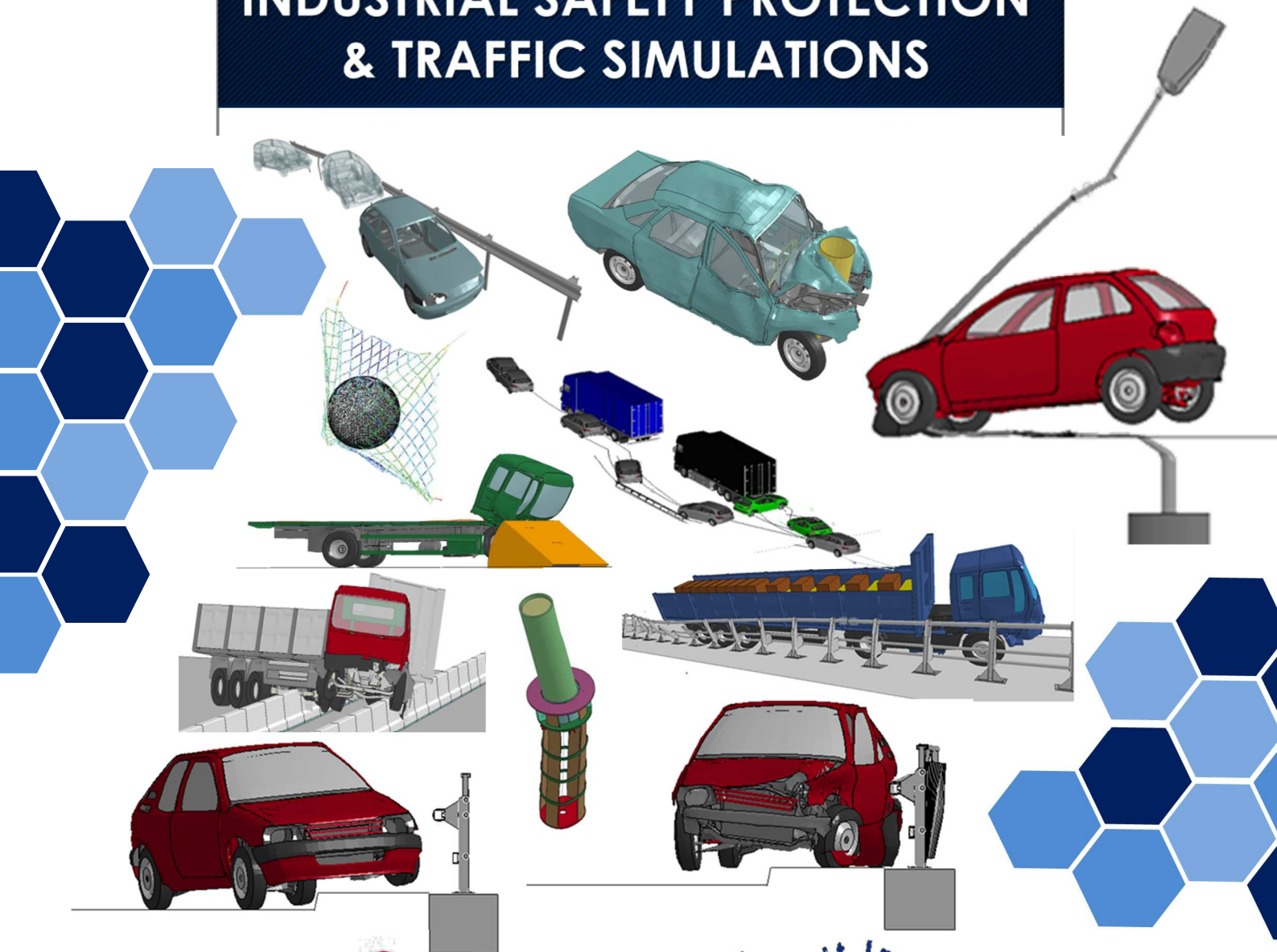
GDTECH engineering

ROAD RESTRAINT SYSTEMS, POLES, ANTI-INTRUSION, INDUSTRIAL SAFETY PROTECTION & TRAFFIC SIMULATIONS



SAMI engineering

open engineering

FEDER – FSE
UNION EUROPEENNE
Wallonie
L'UNION EUROPEENNE ET LA WALLONIE INVESTISSENT DANS VOTRE AVENIR.

Crédit Impôt Recherche CIR

afaq ISO 9001 Qualité AFNOR CERTIFICATION

afaq EN/AS/JISQ 9100 Aéronautique AFNOR CERTIFICATION

CONTACT US : +32 4 367 87 11 – www.gdtech.eu – info@gdtech.eu

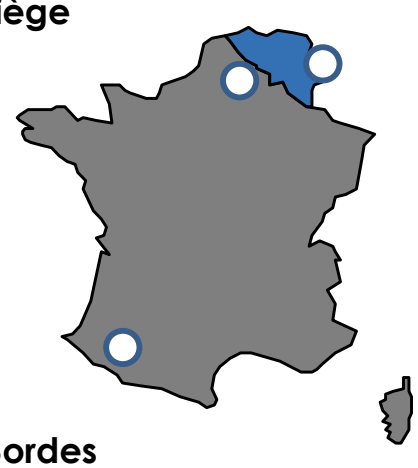
GENERAL PRESENTATION

LOCATIONS

Calgary

Valenciennes

Liège



Bordes

SOFTWARE & HARDWARE

Altair HyperWorks

LS-DYNA

SolidWorks

Cluster #1
128 Cores
256 GB Ram
Intel Xeon E5-2670 @2,60Hz

Cluster #2
128 Cores
512 GB Ram
Intel Xeon E5-2640 @2,60Hz

Cluster #3
160 Cores
768 GB Ram
Intel Xeon Silver 4114 @2,20Hz

Cluster #4
512 Cores
4018 GB Ram
Amd Epyc 2019

REPRESENTATIVE COMPANY

USCOM
we provide confidence

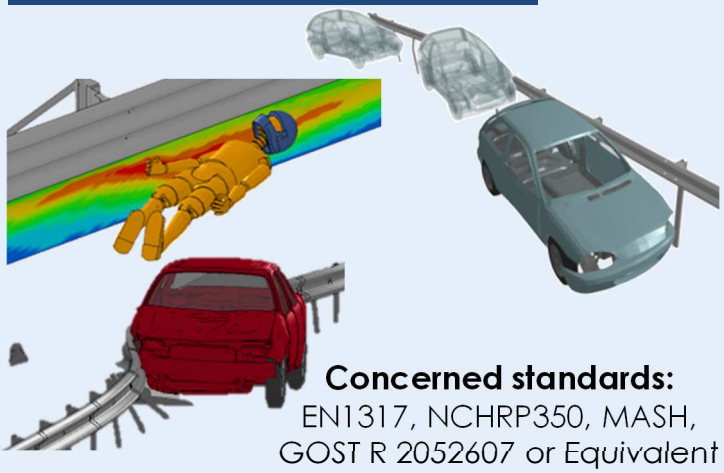
Turkey, Iran, Israel, Georgia, Uzbekistan, Turkmenistan

if3

Australia & New Zealand

GENERAL PRESENTATION

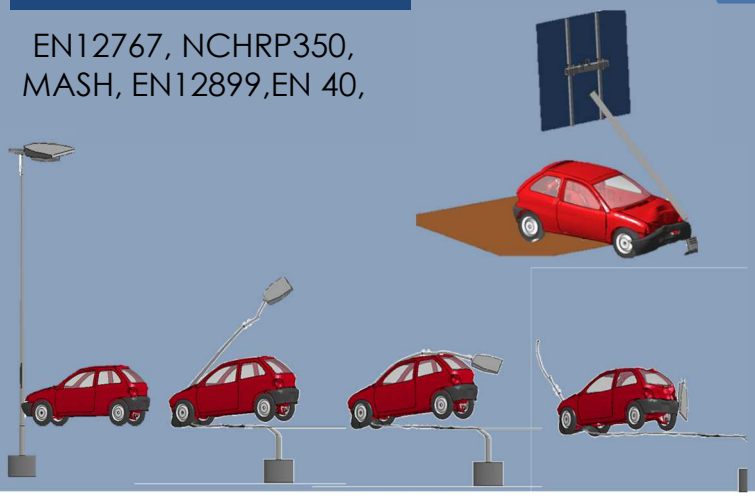
ROAD RESTRAINT SYSTEMS



Concerned standards:
EN1317, NCHRP350, MASH,
GOST R 2052607 or Equivalent

POLES AND PANELS

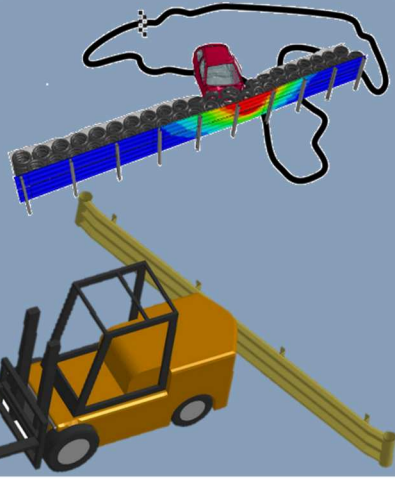
EN12767, NCHRP350,
MASH, EN12899,EN 40,



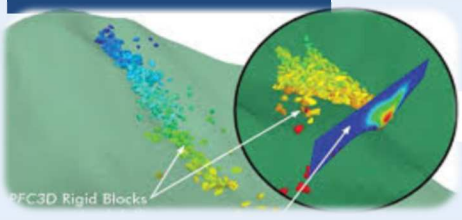
SECURITY PRODUCTS

PAS 68, PAS 69, ASTM F2656,
CWA 16221, IWA 14

INDUSTRIAL PROTECTION AND CIRCUIT

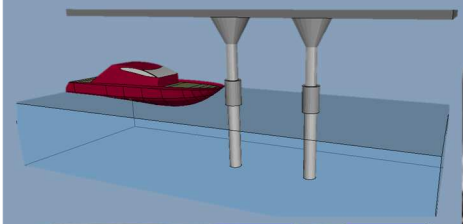


FALLING ROCK



Concerned standard: EAD340059

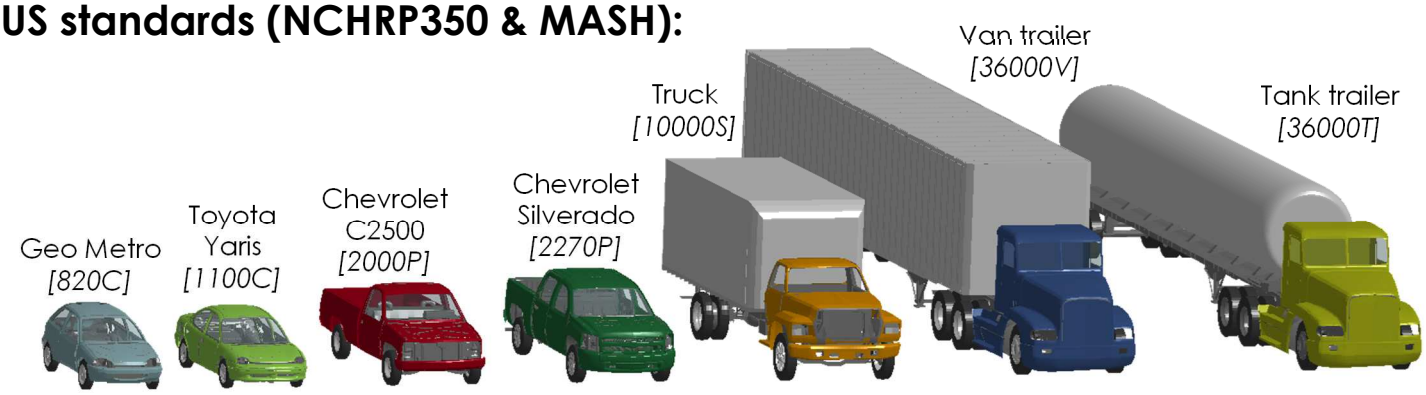
OTHERS



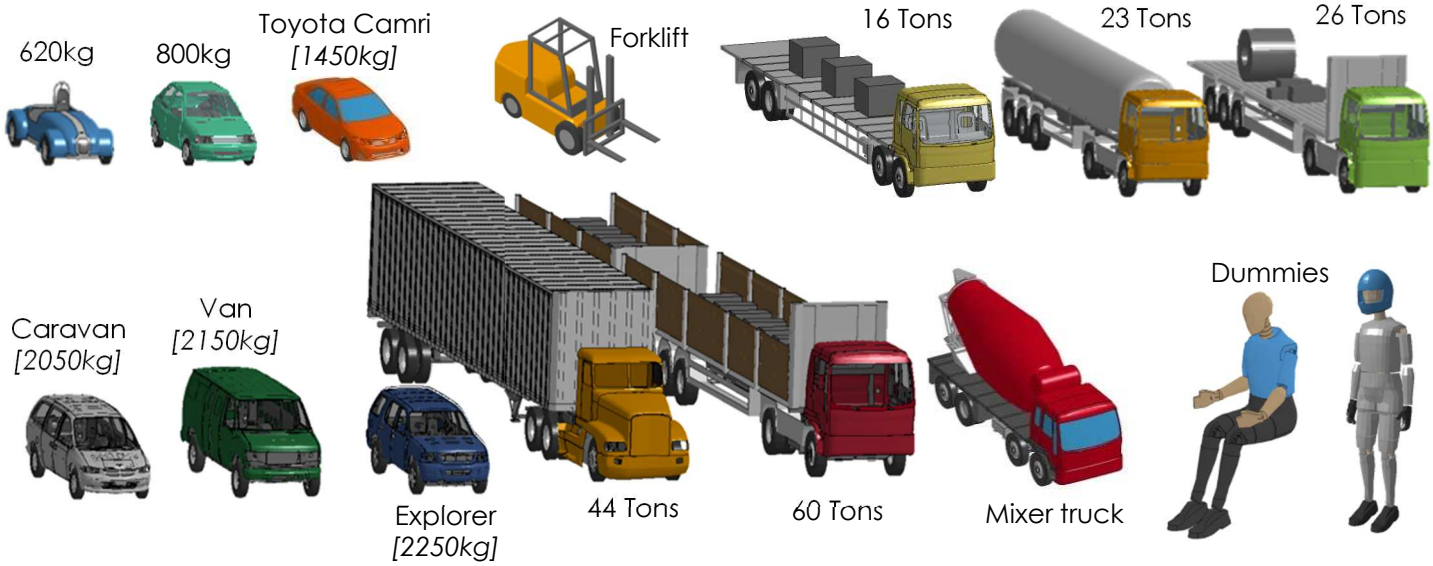
VEHICLES ACCORDING TO INTERNATIONAL STANDARDS

EU standards (EN16303-2 validated models):

US standards (NCHRP350 & MASH):

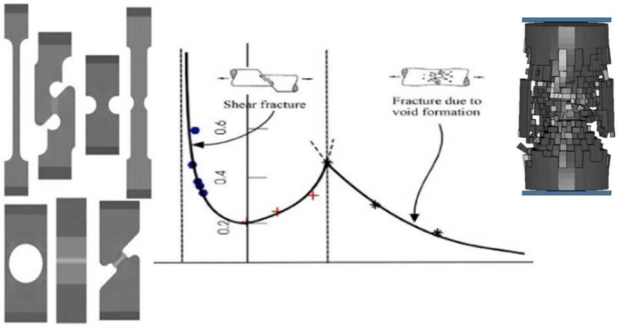


Other possible vehicles:



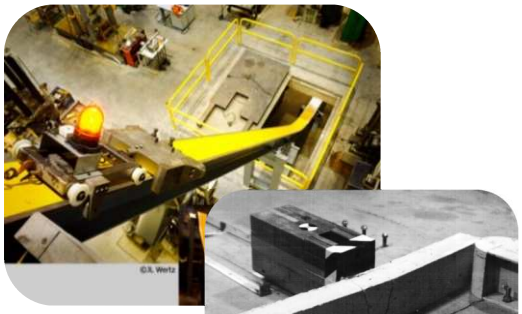
ADVANCED MODELS AND LAB TESTS

Steel



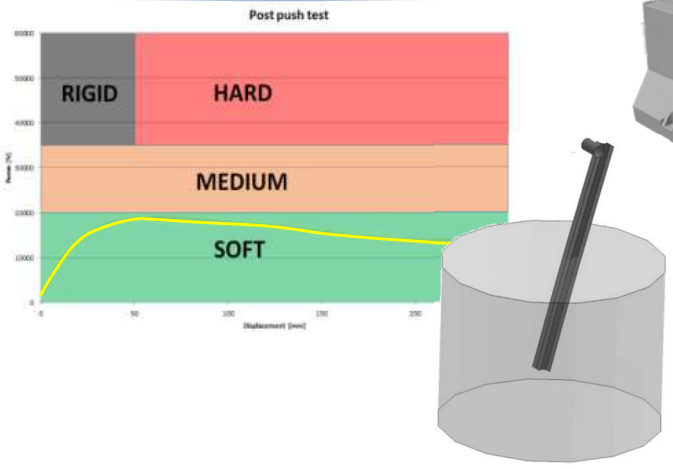
Concrete

Dynamic tests

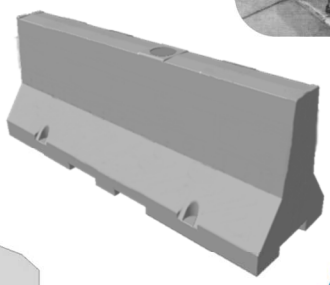


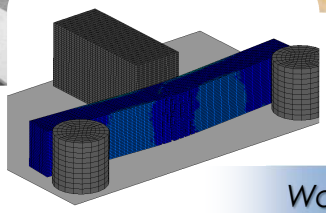
Static Tests

Soil

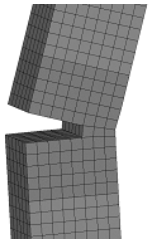


Plastic

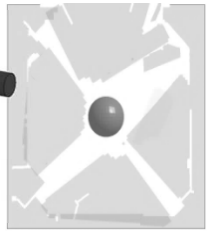




Wood

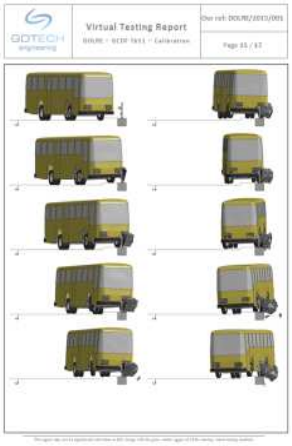


Glass

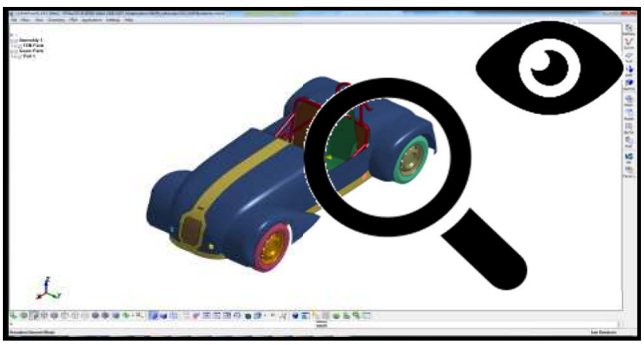


DETAILED REPORTS

Simulation reports



3D Viewer of animated results

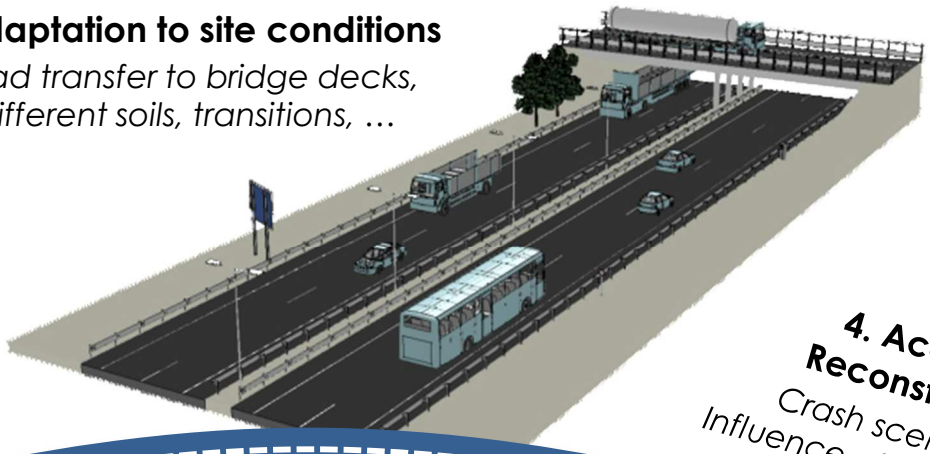


Von Mises Stress - Plastic Strain - Displacement …

ROAD RESTRAINT SYSTEMS

3. Adaptation to site conditions

Load transfer to bridge decks, different soils, transitions, …



1. New Product Development

Safety barriers
Crash cushions
Terminals, …

4. Accident Reconstruction

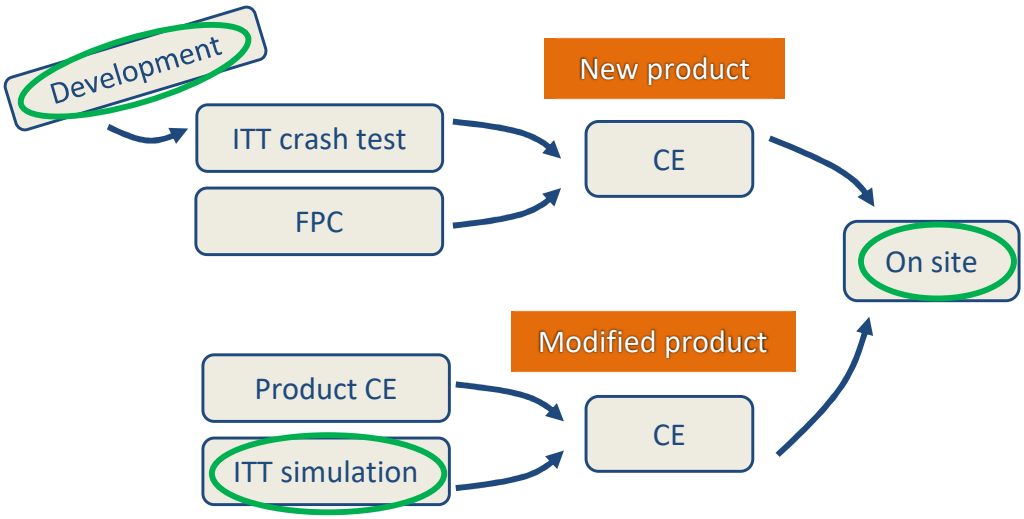
Crash scenarios
Influence of alternatives

2. Certification

ITT (Crash test / Simulation)
CE marking

5. Training Sessions

Before to be placed on the market



EN 1317 rules

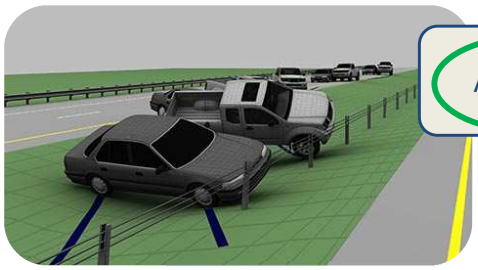
Before installation on site

Adaptation to site conditions:

- *Soil modification*
- *Max speed limit*
- *Max CL in curve*
- *Bridge pile*
- *Gantry*
- *Bridge safety barriers*
- *Transitions*
- *Curve influence*
- *Motorcyclist protection*
- *Concrete safety barriers*
- *…*

National / Regional rules

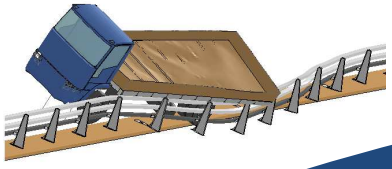
After an accident

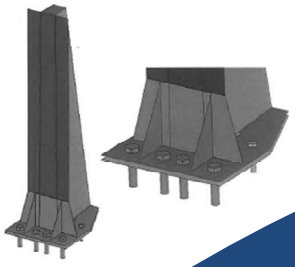


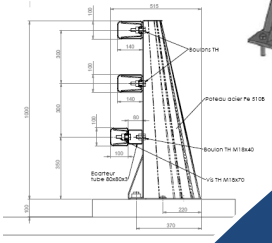
Insurance / Court

GDTech is an independent company of 180 people with a core business being Finite Element Analyses of structures in the Aeronautic and Crash applications. Concerning roadside safety equipment analyses, GDTech has an experience of more than 10 years and has collaborated with many customers worldwide using EN1317, NCHRP350 / MASH, PAS68, ASTM standards mainly. GDTech has delegates representing Belgium in TC226/WG1 and TC226/WG10 writing EN1317 and EN12767 respectively. GDTech is participating at the elaboration of the reference European document about how to simulate correctly EN1317 crashes of vehicles against road restraint systems (TG5-CME).
GDTech actively participates at TRB concerning US standards.
GDTech is member of ERF (European Road Federation) and Smart Transportation Alliance (STA).

