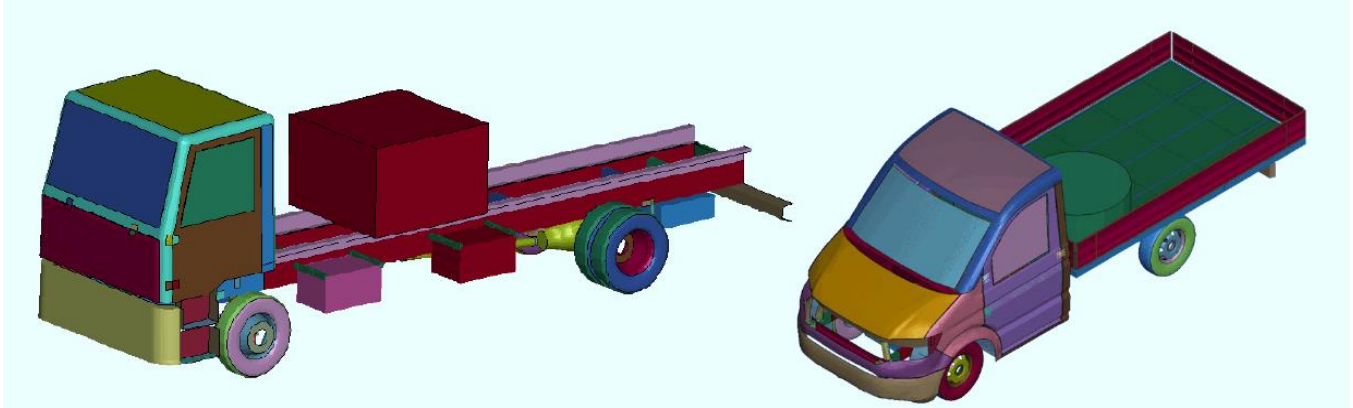
JRC 135550

European Commission

SCIENCE FOR POLICY BRIEF

Data and Tools to Counter Terrorism

Generic vehicle models for finite element numerical simulations



HIGHLIGHTS

- → JRC provides cost-free generic vehicle models under the EU's open source license (EUPL) for numerical finite element simulations focussing on vehicle impacts on security barriers
- → Models follow the characterization of vehicle types as defined in ISO 22343-1:2023 (formerly IWA-14:2013) and do not reflect any specific brand- or model-depending features but cover the most commonly used EU-type vehicles in the categories
- → Model parametrization allows the user to easily modify key attributes of the vehicle (velocity, mass distribution, dimensions, crash related stiffness, suspension properties)
- → Models are validated according to CEN/TR 16303 and by comparison with experimental data

Why generic vehicle models?

Vehicle as a weapon attacks are a common modus operandi for terrorist attacks and vehicle security barriers play an important part in the mitigation of consequences of such attacks for the protection of public spaces and critical infrastructure entities. Testing of the barriers plays a key role in the development process. However, real testing of the barriers is very expensive. The development is therefore very often driven by realistic computer simulations (finite element numerical simulations – FE simulations). A tremendous advantage of the simulations is their ability to answer many questions regarding behaviour of the system before the real crash test is performed. Moreover, FE simulations can quickly predict results of the crash tests under various conditions such as various impact angles, various attacking vehicles or various impact velocities.

Generic vehicle models for numerical vehicle impact simulations open a new and more generalized approach to virtual barrier testing. According to applicable test standards for barrier certification, a single crash test must be performed. However, to assess barrier performance more holistically, it can be useful to perform several experimental crash test scenarios with varying conditions (impact speed, impact angle, friction, etc.) which is generally cost-prohibitive.

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With a generic vehicle model, which can be modified easily through parameters, and which is not computationally expensive, vehicle properties can be varied in a sensitivity analysis. This applies for the same vehicle (e.g. suspension, loaded, unloaded, etc.) but also for vehicles from different manufacturers within the same category that can vary significantly (model, wheelbase, mass distribution, etc.).

Furthermore, to get a general probabilistic assessment of the barrier performance, a stochastic analysis can easily be applied.

Vehicle categories

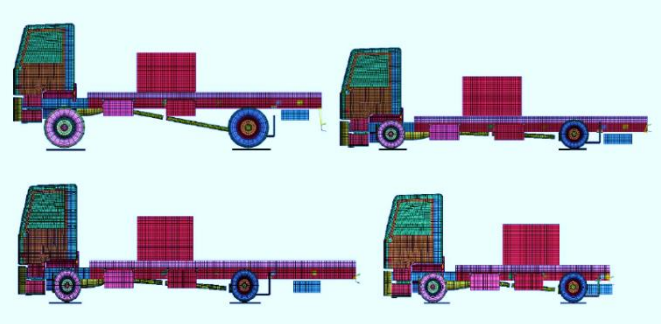
The models follow the characterization of vehicle types as established in *ISO 22343-1:2023* (formerly IWA-14:2013, now superseded). The generic vehicle models do not reflect any specific brand- or model-depending features. The aim is a generic model, representing the most widespread brands and covering the most commonly used EU-type vehicles in the category.

QUICK GUIDE - Take a deep-dive into the *JRC Technical Report* for the N1 model.

Take a deep-dive into the *JRC Technical Report* for the N2A&N3 model.

Models are licensed under EUPL, which is the EU's open source license. Learn more about *EUPL*.

Figure –Variation of dimension parameters



Model parametrization

Model parametrization allows the user to easily modify key attributes of the vehicle (velocity, mass distribution, dimensions, crash related stiffness, suspension properties). This enables the model to represent any real vehicle within the respective vehicle categories N1, N2A and N3D (age variation, fitness, brand, size, mass, etc.). Parametrization makes the model also suitable for stochastic studies.

Model validation

The model is validated by several tests (vehicle in idle, linear track curb test and rigid wall test) according to CEN/TR 16303. The results of the curb test simulation are compared with experimental data. The model is also validated by comparison with experimental data at frontal impact on a bollard.

Convertibility to different FE simulation software solutions

The original version of the model was developed for Ansys LS-DYNA but is convertible to other FE codes as well. There are no strictly Ansys LS-DYNA related features. In particular, the model is being converted by the JRC for calculations with the *EUROPLEXUS software*.

Numerical crash test simulation - bollard configuration

This FE simulation illustrates the use of a generic vehicle model in a crash-test simulation against a single fixed bollard. The images show the impact of a N2A category vehicle with total mass of 7500 kg after 0.5 seconds from a front- and side-perspective. This test was compared with publicly available experimental results to validate the model. Comparison of displacements and velocities show adequate agreement between the behaviour of the real N2A vehicle and FE generic vehicle model.

https://counterterrorism.ec.europa.eu/

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