

**Technical
Reference**

Smooth Silent Ecological

Caged Technology

THK CO., LTD.
TOKYO, JAPAN

CATALOG No.268-2E

Caged Technology

Introduction

Since ball bearings in the initial stage of development were not provided with a cage, they produced high levels of noise, had a short service life and were unable to be used at high rotating speeds.

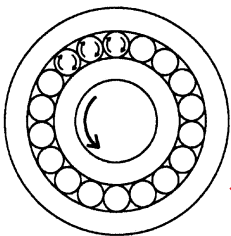
Later, caged ball bearings were developed that exhibited low noise levels even at high rotating speeds.

In addition, these caged ball bearings were able to demonstrate long service life despite the number of balls being fewer than full ball types, and evolved significantly so that they were able to be used in a wide range of applications.

THK, the first manufacturer in the world to develop the LM Guide, has developed its LM Guide with Caged Ball Technology that is able to achieve a dramatic improvement in performance over conventional products. The LM Guide with Caged Ball Technology delivers a long service life and excellent high-speed performance in the same manner as roller bearings, while also eliminating maintenance for a long period of time.

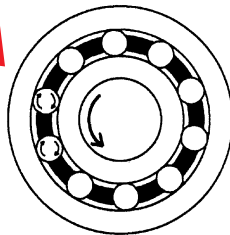
Rotary Bearings

Initial Stage of Development (Full Ball Type)



- Metal contact between balls caused a shortage of grease life.
- Short service life

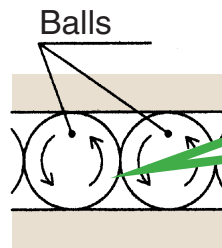
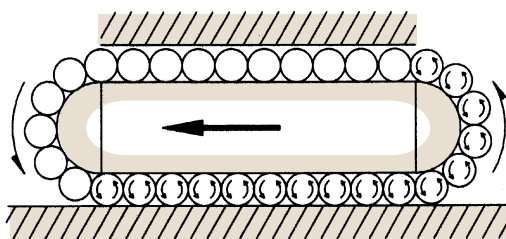
Current Bearings (Caged Ball Type)



- Grease is held by the cage for excellent lubrication.
- No metal contact between balls for extended service life.
- No metal contact between balls suppresses generation of heat.
- No metal contact between balls eliminates ball collision noise.
- Balls exhibit orderly movement for smooth operation.

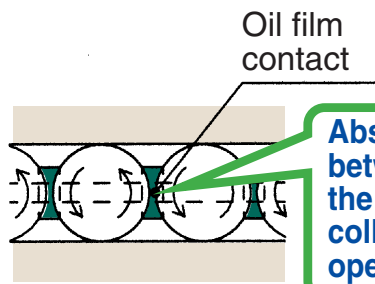
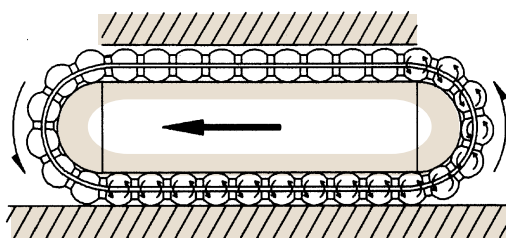
Case of the LM Guide

Without caged ball



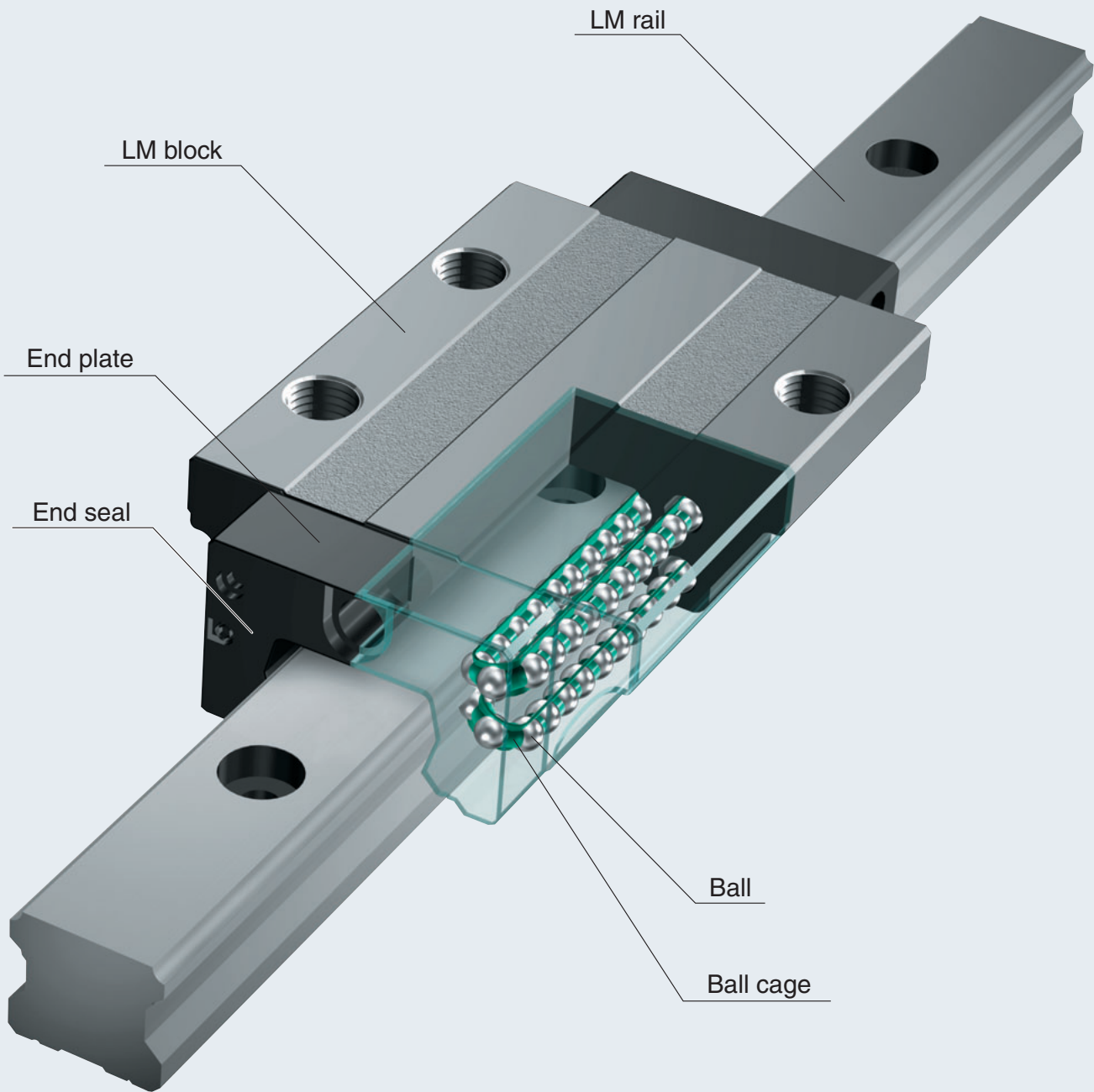
Friction occurs between balls resulting in the generation of collision noise

With caged ball



Absence of friction between balls eliminates the generation of collision noise for quiet operation