1. New Product Development







Experimental Crash-test

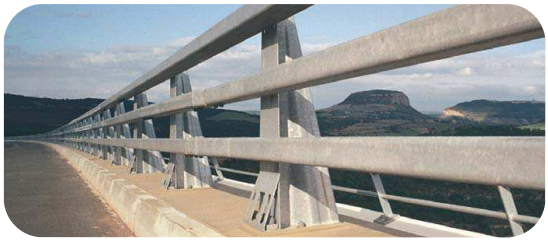
Yes

Simulation → Positive results?

No

Digital model

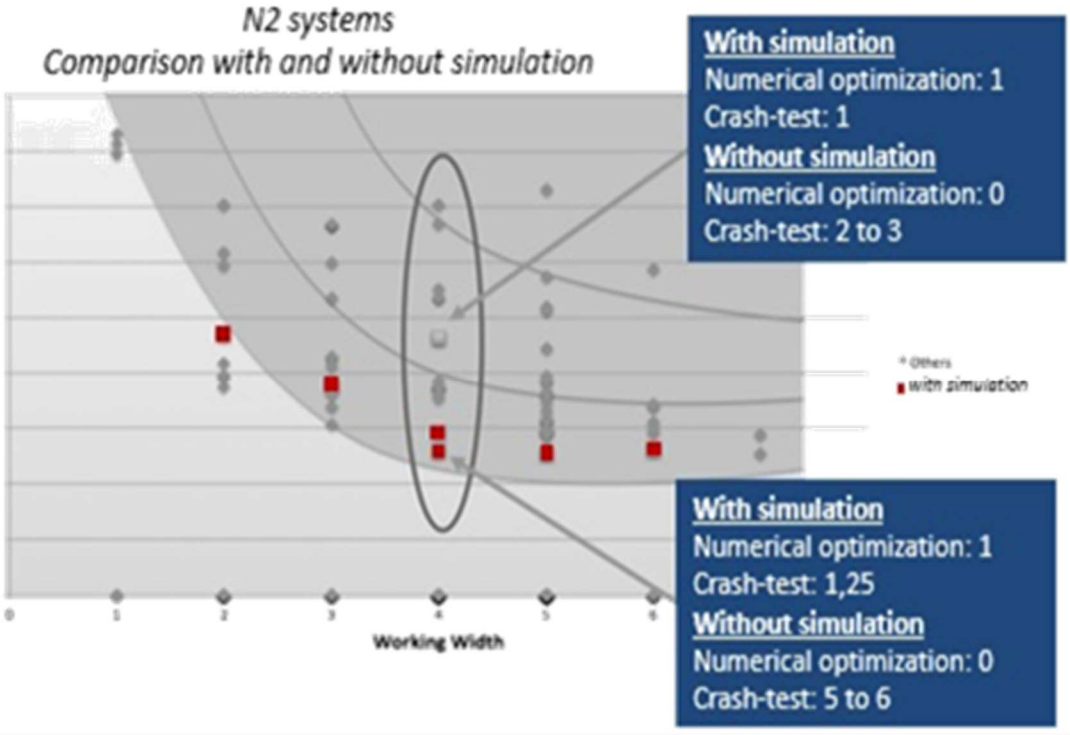
Drawings



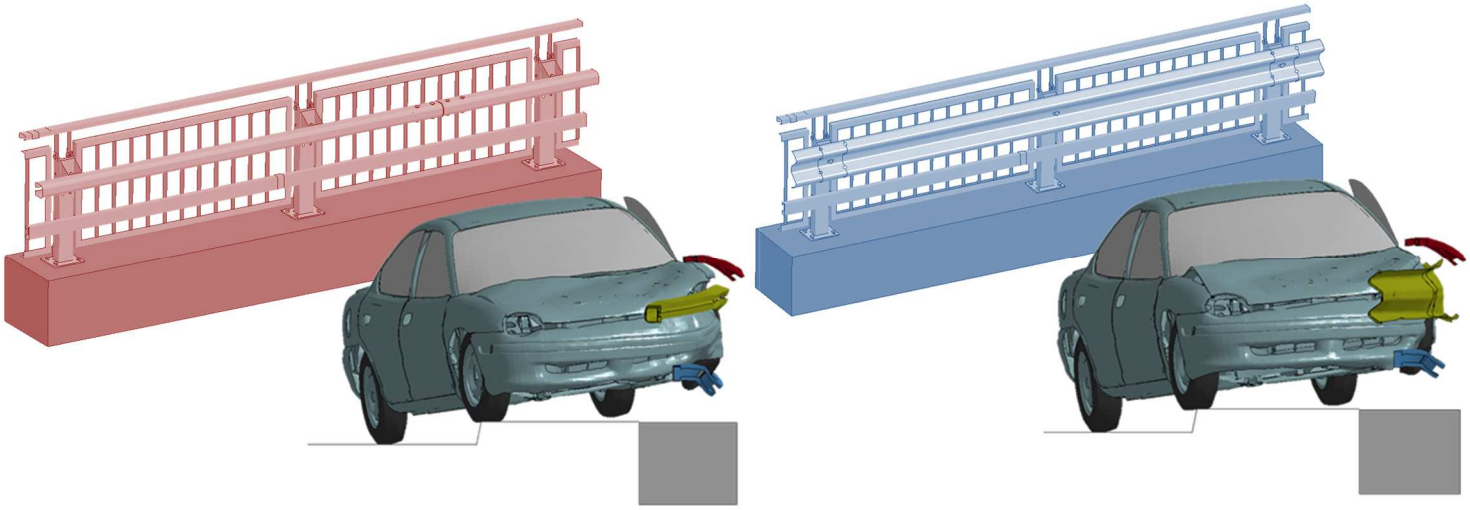
Simulation

Increase probability to pass Crash Test

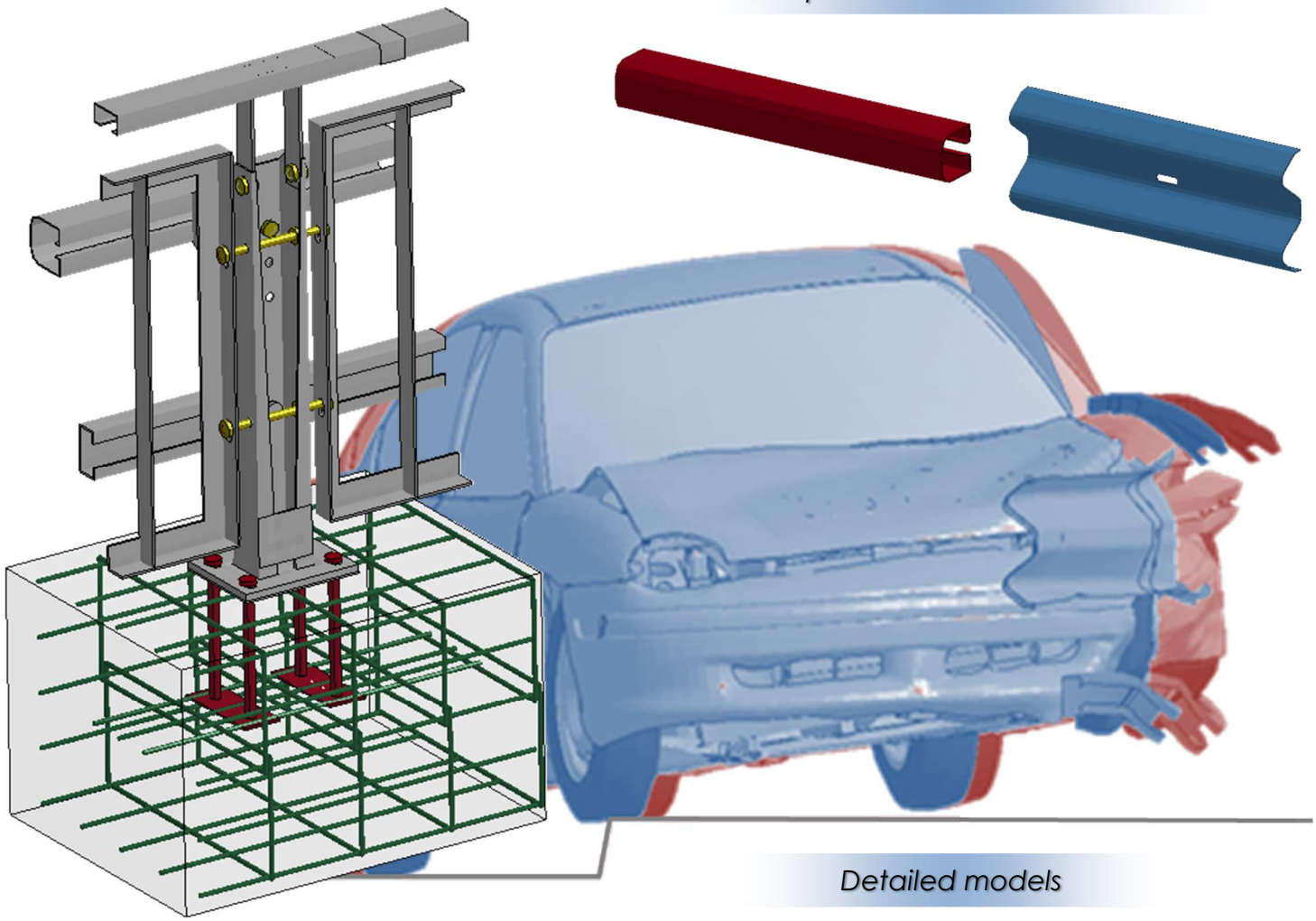
Increase performance and/or decrease costs



