Model Based Development for BEV High-speed Ball Bearing

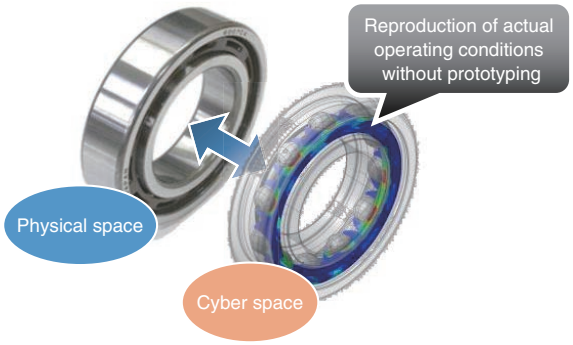


Image of MBD

In recent years, bearing development has come to require not only performance improvements such as to systems, but also shortened development periods. For this reason, JTEKT is actively using model-based development (MBD) to reproduce development targets using cyberspace-based models, which are then used to conduct simulations for performing development and verification. In this paper, we will discuss the details of our development performed on high-speed ball bearings for BEV using MBD.

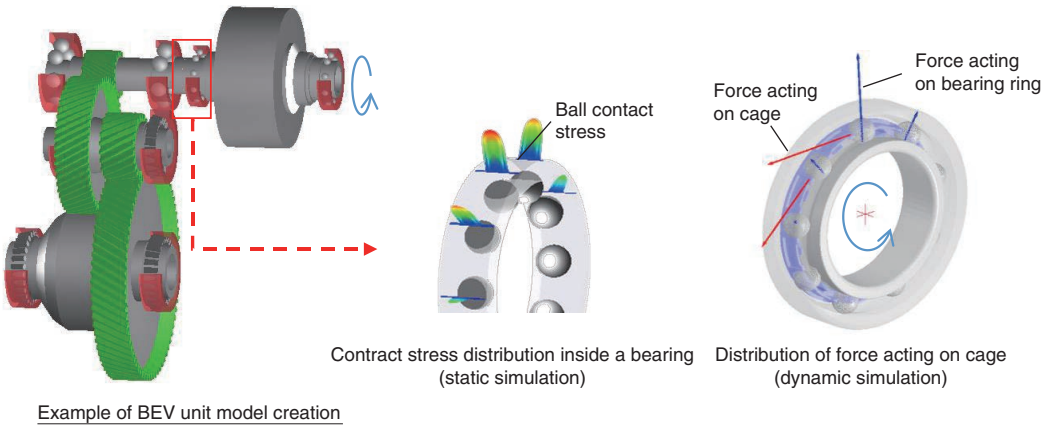
Example of MBD Being Used for Development of High-speed Ball Bearings for BEV

As automotive electrification accelerates, rolling bearings are being required to be capable of high-speed rotation and with lower torque. Because centrifugal force acts on each part of the bearing during rotation, operating conditions are especially harsher than usual during high-speed rotation. In order to develop bearings that do not suffer damage or seizure during high-speed rotation, JTEKT is accelerating its development of MBD technology.

①Shortening development periods by predicting bearing service life during high-speed rotation

JTEKT has developed its own specialized analysis program for bearing design that enables bearing service life and cage durability to be verified in advance.

- Bearing service life and temperature increases can be predicted by accurately estimating the contact stress applied to raceways when loads act upon the bearing.
- Cage durability can be verified by accurately estimating the force that acts upon the cage due to the lead or lag of balls during high-speed rotation.
- Specialized modules for each bearing type have been developed that enable new bearings to be developed quickly.
- Design study periods for newly developed bearings have been halved in comparison to conventional study periods.



Example of using a specialized analysis program for bearing design

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②Contributing to the optimization of lubrication system design by developing a method of predicting lubricant flow during high-speed operation

When performing MBD for bearings, it is necessary to understand the lubrication conditions inside the bearing and construct a fluid simulation model accordingly. For this purpose, we developed a test equipment capable of observing the flow of lubricant inside the bearing during operation*1.

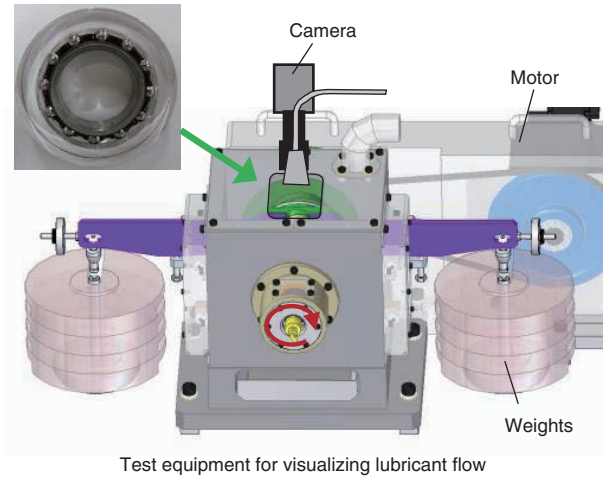
This enabled us to successfully observe the flow of lubricants at a high rotation speed of 20 000 min^{-1}, a world first, while also enabling us to observe the thin film lubrication state that occurs only at high-speed rotation*2.

・We constructed a new simulation model for lubricant flow analysis by applying correlations with observation results.

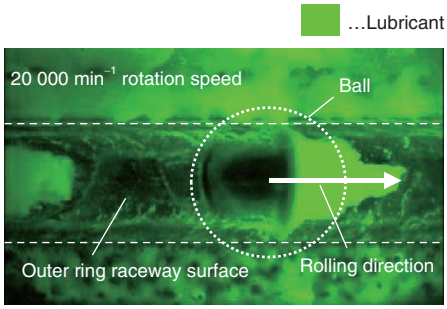
・Being able to predict the amount of lubricant that flows into the bearing in advance enables us to greatly assist in the lubrication system design processes for various customer units.

*1 Jointly developed with Toyota Central R&D Labs, Inc.

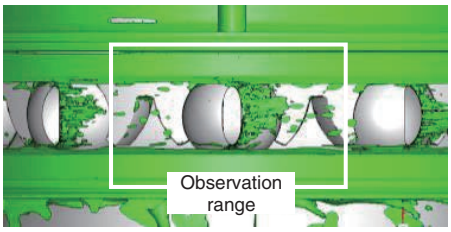
*2 In-house investigation results from December 2021



Test equipment for visualizing lubricant flow
[Provided by Toyota Central R&D Labs, Inc.]



Observation results for lubricant flow



Simulation results for lubricant flow analysis

Method used to predict lubricant flow

By utilizing such MBD technology, we have developed a high-speed rotating ball bearing for BEV capable of 1.85 million $d_m n$*3 using grease lubrication.

*3 "$d_m n$" is an indicator that expresses bearing rotational performance using the equation "ball pitch circle diameter (mm) × rotation speed (min^{-1})."

*Details of development examples are shown in "Development of Grease-lubricated High-speed Bearing" shown on page 82 of this report.

Contributions to Customers

①Being able to deliver high-quality bearing products in short amount of time enables us to contribute in shortening customer development periods.

②We can now propose bearing specifications and lubrication system designs that enhance customer unit performance.

(Engineering Planning Dept., Industrial and Bearing Business Unit)

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