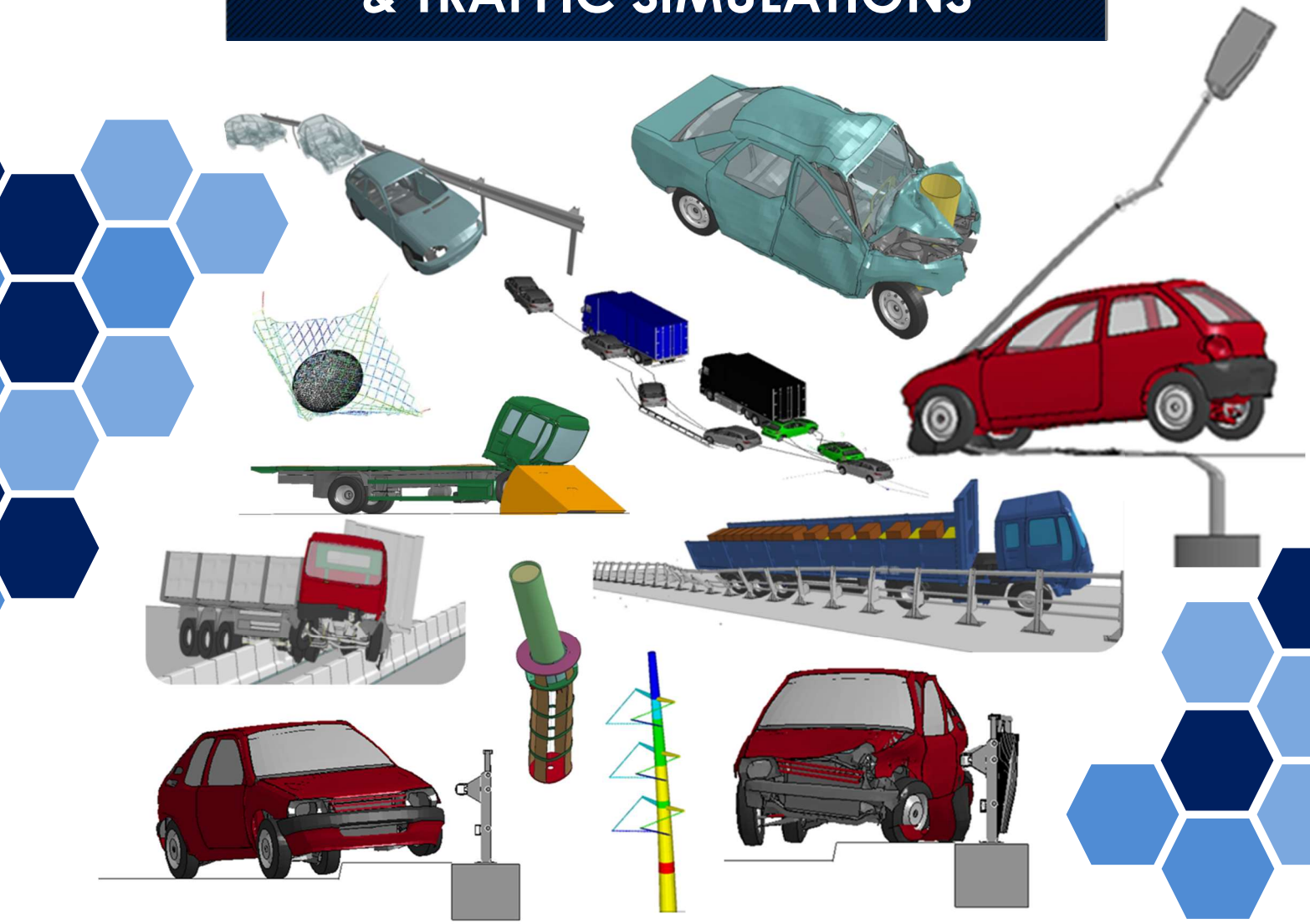
GDTECH
engineering

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



SAMI engineering

AP DYNAMICS 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

LOCATIONS

GDTECH Group (Engineering Services)

IF3

GDTech Belgium

Open Engineering

Sami Engineering

AP Dynamics

GDTech France

SOFTWARE & HARDWARE

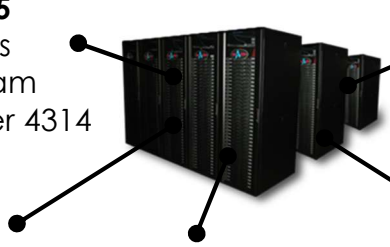
Altair HyperWorks

LS-DYNA

SOLIDWORKS

Cluster #5
768 Cores
6144 GB Ram
Intel Xeon Silver 4314

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



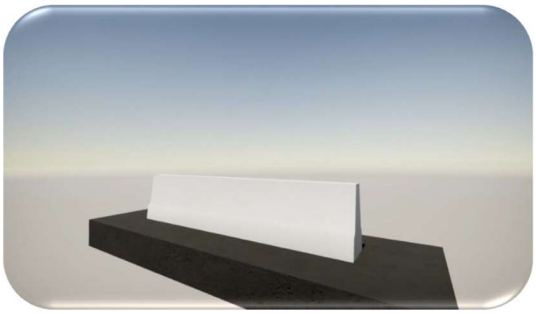
Cluster #4
512 Cores
4096 GB Ram
Amd Epyc 2019

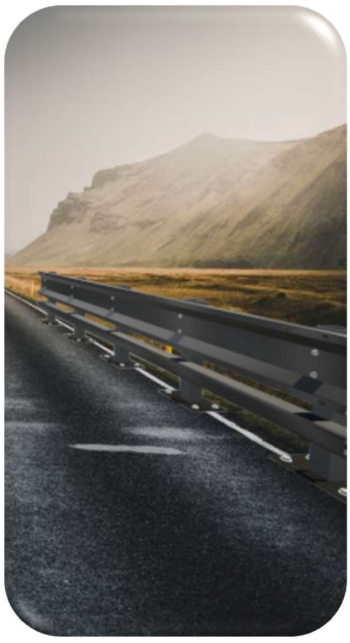
Cluster #2
128 Cores
512 GB Ram
Intel Xeon E5-2640 @2,60Hz

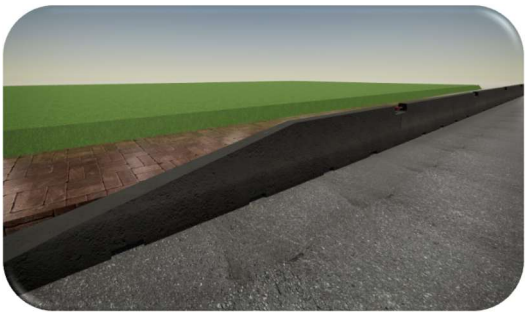
Cluster #3
160 Cores
768 GB Ram
Intel Xeon Silver 4114 @2,20Hz

DRAWING SUPPORT

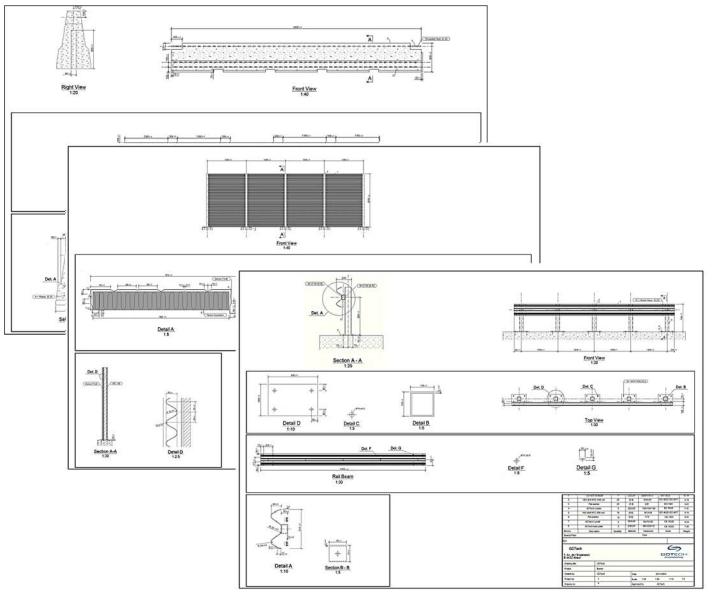
3D AESTHETIC RENDERING (IMAGES & VIDEOS)

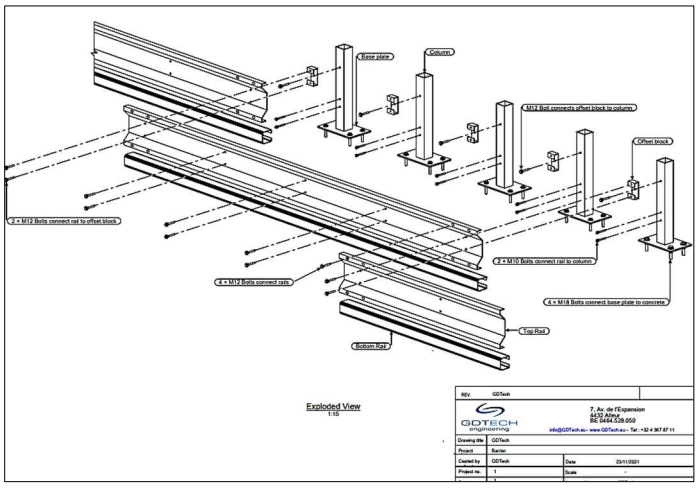






2D DRAWINGS (CE, PRODUCTION, WEBSITE & EXPLODED VIEWS)



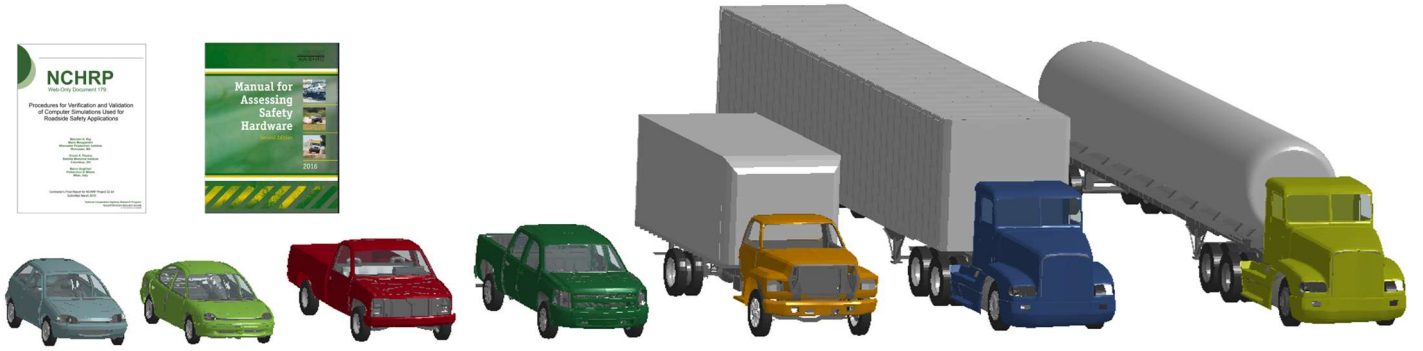


VEHICLES ACCORDING TO INTERNATIONAL STANDARDS

EU standards (EN1317, EN12767, EN16303 validated models):

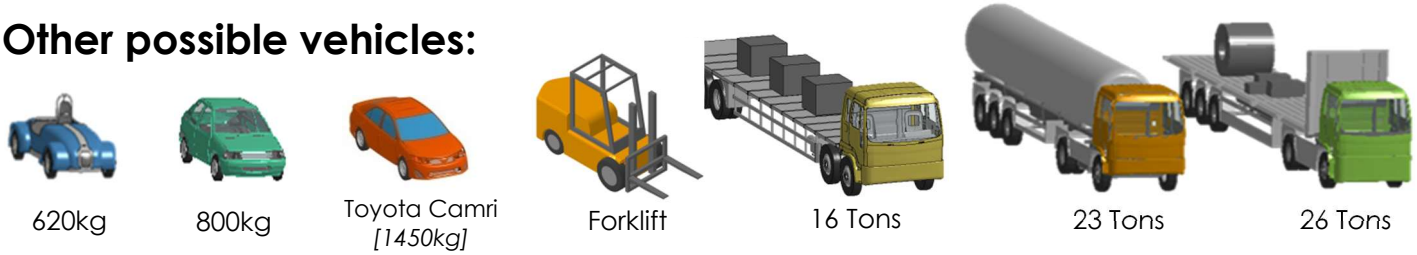
Peugeot 205 *[900kg]* | BMW *[1500kg]* | MAN *[10 Tons]* | Renault Agora Line *[13 Tons]* | Coach SETRA *[13 Tons]* | Renault 270 DCI *[16 Tons]* | ISUZU *[30 Tons]* | Renault Premium Metaco *[38 Tons]*

US standards (MASH & NCHRP350, NCHRP179):



Geo Metro *[820C] (N)* | Toyota Yaris *[1100C] (M)* | Chevrolet C2500 *[2000P] (N)* | Chevrolet Silverado *[2270P] (M)* | Truck *[8000S] (N)* *[10000S] (M)* | Van trailer *[36000V] (N,M)* | Tank trailer *[36000T] (N,M)*

Other possible vehicles:

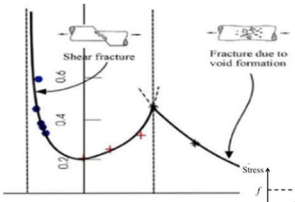


620kg | 800kg | Toyota Camri *[1450kg]* | Forklift | 16 Tons | 23 Tons | 26 Tons

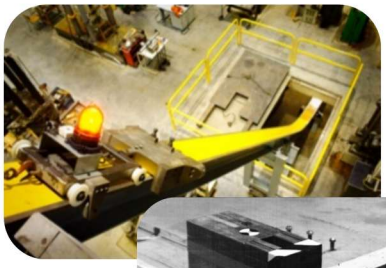
Falling Rock | Caravan *[2050kg]* | Van *[2150kg]* | Explorer [2250Kg] | 44 Tons | 60 Tons | Mixer truck | Dummies

