ULTRA STIFFNESS AND ULTRA LOW WAVING LM GUIDE

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Abstract

Since the launch by THK of the first Linear Motion Guide in 1972, these products have evolved in order to overcome different challenges. A current challenge consists on improving the precision of THK's products up to a nanometric scale. Optimizing the internal design of the block of a linear guide according to concrete specifications can reduce the waving phenomenon caused by the changing load condition of the rolling body in the block. However, this optimization is not enough for improving the precision of the LM Guides in a microscopic level. Increasing the number of effective balls by reducing their diameter, expanding the length of the block and increasing the number of rows in the Guide is a solution that allows a high increase of the rigidity and the reduction of the waving to the desired level.

GEOMETRIC ACCURACY OF MOTION

Straightness and waving are two phenomenons that appear due to the movement of the table of a LM Guide.

Straightness indicates the range of how much the table movement deviates from its ideal line, since this movement should be the straight line.

Waving shows the microscopic wave where it characteristically appears in the rolling motion guidance of the infinite circulation.

As shown in Figure 1, and in order to anticipate the geometric accuracy of the LM Guide, it is important to know how much the table would deform its postural change by the load and the moment influenced to it.

Therefore, it is necessary to know the load distribution of the block interior establishing the theory of the load distribution.

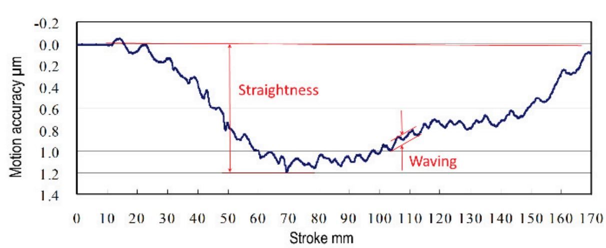

Figure 1: Geometric accuracy of motion.

THEORY OF THE LOAD DISTRIBUTION

This is the theory that consider those respective blocks illustrated in Figure 2 as a single unified system, and varies the external force affecting to the table to a postal change finally by converting the load, elastic deformation, and the contact angle variation where generated at the contact of the rolling body.

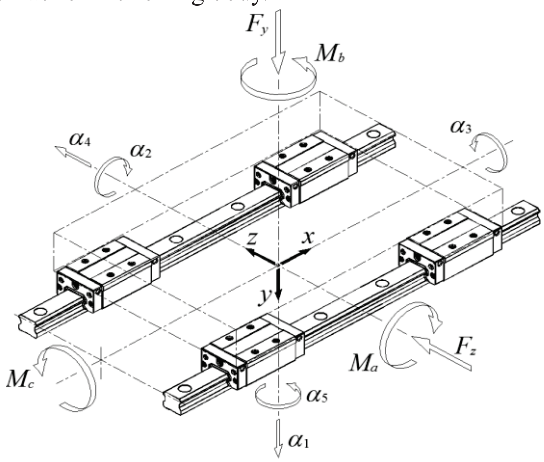

Figure 2: Theory of load distribution.

GENERATING FACTOR OF WAVING

The waving phenomenon occurs due to the movement of the LM block. By this movement, the number of effective balls (balls which are carrying the load) changes increasing and decreasing constantly (Figure 3). This causes a change of the load distribution that creates a changing balance of the load. For this reason appears the factor of waving. The difficulty of correcting this phenomenon is a problem to overcome in order to provide LM Guides of a greater accuracy for ensuring their optimal use in high performance machines.

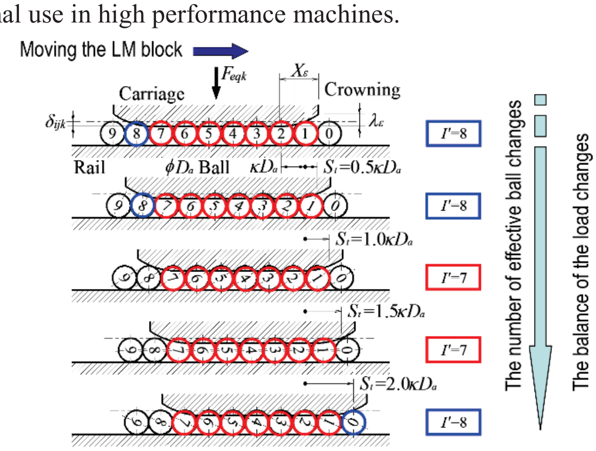

Figure 3: The factor of waving.

OPTIMIZED DESIGN

The initial solution for minimizing the waving consists on determining the optimized design of the block interior for meeting the clients specifications.

PRECISION IMPROVEMENT OF THE LM GUIDE

The merits of the LM Guide include its easy maintenance and the improvement of the machines productivity. Also, it includes a high energy saving and a better improvement of the design with a low total cost.

