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Development of Model Based Testing of RDE for Heavy-duty Vehicles (First Report)

- Reproduction Method of Real Road Conditions -

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Vehicle fuel consumption and exhaust gases during actual operation differ from the values listed in the manufacturers' specifications. Real driving emission (RDE) tests on diesel and gasoline Light-duty vehicles have been performed in Europe since 2018 with the goal of improving air quality; however, in Japan, RDE tests targeting NOx in diesel Light-duty vehicles will start in October 2022.

In the future, RDE testing method will be also adopted for Heavy-duty vehicles. However, it is difficult for Heavy-duty vehicles to estimate by using RDE testing method. The reason is the Heavy-duty vehicles have a lot of vehicle families and powertrain types. Therefore, we considered the test method of RDE for heavy-duty vehicles by using new approach of Model Based Testing (MBT), which combinates HILS (Hardware In the Loop Simulation) and engine bench system. Figure 1 is showed the RDE-HILS concept. This system is constructed actual engine with cooling fan, Powertrain model and Vehicle/Route Model. We introduced the extended-HILS at former repot. In order to construct the MBT method of RDE, we add the vehicle/Route model.

In this report, we considered the reproduction method of the real road conditions. In order to obtain the road data easily and high precision, we focused the electric motor power of EV. This vehicle has 1pedal driving function, which is able to accelerate, decelerate and vehicle stop by using accelerator pedal only. Figure 2 is showed the powertrain layout and wring of test vehicle.

Actually, in order to reproduce the road gradient information, we devised the " EV Power Conversion Method".

Step-1) Test vehicle is driven certification mode with gradient by using chassis dynamometer. We obtained the relationship the road gradient vs. electric power consumption. …Figure 2

Step-2) Test vehicle is driven the real road. At that time, we obtained the information of the electric power consumption.

Step-3) Test vehicle is driven the real road pattern, which is obtained Step-2, without gradient by using chassis dynamometer. We obtained the information of the electric power consumption.

Step-4) We estimated the electric power gap of Step-2 and Step-3. We converted from this gap to the road gradient by using Step-1. …figure 4

In conclusion, by using" EV Power Conversion Method", it was possible to obtain the road data, which is included the road gradient, easily and high precision.

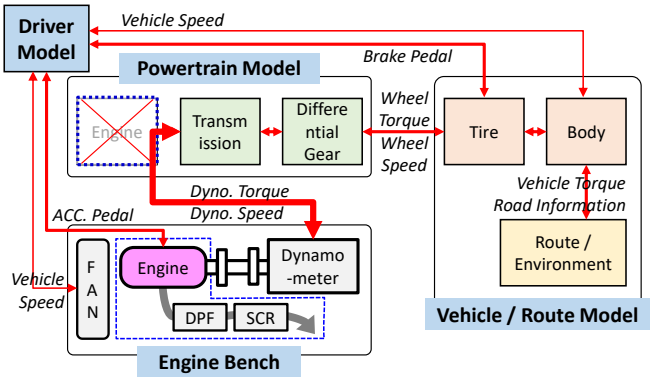
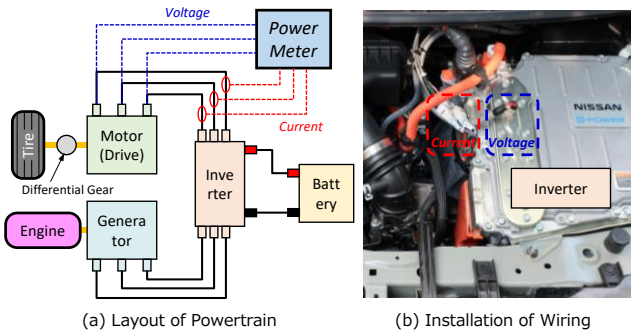
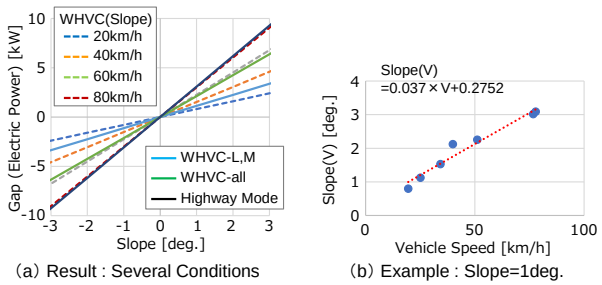


Fig.1 Concept of RDE-HILS



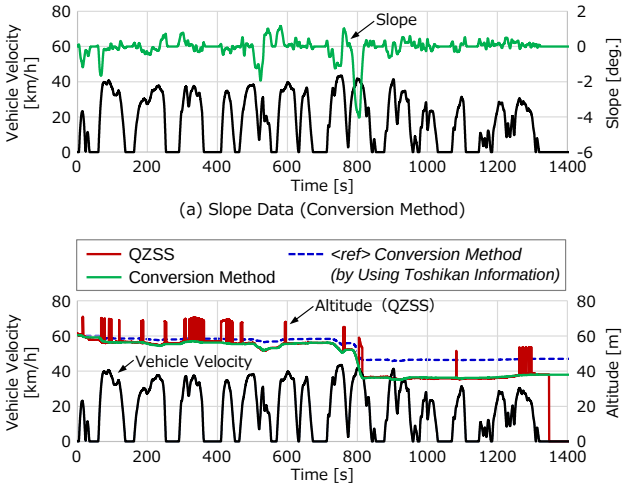
(a) Layout of Powertrain (b) Installation of Wiring

Fig.2 Powertrain Layout and Wring of Test Vehicle



(a) Result : Several Conditions (b) Example : Slope=1deg.

Fig.3 Slope Characteristics of Several Driving Conditions



(a) Slope Data (Conversion Method)

(b) Altitude Data

Fig.4 Conversion Method (STEP-4)