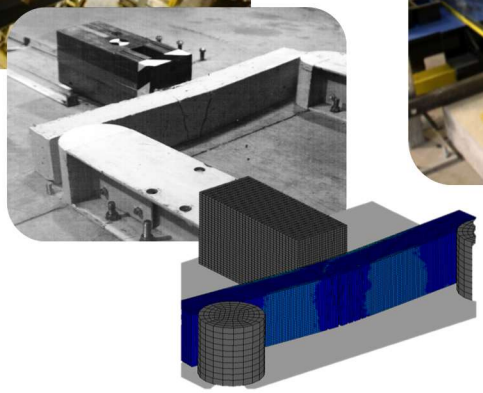
ADVANCED MODELS AND LAB TESTS

Steel



Concrete

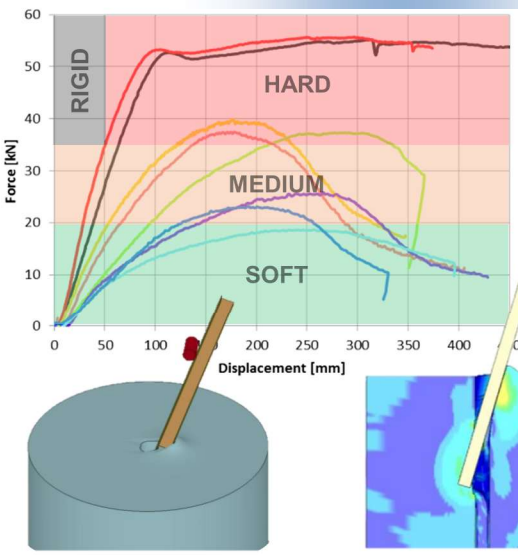




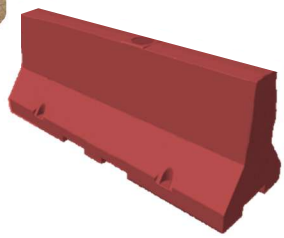
Dynamic tests

Static Tests

Soil

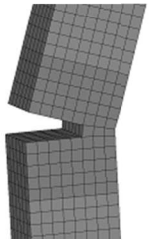


Plastic



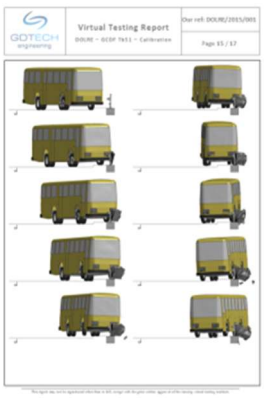
Glass

Wood

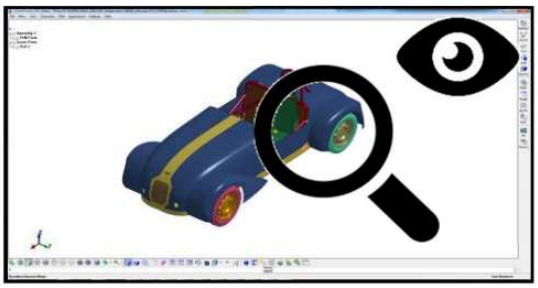


DETAILED REPORTS

Simulation reports



3D Viewer of animated results

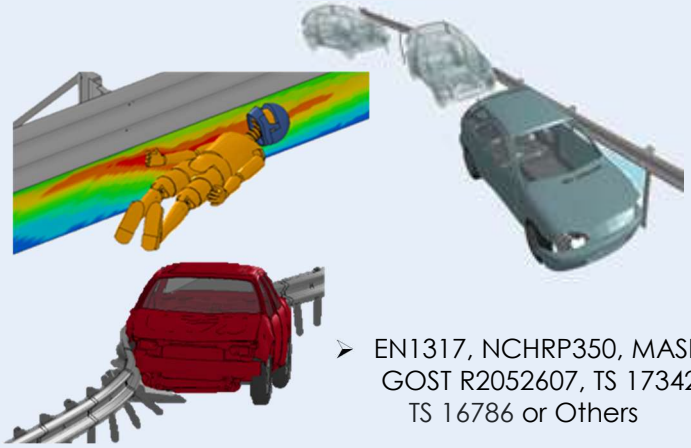


Von Mises Stress - Plastic Strain - Displacement …

GDTECH engineering

SUMMARY

I. ROAD RESTRAINT SYSTEMS



➢ EN1317, NCHRP350, MASH, GOST R2052607, TS 17342, TS 16786 or Others

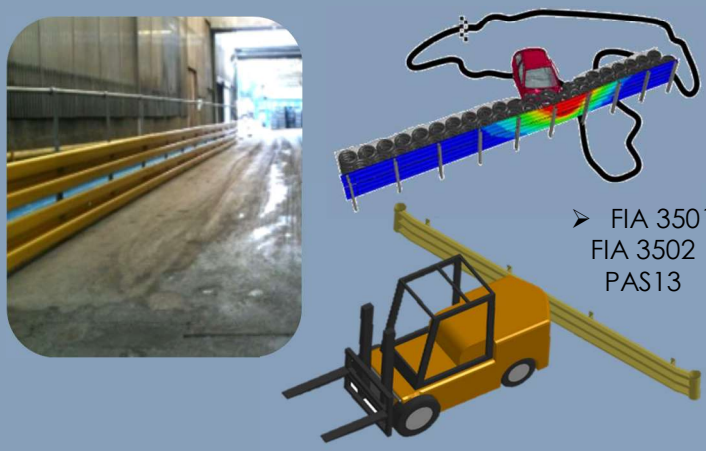
II. LIGHTING POLES & SIGNS

➢ EN12767, NCHRP350, MASH, EN12899, EN 40

III. SECURITY PRODUCTS

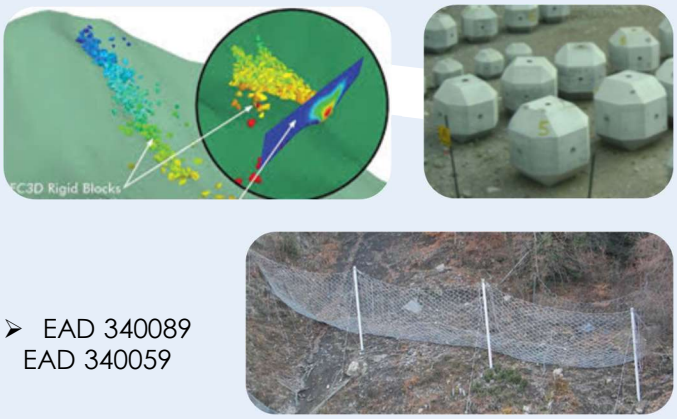
➢ PAS 68, ASTM F2656, ISO 22343

IV. INDUSTRIAL PROTECTIONS



➢ FIA 3501
FIA 3502
PAS13

V. FALLING ROCK PROTECTIONS



➢ EAD 340089
EAD 340059

VI. OTHERS

INDEPENDENT OFFICE

I. ROAD RESTRAINT SYSTEMS

1. New product development

Prior simulation, ITT crash test

2. Family/modification

ITT Simulation

3. Adaptation to site conditions

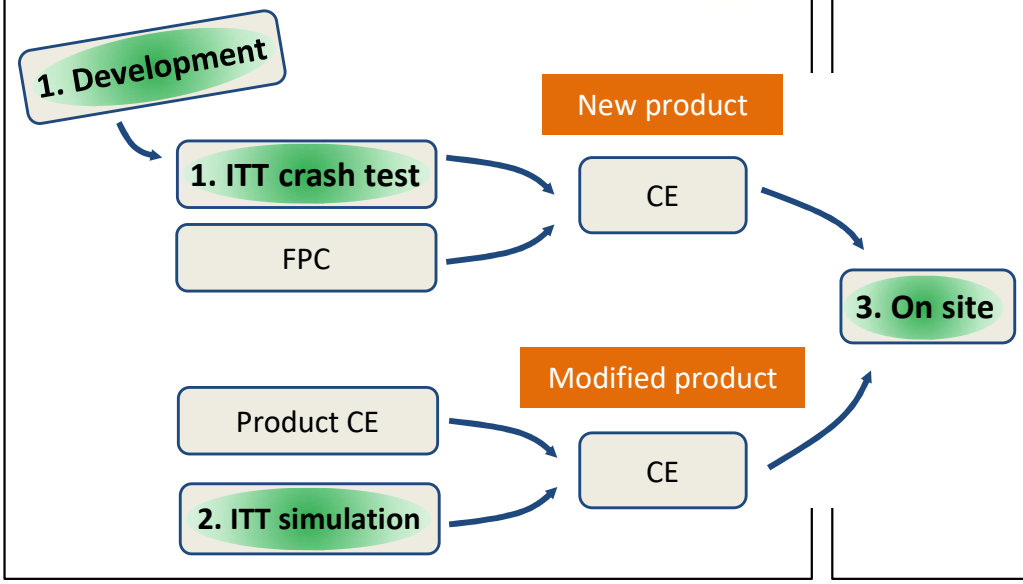
Load transfer to bridge decks, different soils, transitions, …

4. Accident reconstruction

Crash scenarios
Influence of alternatives

5. Training sessions

EN 1317 rules



National / Regional rules

Adaptation to site conditions:

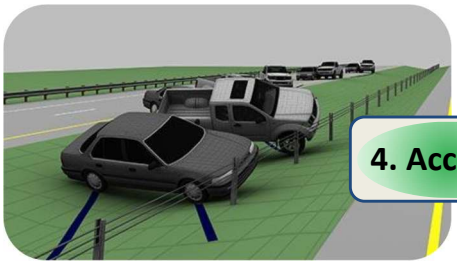
- *Soil modification*
- *Max speed limit*
- *Max CL in curve*
- *Bridge pile*
- *Gantry*
- *Bridge safety barriers*
- *Transitions*
- *Curve influence*
- *Motorcyclist protection*
- *Concrete safety barriers*
- …

About us

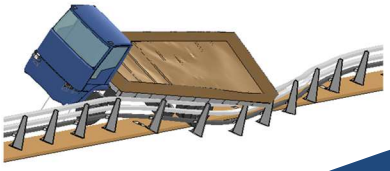
GDTech is an independent company of >200 people with a core business being Finite Element Analyses of structures in the Aeronautic, Defense and Crash applications. Concerning roadside safety equipment analyses, GDTech has an experience of more than 20 years and has collaborated with many customers worldwide using EN1317, EN12767, TS17342, TS16786, NCHRP350, MASH, PAS68, ASTM F2656, ISO22343, EAD340059, EAD340089 and other standards. GDTech has delegates representing Belgium and France 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) such as EN16303 for EU or NCHRP179 for US. GDTech is member of the TRB committe AKD20 concerning US standards. GDTech is member of different associations being: ERF (European Road Federation), Smart Transportation Alliance (STA) and IntOroads.

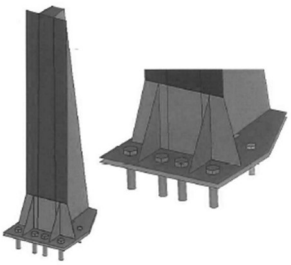
AKD20

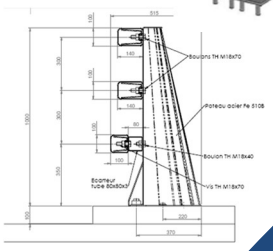
Insurance / Court



1. NEW PRODUCT DEVELOPMENT







YES

Simulation → Positive results?

NO

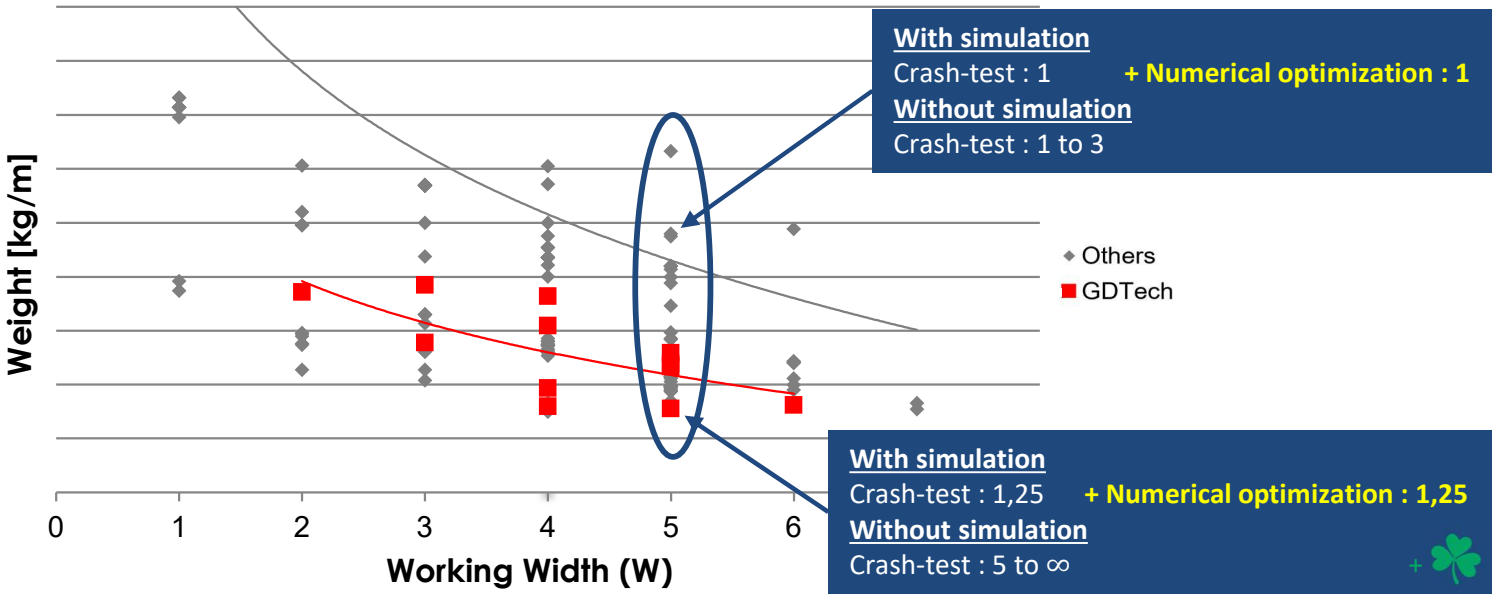
Digital model

Drawings

Simulation → Increase probability to pass Crash Test

Simulation → Increase performance and/or decrease costs

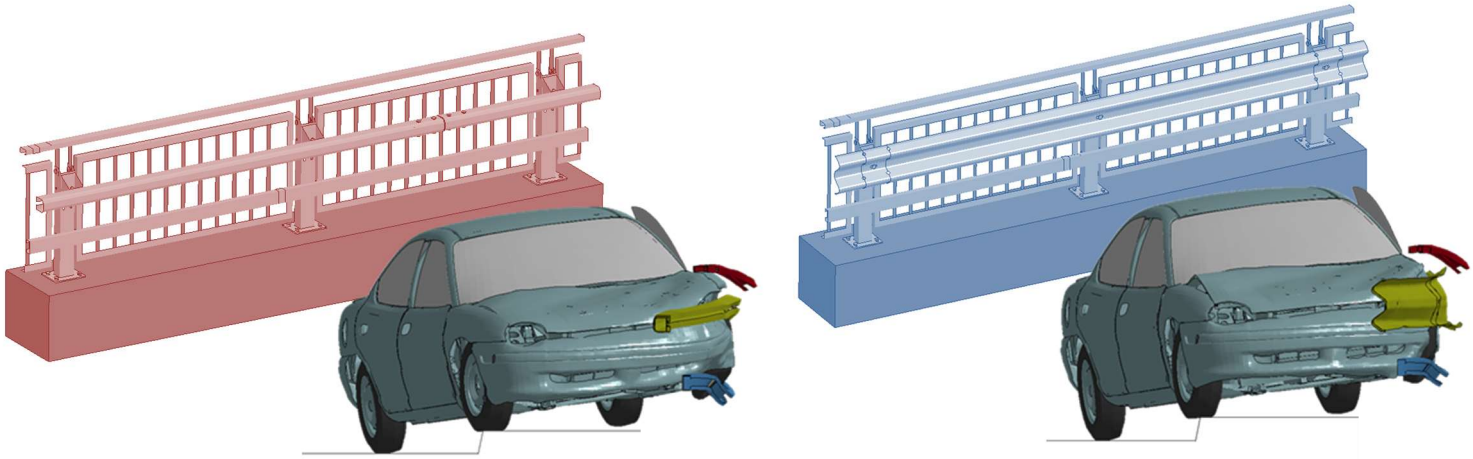
N2 systems



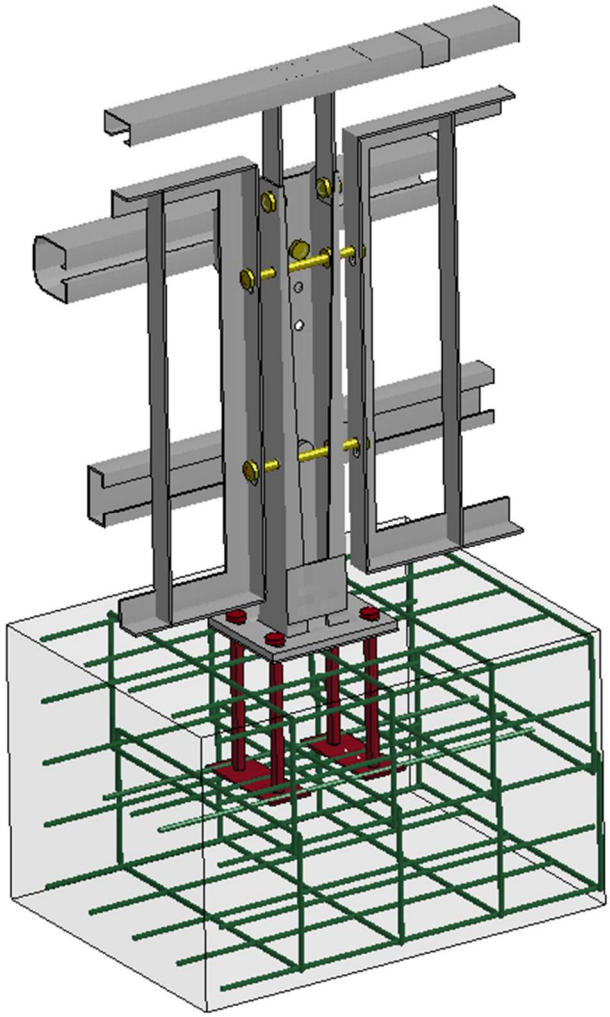
With simulation
Crash-test : 1 **+ Numerical optimization : 1**
Without simulation
Crash-test : 1 to 3

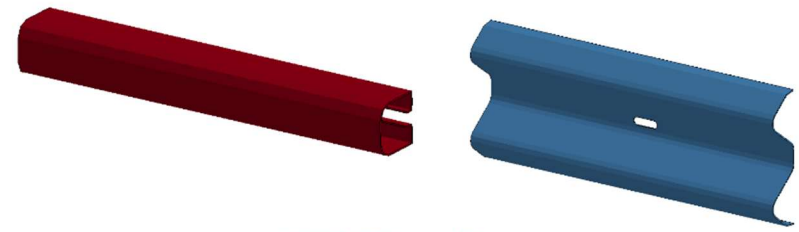
With simulation
Crash-test : 1,25 **+ Numerical optimization : 1,25**
Without simulation
Crash-test : 5 to ∞

