




Technical Reference

Smooth Silent Ecological

Caged Technology

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THK CO., LTD.

HEAD OFFICE 3-1-6, NISHI-GOTANDA, SHINAGAWA-KU, TOKYO 141-8503 JAPAN
INTERNATIONAL SALES DEPARTMENT PHONE:(03)5434-0351 FAX:(03)5434-0353

U. S. A.

CHICAGO
PHONE:(847)310-1111 FAX:(847)310-1182

NEW JERSEY
PHONE:(201)529-1950 FAX:(201)529-1962

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PHONE:(714)891-6752 FAX:(714)894-9315

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PHONE:21-6267-6571, 21-6267-6851 FAX:21-6267-6654

MALAYSIA (KUALA LUMPUR)
PHONE:(03)987-1137 FAX:(03)987-8071

INDIA (BANGALORE)
PHONE:(080)330-1524 FAX:(080)330-1524

KOREA (SEOUL)
PHONE:(02)3463-0351 FAX:(02)3017-0351



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.

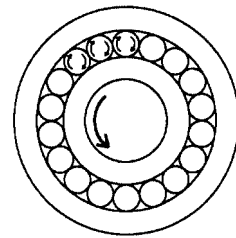
Later, ball bearings with cage were developed that exhibited low noise levels even at high rotating speeds.

In addition, these ball bearings with cage were able to demonstrate long service life despite the number of balls being fewer than packed 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.

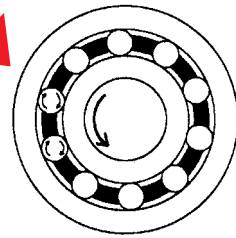
Rotary Bearings

Initial Stage of Development (Full Ball Type)



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

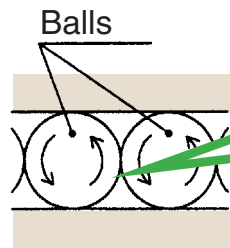
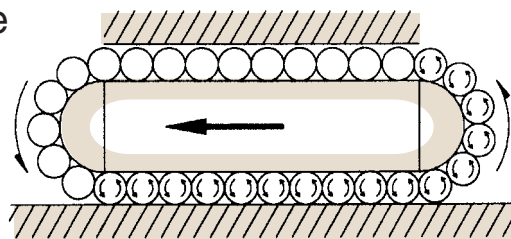
Current Bearings (with Cage)



- 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.

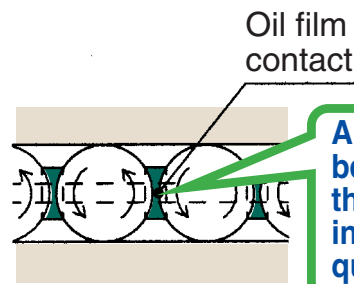
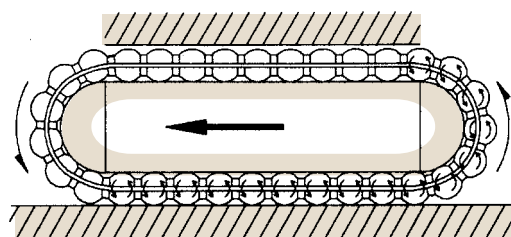
Case of the LM Guide

Without ball cage



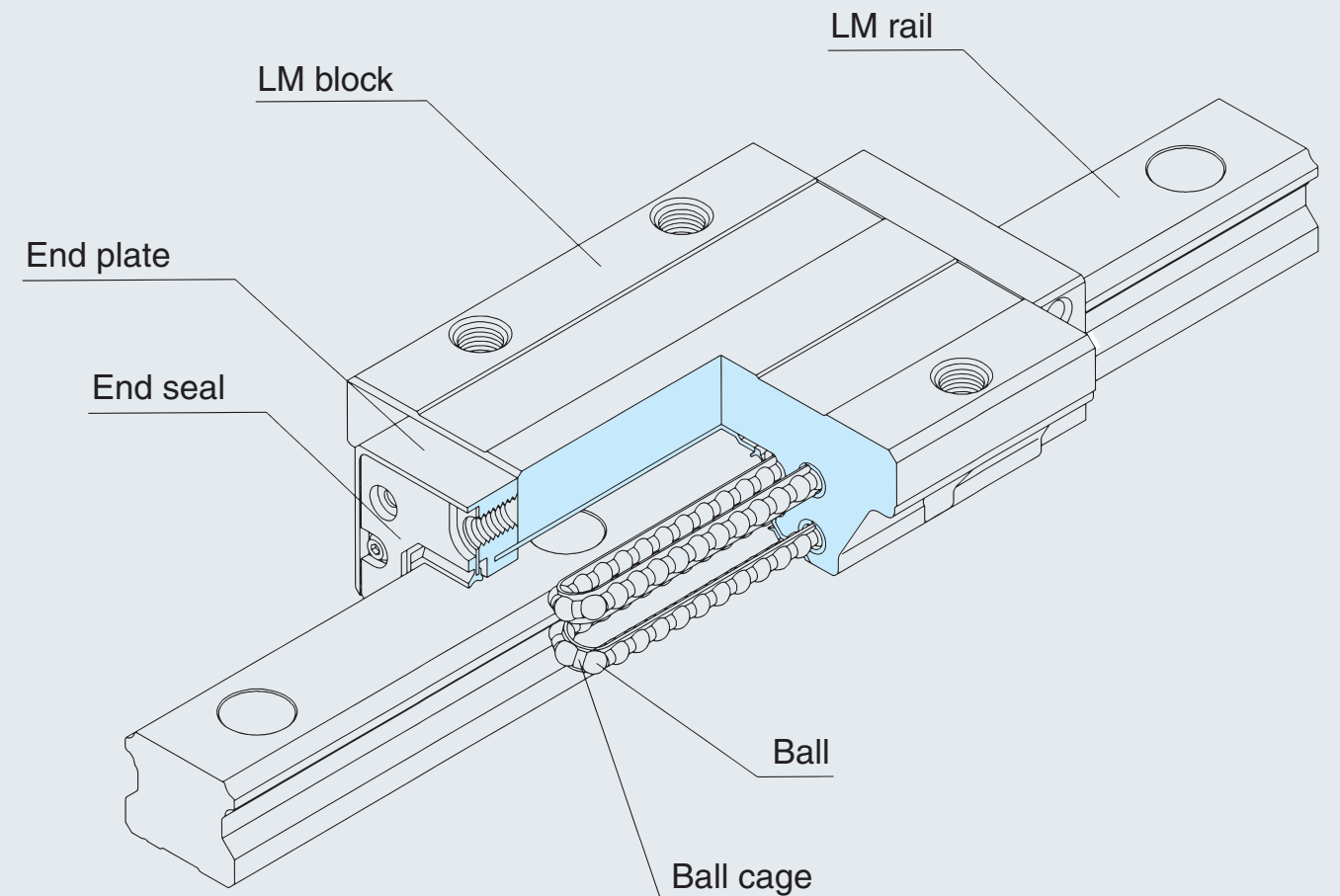
Friction occurs between balls resulting in the generation of interference noise

