Smooth Silent Ecological

Caged Technology
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

- LM rail
- LM block
- End plate
- End seal
- Ball
- Ball cage
**Advantage 1**

Quiet Operation that Minimizes Metal Contact

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

- **Generation of collision noise between balls**
- **Absence of collision noise between balls**

Since metal contact occurs only at the load zone, metal noise is held to a minimum.

**Advantage 2**

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.

- **In the case of the full ball type, the balls demonstrate skewing and move randomly.**
- **Balls are guided by the ball cage so as to be uniformly aligned in the direction of circulation for smooth operation.**

Conventional type (without ball cage) circulating path

Ball cage type circulating path
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.

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.
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

![Testing instrumentation diagram]

2. Testing parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>SHS25V1SS+580LP / HSR25A1UU+580LP</td>
</tr>
<tr>
<td>Number of pieces</td>
<td>32</td>
</tr>
<tr>
<td>Load</td>
<td>11.1 kN per LM block (0.35 C of SHS25V)</td>
</tr>
<tr>
<td>Lubricant</td>
<td>Lithium soap base grease No. 2, Only initial lubrication</td>
</tr>
</tbody>
</table>

![Testing parameters diagram]
3. Test results

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)

<table>
<thead>
<tr>
<th>Calculation Example</th>
<th>LM guide with caged ball</th>
<th>Model SHS25V</th>
<th>C=31.7 kN</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM guide with caged ball</td>
<td>L = ( \frac{C}{P} \times 50 )</td>
<td>( \frac{31.7}{11.1} )\times 50 = 1160 km</td>
<td></td>
</tr>
<tr>
<td>Model SHS25V</td>
<td>( \frac{31.7}{11.1} )\times 50 = 1160 km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LM guide without caged ball</td>
<td>L = ( \frac{C}{P} \times 50 )</td>
<td>( \frac{19.9}{11.1} )\times 50 = 280 km</td>
<td></td>
</tr>
<tr>
<td>Model HSR25A</td>
<td>( \frac{19.9}{11.1} )\times 50 = 280 km</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

● Comparison in terms of dynamic durability values

\[
\begin{align*}
\frac{31.7}{19.9} &= 1.6 \\
\end{align*}
\]

● Service life

\[
\frac{1160}{280} = 4.0
\]

*For details, see General catalog
**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.

![Graph showing rolling resistance data](image)

**Noise Level Data**

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

![Graph showing noise level data](image)
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.

![Graph showing comparison between Conventional products (without ball cage) and SSR20 (with ball cage)](image)

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

![Graph showing distance traveled and total life span](image)

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

Standard Part Block Diagram

Enlarged view of circulating paths

Cross-sectional view
# Features of the **SRG/SRN/SRW** type

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prevents roller skewing</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Long-Term, Maintenance-Free Operation</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Ultra-High Rigidity</strong></td>
<td>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).</td>
</tr>
<tr>
<td><strong>Global Standard Dimensions</strong></td>
<td>The dimensional design complies with the Type HSR developed by THK as the pioneer of linear motion systems and has become the global standard.</td>
</tr>
</tbody>
</table>
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)
**Rigidity values**

<table>
<thead>
<tr>
<th>Radial clearance</th>
<th>SRG</th>
<th>Conventional roller guide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>:</td>
<td>Clearance C0</td>
</tr>
<tr>
<td></td>
<td>:</td>
<td>Equivalent to C0</td>
</tr>
</tbody>
</table>

### Radial rigidity

![Graph showing radial rigidity for SRG45LC (with roller cage) compared to conventional roller guide.](image)

### Reverse radial rigidity

![Graph showing reverse radial rigidity for SRG45LC (with roller cage) compared to conventional roller guide.](image)

### Lateral rigidity

![Graph showing lateral rigidity for SRG45LC (with roller cage) compared to conventional roller guide.](image)
High-Speed Ball Screw with Ball Cage

Structure of the SBK type

Ball cage

Two-raceway, large-lead screw shaft

End cap

Balls

Ball screw nut
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.

**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.

<table>
<thead>
<tr>
<th>Conditions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample tested</td>
<td>SBK3620-7.6</td>
</tr>
<tr>
<td>Number of samples</td>
<td>3</td>
</tr>
<tr>
<td>Maximum rotation speed</td>
<td>4200 min(^{-1}) (DN value : 160,000)</td>
</tr>
<tr>
<td>Stroke</td>
<td>400 mm</td>
</tr>
<tr>
<td>Lubricant</td>
<td>Multemp HRL grease (initial lubrication only)</td>
</tr>
<tr>
<td>Grease quantity</td>
<td>8 cm(^3)</td>
</tr>
<tr>
<td>Applied load</td>
<td>1.87 kN (preload only)</td>
</tr>
<tr>
<td>Acceleration</td>
<td>1G</td>
</tr>
</tbody>
</table>

The test results on 3,000-km of running performance show that the lubricant film neither peels off nor is broken.
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.

<table>
<thead>
<tr>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Shaft diameter/lead</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Shaft rotational speed</td>
</tr>
<tr>
<td>Stroke</td>
</tr>
<tr>
<td>Lubricant</td>
</tr>
</tbody>
</table>

**Noise Level Data**

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

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<tr>
<th>Conditions</th>
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<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Shaft diameter/lead</td>
</tr>
<tr>
<td>Lubricant</td>
</tr>
<tr>
<td>Measuring distance</td>
</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Shaft diameter/lead</td>
</tr>
<tr>
<td>Shaft rotational speed</td>
</tr>
<tr>
<td>Stroke</td>
</tr>
<tr>
<td>Lubricant</td>
</tr>
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</table>
A Lineup of Caged Ball/Roller LM Systems

Caged Ball LM Guides

Global Standard

Model SHS

Radial Type

Model SSR

Lightweight, Compact

Model SRS

Ultra-heavy Load Type

Model SNR/SNS

Wide, Low Gravity Center Type

Model SHW

- Conveyance system
- NC lathe
- Machining center
- FPD manufacturing machine
- Drilling machine
- Semiconductor manufacturing machine
- Medical equipment
- Optical stage
- Medical equipment
- Chip mounter
- Printer
- Chip mounter
- Semiconductor manufacturing machine
- FPD manufacturing machine
- Conveyance system
- Chip mounter
with Superb Features  S Series

Caged Roller LM Guides

Super-ultra-high Rigidity Type

Model **SRG**

- Machining center
- Ultra precision lathe
- Heavy cutting machine

Super-ultra-high Rigidity, Low Gravity Center Type

Model **SRN**

- Machining center
- Ultra precision lathe
- Heavy cutting machine

Super-ultra-high Rigidity, Wide Type

Model **SRW**

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

High Speed Ball Screws with Ball Cage

High Speed Ball Screw

Model **SBN**

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

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

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

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