Structure of the LM Guide with Ball Cage

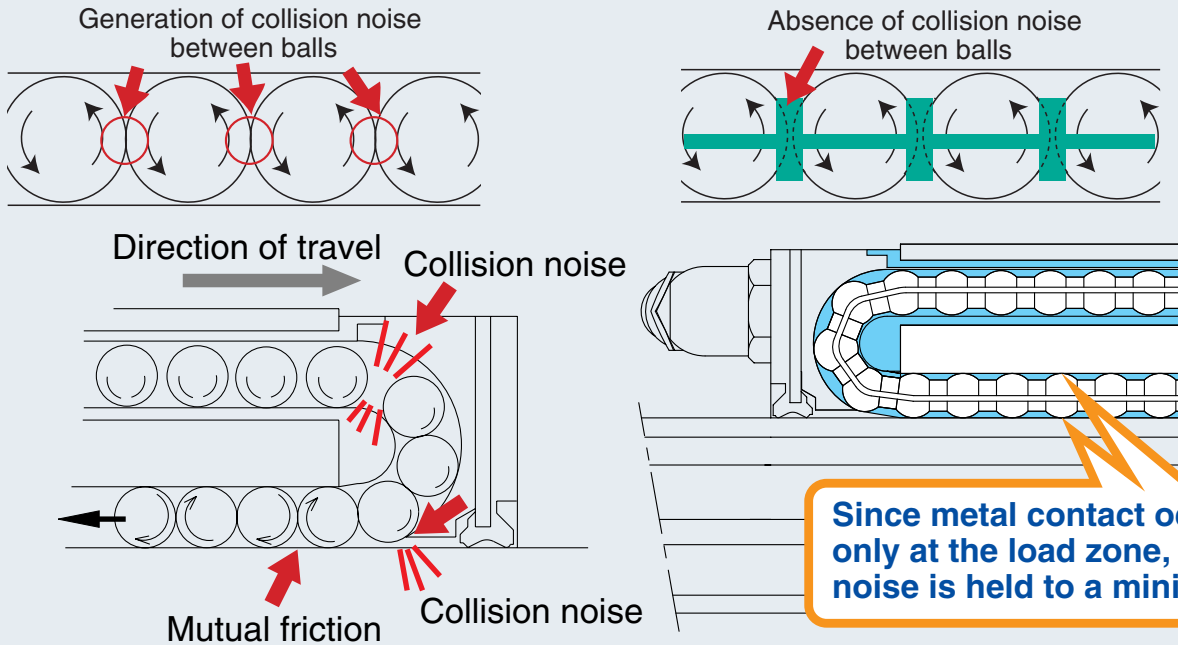


Advantage 1

of Caged Ball

Quiet Operation that Minimizes Metal Contact

Collision noise between balls is eliminated by the ball cage resulting in quiet operation.

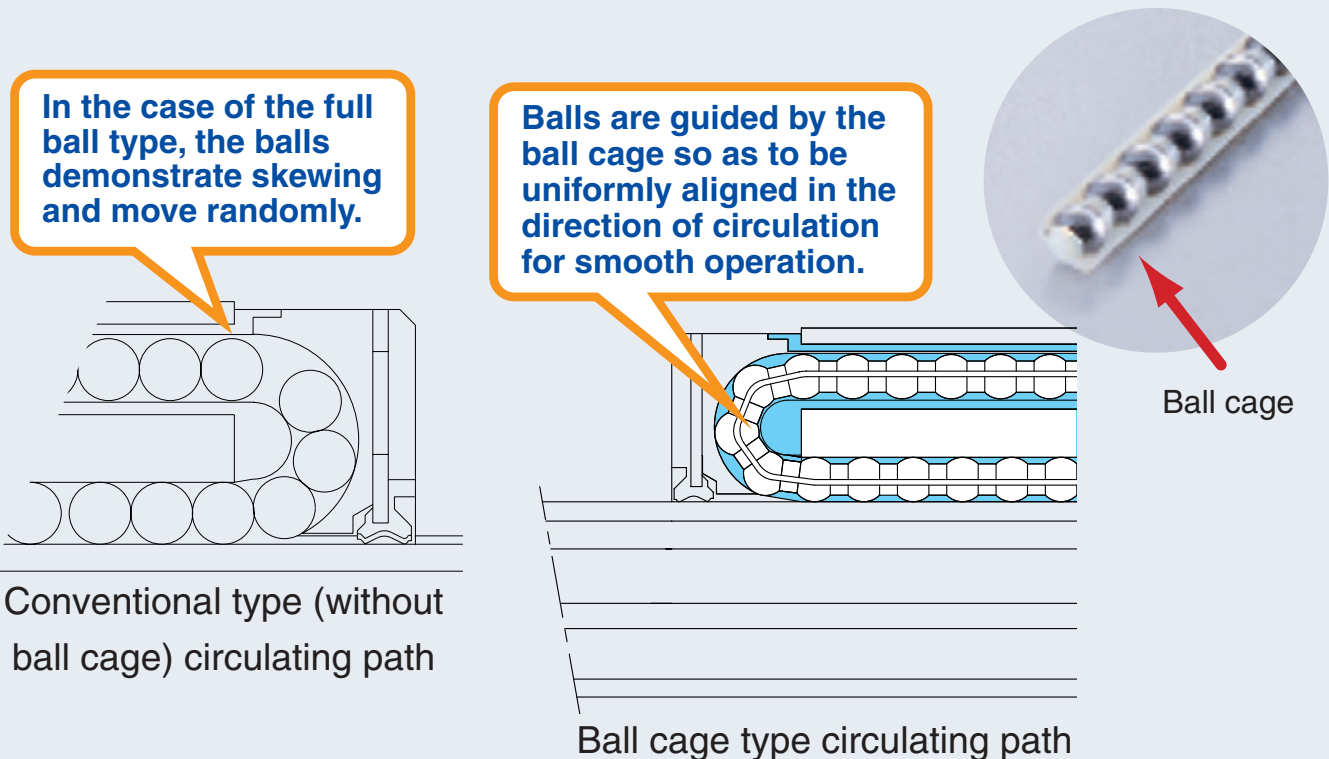


Advantage 2

of Caged Ball

Orderly Ball Movement

Since the balls are held by the ball cage in the form of a belt, they are aligned uniformly and move in a circulating manner. There is no skewing of the balls, while sudden variations in friction are also eliminated, allowing for stable movement.

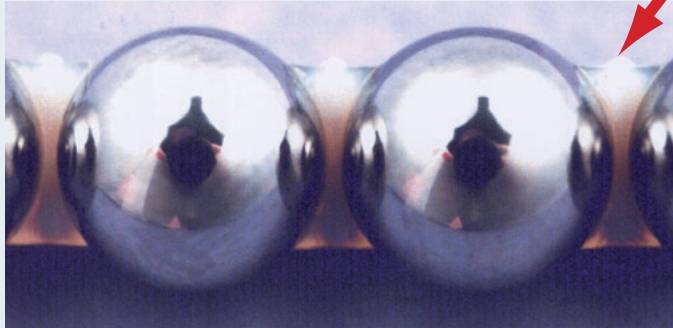


Advantage 3

of Caged Ball

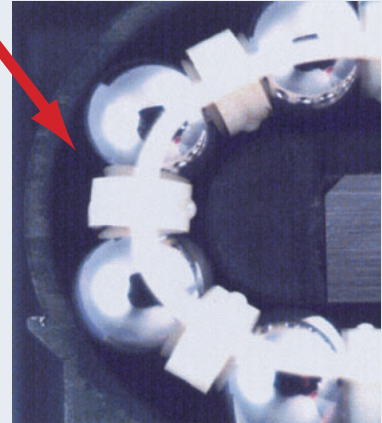
Original Cage Structure Exhibiting Excellent High-Speed Performance

The use of ball cages eliminates generation of heat caused by friction between balls resulting in excellent high-speed performance.