With ball cage



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

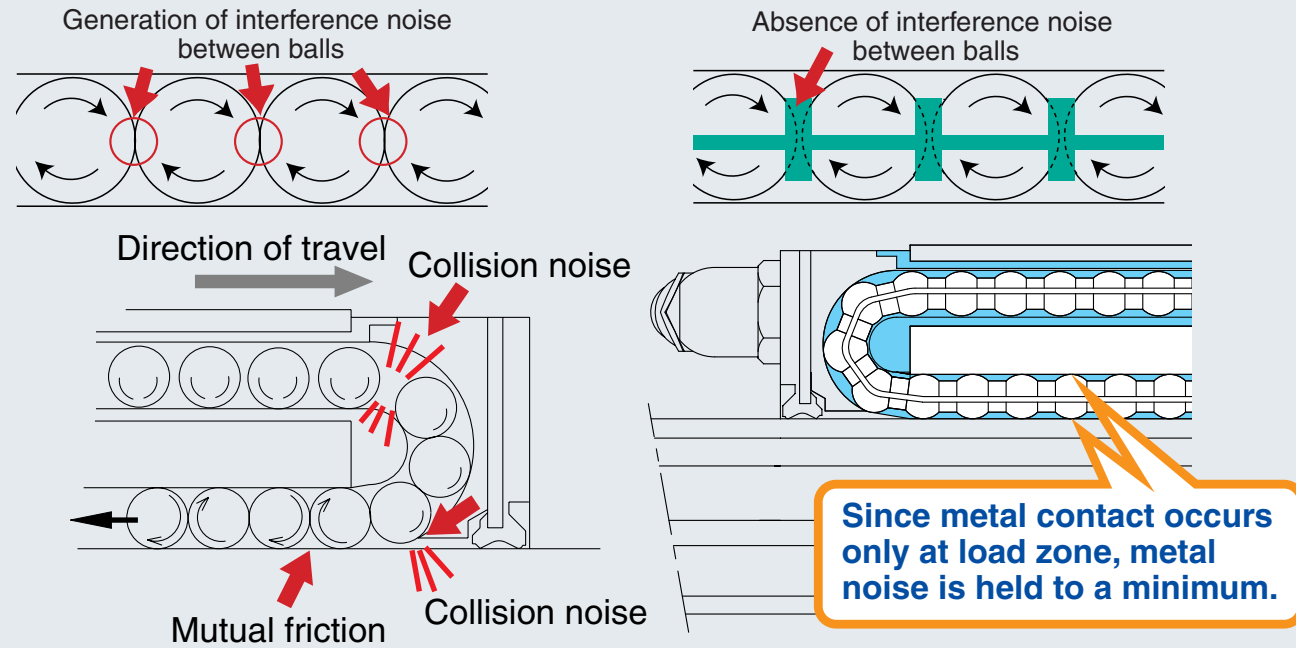
Structure of the LM Guide with Ball Cage



Advantage 1 of Caged Ball

Quiet Operation that Minimizes Metal Contact

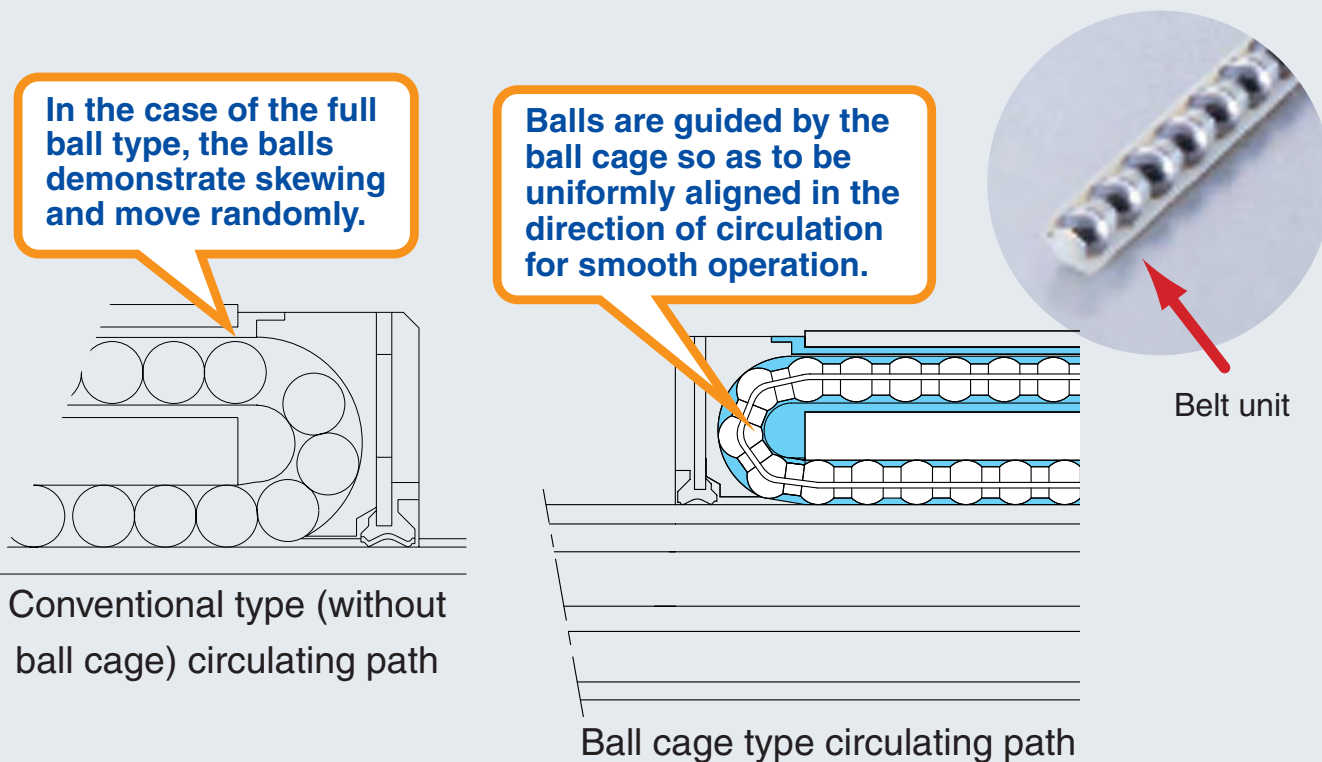
Interference noise between balls is eliminated by the ball cage resulting in quiet operation.



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.