1. New Product Development



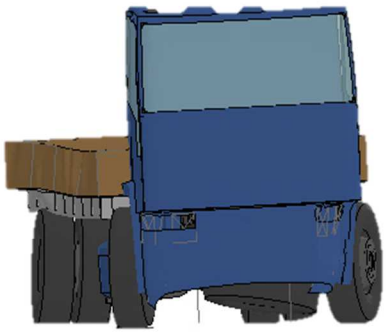
Comparison with different beams

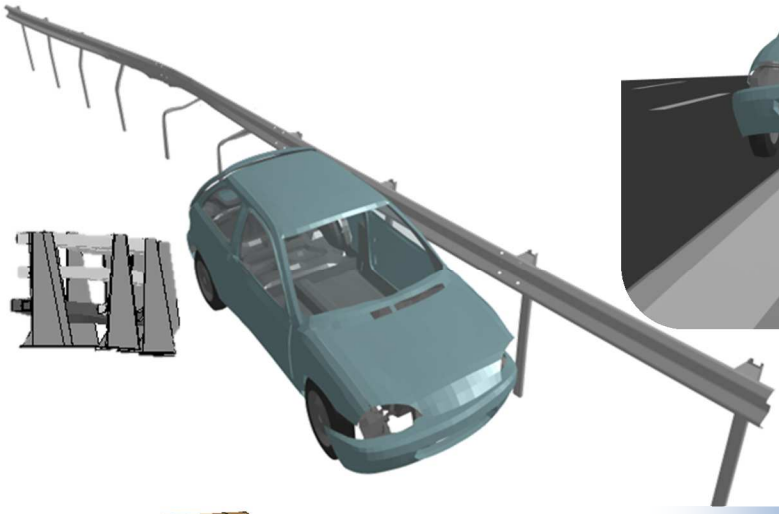


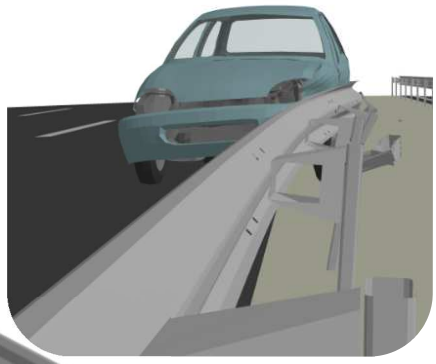
Detailed models

1. New Product Development

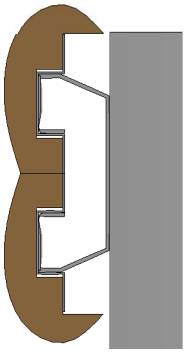
Steel Barriers

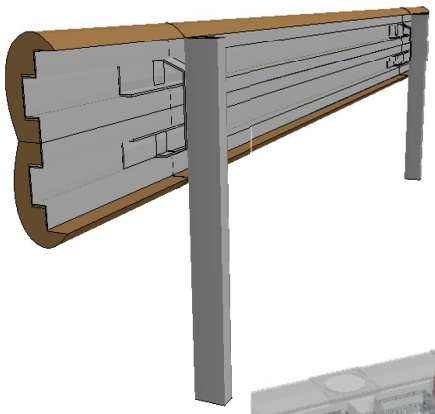




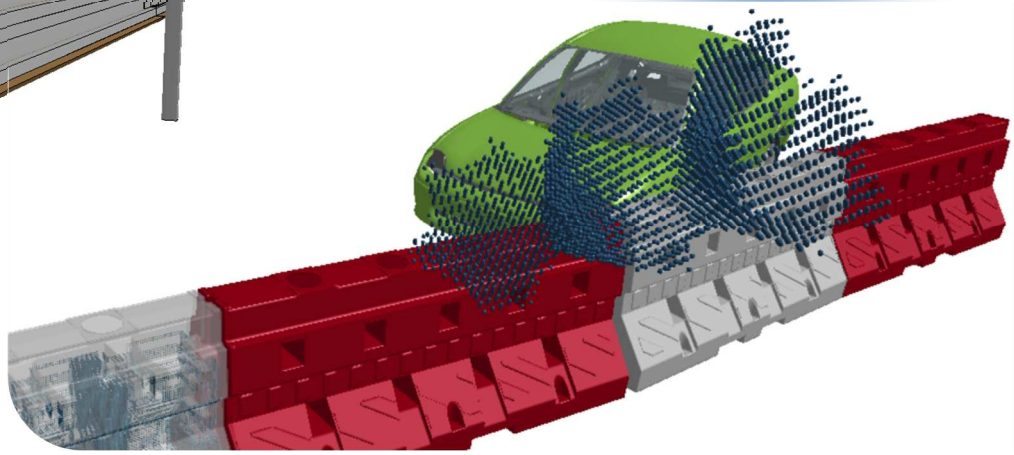


Wood-Steel Barriers

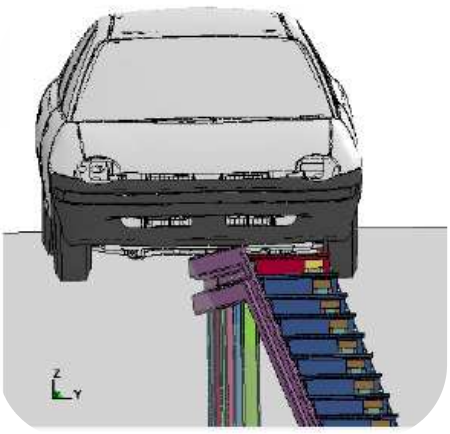




Plastic Barriers

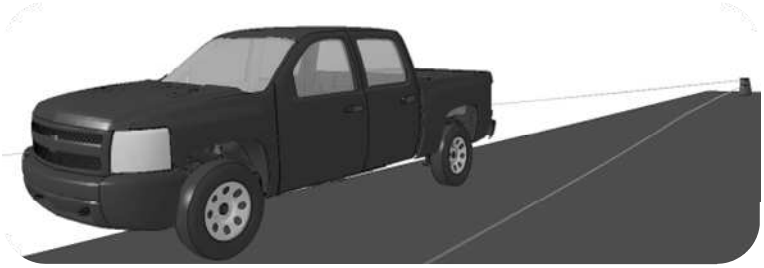


End Terminals

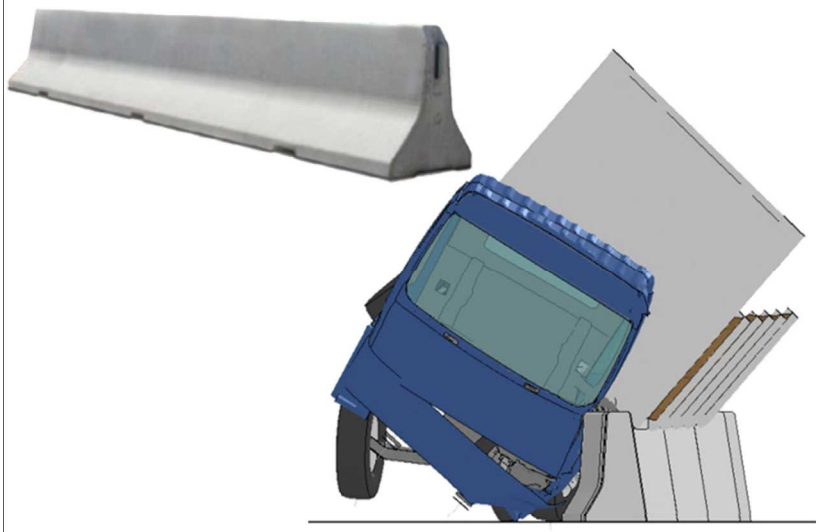


1. New Product Development

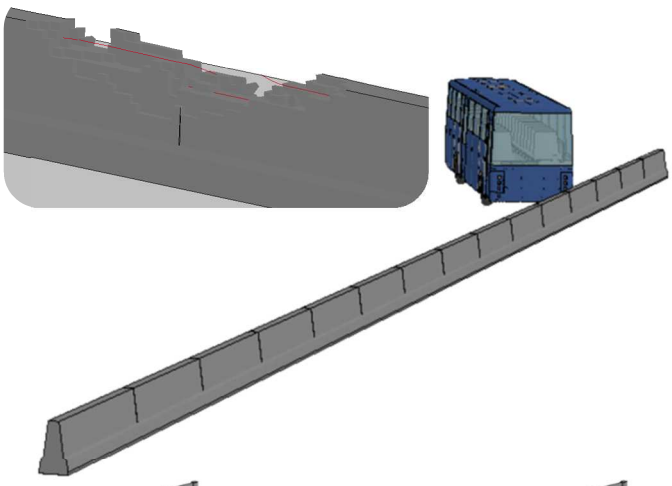
Cable Barriers



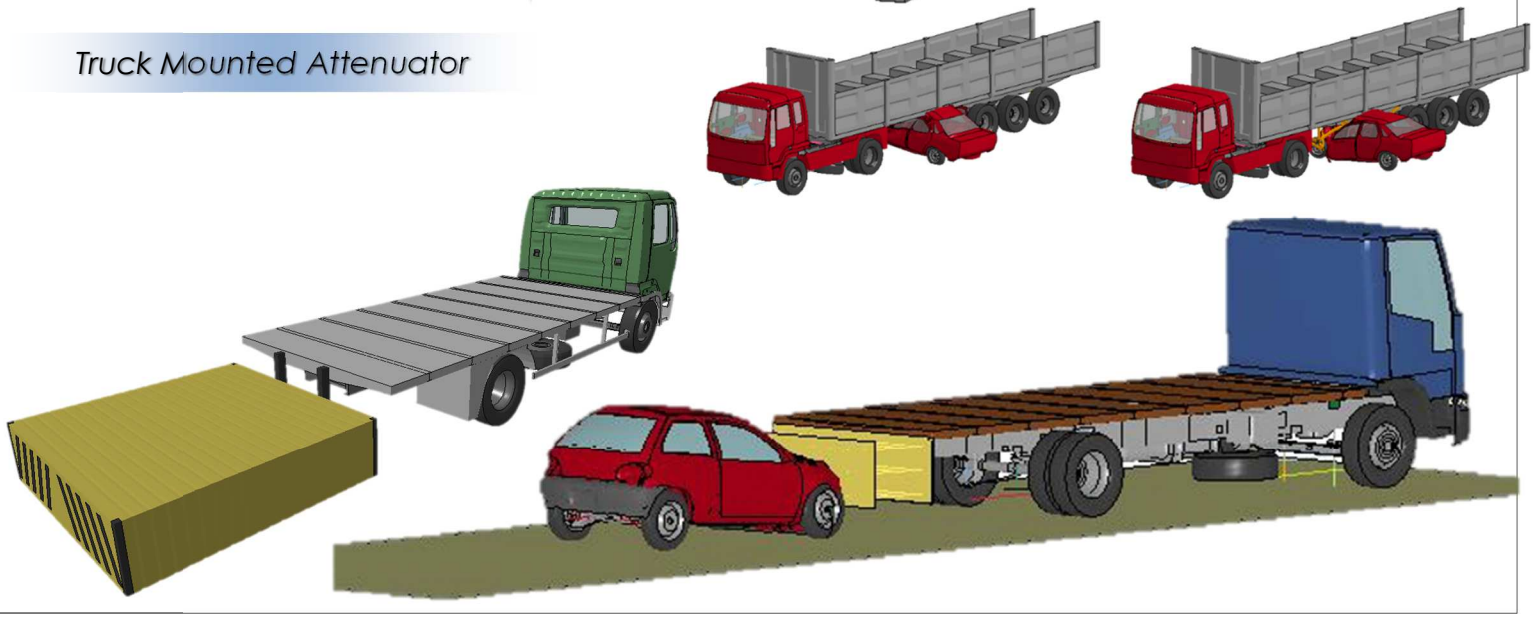
Prefabricated Concrete Barriers



Cast in Place / in site Concrete Barriers

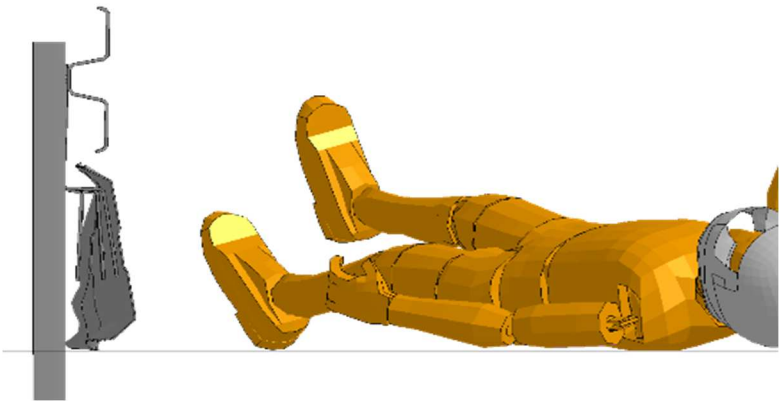


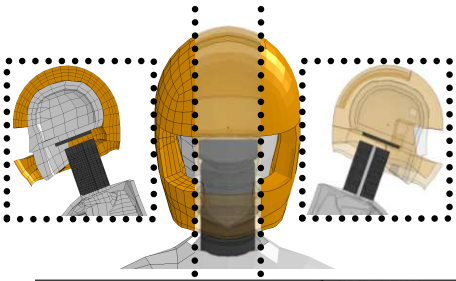
Truck Mounted Attenuator

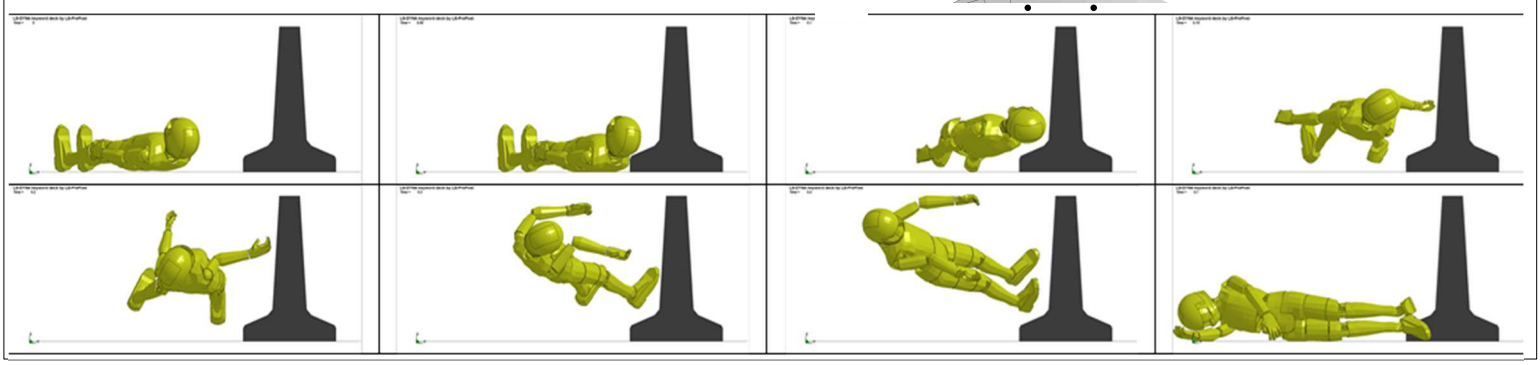


1. New Product Development

Dummies







2. CERTIFICATION

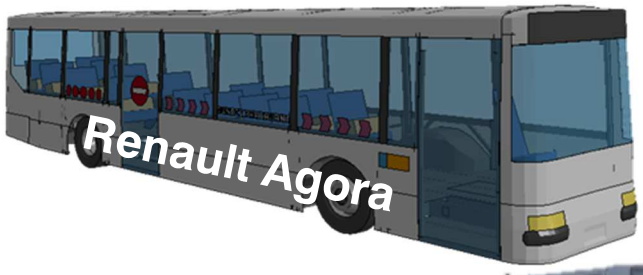
Category	Change
A	Slight
B	Moderate
C	Significant

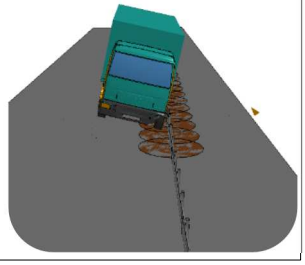
Category B allows simulation to be used for certifying modified products or families of products

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.

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 • Extend you family of products *[without having to perform new crash tests]*	• A simulation of the modified product using proven models according to EU best-practices

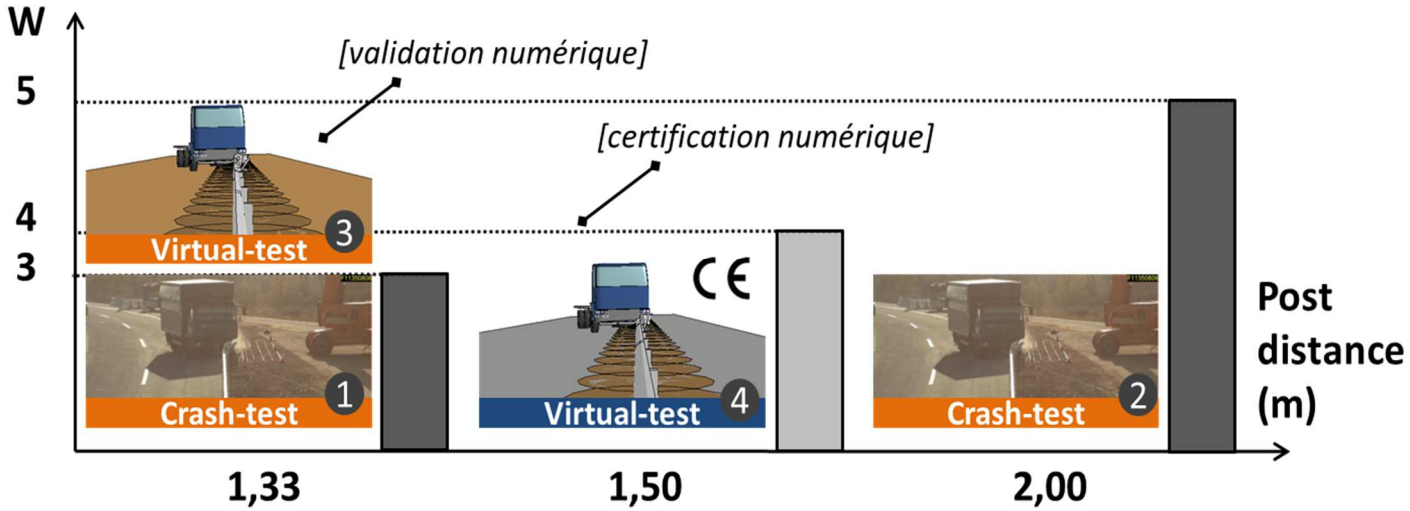
Measure	Crash-Test	Virtual-Test	Acceptance	Difference
Normalized dynamic deflection [m]	0.8	0.76	<0.18	0.04
Normalized working width [m]	0.9	0.86	<0.18	0.04



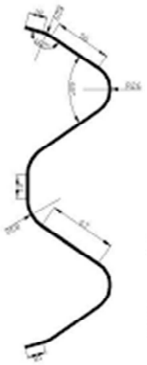


2. CERTIFICATION

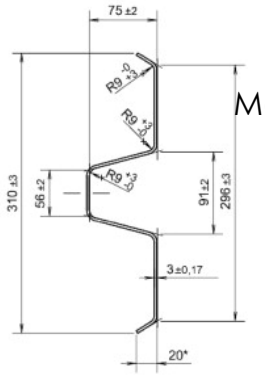
Example 1: Family of products



Example 2: Guardrail profile

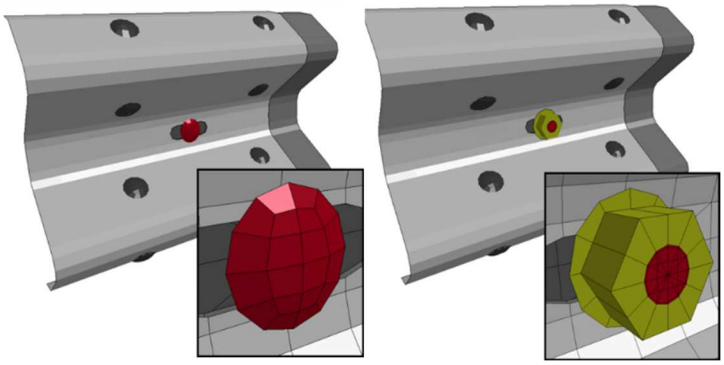


Original model Tested - Profile A

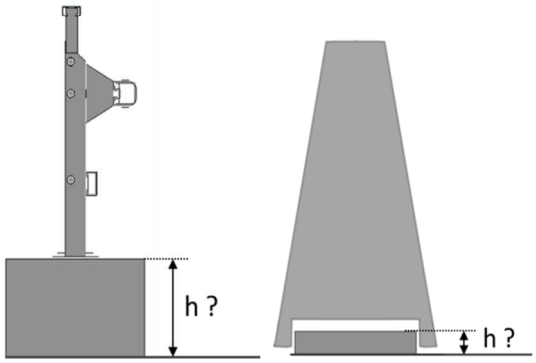


Modified model - Profile B

Example 3: Bolt orientation changed



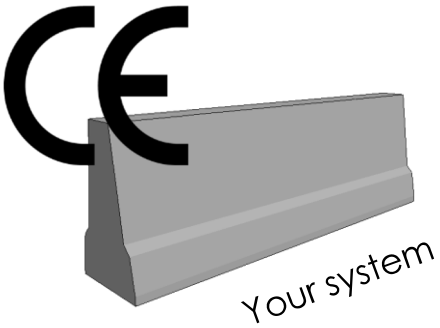
Example 4: Different concrete basement heights



2. CERTIFICATION

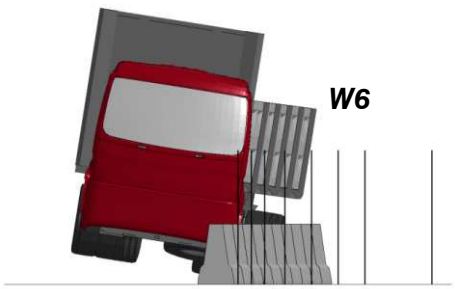
Example 5: Assess the working width for lower containment levels

Tested H4 W6 system

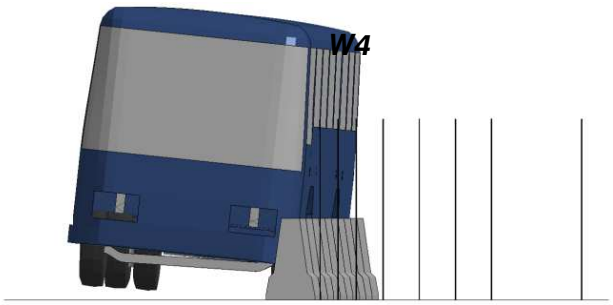


is also H2 W6 system ⟷ **According to EN1317**

Calibrated model

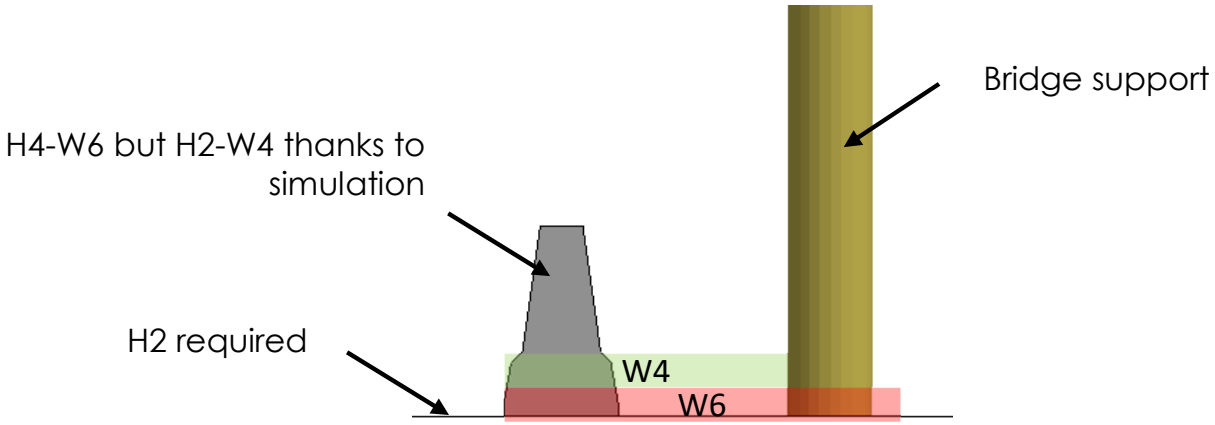


H4 W6



H2 W4

CE *of H2 W4 Using numerical simulation*



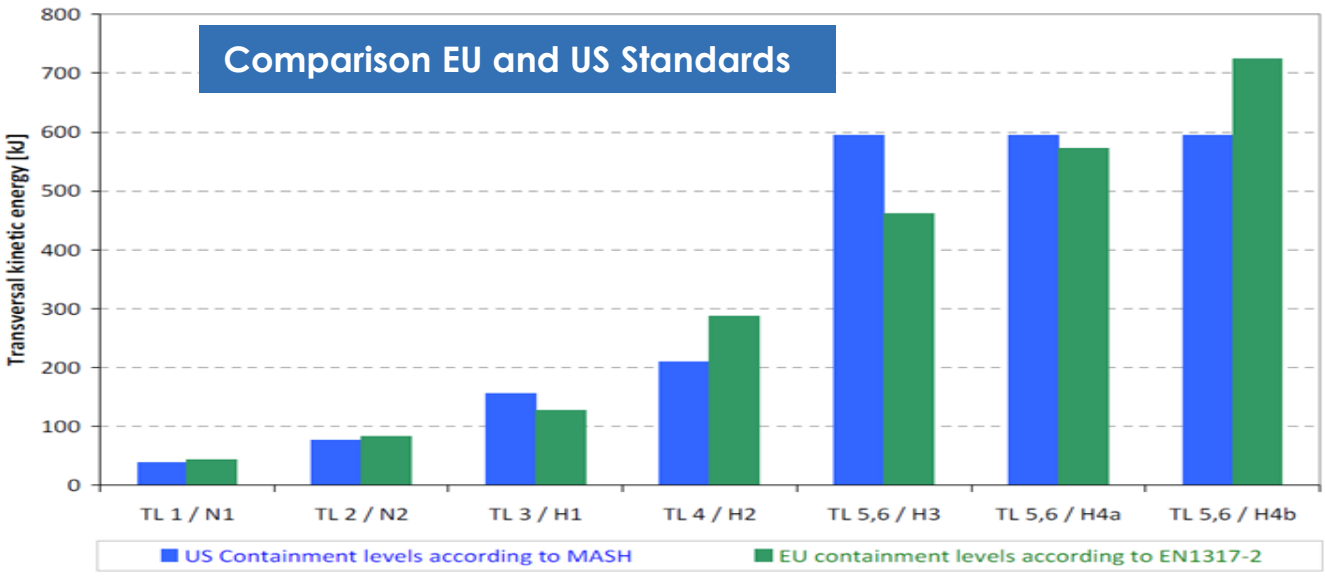
2. CERTIFICATION

Simulation for assessing performance of a tested product according to a different international standard (EN1317, NCHRP 350, MASH, GOST, …)

A — Tested product according to EN1317

B — Simulation reproducing the Real-test

C — Simulation according to another performance standard



3. Adaptation to Site Conditions

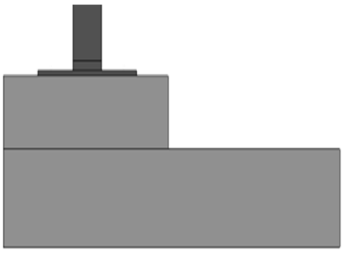
a) Loads from bridge parapets to decks

EN1317 Test conditions

A	Forces from real crash-test (from anchoring bolts)
B	Forces from EN1317 crash simulation
C	Max. forces (analytical calculations at rupture)
D	Max. forces (dynamic simulations at rupture)

Maximum loads

b) Reinforce bridge decks (Existing/New)

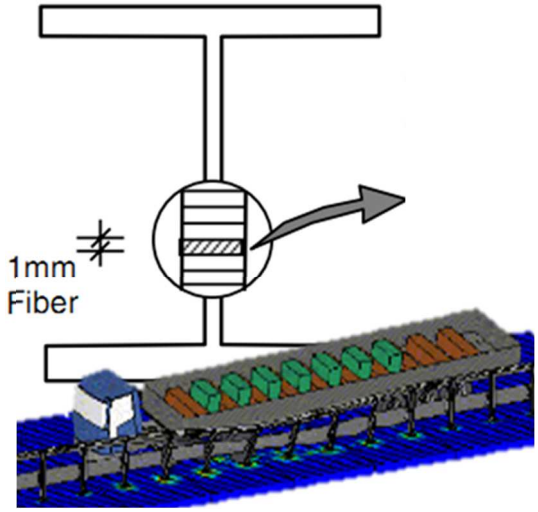


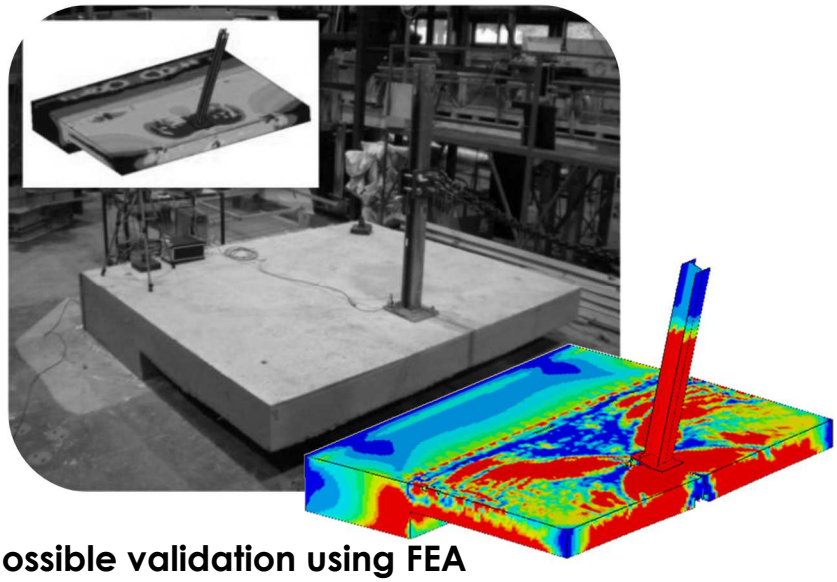
$$M = \int_{-h/2}^{h/2} \sigma . b_y . y . dy$$

