



Technical
Reference



Smooth Silent Ecological

Caged Technology

For details, visit THK at www.thk.com

*Product information is updated regularly on the THK website.

THK CO., LTD.
TOKYO, JAPAN

CATALOG No.268-6E

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.

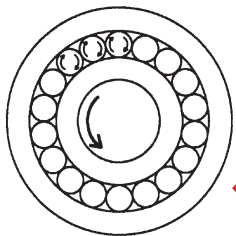
Later, caged ball bearings were developed that exhibited low noise levels even at high rotating speeds.

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.

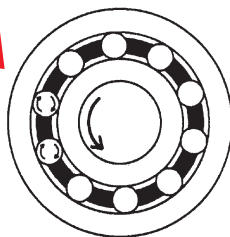
Rotary Bearings

Initial Stage of Development (Full Ball Type)



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

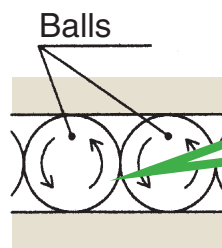
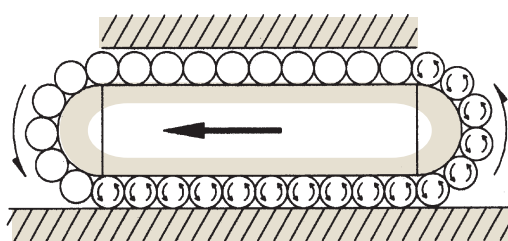
Current Bearings (Caged Ball Type)



- 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.

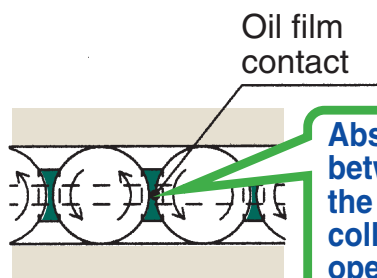
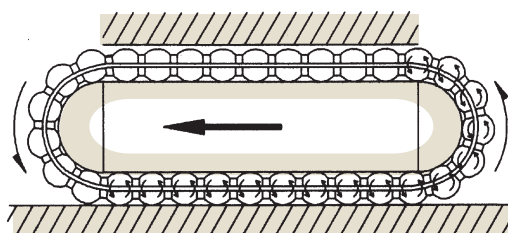
Case of the LM Guide

Without caged ball



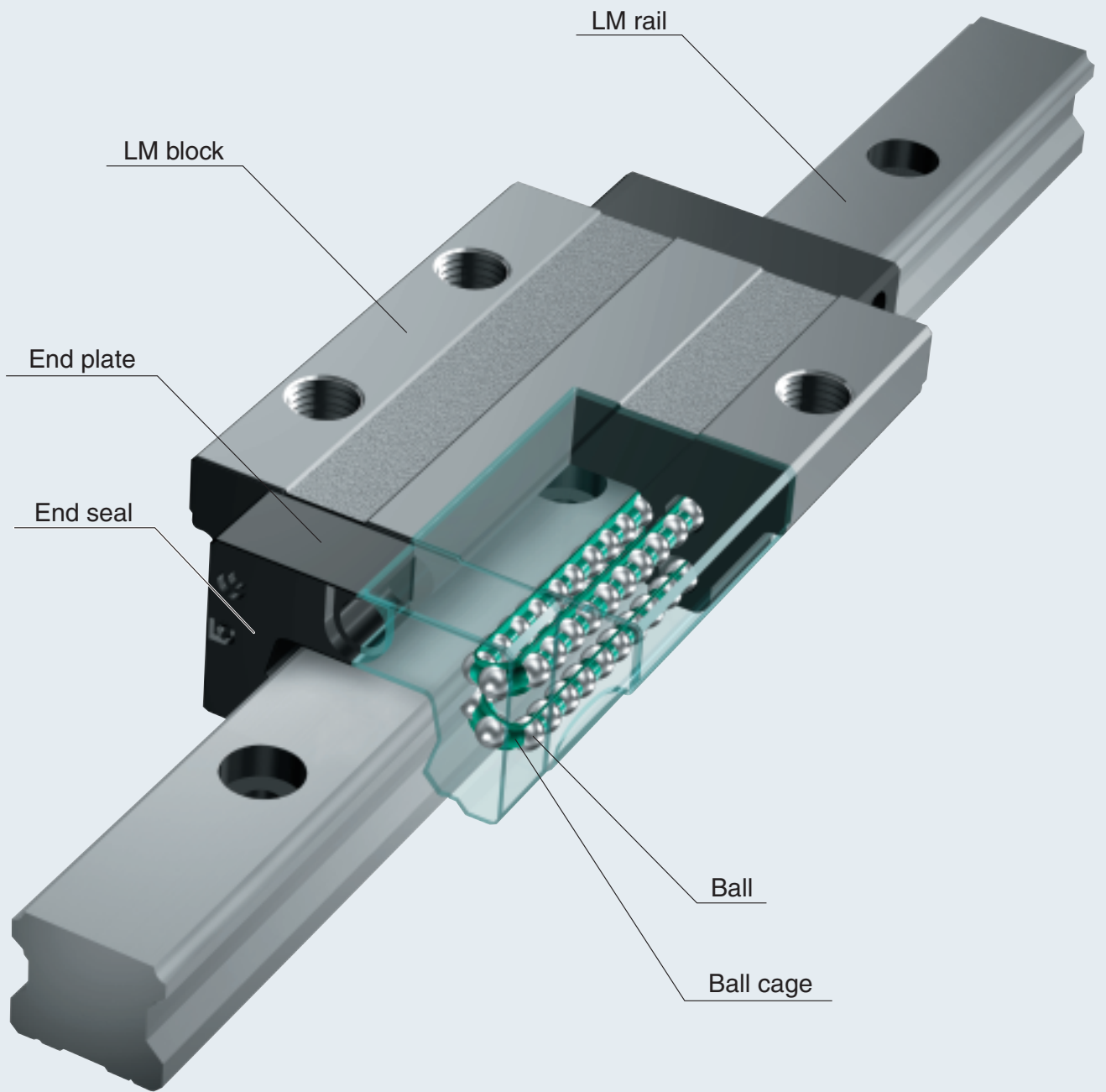
Friction occurs between balls resulting in the generation of collision noise