Contact state between balls and ball cage

Ball cage



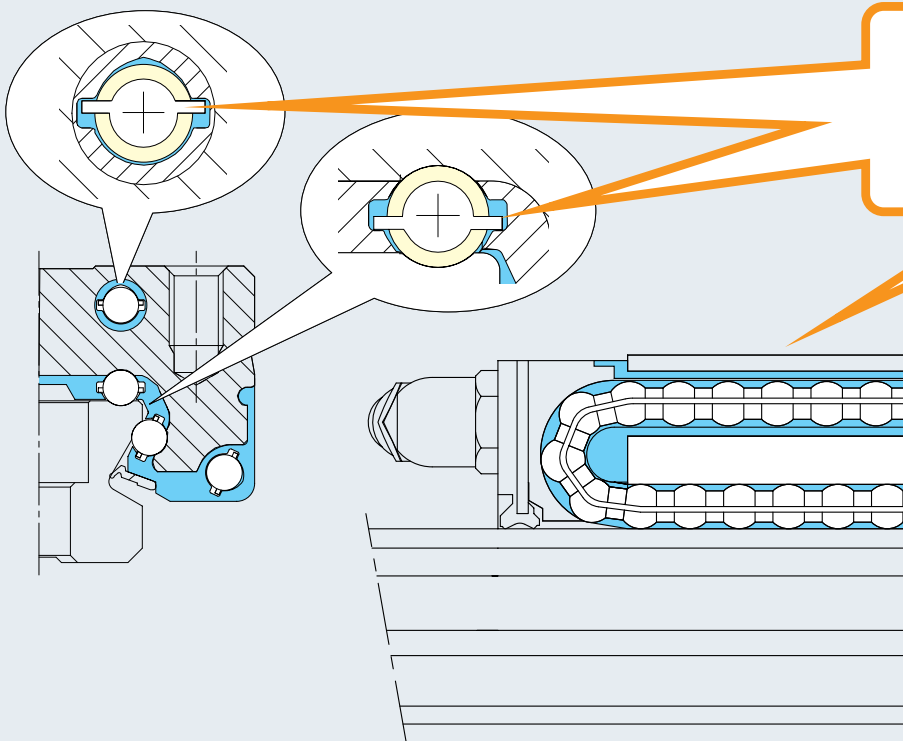
State at turning sections

Advantage 4

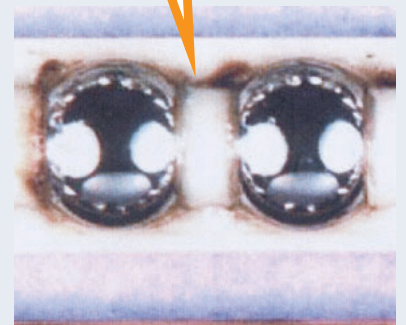
of Caged Ball

Grease Holding Structure (Consecutive Grease Pockets) for Long-Term, Maintenance-Free Operation, Long Service Life

Grease pockets are provided consecutively over the entire ball circulation path to constantly lubricate the balls enabling long-term, maintenance-free operation, Long Service Life.



Grease pockets are provided throughout the ball cage.



Grease retention status after travel (SHS45LV: load endurance test)

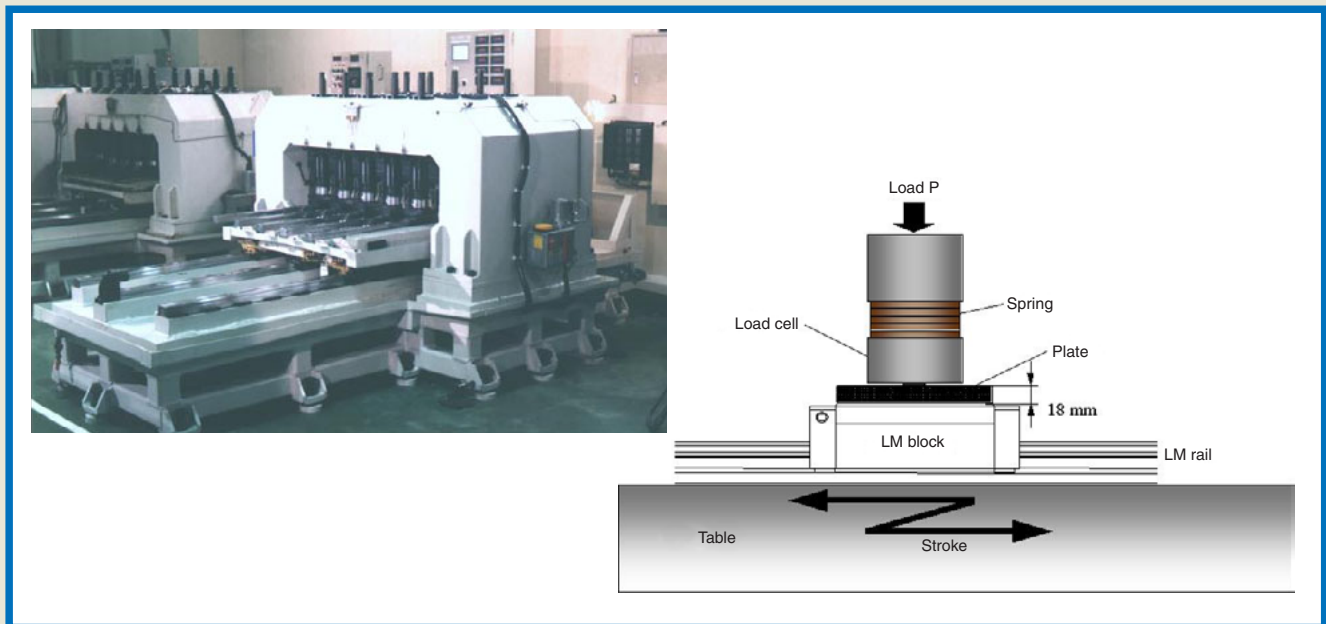
Data on LM Guide with Caged Ball

Improved Service Life

The Caged Ball not only allows the LM guide to be run for a long time period free of maintenance, but also significantly improves the service life of the system. As described below, a performed service life test has offered data about this improvement.

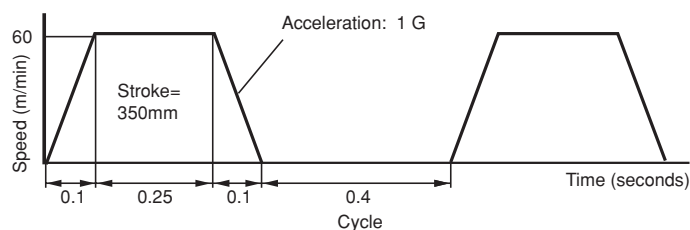
Service life test for LM Guide

1. Testing instrumentation

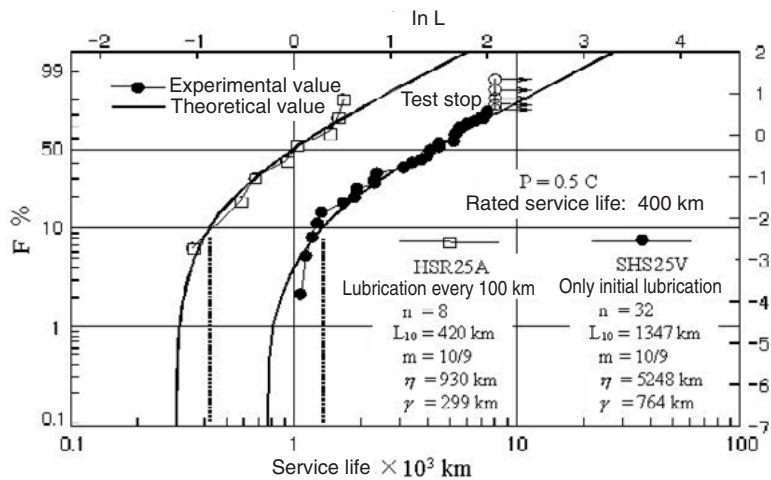


2. Testing parameters

Model : SHS25V1SS+580LP
Number of pieces : 32
Load : 11.1 kN per LM block (0.35 C)
Surface pressure : 2,664 MPa
Lubricant : Lithium soap base grease No. 2, Only initial lubrication



3. Test results



Status of Remaining Grease after the Durability Test

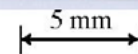


Ball cage before running



Ball cage after running 8,000 km

Nominal life: $L_{10} = 400$ km



Remaining grease is observed in the ball cage.

The results of the performed test indicate that the dynamic durability values of the LM guide implemented by Caged Technology are higher than of the conventional LM guide.

