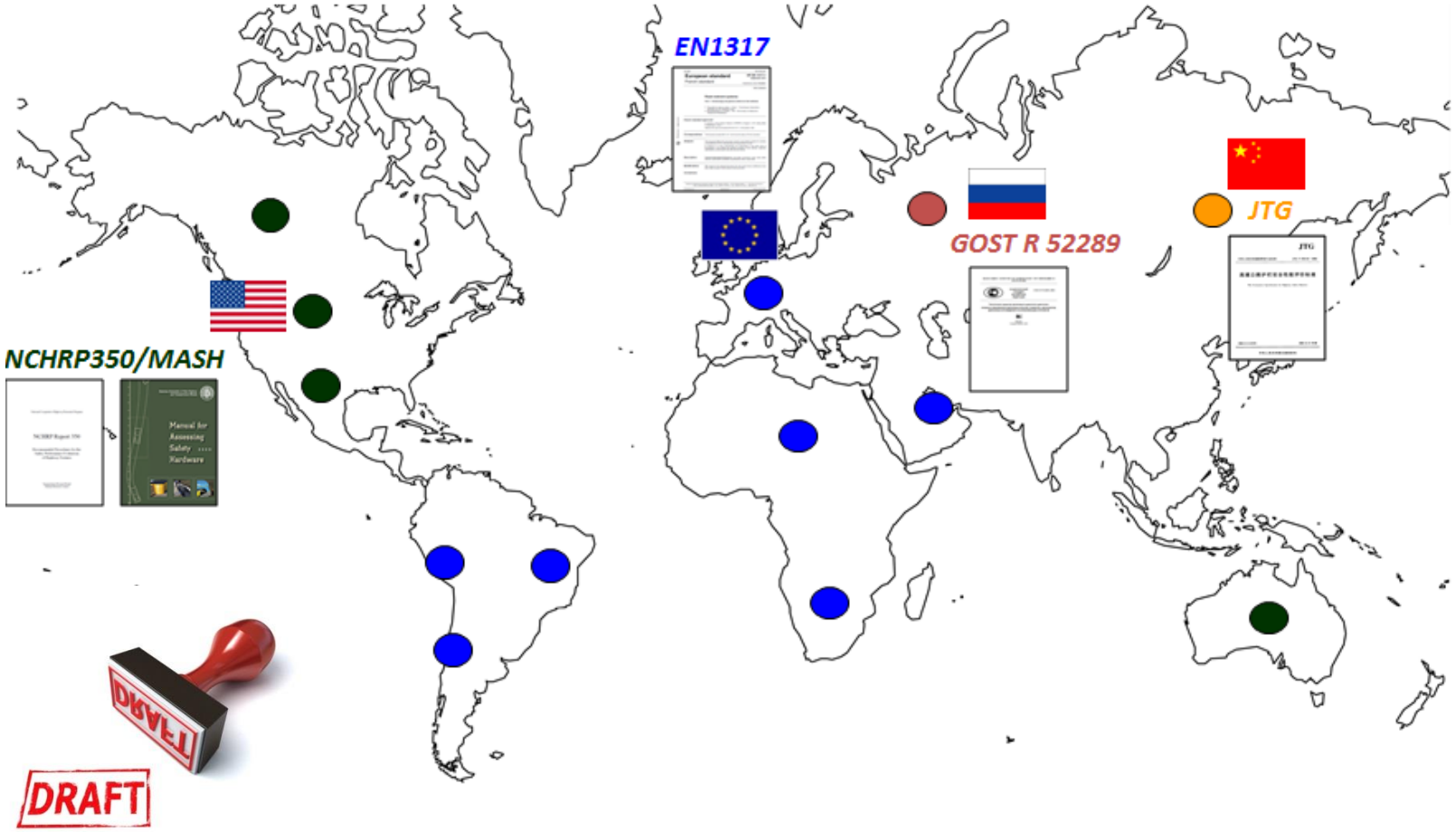
Innovative Technologies for High-Speed Roads
Moscow (Russia) - 13 October 2015

The use of LSDYNA to predict roadside safety equipment behavior: a useful complementary tool for Accident Reconstruction

Joseph Marra, Dario Guarino
Joseph.Marra@gdtech.eu GDTech

Introduction

- Possible standards concerned



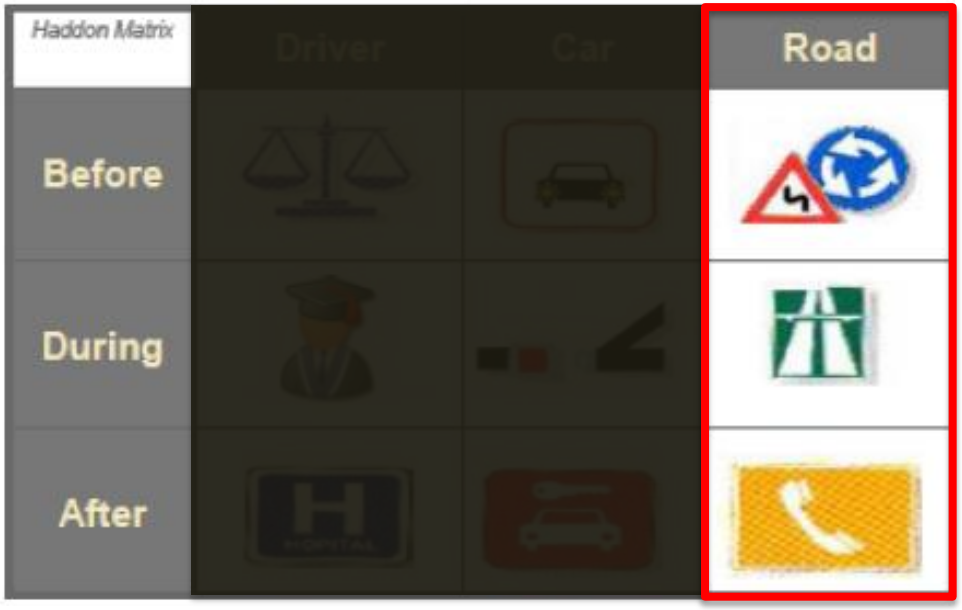
Introduction

- How does road safety work?

Haddon Matrix	Driver	Car	Road
Before			
During			
After			

Introduction

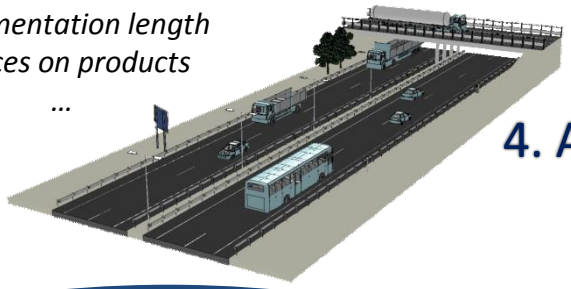
- How does road safety work?



