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Vehicle Dynamics improvement by reducing extremely low frequency vibration

- Vehicle Neutral characteristics improvement by development of aerodynamic item (UMVG) –

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Vehicle Neutral characteristics is one of the most important performance of Vehicle Dynamics. It is the vehicle motion starting point that the vehicle always fits, and vehicles that do not have this characteristic are not rated as vehicles with a high sense of security. Vehicle Neutral characteristics is expressed in sensuality, but it is not quantitatively clear. Traditionally, it has become difficult to quantitatively express sensuality expressions. So we conducted research for the following purposes: (1) Quantitatively clarify the phenomenon of Vehicle Neutral characteristics that feels sensuality. (2) And explain the mechanism. (3) Develop items that can be solved in principle based on the mechanism results.

As a result of reinvestigating multiple events that felt Vehicle Neutral by adding items in the past, we focused on extremely low frequency vibration, which was an area where common knowledge gained was not handled much in the past. And as a result of measuring the extremely low frequency vibration of the vehicle when driving straight on a long straight line using a vehicle with good Vehicle Neutral characteristics, and a vehicle that is not, it was confirmed that vehicles with good Vehicle Neutral characteristics from low vehicle speed to high vehicle speed have small vibration level. By carefully observing the extremely low frequency vibration especially checking the chronological waveform based on yaw-rate out of the 6 degrees of freedom in the vehicle, we were able to clarify the mechanism of Vehicle Neutral characteristics.

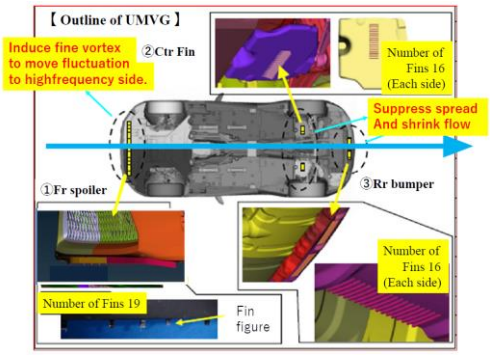
From the results of air flow changes due to the charge load in past wind tunnel experiments, it was found that extremely low frequency vibration is caused by air flow. Then, it turns out that the cause of extremely low frequency vibration is air flow, we developed items that improves its aerodynamic characteristics in principle. The unique idea is whether the loose vibration energy associated with extremely low frequency vibration can be forcibly generated into the energy on the high-frequency side by forcing fine vortexes. So we developed the following items named Under-floor Multi Vortexes Generator (UMVG): An item devised so as not to lower the flow rate by setting multiple thin protrusions, etc. on the front side of the under the floor to generate fine vortexes, setting multiple slits in the center and back edges to shrink, and not to lower the flow rate. (Fig.1) We tried to simulate the flow field by CFD with or without UMVG, and confirmed that the Yaw-moment(YM) fluctuation decreases in the extremely low frequency range. In the actual driving test with or without UMVG, vehicle equipped with UMVG confirmed that Yaw-rate (YR) fluctuation in extremely low frequency range were reduced as intended, and sensuality confirmed that the Vehicle Neutral characteristics have been improved. In addition, in the wind tunnel test, vehicle equipped with UMVG confirmed that the left and right difference pressure fluctuations in actual measurement decreased in the extremely low frequency range, and confirmed that Cd and Cl values do not get worse. From the above, the aim of UMVG has been verified. The conclusion is as follows:

(1) By expanding the way of thinking to extremely low frequency range, it showed that Vehicle Neutral characteristics can be expressed quantitatively with the extremely low frequency vibration reduction effect.

(2) Focusing on YR fluctuations, it shows that when it is close to zero, the same response is always obtained from there, we explained the mechanism that extremely low frequency vibration reduction represents Vehicle Neutral characteristics.

(3) Since extremely low frequency vibration is mainly caused by aerodynamics fluctuations, UMVG which was devised to reduce the fluctuations, showed that it will reduce extremely low frequency vibration and achieve the Vehicle Neutral, and verified its effectiveness.

(4) This aerodynamics effect by UMVG overturned common sense in the past and not only showed that it is quantitatively effective even at low vehicle speed of 30km/h, but also showed that it is effective even at ultra-high speed of 250km/h.



Fig,1 Outline of UMVG