$$V = \int_{-h/2}^{h/2} \tau . b_y . dy$$

According to Eurocodes & PTV869 valid for

agentschap Wegen en Verkeer — DGO 1 — Wallonie — SPW Service public de Wallonie

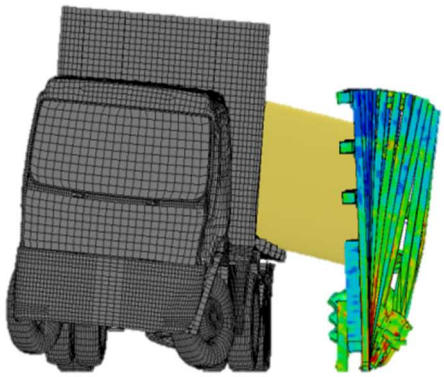


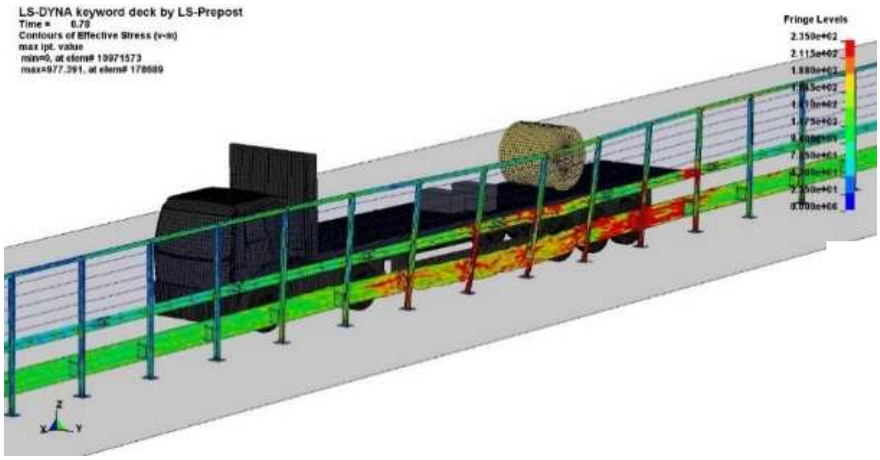


Possible validation using FEA

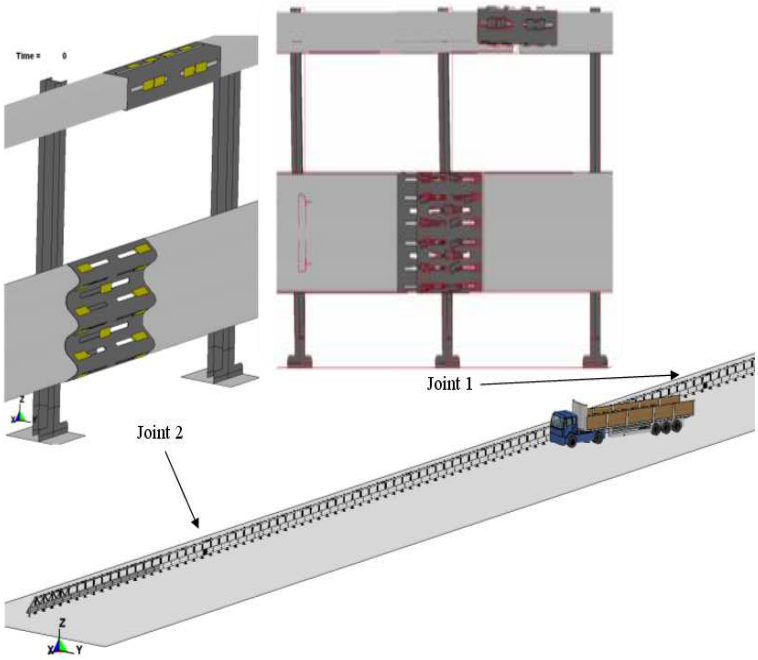
3. Adaptation to Site Conditions

Falling Load | Acoustical Walls | Anti-suicide Walls | Pedestrian Protection





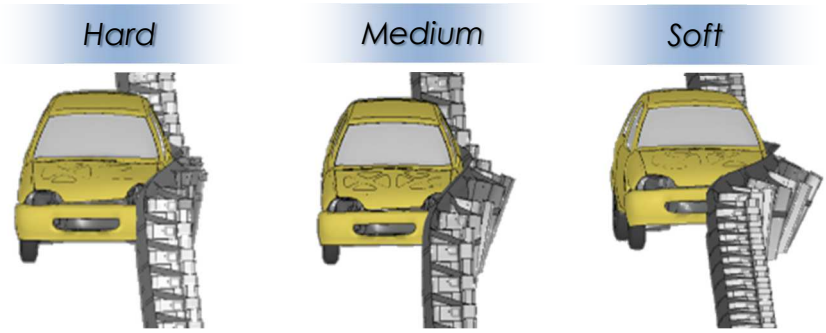
Steps & Expansion joints

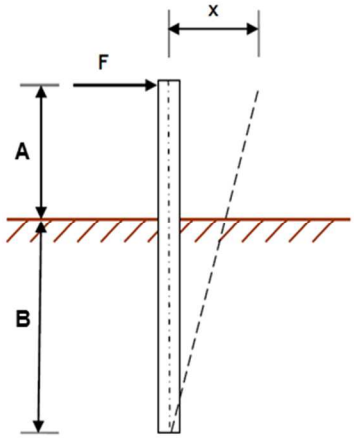


3. Adaptation to Site Conditions

Soil influence

New methodology
to check &
adapt safety barriers
to different soils



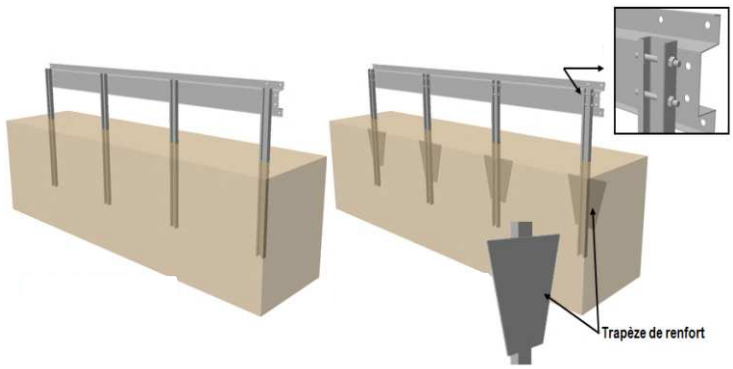


EN1317 / Soil	
Profil	HEB120-S335JR
A	1,00m
B	1,00m
x	0,20m

Classes	Forces
hard	F > 35 kN
medium	20 < F ≤ 35 kN
soft	F ≤ 20 kN

PTV869 / Soil	
Profil	HEB100-S235JR
A	0,65m
B	1,00m
x	0,35m

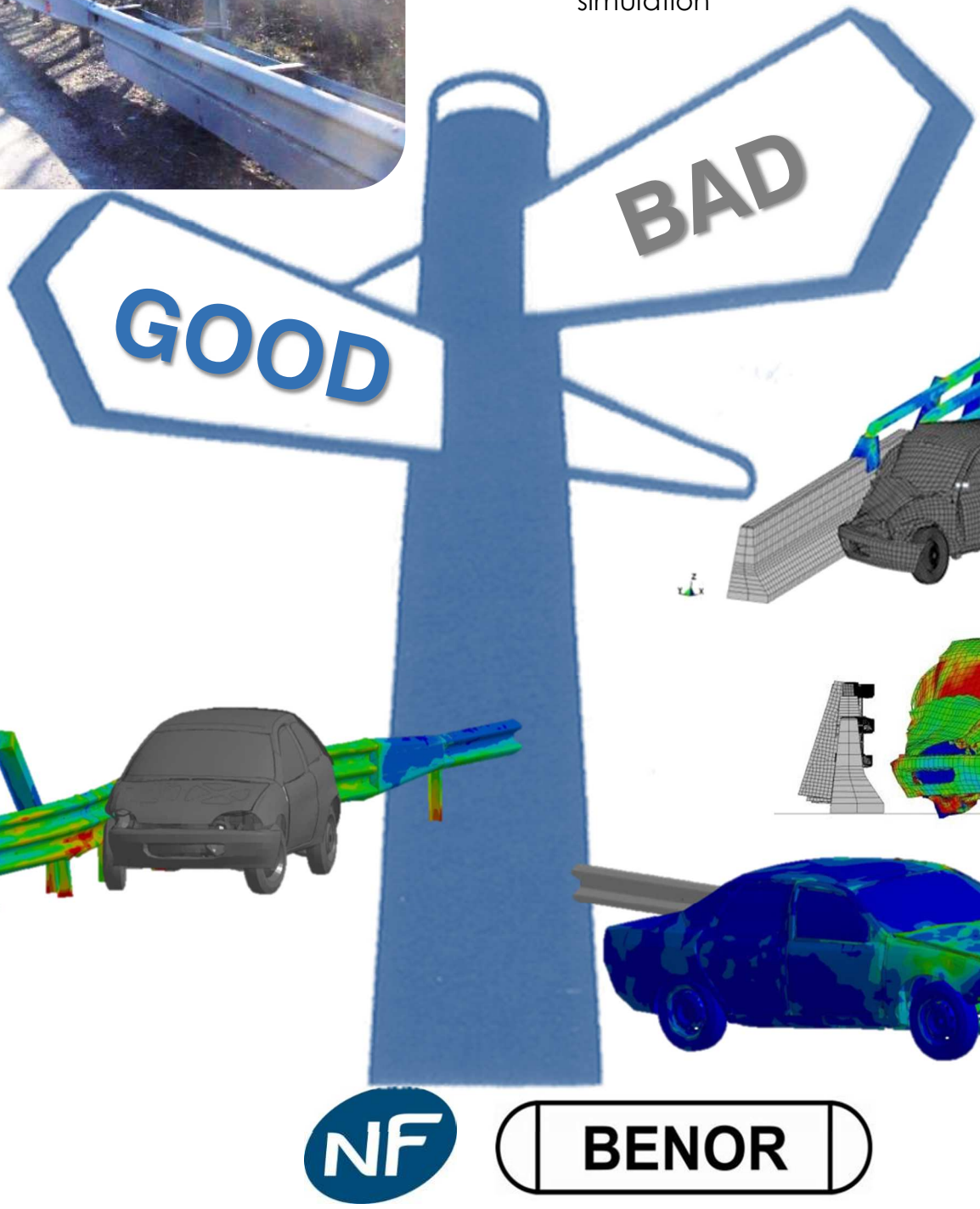
Classes	Forces
hard	16 < F ≤ 25 kN
medium	10 < F ≤ 16 kN
soft	F ≤ 10 kN



3. Adaptation to Site Conditions

Transition between systems

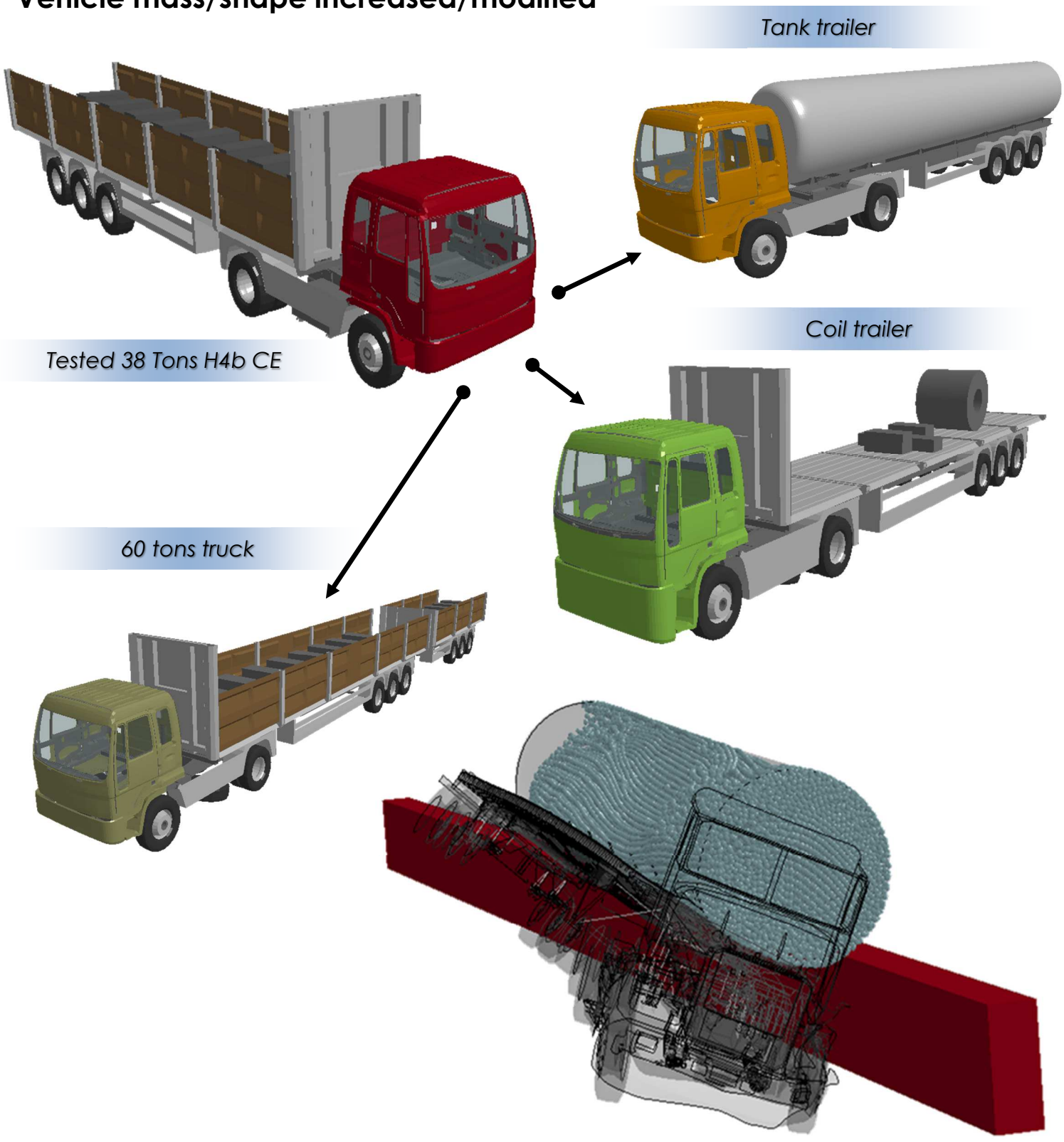
- Simulation reports valid for NF Certification or equivalent
- Possibility for GDTech to review customer's simulation



NF BENOR

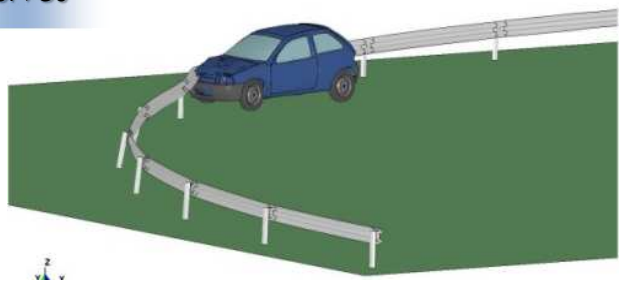
3. Adaptation to Site Conditions

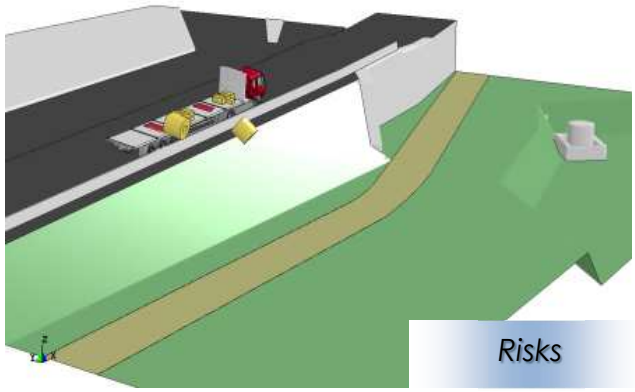
Vehicle mass/shape increased/modified



3. Adaptation to Site Conditions

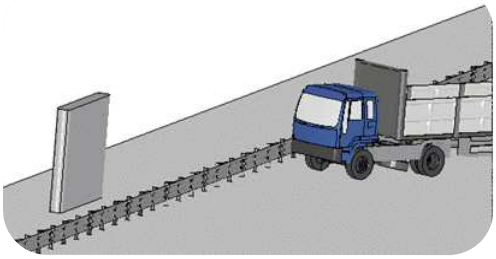
Curves



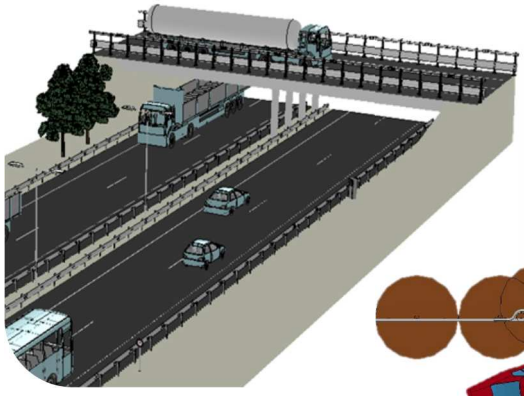


Risks

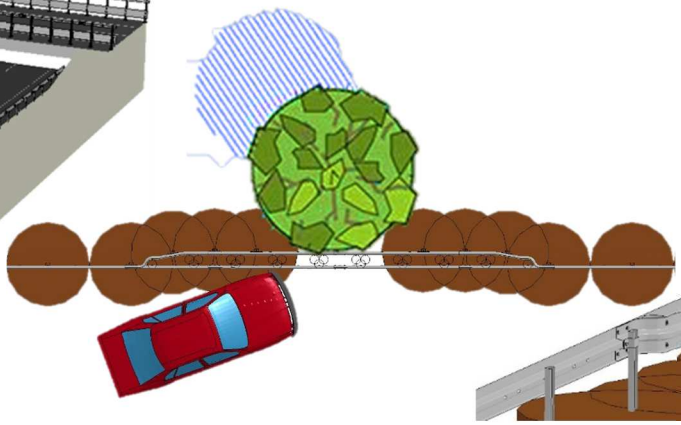
Impact on bridge pile



Steps

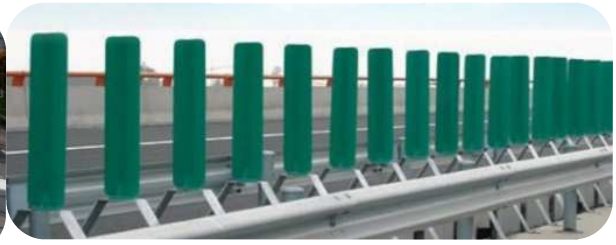


Tree protection



Wiring

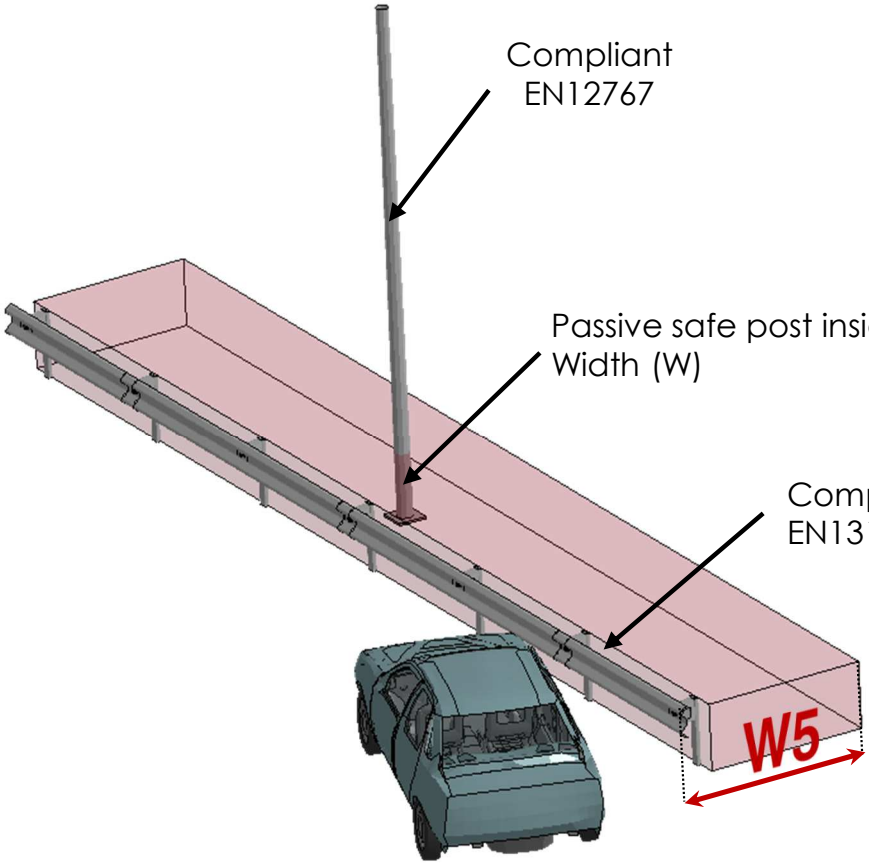
Anti Dazzle

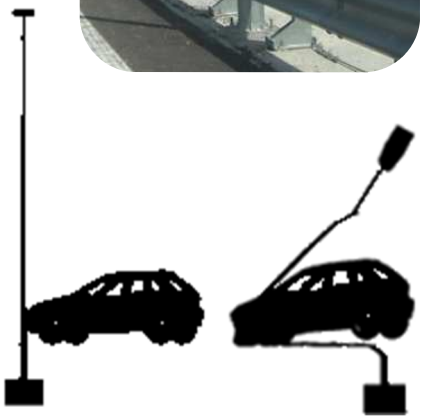


Possibility to investigate & solve many roadside real problems.