Fields of application for simulation

3. Road Design

Implementation length
Advices on products
…



1. New Product Development

Safety barriers
Crash cushions
Terminals, Transitions
…

4. Accident Reconstruction

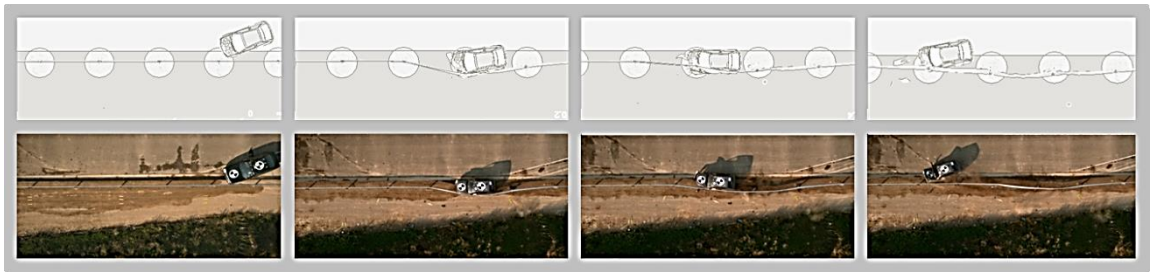
Crash scenarios
Influence of alternatives
…

2. Certification

ITT (Crash test / Simulation)
CE marking

New product (Crash-tests)

Modified product



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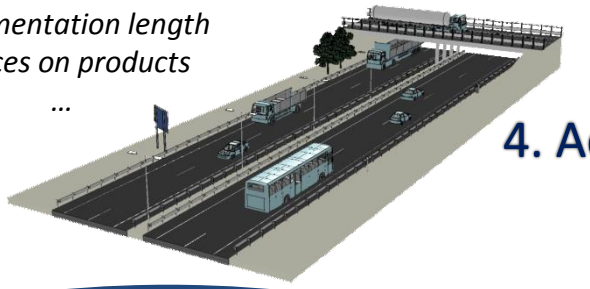

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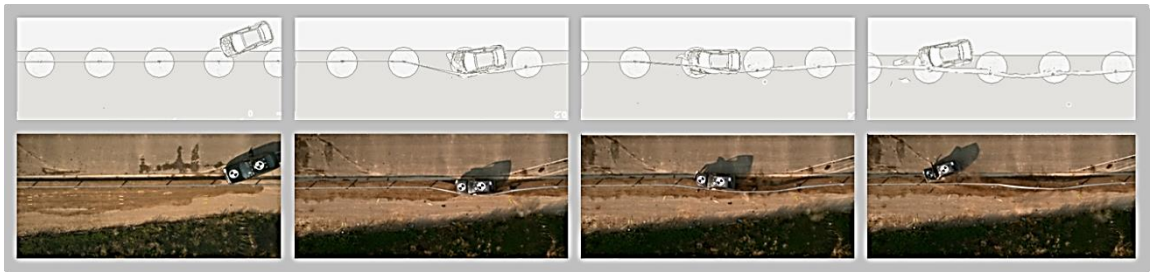
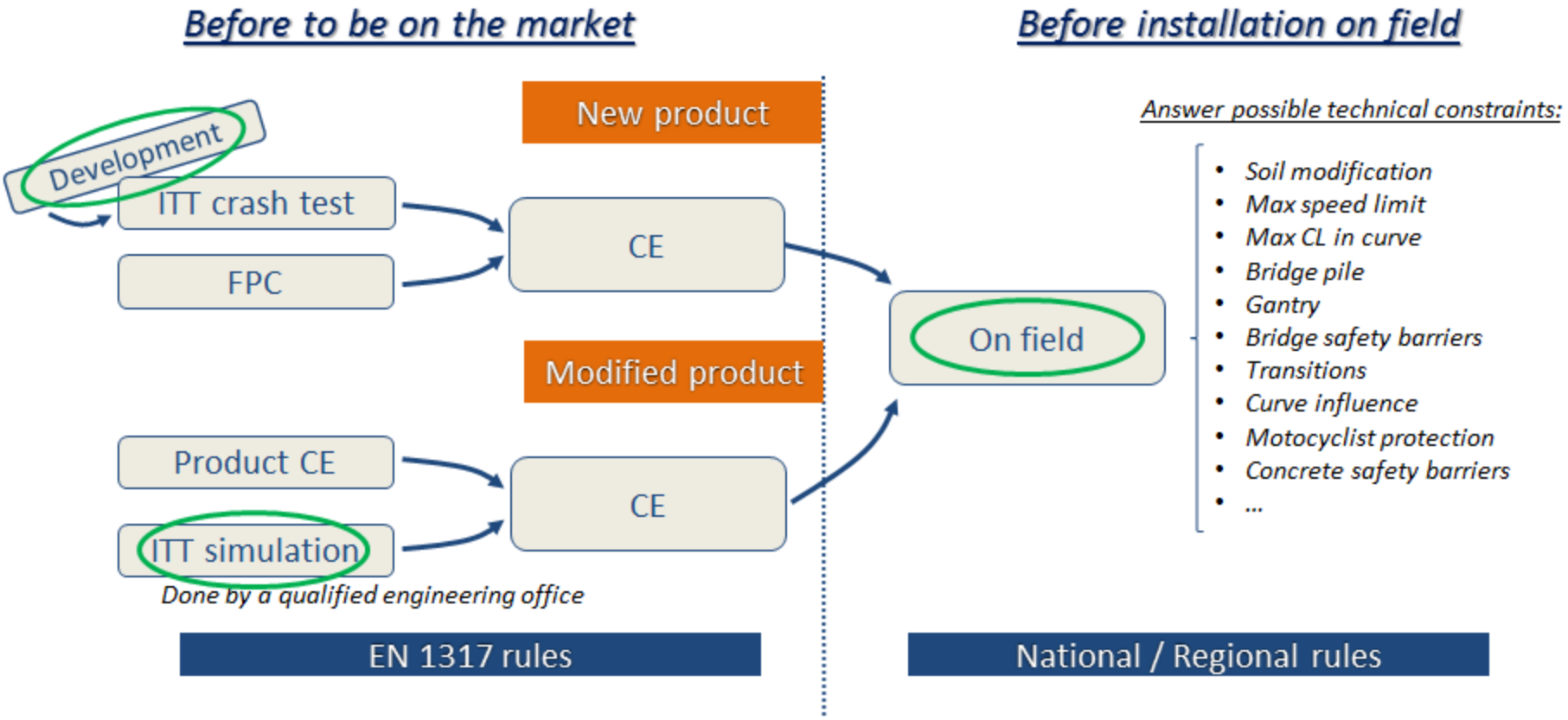


1. New product development

Fields of application for simulation



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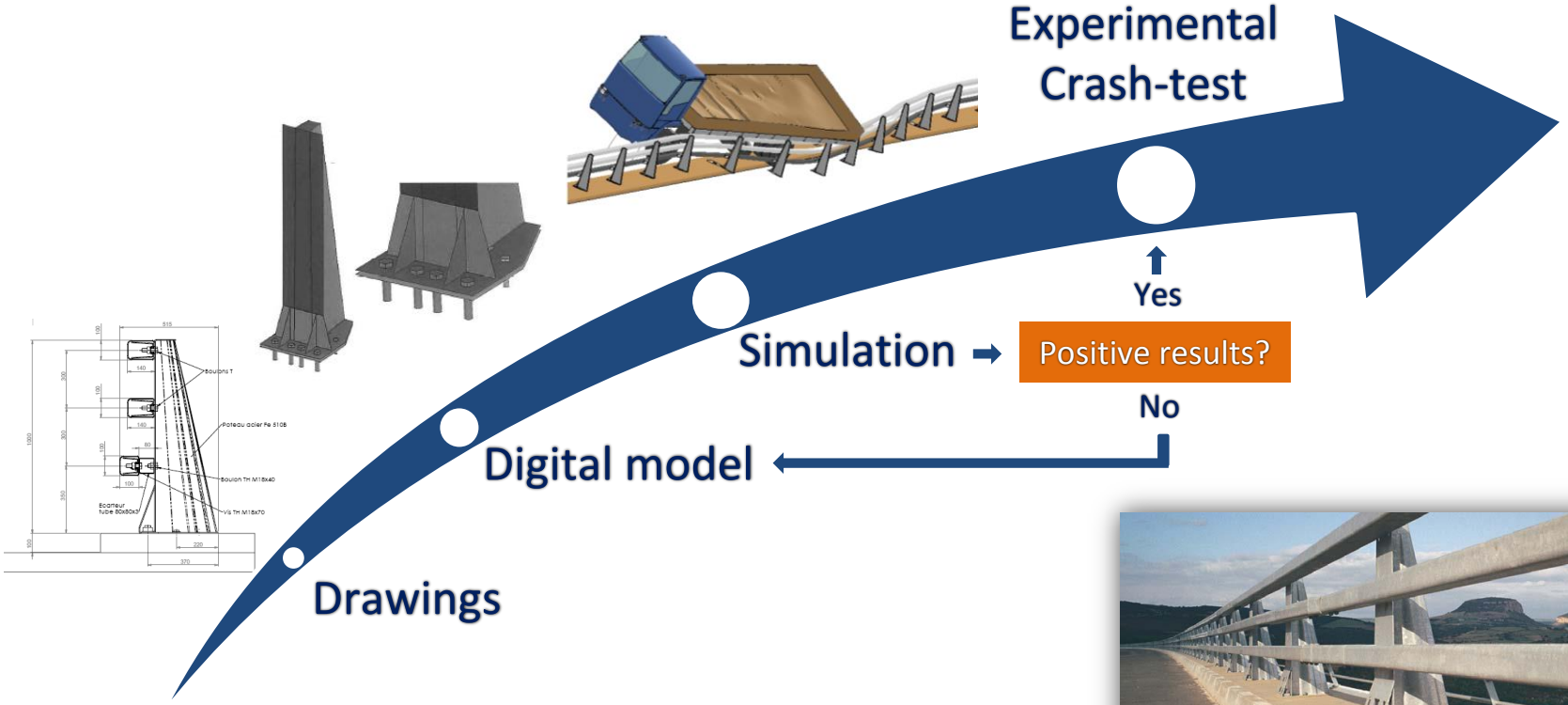