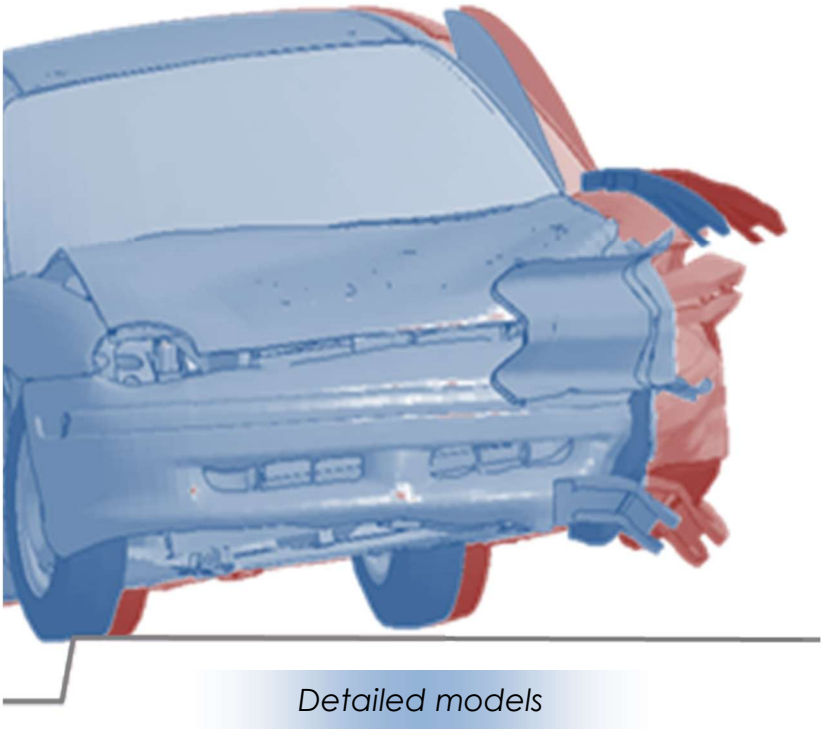
1. NEW PRODUCT DEVELOPMENT



Comparison with different beams





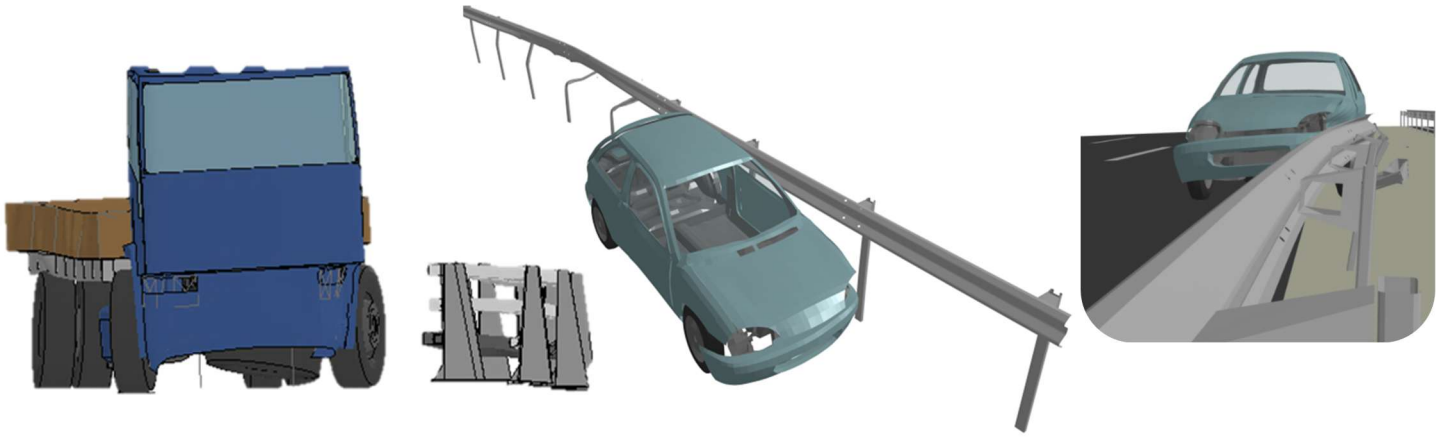


Detailed models

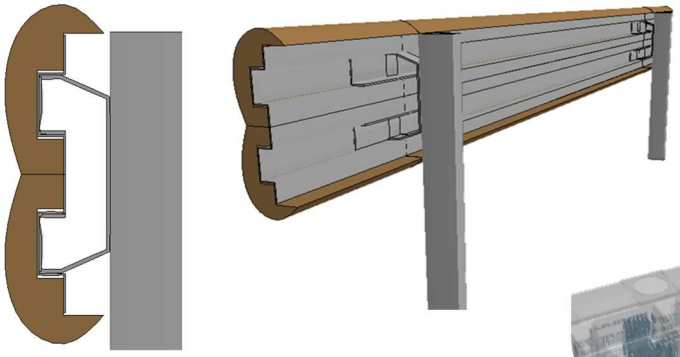
1. NEW PRODUCT DEVELOPMENT

➢ EN 1317-2

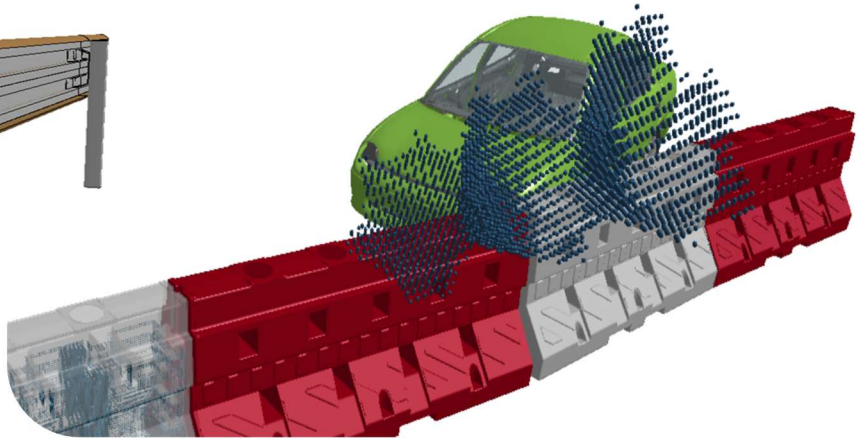
Steel barriers



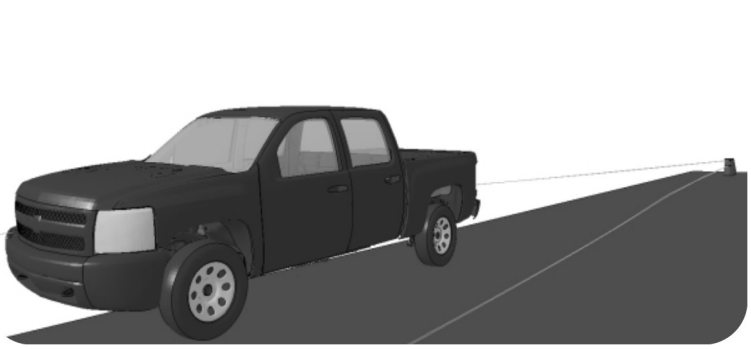
Wood-steel barriers

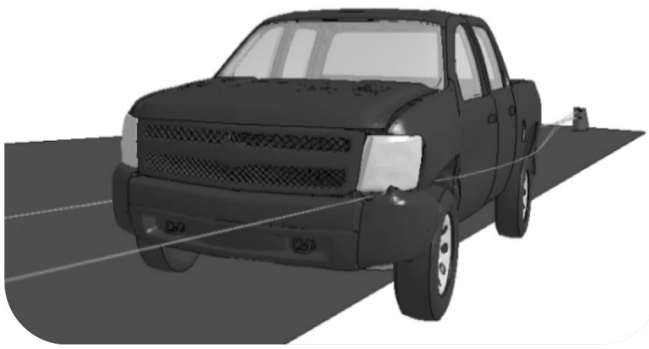


Plastic barriers



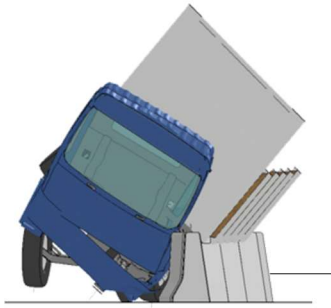
Cables barriers



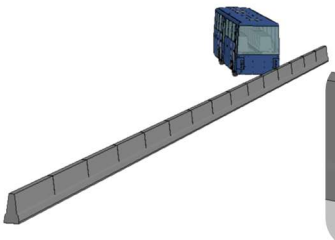
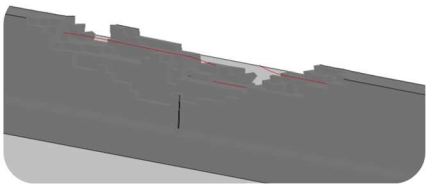


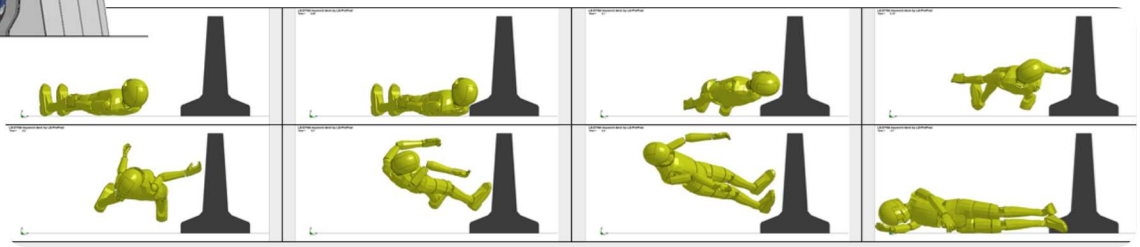
1. NEW PRODUCT DEVELOPMENT

Prefabricated concrete barriers




Cast in place / in site concrete barriers



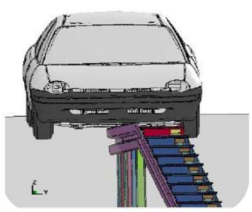
Temporary barriers




End terminals

➢ CEN/TS 1317-7

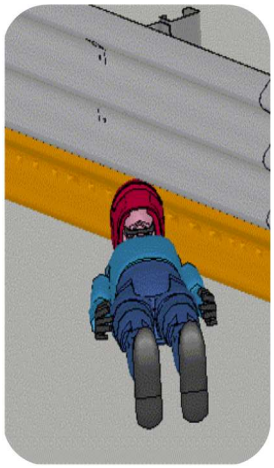
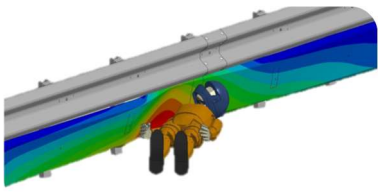


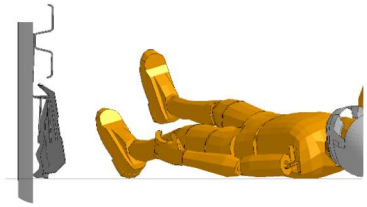
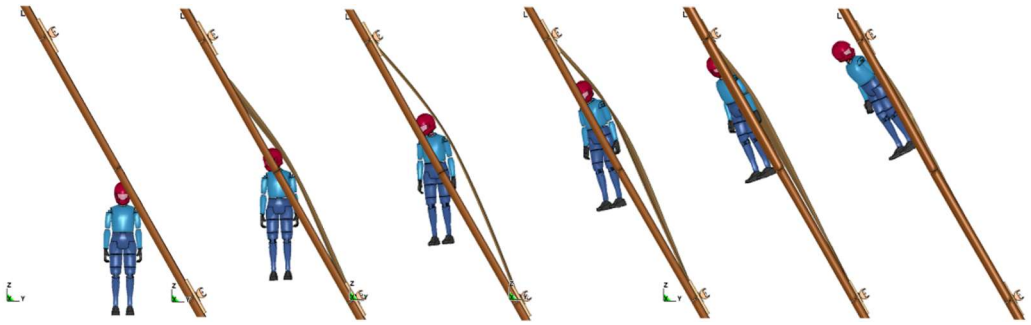
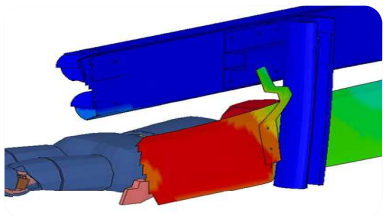
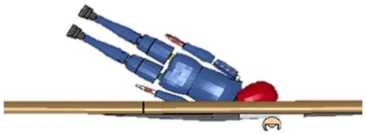
1. NEW PRODUCT DEVELOPMENT

Motorcyclist protection

➢ TS 17342



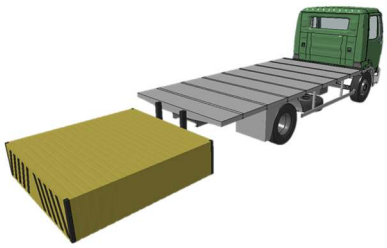





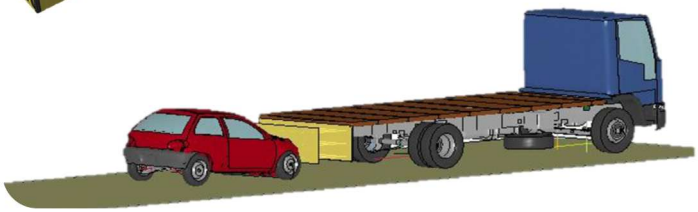
Crash cushions

➢ EN 1317-3


Truck mounted attenuators

➢ TS 16786



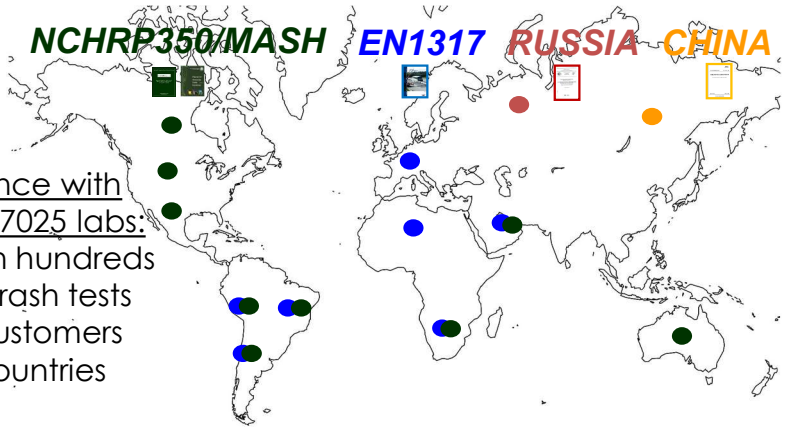


1. NEW PRODUCT DEVELOPMENT

ITT carsh test

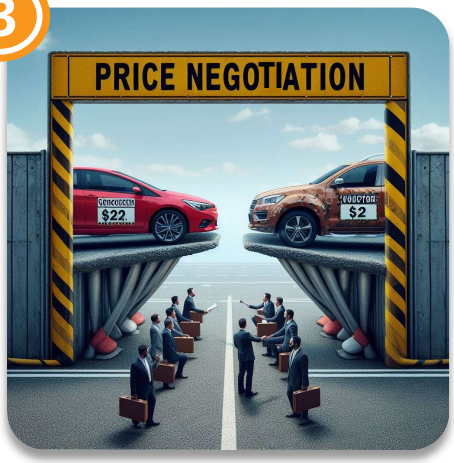
1

2



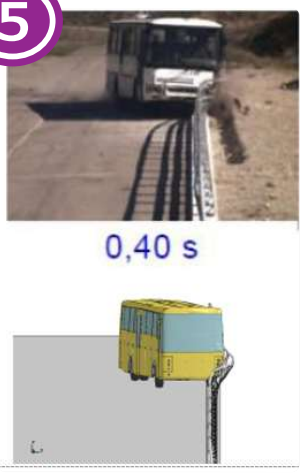
Experience with ISO/IEC 17025 labs:
More than hundreds of real crash tests
> 100 customers
> 25 countries

3



4

5

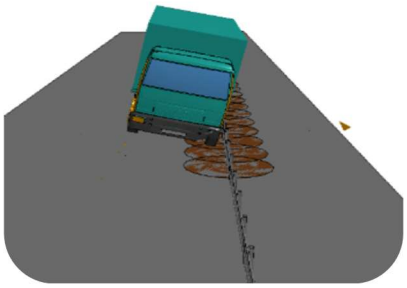


2. FAMILY/MODIFICATION

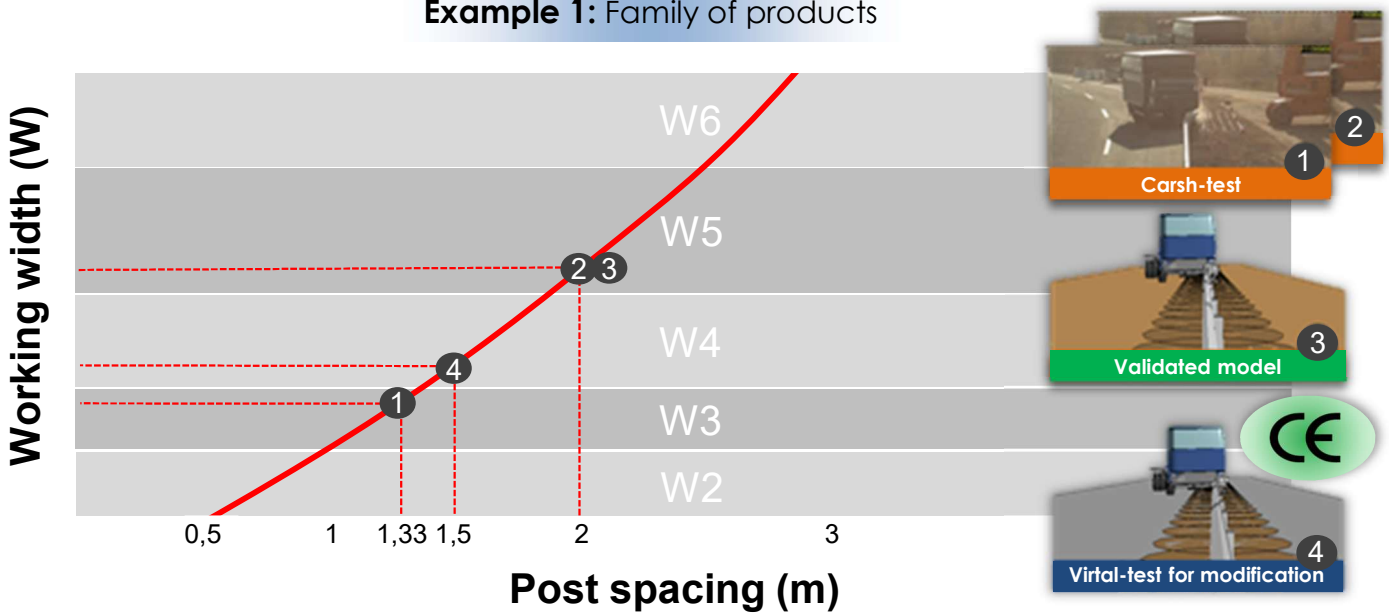
Category	Change
A	Slight
B	Moderate
C	Significant

Simulation of "modification" should rely on validated models (EN16303)

Measure	C-T	V-T	Check
Normalized dynamic deflection [m]	0.8	0.76	0,04 < 0.18
Normalized working width [m]	0.9	0.86	0,04 < 0.18



Example 1: Family of products

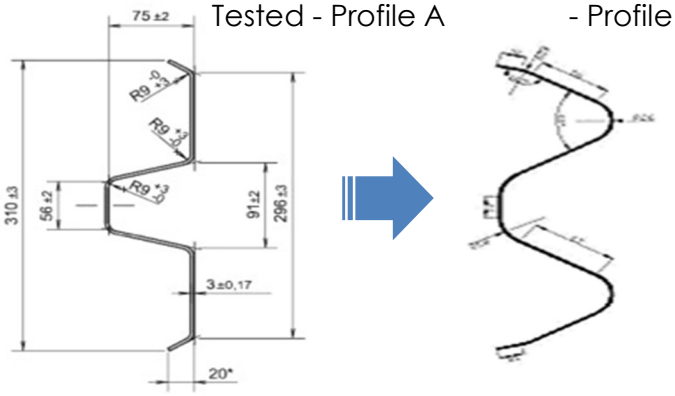


2. FAMILY/MODIFICATION

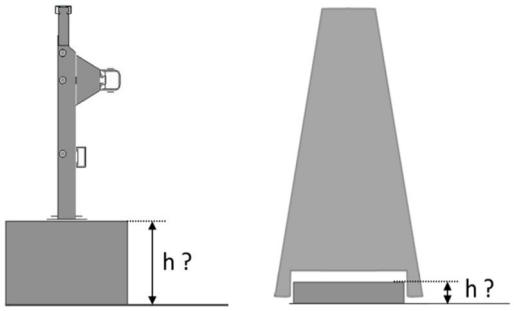
Example 2: Guardrail profile

Original model
Tested - Profile A

Modified model
- Profile B

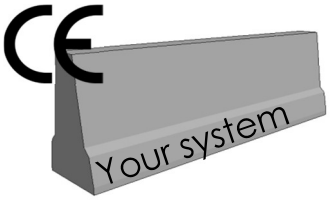


Example 3: Different concrete basement heights



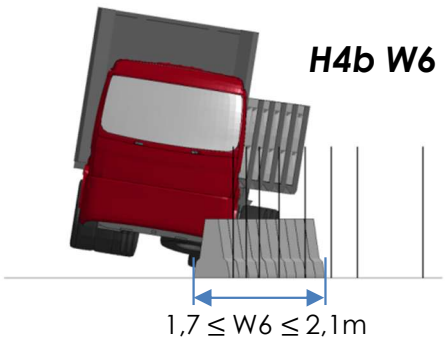
Example 4: Assess the working width for lower containment levels