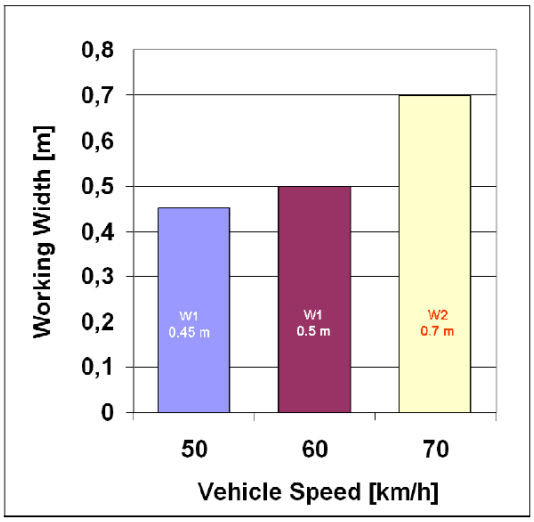
3. Adaptation to Site Conditions

Passive safe posts inside the W:





Speed to get W1 when only N2 W2 are available:



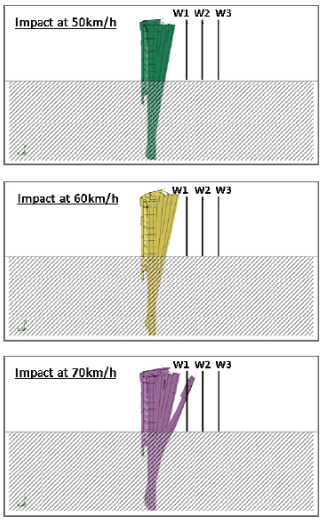
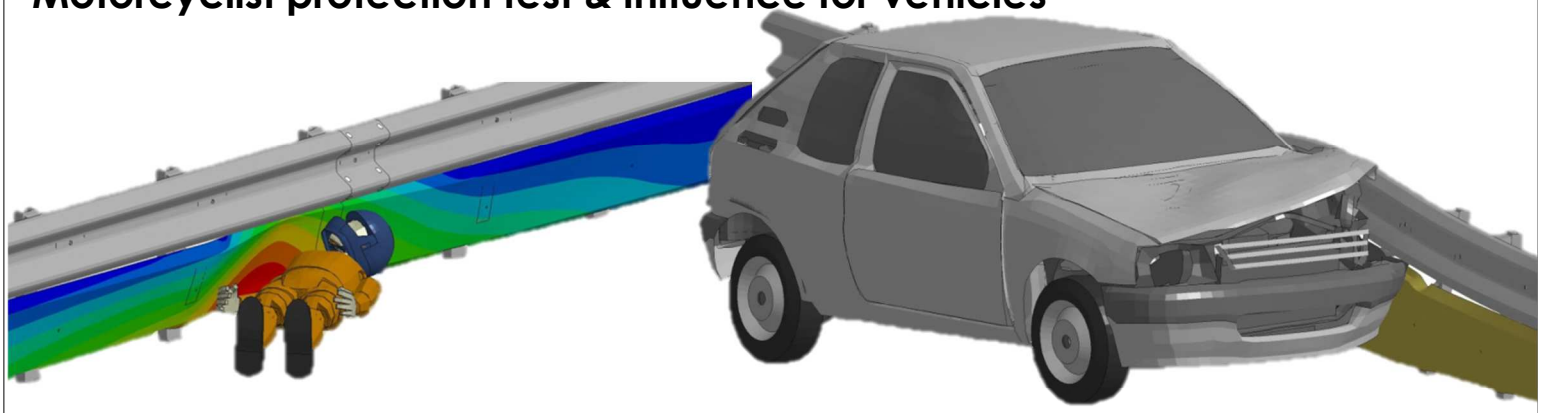
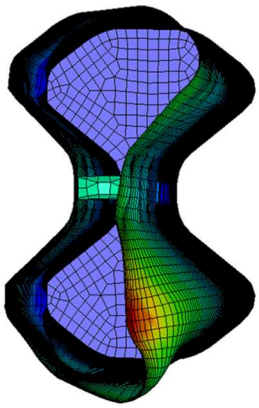


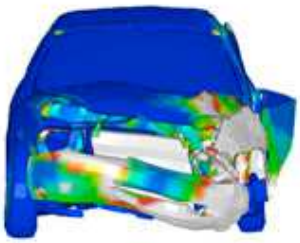
Figure 11: WW values from the simulation with reduced speed

3. Adaptation to Site Conditions

Motorcyclist protection test & influence for vehicles



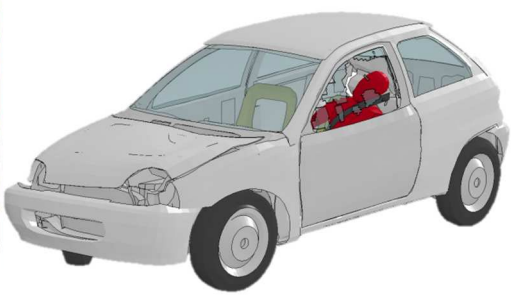




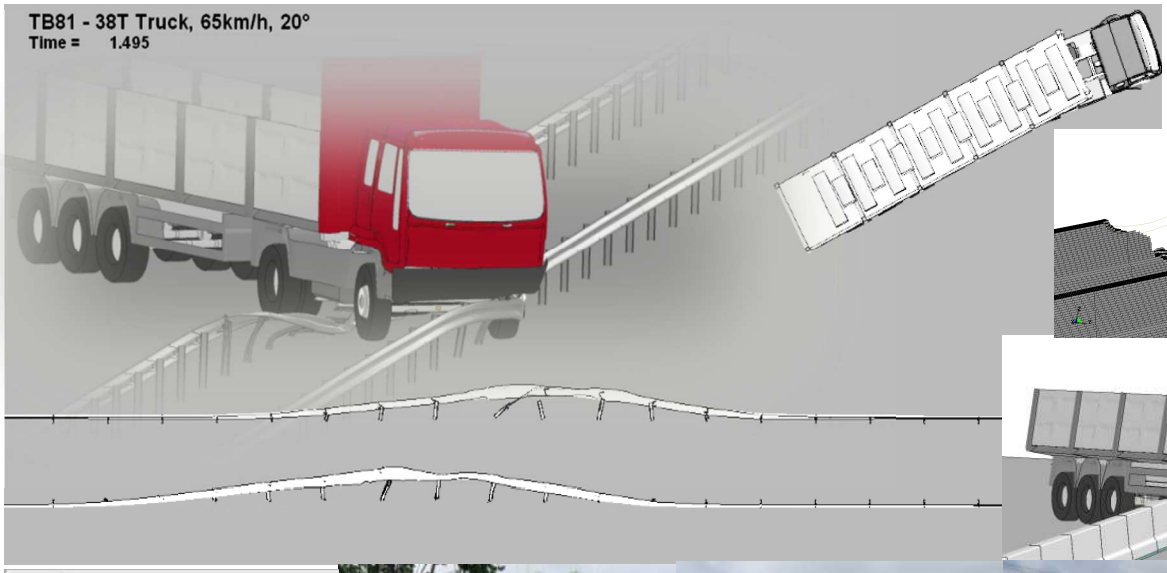
4. ACCIDENT RECONSTRUCTION

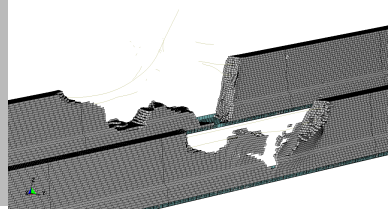
Activities		GDTech
A-	On-site measurements and photographs, 3D scan of vehicle deformations / obstacles	✗ / ✓
B-	Analysis based on analytical calculation (energy balance, ...) and the experiment	✗
C-	Quick « Accidenta Report » compare to more 6000 real crash-test	✓
D1-	Read and interpret the "black boxes of the vehicle" to confirm (or not) the conclusion of B and obtain input data for E and F;	✓
D2-	CDR case sales and training for its use	✓
E-	PC-crash simulation to rebuild the accident	✓
F-	LS-Dyna simulation to analyze cases that are more difficult to solve (involving road equipment, etc.)	✓
G-	Realistic visualization of accident situations	✓
H-	Execute a real crash reproducing the conditions of the accident	✓

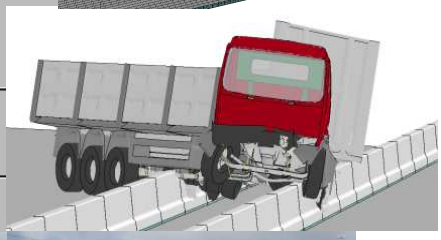
Standard & Tailored test

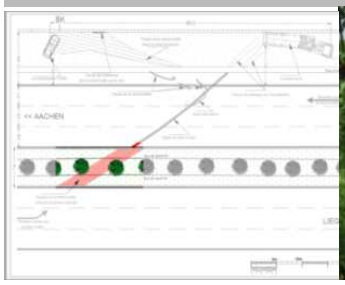


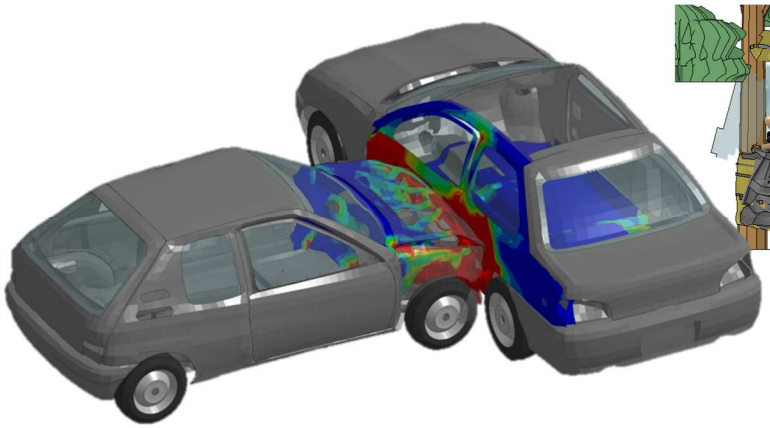
4. Accident Reconstruction

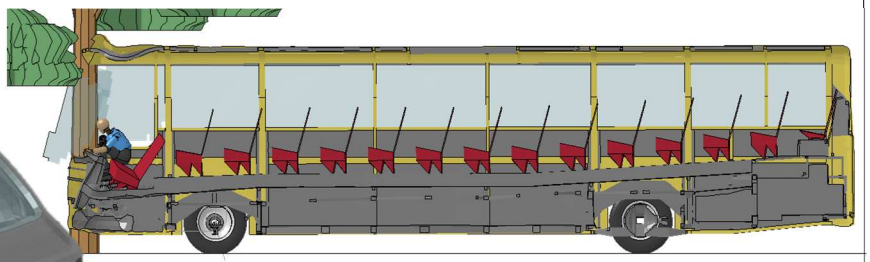


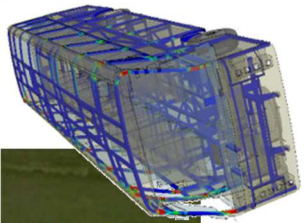


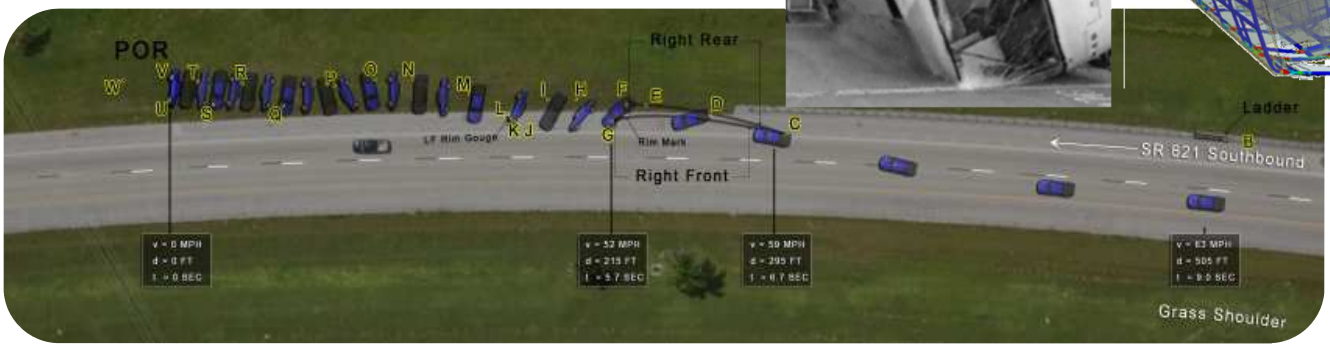












5. Training Sessions

Customized program in collaboration with local players

A Workshop on Vehicle Restraint Systems (VRS) — ☐ 1,5 day

- International Standards and focus on European ones and updates
- From perspective to performance standards: national examples
- Performance standard for safer and more economical products:
  - Longitudinal barriers
  - Crashworthy terminals
  - Crash cushions
  - Motorcyclists and VRS
  - Energy absorbing poles
- Answers to specific situations:
  - Safety barriers in curves
  - Transitions
  - Soil influence & cliffs
  - Bridge safety barriers
  - Special zones protections
- National regulations on uncovered requirements by EN 1317
- Regulations on installation & repair: national examples

B Workshop on local problematics on VRS — ☐ 0,5 day

- To be discussed

C Workshop on Work Zones Safety — ☐ 0,5 day

- Regulations on lateral protection: national examples
- Truck mounted attenuators & truck lateral protection
- Traffic management for work zones

D Workshop on Traffic Management & Accidents — ☐ 0,5 day

- Traffic management
- Accident reconstructions

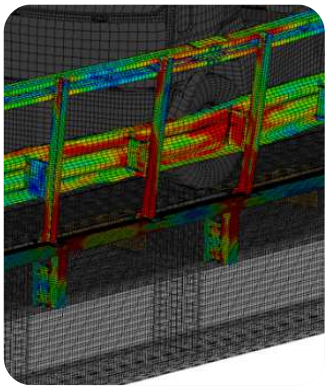
BRIDGE BARRIER UPGRADING

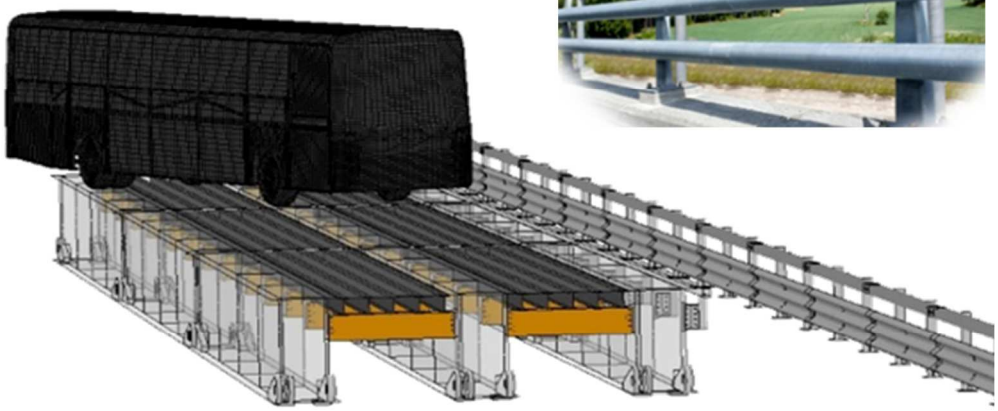
NEW EN1317

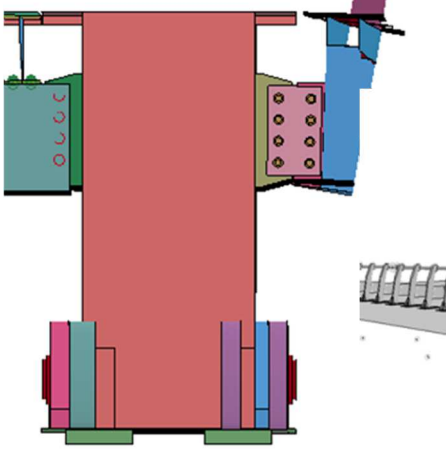
Mandatory to use CE crash-tested barriers on bridges

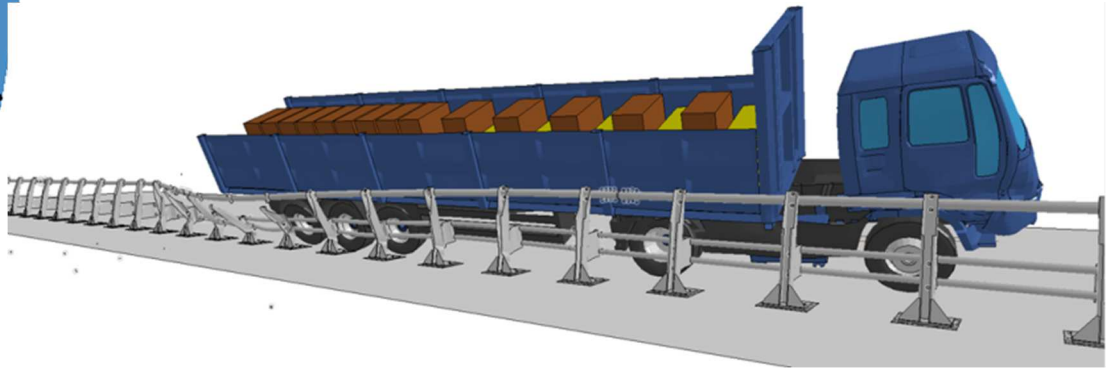
HOW TO COLLABORATE?

- Upgrade your current barriers to fit with EN1317
- Choose one existing and already tested safety barriers and develop an effective anchoring solution



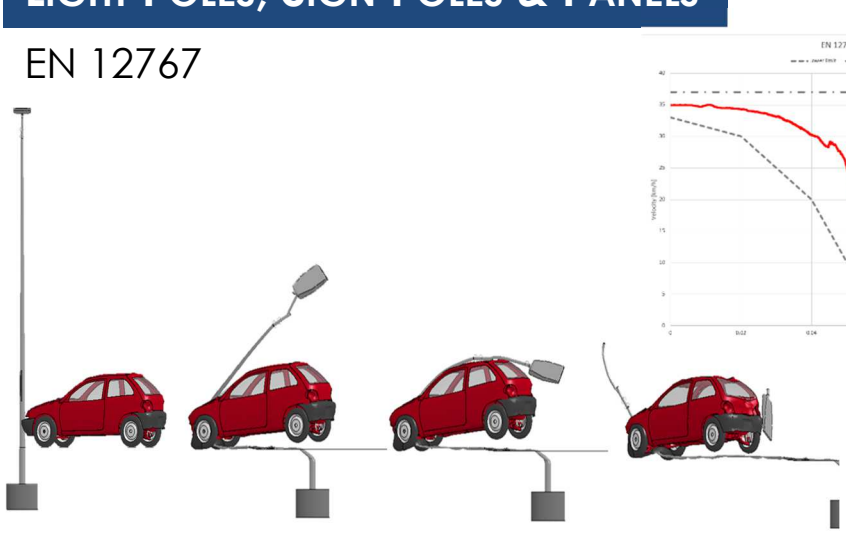


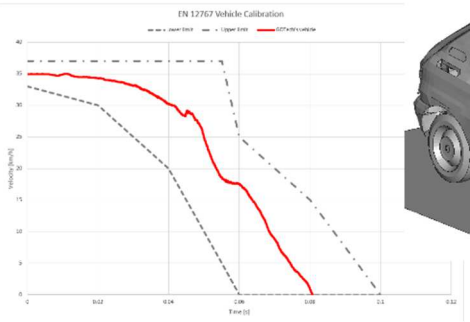


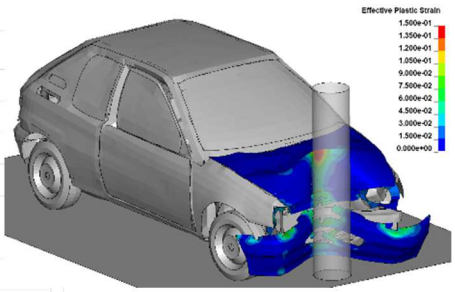


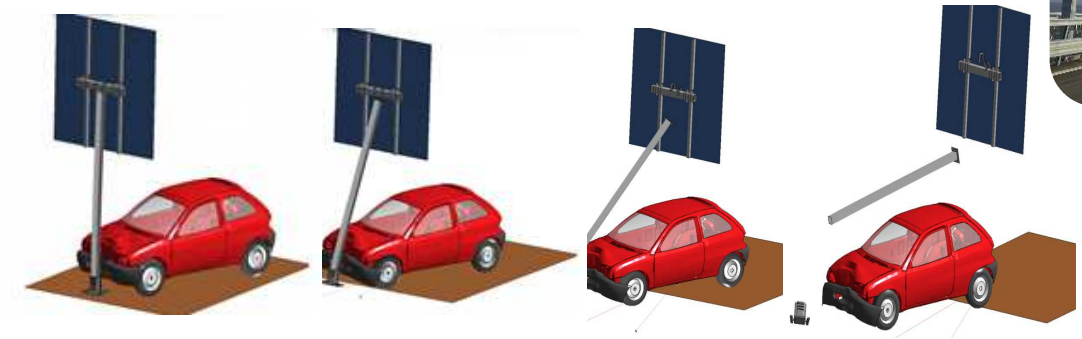
LIGHT POLES, SIGN POLES & PANELS

EN 12767

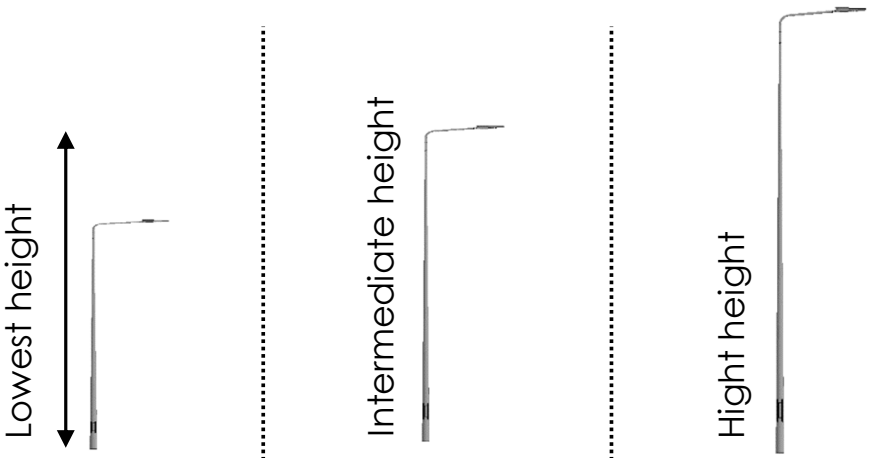








SIMULATION FOR CERTIFICATION OF FAMILIES OF PRODUCT

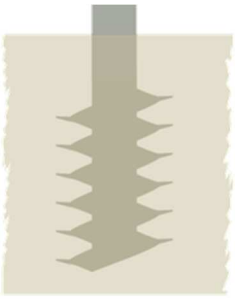


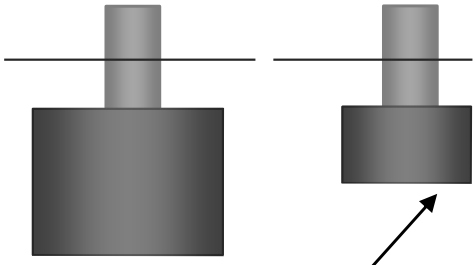
Light vehicle	Real crash	Simulation*	
Heavy vehicle			Real crash