Simulation → Increase probability to pass Crash Test
Increase performance and/or decrease costs

1. New product development

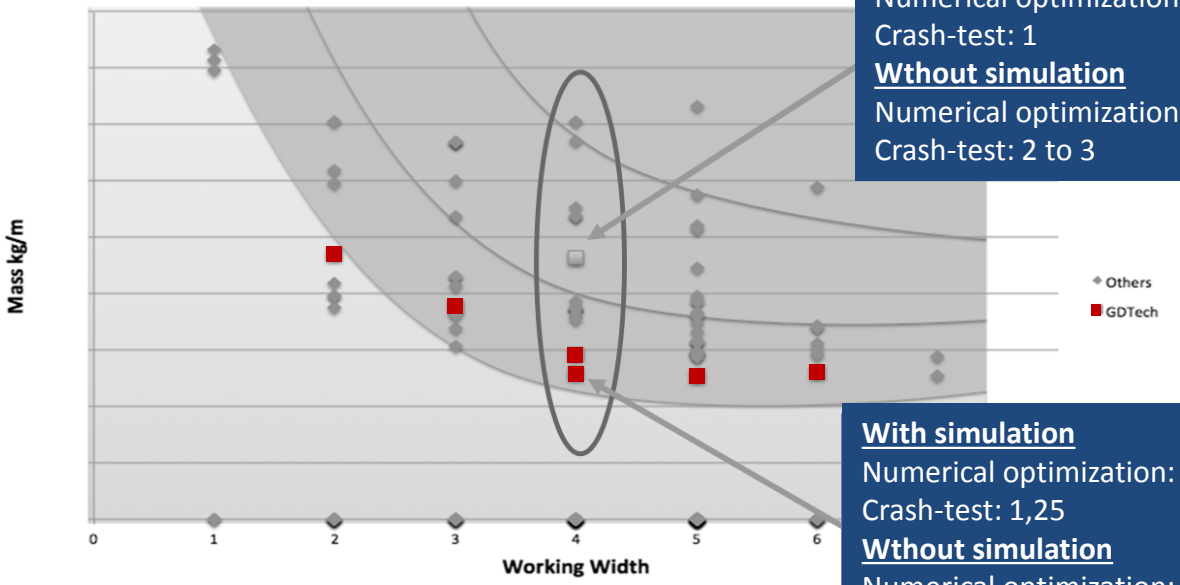
Product Optimization

Example of W4:

Old National Products:
x kg/m
With simulation:
less than ¾ x kg/m

➡ ***Min 25% lighter***

N2 systems
Comparison with and without simulation



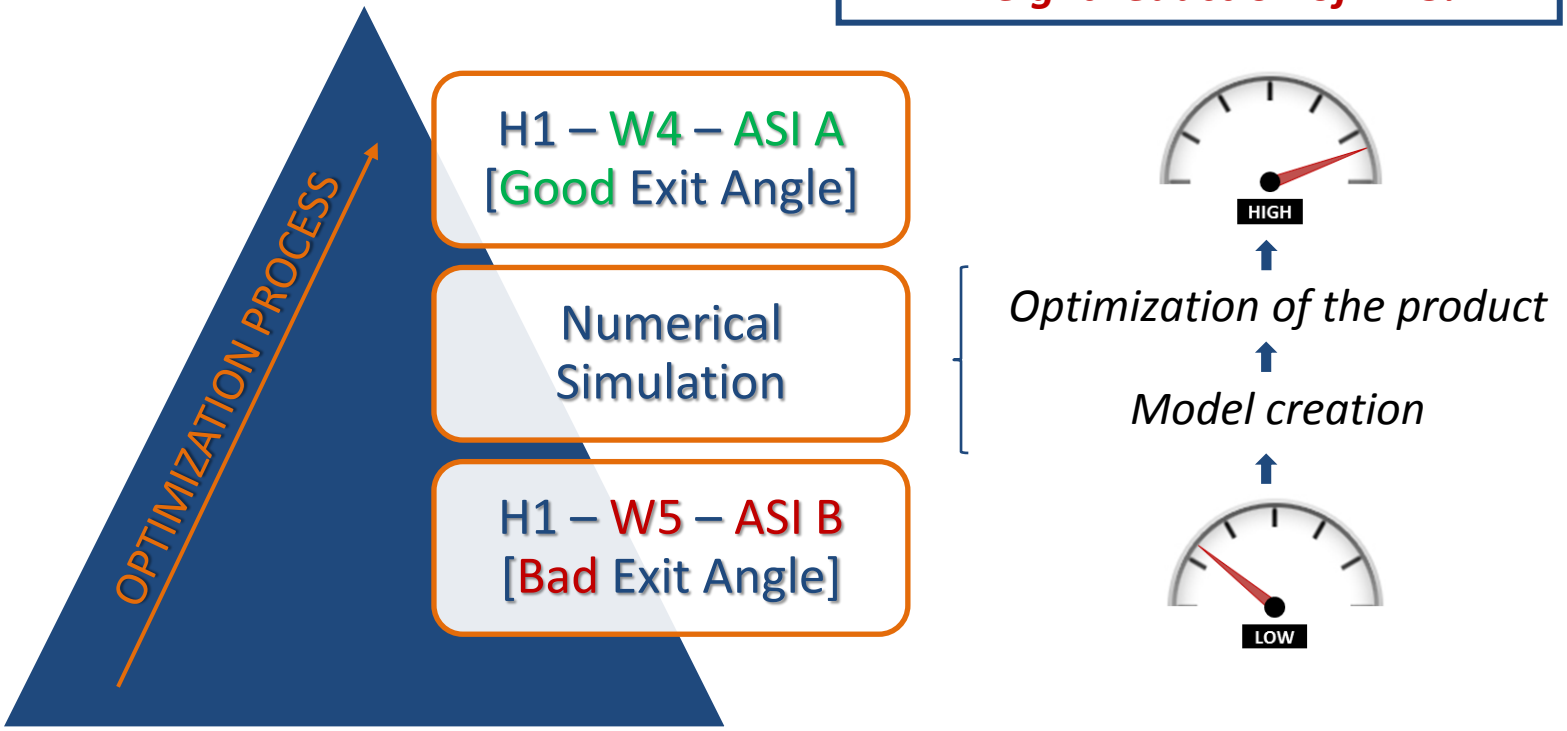
With simulation
Numerical optimization: 1
Crash-test: 1
Wthout simulation
Numerical optimization: 0
Crash-test: 2 to 3

With simulation
Numerical optimization: 1
Crash-test: 1,25
Wthout simulation
Numerical optimization: 0
Crash-test: 5 to 6