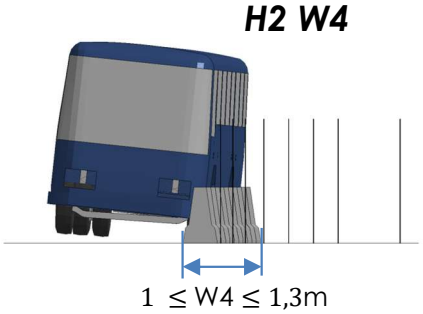
Tested H4b W6 system



H2 W6 system ⟷ **According to EN1317**

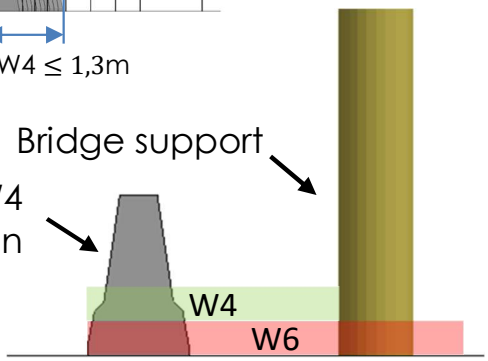
Validated model





of H2 W4 Using numerical simulation

H4b-W6 → H2-W4 thanks to simulation



2. FAMILY/MODIFICATION

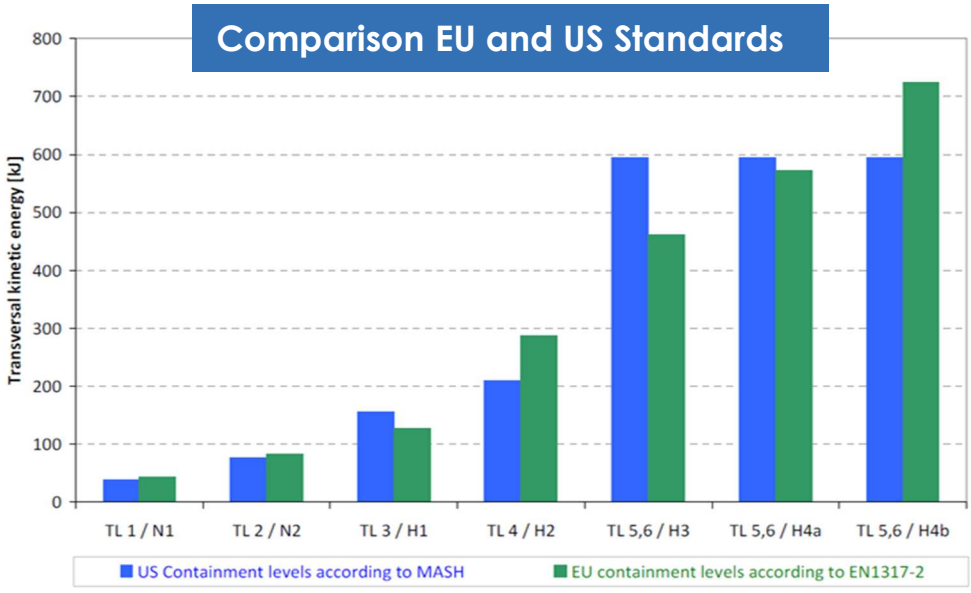
Simulation for assessing performance of a tested product according to a different international standard (EN1317, NCHRP 350, MASH, GOST, …)

A Tested product according to EN1317

B Simulation reproducing the Real-test

C Simulation according to another performance standard

Comparison EU and US Standards

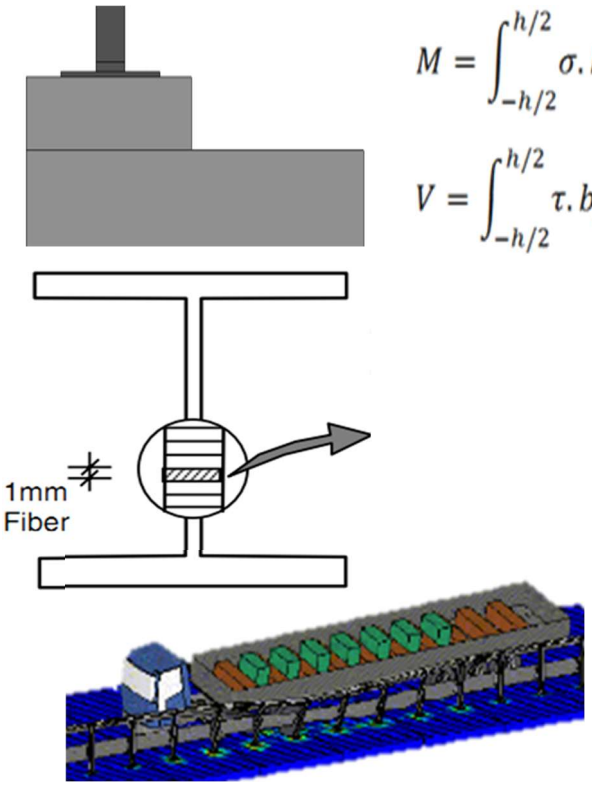


3. ADAPTATION TO SITE CONDITIONS

Loads from bridge parapets to decks

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)

Reinforce bridge decks (Existing/New)

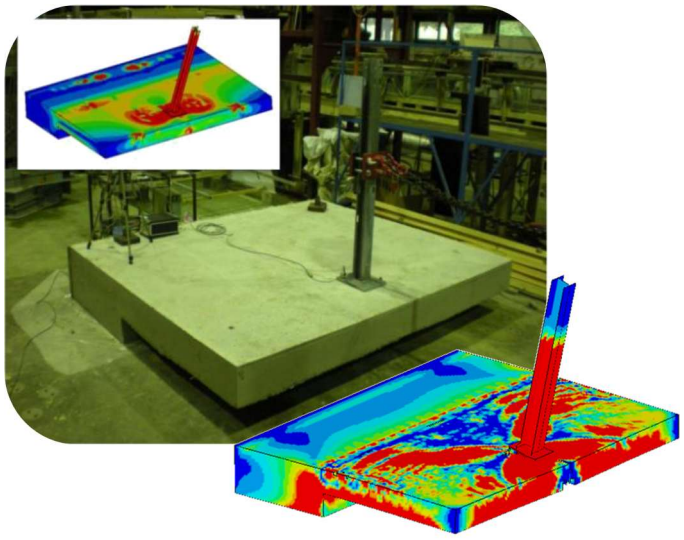


$$M = \int_{-h/2}^{h/2} \sigma . b_y . y . dy$$

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

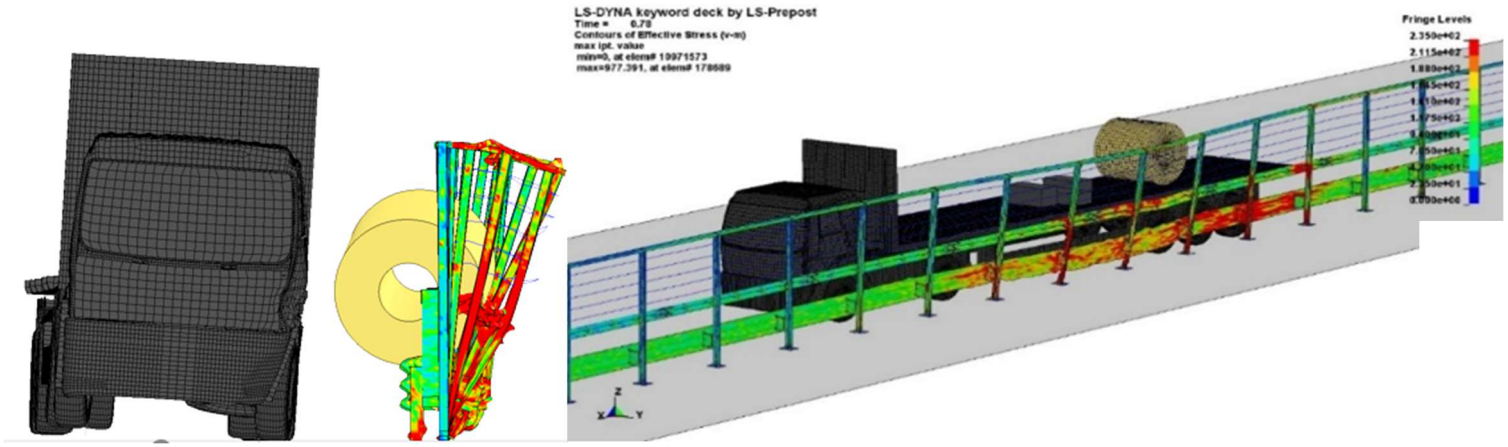
According to Eurocodes & PTV869 valid for :

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

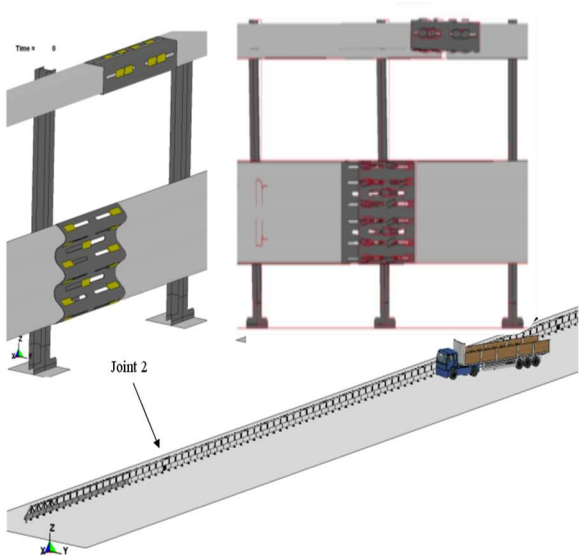


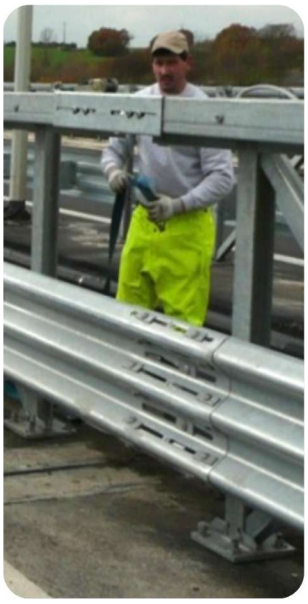
3. ADAPTATION TO SITE CONDITIONS

Falling load – Acoustical walls – Anti-suicide walls – Pedstrian protection



Steps & expansion joints



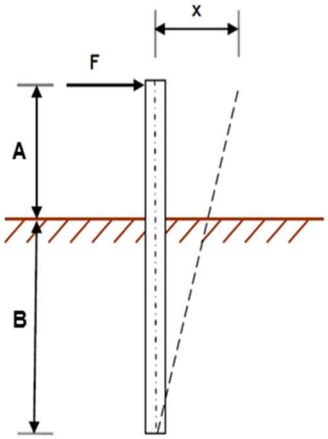


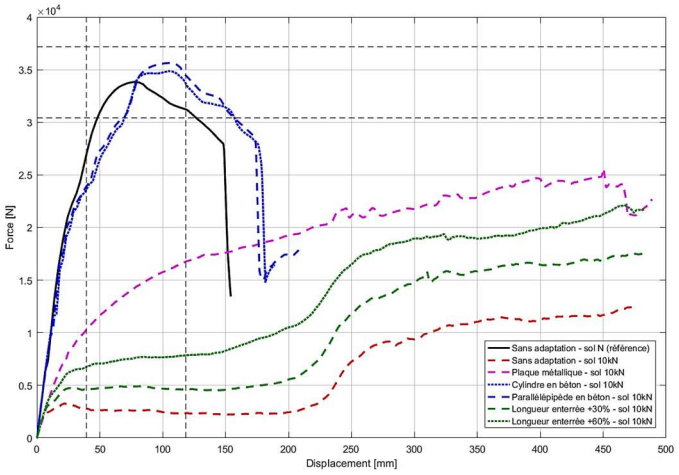
3. ADAPTATION TO SITE CONDITIONS

Soil influence

New methodology for checking and adapting safety barriers to different soils.

Hard *Medium* *Soft*



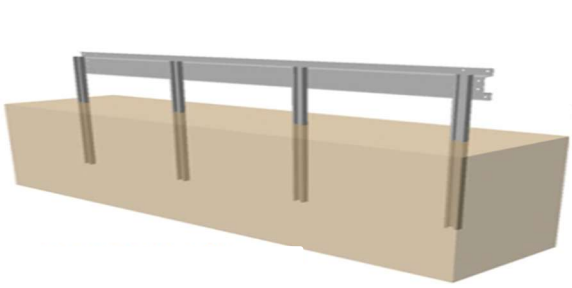


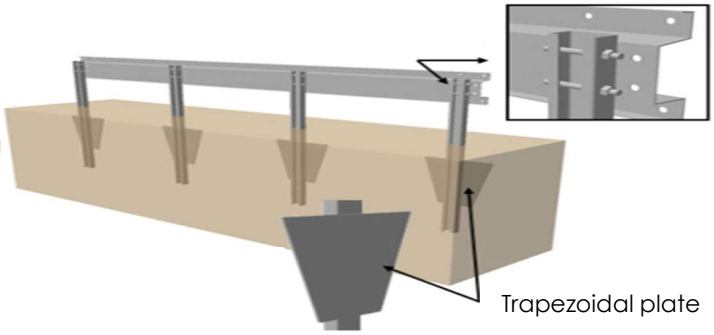
EN1317 / Soil	
Profil	HEB120-S335JR
A	1,00m
B	1,00m
x	0,20m

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



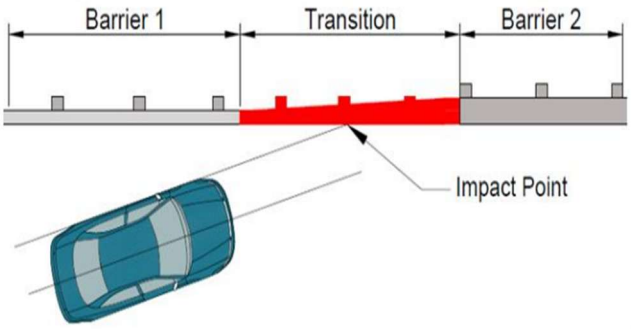


Trapezoidal plate

3. ADAPTATION TO SITE CONDITIONS

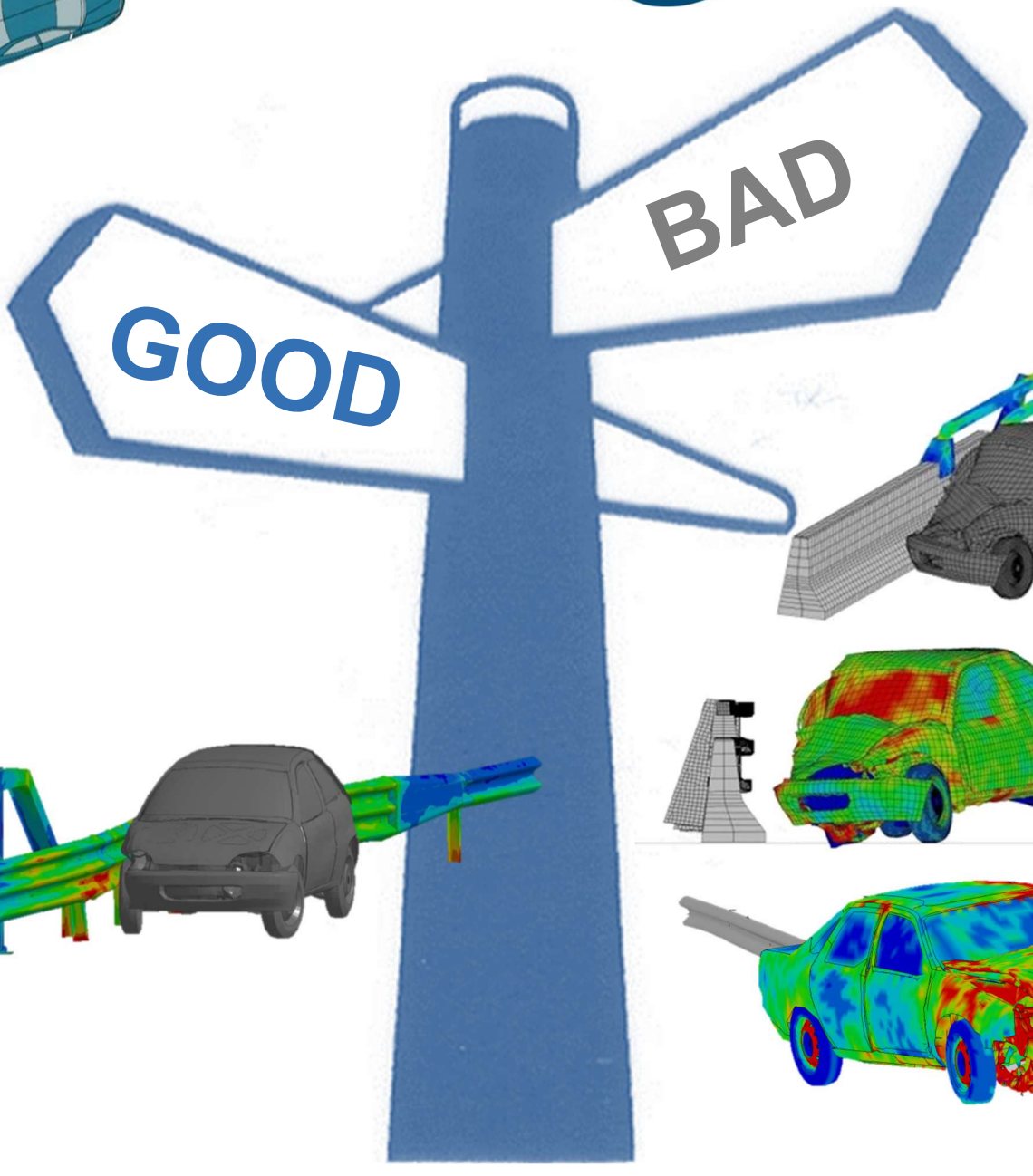
Transition between systems

➢ CEN/TS 1317-10



➢ ***Simulation reports valid for NF/BENOR certification.***
➢ ***Possibility for GDTech to review customer's simulation.***

