Hood Fluttering caused by unsteady Aerodynamic loads by on route vehicles' interaction

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Abstract including:

Over the last few years, automotive manufacturers have been optimizing the weight of the vehicles by using lighter materials and reducing the thickness of sheet metal panels. As a result of the reduction in thickness, deformation of panels under standard loads has increased in many cases. These higher deformations do not mean that the vehicle quality is lower in terms of functional performance, however they are perceived by the Customers as poor product quality and should be avoided.

One of these "standard load cases" appears when one car overtakes another vehicle (truck, pick-up or other). In this case, the turbulent structures in the wake of the car in-front reach the overtaking car, causing time- and space-variant pressure oscillations on the panels which cause vibrations. In the case of the hood, these vibrations can be of several millimeters at the trailing edge and may be visible from the driver point of view. Such issues are typically detected at the late testing stages, leading to costly design improvements.

These effects can be virtually predicted by automated chained simulations easy to set up to allow its assessment and necessary design changes along the vehicle development iterations. In collaboration between SEAT and ESI Group, a computational methodology has been developed to detect such issues early in the vehicle engineering process, chaining Computational Fluid Dynamics (OpenFOAM) for the aerodynamic predictions and Finite Elements (Virtual Performance Solution - VPS) for the structural predictions.

The application of this process with virtual prototypes enables engineers to detect such problems long before the actual physical prototypes are built and propose solutions to minimize the impact and avoid low perceived quality by the Customers. This paper describes the application of the developed methodology in detecting the vibrations in the

early design stage and proposing countermeasures. The process showed in this paper opens the door to many other load cases, in which combinatorial CAE analyses are relevant, that can be evaluated virtually to improve the vehicle quality impacting the design in early stages of the development.

Keywords:

Aerodynamics, Overtaking Vehicles, Fluttering, Lightweight, Computational Fluid Dynamics,
Finite Element, Virtual Prototypes.