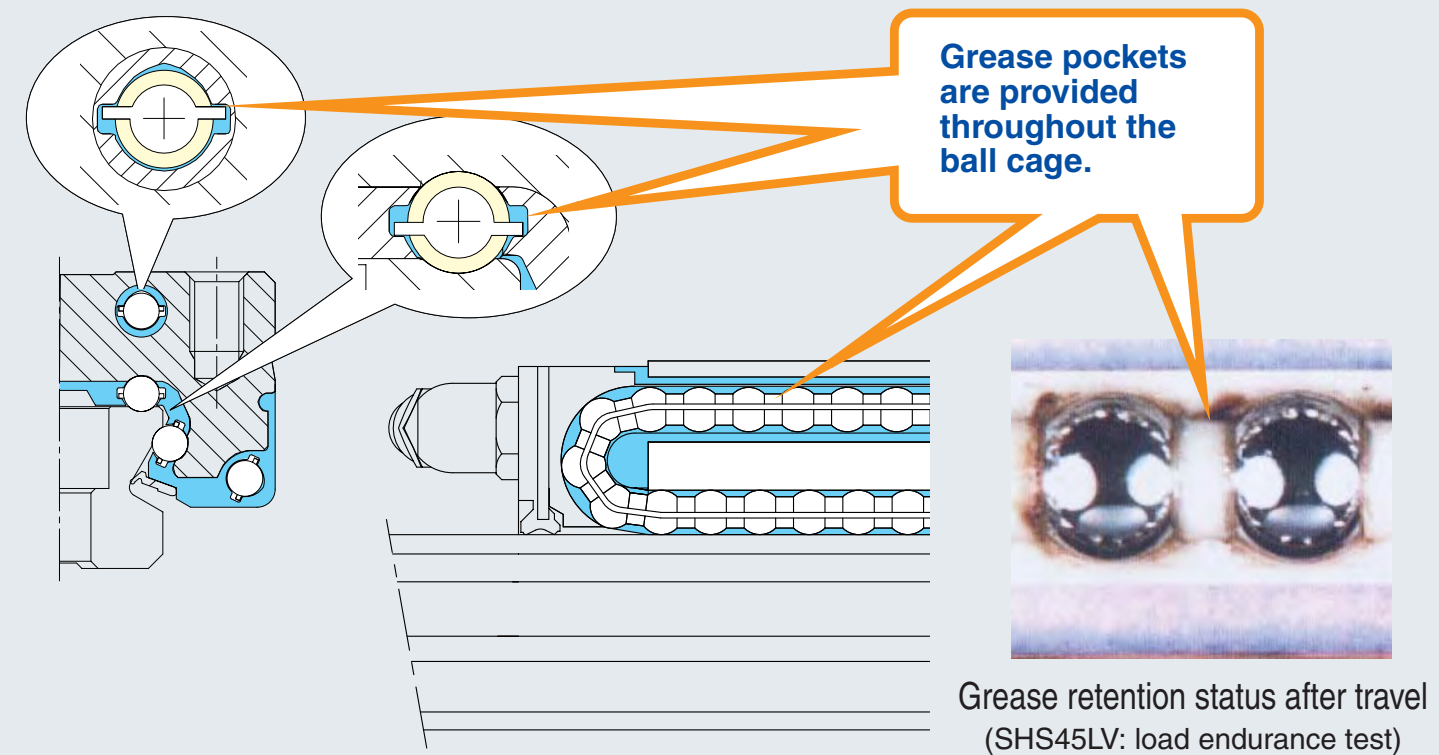
Contact state between balls and ball cage

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 circulating path to constantly lubricate the balls enabling long-term, maintenance-free operation, Long Service Life.



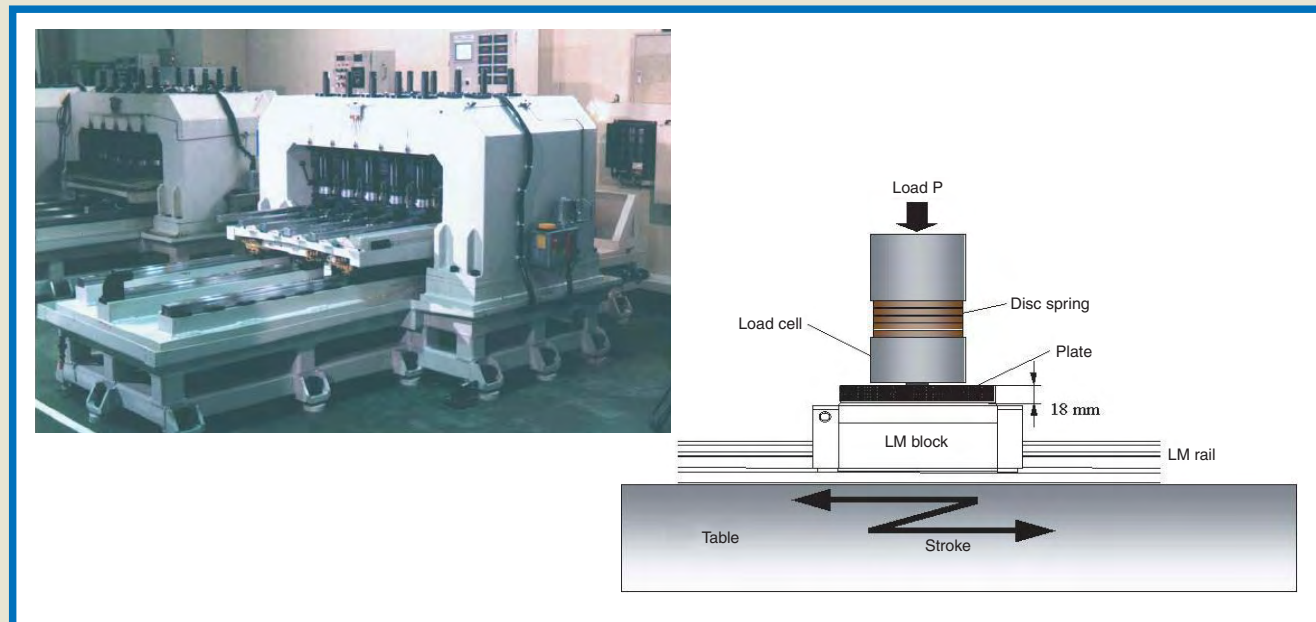
Data on LM Guide with Caged Ball

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.