NF BENOR



3. ADAPTATION TO SITE CONDITIONS

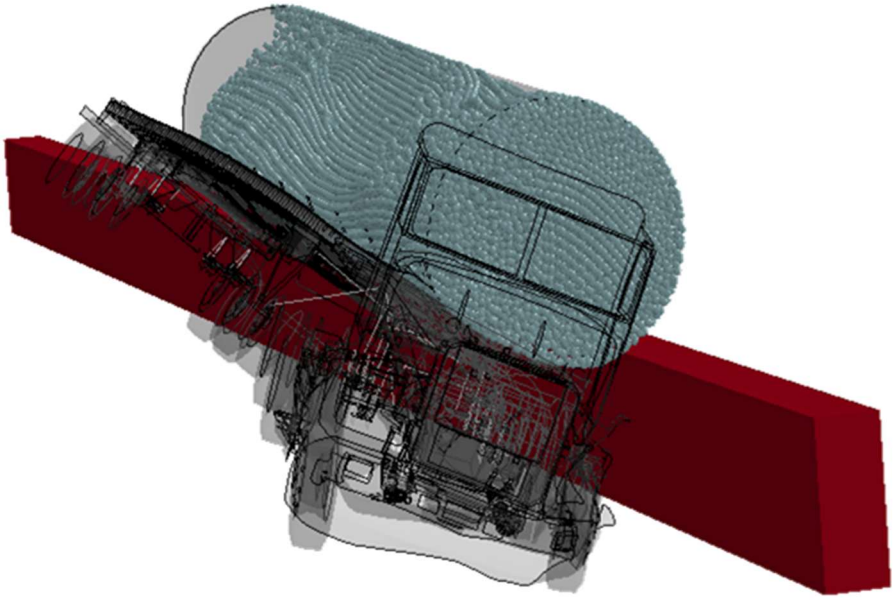
Vehicle mass/shape increased/modified

Tested 38 tons H4b CE

Tank trailer

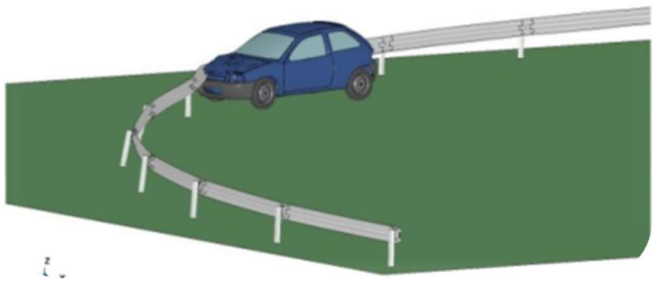
Coil trailer

60 tons truck

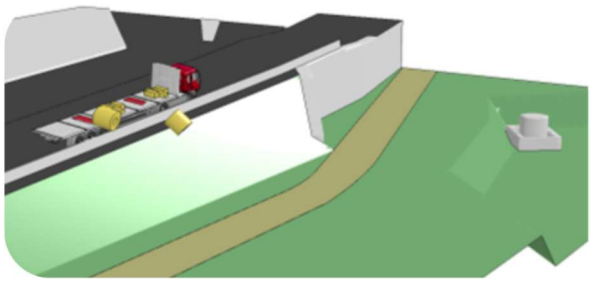


3. ADAPTATION TO SITE CONDITIONS

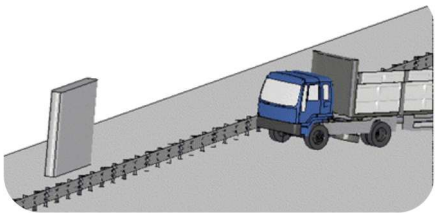
Curves



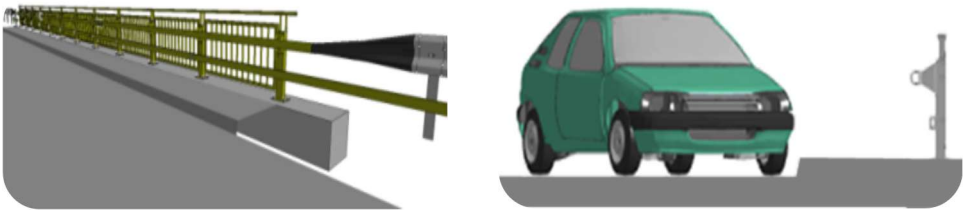
Falling risks



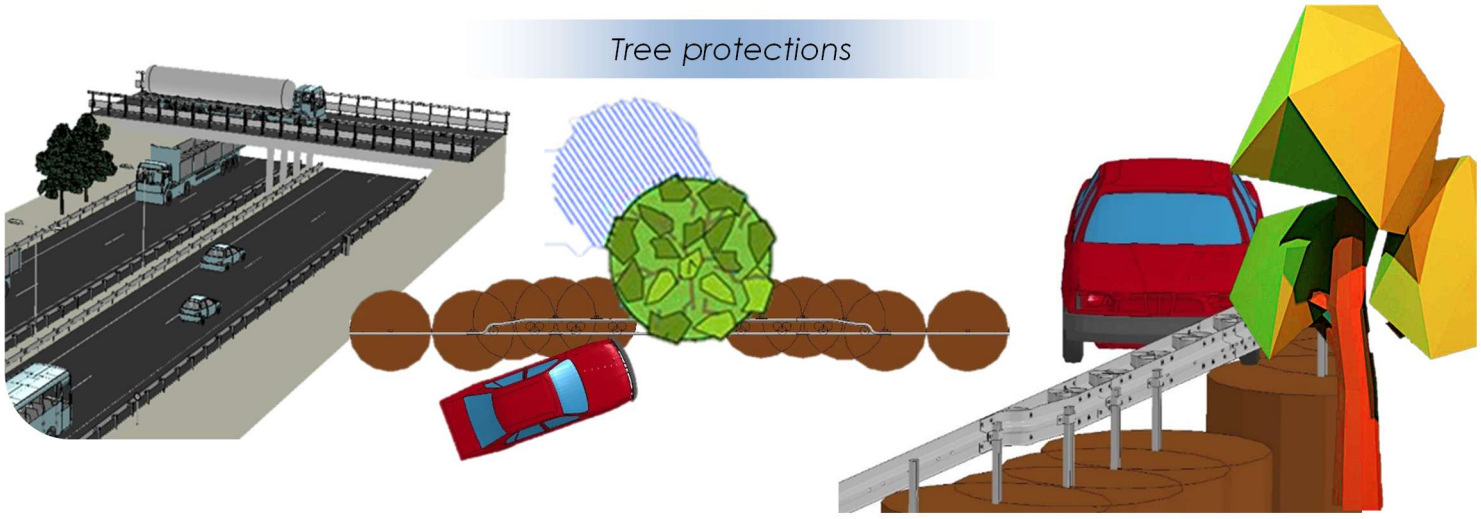
Impact on bridge pile



Steps



Tree protections



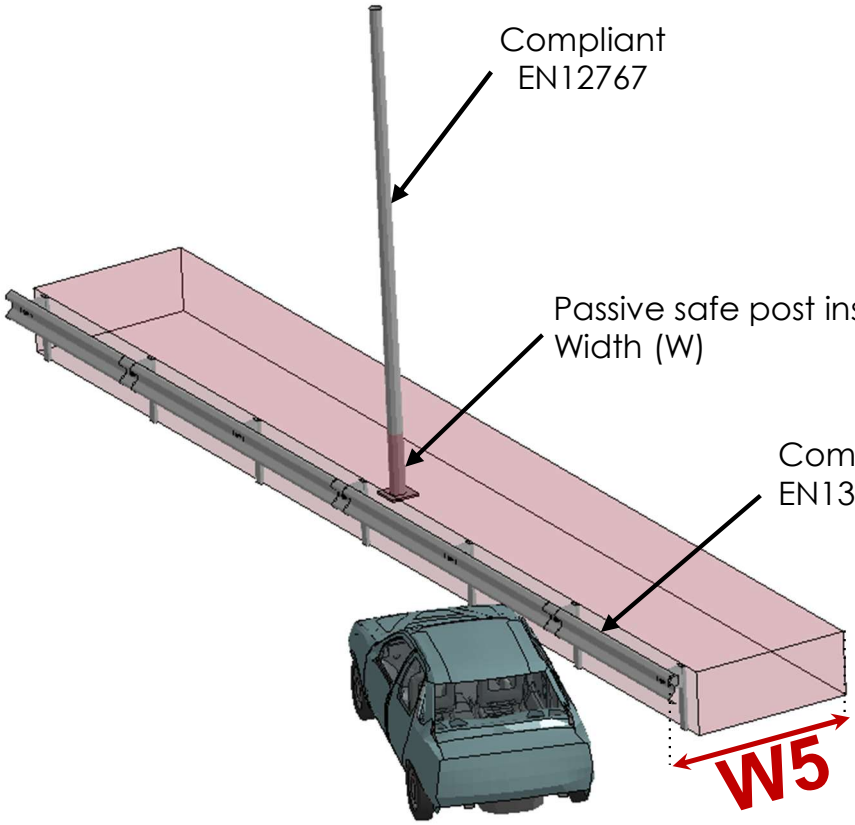
Wirings

Anti dazzles

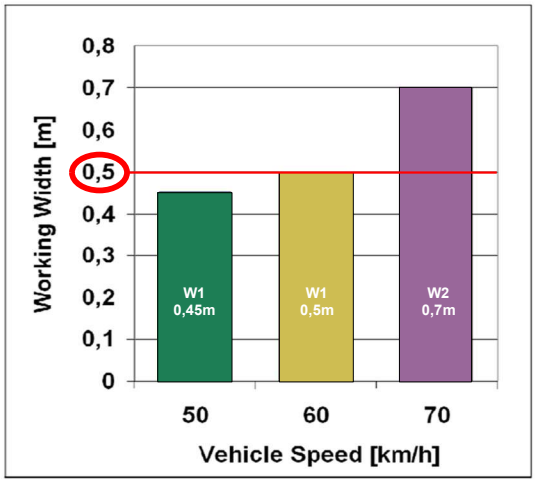
Possibility to investigate real conditions & to solve possible problems.

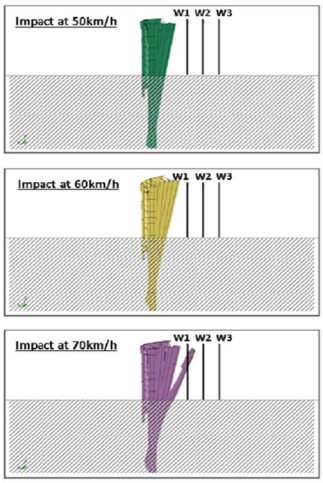
3. ADAPTATION TO SITE CONDITIONS

Passive safe posts inside the W :



Reduce speed to get W1 when only N2 W2 are available :



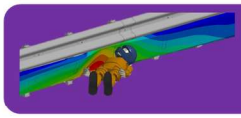


3. ADAPTATION TO SITE CONDITIONS

Adding a motorcyclist protection on a different barriers

TS17342 tested system on barrier A

What if installed on EN1317's tested barrier B?



Motocyclist simulation according to TS17342

Product modification

YES

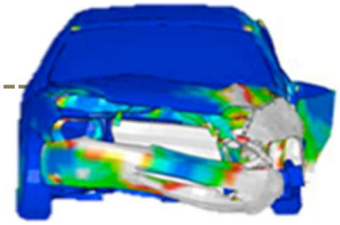
NO

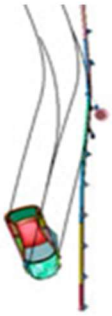
Check EN1317 conditions via simulation

YES

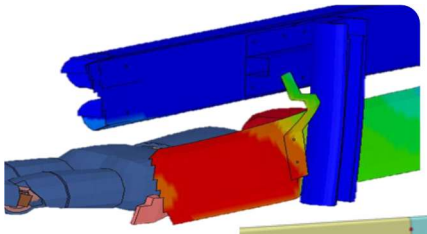
NO

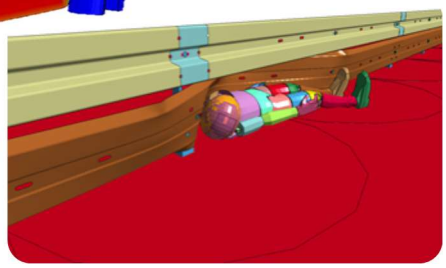
National marking





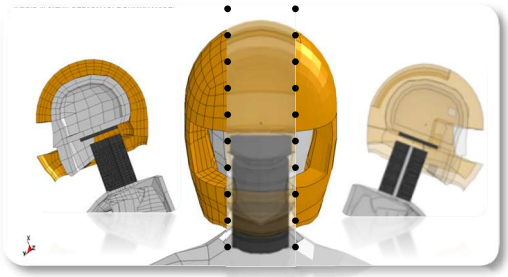
Example of bad behaviours :

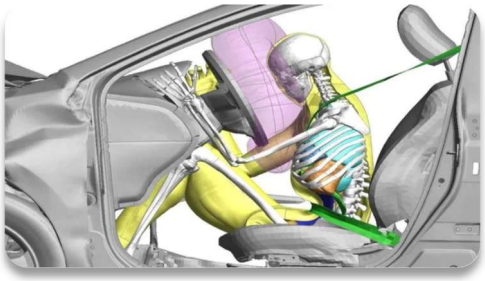


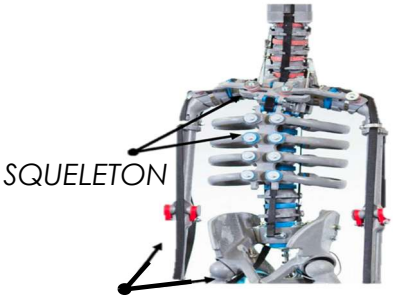


4. ACCIDENT RECONSTRUCTION

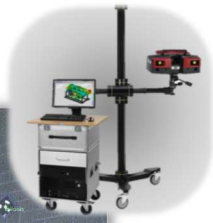
Dummies

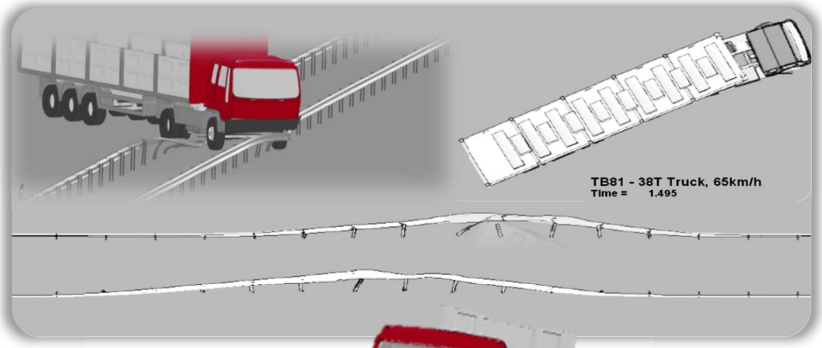


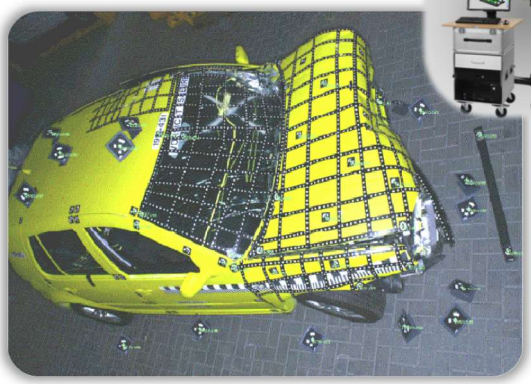


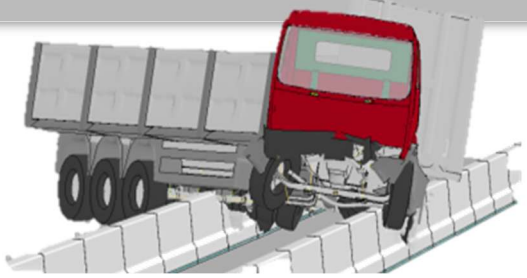


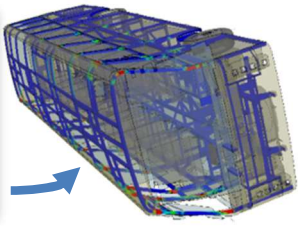
Standard & tailored test

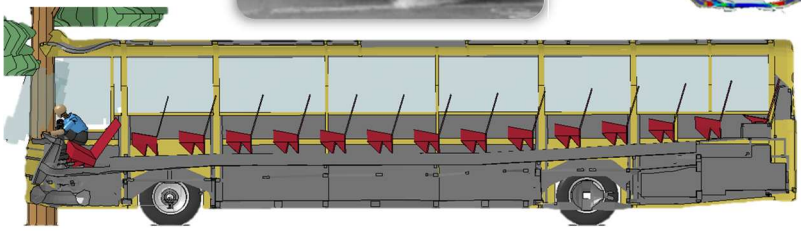


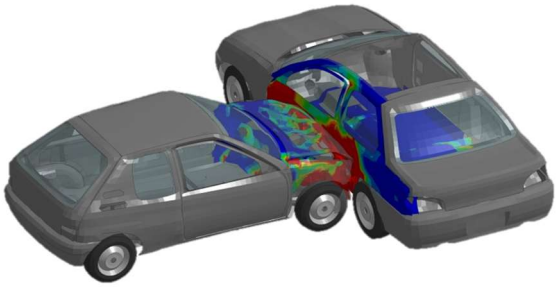


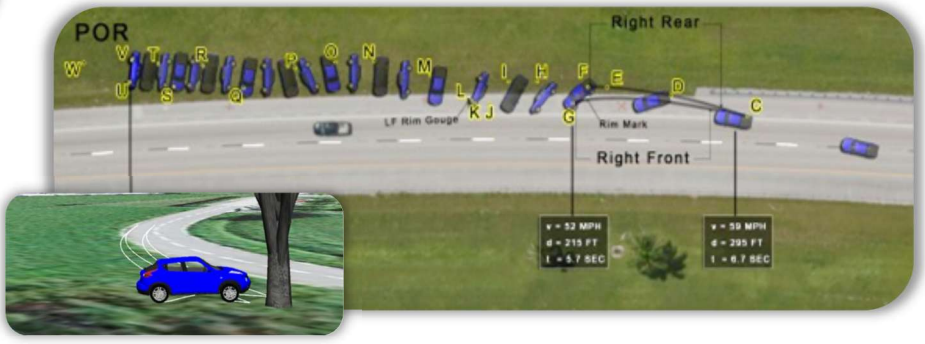












5. TRAINING SESSIONS

Customized program in collaboration with local players

A Workshop on vehicle restraint systems (VRS) — 1/2 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 protection zones
- National regulations on requirements not covered by EN 1317.
- Installation and repair regulations: national examples.

