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Proposal of Concept Shape for Drastic Improvement of Aerodynamic Performance of Heavy-Duty Vehicles

-Optimization of Cab Shape-

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Heavy-duty vehicls in Japan are limited in size by the Road Traffic Law, so the shape of the vehicle is designed with an emphasis on load capacity. In addition, aerodynamic performance has not been considered much at present, with aerodynamic parts being installed only to improve aerodynamic performance. In addition, heavy-duty vehicles often travel long distances at high speeds. Thesefactors inevitably increase aerodynamic drag, which is proportional to both the coefficient of aerodynamic drag for each body shape and the square of the speed. To reduce this drag and improve fuel efficiency, it is essential to improve vehicle geometry without being restricted by conventional regulations. In this study, we conducted numerical simulations of the front shape, which is largely related to aerodynamic characteristics, by setting the front virtual angle θ_{FT}, the ratio of hood height to vehicle height h_{FT}/H, and the windshield tilt angle θ_{FWT}. The resulting base model was optimized at four locations: roof header (location A), leading edge (location B), both ends of the windshield (location C), and both ends of the front face (location D). The design variable was set to be the *R* of each section, and the objective functions were set to be the drag and lift coefficients. H The formulas for calculating the drag and lift coefficients are shown below. ΔCd was calculated from the obtained *Cd* values.

$$D = \frac{1}{2} C_d \rho v^2 S$$

$$L = \frac{1}{2} C_l \rho v^2 A$$

D : Drag [N], L : L [N], ρ : Density [kg/m^3], v : Wind speed [m/s],
S : Frontal projection area [m^2] , A : Bottom projection area [m^2]

Comparison of *Cd* values showed that models with θ_{FT} and θ_{FWT} of 30° suppressed flow separation better than the other models. h_{FT}/H was constant at about 0.4. A 43% improvement in aerodynamic performance was obtained for the base model. The results were validated by additional wind tunnel tests. In addition, optimization was performed to improve aerodynamic performance at each of these locations. As a result, significant improvements were obtained in locations C and D, but not in locations A and B. The reasons for this are that in locations A and B. detachment was suppressed during base model extraction, and in locations C and D, the high pressure region in front of the vehicle body was reduced. The reasons for this are the suppression of separation during base model extraction in locations A and B, and the reduction of the high pressure area in front of the vehicle body in locations C and D.

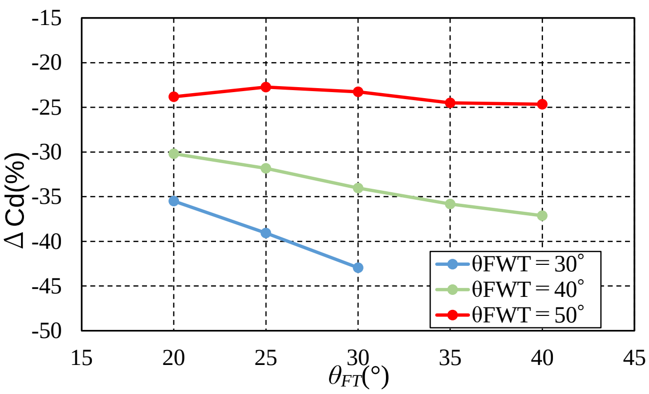

Fig.1 Relationship between front virtual angle and *Cd*

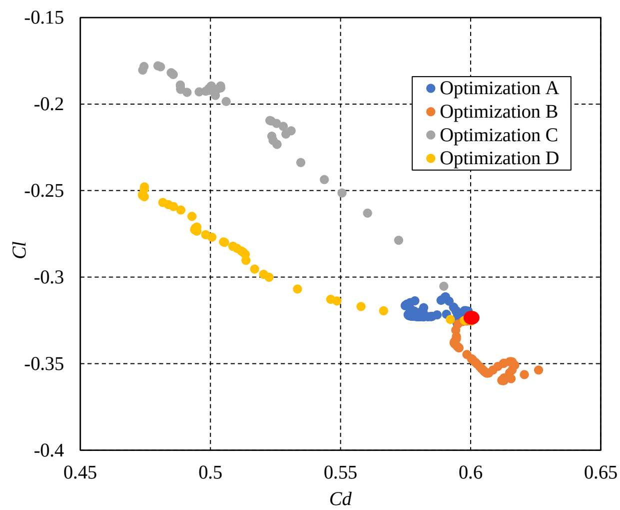

Fig.2 Optimization result