Comparison in terms of dynamic durability values (c) and service life (L)

Calculation Example

LM guide with caged ball Model SHS25L $C=36.8$ kN
 LM guide without caged ball Model HSR25L $C=27.2$ kN
 Under an applied load of $P=13.6$ kN

LM guide with caged ball $L = \left(\frac{C}{P}\right)^3 \times 50 = \left(\frac{36.8}{13.6}\right)^3 \times 50 = 990$ km
 Model SHS25L

LM guide without caged ball $L = \left(\frac{C}{P}\right)^3 \times 50 = \left(\frac{27.2}{13.6}\right)^3 \times 50 = 400$ km
 Model HSR25L

● Comparison in terms of dynamic durability values $\frac{36.8}{27.2} = 1.3$

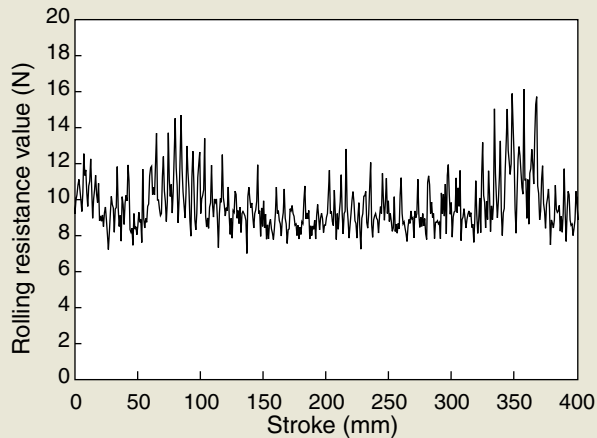
● Service life $\frac{990}{400} = 2.4^*$

*For details, see General catalog

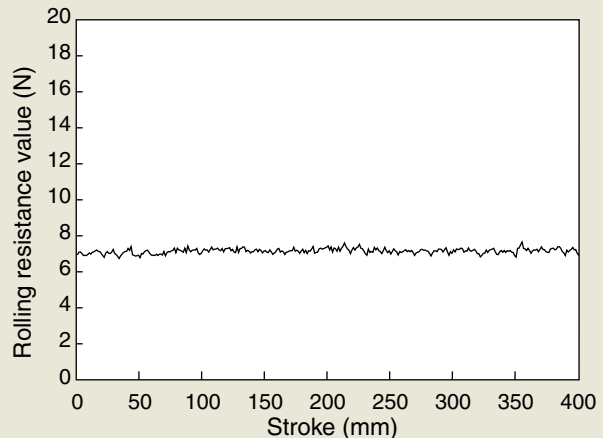
LM Guide with Caged Ball Technology

Rolling Resistance Data

The use of a ball cage enables the balls to be uniformly aligned, eliminating crowding of the balls that occurs when they enter the block. As a result, smooth and stable movement can be obtained in all forms of installation, and fluctuations in rolling resistance are reduced for the realization of high accuracy.



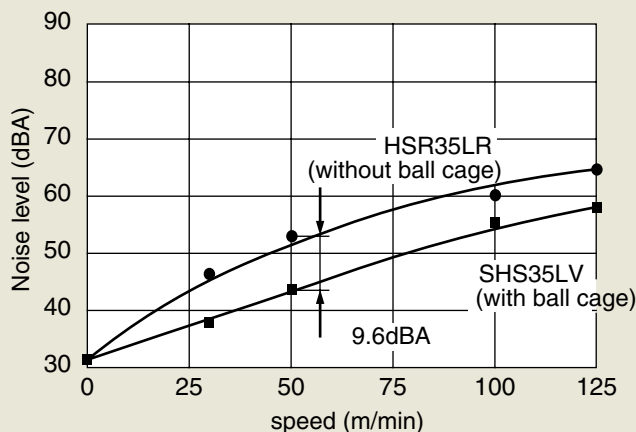
Results of Measuring Fluctuations in Rolling Resistance of HSR25LR (without ball cage)
(feeding speed: 10 mm/sec)



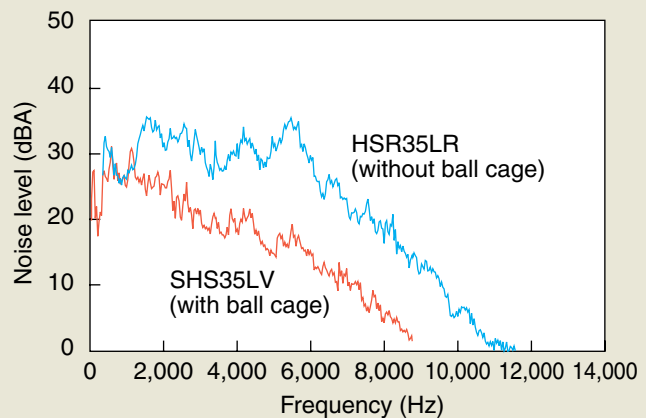
Results of Measuring Fluctuations in Rolling Resistance of SHS25LV (with ball cage)
(feeding speed: 10 mm/sec)

Noise Level Data

The use of a ball cage eliminates interference between balls resulting in low noise levels.



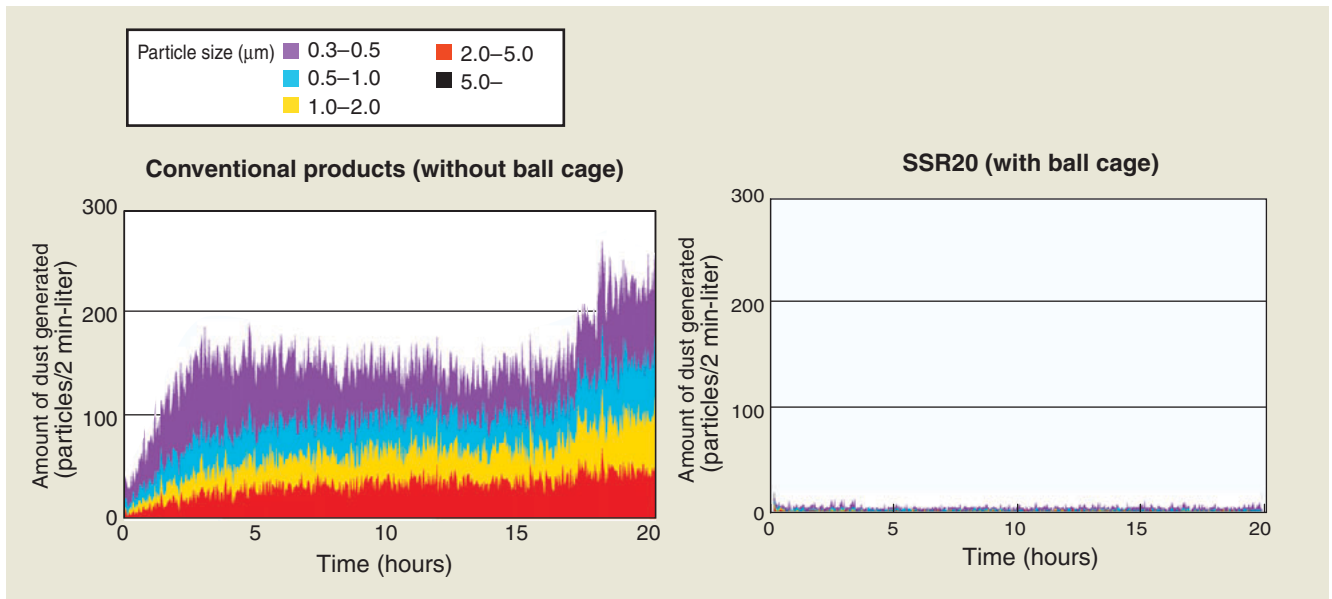
Comparison of Noise Levels Between the SHS35LV and HSR35LR



Comparison of Noise Levels Between the SHS35LV and HSR35LR
(speed: 50 m/min)

Low Generation of Dust

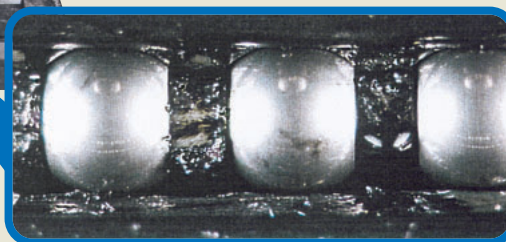
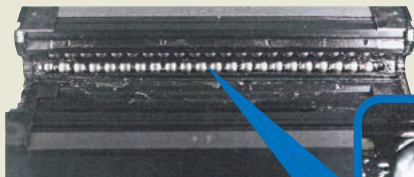
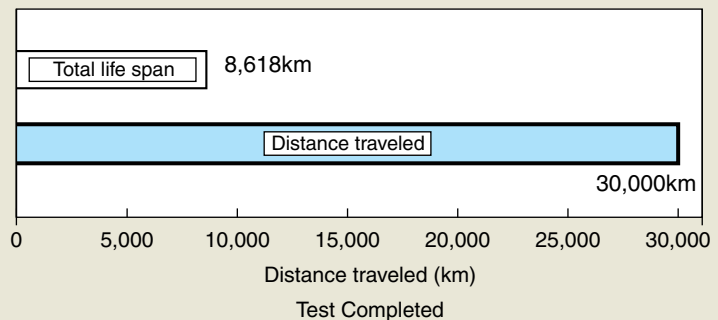
The use of a ball cage eliminates friction between balls resulting in a corresponding decrease in the generation of metal wear fragments for outstanding effects against prevention of the generation of dust.