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

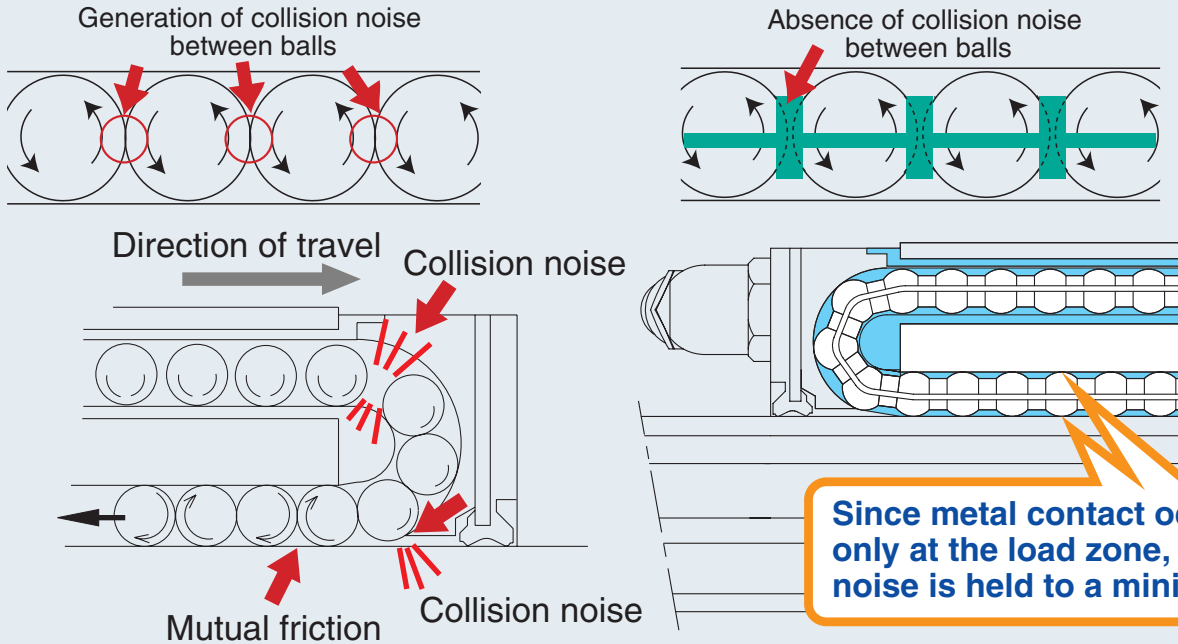


Advantage 1

of Caged Ball

Quiet Operation that Minimizes Metal Contact

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

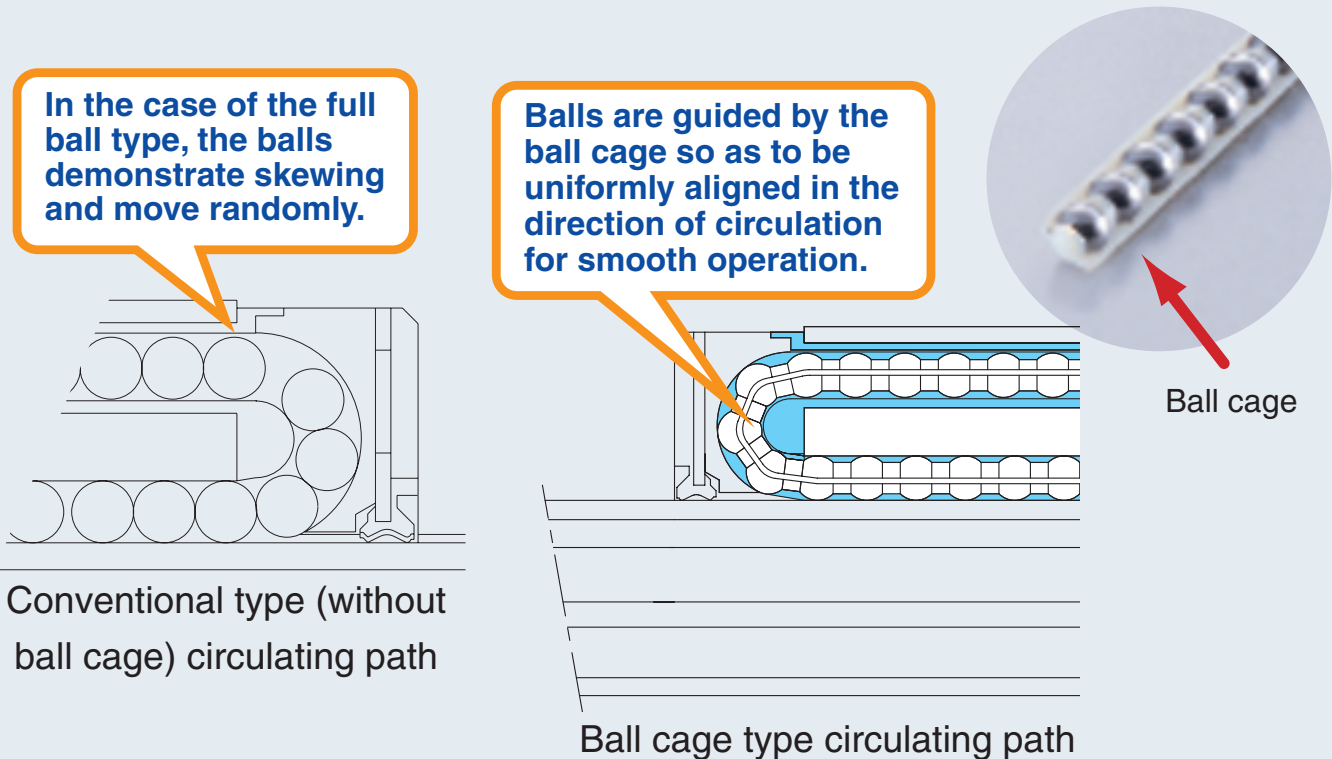


Advantage 2

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.

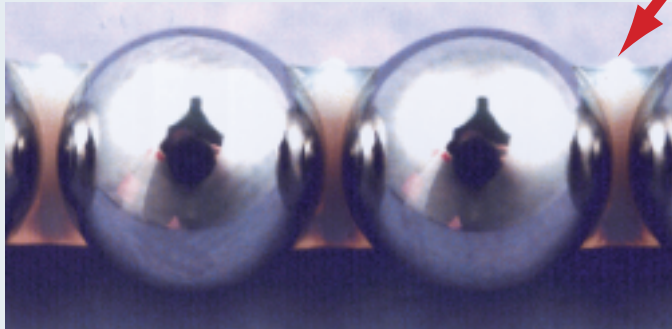


Advantage 3

of Caged Ball

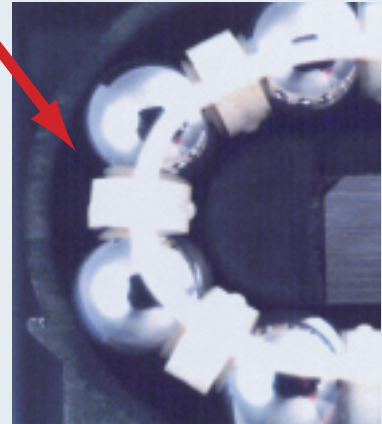
Original Cage Structure Exhibiting Excellent High-Speed Performance