1. New product development

Product Improvement

+ Weight reduction of ~ 25%



Fields of application for simulation

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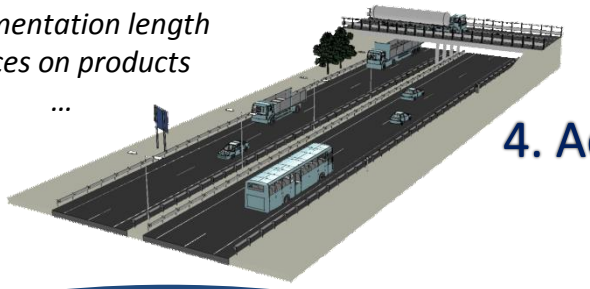

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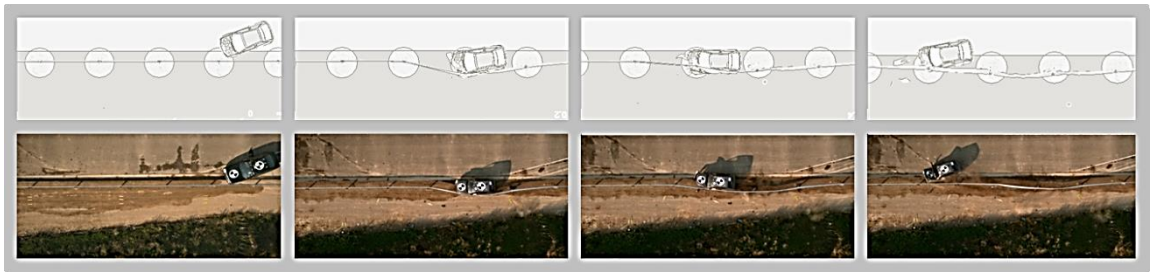


2. Certification

Annex A
(normative)

Modification of VRS tested in accordance with EN 1317-1, EN 1317-2, EN 1317-3 or ENV 1317-4

A.1 General

This annex gives rules for eva
been modified and methods
performance.

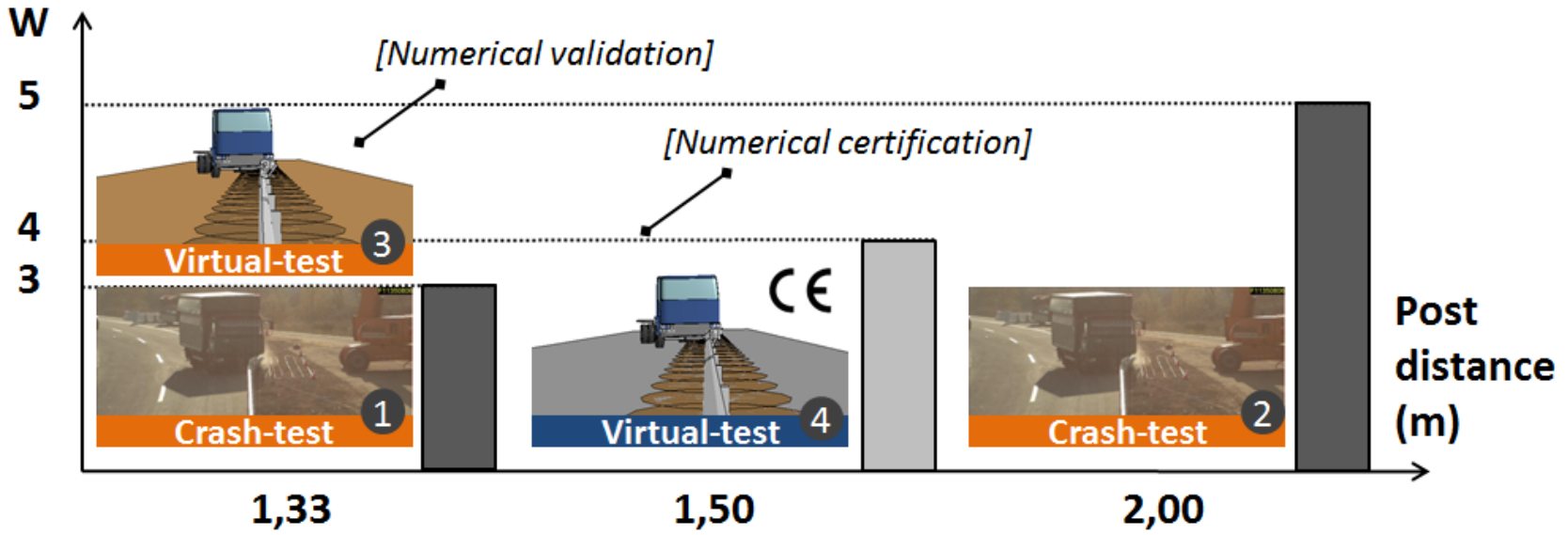
Table A.1 – Categories of modifications

Category	Change	Description
A	Slight	Modifications requiring no mechanical changes to the VRS.
B	Moderate	Modifications to one or more components where their effects on the performance of the VRS can be determined by static or dynamic analysis or other appropriate means.
C	Significant	Modifications in excess of A or B.

Category B allows simulation to be used for certifying modified products

2. Certification

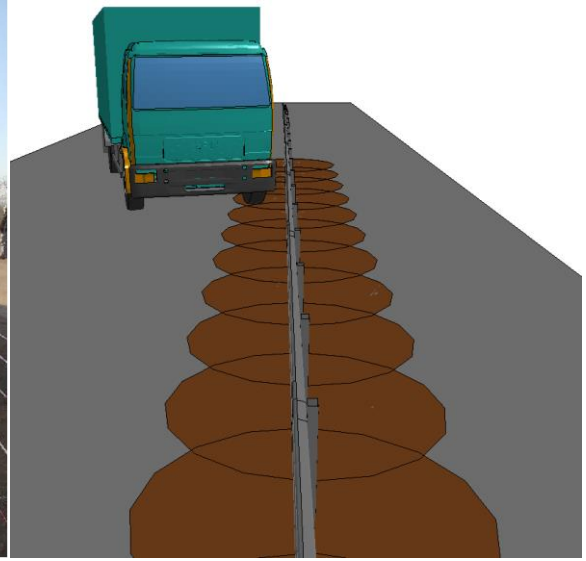
What you have :	What you want :	What you need :
• A product that passed the necessary crash-tests • A simulation reproducing the successful crash-tests	• adapting your product without having to perform new crash tests	• A simulation of the modified product using proven models according to EU best-practices



2. Certification

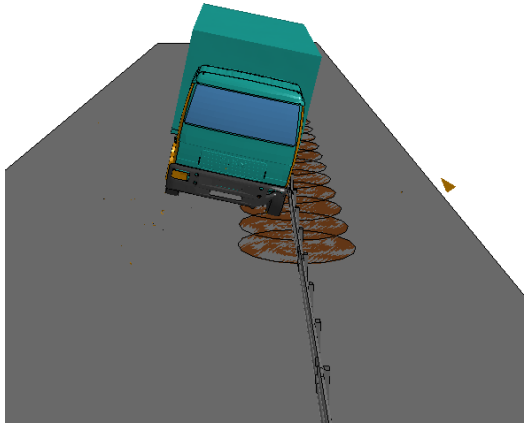
	Real Vehicle	Vehicle model	EN1317 Specifications	Tolerances	Acceptance
Length	7.2 m	7.22 m	-	-	-
Width	2.52 m	2.52 m	-	-	-
Wheel track	1.74 m	1.96 m	2 m	±15%	YES
N of axles	2	2	-	-	-
Wheel radius	0.44 m	0.45 m	0.46 m	±15%	YES
Wheel base	4.03 m	4.03 m	4.6 m	±15%	YES
Height (platform)	1.44 m	1.08 m	-	-	-

Development of a MAN truck (10T) with support of:



