SIST

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Oprema cest - Postopek validacije in verifikacije računalniške simulacije preskusnih trčenj v sisteme za zadrževanje vozil

Road restraint systems - Validation and verification process for the use of virtual testing in crash testing against vehicle restraint system

Rückhaltesysteme an Straßen - Validierungs- und Nachweisverfahren für die Nutzung von Computersimulationen bei Anprallprüfungen an Fahrzeug-Rückhaltesysteme

Dispositifs de retenue routiers - Processus de vérification et de validation pour l'utilisation d'essais virtuels dans les essais de choc contre un dispositif de retenue pour véhicules

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English Version

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 226.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (prEN 16303:2018) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede CEN/TR 16303-1:2012, CEN/TR 16303-2:2012, CEN/TR 16303-3:2012 and CEN/TR 16303-4:2012 (which have been merged).

In comparison to the previous Technical Reports, this document contains the following changes:

— some symbols and abbreviations have been modified;

— the roadmap for the validation of the numerical vehicle model has been updated and acceptance conditions have been provided;

— the validation requirements for virtual testing against roadside devices have been updated;

— the verification Evaluation Criteria for Finite Element model have been updated.

Annexes A, B, are normative and Annexes C to I are informative.

Introduction

This document provides a common basis for the use of virtual testing to reproduce vehicle impacts against roadside safety devices including safety barriers, crash cushions, terminals, removable barrier sections, transitions and passive safety devices in accordance with the EN 1317 series and EN 12767.

This document provides requirements to establish the degree to which the numerical models of roadside safety device and of vehicle are an accurate representation of the real word from the perspective of the intended uses of the model.

Two main modelling approaches have been considered:

— Finite Element (FE) Method;

— Multi-Body (MB) approach.

In this document a methodology is defined to validate the results obtained with computational mechanics work and to verify the reliability of the virtual test. It also includes a report template and incorporates specific content for general requirements for the competence of entities performing virtual testing.

General recommendations based on experiences for developing numerical models of roadside safety devices and vehicles for virtual tests are also given.

1 Scope

This document defines the accuracy, credibility and confidence in the results of virtual crash test to roadside safety devices through the definition of procedures for verification, validation and development of numerical models for roadside safety application. Finally it defines a list of indications to ensure the competences of an expert/organization in the domain of virtual testing.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1317-1:2010, *Road restraint systems – Part 1: Terminology and general criteria for test methods*

EN 1317-2:2010, *Road restraint systems – Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers including vehicle parapets*

EN 1317-3:2010, *Road restraint systems – Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions*

ENV 1317-4:2001, *Road restraint systems – Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers*

EN 1317-5, *Road restraint systems – Part 5: Product requirements and evaluation of conformity for vehicle restraint systems*

CEN/TS 1317-8, *Road restraint systems – Part 8: Motorcycle road restraint systems which reduce the impact severity of motorcyclist collisions with safety barriers*

EN 12767:2007[1], *Passive safety of support structures for road equipment - Requirements, classification and test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

[1] Currently under review.

3.1
Numerical Model
mathematical model of roadside safety device and vehicle

Note 1 to entry: It refers to a numerical model which might be analytical or discrete and aims to reproduce the basic physical phenomena of a subject.

3.2
roadside safety device
device tested according to the EN 1317 series

3.3
passive safety device
device tested according to EN 12767

3.4
test
full-scale impact test performed at a test house according to the relevant standard

3.5
test item
device to be assessed using virtual testing

3.6
validated model
numerical model of the roadside device or vehicle that fulfils requirements of this document

3.7
validation procedure
set of activities defined to assess whether a numerical model can be considered representative of a physical system or part in a specified range of conditions

3.8
verification procedure
set of activities defined to check whether a numerical model is reliable and numerically stable

3.9
virtual test or testing
activities related to the use of a numerical model to reproduce a real test

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply:

ASI	Acceleration Severity Index
CoG	Center of gravity
D	Dynamic deflection
D_m	Measured maximum Dynamic Deflection of the real test, in metres (m)
D_{VT}	Measured maximum Dynamic Deflection of the virtual test, in metres (m)
FE	Finite elements
HGV	Heavy goods vehicle

LD	Lateral displacement
LD_m	Measured Lateral displacement of the real test, in metres (m)
LD_{VT}	Measured Lateral displacement of the virtual test, in metres (m)
MB	Multi-body
RT	Real test or testing
THIV	Theoretical Head Impact Velocity
VI	Vehicle intrusion
VI_m	Measured Vehicle Intrusion of the real test, in metres (m)
VI_{VT}	Measured Vehicle Intrusion of the virtual test, in metres (m)
VT	Virtual test or testing
W	Working width
W_m	Measured Working Width of the real test, in metres (m)
W_{VT}	Measured Working Width of the virtual test, in metres (m)

5 Requirements for numerical vehicle model

5.1 General

A complete 3D numerical model of the vehicle shall be created. The geometry of the vehicle and all inertial properties shall be reproduced faithfully. The numerical model shall include:

— frame;

— body;

— suspensions systems, front and rear;

— wheels;

— steering system;

— windows;

— engine block.

Vehicle specifications under test conditions shall be as specified as in EN 1317-1:2010, Table 1.