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



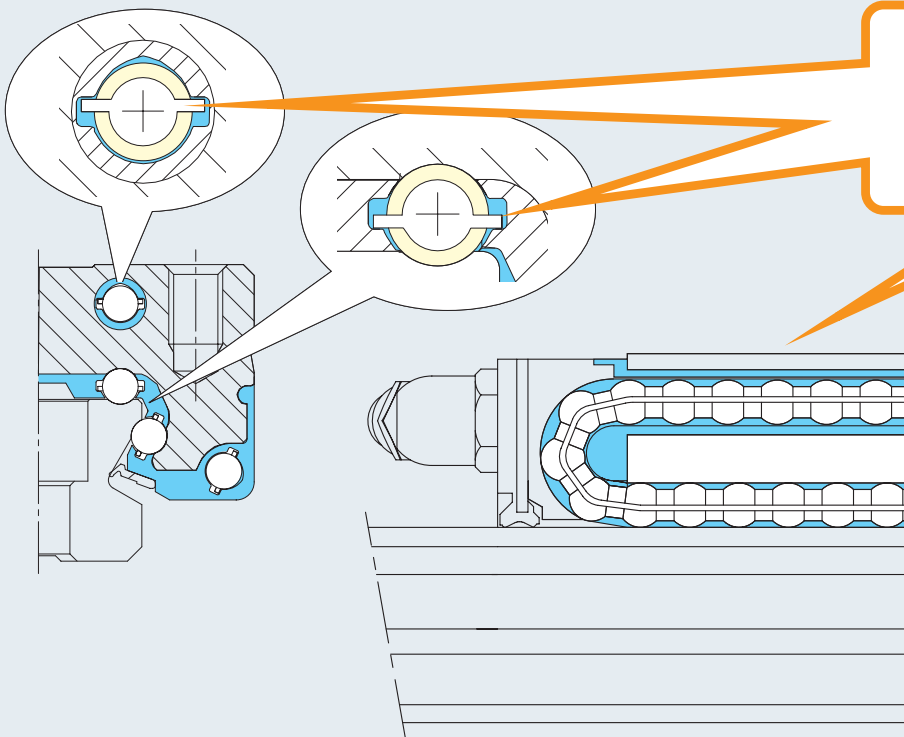
State at turning sections

Advantage 4

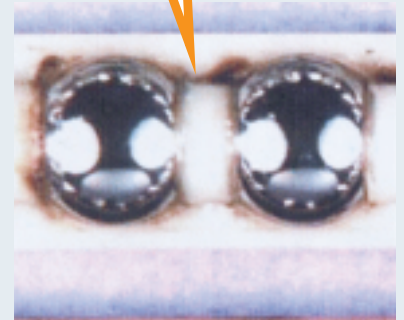
of Caged Ball

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)

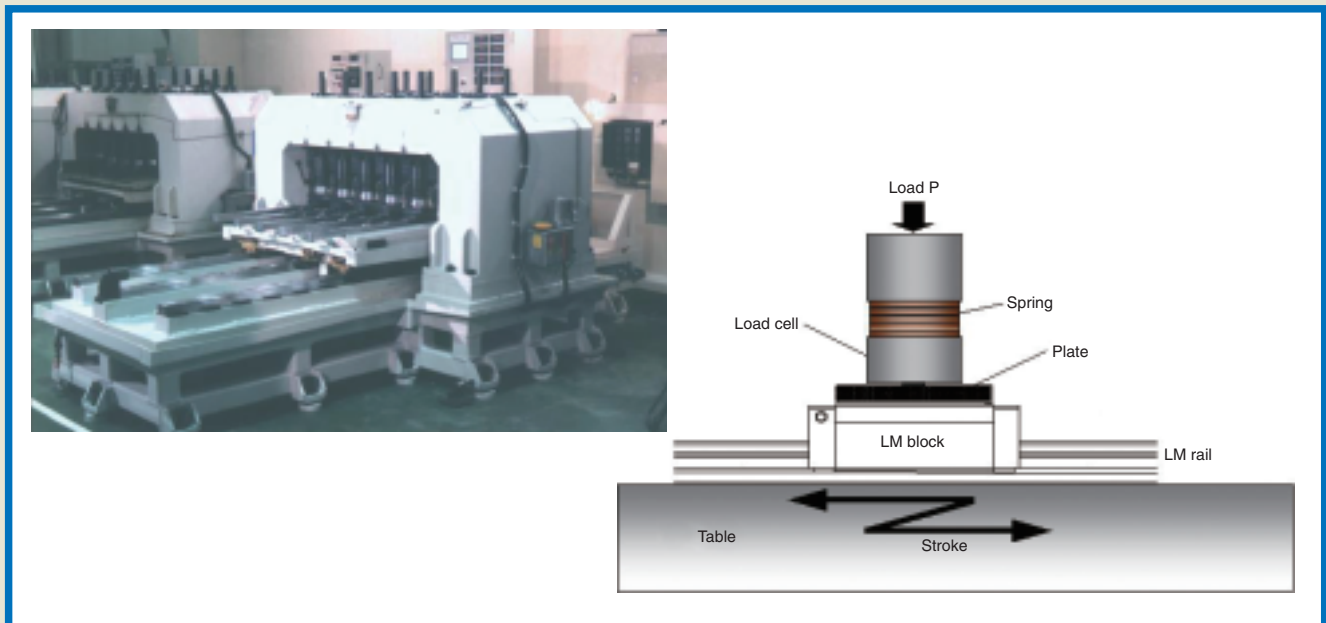
Data on LM Guide with Caged Ball

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.

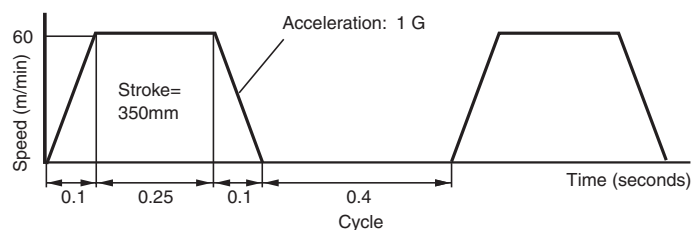
Service life test for LM Guide

1. Testing instrumentation

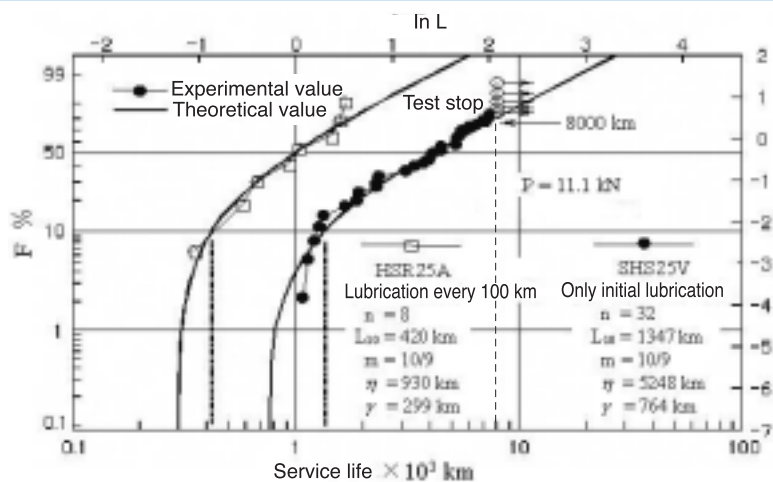


2. Testing parameters

Model : SHS25V1SS+580LP / HSR25A1UU+580LP
Number of pieces : 32
Load : 11.1 kN per LM block (0.35 C of SHS25V)
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 (Test stop)

