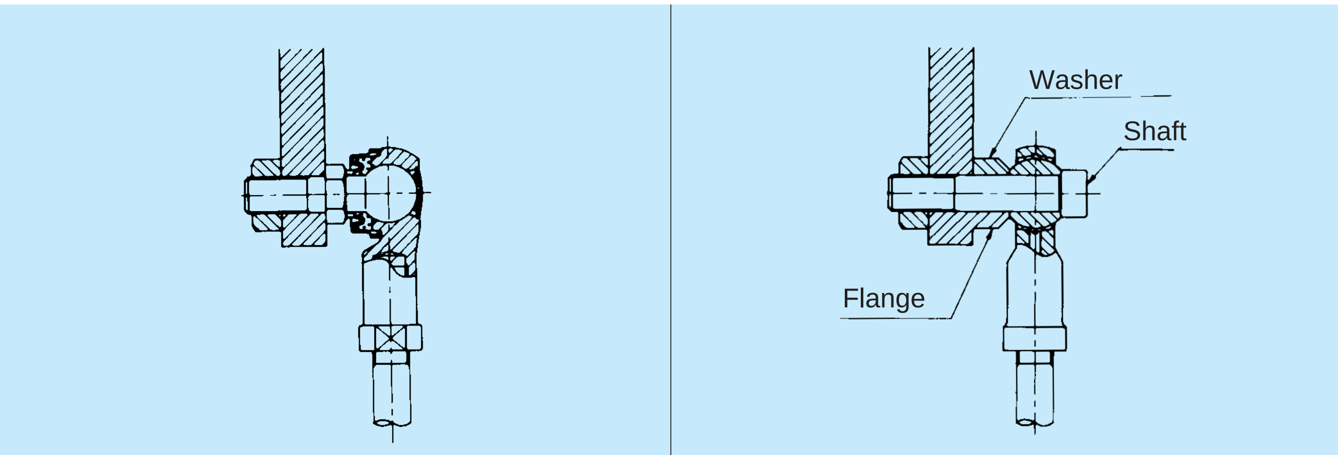
Pushing load and pulling load

Of loads applied in the axial direction, a load that presses the ball shank against the holder is called a pushing load, and one that draws the shank from the holder is called a pulling load.



5. Sample Assembly

Comparison between the THK Link Ball and a conventional rod end



THK Link Ball Type BL

Conventional Rod End Type PHS

- As the shaft is attached, the mounting procedures can be made very simple, particularly for a rod assembly.
- The improved boot lip shape has increased the ability to prevent the entry of water and mud during use in a muddy-water environment.
- As grease is sealed in, the Link Ball can remain in service without oiling (high lubrication performance).
- Whereas in conventional rod ends the clearance between the shaft and ball interior hinders complete fastening, the ball in Link Ball type BL is formed into one unit with the shaft. Due to the one-piece structure, type BL causes only minimal run-out, deflection, and distortion, and features high rigidity.

6. A-1 Alloy: High-Strength Aluminum Alloy

A-1 Alloy, a high-strength aluminum alloy newly developed for the Link Ball and used for the holders of types AJ and AL, is based on Al-Zn-Si3. It is a completely new type of die-casting aluminum alloy.

1. Features of A-1 Alloy

- Among the highest strength of any die-casting aluminum alloy
- Proof stress approximately twice that of ordinary die-casting aluminum alloys (e.g., ADC12)
- Hardness equivalent to that of high-strength zinc alloy. Features excellent wear resistance.
- Specific gravity of half or less of that of high-strength zinc alloy. A substantial weight reduction is therefore possible.
- Features high corrosion resistance and can therefore be applied to automobile suspensions

2. Mechanical properties

Tensile strength : 343 to 392 N/mm²
Tensile proof stress (0.2%) : 245 to 294 N/mm²
Compressive strength : 490 to 637 N/mm²
Compressive proof stress (0.2%) : 294 to 343 N/mm²
Charpy impact : 0.098 to 0.196 N-m/mm²
Elongation : 2% to 3%
Hardness : 140 to 160 HV

3. Physical properties

Specific gravity : 3.0
Specific heat : 793 J/(kg-k)
Melting point : 570°C
Linear expansion rate : 22×10^{-6}

4. Wear resistance

THK in-house tests have demonstrated that the wear resistance of A-1 Alloy is equivalent to that of high-strength zinc alloy.

Rotation-and-Rocking Durability Comparative Test between Type AL10D (A-1 Alloy) and Type BL10D (High-Strength Zinc Alloy)

Test conditions	Ambient temperature	Normal temperature	
	Applied load	±1.9 kN (direction perpendicular to the axis)*	
	Loading frequency	0.6 Hz	
	Movement angle	Rotation ±20°	Rocking ±20°
	No. of test cycles given	40 per min.	40 per min.
	Total No. of test cycles	1×10^6	
Test results: change in clearance (mm)		AL10D (A-1 Alloy)	BL10D (high-strength zinc alloy)
	Direction perpendicular to the axis	0.036	0.033
	Axial direction	0.052	0.045

*Note: For loading directions, see page H-20.

7. High-Strength Zinc Alloy

The high-strength zinc alloy used for the holders of Link Ball types BL, RBL, and TBS was developed as a bearing alloy by mixing aluminum, copper, magnesium, beryllium, and titanium, with zinc as the base component. This alloy features excellent mechanical properties, seizure resistance, and wear resistance.