* Using models that are proved to reproduce the real crash tests

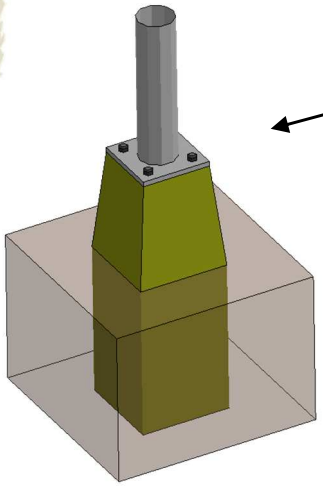
PARTICULAR INSTALLATION

Special anchoring

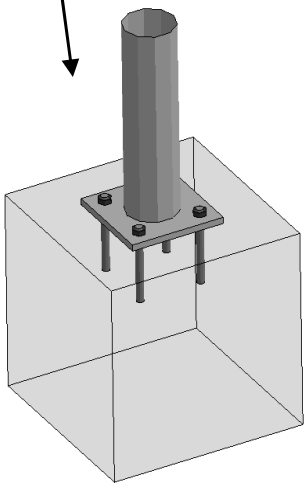


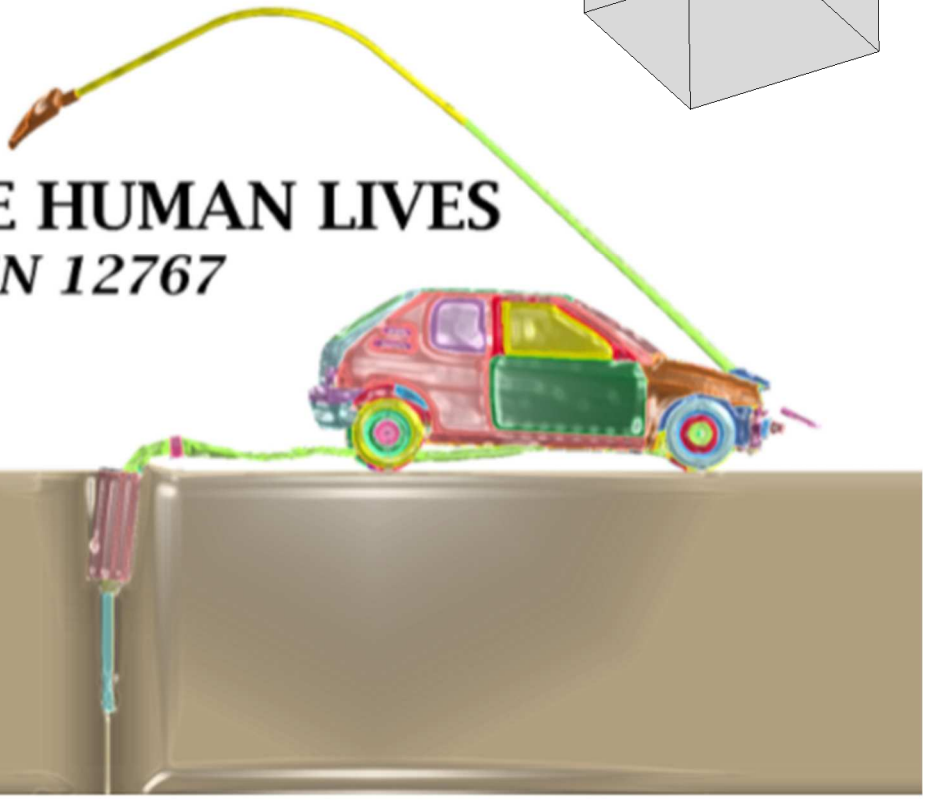


Crash-test Anchoring



Different concrete masses





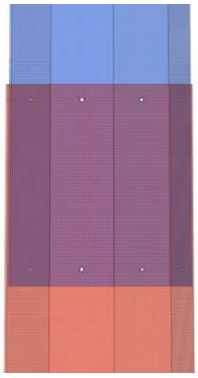
Example of a product development made for a customer

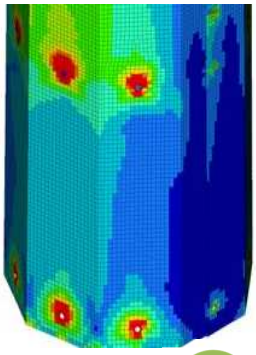
WIND CALCULATION OF POLES & PANELS

Analytic model

≠

Numerical model





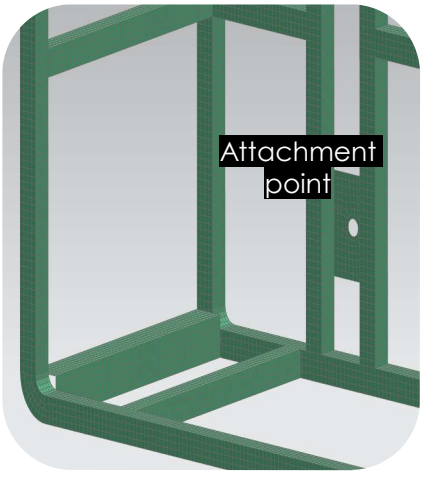
Fast & simple but could be far from reality

Could be more accurate

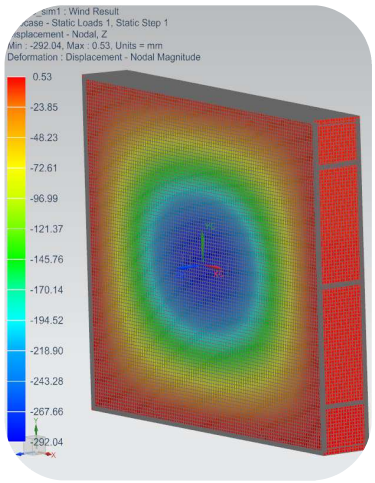
Classe de vent	Terrain de classe 0 (côte)**	Terrain de classe 2 (intérieur du pays)***
Hauteur* ≤ 3.5 m	WL4	
Hauteur* ≤ 4.5 m		WL3
Hauteur* > 3.5 m	WL5	
Hauteur* > 4.5 m		WL4
(*) Hauteur du centre de gravité géométrique de l'ensemble des surfaces des panneaux		
(**) selon ce critère, il est entendu par classe 0 : la zone côtière jusqu'à 2 km à l'intérieur des terres et 2 km depuis le bord de l'Escaut autour d'Anvers (depuis Kallo jusqu'à la frontière néerlandaise).		
(***) Les documents contractuels définissent à quelle classe de terrain il faut faire référence.		

Tableau 6 : exigences pour la charge du vent

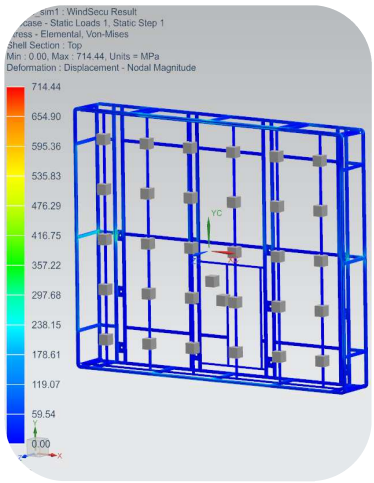
Mesh



Movement



Von Mises stress



PAS 68
PAS 69
ASTM F2656
CWA 16221
IWA 14

Adaptation

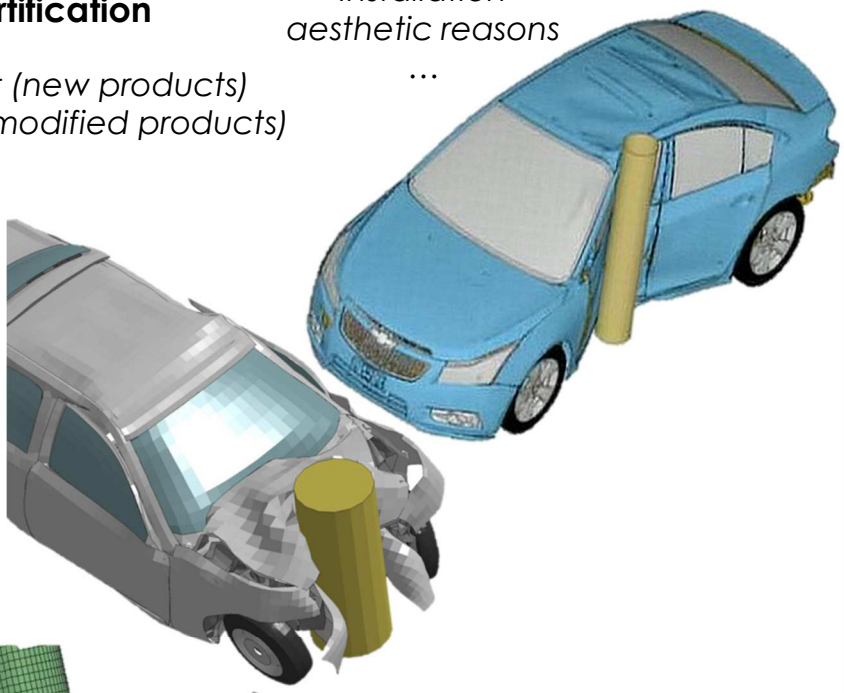
production
Installation
aesthetic reasons
…

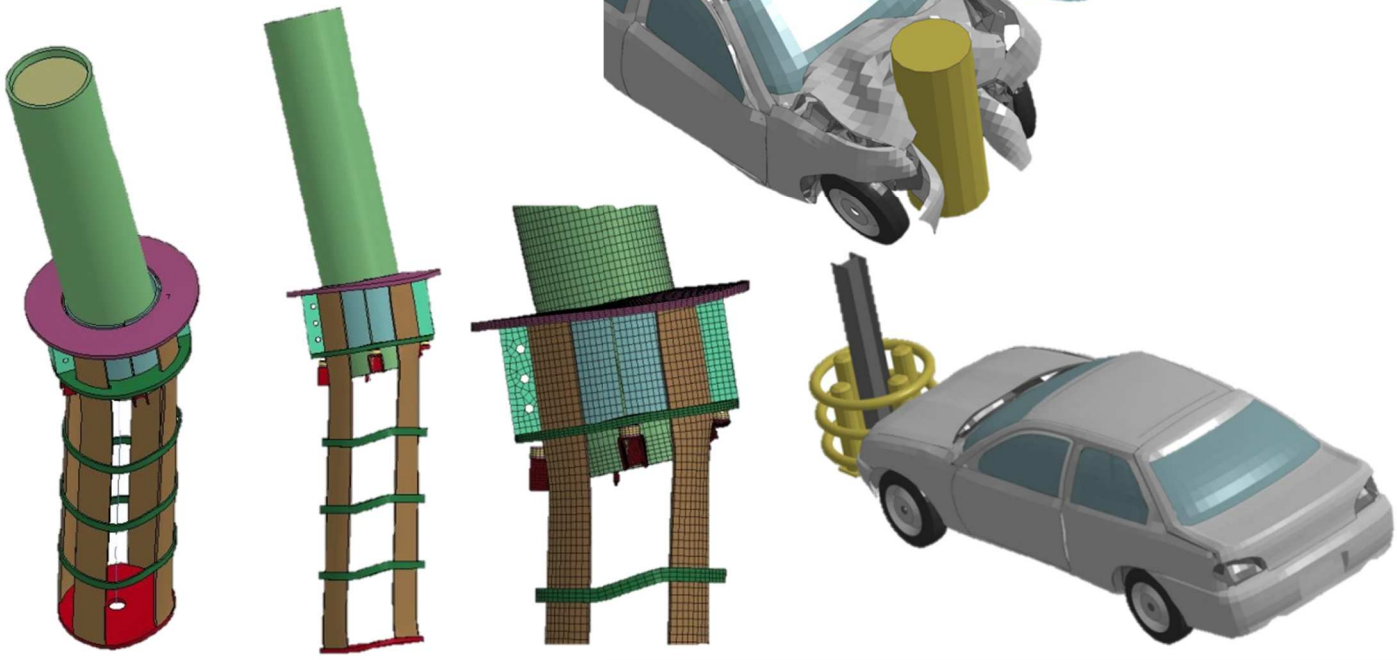
Certification

Crash test (new products)
Simulation (modified products)

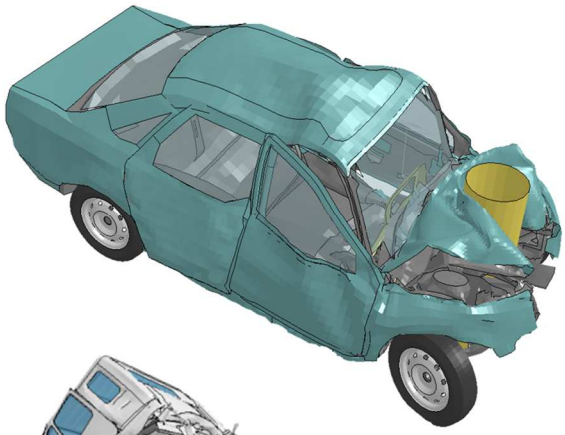
New Product Development

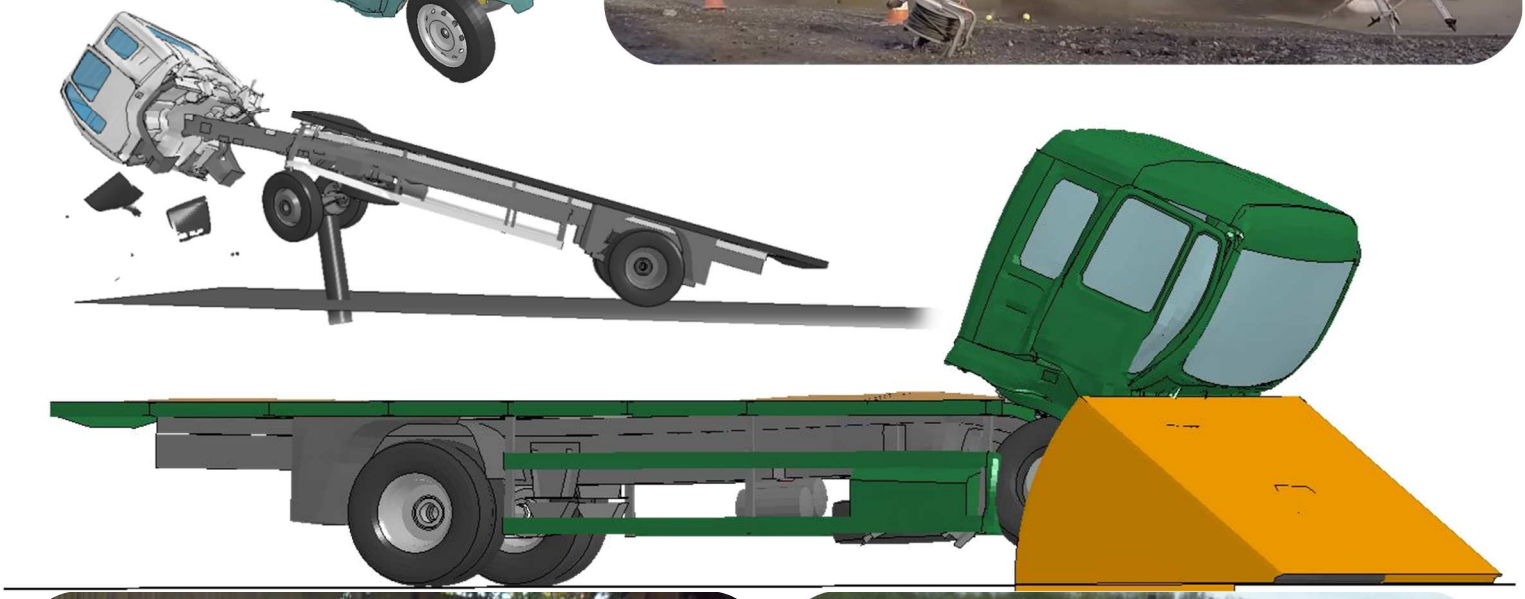
Calculation prior crash test





PAS 68
PAS 69
ASTM F2656
CWA 16221
IWA 14

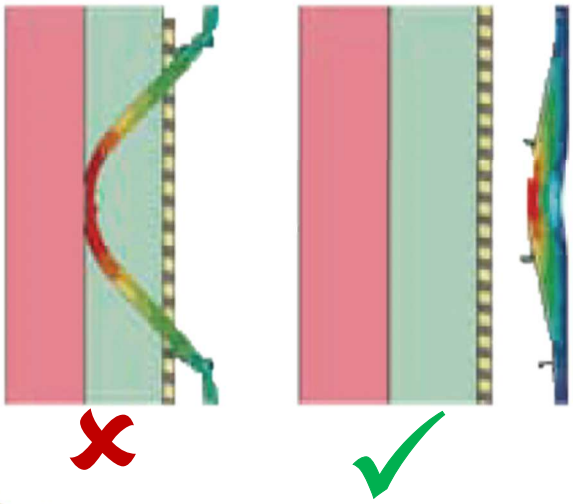




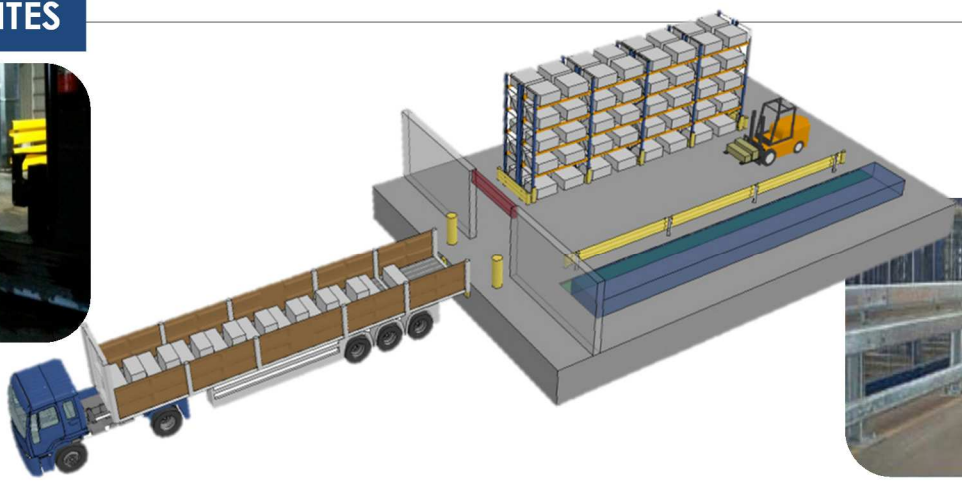
SECURITY PRODUCTS

LOW DEFORMATION & MAINTENANCE

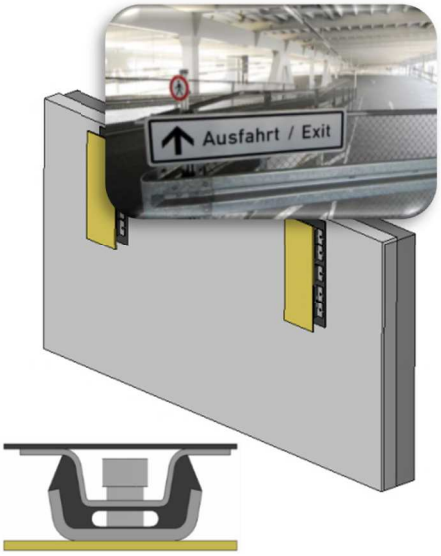
Less maintenance costs with more adapted & safe solutions