High-Speed Durability Test Results

Since the use of a ball cage eliminates friction between balls, there is less generation of heat making it possible to demonstrate excellent high-speed operation.

Sample : SHS65LVSS
 Speed : 200 m/min
 Stroke : 2500 mm
 Lubrication : Initial injection of grease only
 Load : 34.5 kN
 Acceleration : 1.5 G



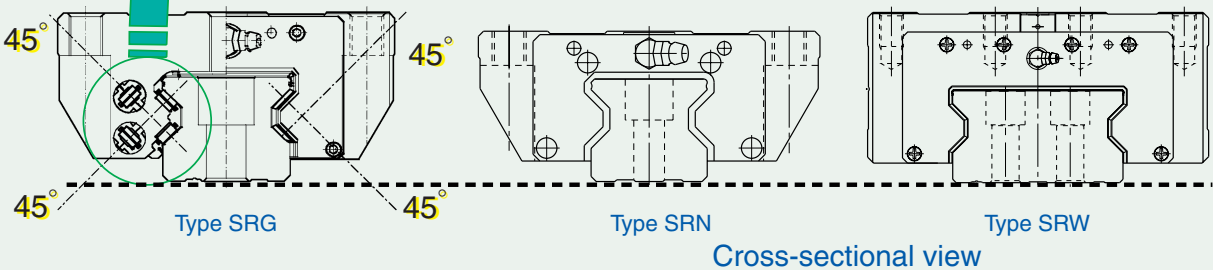
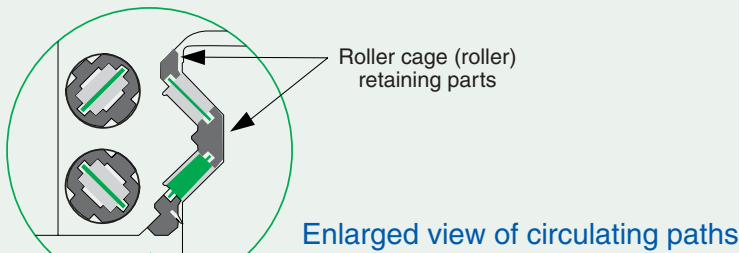
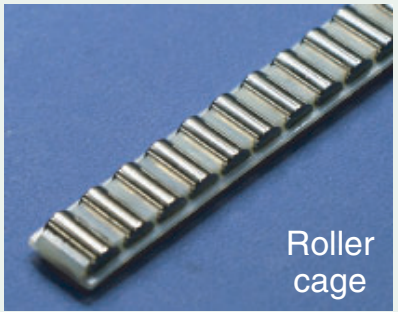
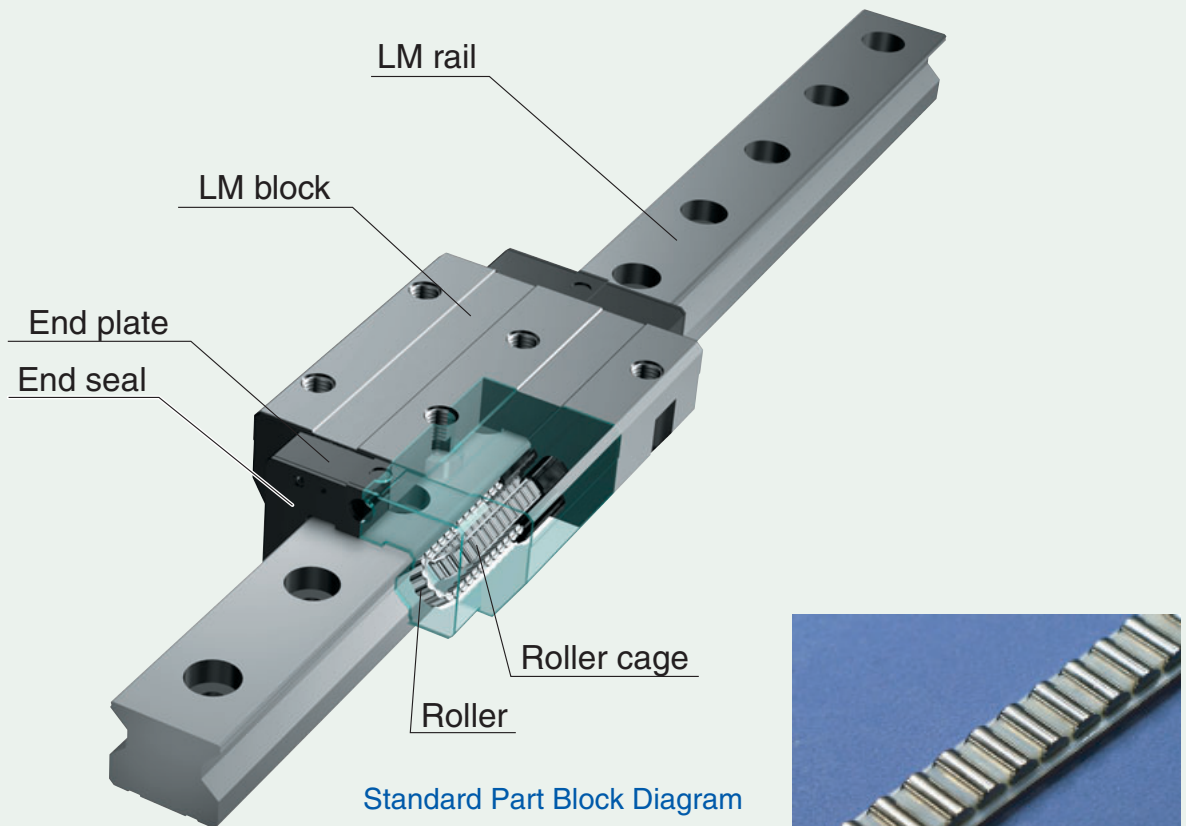
Detailed drawing of ball cage

Grease was still present and there were no abnormalities observed in the balls or grease.

Caged Roller Technology

SRG/SRN/SRW

Structure of the *SRG/SRN/SRW* type



Features of the *SRG/SRN/SRW* type

Prevents roller skewing

The use of a roller cage allows the rollers to circulate while uniformly aligned, preventing skewing when entering block load area, and reducing variation in rolling resistance to obtain stable and smooth movement.

Long-Term, Maintenance-Free Operation

The use of a roller cage eliminates friction between rollers, and retains lubricant in the grease pockets between adjacent rollers, ensuring the required amount of lubricating oil is supplied to the curved contact surfaces of the spacers and rollers of the circulating path to realize long-term maintenance-free operation.

Ultra-High Rigidity

Ultra-high rigidity is achieved by using rollers having a low degree of elastic deformation for the rolling elements and an optimized roller diameter and length. Also, each row of rollers is arranged at a 45° contact angle so that an equal load rating is applied in four directions (radial, reverse radial, and lateral directions).

