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Multibody Dynamics Technology for a Counter Arrangement Groove Structure in a Constant Velocity Joint(CVJ)

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CVJ of the counter groove structure that was developed to put it on the Drive Shaft equipping a front wheel drive vehicle accomplished coexistence of high transmission efficiency and the NV performance and, on top of that, secured strength establishment characteristics. In the development of CVJ of the counter groove structure, we developed a technique of the multibody dynamics as a simulation technology before making a prototype component. This paper introduces the example that utilize a simulation technology in development.

A driving torque from Engine is input to Drive Shaft of FF vehicle through Transmission. And the Drive Shaft transmits a driving torque to Tire. Out board CVJ installed in the tire side of the Drive Shaft transmits rotary torque at constant velocity and, depending on the Suspension of up-and-down motion and the Steering motion, is the coupling which can take the joint angle in the input axis and the output axis(Fig.1).

In the Drive Shaft transmitting a torque, a transmission efficiency influences the fuel consumption, and internal friction of CVJ becomes the factor to worsen it. In addition, the idling vibration of the Engine transmits it to the vehicle body through the Drive Shaft. Because the vibration transmission to the vehicle body is high when frictional resistance of CVJ is high, one of the requirements becoming advantageous to NV performance is a low friction.

For the counter groove structure , a direction of the ball load in the A groove is on the lips side, and it in the B groove is on the depths side. Therefore a direction of the loads into a cage is the lips side and the depths side in turn, and it is counterbalance as a total. Therefore, the cage becomes the floating state, and the spherical surface friction when CVJ is rotating is reduced. CVJ of the counter groove structure can reduce transmission of the vibration and can be accomplished high transmission efficiency.

We built an analysis technology of the multibody dynamics in CVJ development of the counter groove structure and confirmed predictive precision of NV performance and the strength performance in comparison with a result of the actual measurement. Using the multibody dynamics that we built, it inflected in a performance prediction and mechanism analysis before making a prototype component.

In a multibody dynamics model contact definition between rigid surfaces defined not with the surface of discontinuity of the general polygon, but with the continuity surface by functional form. The contact stiffness calculated from a contact formula of Hertz and defined it to a model. In this way the contact model achieved smooth results of calculation.

In NV performance, a dynamic stiffness of articulation of CVJ the condition of which indicates idling vibration is predictable by application of a built multibody dynamics technology, and compared the performance of conventional and counter arrangement groove structure by using the predictive technology. The superiority of the counter groove structure was confirmed, and it contributed to the decision to launch the development of CVJ. In addition, it was confirmed that the accuracy was sufficient by experiments and verification(Fig.2).

In strength performance, it developed multibody dynamics technology that is not only to achieve smooth contact results, but also to taken into consideration of elastic deformation of the outside diameter(Fig.3), and to be excellent computational efficiency. In the experiment and verification, it was confirmed that the characteristics of the waveform of the ball groove load during one rotation can be simulated with high accuracy(Fig.4). As a result, at the design stage before making the prototype, it has become possible to evaluate the load of the ball groove equivalent to the prototype with high accuracy.

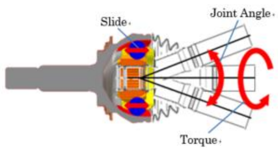

Fig.1 Structure and Movement of CVJ

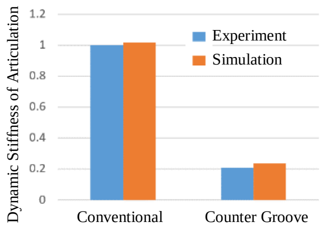

Fig.2 Dynamic Stiffness of Articulation

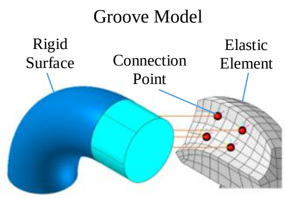

Fig.3 Smooth Contact Elastic Model

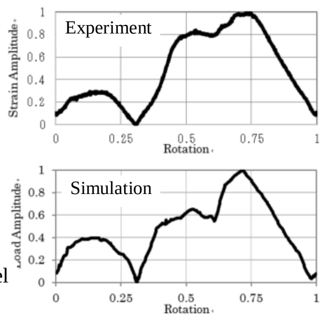

Fig.4 Comparison of Cage Load

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