B Workshop on local problematics on VRS — 1/2 day

- To be discussed.

C Workshop on work zones safety — 1/2 day

- Lateral protection regulations : national examples.
- Truck mounted attenuators & truck lateral protection.
- Traffic management for work zones.

D Workshop on traffic management & accidents — 1/2 day

- Traffic management.
- Accident reconstructions.

BRIDGE BARRIER UPGRADING

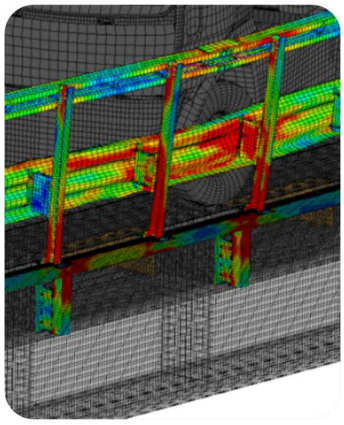
NEW EN1317

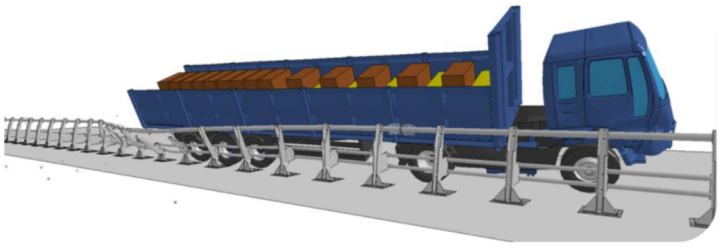
Mandatory to use CE crash-tested barriers on bridges.

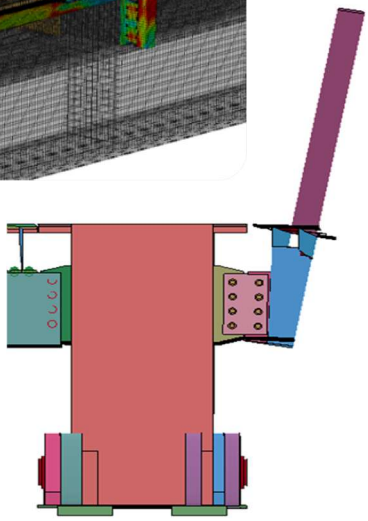
HOW TO COLLABORATE?

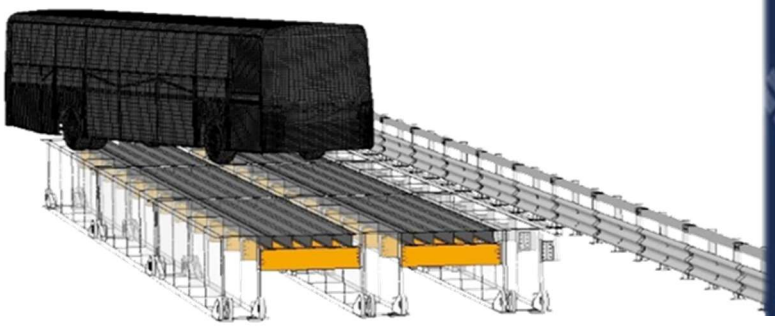
Choose one existing and already tested safety barrier and develop an effective anchoring solution.

Upgrade your current barriers to fit with EN1317.





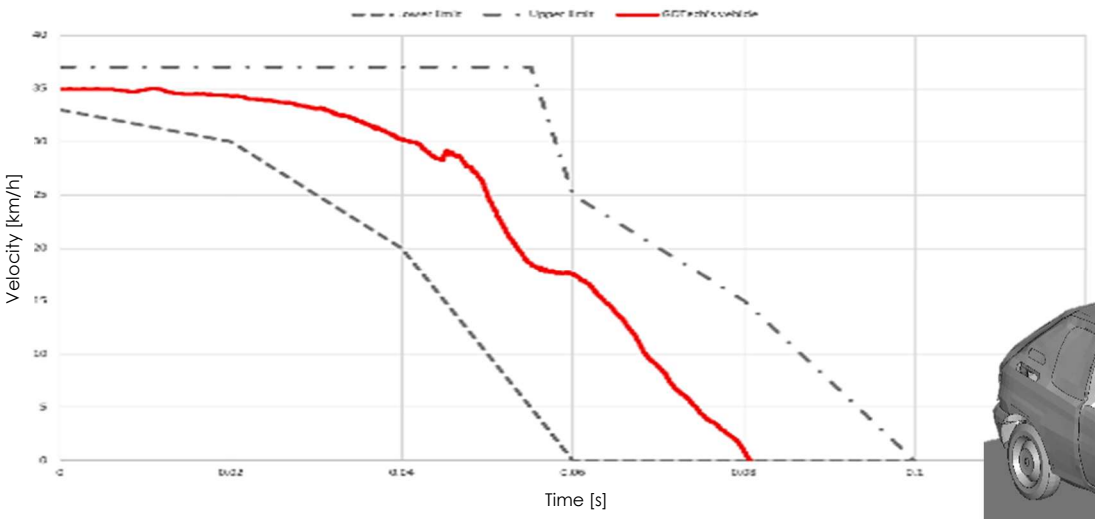


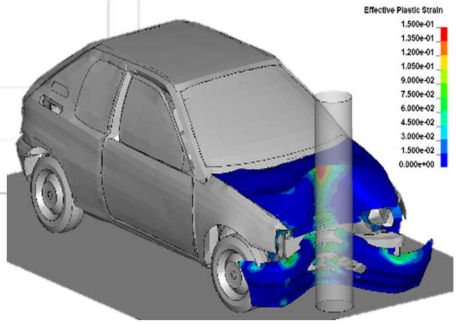


PASSIVE SAFETY

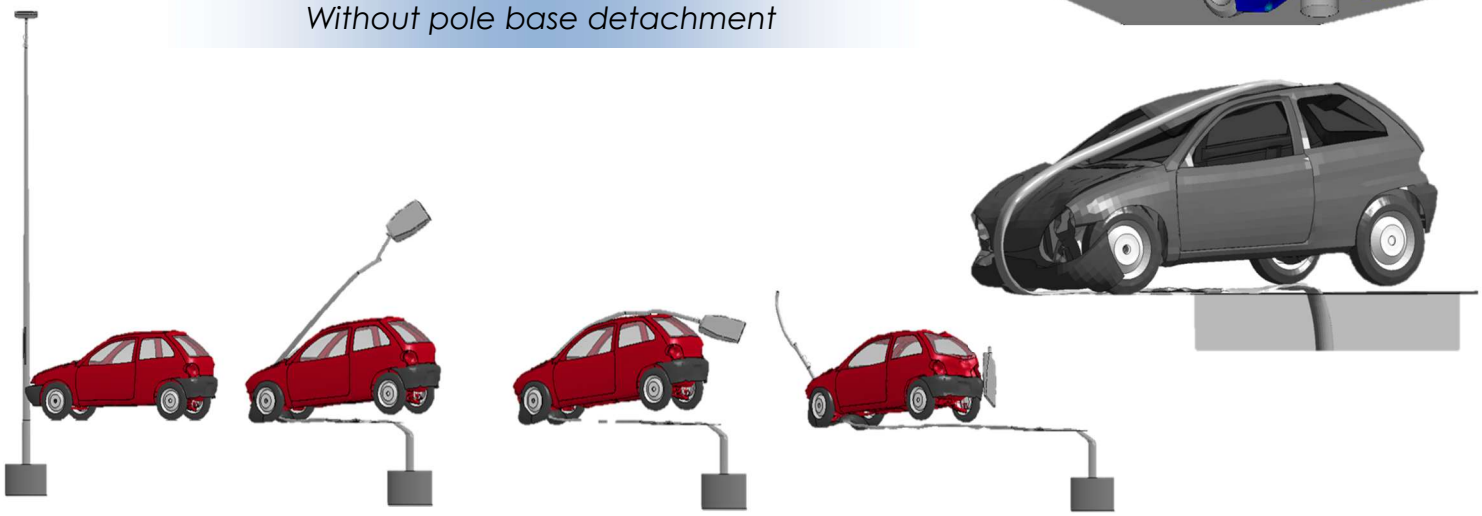
EN 12767 vehicule calibration

- EN 12767
- EN 40
- EN 12899

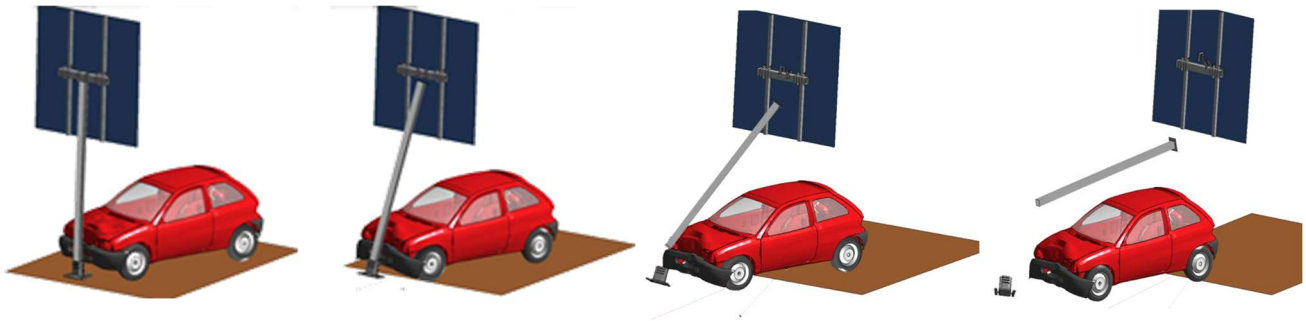




Without pole base detachment



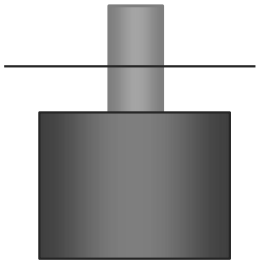
With pole base detachment

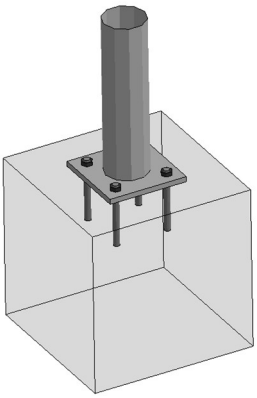


PARTICULAR INSTALLATION

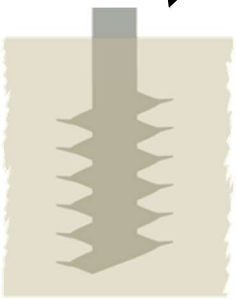
Crash-test anchoring

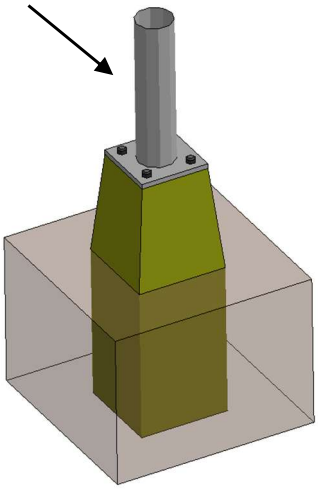
Special anchoring

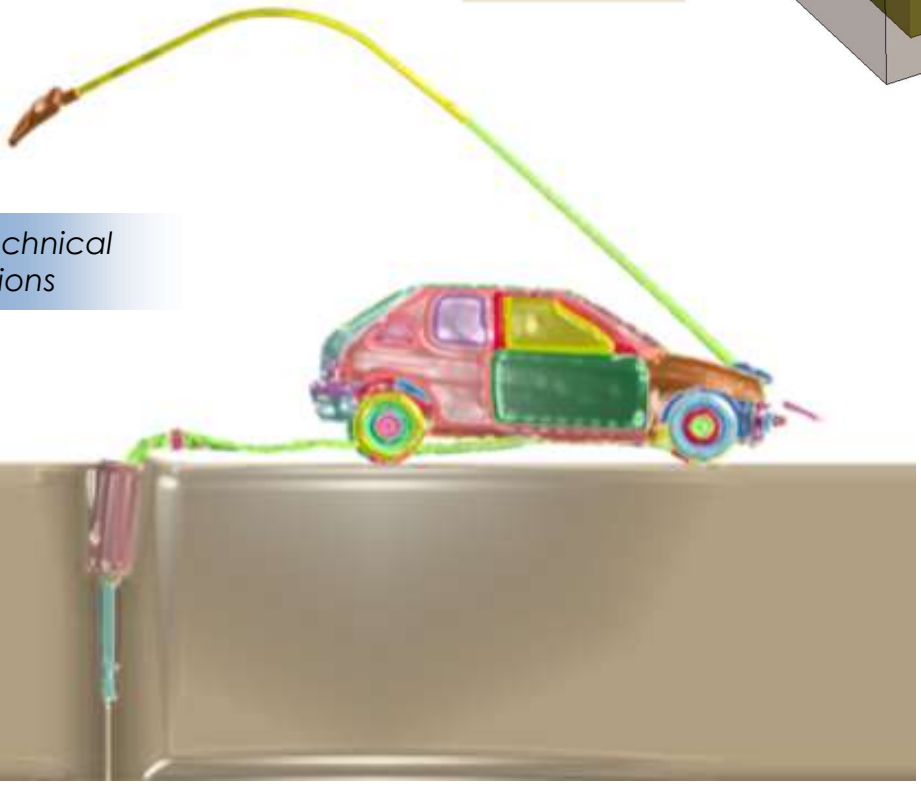




Different types of concrete foundations





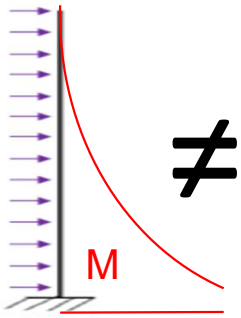


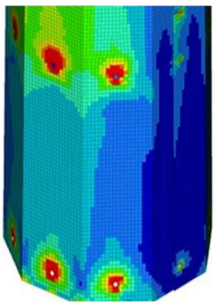
Highly technical solutions

II. LIGHTING POLES & SIGNS

WIND RESISTANCE

Analytical model | *Numerical model* | *Panels*

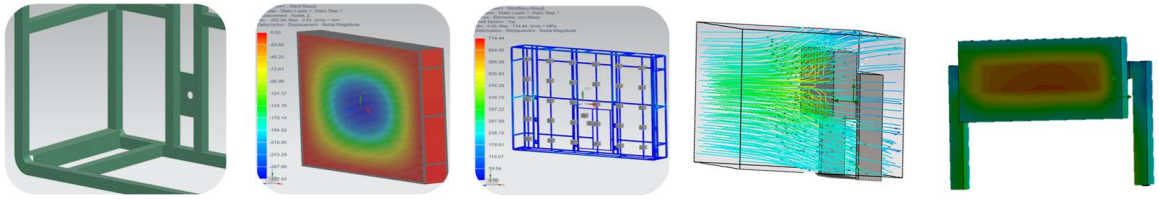




Fast & simple but can be highly inaccurate

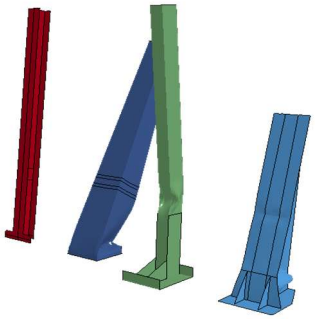
Complex but more accurate

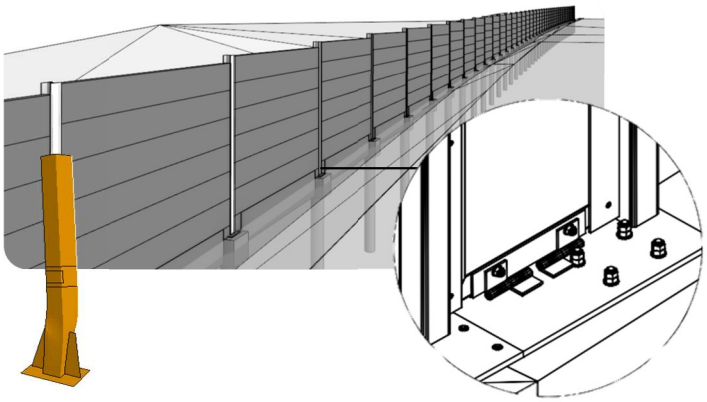
Simulation



STRUCTURE RESISTANCE & NOISE REDUCING DEVICES

- EN 40
- EN 12899
- EN 12966
- EN 1793, 1794
- EN 14388



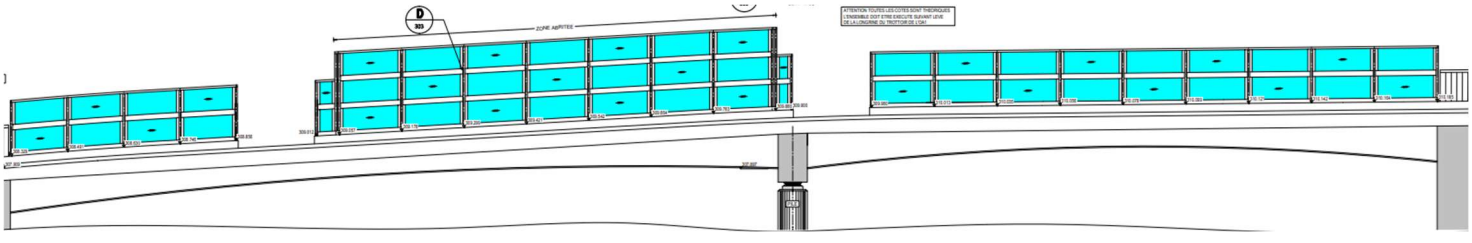


Wind load

$$q(z) = \delta * \beta * f * C_e(z) * q_{(10)}$$

Total wind force

$$F_w = c_s c_d \, . \, c_f \, . \, q_p(z_e) \, . \, A_{ref}$$



III. SECURITY PRODUCTS

STANDARDS

- PAS 68
- ASTM F2656
- ISO 22343

New Product Development

Vehicle security barrier systems, bollards, road blockers…

Family/modification

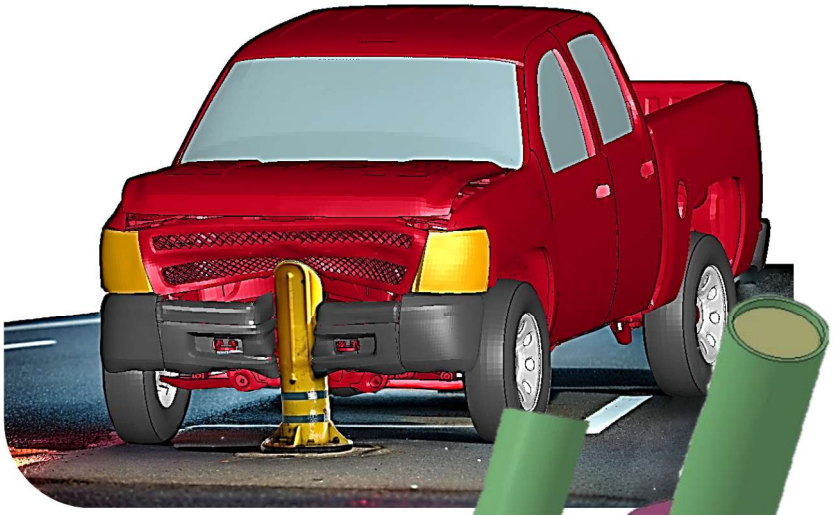
Simulation (modified products)