1. Chemical composition

Chemical Composition of High-Strength Zinc Alloy

Unit: %

Aℓ	3.0 ~ 4.0
Cu	3.0 ~ 4.0
Mg	0.03 ~ 0.06
Be	0.02 ~ 0.06
Ti	0.04 ~ 0.12
Zn	Rest

2. Mechanical properties

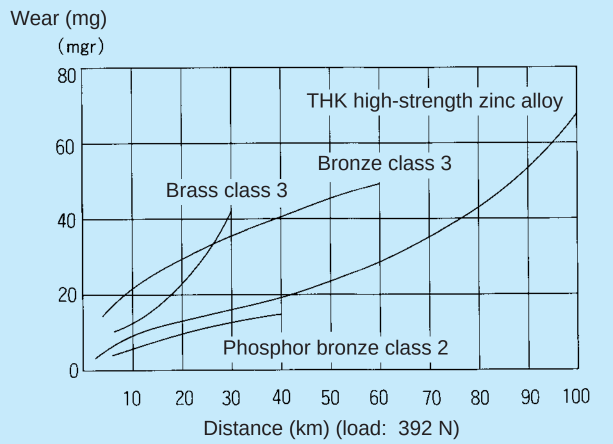
Tensile strength : 275 to 314 N/mm²
Tensile proof stress (0.2%) : 216 to 245 N/mm²
Compressive strength : 539 to 686 N/mm²
Compressive proof stress (0.2%)
: 294 to 392 N/mm²
Fatigue strength : 132 N/mm² x 10^7
(Schenk bending test)
Charpy impact : 0.098 to 0.490 N-m/mm²
Elongation : 1% to 5%
Hardness : 120 to 145 HV

3. Physical properties

Specific gravity : 6.8
Specific heat : 460 J/(kg-k)
Melting point : 390°C
Linear expansion rate : 24 x 10^{-6}

4. Wear resistance

The wear resistance of high-strength zinc alloy is greater than that of brass class 3 and bronze class 3, and practically equivalent to that of phosphor bronze class 2.



Amsler abrasion testing machine
Test-piece rotational speed : 185 min⁻¹ (rpm)
Load : 392 N
Lubricant : Dynamo oil

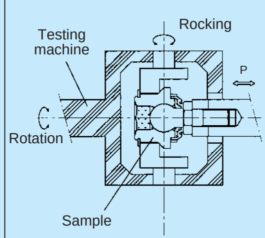
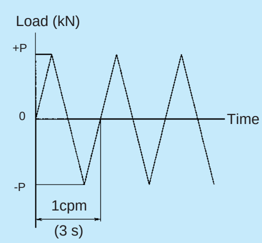
Wear Resistance of High-Strength Zinc Alloy

8. Durability Test Results for Link Ball Type AJ

1. Purpose of the Test

This test was conducted to identify the difference in performance between the THK Link Ball and the equivalent product of a different manufacturer.

2. Subject Products and Test Items and Conditions

Test item	Subject product	Test conditions					
		Applied load P	Rotation or rocking angle	Frequency	Total No of cycles given	Ambient temper-ature	Loading conditions, etc.
Rotation-and-rocking durability	THK AJ14D and different manu-facturer's product	±400 N (axial direction)	Rotation angle $\theta = \pm 50°$ Rocking angle $\alpha = \pm 10°$	20 times/ min	1×10^6	Normal temper-ature	Movement direction  Loading Diagram 

3. Test Results

Subject product	Test results			Evaluation
	Clearance change, mm		Observation	
	Direction perpendicularto the axis	Axial direction		
THK AJ14D	0.013	0.050	After 1×10^6 cycles of testing, the shank rotated smoothly and could continue to be used.	• THK AJ14D features excellent durability and wear resistance under a compound link motion.
Different manufacturer's product (values after 8×10^5 cycles of testing)	0.064	1.320	Chipping occurred after 8×10^5 cycles, and testing could not be continued.	• Wear at the time of chipping occurrence is some four times greater than that of THK AJ14D.

4. General Evaluation

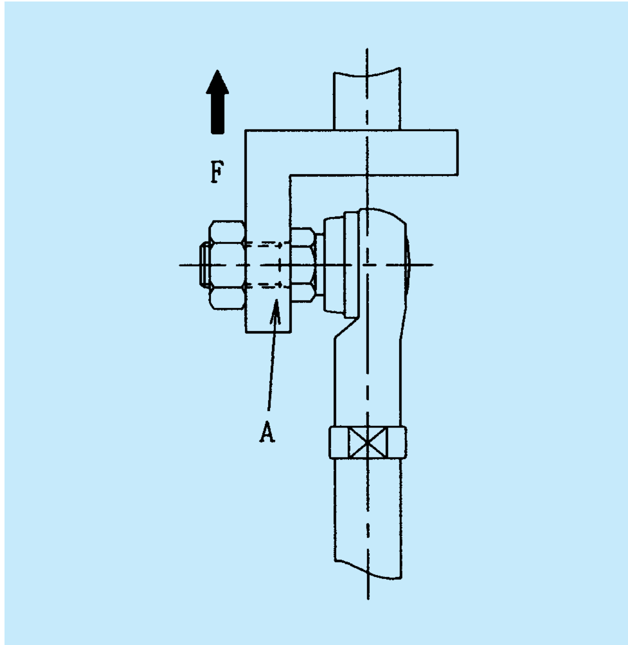
In a comparison between THK AJ14D and a different manufacturer's product made by carrying out a rotation-and-rocking durability test, it was found that THK Link Ball type AJ14D surpasses the different manufacturer's product in terms of both strength and the wear resistance of components.

This is attributable to THK's unique manufacturing process for the holder and shank, the high strength of the newly developed A-1 Alloy, and the effect of the two grease pockets provided at the top and bottom of the spherical section.

9. Tensile-Strength Test Results for Type AL10D

Test method

A unit of Type AL10D was placed on the Amsler universal testing machine as shown. Under a load in the direction perpendicular to the axis, the tensile breaking load was measured.