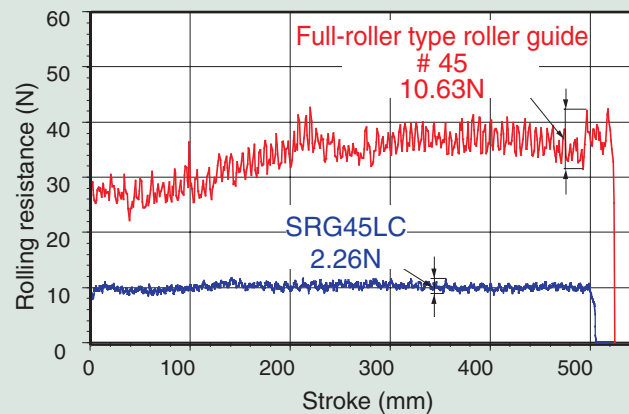
Global Standard Dimensions

The dimensional design complies with the Type HSR developed by THK as the pioneer of linear motion systems and has become the global standard.

LM Guide with Caged Roller Technology

Rolling Resistance Value Data

The use of a roller cage eliminates friction between rollers while also enabling the rollers to circulate while uniformly aligned. As a result, there is reduced occurrence of skewing allowing stable movement.



Durability Data

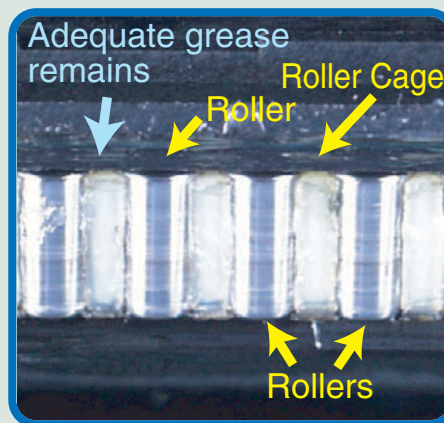
The use of a roller cage enables grease to be retained in the space between adjacent rollers, realizing long-term, maintenance-free operation by inhibiting the escape of grease from the circulating path.

Sample) : SRG45LCC0

Conditions) : Pre-loading : C0 clearance
Speed : 180 m/min
Acceleration : 1.5 G
Stroke : 2300 mm
Lubricant : Initial injection of grease only

- Intermediate results:
No abnormalities during 15,000 km of travel

(flaking or insufficient grease was not observed)



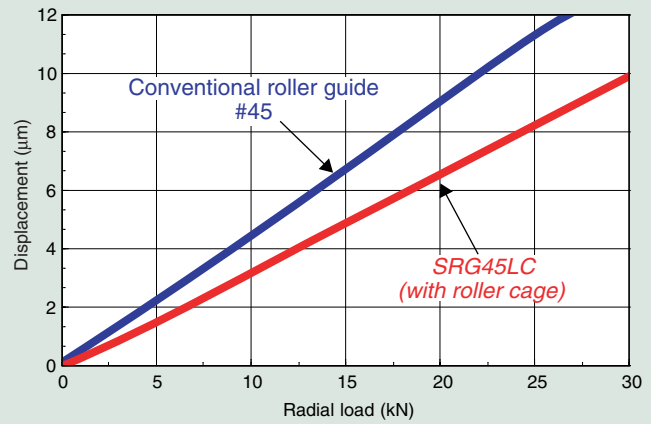
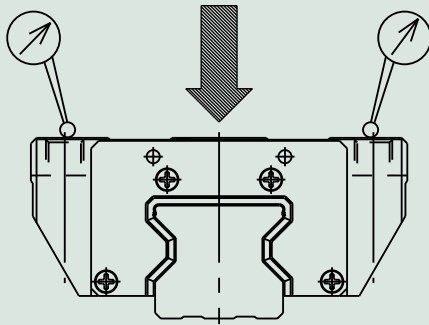
No discoloration of grease is observed.

Detailed drawing of roller cage

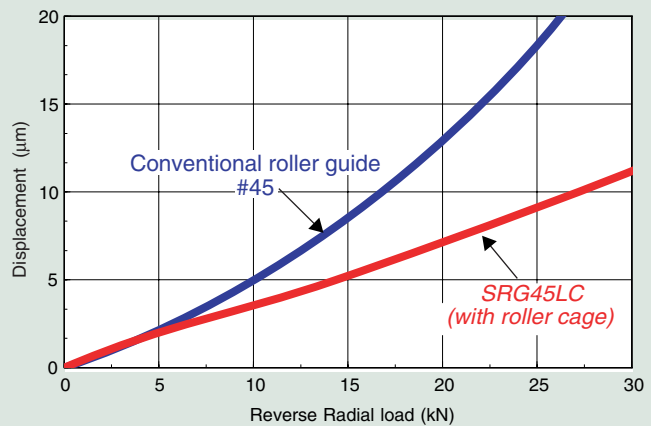
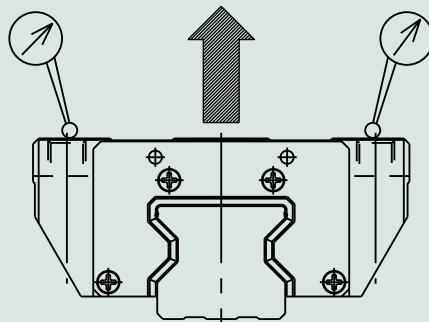
Rigidity values

Radial clearance SRG : Clearance C0
 Conventional roller guide : Equivalent to C0

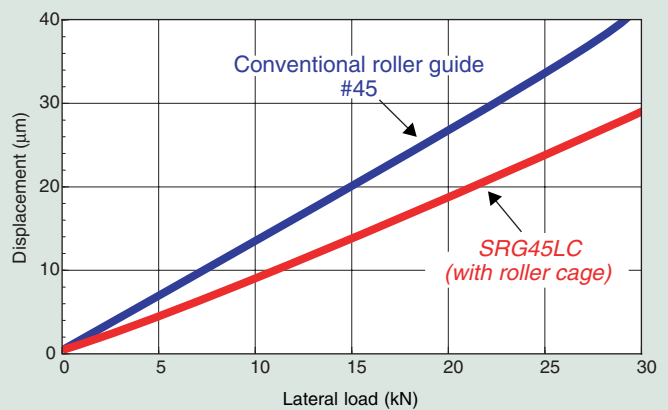
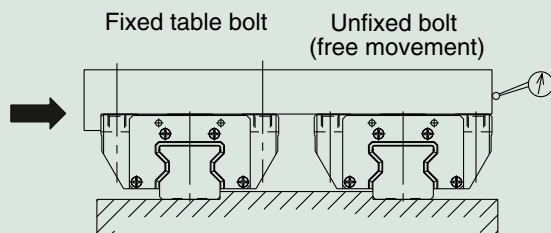
Radial rigidity