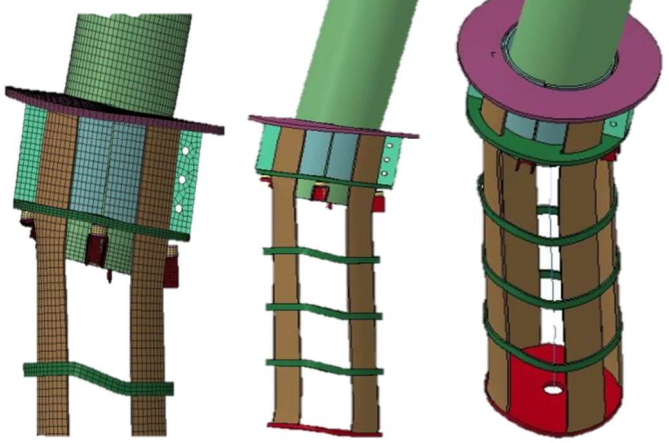
Adaptation to site conditions

Production, installation, aesthetic reasons …

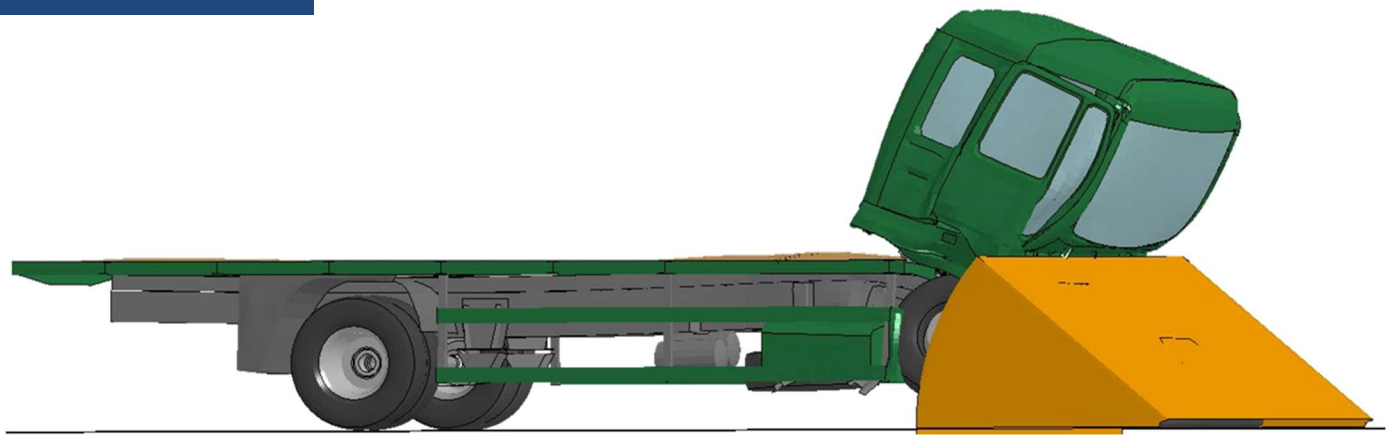
> **6 Design method**
>
> *NOTE The design method is used for variations or modifications in design to a previously classified VSB. Full-scale test data is used for interpolation and finite element analysis (FEA) may form part of this method. Further information on FEA and computer modelling validation can be found in PD CEN/TR 16303-4.*

BOLLARDS



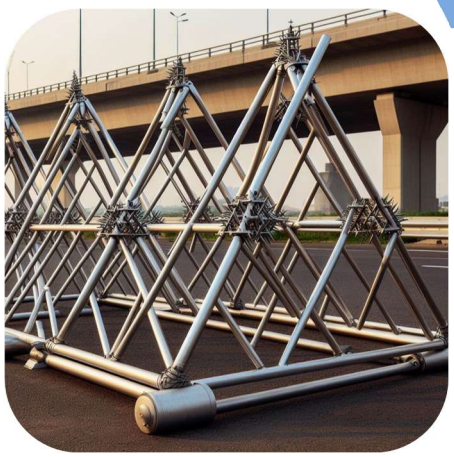


ROAD BLOCKERS



SECURITY BARRIERS

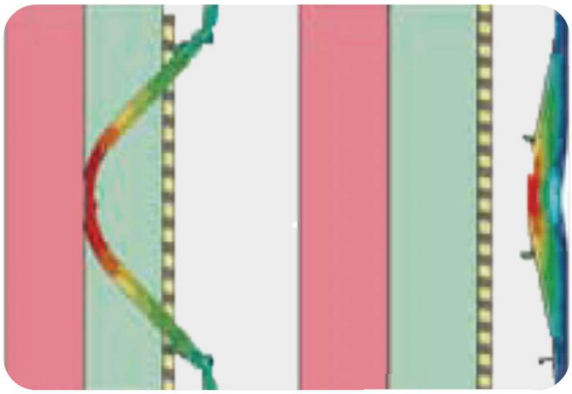
Mobile vehicle barriers (MVB)



Integrated products

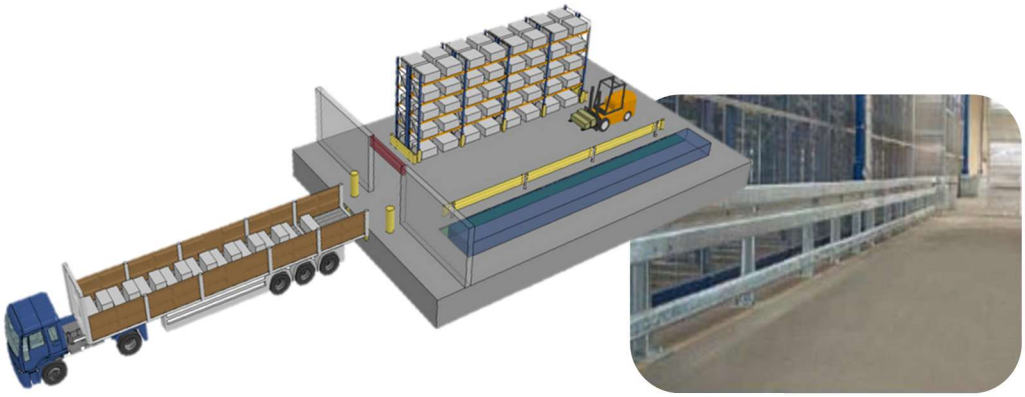
SAFETY BARRIERS

Lower maintenance costs with
more adapted and safe solutions

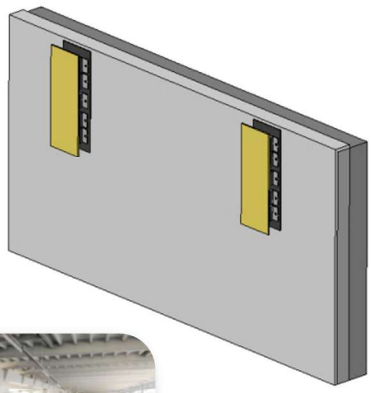


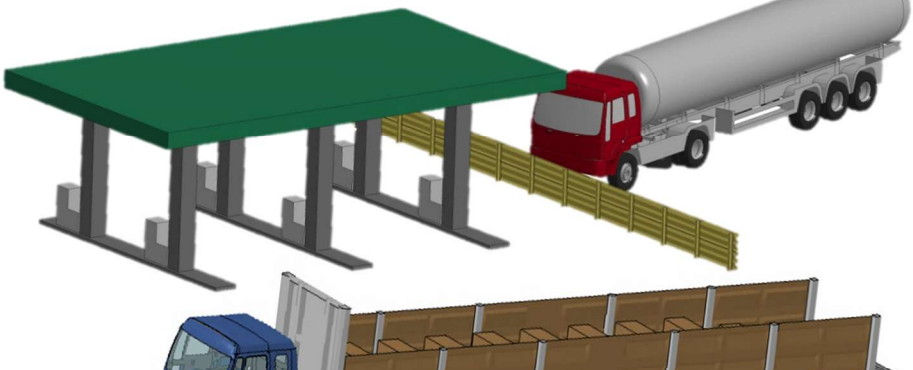
IV. INDUSTRIAL PROTECTIONS

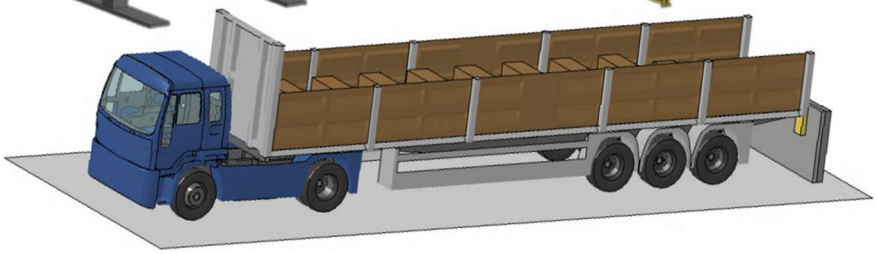
INDUSTRIAL SITES



SERVICE STATIONS & PARKINGS





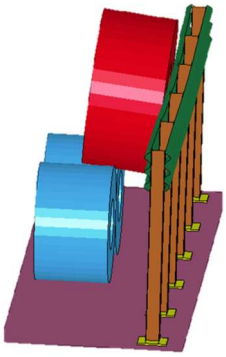


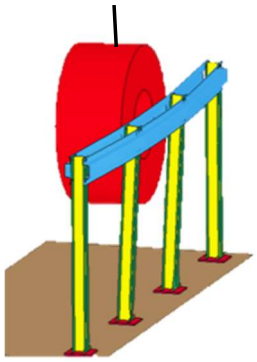
WALKWAY PROTECTIONS

IV. INDUSTRIAL PROTECTIONS

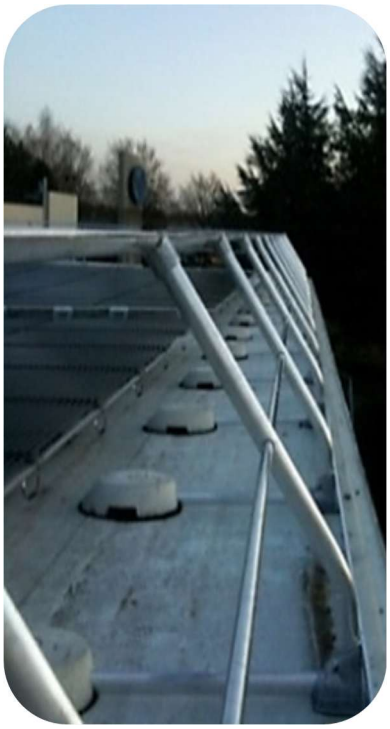
FALL PROTECTIONS

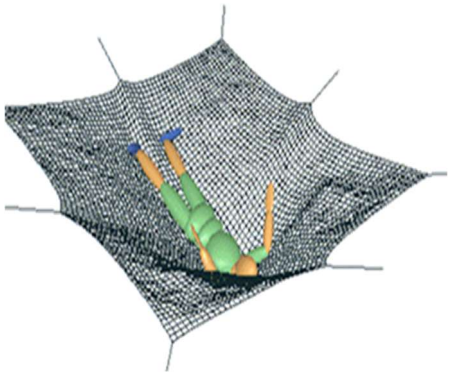
Objects



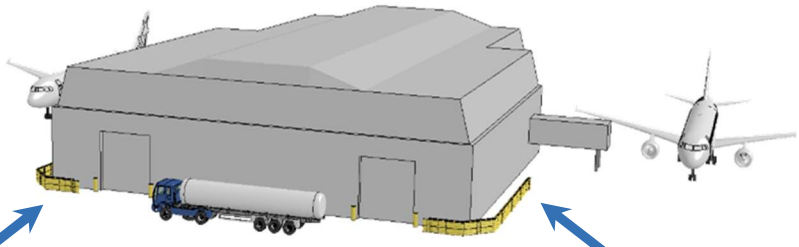


People





LOGISTICS



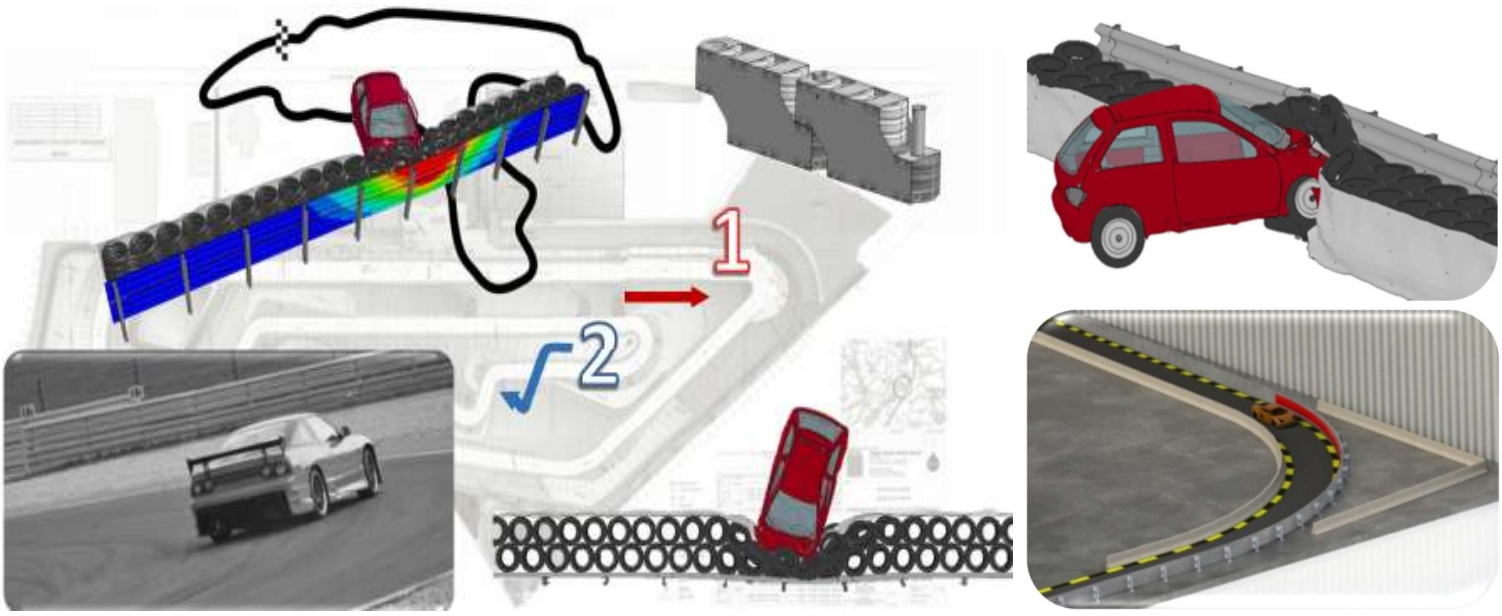
IV. INDUSTRIAL PROTECTIONS

CIRCUIT SAFETY BARRIERS

➢ FIA 3501-2017

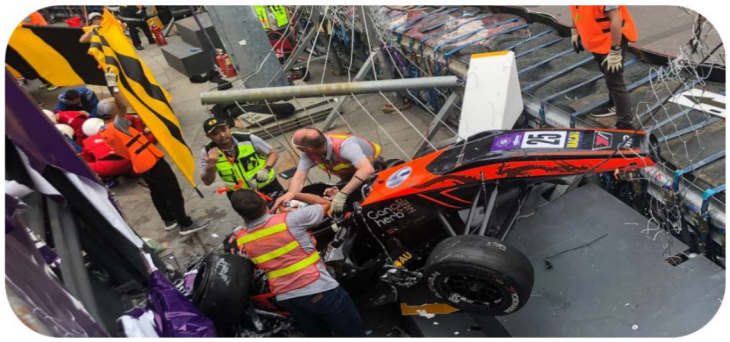
Analysis of trajectories, masses & speeds