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 ballModel SHS25V C=31.7 kN
 LM guide without caged ball.....Model HSR25A C=19.9 kN
 Under an applied load of P=11.1 kN

LM guide with caged ball $L = \left(\frac{C}{P}\right)^3 \times 50 = \left(\frac{31.7}{11.1}\right)^3 \times 50 = 1160 \text{ km}$
 Model SHS25V

LM guide without caged ball $L = \left(\frac{C}{P}\right)^3 \times 50 = \left(\frac{19.9}{11.1}\right)^3 \times 50 = 280 \text{ km}$
 Model HSR25A

● Comparison in terms of dynamic durability values $\frac{31.7}{19.9} = 1.6$

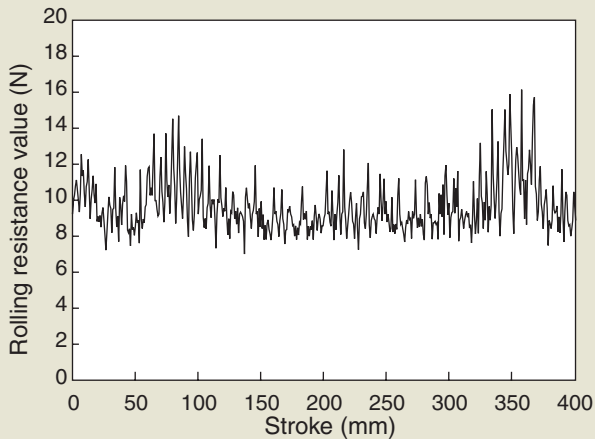
● Service life $\frac{1160}{280} = 4.0^*$

*For details, see General catalog

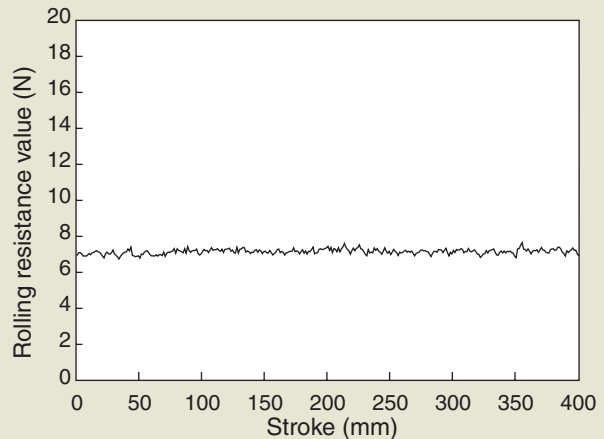
LM Guide with Caged Ball Technology

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.



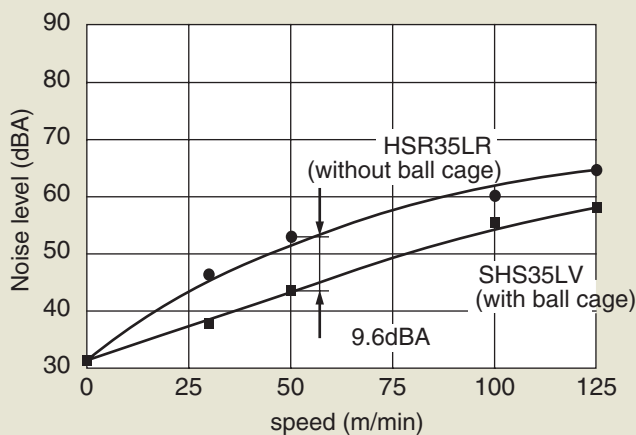
Results of Measuring Fluctuations in Rolling Resistance of HSR25LR (without ball cage) (feeding speed: 10 mm/sec)



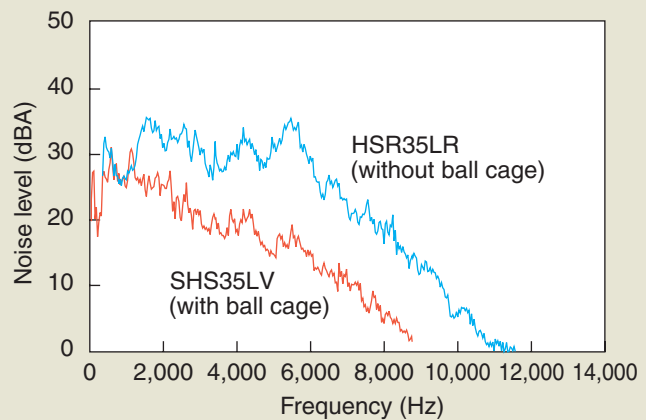
Results of Measuring Fluctuations in Rolling Resistance of SHS25LV (with ball cage) (feeding speed: 10 mm/sec)

Noise Level Data

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



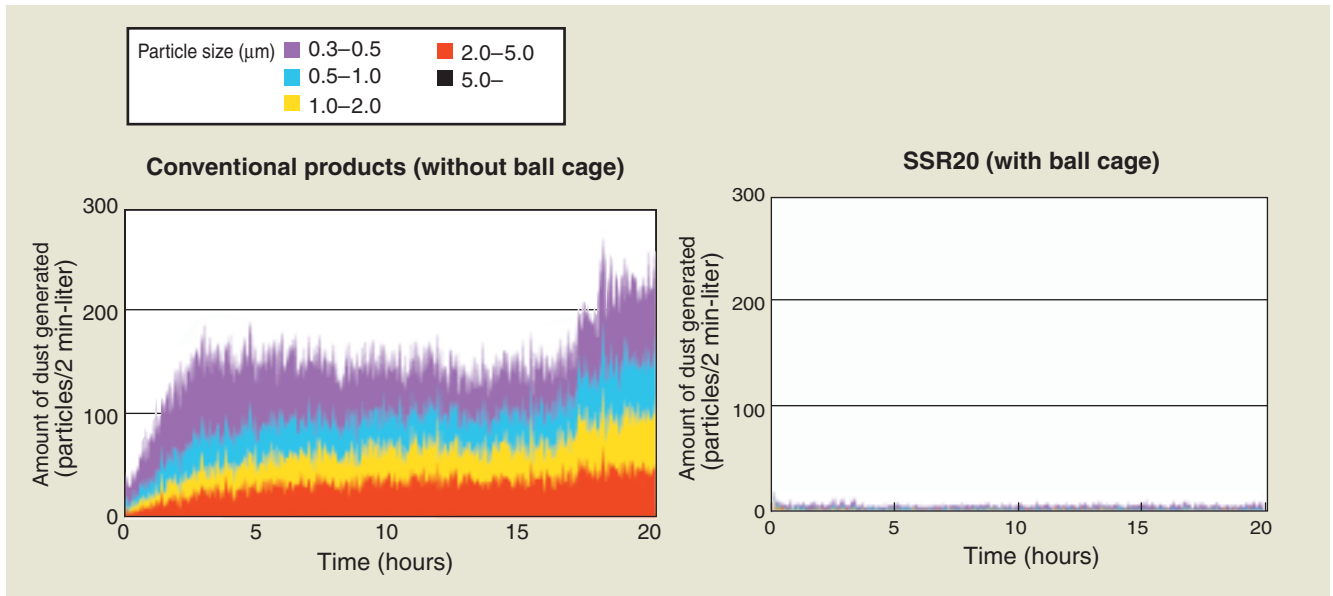
Comparison of Noise Levels Between the SHS35LV and HSR35LR