2. Certification

Measure	C-T	V-T	Acceptance	Difference
Dynamic deflection [m]	0.9	0.78		
Normalized dynamic deflection [m]	0.8	0.76	<0.18	0.04
Working Width [m]	0.9	0.88		
Normalized working width [m]	0.9	0.86	<0.18	0.04
Class of normalized working width	W3	W3		
Max permanent deflection [m]	0.6	0.54		



Fields of application for simulation

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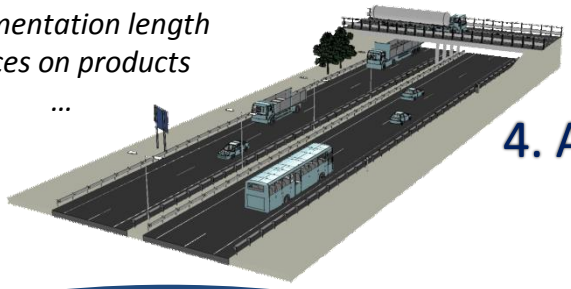

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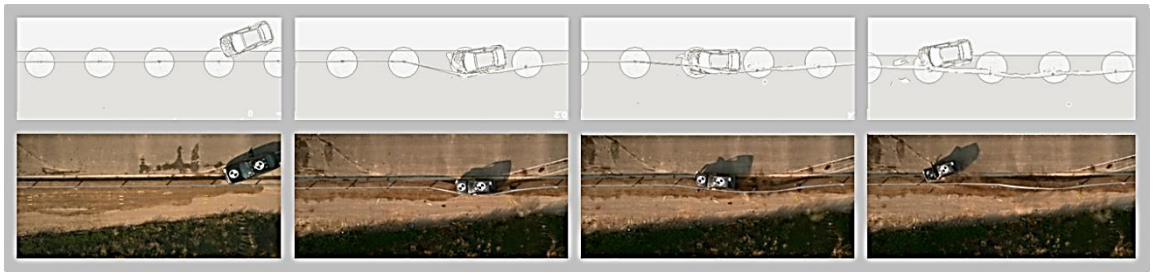


3. Road Design

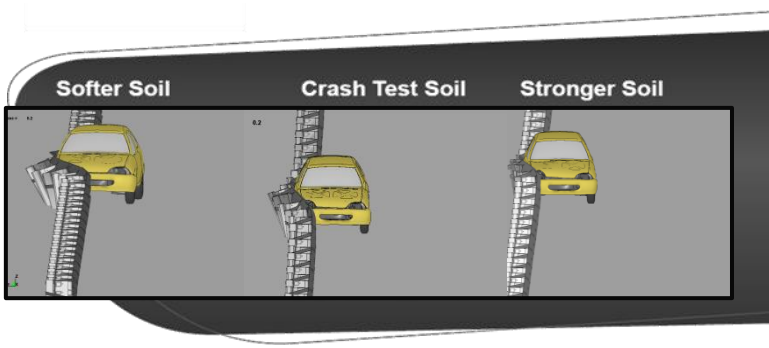
Example of **3 criteria** for comparing safety barriers **in standardized** crash-test **conditions:**

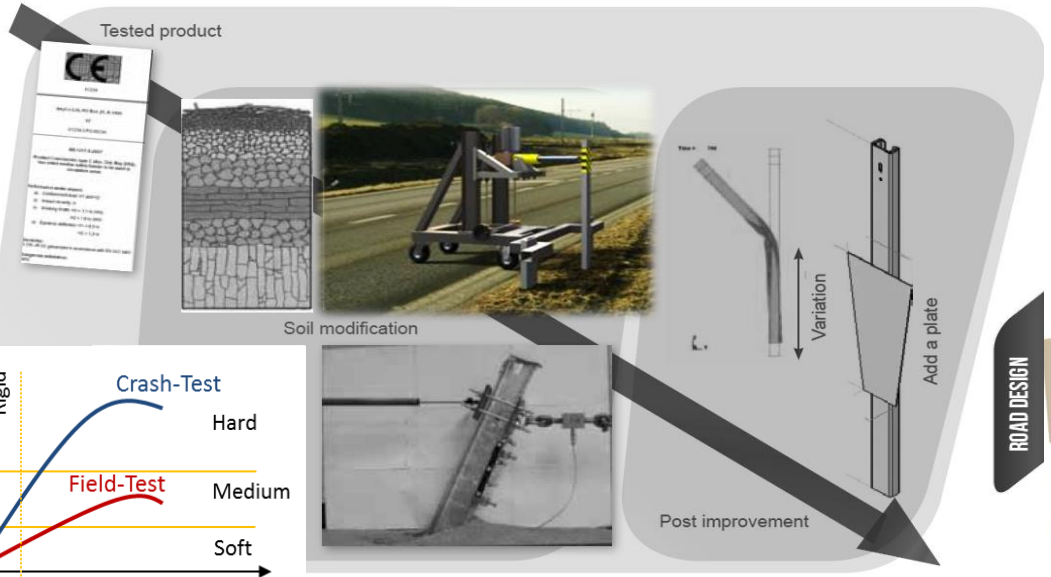
First criteria	• *Containment Level* • *N1, N2, H1, H2, H3, H4a, H4b* • *L1, L2, L3, L4a, L4b*
Second criteria	• *Acceleration Severity Index* • *A, B, C*
Third criteria	• *Working Width (W)* • *Vehicle Intrusion (VI)* • *Classes 1 → 8*

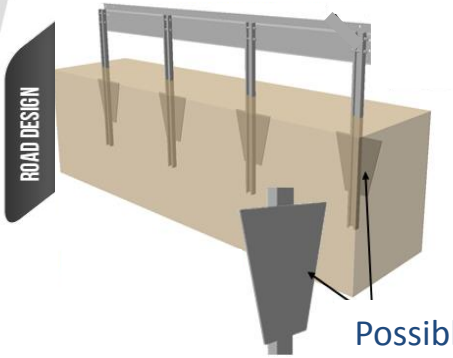
Those performances can change in non-standardized conditions.

