

Analysis of driving and dynamic characteristics of BEV trucks considering loading conditions

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KEY WORDS: Vehicle dynamics, heavy duty vehicle, dynamic model, 3-DOF vehicle model [B1]

In recent years, the electrification of commercial vehicles has been gaining momentum, and battery electric light-duty trucks (BEV truck) have also appeared on the market. However, there are no known studies examining their dynamic characteristics. When vehicles transition from internal combustion engine vehicles to battery electric vehicles, their dynamic characteristics change due to alterations in vehicle specifications. Trucks, which are heavier than passenger cars and carry cargo, are expected to experience even more significant changes in dynamic characteristics because of electrification. Furthermore, since the transition from internal combustion engine light-duty truck (ICE truck) to BEV trucks is expected to accelerate in the future, it is important to understand the differences in the dynamic characteristics between the two and to gain insights necessary for their safe operation.

In this study, we use a 3-degree-of-freedom (3-DOF) vehicle motion model to simulate the vehicle response to steering inputs for ICE truck and BEV truck and analyze the effects of the transition to BEV truck and cargo loading on their dynamic characteristics. The simulation conditions included: 0% Load, 50% Load (Lower), 50% Load (Front), 50% Load (Rear), 100% Load. The main vehicle specifications for each loading condition are summarized in Table 1. We simulate vehicle motion using a 3-DOF vehicle model. Specifically, while the vehicle is traveling at a constant speed $V = 60(\text{km/h})$, we apply a step-like front-wheel steering angle $\delta_f = 0.05(\text{rad})$ to simulate the vehicle's motion in response to the steering input. As simulation results, we obtained the time-history responses of the vehicle's lateral slip angle β , yaw rate γ , lateral acceleration α , and roll angle ϕ . We defined the value 30 seconds after the start of the simulation as the steady-state value A , and the time it takes for the front-wheel steering angle to settle within $\pm 5\%$ of the steady-state value after it is input as the settling time T . By comparing these characteristic values, we verify the changes in vehicle dynamic characteristics resulting from the transition to a BEV.

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Table1 Vehicle specifications for each loading condition

Loading condition	Mass of vehicle (kg)		Front and rear weight ratio (F : R)		C.G. height (m)	
	ICE	BEV	ICE	BEV	ICE	BEV
0%	1800	2300	60.8 : 39.2	49.0 : 51.0	0.750	0.500
50%(Lower)	2550	3050	47.6 : 52.4	40.9 : 59.1	0.912	0.615
50%(Front)	2550	3050	56.4 : 43.6	48.3 : 51.7	1.059	0.739
50%(Rear)	2550	3050	38.8 : 61.2	33.5 : 66.5	1.059	0.739
100%	3300	3800	40.4 : 59.6	36.0 : 64.0	1.227	0.883

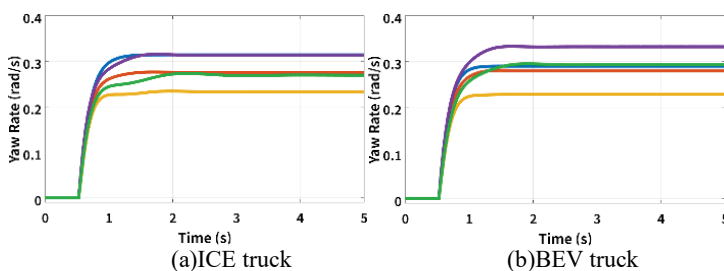


Fig. 1 Time history response of γ

Table2 Settling time and steady-state values of γ

Loading condition	T_γ (s)		A_γ (rad/s)	
	ICE	BEV	ICE	BEV
0%	0.52	0.43	0.3141	0.2896
50%(Lower)	0.51	0.49	0.2755	0.2800
50%(Front)	0.40	0.40	0.2331	0.2279
50%(Rear)	0.68	0.66	0.3130	0.3322
100%	0.97	0.78	0.2694	0.2929