Security barrier performance assessment with numerical simulations using generic vehicle models

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Vehicle security barriers preventing the entry of vehicles into pedestrian zones can effectively mitigate terrorist attacks by vehicle-ramming. The performance of barriers against vehicle impact is certified through physical tests using real vehicles of given UNECE categories following the standard ISO 22343 from 2023. Due to the high cost, the number of performed crash-tests is very limited and cannot cover all impact scenarios of interest for the assessment of a barrier performance.

The use of numerical simulations seem the most appropriate way to enhance the physical testing approach, since they are more accurate than the simple analytical methods and more cost efficient than experiments. Over the last decades, the automotive industry and associated research communities have developed efficient numerical simulations tools for vehicle impact analyses, related to the passenger's and vulnerable road users' safety. With some adjustments, these simulations methods and tools can be directly transposed to the analyses of vehicle impacts on security barriers.

The numerical vehicle models used for passengers' safety are far too detailed and too specific than needed for the vehicle ramming applications. Namely, in this context, the objective of the simulation is to assess the performance of a barrier not of the vehicle. In addition, a barrier's performance needs to be assessed for an entire category of vehicles, not for one specific vehicle.

Therefore, for simulating vehicle impacts on security barriers several generic vehicle models have been developed to represent vehicles of a broad range of categories (from 3.5t to 30t trucks). These models are generic in the sense that they do not represent a specific vehicle brand, but can represent most of the vehicles of a given category. In addition, they are adjustable through a set of parameters, so that its properties could fit to various vehicle configurations. In particular, can be varied the mass of the vehicle, including its distribution, the main vehicle dimensions (length, width, etc.) and some mechanical characteristics related to the crash behaviour.

In this communication, several numerical simulations using the generic vehicle models will be presented. Model validation with experimental results and sensitivity analyses on vehicle characteristics and impact configurations will be discussed. It will be shown that there are several crucial vehicle properties, which can significantly influence its crash behaviour and therefore the load on a security barrier subject to an impact.