3. Road Design

Soil Modification - Influence





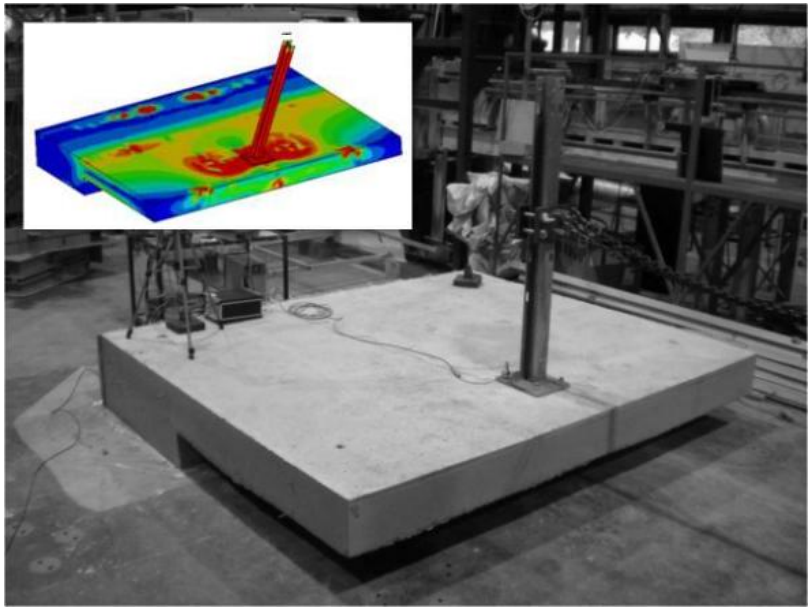


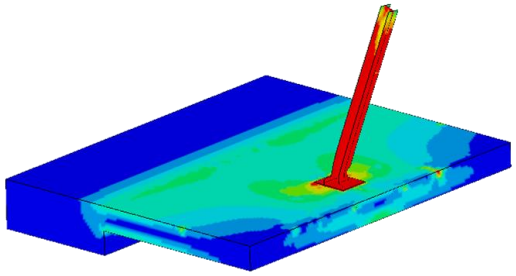
Possible reinforcement

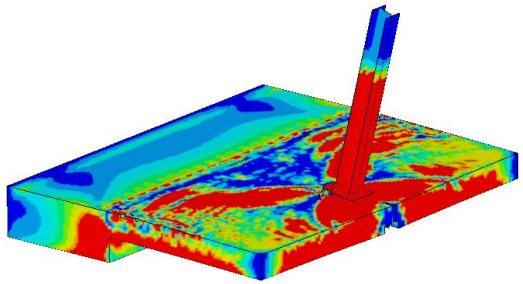
3. Road Design

Bridge load tranfer

Bridge Resistance
Numerical models calibrated with experimental tests

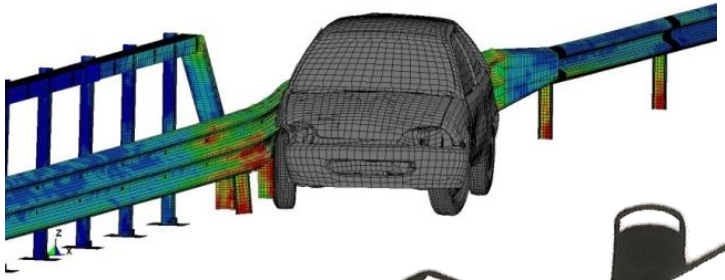


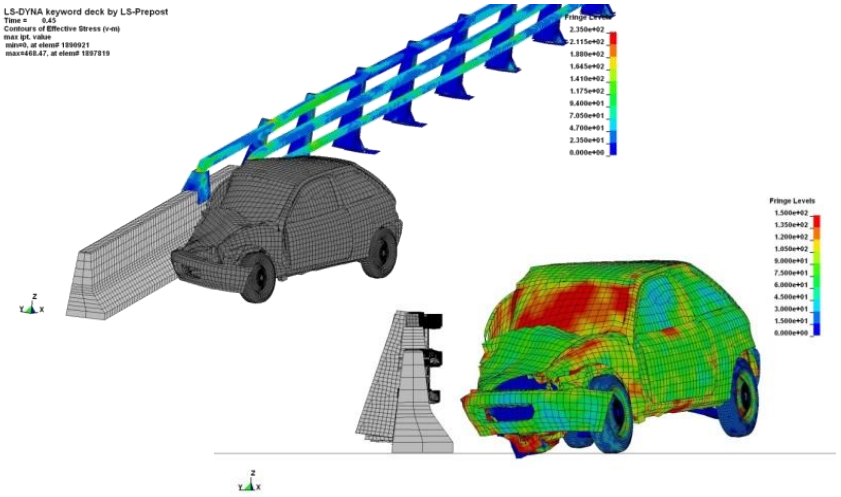


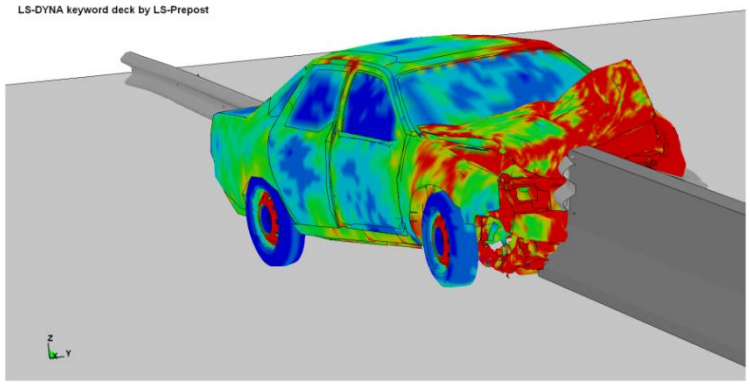


3. Road Design

Transition between systems

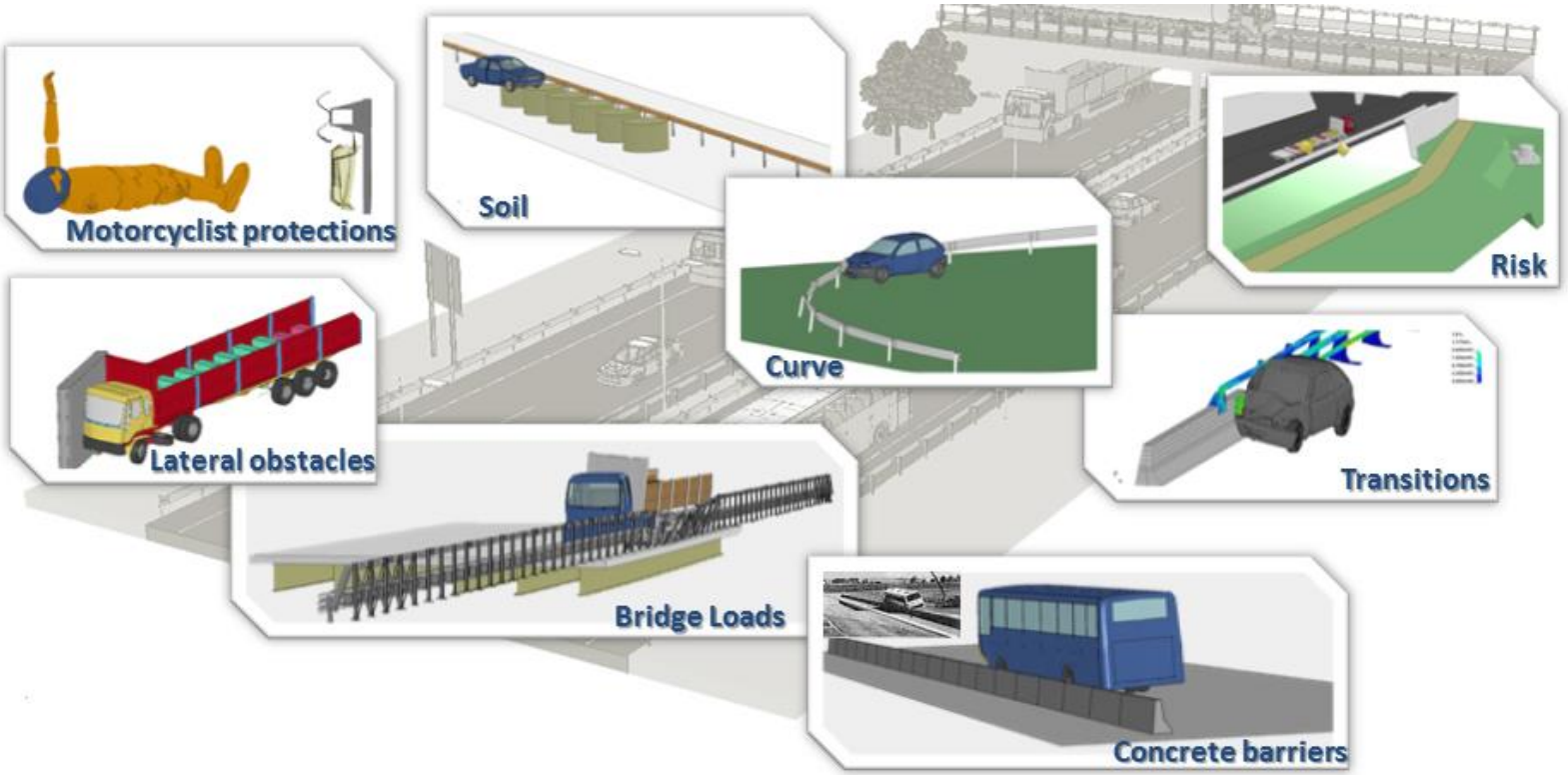






3. Road Design

Other cases



Fields of application for simulation

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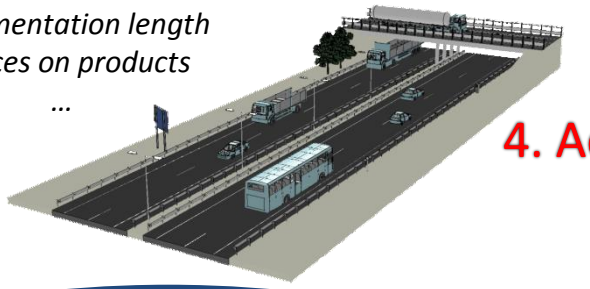