Test results

Sample No.	Breaking load (kN)	Break location
1	18.82	A
2	18.72	A
3	18.60	A
4	18.78	A
5	18.45	A
6	18.95	A
7	18.65	A
8	18.91	A
9	18.55	A
10	18.50	A
X	18.693	—
R	0.5	—

All samples broke at the shank, verifying that the holder has sufficient strength.

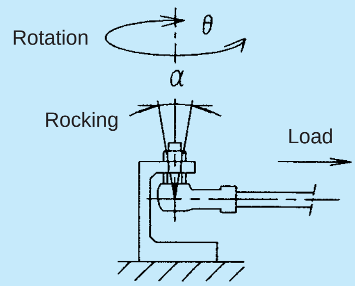
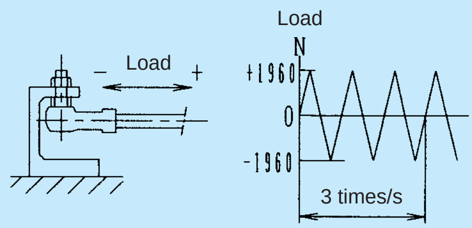
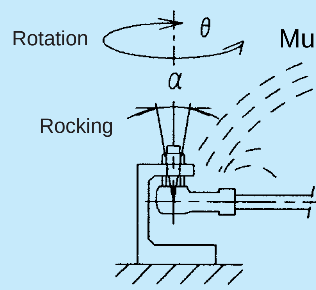
10. Various Durability Test Results for Link Ball Type AL

1. Purpose of the Test

This test was conducted to evaluate the durability of THK Link Ball type AL from various perspectives, as required for automobile suspensions.

2. Subject Product: THK Link Ball Type AL10D

3. Test Items and Conditions, and Results

Test item	Test conditions					
	Applied load	Rotation or rocking angle	Fre-quen-cy	Total No. of cycles given or testing time	Ambient temper-ature	Loading conditions, etc.
Rotation-and-rocking durability	1960 N Loading direction: Perpen-dicular (unilateral)	Rotation angle θ=±5° Rocking angle θ=±10°	Rotation 25 times/min Rocking 75 times/min	5×10^5 (rocking)	Normal temper-ature	
Fatigue durability	±1960 N Loading direction: Perpen-dicular (bilateral)	—	180 times/min	1×10^6 (rocking)	Normal temper-ature	
Muddy-water rotation-and-rocking durability (boot-sealing performance)	—	Rotation angle θ=±12° Rocking angle θ=±12°	Rotation 25 times/min Rocking 75 times/min	5×10^5 (rocking)	Normal temper-ature	 Muddy water jetted to the boot • Jetting rate: 1ℓ/min • JIS Class-8 Kanto roam powder mixed at 10%
Boot weather-ability	—	—	—	96 h	-30°C	Left standing
				96 h	70°C	Left standing
		Rotation angle θ=±10°	60 times/min	144 h	40°C	• Ozone concentration: 80 pphm
Salt-water spray resistance	—	—	—	200 h	35°C	• Salt-water concentration: 5% • Spray-solution temperature: 33°C to 37°C • Spray pressure: 0.098 MPa • Following spraying, a pushing load was applied to measure strength.

4. General Evaluation

In various durability tests, it has been demonstrated that THK Link Ball type AL has sufficient strength, wear and corrosion resistance, and sealing performance in the boot.

This is attributable to the superior characteristics of the newly developed A-1 Alloy, and THK's unique manufacturing process. THK Link Ball type AL thus provides high performance as a reliable lightweight component.

<table>
<tr><th></th><th colspan="3">Test results</th><th>Evaluation</th></tr>
<tr><td rowspan="6"></td><td rowspan="2">Sample No.</td><td colspan="2">Clearance change (mm)</td><td rowspan="6">• Despite severe test conditions consisting of compound link motion under an axial load, no fault was found in the samples after the test, and wear was slight and consistent in all samples.
This demonstrates that the subject product features high wear resistance and stable quality.</td></tr>
<tr><td>Direction perpendicular to the axis</td><td>Axial direction</td></tr>
<tr><td>q</td><td>0.038</td><td>0.020</td></tr>
<tr><td>w</td><td>0.040</td><td>0.030</td></tr>
<tr><td>e</td><td>0.042</td><td>0.040</td></tr>
<tr><td>r</td><td>0.038</td><td>0.030</td></tr>
<tr><td></td><td colspan="3">• Appearance
No fault was noted, including a broken sample.

• Movement
After the test, the ball shank showed smooth rocking motion; no fa ult was noted, including heavy or irregular movement.</td><td>• After 1×10^6 cycles of the fatigue durability test, no fault was found in the appearance or function of the samples. They can therefore continue to be used as is. This demonstrates that the subject product has high durability.</td></tr>
<tr><td></td><td colspan="3">• Movement
After the test, the ball shank showed smooth rocking motion; no fault was noted, including heavy or irregular movement.
• Muddy-water entry
Visual checks of the separated boot revealed no entry of muddy water.
• Boot condition
There was no tearing on the boot or abnormal wear on the lips.</td><td>• No fault was found in the movement of the samples after the test. The fact that no muddy water entered the boot and that the grease did not deteriorate proves the high reliability of the boot-sealing performance.</td></tr>
<tr><td></td><td colspan="3">• Boot condition
There was no harmful ozone cracking on the boot following the test; the softness remained the same as before the test.</td><td>• No fault was found in the movement of the samples. The fact that no muddy water entered the boot and that the grease did not deteriorate proves the high weatherability of the boot.</td></tr>
<tr><td></td><td colspan="3">• Appearance
No fault was noted, including erosion on the holder or a broken sample.
• Movement
After the test, the ball shank showed smooth rocking motion.</td><td>• Following the test, there was no deterioration in the function or performance of the samples attributable to erosion. This demonstrates that A-1 Alloy has high corrosion resistance.</td></tr>
</table>

