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CFD analysis of a monorail vehicle under the influence of crosswind and oncoming traffic

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In order to increase mobility in rural areas and to support public transport, an autonomous monorail vehicle (MonoCab [1]) is developed, which is able to use old unused railroad tracks. A narrow design makes it possible for two vehicles to pass each other on one track in two-way traffic. A fully automated driving mode allows the vehicle to be ordered on demand via app.
Due to the design on only two wheels, monorail vehicles must be able to react quickly to environmental influences, such as wind, in order to prevent overturning. To avoid critical tilt angles during travel and ensure ride comfort, gyroscopic stabilizers and linear masses are used to hold the vehicle in the desired position in real time.

In this study, the vehicle behavior is investigated by determining flow coefficients when crosswind occurs. For this purpose, a guideline from the German railroad standard DIN EN 14067-6 is applied. This standard specifies a flow around the vehicle in 5-degree increments from 0 degrees to 50 degrees, followed by 10-degree increments to 90 degrees, to simulate crosswinds from different directions. The flow vector is calculated from the vehicle speed and the wind speed, taking into account the wind angle. In order to better detect occurring instabilities at the vehicle geometry, the simulation series is calculated with the transient solver pimpleFoam. These simulations are used to generate characteristic curves using calculated moment coefficients.

In addition, the pressure surge is examined, which occurs when two vehicles pass each other in oncoming traffic. This is achieved using the dynamic mesh solver overPimpleDyMFoam for overlaid meshes. Two opposing vehicles with projected track gauge spacing are defined with a linear motion function of maximum vehicle speed magnitude. During the passing of both vehicles at maximum speed, the forces and moments around the point of contact on the rail are recorded.

[1] https://www.monocab-owl.de