Changing the load condition of the body in the different stroke generates a waviness phenomenon. Therefore, it was adopted the guidance of the static oil pressure for the high performance machine.

The goal is adding the merit of achieving the ultra-high precision of the LM Guide by realizing the waving of nano-level.

HOW TO MINIMIZE THE WAVING

As previously seen, the objective for achieving a functioning LM Guide, is increasing the number of effective balls in order to have a better distribution of the load. This objective tries to meet the merits of hydrostatic guides with the advantages of caged ball LM Guides (Figure 4).

Therefore, the first action to be taken in order to increase the number of effective balls, is reducing the diameter of the balls. The reduction of the balls by ½ allows increasing the number of effective balls two times.

Also, increasing the number of rows from 4 to 8, allows having contact with the double of balls.

At last, changing the length of the guide's block is another way of increasing the number of effective balls. An expansion of the LM Guide block of two times its standard length, increases the number of effective balls by 2.

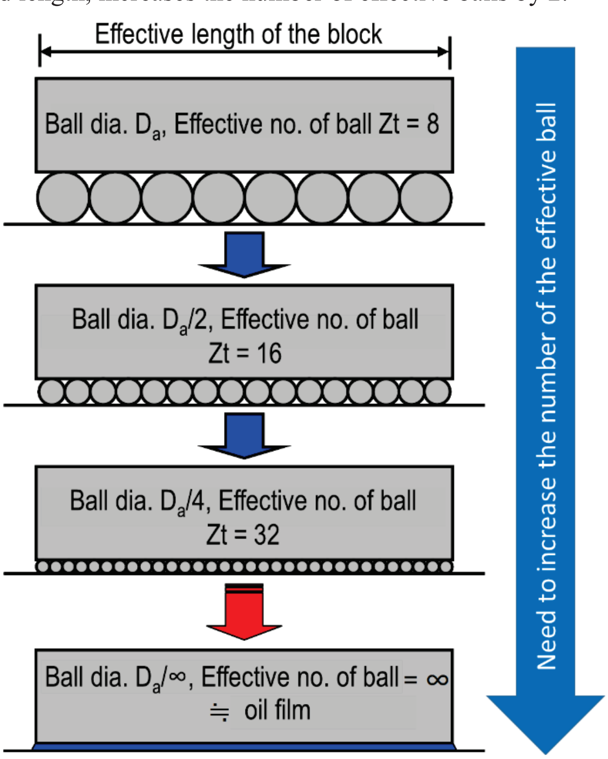

Figure 4: Reduction of the waving.

ADVANTAGES

By the adoption of the previously indicated actions, the SPR/SPS LM Guide meets several advantages.

In the first place, it allows increasing the number of effective balls around 8 times. This has as a consequence a higher accuracy and the achievement of a super-low waving.

These guides allow a high accuracy in a rolling guide that reaches the level of the nanometric scale. The waving phenomenon can be reduced around an 80%.

Also, the SPR/SPS models reach a super high rigidity and a higher load rating. The rigidity of these guides is higher than a roller's guide rigidity.

According to the experimental tests, the measurement of the waving results of 9.5 nm in the vertical direction (Figure 5), and 21 nm in the horizontal direction (Figure 6).

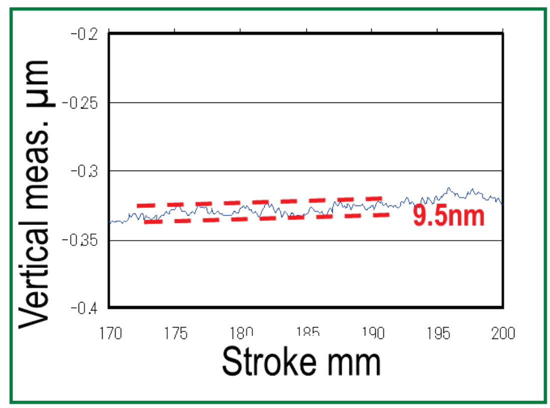

Figure 5: Vertical measurement.

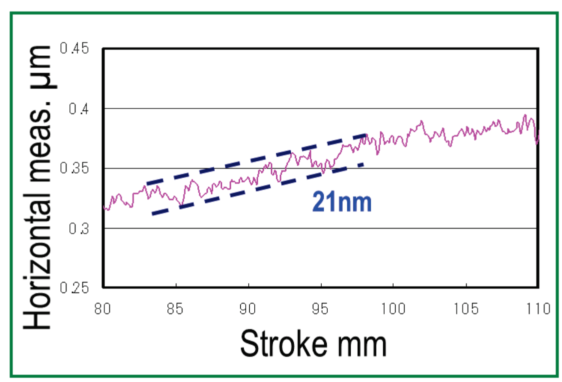

Figure 6: Horizontal measurement.