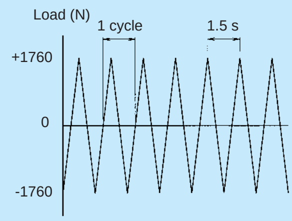
11. Various Durability Test Results for Link Ball Type BL

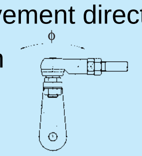
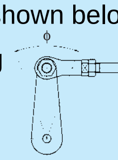
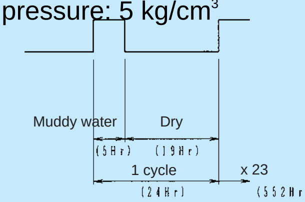
1. Purpose of the Test

This test was conducted to evaluate differences in performance between THK Link Ball type BL and the equivalent product of a different manufacturer.

The test results were useful to promote sales of type BL for applications in the transmission controls of automobiles, trucks, and buses; links in the steering systems of agricultural tractors; and the like.

2. Subject Product and Test Items, Conditions, and Results

<table>
<tr><th rowspan="2">Test item</th><th rowspan="2">Subject product</th><th colspan="6">Test conditions</th></tr>
<tr><th>Applied load</th><th>Rotation or rocking angle</th><th>Frequency</th><th>Total No. of cycles given or testing time</th><th>Ambient temperature</th><th>Loading conditions, etc.</th></tr>
<tr><td>Rotation-and-rocking durability</td><td>THK BL10D and different manufacturer's product</td><td>±1760 N (direction perpendicular to the axis)</td><td>Rotation angle $\theta = \pm 20°$
Rocking angle $\alpha = \pm 20°$</td><td>40 times/min</td><td rowspan="5">1×10^6</td><td>Normal temperature</td><td>The loading diagram is as shown below.


The movement direction is as shown below.
Rotation  Rocking </td></tr>
<tr><td>Low-temperature rotation durability</td><td rowspan="2">THK Type BL10D only</td><td rowspan="4">±1225 N (direction perpendicular to the axis)</td><td rowspan="2">Rotation angle $\theta = \pm 30°$</td><td rowspan="4">60 times/min</td><td>-30°C</td><td>Low-temperature retention time: 280 h
Motion in the rotational direction</td></tr>
<tr><td>High-temperature rotation durability</td><td>100°C</td><td>High-temperature retention time: 280 h
Motion in the rotational direction</td></tr>
<tr><td>Muddy-water rotation durability</td><td>THK Type BL10D only</td><td>Rotation angle $\theta = \pm 30°$</td><td rowspan="2">Normal temperature</td><td rowspan="2">Motion given: Rotation and rocking separate
Muddy-water jetting pattern
Muddy-water concentration:
Salt and dust at 5 Wt% in 1 ℓ of water
Jetting direction: Onto boot lips
Jetting pressure: 5 kg/cm³

</td></tr>
<tr><td>Muddy-water rocking durability</td><td>THK BL10D and different manufacturer's product</td><td>Rocking angle $\alpha = \pm 20°$</td></tr>
</table>

3. General Evaluation

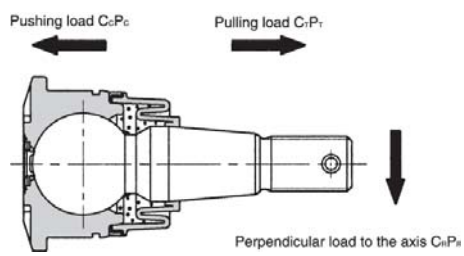
- In a comparison based on typical durability tests between THK Type BL10D and the equivalent product of a different manufacturer, it has been demonstrated that THK Type BL10D features superior holder strength, wear resistance, and boot-sealing performance.
- These features are attributable to THK's unique manufacturing process for the holder and shank, the material used, the grease pockets provided at the top and bottom of the spherical section, and the development of a highly sealable boot.

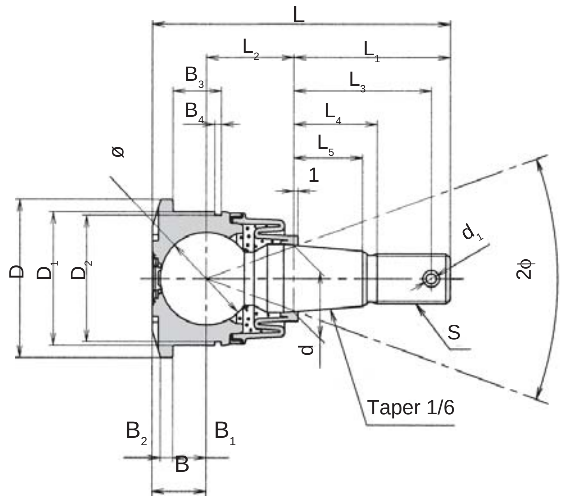
		Test results				Evaluation
		Sample No.	Clearance change (μm) Direction perpendicular to the axis	Clearance change (μm) Axial direction	Holder condition	
	THK BL10D	q	26	42	The shank showed smooth movement even after 1×10^6 cycles of the test; the samples can continue to be used.	• In compound link motion as well, THK Type BL10D was found to surpass the non-THK product in terms of holder durability and wear resistance.
		w	25	40		
	Product of a different manufacture	q	Breakage at the holder neck after 8,600 cycles 154	60	After approximately 1.5×10^5 cycles of the test, wear and damage were noted on the holder spherical surface.	• The wear immediately before holder breakage in the non-THK product was six times greater than that in THK Type BL10D.
		w	Breakage at the holder neck after 151,300 cycles 62	20		
	THK BL10D	q	63	65	Low temperatures did not cause cracking or other faults on the boot.	• THK Type BL10D has proven to be fully applicable for outdoor use in cold areas.
		w	56	59		
	THK BL10D	q	79	84	High temperatures did not cause abnormal wear on the holder or thermal deterioration on the boot.	• THK Type BL10D has proven to be fully applicable for use in hot areas near truck engines.
		w	74	78		
	THK BL10D	q	48	51	Wear caused by entry of muddy water did not occur.	• THK Type BL10D has proven to be fully applicable for use in an environment subjected to muddy water, such as parts of trucks, construction-work vehicles, agricultural machines, and the like, as the high sealing performance of the boot prevents the entry of water and mud.
		w	57	63		
	THK BL10D	q	32	38	Wear caused by entry of muddy water did not occur.	
		w	35	42		
	Product of a different manufacture	q	240	105	Muddy water entered the boot, causing chipping to the spherical surface and cuts on the boot interior.	• The non-THK product cannot be used in an environment subjected to muddy water, as chipping and other problems occur. In addition, the spherical surface wears to an extraordinary degree, 7.4 times greater than the wear on THK Type BL10D, at 0.24 mm. The fit becomes too loose.
		w	246	107		