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

Low Generation of Dust

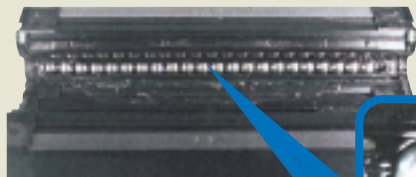
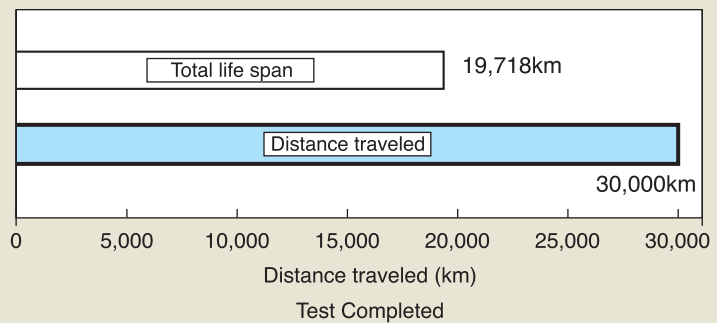
The use of a ball cage eliminates friction between balls resulting in a corresponding decrease in the generation of metal wear fragments for outstanding effects against prevention of the generation of dust.



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



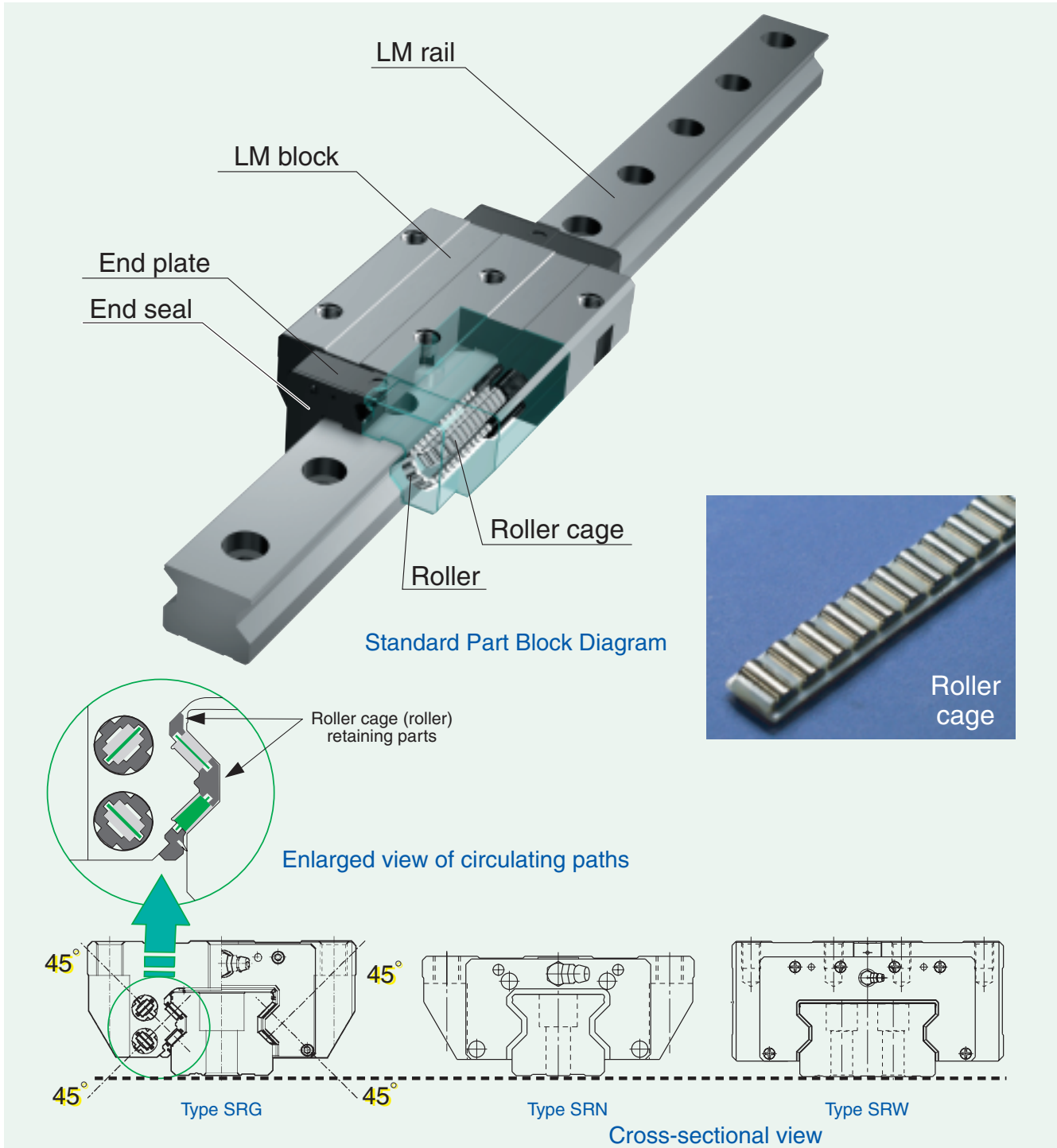
Detailed drawing of ball cage

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).