Reverse radial rigidity



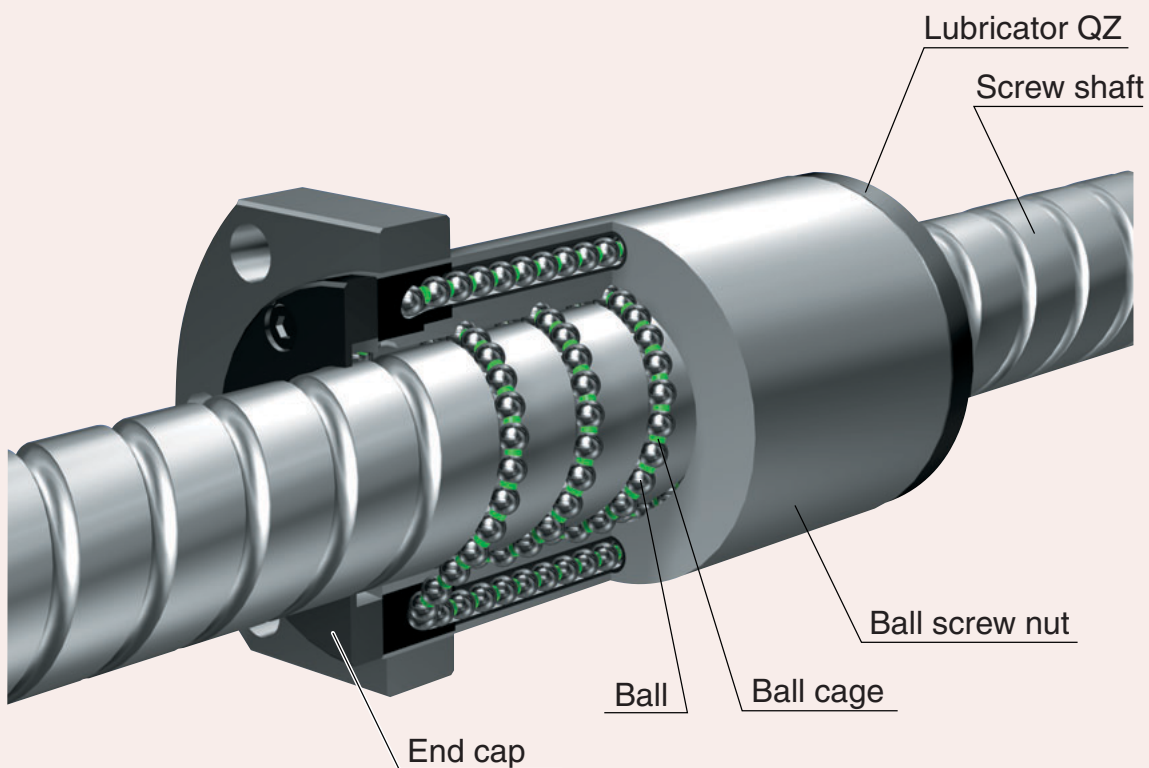
Lateral rigidity



High-Speed Ball Screw with Ball Cage

SBK

Structure of the **SBK** type

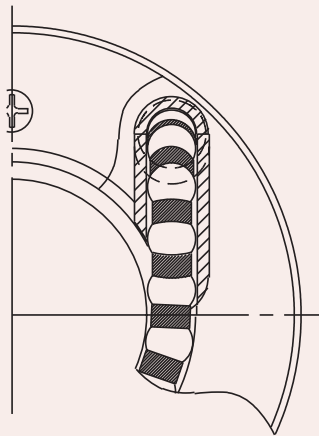


Features of the **SBK** type

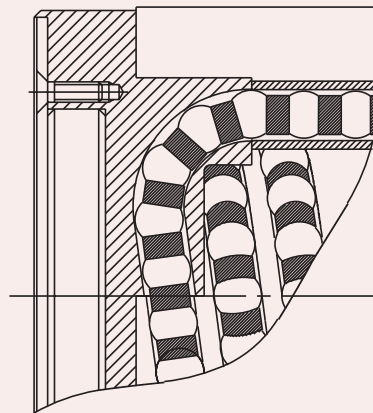
High-speed Operation

Because of its circulation structure where the end caps enable the balls to be picked up in the tangential direction and the lead angle direction, this model is capable of high-speed operation at a DN value of 160,000, achieving high-speed feed 2.2 times faster than the conventional model.

Balls circulate in the tangential direction

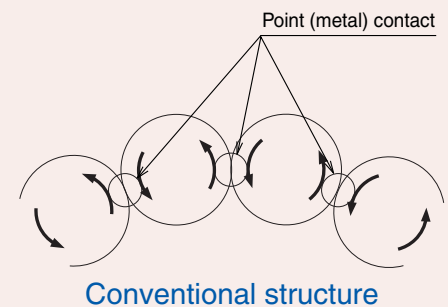
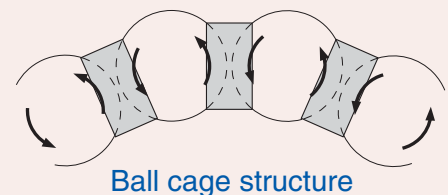


Balls circulate in the lead angle direction



Low Noise, Acceptable Running Sound

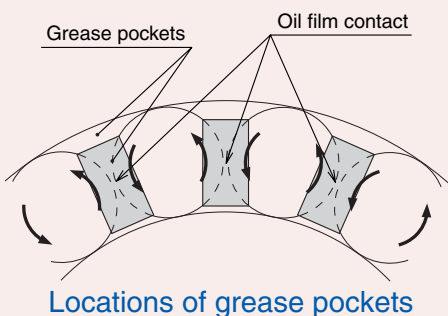
Use of a ball cage allows balls to be evenly spaced and eliminates collision noise between balls. In addition, balls are picked up in the tangential direction, which also contributes to eliminating collision noise. As a result, **low noise and acceptable running sound are achieved.**



Long-term Maintenance-free Operation

The formation of grease pockets increases grease retention and achieves **long-term maintenance-free operation.** In addition, even in adverse environments (e.g., coolant, foreign matter), this model ensures long-term maintenance-free operation when attached with an optional wiper ring or a QZ Lubricator*.

(*: For wiper ring and QZ Lubricator, contact THK.)



Excellent Sliding Properties

Ball cages arranged between balls eliminate mutual friction of the balls and significantly improve torque characteristics. Pre-load dynamic torque fluctuations are also reduced allowing the obtaining of **excellent sliding properties.**

Improved Service Life

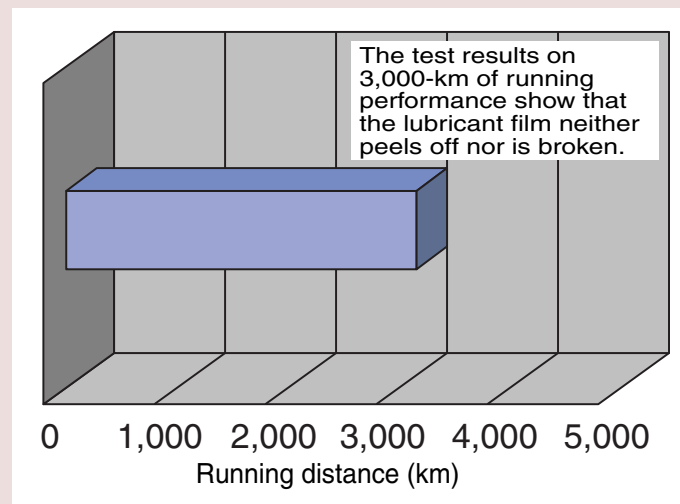
■ Service life test

Service life test under a high speed (free of maintenance)

Testing instrumentation for a long-period high-speed test was used to test model SBK with lubrication system QZ. The operating cycles were run under a DN value of 160,000 and with only initial lubrication carried out.

Conditions

| | |
|------------------------|---|
| Sample tested | SBK3620-7.6 |
| Number of samples | 3 |
| Maximum rotation speed | 4200 min ⁻¹ (DN value : 160,000) |
| Stroke | 400 mm |
| Lubricant | Multemp HRL grease (initial lubrication only) |
| Grease quantity | 8 cm ³ |
| Applied load | 1.87 kN (preload only) |
| Acceleration | 1G |



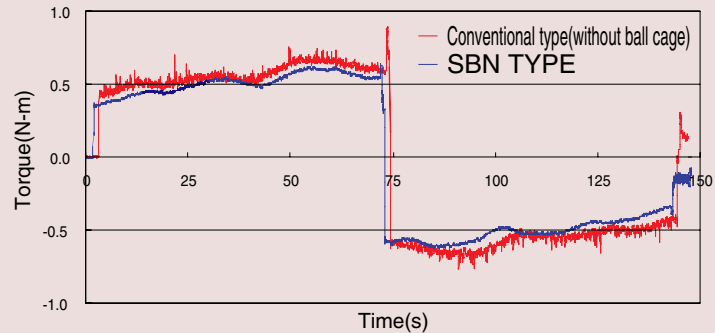
Ball Screw with Caged Ball Technology

Torque Fluctuations and Sliding Properties

The ball cage reduces torque fluctuations enabling excellent constant speed characteristics to be obtained even at low speed for a high degree of positioning accuracy.

