Computational Study of Air Flow Interactions and Drag Reduction Techniques in Vehicle Platoons

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1. INTRODUCTION & OBJECTIVE

The main objective is to develop insight in the aerodynamic drag reduction of an isolated car and platoon and also compare the influence of rear drag reduction devices towards an optimized aerodynamic drag reduction. To study this problem, an isolated as well as platoon of simplified generic passenger vehicle, called the Ahmed car model with rear drag reduction devices will be simulated using CFD. Also the effect of inter-vehicle spacing will be identified for the case of a two, three and six model platoons. The computational part consists of numerical simulation of the flow around the Ahmed bodies in platoon employing CFD (Computational Fluid Dynamics) techniques. The designing of model and CFD simulation is carried out in ANSYS Workbench and FLUENT (ANSYS 15.0).

The experimental analysis reveals that rear slant angle of the model and the inter-vehicle spacing greatly influences the wake structures and ultimately the vehicles aerodynamic drag coefficients in platoons. Validation of the obtained results will be done will the available computational and experimental results.

2. RESULTS & HIGHLIGHTS OF IMPOINTANT POINTS

The main focus was to find out the influence of inter-vehicle spacing and effect of the drag reduction devices on the platoon.

Two cars in tandem:

The study revealed that the lead model experiences minimal drag coefficient for certain inter-vehicle spacing which was due to the presence of the trailing model in its wake. The trailing model helped to increase the base pressure of the lead model. The flow leaving the lead model’s rear slant impinges on the front part of the trailing model. Because of this the trailing model experienced direct flow interaction, which kept its drag coefficient higher for longer vehicle spacing.

Three cars in tandem:

***Platoon without tails*:**

Platooning without tails is certainly beneficial at small spacing's. At larger spacing's the average drag of the platoon is increased compared to the isolated bodies.

Platoon with tails:

Adding tails to a platoon models has various influences. At short spacing's the TNN- and TTT-configuration have only little effect on the total drag of the platoon. The bodies equipped with a tail are benefiting from the increased pressure at the back, but the succeeding body has an increased drag due to this pressure increase and the inwards deflected streamlines.The NNT-configuration performs the best at a relative spacing of 0.5 with the 12° tail.

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Effect of fore-body rounding:

On increasing fore-body rounding, the drag coefficient decreases. For the any relative spacing the best option in a platoon is the NNN-configuration with a rounding radius of 0.1 m

Influence of Spacing:

The best option is to drive in a platoon at a short relative spacing (0.5) with only the last body equipped with a tail. Equipping bodies with a tail inside the platoon (NTN) is not recommended since only those bodies benefit from the tail, but the succeeding body has an increased drag. Platooning has less effect at larger relative spacing, so the bodies are acting as isolated bodies. This means that it is best to equip all bodies with tails (TTT) at larger spacing.

Six cars in tandem:

When vehicles are expected to travel in long platoons, small rear slant angles are well suited for platooning as they offer reduced drag coefficients. In the case of vehicles with rear slant angles between 5° to 30°, close inter-vehicle spacing is recommended for drag savings.

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