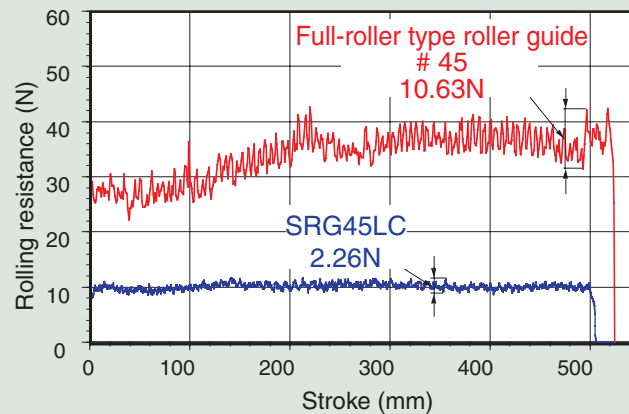
Global Standard Dimensions

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

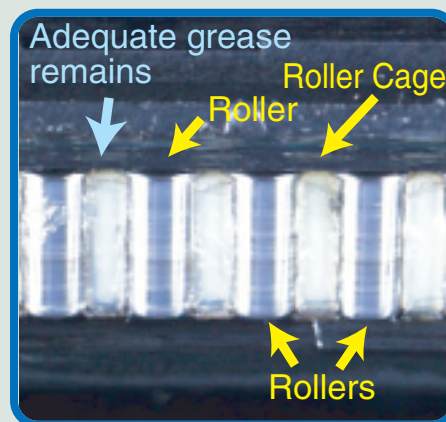
The use of a roller cage enables grease to be retained in the space between adjacent rollers, realizing long-term, maintenance-free operation by inhibiting the escape of grease from the circulating path.

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)



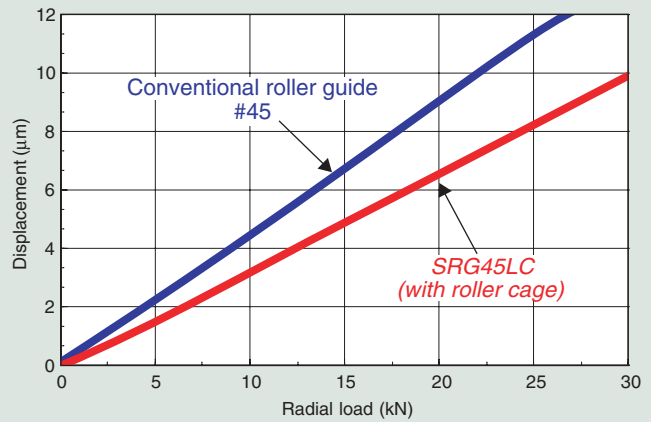
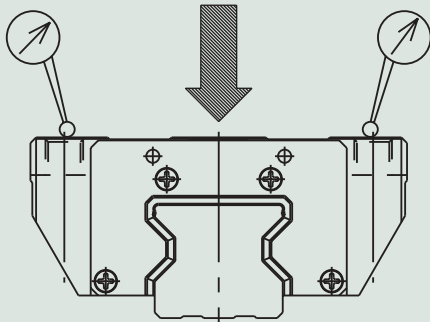
No discoloration of grease is observed.

Detailed drawing of roller cage

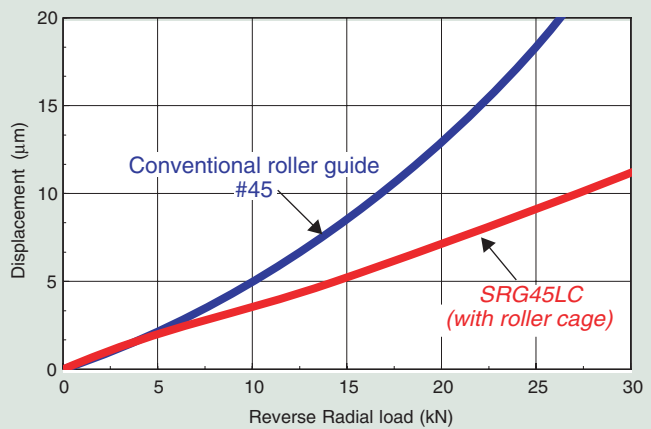
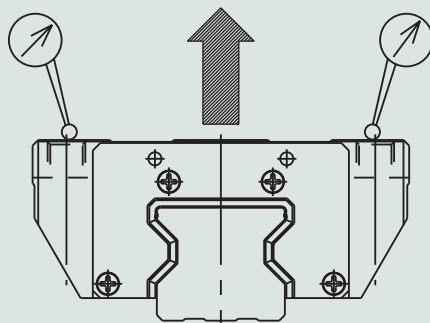
Rigidity values

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

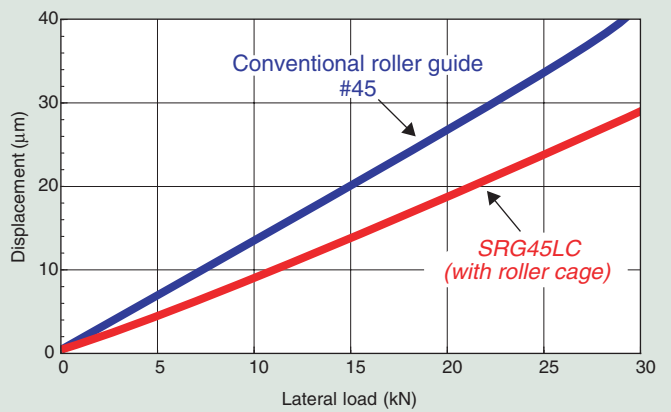
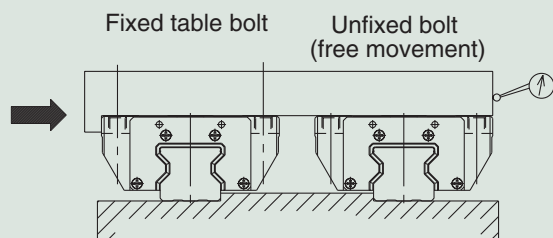
Radial rigidity