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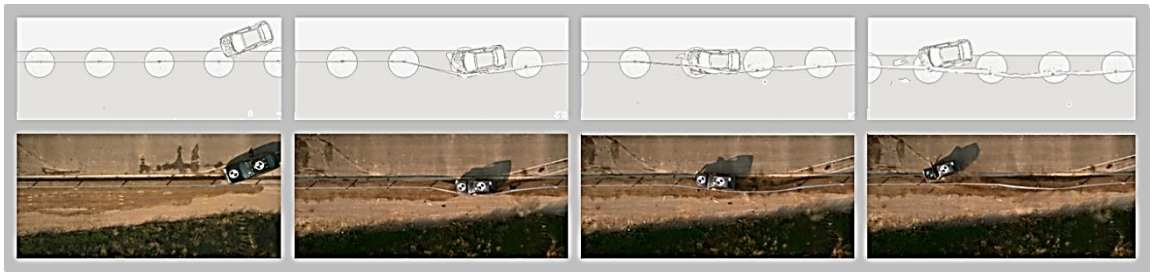


4. Accident Reconstruction

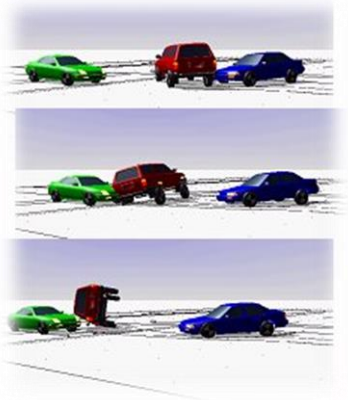
Multi-Body codes
PC-Crash, ..

Many impact
scenario simulated

Accident
reconstructed

Information that can be gathered:

- Impact speed and angle
- Trajectory reconstruction
- Vehicle dynamic
- …



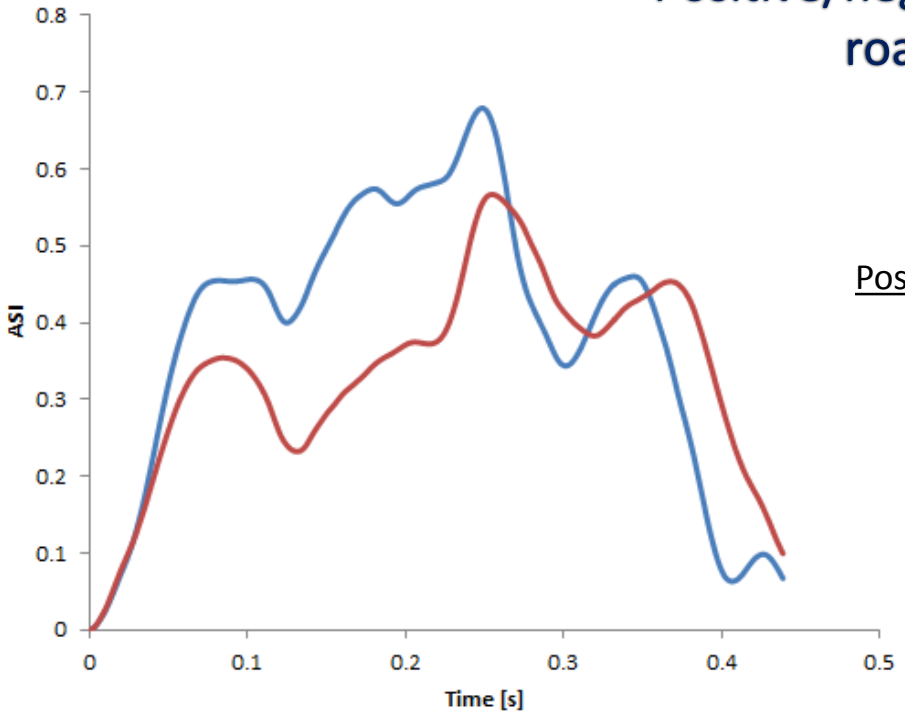
4. Accident Reconstruction

Helpfulness of using FEM analysis (for example using LSDYNA):

- Roadside safety equipment behavior analyses
- Evaluation of alternative roadside safety hardware solutions to improve safety
- Other interests of using FEM?

4. Accident Reconstruction

Post-spacing – Influence on the ASI index



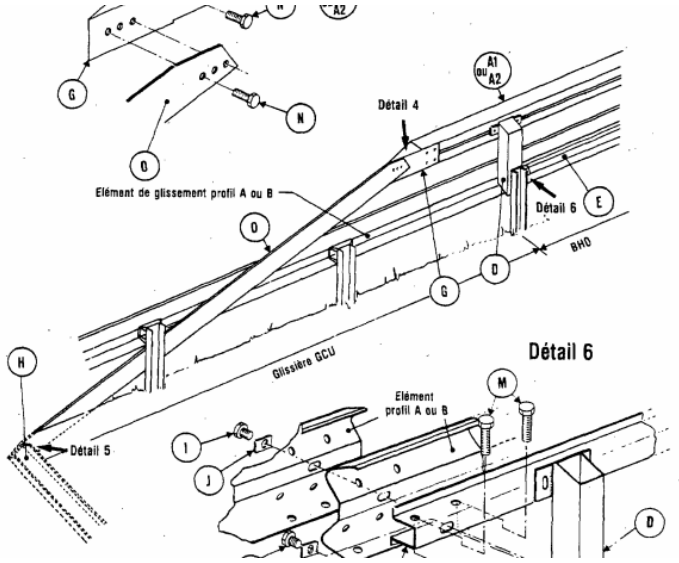
Positive/negative effects of strengthening roadside safety barriers?

Post-spacing

2m

4m

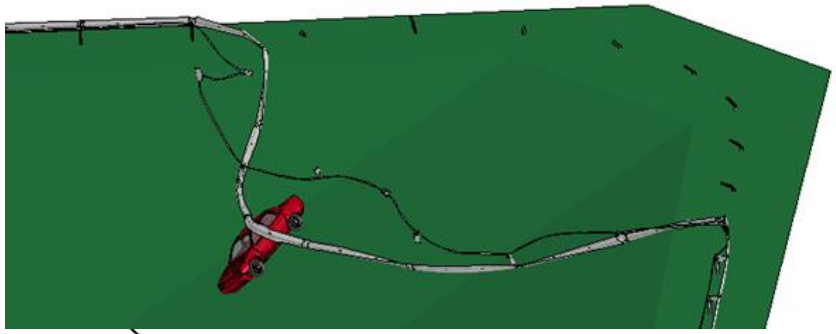
Safety Barrier upgrading

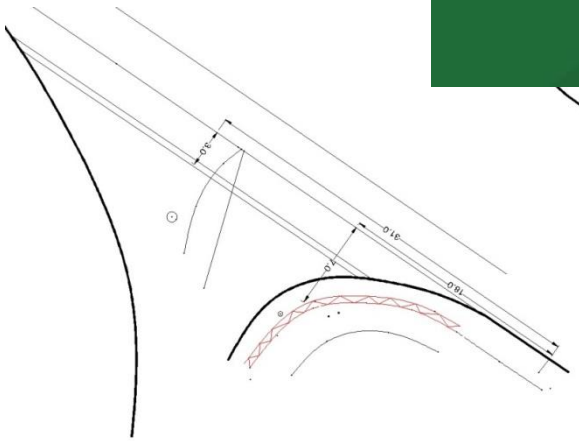


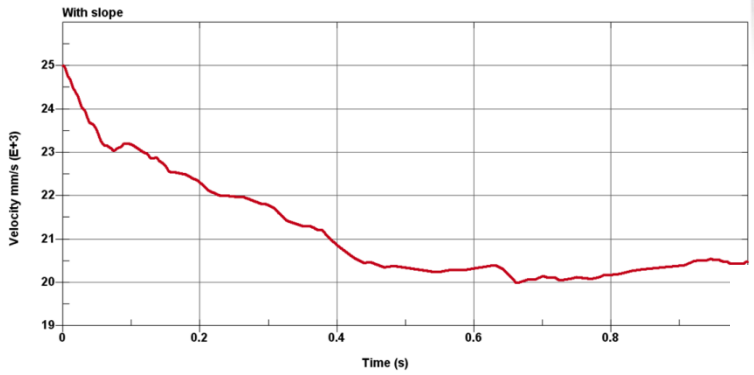
Source: http://dtrf.setra.fr/pdf/pj/Dtrf/0001/Dtrf-0001915/TO1915.pdf?openerPage=notice