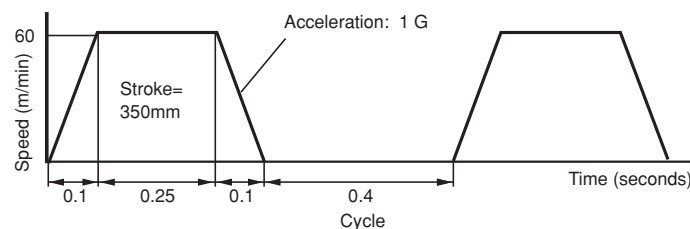
Service life test for LM Guide

1. Testing instrumentation

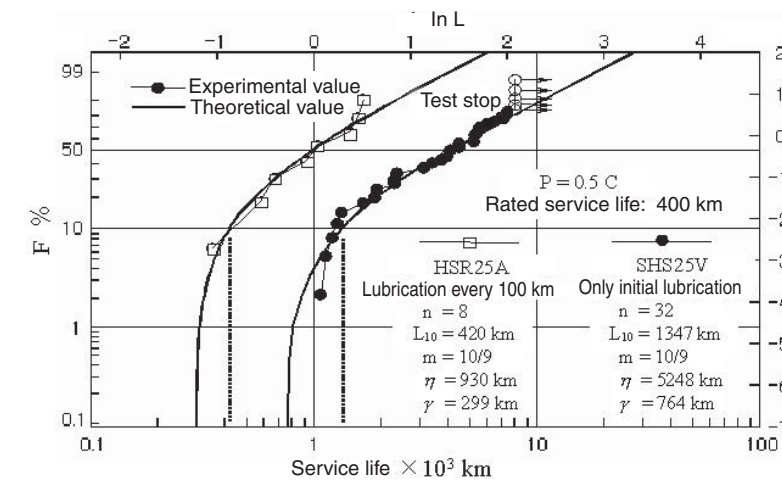


2. Testing parameters

- 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: L₁₀ = 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=13.6kN

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

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

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

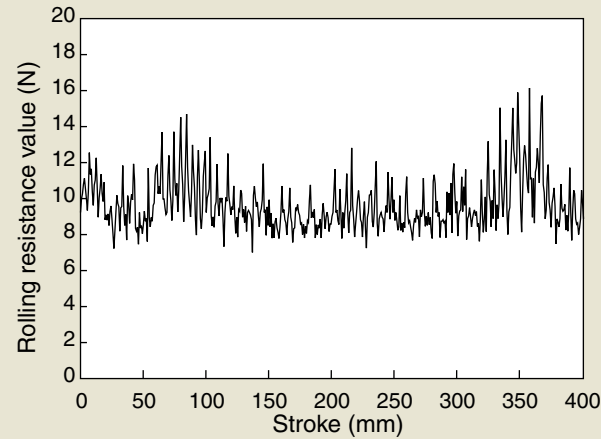
● Service life $\frac{990}{400} = 2.4^*$

*For details, see General catalog

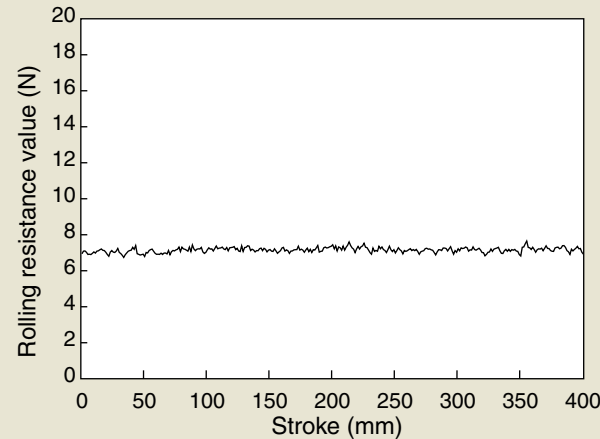
LM Guide with Caged Ball Technology

Rolling Resistance Data

The use of a ball cage enables the balls to be uniformly aligned, eliminating snaking 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.



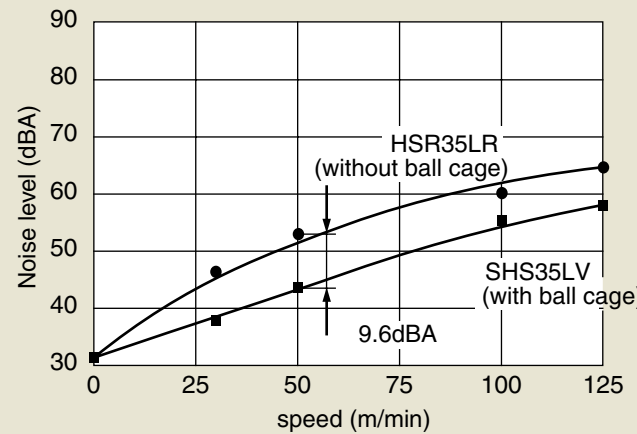
Results of Measuring Fluctuations in Rolling Resistance of HSR25LR (without ball cage) (feeding speed: 10 mm/sec)



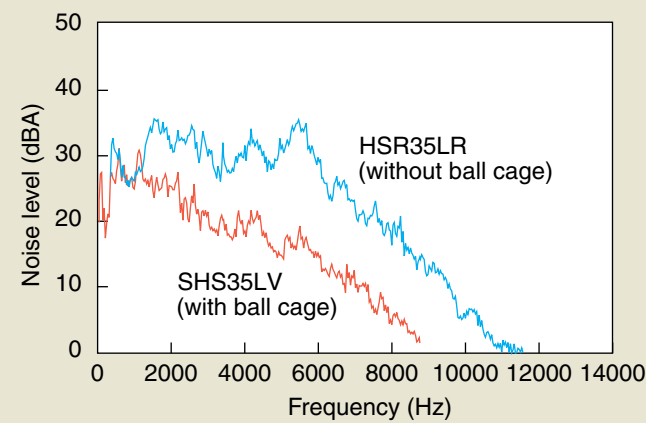
Results of Measuring Fluctuations in Rolling Resistance of SHS25LV (with ball cage) (feeding speed: 10 mm/sec)

Noise Level Data

The use of a ball cage eliminates interference between balls to realize low noise levels.



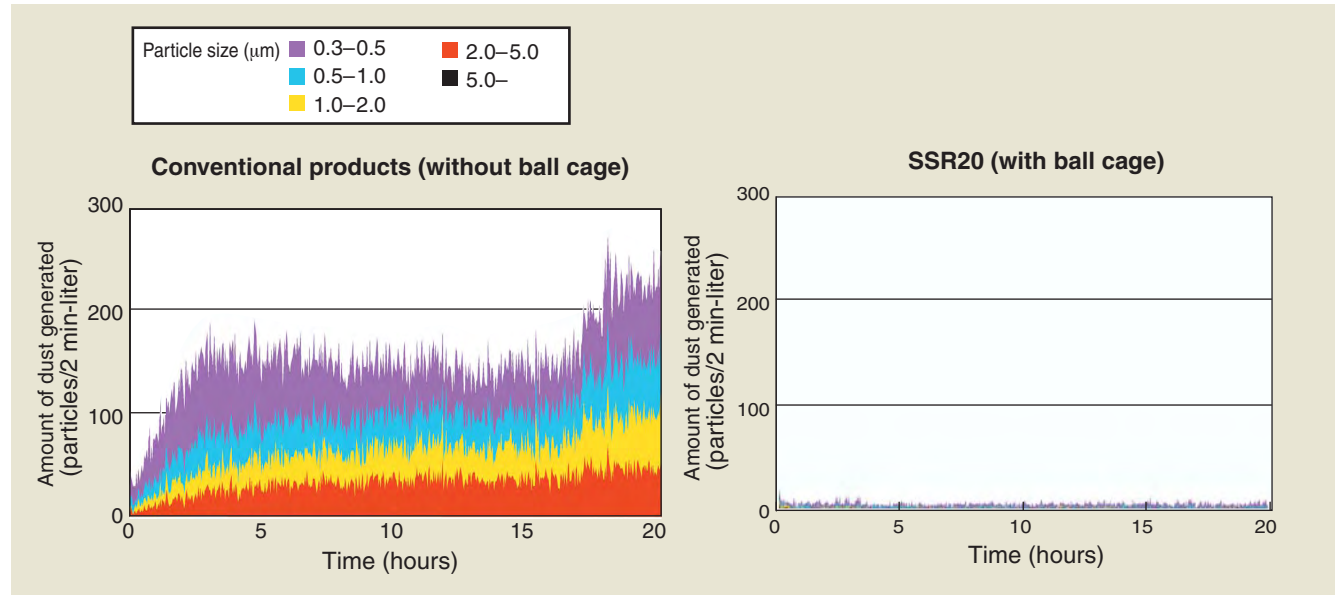
Comparison of Noise Levels Between the SHS35LV and HSR35LR