Conditions

| Item | Description |
|------------------------|------------------------|
| Shaft diameter/lead | 32 / 10 mm |
| Speed | 10 mm/s |
| Shaft rotational speed | 60 min ⁻¹ |
| Stroke | 700 mm |
| Lubricant | Mobil Vactra No. 2 oil |

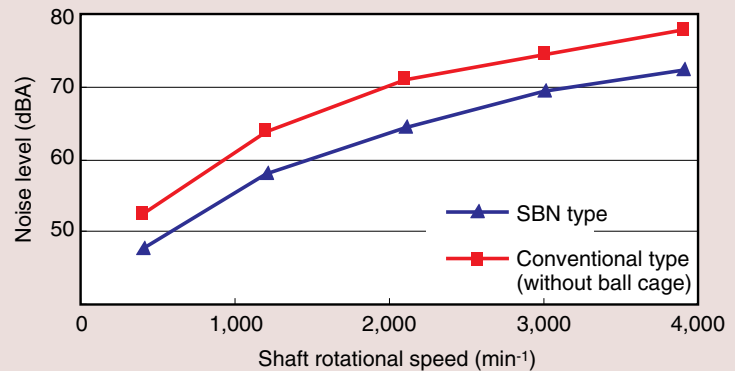


Noise Level Data

The use of a ball cage reduces friction between balls to realize low noise levels.

Conditions

| Item | Description |
|---------------------|----------------|
| Shaft diameter/lead | 32 / 10 mm |
| Lubricant | THK AFG grease |
| Measuring distance | 1 m |

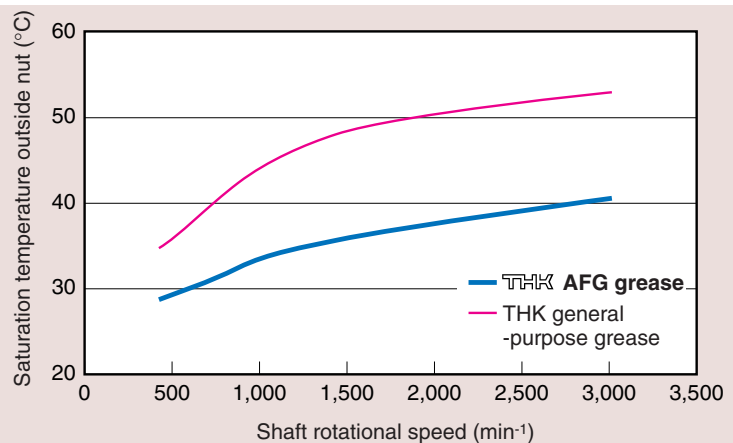


Heat Generation Data

Although the use of a ball cage eliminates friction between balls making it possible to demonstrate low levels of heat generation and outstanding high-speed operation, the use of THK AFG grease (low heat-generation grease) suppresses heat generation even more.

Conditions

| Item | Description |
|------------------------|--|
| Shaft diameter/lead | 32 / 10 mm |
| Shaft rotational speed | 400-3000 min ⁻¹ |
| Stroke | 400 mm |
| Lubricant | THK AFG grease THK general-purpose grease |

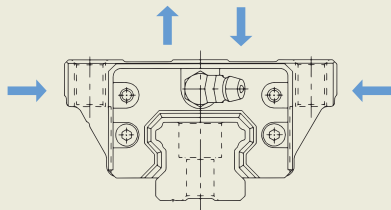


A Lineup of Caged Ball/Roller LM Systems

Caged Ball LM Guides

Global Standard

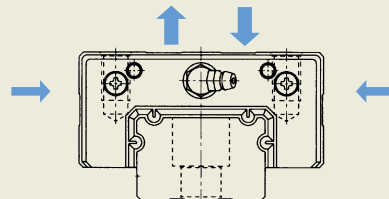
Model **SHS**



Conveyance system FPD manufacturing machine
 NC lathe Drilling machine
 Machining center

Ultra-heavy Load Type

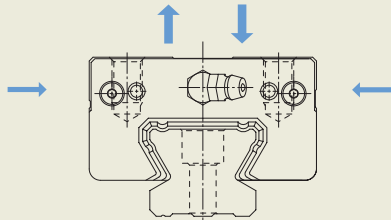
Model **SNR/SNS**



Machining center Five-axis milling machine
 NC lathe Grinding machine

Radial Type

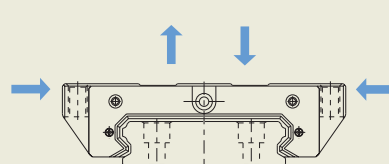
Model **SSR**



Conveyance system Semiconductor manu-
 FPD manufacturing machine facturing machine
 Medical equipment Chip mounter

Wide, Low Gravity Center Type

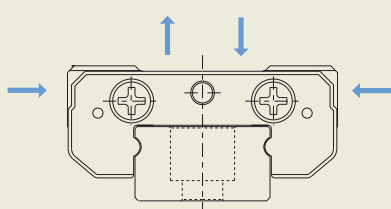
Model **SHW**



Semiconductor manu- FPD manufacturing
 facturing machine machine
 Conveyance system Chip mounter

Lightweight, Compact

Model **SRS**



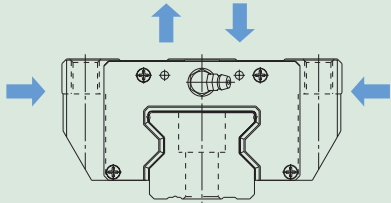
Semiconductor manufacturing machine FPD manufacturing machine
 Optical stage Printer
 Medical equipment Chip mounter

with Superb Features **S Series**

Caged Roller LM Guides

Super-ultra-high Rigidity Type

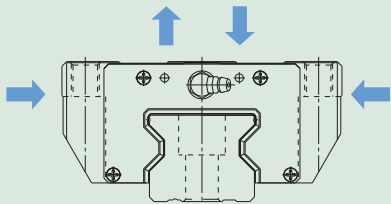
Model *SRG*



| | |
|-----------------------|---------------------------|
| Machining center | Five-axis milling machine |
| Ultra precision lathe | Drilling machine |
| Heavy cutting machine | |

Super-ultra-high Rigidity, Low Gravity Center Type

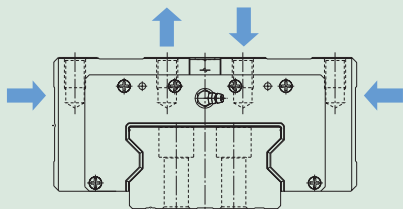
Model *SRN*



| | |
|-----------------------|---------------------------|
| Machining center | Five-axis milling machine |
| Ultra precision lathe | Drilling machine |
| Heavy cutting machine | |

Super-ultra-high Rigidity, Wide Type

Model *SRW*

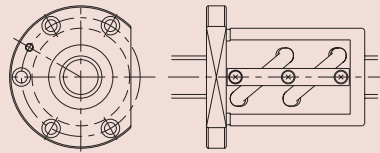


| | |
|------------------------|---------------------------------|
| Plano miller | Large five-face milling machine |
| Large pressing machine | Injection molding machine |
| | |

High Speed Ball Screws with Ball Cage

High Speed Ball Screw

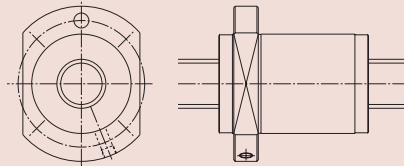
Model *SBN*



| | |
|-----------------------------|---|
| High-speed machining center | High-speed conveyance system |
| High-speed chip mounter | High-speed printed board drilling machine |

High Speed Ball Screw

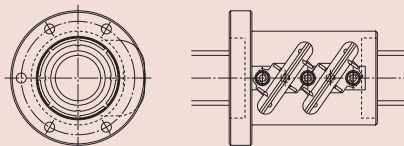
Model *SBK*



| | |
|-----------------------------|---|
| High-speed machining center | High-speed conveyance system |
| High-speed chip mounter | High-speed printed board drilling machine |

High Load Ball Screw

Model *HBN*



| | |
|---------------------------|---------------------------|
| Injection molding machine | Extrusion molding machine |
| Die-casting machine | Pressing machine |

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