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Aerodynamics Control of a Simplified Vehicle Model Affected by an Overtaking Vehicle using Continuous Jet

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A vehicle running on the road suffers from crosswind effects and its aerodynamic performance often becomes worse due to the effects. Especially, some vehicles show changes in wake patterns caused by the crosswind, and the aerodynamic force acting on the vehicle changes drastically. In this study, to suppress such drastic change in aerodynamics, an aerodynamics control method using continuous jet [(1), (2)] has been applied in the more realistic crosswind condition occurred under the parallel running and overtaken situations. Effectiveness of the aerodynamic control method in the typical crosswind condition on the road has been numerically demonstrated.

The investigated vehicle model, so called Ahmed model, is shown in Fig.1. The slant angle ϕ is 32°, which showed wake pattern change at a certain yaw angle [(1), (2)] and parallel running conditions [(3)]. As the aerodynamics control method, planer jet flow is generated from eight slit nozzles near the rear edge [(1)], as shown in Fig. 1. The jet blows to the upstream side in order to enhance the flow separation from the leading edge of the slant. As a realistic crosswind condition on the road, the vehicle model travelling with the Ahmed model with $\phi = 0°$ running in the adjacent lane have been considered. The schematic view of the target condition is drawn in Fig.2. The effect of the flow control method was numerically investigated in the quasi-steady parallel running condition ($U_1 = 0$) and in the transient overtaken condition ($U_1 = 0.005U_0$).

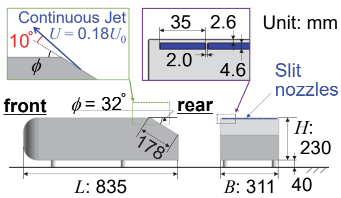


Fig.1 Investigated model.

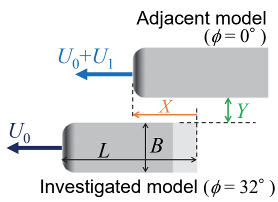


Fig.2 Target condition.

For the numerical analysis of transient flow field, the large-eddy simulation (LES) was adopted for the turbulence modelling approach. The overtaken process was reproduced by sliding mesh technique [(3)] between the two domains including each model. In the overtaken condition, the continuous jet was applied only in the section from X/L = 0.0 to 0.4 where the model showed significantly large drag increase without the jet.

For each case, the drag coefficient increase ΔC_D compared to the model travelling alone is shown in Fig. 3. The continuous jet decreased ΔC_D in the both conditions, and the maximum reductions of drag coefficient reached to 0.08 and 0.09 in the parallel running and overtaken conditions, respectively. Instantaneous flow fields in both cases with and without the continuous jet are extracted from one position X/L = 0.25 of the controlling interval. Iso-surface of total pressure around the investigated model was visualized in Fig. 4. The wake pattern was shifted from reattached flow on the slant to fully separated flow by the continuous jet.

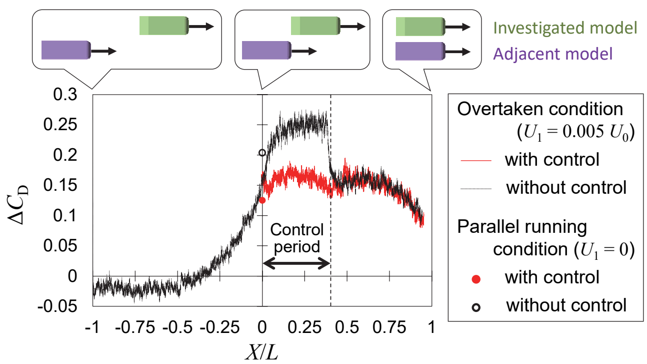
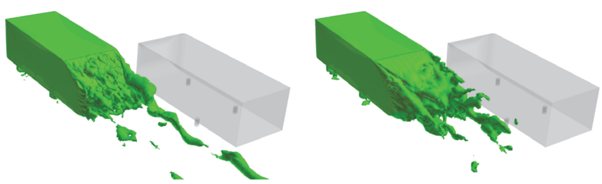


Fig. 3 Increase in drag coefficient ΔC_D depending on X/L.



(a) without control (b) with control

Fig.4 Iso-surface of instantaneous total pressure $C_{tp} = 0.0$ at $X/L = 0.25$ in the overtaken condition.

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