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

Low Generation of Dust

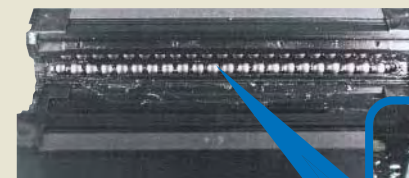
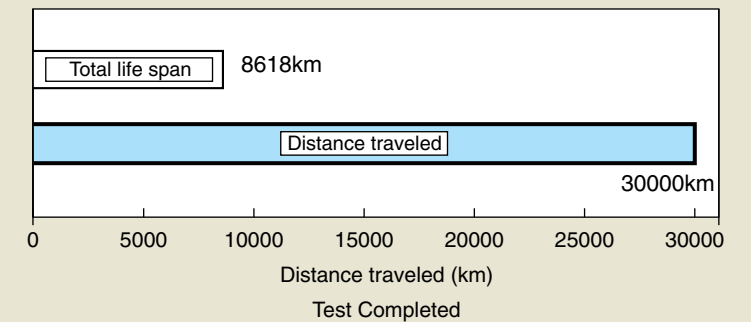
The use of a ball cage eliminates friction between balls resulting in a corresponding decrease in the generation of metal wear fragments for outstanding effects against prevention of the generation of dust.



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



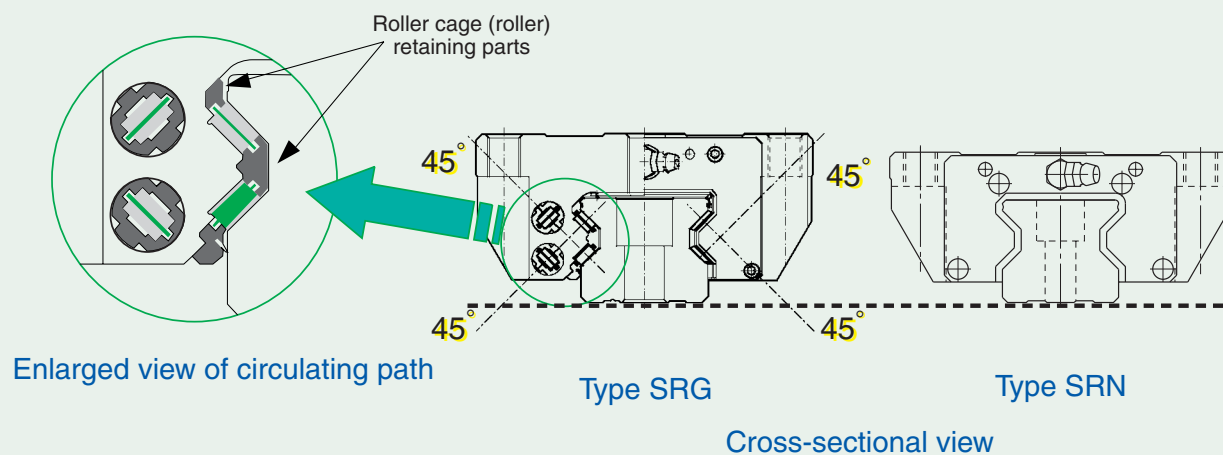
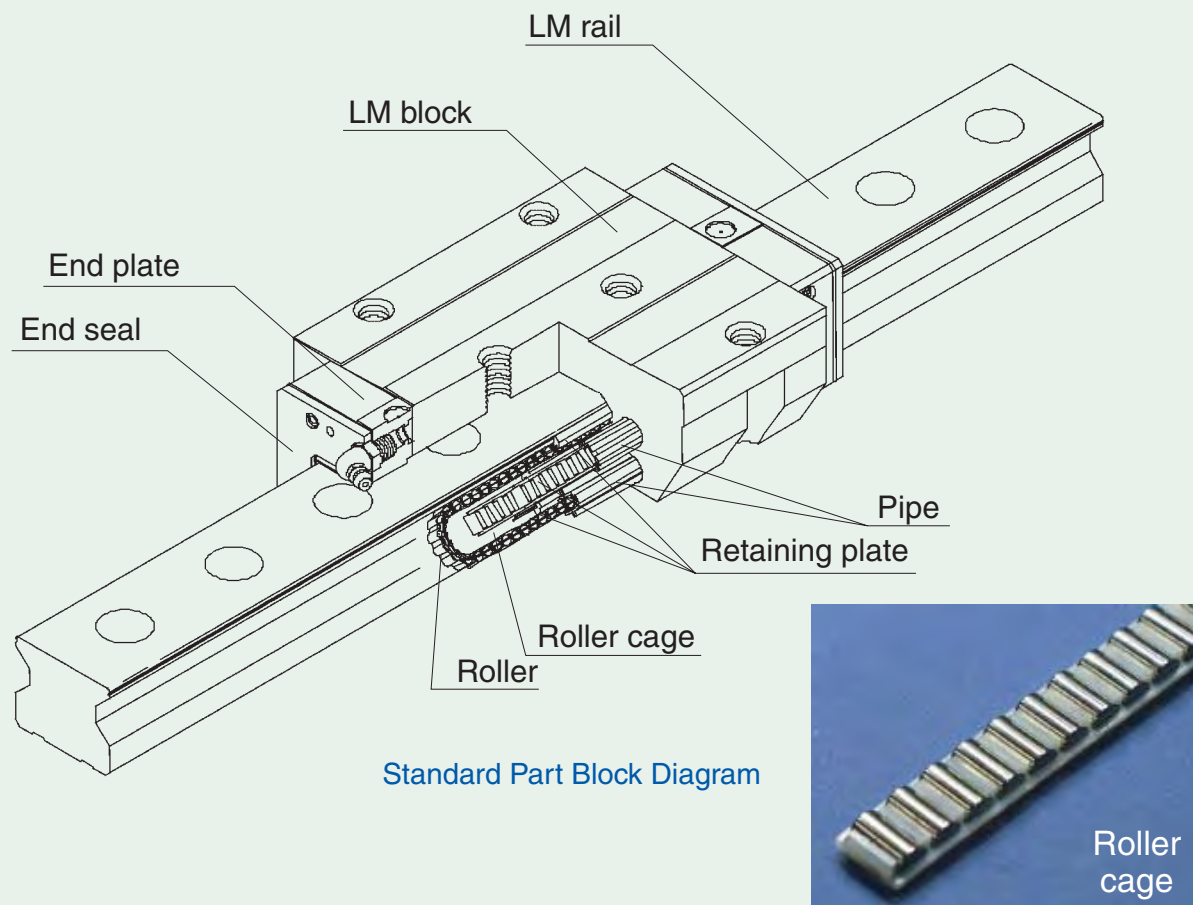
Detailed drawing of ball cage

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

Caged Roller Technology

SRG/SRN

Structure of the SRG/SRN type



Features of the SRG and SRN 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).