Type AJ — New product

Model No.	External dimensions, mm		Holder dimensions, mm							Thread
	D	L	D_1 s6	D_2	B	B_1 ±0.3	B_2	B_3 $^{+0.2}_{0}$	B_4 $^{+0.1}_{0}$	S JIS Class 2
AJ10D	33	61	28	26.6 $^{0}_{-0.21}$	11	6.8	2.6	9.6	1.6	M10 × 1.25
AJ12D	38	71.5	32	30.3 $^{0}_{-0.25}$	13	8	3	11.6	1.6	M12 × 1.25
AJ14D	45	82	38	36 $^{0}_{-0.25}$	15	9	3.5	12.8	1.8	M14 × 1.50

1. Material
   Holder : A-1 Alloy (See Page H-22)
   Ball shank : Bearing steel ball with a hardness of Hv650 or higher
   Shank : SCM435 (H_RC32 to 38)
   Color-chromate-treated
   Boot : NBR-based special synthetic rubber
2. Spherical clearance
   Direction perpendicular to the axis : 0.02 to 0.05 mm max.
   Axial direction : 0.1 mm max.
3. Yield strength : Strength in the direction shown below





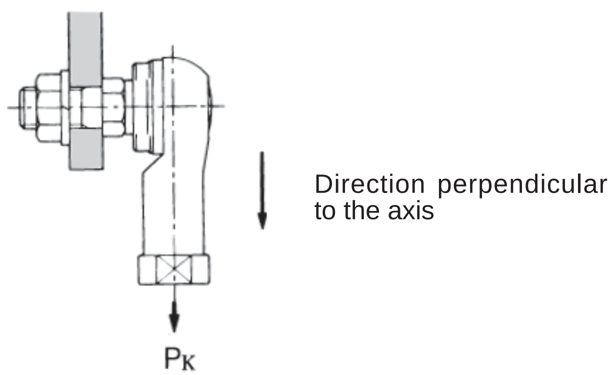
Ball-shank dimensions, mm							Ball diameter	Permissible tilting angle	Static-load-carrying capability, N			Yield strength, N			Mass
L_1 0 -1.0	L_2 ±0.3	L_3 ±0.5	L_4 +0.5 -1.0	L_5 0 -0.26	d	d_1	ϕ	2θ	C_C	C_T	C_R	P_C	P_T	P_R	g
32	18	28.5	17	14	14	2	19.05	40º	38100	9900	33100	18600	13800	14800	80
37.5	21	33	20	16.5	16	2.5	22.225	40º	52000	13600	45200	21300	18900	20100	140
43	24	38	23	18.8	18	3.2	25.4	40º	67800	17600	58900	32900	24700	26200	230

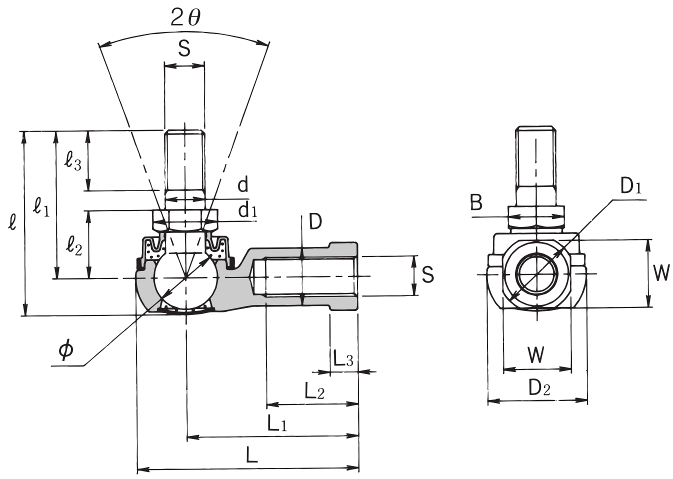
4. Lithium soap-based grease No. 2 is sealed in the boot and cap.

