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A method to simulate vehicle body electrical resistance for steering feeling

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In recent years, chassis components have been increasingly electrified from the viewpoint of carbon neutrality and improved control of vehicle motion. Electric power steering can improve the steering feel by motor control, but to extract more performance, it is important to stabilize the applied voltage, and it is necessary to consider the grounding method of electronic components and to set the appropriate electrical resistance value. Currently, when optimizing the electrical resistance of the body ground, measurement of the actual vehicle is required, and thus reducing person-hours and front-loading of development is a challenge. In this paper, a method for calculating the electrical resistance of the body shell is investigated for body grounding.

In general, current analysis solvers require solid elements. But for body-scale electrical resistance calculations, modeling with solid elements requires large number of nodes, which increases model creation and calculation time. Therefore, a finite element model consisting of shell elements for noise and vibration analysis was used. Also focusing on the similarity between current analysis and heat transfer analysis, a heat transfer analysis solver capable to handle shell elements was used. By specifying conductivity in the material properties as thermal conductivity, replacing voltage by temperature, current by heat transfer quantity, the calculated thermal resistance can be treated as electrical resistance, which makes steady state current analysis results capable to be obtained from steady state heat transfer analysis solver.

To calculate the electrical resistance between the main battery and an electric component ground point, 10[A] was applied to the bolt holes of the ground point of the main battery and -10[A] to the bolt holes of the ground points of other electronic components. Using the voltage obtained from simulation, the resistance was calculated from Ohm's law. The calculated resistance values were about 10% higher than the measured values, but captured the tendency due to distance(Fig1). From the above, the calculation results of this method were judged to be reasonable.

To examine the contribution of body shell components to the electrical resistance it is necessary to narrow down the area. Therefore, we focused on the shortest transmission paths of voltage between the ground points to identify the area which contributes significantly to electrical resistance. The results showed that the voltage change near the ground point was the largest and contributed the most to the electrical resistance.

Next, considering that the actual vehicle has multiple electronic components, the electrical resistance was calculated for the case of two electronic components. In this calculation, voltages were input to three ground points: one main battery and two electronic components. Unlike the 2-point input, the 3-point input has different electrical resistance values because the voltage distribution differs depending on the relative relationship of the input voltage values at the three points. Since the electrical resistance for 3-point input cannot be calculated using the results of the 2-point input calculations, it is required to perform 3-point calculation for the regarding condition.

The contribution of sites on the shortest transmission path of for electrical resistance was examined, and the contribution near the ground point was the highest for the 3-point input as well as the 2-point input. Therefore, the position of the ground point of the electronic component was changed to an area near the initial position and with high electrical conductivity, resulting in a reduction of the electrical resistance(Fig2). To reproduce the conditions of an actual vehicle, the ground point and the applied voltage value must be accurately specified.

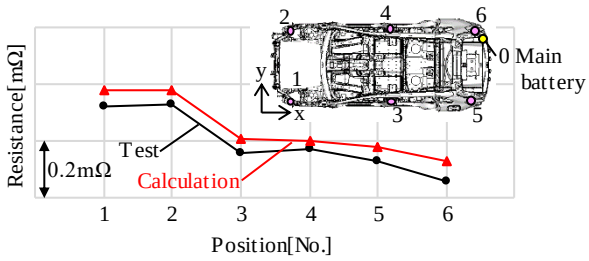

Fig.1 Resistance of the body (test and calculation)

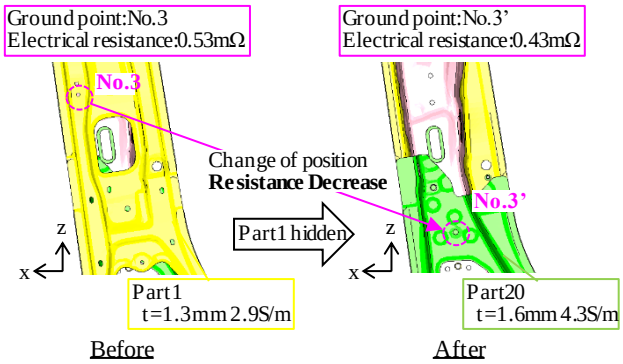

Fig.2 Change of ground point position