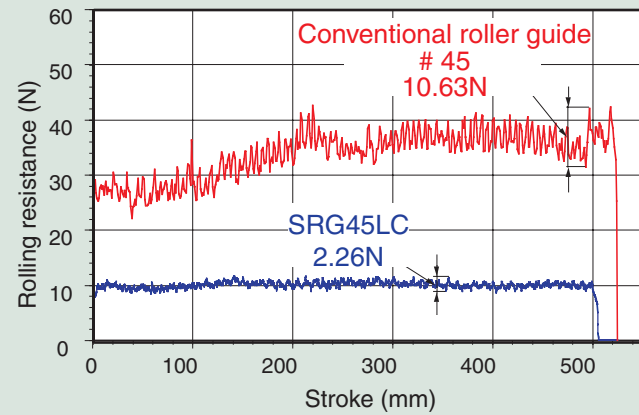
Global Standard Dimensions

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 the obtaining of stable movement.



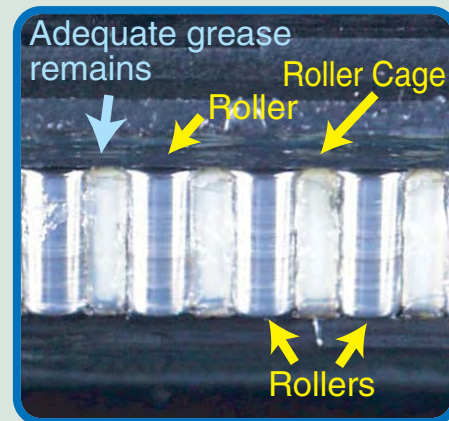
Durability Data

The use of a roller cage enables grease to be retained in the spacer portions 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.)



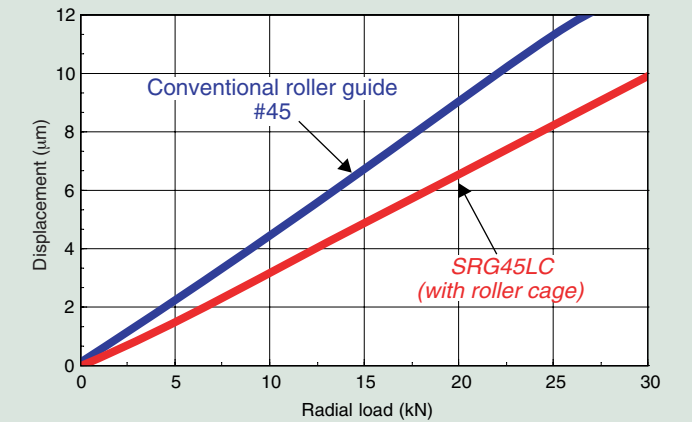
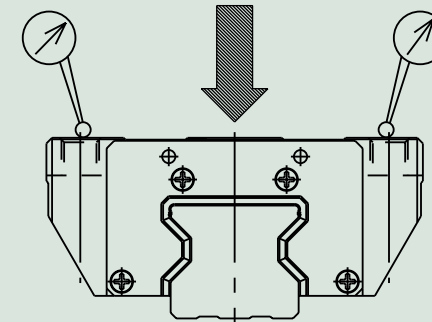
No discoloration of grease is observed.

Detailed drawing of roller cage

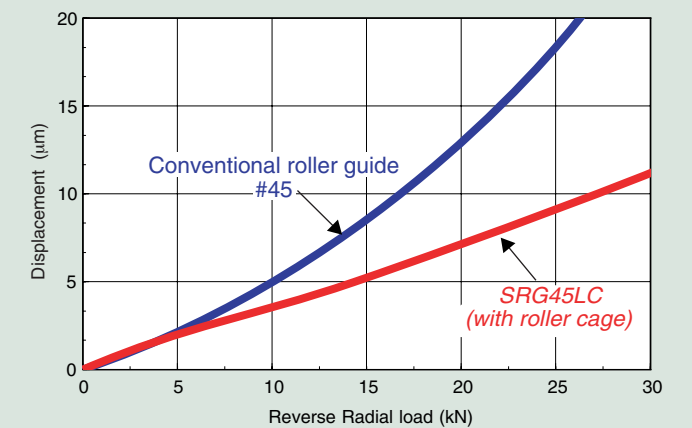
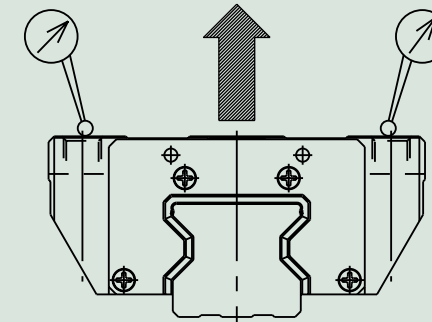
Rigidity values

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

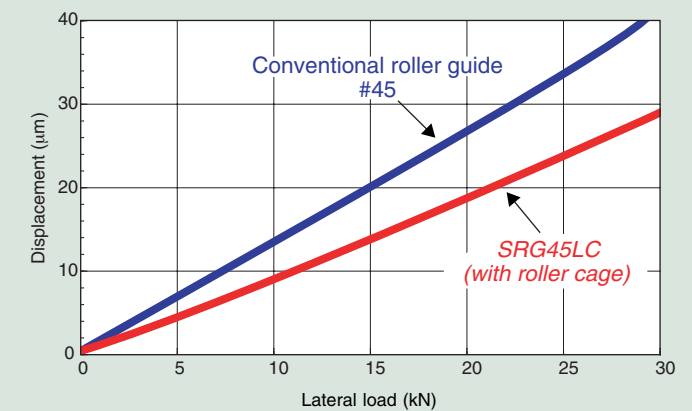
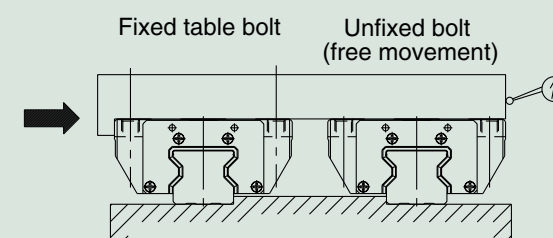
Radial rigidity