The vehicle shall be fitted with, as a minimum, one accelerometer for measurement in the longitudinal (forward) direction, one for the lateral (sideways) direction, one for the vertical direction (downward) and an angular velocity sensor (rate sensor). The accelerometers shall be mounted as prescribed by the EN 1317-1. Vehicular accelerations shall be used for the calculation of the severity indices, accordingly to EN 1317-1.

Justification of chosen material models and implemented material failure and strain rate dependency shall be provided.

5.2 Validation

For the validation of the numerical vehicle model, tests shall be performed according to this standard, comparable parameters shall be measured and the results shall be fully documented.

The validation tests that shall be carried out to ensure the numerical stability and the capability of the numerical model are divided in categories dealing with vehicle setup, dynamics, handling and crashworthiness.

5.3 Test methodology

5.3.1 General

The scope of the following test is to ensure the stability and robustness of the vehicle model and the level of reliability of the results.

The finite element model and the multi body vehicle model shall be validated with the same requirements and limit.

This procedure consists of a fixed number of compulsory tests and a series of additional tests that can be performed depending on the availability of experimental tests and on the intended use of the model.

For the vehicle model in order to be considered validated all compulsory tests shall be completed without error terminations.

The test shall be performed when the vehicle development is completed. Modification(s) that might influence the result(s) of one or more test will request to perform these (those) test(s) again.

If the tests do not satisfy limits described in Table 1, the entity performing the vehicle validation activity shall explain his motivations inside the final validation report and those motivations shall be checked and agreed by the certification body.

If some of tests listed in Table 1 are not performed, the entity performing the vehicle validation activity shall explain his motivations inside the final validation report and those motivations shall be checked and agreed by the certification body.

5.3.2 Test description

5.3.2.1 Compulsory test

The tests are grouped in four different sets:

— Set 1. – Vehicle setup;

— Set 2. – Vehicle suspension and steering kinematics;

— Set 3. – Vehicle handling;

— Set 4. – Vehicle crashworthiness.

The tests included in Table 1 shall be performed to complete the vehicle validation.

The table includes the scope of the test, the results to be provided and the acceptance conditions (limits).

Table 1 — Validation Roadmap – Reduced procedure

Set 1. – Vehicle setup		
Test 1 - Idle test		
Scope: Verify stability of the vehicle model and general setup	Results to be Provided: — Acceleration time (filtered) — Suspensions movement time history	Limits: — Filtered accelerations CG < ± 2,5 G — Suspension movement < 15 mm
Set 2. – Vehicle suspension and steering kinematics		
Test 1 – Isolated suspensions system (constrained vehicle) – full compression		
Scope: Verify suspension kinematic and loading and unloading capacity	Results to be Provided: — Comparison between theoretical and virtual stiffness curves — identify the suspension maximum compression	Limits: — Allowed variation between theoretical and virtual working curves: ±5%
Test 2 – Isolated suspensions system (constrained vehicle) – full extension		
Verify suspension kinematic and loading capacity	Results to be Provided: — Comparison between theoretical and virtual stiffness curves — Identify the suspension maximum extension	Limits: — Allowed variation between theoretical and virtual working curves: ±5%
Test 3 – Isolated steering system (constrained vehicle) – full rotation both sides		
Scope: Verify steering kinematic	Results to be Provided: — Comparison between left and right wheel steering angle (time Vs angle curves) — Identify the steering maximum angle in compression	Limits: — Verify Ackerman principle
Set 3. – Vehicle handling		
Test 1 - Linear track test		
Scope: Verify the general behavior of the vehicle (steering and suspension system) and its capability to run	Results to be Provided: — Trajectory plot — Energies balance in time	Limits:

		— acceptable deviation from the linear trajectory < 10 % of the length
Test 2 - Test on curvilinear track		
Scope: Verify the general behavior of the vehicle (steering and suspension system) and its capability of steering under an applied load and returning in neutral (without steering) when the force is removed	Results to be Provided: — Trajectory plot — Energies balance in time	Limits: — the vehicle shall start turning until it reaches the minimum radius and then reach a straight line when the steering is removed — total energy lost < 5 %
Test 3 - Step test		
Scope: Verify dynamic behavior of the suspension and general robustness of the model	Results to be Provided: — Spring suspension change in length Vs time curve. — Kinetic and total energy time histories	Limits: — total energy lost < 5 %
Set 4. – Vehicle crashworthiness		
Test 1 - against rigidwall (EN 1317-2) / rigid pole (EN 12767)		
Scope: verify the capability of suffering strong deformations. Control of the contact definition.	Results to be Provided: — Post-impact analyses (severity indexes for cars) — Kinetic and total energy time histories	Limits: — total energy lost < 5 %

A more detailed test description is provided within Annex C.

5.3.2.2 Additional test

Additional tests could be done to evaluate features of the vehicle that are not evaluated by the test in Table 1 such as the suspension failure (using a test similar to the “Isolated suspensions tests”) or a front vehicle deformation (performing the “front collision test” described within EN 12767).

5.4 Verification

For the verification of the numerical vehicle model, requirements of 5.3.2 shall be fulfilled.

5.5 Reporting

All mandatory validation tests shall be reported in vehicle model verification and validation report (see Annex A).

If vehicle models are modified the validated vehicle model shall be mentioned as basis (report reference to vehicle model validation report) and all changes shall be described in detail.