Reverse radial rigidity



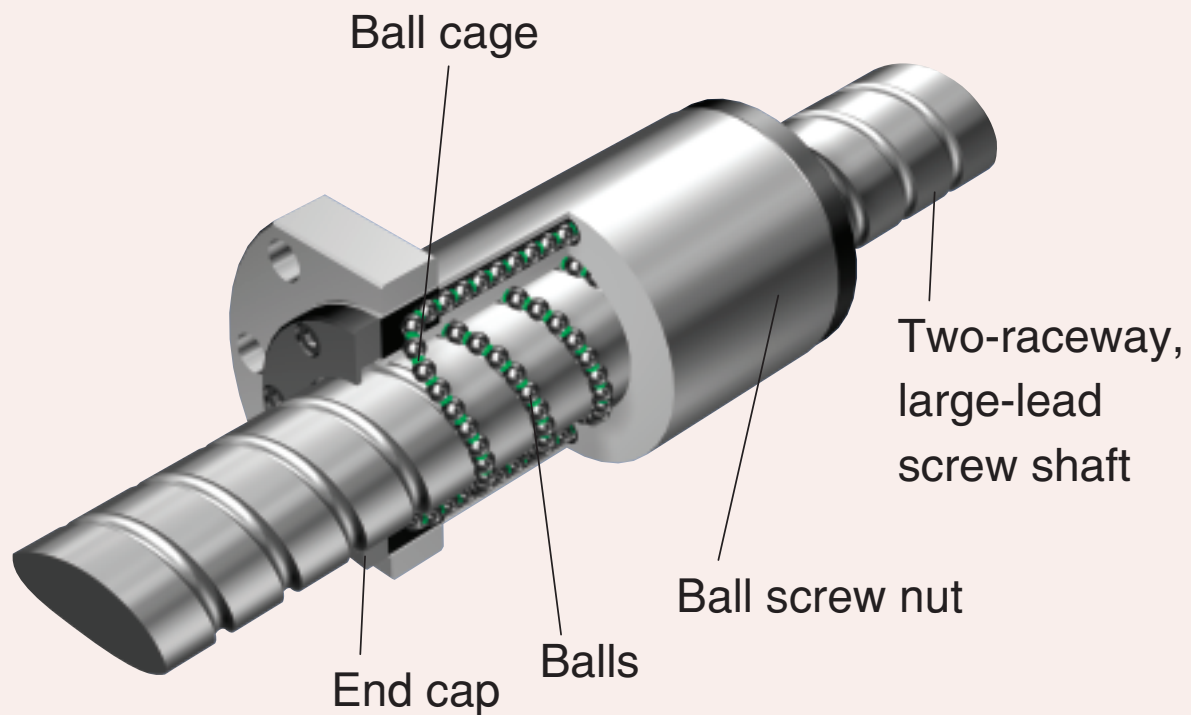
Lateral rigidity



Ball Screw with Ball Cage

SBN/SBK/SDA/HBN/SBKH

Structure of the **SBK** type

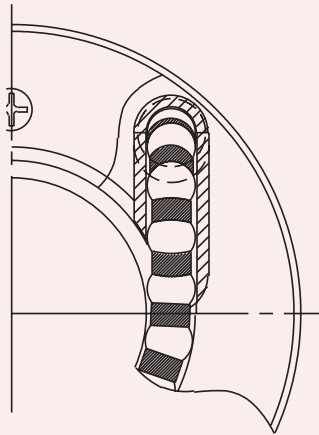


Features of the **SBK** type

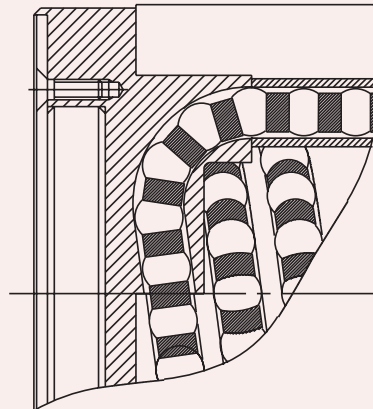
High-speed Operation

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

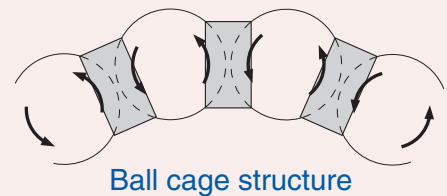


Balls circulate in the lead angle direction



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.**

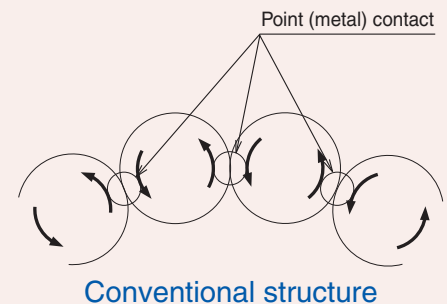


Ball cage structure

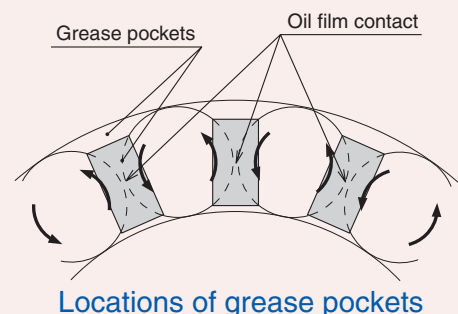
Long-term Maintenance-free Operation

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.)