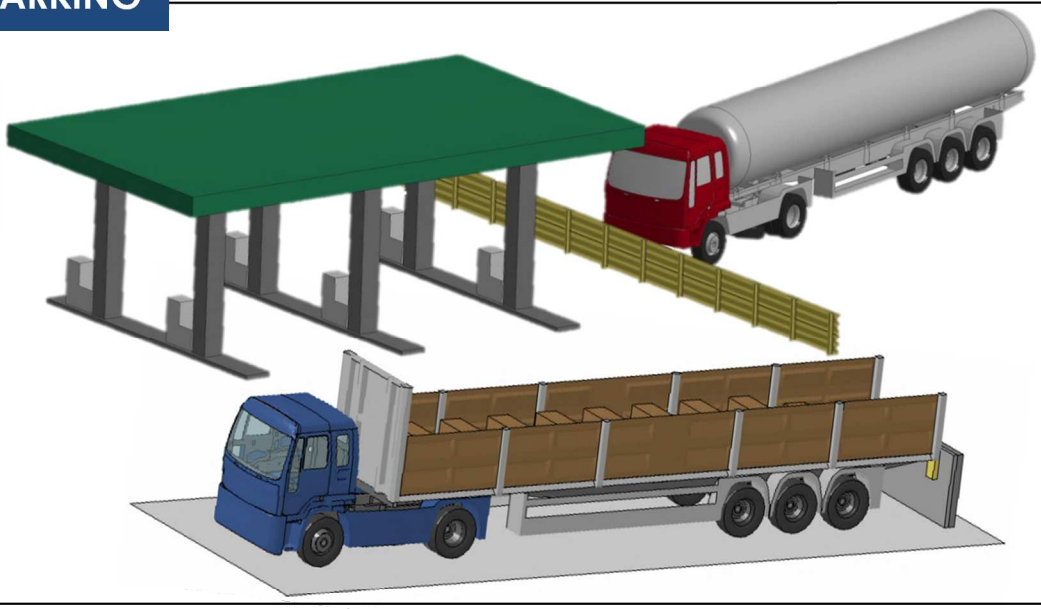


INDUSTRIAL SITES



SERVICE STATION & PARKING

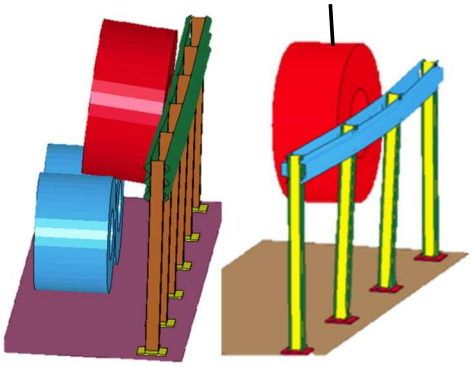




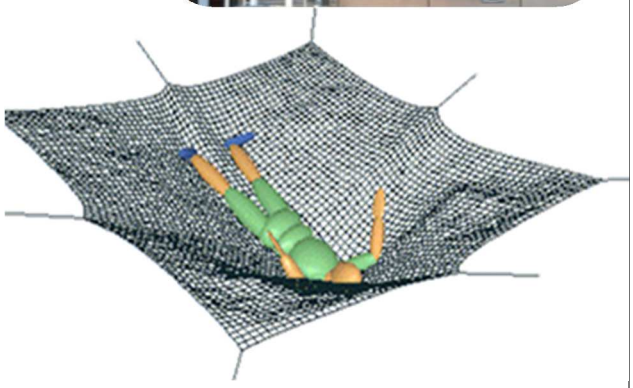
WALKWAY PROTECTIONS

PROTECTION FOR FALLING

Objects

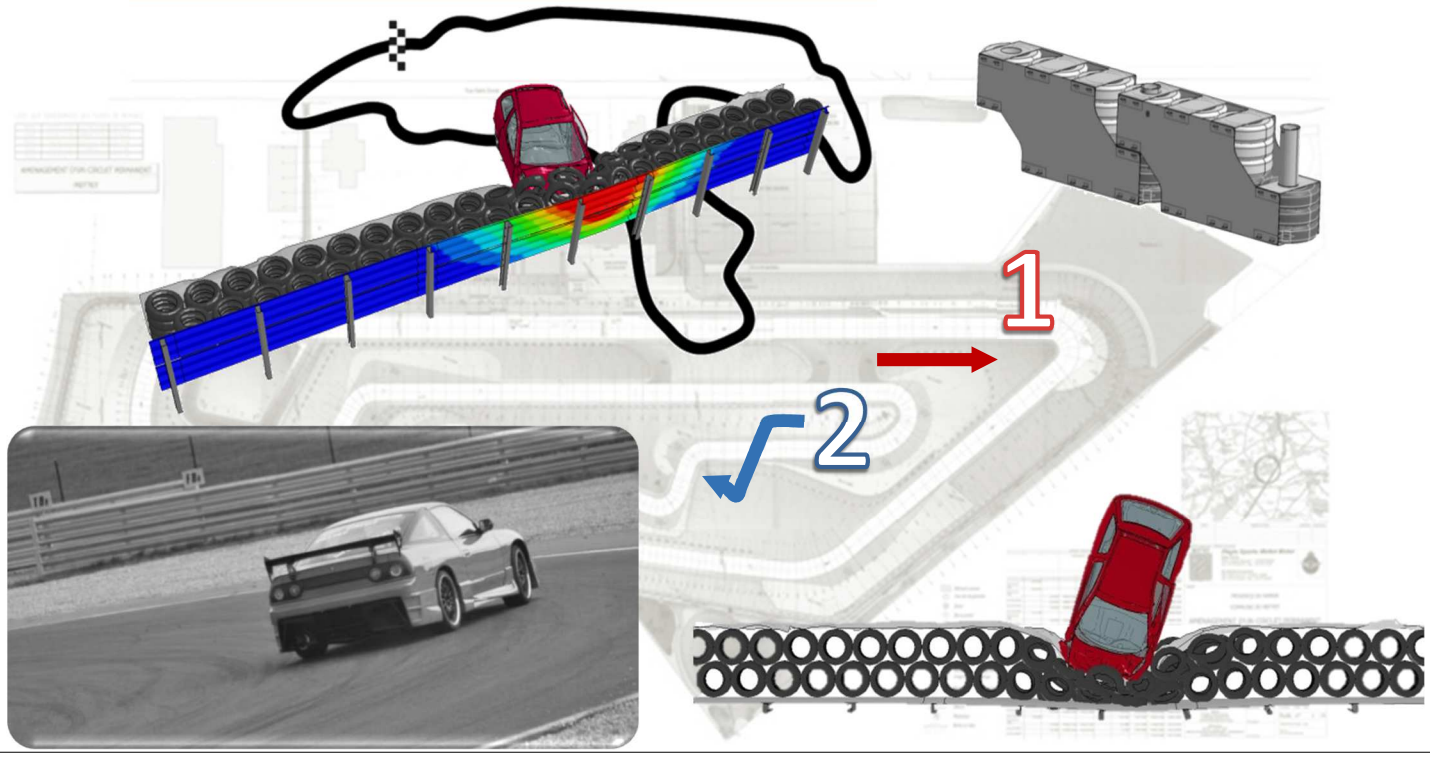


People

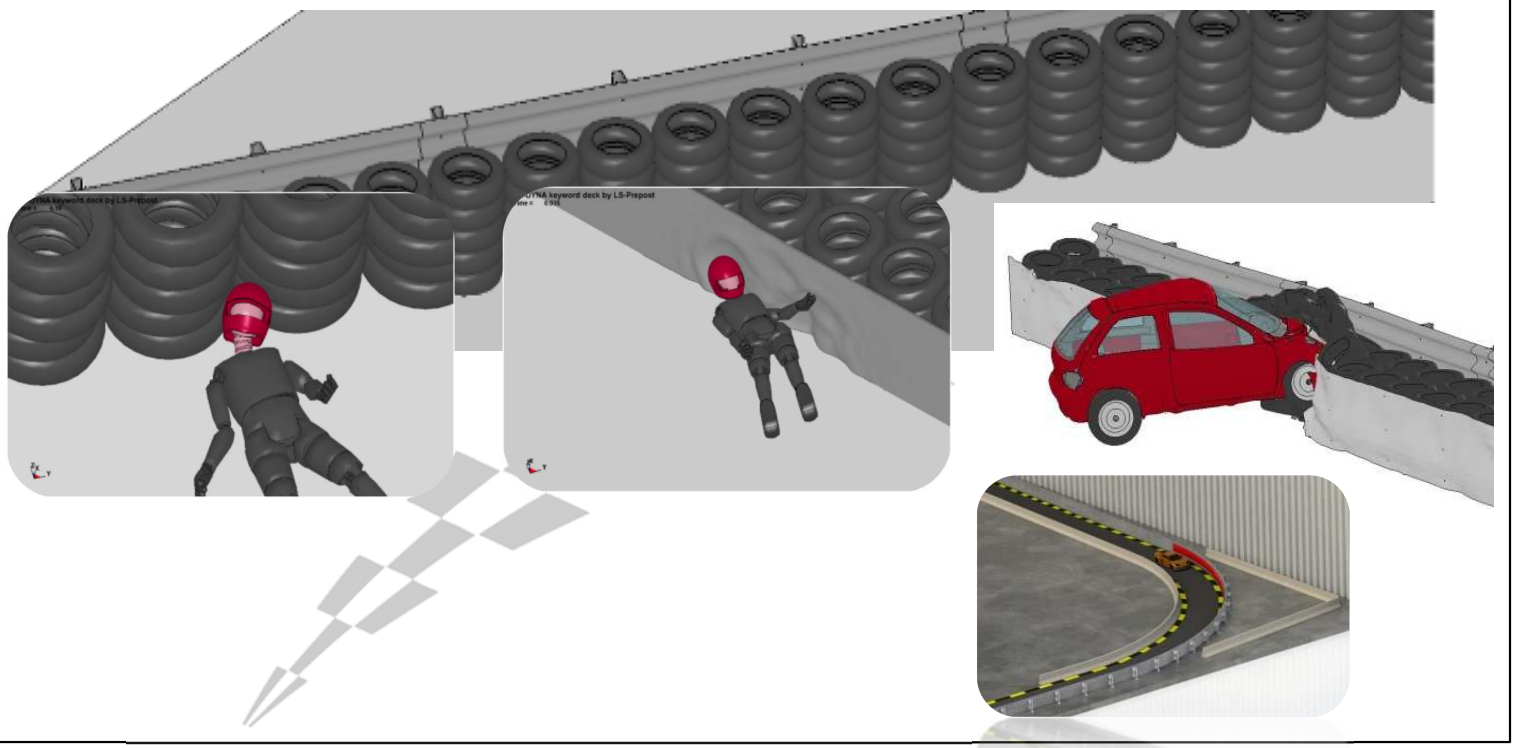


LOGISTICS

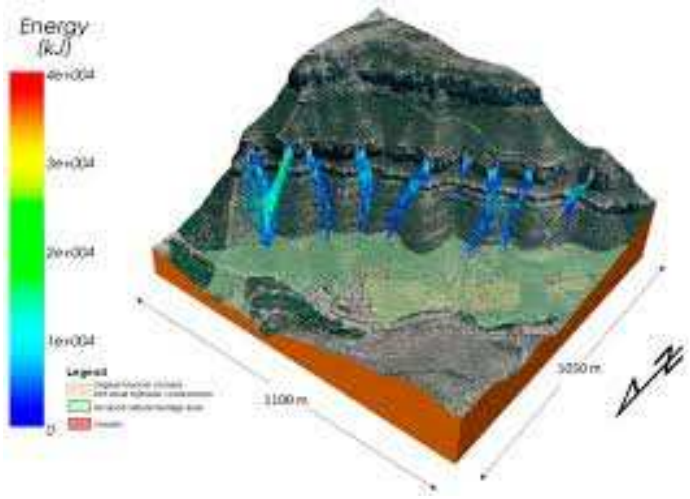
ANALYZE OF THE TRAJECTORIES, MASSES & SPEEDS



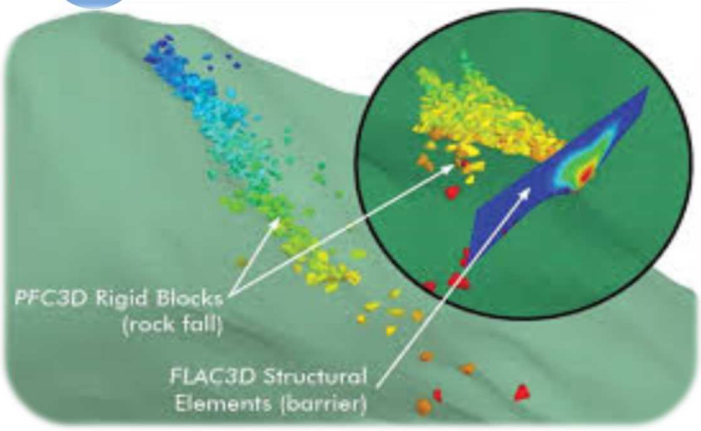
DESIGN OF APPROPRIATE PROTECTION FOR CARS & MOTORCYCLISTS



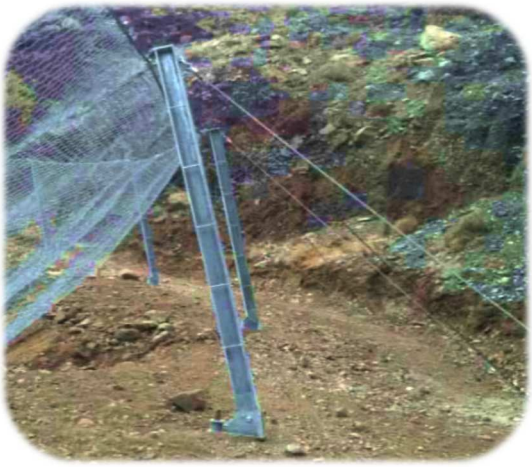
New product development



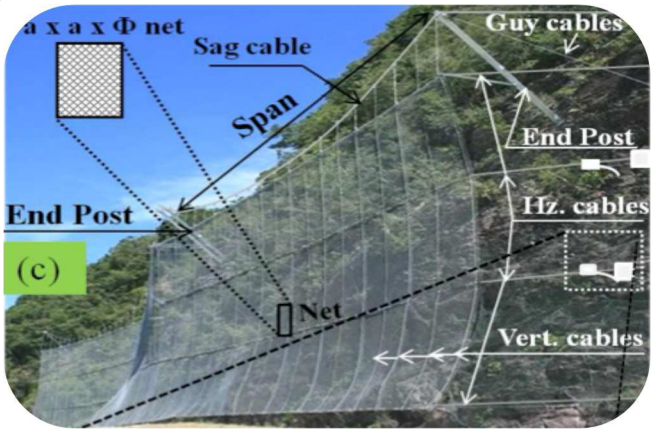
Certification



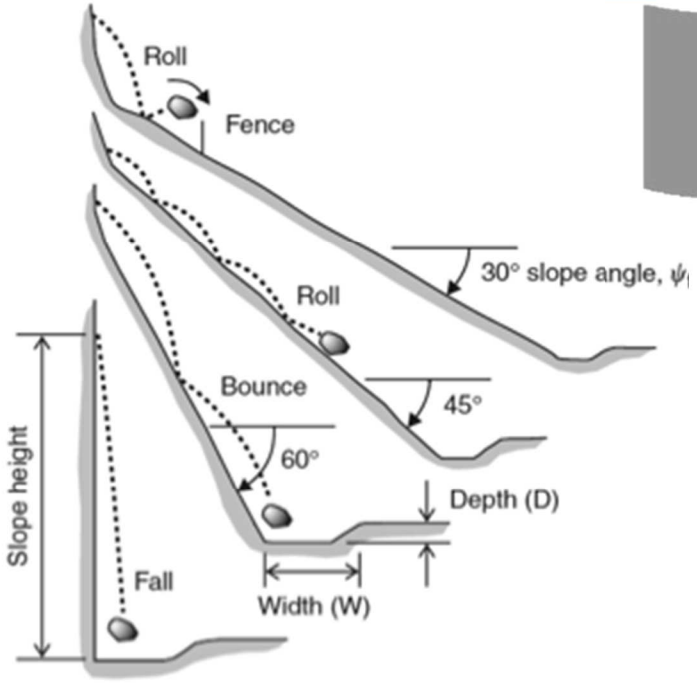
CE
EAD340059

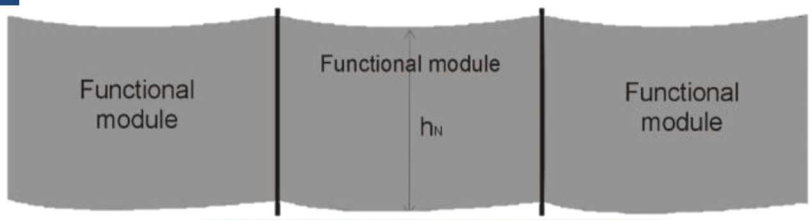


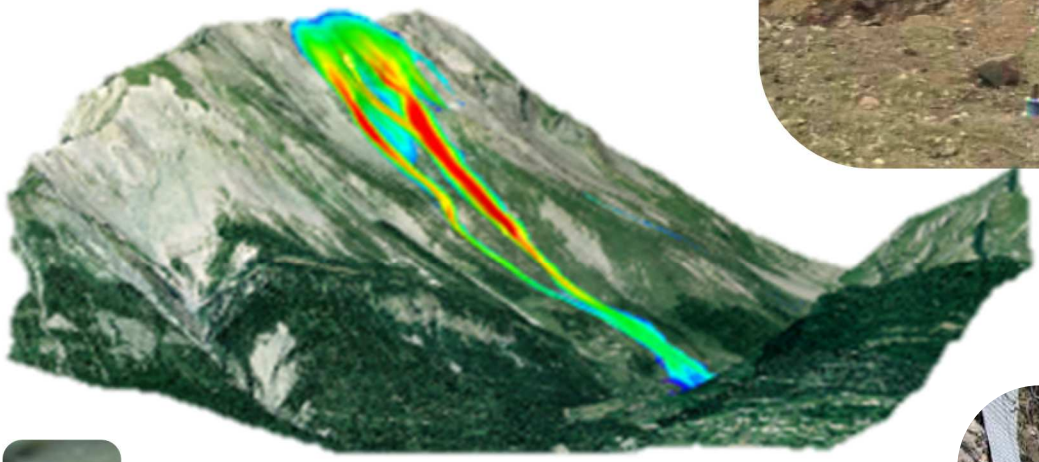
Adaptation to site condition



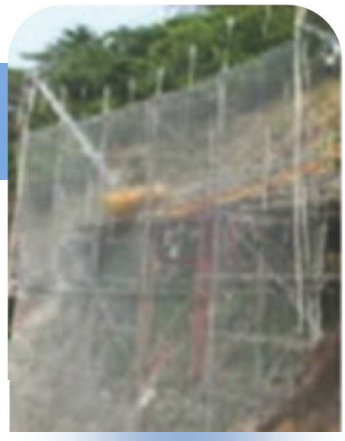
2. CERTIFICATION (EAD340059)



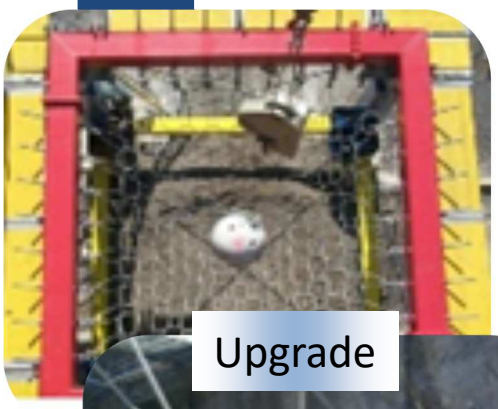




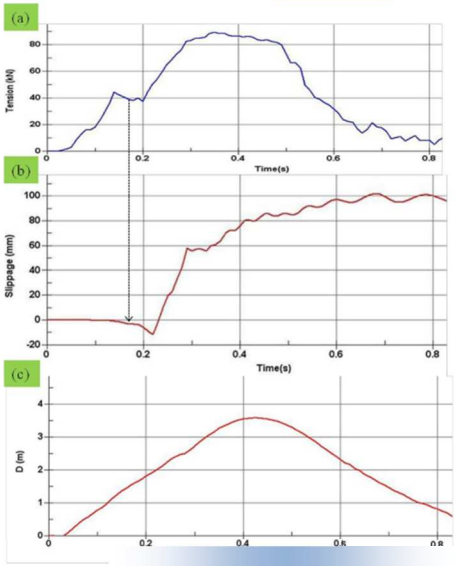
3. ADAPTATION TO SITE CONDITION



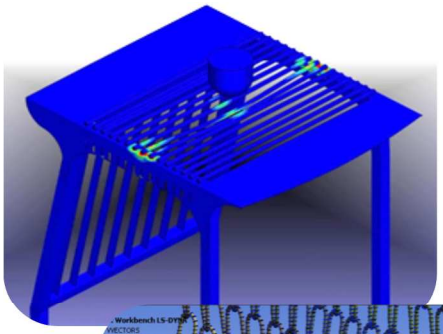
Real tests

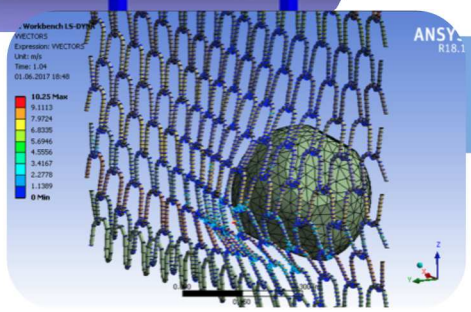


Upgrade



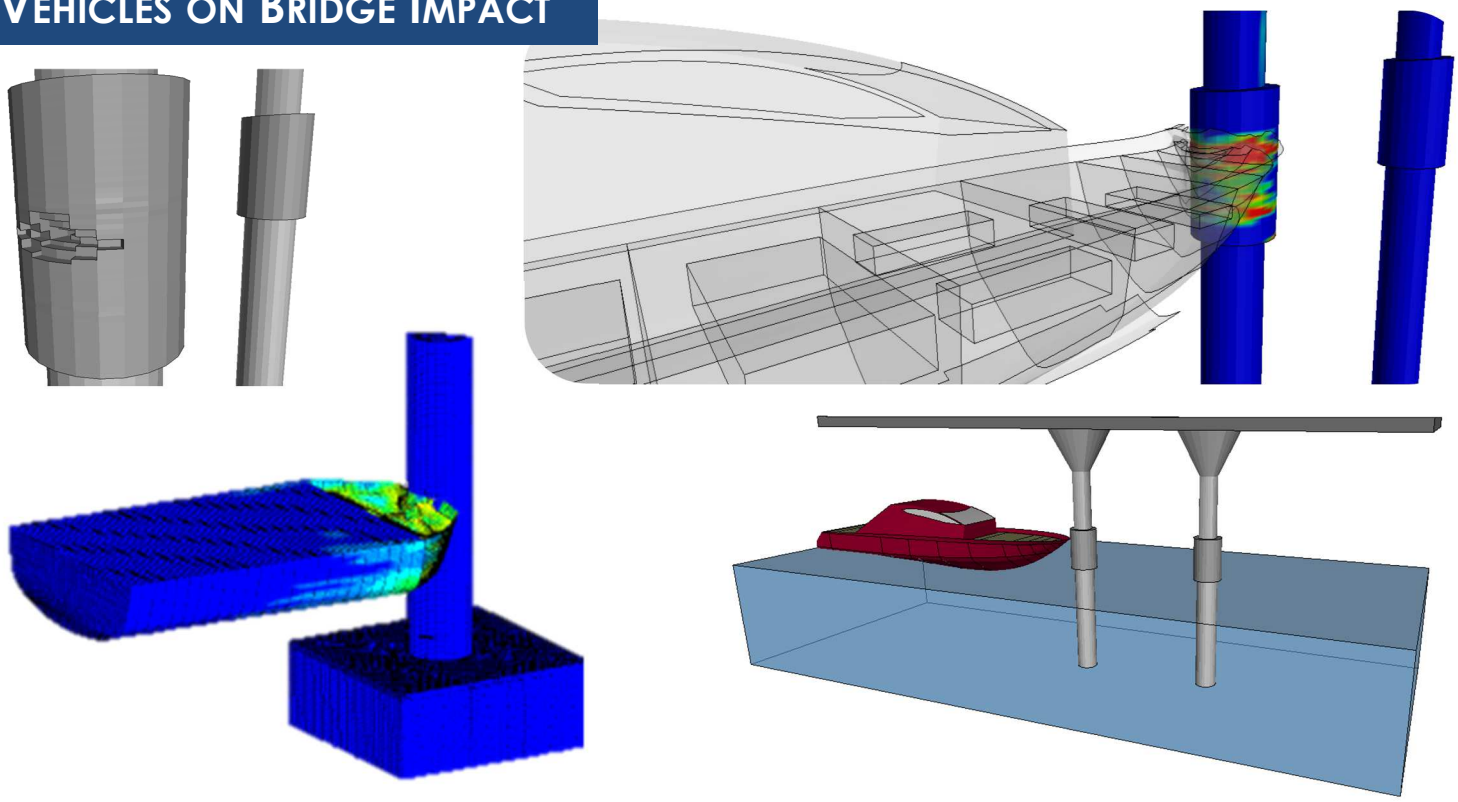
Results analysis



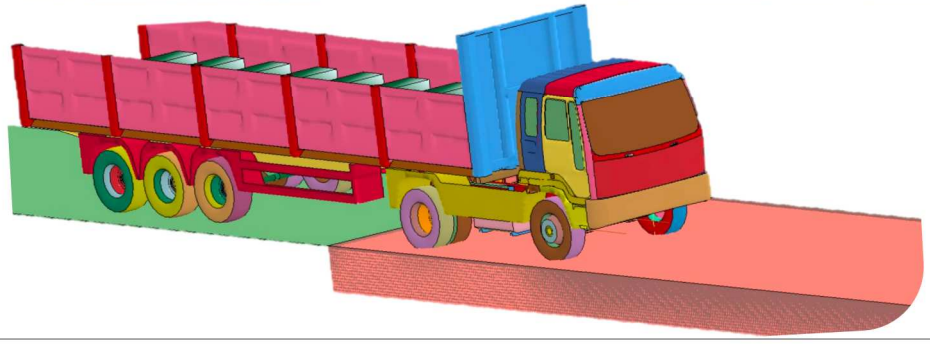


Modelling

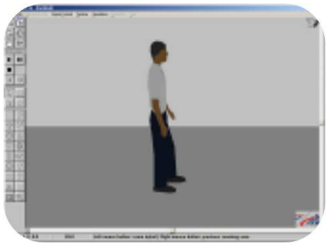
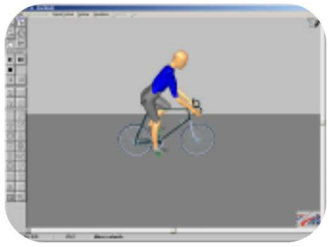
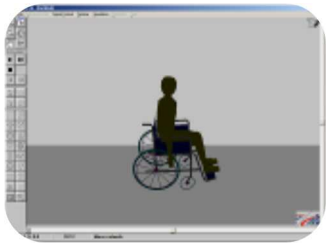
VEHICLES ON BRIDGE IMPACT