Reverse radial rigidity



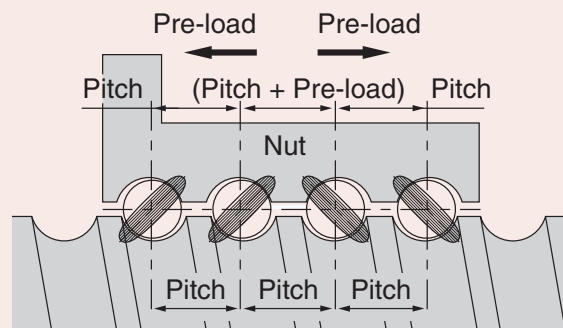
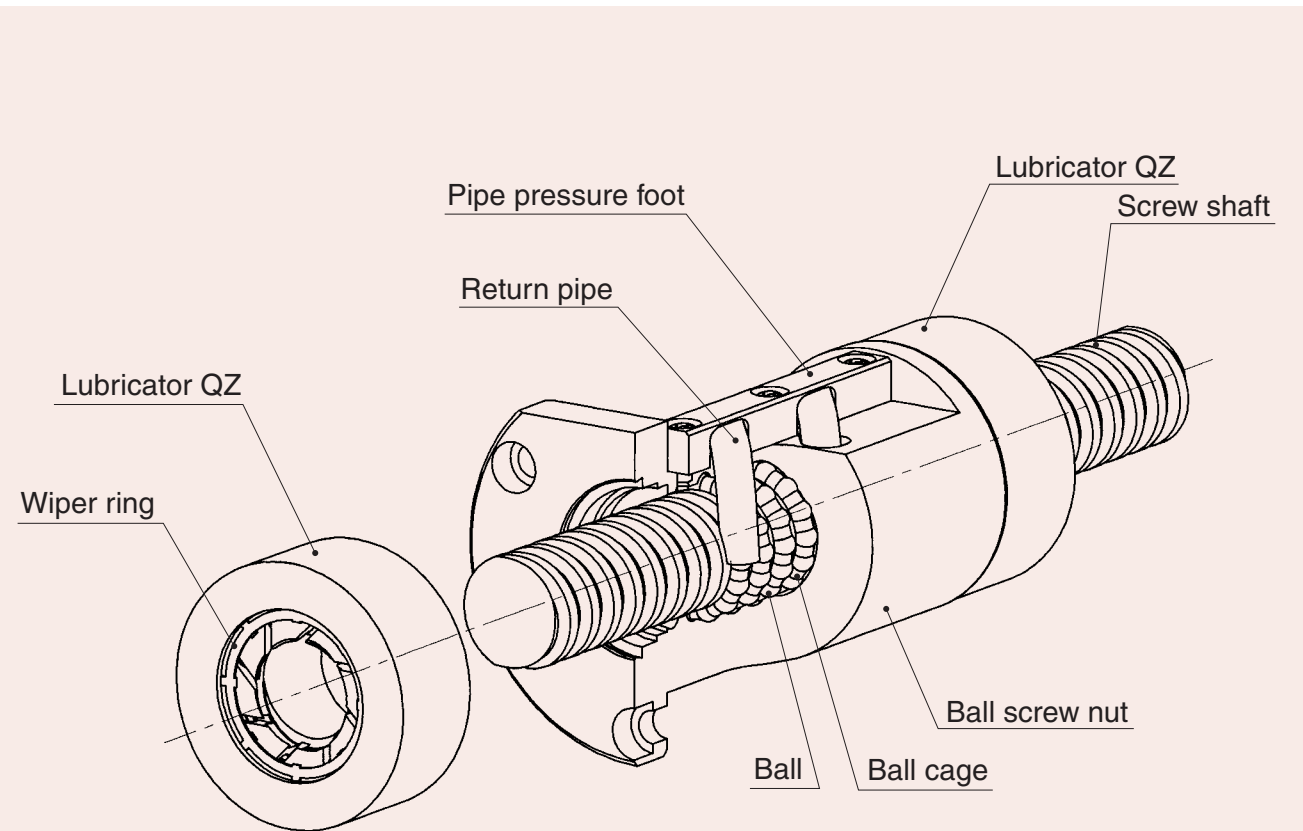
Lateral rigidity



High-Speed Ball Screw with Ball Cage

SBN

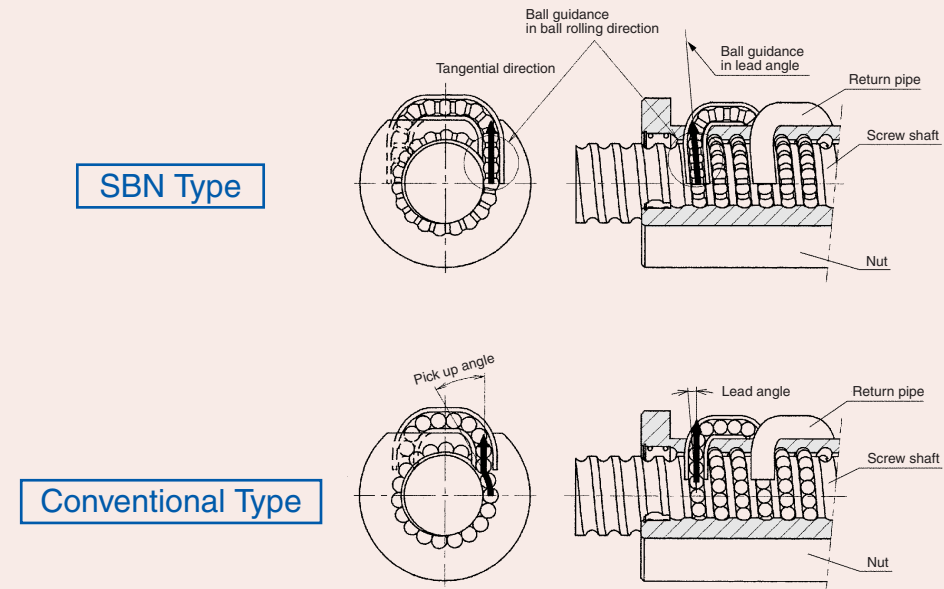
Structure of the SBN type



Features of the SBN type

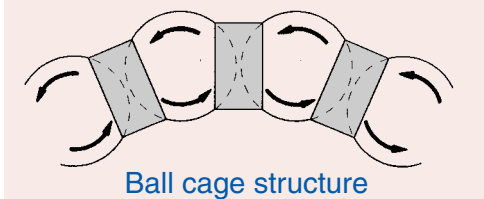
High-Speed Compatibility

The SBN type return pipe offers the ideal circulation method for creating a flexible ball track as a result of not having a lip so that balls are picked up in the tangential direction. In addition, the use of a design that provides the return pipe and ball cage with adequate strength **enables the SBN type to be used at a DN value of 130,000.**