Conventional structure



Locations of grease pockets

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

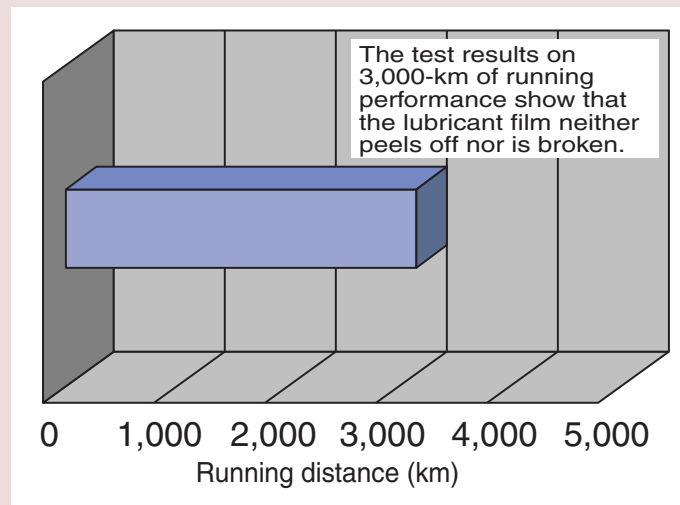
■ Service life test

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



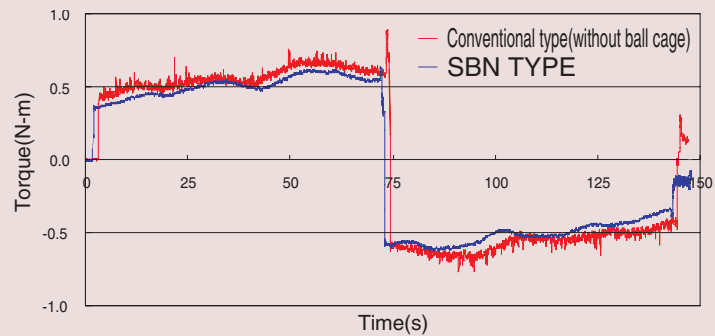
Ball Screw with Caged Ball Technology

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

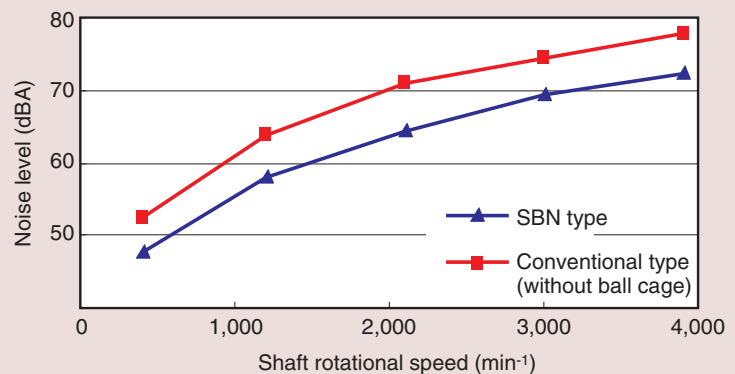


Noise Level Data

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

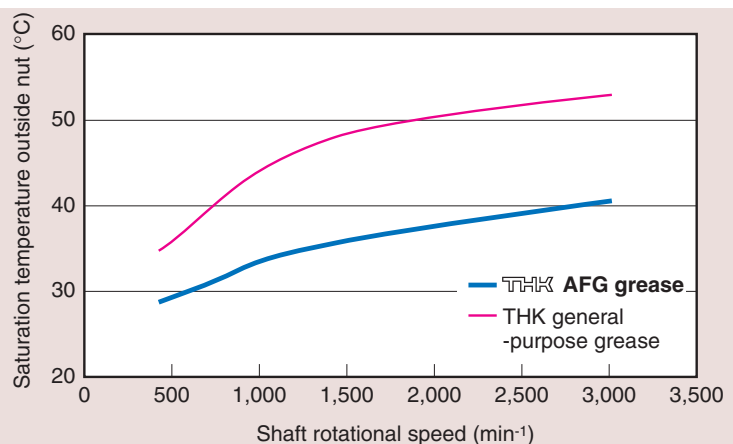


Heat Generation Data

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

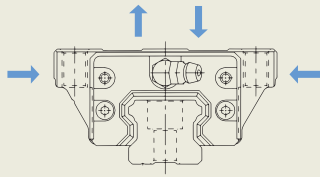


A Lineup of Caged Ball/Roller LM Systems

Caged Ball LM Guides

Global Standard

Model **SHS**

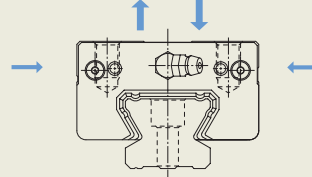


Conveyance system
NC lathe
Machining center

FPD manufacturing machine
Drilling machine

Radial Type

Model **SSR**

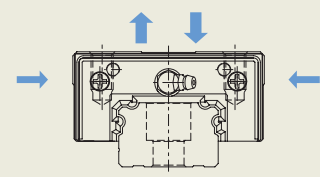


Conveyance system
FPD manufacturing machine
Medical equipment

Semiconductor manufacturing machine
Chip mouter

For Machine Tools/Highly dust-proof

Model **SVR/SVS**

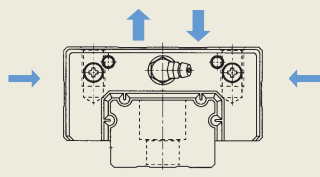


Machining center
NC lathe

Five-axis milling machine
Grinding machine

For Machine Tools

Model **SNR/SNS**

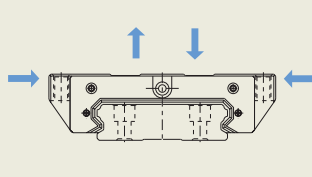


Machining center
NC lathe

Five-axis milling machine
Grinding machine

Wide, Low Gravity Center Type

Model **SHW**

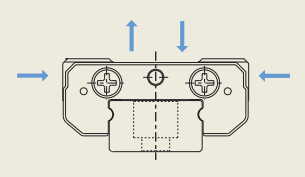


Semiconductor manufacturing machine
Conveyance system

FPD manufacturing machine
Chip mouter

Lightweight, Compact

Model **SRS**

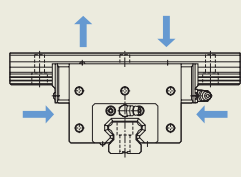


Semiconductor manufacturing machine
Optical stage
Medical equipment

FPD manufacturing machine
Printer
Chip mouter

Integrated X-Y Type

Model **SCR**

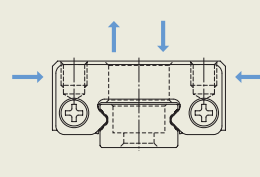


Precision alignment stage
Wire-cut electric discharge machine
XY table

Optical measuring instrument
Bonding machine

Finite Stroke

Model **EPF**



Semiconductor manufacturing machine
Inspection equipment

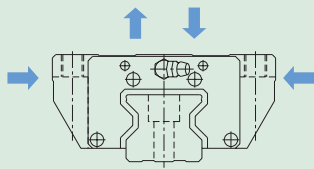
Medical equipment
Industrial machinery

with Superb Features **S Series**

Caged Roller LM Guides

Super-ultra-high Rigidity Type

Model **SRG**

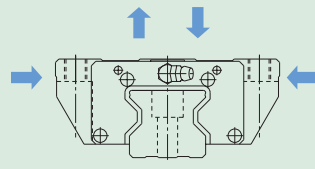


Machining center
Ultra precision lathe
Heavy cutting machine

Five-axis milling machine
Drilling machine

Super-ultra-high Rigidity, Low Gravity Center Type

Model **SRN**

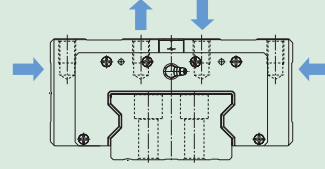


Machining center
Ultra precision lathe
Heavy cutting machine

Five-axis milling machine
Drilling machine

Super-ultra-high Rigidity, Wide Type

Model **SRW**



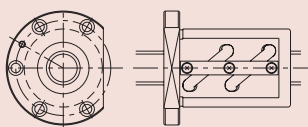
Plano miller
Large pressing machine

Large five-face milling machine
Injection molding machine

Ball Screws with Ball Cage

High Speed Ball Screw

Model **SBN**

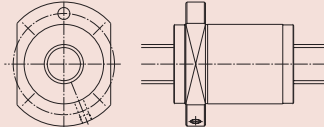


High-speed machining center
High-speed chip mounter

High-speed conveyance system
High-speed printed board drilling machine

High Speed Ball Screw

Model **SBK**

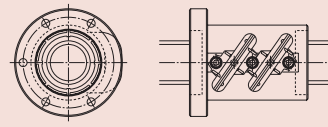


High-speed machining center
High-speed chip mounter

High-speed conveyance system
High-speed printed board drilling machine

High Load Ball Screw

Model **HBN**

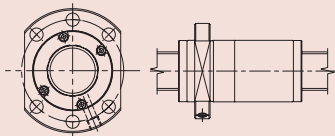


Injection molding machine
Die-casting machine

Extrusion molding machine
Pressing machine

Compact Ball Screw

Model **SDA**

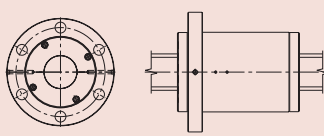


High-speed laser cutting machine
High-speed chip mounter

High-speed conveyance system
High-speed printed board drilling machine

High-Load, High-Speed Ball Screw

Model **SBKH**



Injection molding machine
Blow molding machine
Extrusion molding machine

Pressing machine
Die-casting machine

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