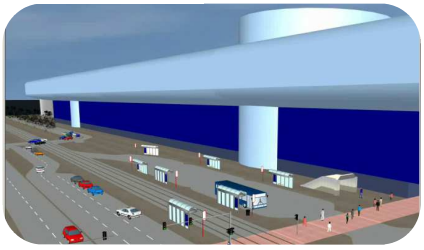
EMERGENCY RAMP



TRAFFIC CALCULATION

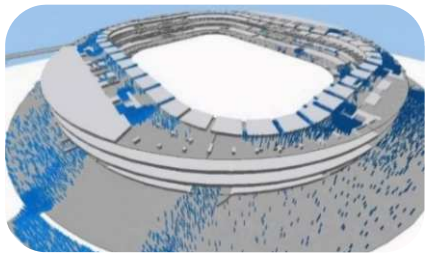
Analysis, optimization and simulation

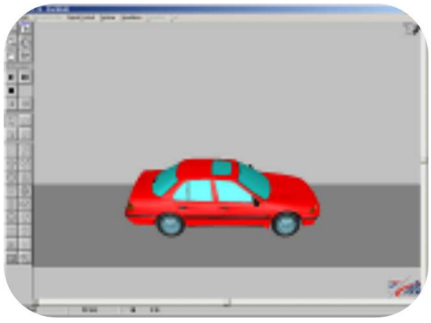
From huge avenues to details

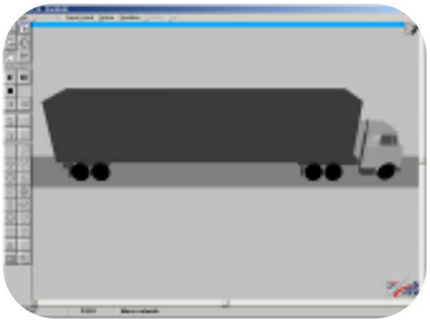

Manage crisis scenarios

Design emergency exits to guarantee the quickest and safest evacuation of large buildings and events



Vehicles





EN 1317: RRS EUROPEAN STANDARD

Containment level

Table 1 — Vehicle impact test descriptions

Test	Impact speed km/h	Impact angle °	Total mass kg	Type of vehicle
TB 11	100	20	900	Car
TB 21	80	8	1 300	Car
TB 22	80	15	1 300	Car
TB 31	80	20	1 500	Car
TB 32	110	20	1 500	Car
TB 41	70	8	10 000	Rigid HGV
TB 42	70	15	10 000	Rigid HGV
TB 51	70	20	13 000	Bus
TB 61	80	20	16 000	Rigid HGV
TB 71	65	20	30 000	Rigid HGV
TB 81	65	20	38 000	Articulated HGV

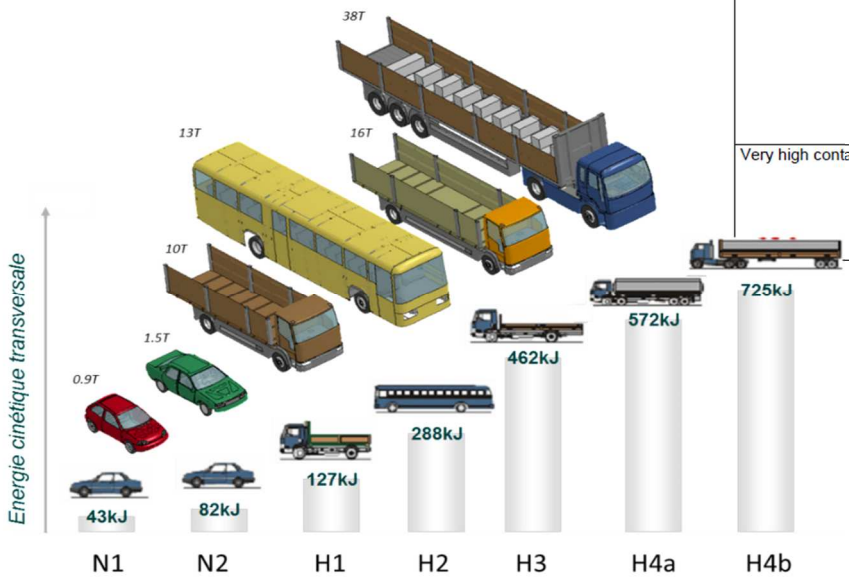


Table 2 — Containment levels

Containment levels			Acceptance test
Low angle containment	T1		TB 21
	T2		TB 22
	T3		TB 41 and TB 21
Normal containment	N1		TB 31
	N2		TB 32 and TB 11
Higher containment	H1		TB 42 and TB 11
	L1		TB 42 and TB32 and TB 11
	H2		TB 51 and TB 11
	L2		TB 51 and TB32 and TB 11
	H3		TB 61 and TB 11
	L3		TB 61 and TB32 and TB 11
Very high containment	H4a H4b		TB 71 and TB 11 TB 81 and TB 11
	L4a L4b		TB 71 and TB32 and TB 11 TB 81 and TB32 and TB 11

Acceleration severity index

Table 3 — Impact severity levels

Impact severity level	Index values		
A	ASI ≤ 1,0	and	THIV ≤ 33 km/h
B	ASI ≤ 1,4		
C	ASI ≤ 1,9		

Working Width (W) and Vehicle Intrusion (VI)

Classes	Levels of normalized working width (m)	Levels of normalized vehicle intrusion (m)
1	$W_N \leq 0,6$	$VI_N \leq 0,6$
2	$W_N \leq 0,8$	$VI_N \leq 0,8$
3	$W_N \leq 1,0$	$VI_N \leq 1,0$
4	$W_N \leq 1,3$	$VI_N \leq 1,3$
5	$W_N \leq 1,7$	$VI_N \leq 1,7$
6	$W_N \leq 2,1$	$VI_N \leq 2,1$
7	$W_N \leq 2,5$	$VI_N \leq 2,5$
8	$W_N \leq 3,5$	$VI_N \leq 3,5$
9	/	$VI_N \geq 3,5$

NCHRP350

Test Level	Test Designation	Impact Conditions		
		Vehicle	Nominal Speed (km/h)	Nominal Angle ɵ (deg)
1	1-10 1-11	820C 2000P	50 50	20 25
2	2-10 2-11	820C 2000P	70 70	20 25
3	3-10 3-11	820C 2000P	100 100	20 25
4	4-10 4-11 4-12	820C 2000P 8000S	100 100 80	20 25 15
5	5-10 5-11 5-12	820C 2000P 36000V	100 100 80	20 25 15
6	6-10 6-11 6-1	820C 2000P 36000T	100 100 80	20 25 15

MASH

Test Level	Test Vehicle Designation and Type	Test Conditions	
		Speed mph (km/h)	Angle (deg.)
1	1100C (Passenger Car) 2270P (Pickup Truck)	31 (50.0) 31 (50.0)	25 25
2	1100C (Passenger Car) 2270P (Pickup Truck)	44 (70.0) 44 (70.0)	25 25
3	1100C (Passenger Car) 2270P (Pickup Truck)	62 (100.0) 62 (100.0)	25 25
4	1100C (Passenger Car) 2270P (Pickup Truck) 10000S (Single Unit Truck)	62 (100.0) 62 (100.0) 56 (90.0)	25 25 15
5	1100C (Passenger Car) 2270P (Pickup Truck) 36000V (Tractor-Van Trailer)	62 (100.0) 62 (100.0) 50 (80.0)	25 25 15
6	1100C (Passenger Car) 2270P (Pickup Truck) 36000T (Tractor-Tank Trailer)	62 (100.0) 62 (100.0) 50 (80.0)	25 25 15

EN 12767: PASSIVE SAFETY OF SUPPORT STRUCTURES

Peugeot 205 *[900kg]*

Table 1 — Impact speeds

Speed class km/h	Impact speeds km/h
50	35 and 50
70	35 and 70
100	35 and 100

Table A.1 — Passive safety performance types

	Alternatives	Clause
Speed class	50, 70, 100	A.2
Energy absorption category	HE, LE or NE	A.3
Occupant safety class	A, B, C, D, E	A.4
Backfill type	S, X, R	5.2.1, Table 1
Collapse mode	SE, NS	A.5
Direction class	SD, BD, MD	A.6

Table A.3 — Table A.3 — Energy absorption categories

Speed class	50	70	100
Energy absorption category	Vehicle exit speed, v_e km/h		
HE	$v_e = 0$	$0 \le v_e \le 5$	$0 \le v_e \le 50$
LE	$0 < v_e \le 5$	$5 < v_e \le 30$	$50 < v_e \le 70$
NE	$5 < v_e \le 50$	$30 < v_e \le 70$	$70 < v_e \le 100$

Table A.4 — Impact severity indexes

Energy absorption categories	Occupant safety class	Speeds			
		Low speed test (35 km/h)		High speed test (50 km/h , 70 km/h , 100 km/h)	
		Maximum values		Maximum values	
		ASI	THIV (in km/h)	ASI	THIV (in km/h)
HE / LE / NE	E	1	27	1,4	44
HE / LE / NE	D	1	27	1,2	33
HE / LE / NE	C	1	27	1	27
HE / LE / NE	B	0,6	11	0,6	11
NE	A	No test required	No test required	No ASI and THIV measurements[a]	

PAS 68 / PAS 69: VEHICLE SECURITY BARRIER SYSTEMS

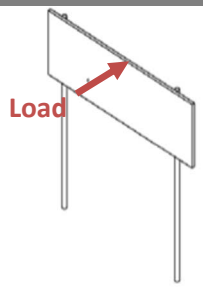
Test vehicle classification		Test classification kg	Test speed km/h	Impact angle
Car	M1	1500	16, 32, 48, 64, 80, 96, 112	0° to 90° in 5 intervals
4x4 pick-up (crew cab design)	N1G	2500	16, 32, 48, 64, 80, 96, 112	0° to 90° in 5 intervals
Day cab vehicles	N1 flat bed (RWD)	3500	16, 32, 48, 64, 80, 96	0° to 90° in 5 intervals
	N2 2-axle rigid	7500	16, 32, 48, 64	0° to 90° in 5 intervals
	N3 2-axle rigid	7500	16, 32, 48, 64, 80	0° to 90° in 5 intervals
	N3 4-axe rigid	30000	16, 32, 48, 64, 80	0° to 90° in 5 intervals

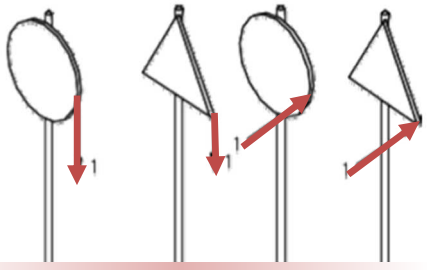
ASTM (US) : VEHICLE SECURITY BARRIER SYSTEMS

Type of test vehicle (Kg)	Condition Designation	Nominal minimum test velocity (Km/h)	Kinetic Energy (KJ)
Small passenger car (C) 1100	C40	65	180
	C50	80	270
	C60	100	420
Pick Up Truck (P) 2300	PU40	65	380
	PU50	80	570
	PU60	100	890
Medium-Duty Truck (M) 6800	M30	50	660
	M40	65	1110
	M50	80	1680
Heavy Goods Vehicle (H) 29500	H30	50	2850
	H40	65	4810
	H50	80	7280

EN 12899-1: ROAD SIGNS MECHANICAL RESISTANCE

Application point





Bi-directional testing

Classe	Wind pressure kN.m⁻²
WL0	Aucune performance déterminée
WL1	0,40
WL2	0,60
WL3	0,80
WL4	0,90
WL5	1,00
WL6	1,20
WL7	1,40
WL8	1,50
WL9	1,60

Table 11 — Maximum temporary deflection – Bending

Class	Bending mm·m⁻¹
TDB0	No performance determined
TDB1	2
TDB2	5
TDB3	10
TDB4	25
TDB5	50
TDB6	100

Table 12 — Maximum temporary deflection – Torsion

Class	Torsion degree·m⁻¹
TDT0	No performance determined
TDT1	0,02
TDT2	0,06
TDT3	0,11
TDT4	0,29
TDT5	0,57
TDT6	1,15

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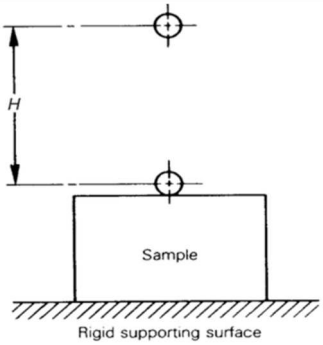
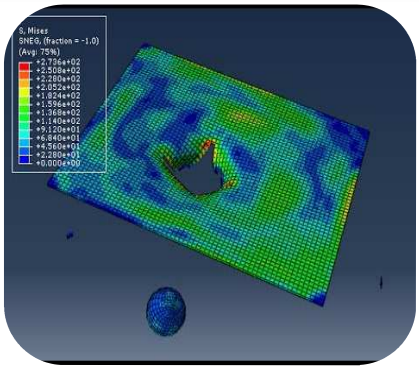
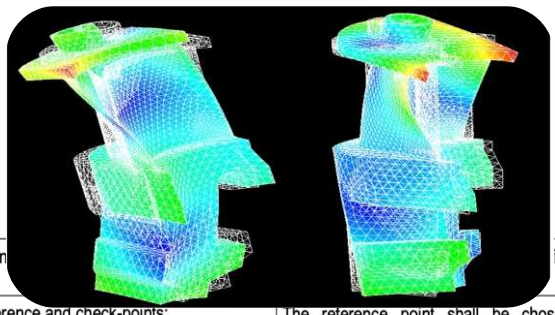
Table 13 — Impact Test

Impact tests shall be conducted on horizontally mounted test module front panel using a steel ball of 50 mm diameter with a mass of 0.51 kg dropped from a height h (1.3 m) to produce an impact energy of 6.5 Nm.
The test module shall be conditioned at a temperature of 20 °C (± 2 °C) and then be subject to three single impacts, at the weakest point on the front panel of the test module, this shall be determined by the Test-House in consultation with the manufacturer.
The test module shall be cooled to a temperature of -5 °C (±2 °C), which shall be maintained for three hours. Whilst the test module is at this temperature it shall be subjected to three single impacts at the weakest point on the front panel of the test module, this shall be determined by the Test-House in consultation with the manufacturer.
After the test the test module front panel or parts of it shall show no damage other then small indentations in the front surface; it shall exhibit no cracking. The test module shall continue to meet all the requirements of the standard.



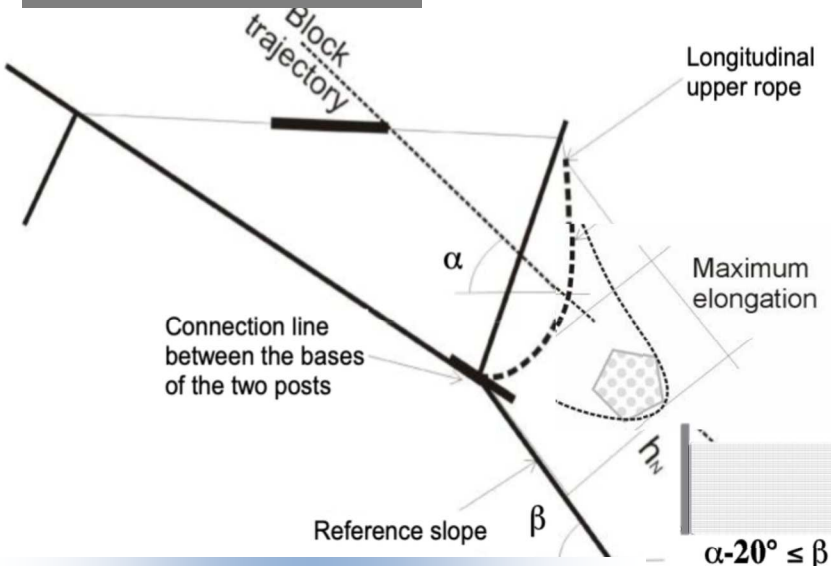


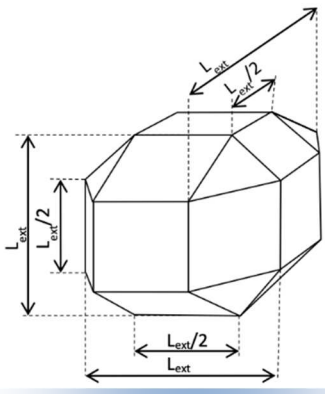


Mount	ixed to the
Reference and check-points:	The reference point shall be chosen on the vibrating table; in the case of large test module it shall be a virtual point, where the reference signal spectrum will be defined as the arithmetic mean of ASD (Acceleration Spectrum Density) values of signals measured at the check points.
Frequency range:	10 Hz to 200 Hz.
ASD levels:	0.013 g²/Hz (10 Hz to 50 Hz). 0.013 g²/Hz (50 Hz to 200 Hz with a negative slope 3 dB/octave). Overall RMS acceleration 1.2 g.
Duration of conditioning:	90 min in each of 3 axes.
Reproducibility:	Low.
Initial measurements:	Visual inspection and Function test.
Functioning during conditioning:	No.
Final measurements:	Visual inspection and Function test.

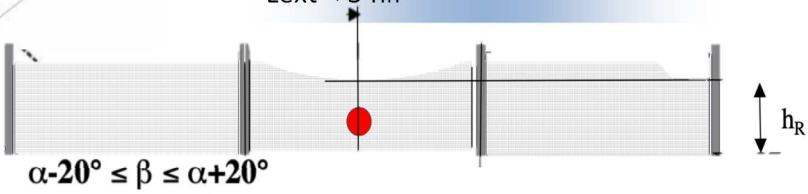
EAD340059: FALLING ROCK PROTECTION

ENERGY ABSOPTION TEST





Made of concrete
Density 2500 Kg/m³- 3000 Kg/m³
Lext < 3 hn



α-20° ≤ β ≤ α+20°
h_N = nominal height of the barrier

Three functional modules shall be used (4 posts)
Impact speed >= 25m/s

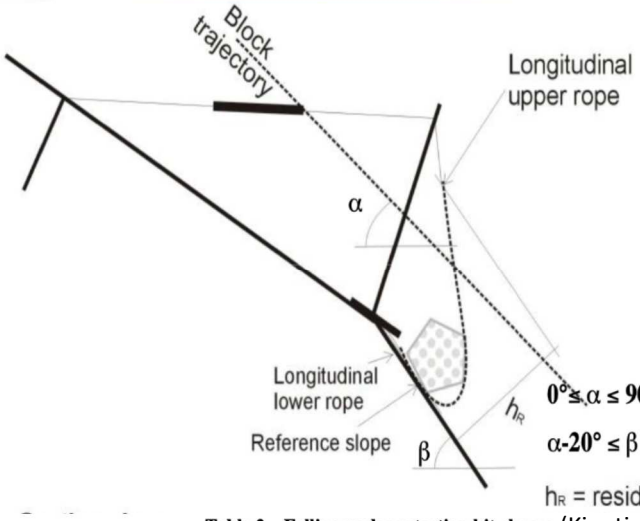


Table 2 – Falling rock protection kit classes (Kinetic Energy Kj)

Energy level classification	0	1	2	3	4	5	6	7	8
SEL	-	85	170	330	500	660	1 000	1 500	>1 500
MEL≥	100	250	500	1 000	1 500	2 000	3 000	4 500	>4 500

SEL = Service Energy Level
MEL = Maximum Energy Level
The residual height shall be measured and declared after SEL and MEL (**Category A**: Residual Height ≥ 50 % nominal height
Category B: 30% nominal height < Residual Height < 50 % nominal height)
The maximum elongation of the net fence during the MEL and SEL tests shall be measured and declared

	1st test	2nd test	MEL
The block is stopped by the kit	✓	✓	✓
No ruptures in the connection components	✓	✗	✗
Residual height of the kit after the test (without removing the block) >=70 % nominal height.	✓	✗	✗
Mesh height at the post >= residual height	✓	✗	✗
Block hasn't touched the ground until the kit has reached the maximum elongation	✓	✓	✓

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