Type AL — New product

Model No.	External dimensions, mm Length L	Diameter D_2	Height ℓ	Thread S JIS Class 2	Holder dimensions, mm L_1	L_2	L_3	D	D_1	W $^{0}_{-0.3}$
AL 4D	24.5	13	20	M 4 × 0.7	18	8	4	7.5	9.5	8
AL 5D	34.5	15	26.7	M 5 × 0.8	27	15	4	9	12	10
AL 6D	38.5	17	32.6	M 6 × 1	30	16	5	10	13	11
AL 8D	46	20	38.6	M 8 × 1.25	36	19	6	13	16	14
AL10D	56	26	46.3	M10 × 1.25	43	23	7	15.5	19	17
AL10BD	56	26	52.3	M10 × 1.5	43	23	7	15.5	19	17

1. Material
   Holder : A-1 Alloy (See Page H-22)
   Ball shank : Bearing steel ball with a hardness of Hv650 or higher
   Shank : S35C (H_RC20 to 28) Color-chromate-treated
   Boot : NBR-based special synthetic rubber
2. Spherical clearance
   Direction perpendicular to the axis : 0.02 to 0.06 mm max.
   Axial direction : 0.3 mm max.
3. The recommended tolerance for the hole into which the ball shank is inserted is H10.
4. Yield strength : Strength in the direction shown below





Ball-shank dimensions, mm						Ball diameter	Permissible tilting angle	Static-load-carrying capability	Yield strength	Mass
d	ℓ_1	ℓ_2	ℓ_3	Hexagon B		ϕ		C_S	P_K	
h9		±0.3		$^{0}_{-0.3}$	d_1	mm	2θ	N	N	g
4	15	7	6	7	8.1	7.938	40°	4510	1370	7
5	21	10	8	8	9.2	9.525	40°	6470	2250	12
6	26	11	11	10	11.6	11.112	40°	9900	3920	18
8	31	14	12	12	13.8	12.7	40°	12500	6570	32
10	37	17	15	14	16.2	15.875	40°	18300	11300	65
10	43	17	21	14	16.2	15.875	40°	18300	11300	68

5. Lithium soap-based grease No. 2 is sealed in the boot and cap.
6. The left-hand internal thread should be identified by its cap color and impression.

[Ex.] Type AL 6 D L

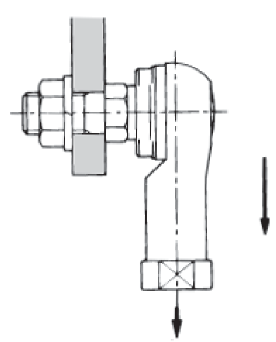
- L — Left-hand thread
- D — Boot provided
- AL 6 — Model No.

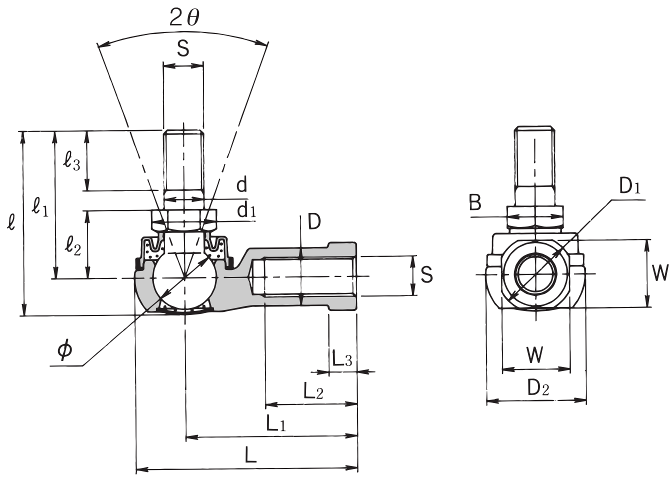
Thread	Identification	
	Cap color	Impression on the cap
Right-hand	White	—
Left-hand	Yellow	Impress “L”

Type BL

Model No.	External dimensions, mm			Thread	Holder dimensions, mm					
	Length L	Diameter D_2	Height ℓ	S JIS Class 2	L_1	L_2	L_3	D	D_1	W $^{0}_{-0.3}$
BL 6 D	38	16	32.6	M 6 × 1	30	16	5	10	13	11
BL 8 D	45.5	19	38.6	M 8 × 1.25	36	19	6	12.5	16	14
BL 10 D	55.5	25	46.3	M10 × 1.25	43	23	7	14.5	19	17
BL 10 BD	55.5	25	52.3	M10 × 1.5	43	23	7	14.5	19	17
BL 12 D	64.5	29	52.7	M12 × 1.25	50	26	8	17.5	22	19
BL 12 BD	64.5	29	59.7	M12 × 1.75	50	26	8	17.5	22	19
BL 14 D	74	34	68.4	M14 × 1.5	57	30	10	20	25	22
BL 14 BD	74	34	74.4	M14 × 2	57	30	10	20	25	22
BL 16 D	83	38	74	M16 × 1.5	64	34	11	22	27	24
BL 16 BD	83	38	80	M16 × 2	64	34	11	22	27	24

1. Material
   Holder : A-1 Alloy (See Page H-23)
   Ball shank : Bearing steel ball with a hardness of Hv650 or higher
   Shank : S35C (H_RC20 to 28)
   Color-chromate-treated
   Boot : NBR-based special synthetic rubber
2. Spherical clearance
   Direction perpendicular to the axis : 0.02 to 0.06 mm max.
   Axial direction : 0.3 mm max.
3. The recommended tolerance for the hole into which the ball shank is inserted is H10.
4. Yield strength : Strength in the direction shown below