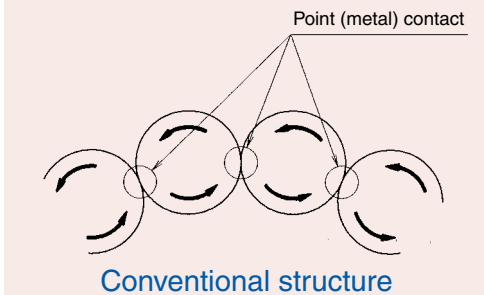
Low Noise Levels and Good Sound Quality

Ball cages arranged between the balls eliminate collision noise between the balls. In addition, the absence of a lip on the return pipe enables balls to be picked up in the tangential direction which also eliminates collision noise. The result is the **realization of low noise levels and good sound quality.**



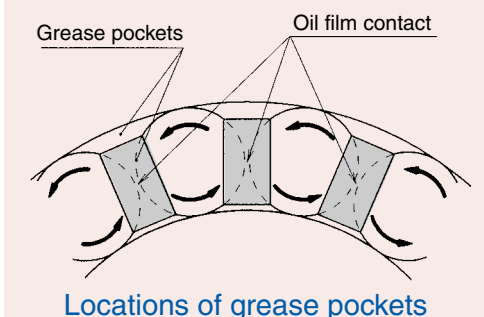
Long-Term, Maintenance-Free Operation

Long-term, maintenance free operation is realized as a result of the ball cage holding the grease. In addition, installation of the optional wiper ring and lubricator QZ* contributes to long-term, maintenance-free operation even in harsh environments (in the presence of coolant or foreign matter).
(*: Please contact **THK** regarding the wiper ring and ball screw lubricator QZ.)



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

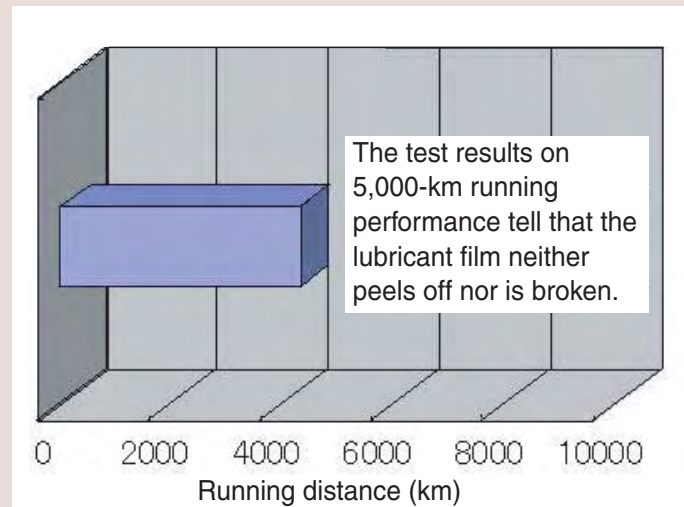
Service life test

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

Testing instrumentation for a long-period high-speed test was used to test model SBN with lubrication system QZ. The operating cycles were run under a DN value of 130,000 and with only initial lubrication carried out.

Conditions

Test item	Value
Shaft diameter/lead	32 / 10 mm
Number of test pieces	1
Load	1,720 N (Only initial tension)
Speed	39 m/min
Shaft rotational speed	3,900 min ⁻¹ DN value: 130,000
Acceleration	9.8 m/s ² (1G)
Stroke	400 mm
Lubricant	THK AFG grease
Lubrication frequency	Only initial lubrication
Testing instrumentation	Testing instrumentation for the long-time high-speed test



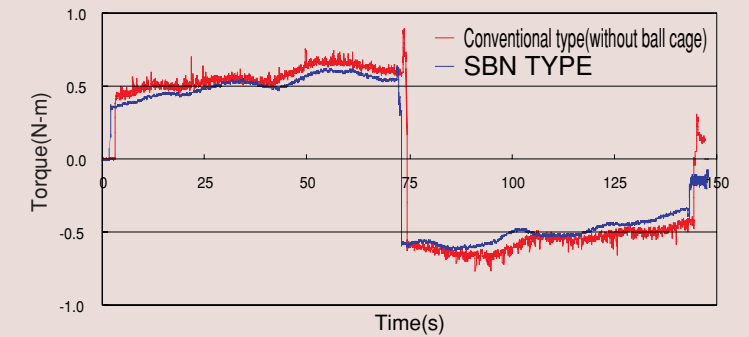
Ball Screw with Caged Ball Technology

Torque Fluctuations and Sliding Properties

The ball cage reduces torque fluctuations enabling the obtaining of excellent constant speed characteristics 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

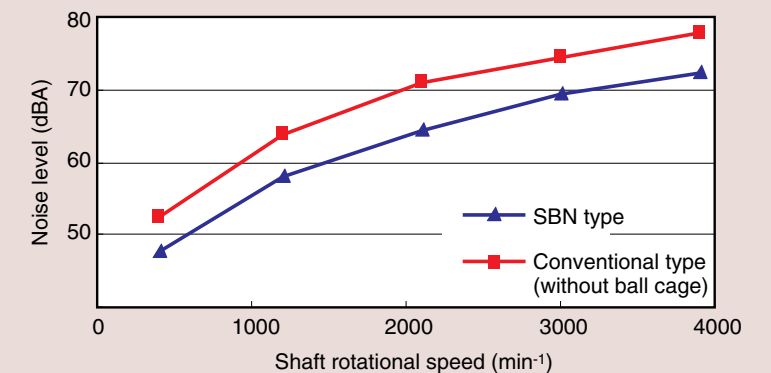


Noise Level Data

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

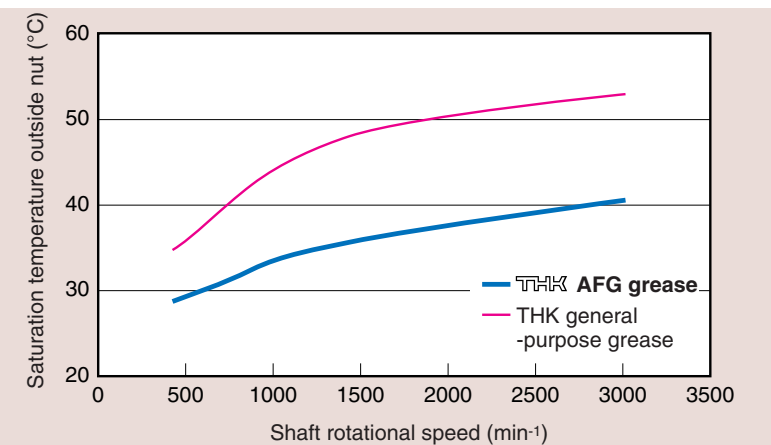


Heat Generation Data

Although the use of 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



Caged Technology Products Provide Outstanding Features

S Series