4. Accident Reconstruction

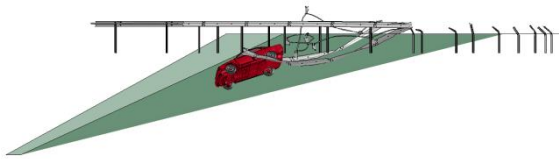
Frontal impact on N2





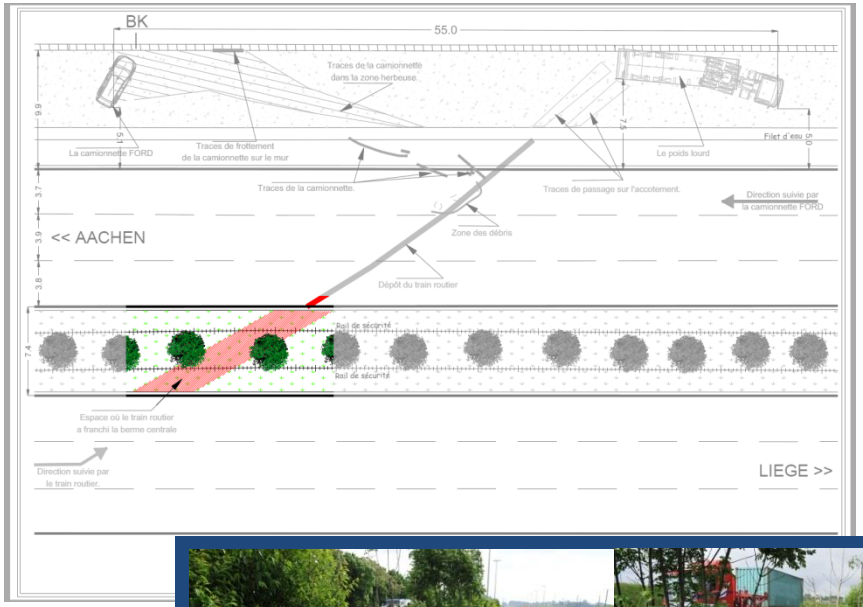


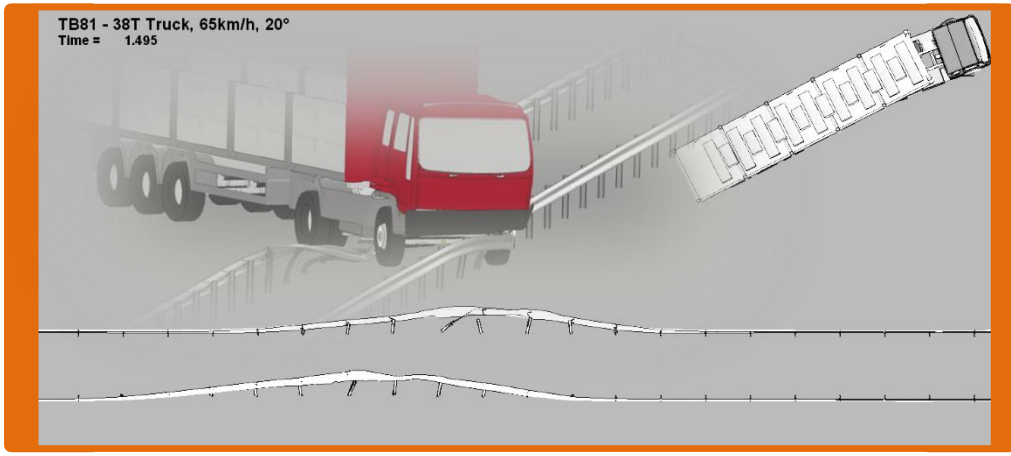
90 km/h → 74 km/h → 483 kJ → 326 kJ

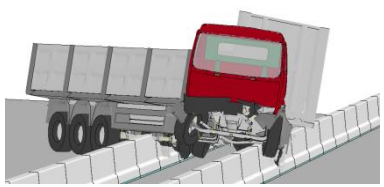


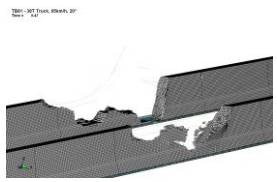
4. Accident Reconstruction

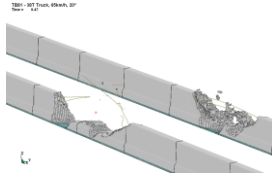
Crossing of central reserves







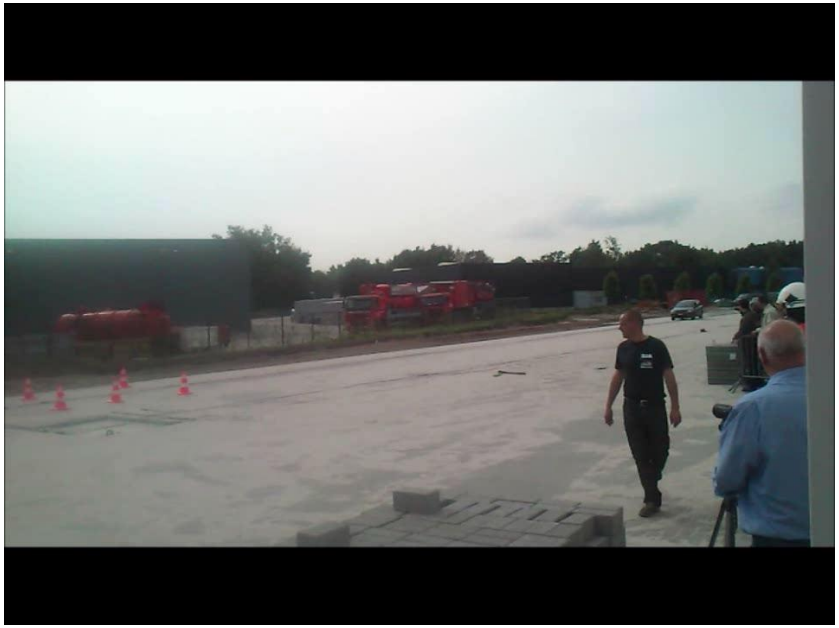




Concerned products

Safety barriers (EN1317, …)

Safe Poles (EN12767, …)



And all other roadside safety hardware

(crash cushions, truck mounted attenuators, motorcyclist protections, …)

Thank you for your attention!

Joseph MARRA - 0032 479 43 04 59 - Joseph.Marra@GDTech.EU

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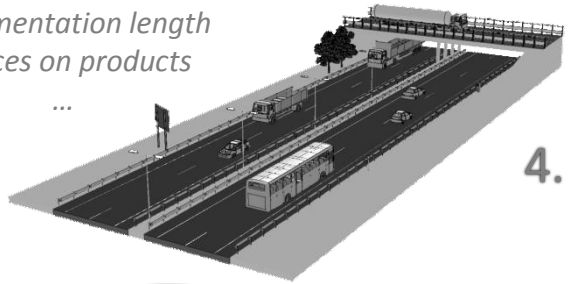

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