Thread S JIS Class 2	Ball-shank dimensions, mm d h9	ℓ_1	ℓ_2 ±0.3	ℓ_3	Hexagon B $^{0}_{-0.3}$	d_1	Ball diameter φ mm	Permissible tilting angle 2θ	Static-load-carrying capability C_S N	Yield strength P_K N	Mass g
M 6 × 1	6	26	11	11	10	11.6	11.112	40°	9900	3920	26
M 8 × 1.25	8	31	14	12	12	13.8	12.7	40°	12500	6570	49
M10 × 1.25	10	37	17	15	14	16.2	15.875	40°	18300	11300	87
M10 × 1.5	10	43	17	21	14	16.2	15.875	40°	18300	11300	90
M12 × 1.25	12	42	19	17	17	19.6	19.05	40°	26700	16400	143
M12 × 1.75	12	49	19	24	17	19.6	19.05	40°	26700	16400	148
M14 × 1.5	14	56	21.5	22	19	21.9	22.225	40°	36400	19800	235
M14 × 2	14	62	21.5	28	19	21.9	22.225	40°	36400	19800	245
M16 × 1.5	16	60	23.5	23	22	25.4	22.225	40°	36400	26900	315
M16 × 2	16	66	23.5	29	22	25.4	22.225	40°	36400	26900	325

5. Lithium soap-based grease No. 2 is sealed in the boot and cap.
6. The left-hand internal thread should be identified by its cap color and impression.

[Ex.] Type BL 6 D L

- L — Left-hand thread
- D — Boot provided
- BL 6 — Model No.

Thread	Identification: Cap color	Impression on the cap
Right-hand	White	—
Left-hand	Yellow	Impress “L”

H

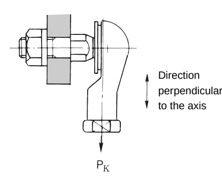
Type RBL — Semi-standard product

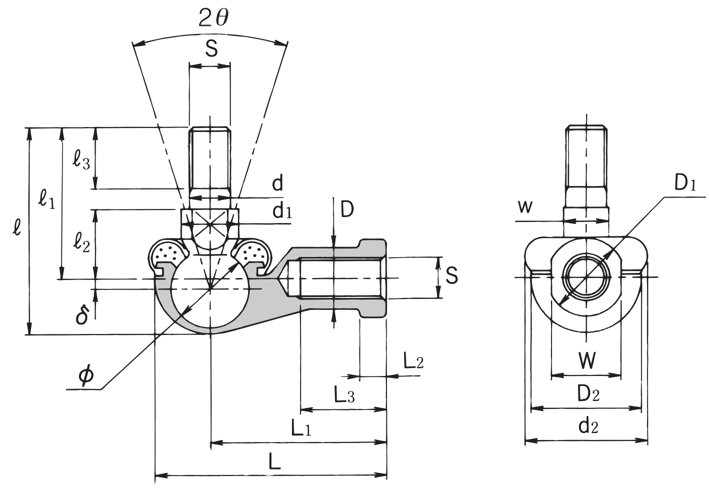
Model No.	External dimensions, mm			Thread	Holder dimensions, mm					
	Length L	Diameter D_2	Height ℓ	S JIS Class 2	L_1	L_2	L_3	D	D_1	W $^{0}_{-0.3}$
RBL 5 D	35	16	29	M 5 × 0.8	27	4	14	9	11	9
RBL 6 D	40	19	35.5	M 6 × 1	30	5	14	10	13	11
RBL 8 D	48	23	42.5	M 8 × 1.25	36	5	17	12.5	16	14
RBL 10 D	57	27	50.5	M10 × 1.25	43	6.5	21	15	19	17
RBL 10 BD	57	27	56.5	M10 × 1.5	43	6.5	21	15	19	17
RBL 12 D	66	31	57.5	M12 × 1.25	50	6.5	25	17.5	22	19
RBL 12 BD	66	31	64.5	M12 × 1.75	50	6.5	25	17.5	22	19
RBL 14 D	75	35	73.5	M14 × 1.5	57	8	26	20	25	22
RBL 14 BD	75	35	79.5	M14 × 2	57	8	26	20	25	22
RBL 16 D	84	39	79.5	M16 × 1.5	64	8	32	22	27	22
RBL 16 BD	84	39	85.5	M16 × 2	64	8	32	22	27	22
RBL 18 D	93	44	90	M18 × 1.5	71	10	34	25	31	27
RBL 20 D	99	44	90	M20 × 1.5	77	10	35	27.5	34	30
RBL 22 D	109	50	95	M22 × 1.5	84	12	41	30	37	32

1. Material
   - Holder : A-1 Alloy (See Page H-23)
   - Ball shank : Bearing steel ball with a hardness of Hv650 or higher
   - Shank : S35C
     Color-chromate-treated
   - Boot : NBR-based special synthetic rubber

2. Spherical clearance
   - Direction perpendicular to the axis : 0.02 to 0.06 mm max.
   - Axial direction : 0.3 mm max.

3. Yield strength:
   Strength in the direction shown below





Thread S JIS Class 2	Ball-shank dimensions, mm d h9	ℓ_1	ℓ_2 ±0.3	ℓ_3	w $^{0}_{-0.3}$	d_1	Boot d_2	Eccen-tricity δ mm	Ball diameter ϕ mm	Permissible tilting angle 2θ	Static-load-carrying capability C_S N	Yield strength P_K N	Mass g
M 5×0.8	5	21	10	8	7	9	19	1	11.112	45°	9220	2250	24
M 6×1	6	26	11	11	8	10	20	1.2	12.7	45°	12100	3530	37
M 8×1.25	8	31	14	12	10	12	24	2	15.875	45°	19100	6570	67
M10×1.25	10	37	17	15	11	14	30	2.5	19.05	45°	27500	10700	110
M10×1.5	10	43	17	21	11	14	30	2.5	19.05	45°	27500	10700	113
M12×1.25	12	42	19	17	17	19	32	2	22.225	45°	37500	16400	165
M12×1.75	12	49	19	24	17	19	32	2	22.225	45°	37500	16400	170
M14×1.5	14	56	21.5	22	17	19	38	2	25.4	45°	48900	19800	255
M14×2	14	62	21.5	28	17	19	38	2	25.4	45°	48900	19800	260
M16×1.5	16	60	23.5	23	19	22	44	2	25.4	45°	48900	26900	335
M16×2	16	66	23.5	29	19	22	44	2	25.4	45°	48900	26900	340
M18×1.5	18	68	26.5	25	20	23	48	4.5	28.575	45°	61900	33300	465
M20×1.5	20	68	27	25	24	29	50	2	28.575	45°	61900	45900	540
M22×1.5	22	70	28	26	24	27	54	5.0	31.75	45°	75400	48000	715

