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"Active Crosswind Generation and its Effect on the Unsteady Aerodynamic Vehicle Properties Determined in an Open Jet Wind Tunnel"

Abstract

In this thesis the unsteady aerodynamic properties of different vehicle models as well as the influence of the wind tunnel environment on the resulting unsteady aerodynamic forces and moments under crosswind excitation are investigated using experimental and corresponding numerical methods. FKFS ***swing***® (Side Wind Generator) is used to reproduce the essential properties of natural stochastic crosswind in the open jet test section of the IVK model scale wind tunnel. The results show that the test environment of an open jet wind tunnel alters the amplitudes of side force and yaw moment under crosswind excitation when compared to an ideal environment neglecting wind tunnel interference effects. Furthermore, the results of the unsteady response to crosswind excitation of the realistic DrivAer model show that the commonly used steady state approach underpredicts forces and moments in the frequency range relevant to driving dynamics. The presented approach for the quantification of the unsteady behavior of the flow field provides a basic understanding of the phenomena occurring under the dynamic deflection of a wind tunnel jet. It can be shown that the wind tunnel jet has a dynamic behavior that superimposes the aerodynamic response of the vehicle. The investigation of different model scales gives information about the interaction of the dynamic jet behavior with the vehicle response as well as the magnitude of the expected influence. For the first time, a validated simulation model of the unsteady aerodynamic vehicle properties of the realistic DrivAer model as well as of the model scale wind tunnel is introduced. The presented simulation environment without interference effects allows the quantification of the unsteady aerodynamic response of a vehicle without external influences. This is mandatory to derive suitable measures for the optimization of a vehicle under crosswind excitation. Thus, a statement about the unsteady aerodynamic vehicle response can be made at an early stage of the vehicle development, providing a decisive contribution to the future development of unsteady aerodynamic vehicle properties.