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Development of overall optimal mounting design method for water resistance using the particle method

- Work style reform for the realization of a carbon-neutral society -

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As a means to solve the current problems, we focused on the particle method (MPS), which makes it possible to visualize the behavior of water, and conducted a study. Because MPS can express the fluid flow by the particles themselves, there is no need to create a grid. As a result, it is possible to freely move within the analysis area, so that natural fluid behavior can be reproduced. MPS is a method of discreteizing the governing equation with an interparticle interaction model and calculating the fluid behavior by the motion of the particles. In this paper, we selected two parameters that are the dominant factors of water flow and searched for the optimum conditions. (Particle contact angle between fluid and vehicle; surface tension coefficient and Dynamic friction force between fluid and vehicle; wall surface slip coefficient) Specifically, for the surface tension coefficient, a potential force such as an intramolecular force was introduced as an external force term between particles. The dynamic friction force between the fluid and the vehicle was adjusted by the wall surface slip coefficient.

As a procedure for optimization study, we first carried out a single model and then an actual vehicle model. As shown in Table 1, the single model examined the flow path characteristics of three types of materials.

Table1 Affecting factors

Analysis conditions	Setting value, setting item
Material	Iron , Resin , Emboss processing
Flow velocity [ml/min]	60,100,600
Tilt angle [deg]	20,40,60
Particle contact angle [deg]	30,45,60,75,90,105,120,135,150
Slip coefficient for wall surface	1,4,7,10,13,16,19,22,25
Particle size [mm]	0.3,1

From the bench model results, it is possible to reproduce the flow path direction regardless of the material and velocity under the current conditions, but it was not possible to reproduce the continuous flow.(Fig.1) This result is due to the particle size and can be solved by reducing the particle size, but it is a trade-off with the analysis time.

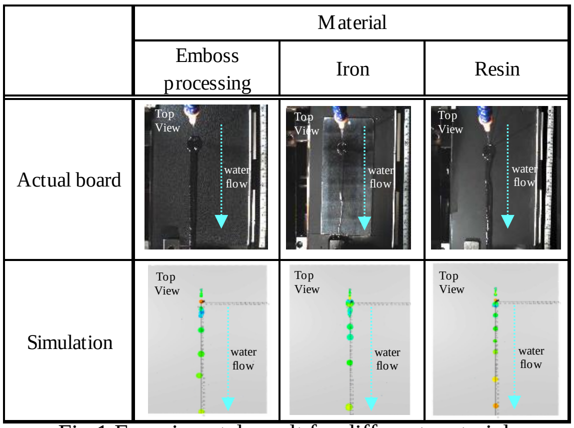

Fig.1 Experimental result for different materials

From the above examination, when the analysis is carried out with the actual vehicle model, it is expected that the analysis accuracy will be significantly reduced because the ECU and Wire Harness are complicatedly installed. Therefore, we changed the method of using the full vehicle, which we had been thinking about so far, to the method of using the simulation separately for upstream measures and downstream measures. First, in upstream measures, it is used as a measure to prevent water from splashing on multiple parts. In downstream measures, simulations are used to individually consider measures for parts that cannot be taken by upstream measures.

Finally, it was found that the results of the simulated watering route had almost the same tendency as those of the actual vehicle. As for upstream measures, it is possible to realize measures to prevent water from splashing on multiple parts at once, and it is possible to realize an overall optimum design at low cost. Furthermore, since it is a small-scale analysis, it can be analyzed with a general-purpose terminal. The analysis technology developed this time can be used for waterproofing measures, and it is possible to realize no evaluation of actual vehicles. (Fig.2) Using the analysis technology developed this time, we were able to apply it to the installation study of an actual vehicle project, shorten the development period, and reduce CO_2 during test vehicle manufacturing.

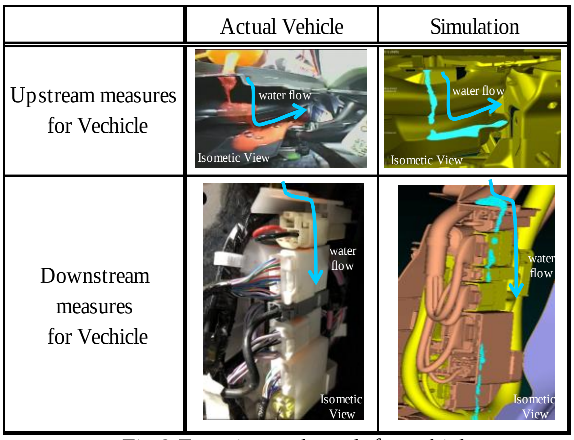

Fig.2 Experimental result for vehicles

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