4. The recommended tolerance for the hole into which the ball shank is inserted is H10.
5. Lithium soap-based grease No. 2 is sealed in the boot and cap.
6. The permissible tilting angle when no boot is provided is approximately 5° greater than otherwise.
7. The left-hand internal thread should be marked "L." The marking "L" is placed on the portion with which a wrench is to be engaged.
8. Thin typeface in a model number indicates that the model is a semi-standard product. Use of type BL

[Ex.] Type RBL 10 D L

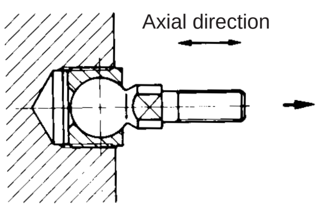
- L — Left-hand thread
- D — Boot provided
- RBL 10 — Model No.

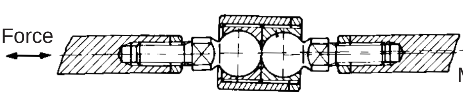
H

Type TBS

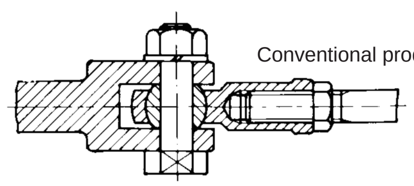
Model No.	External dimensions, mm		Holder dimensions, mm					Shaft diameter	
	Thread S_0 JIS Class 2	Length L	B	B_1	B_2	B_3	W $^{0}_{-0.3}$	d h9	Thread S JIS Class 2
TBS 6	M20 × 1.5	34.2	11.5	8	2	7	17	6	M 6 × 1
TBS 8	M22 × 1.5	41.5	14.5	11	2	8.5	19	8	M 8 × 1.25
TBS 10	M25 × 1.5	55.5	17	13.5	2	10	22	10	M10 × 1.5
TBS 12	M30 × 1.5	63	20	15.5	3	12	27	12	M12 × 1.75

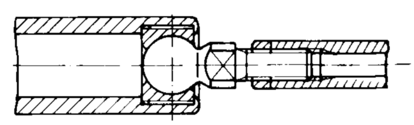
1. Material
   Holder : A-1 Alloy (See Page H-23)
   Ball shank : Spherical-section hardness Hv650 min.
   Shank : S35C
   Color-chromate-treated
2. Spherical clearance
   Direction perpendicular to the axis
   : 0.03 mm max.
   Axial direction : 0.1 mm max.
3. Outer-ring mounting internal thread: JIS Class 2
4. Yield strength : Strength in the direction shown below

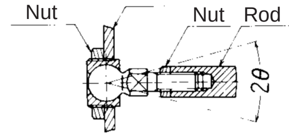


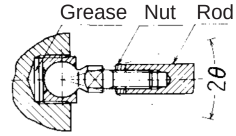


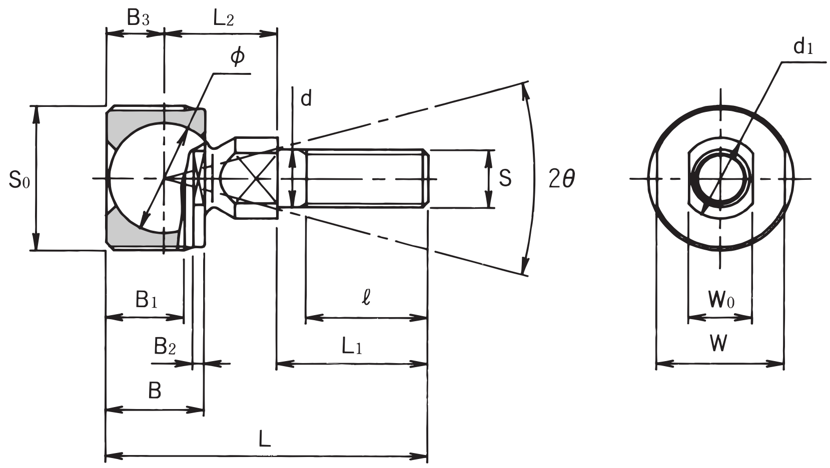
5. Sample assembly
   Compared with assembly using a conventional Frog-type joint as shown below, the unit itself is compact and the mounting procedures are simple.











Ball-shank dimensions, mm						Permissible tilting angle	Yield strength	Static-load-carrying capability			Mass
								Direction perpen-dicular to the axis	Axial direction		
Ball diameter ϕ	d_1	L_1	L_2	ℓ	W_0 0 -0.3	2θ	P_K N	C_S N	C_{sa} (Tensile) N	C_{sa} (Compressive) N	g
12.7	10	15	12.2	11	8	30°	2450	13700	4900	12000	30
15.875	12	17	16	12	10	30°	5200	24600	10400	17600	50
19.05	14	26	19.5	21	11	30°	7250	32700	14400	25000	80
22.225	19	30	21	24	17	30°	9220	44000	18300	35000	130

6. Lubrication

As the holder contains a grease reservoir, grease can be applied whenever necessary.