Protection design



DEBRIS FENCES

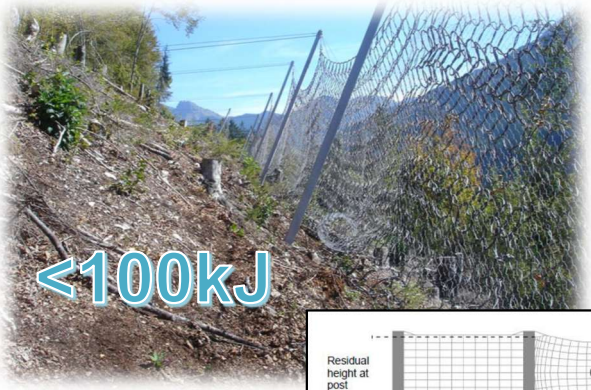
➢ FIA 3502-2018



ENERGY OF THE ROCK

Low — High

EAD 340089 — EAD 340059-00-0106



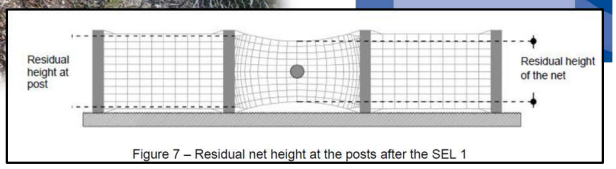
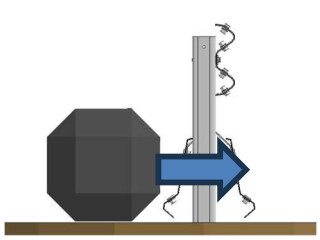
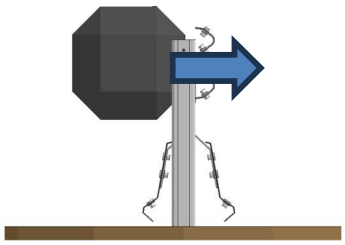
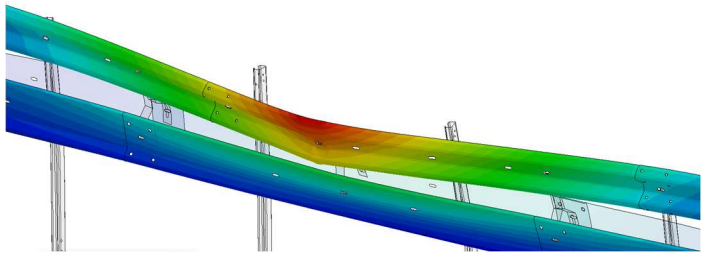
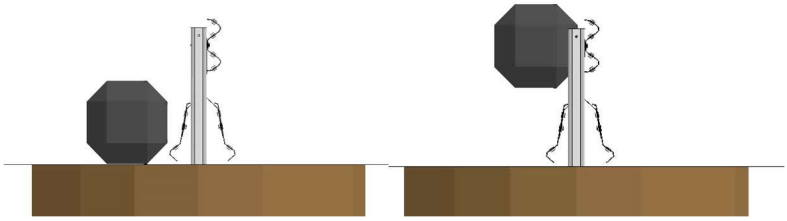


Figure 7 – Residual net height at the posts after the SEL 1







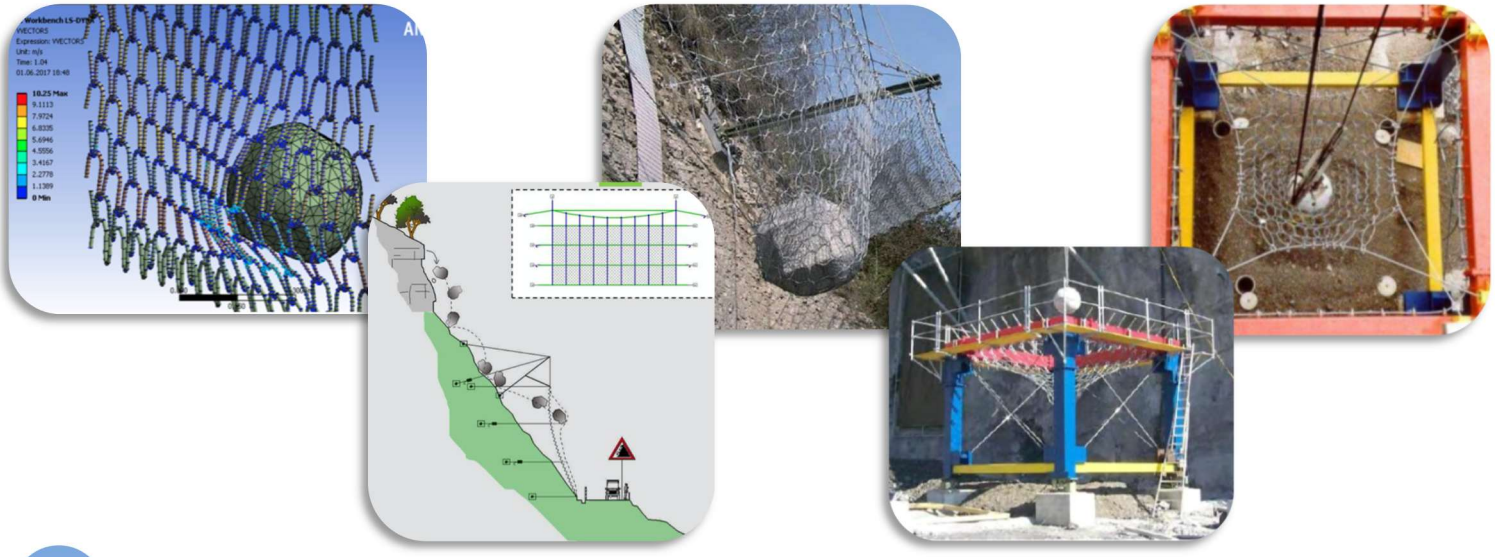


Adding a motorcycle protection on the reverse side of the system

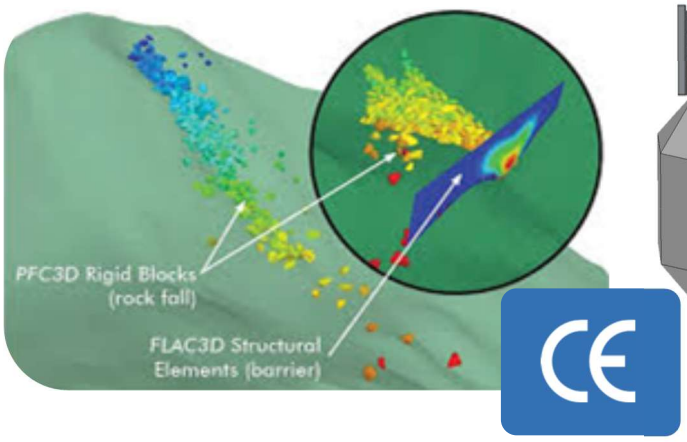
STANDARDS

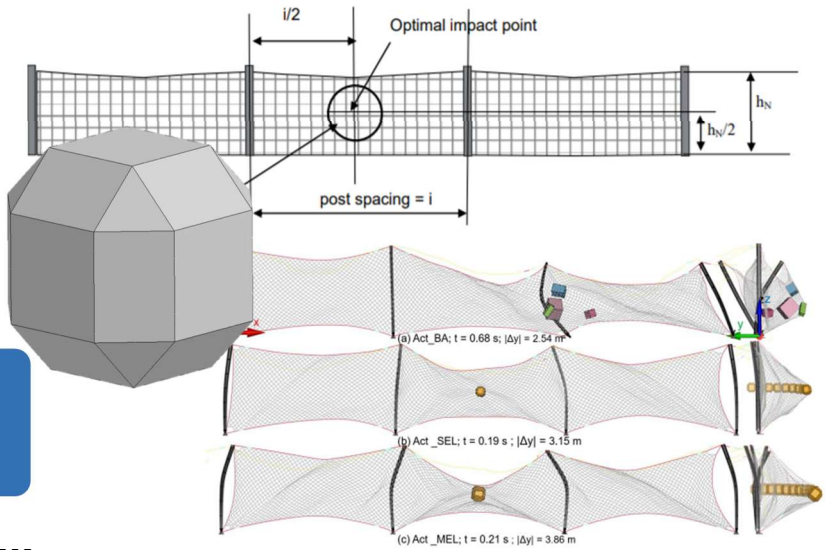
New product development

➢ EAD 340059

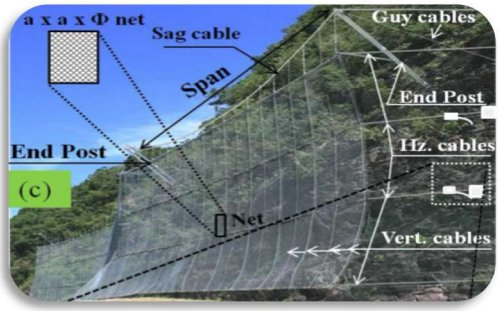


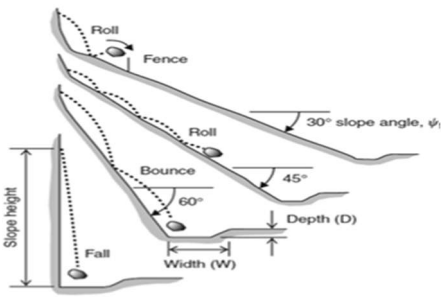
Family / modification



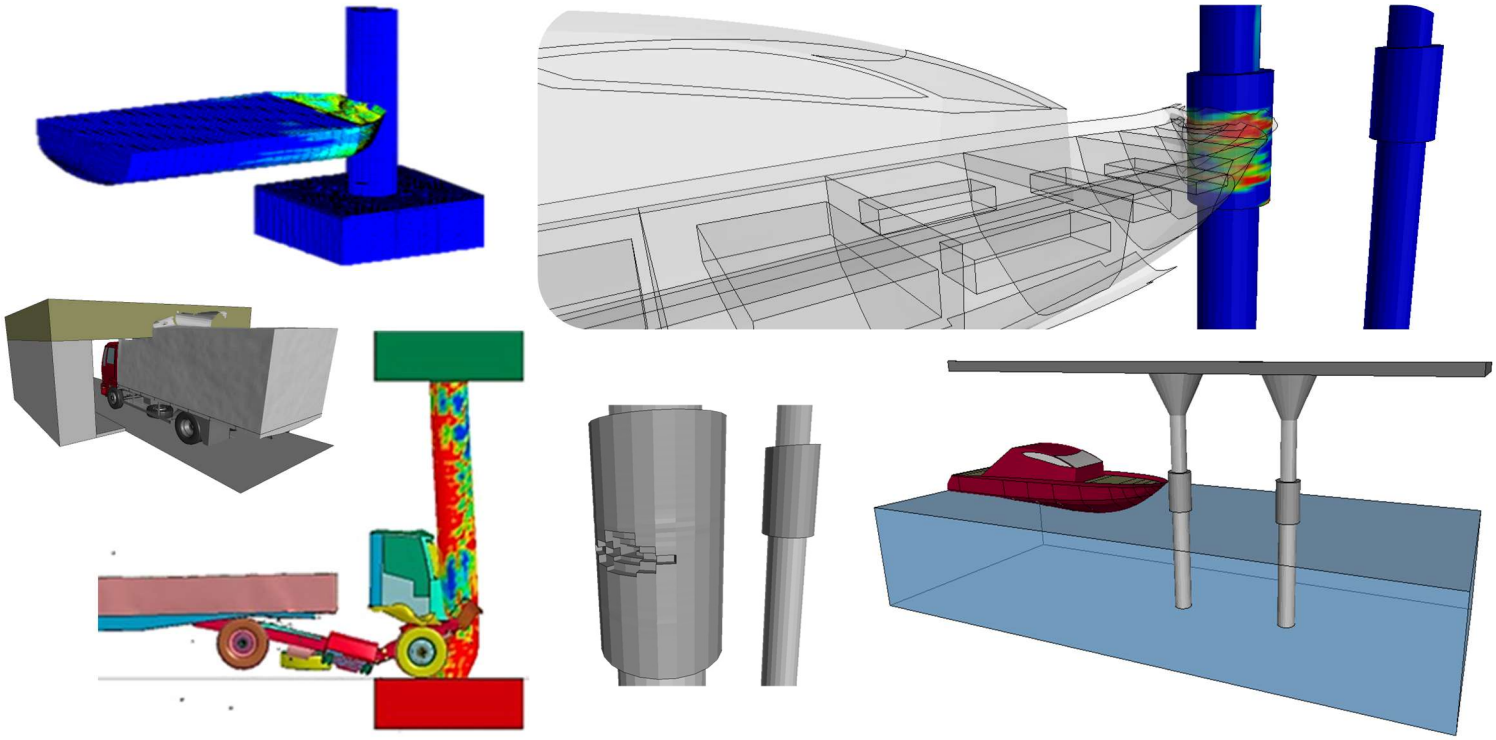


Adaptation to site conditions

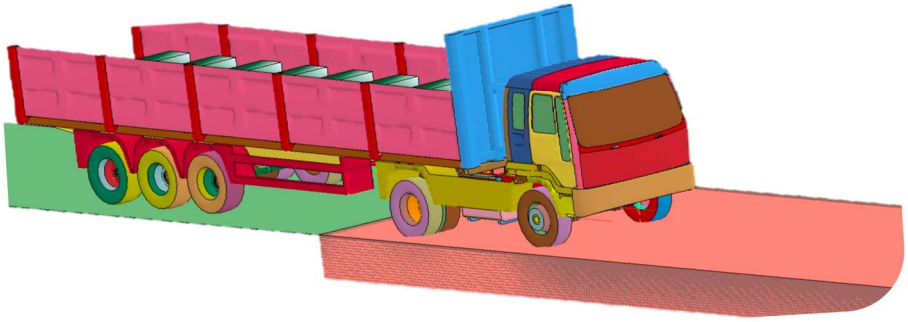




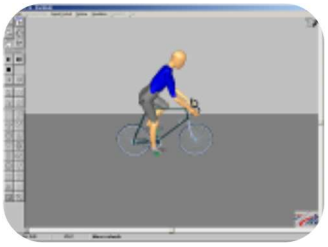
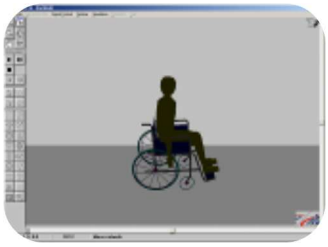
VEHICLES ON BRIDGE IMPACT



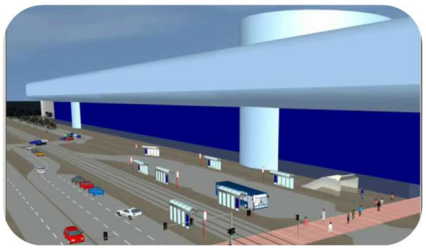
EMERGENCY RAMP



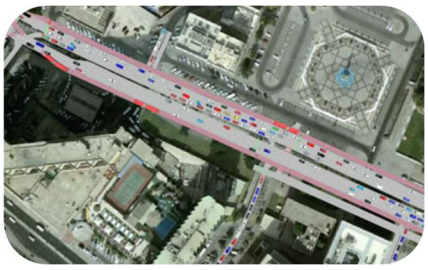
TRAFFIC SIMULATION

Analysis, optimization and simulation

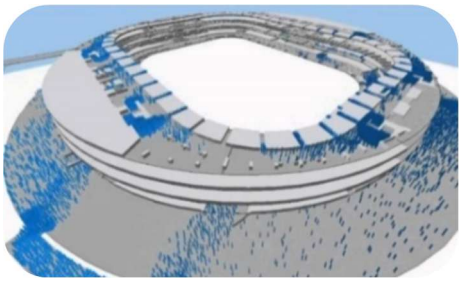



From huge avenues to details

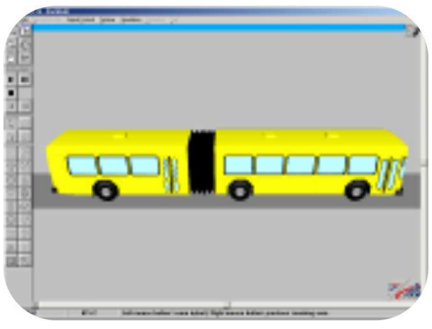
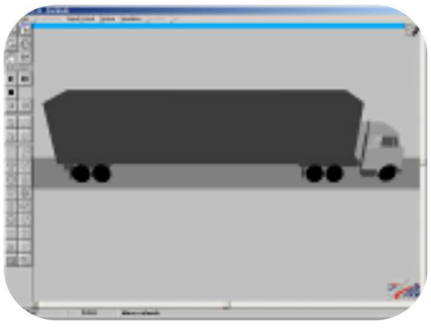



Manage crisis scenarios

The design of emergency exits guarantees the fastest and safest evacuation of large buildings and events



Vehicles

EN 1317: RRS EUROPEAN STANDARD

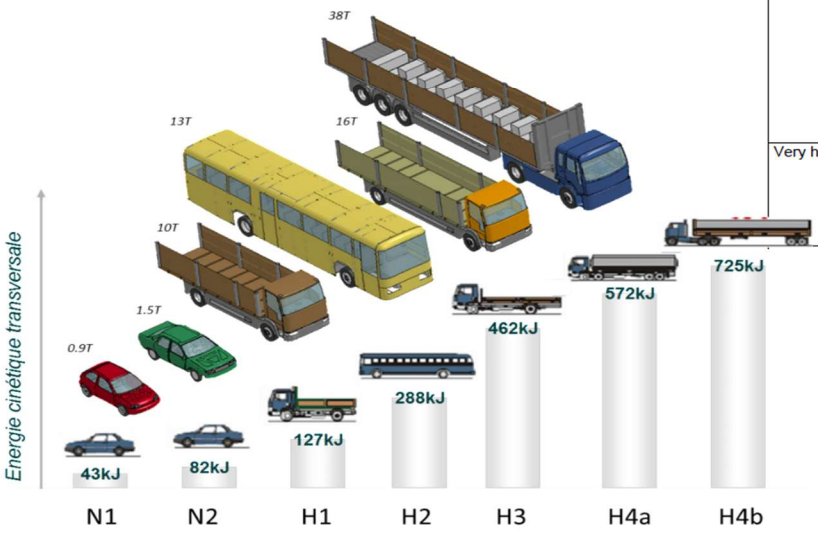
Containment level

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

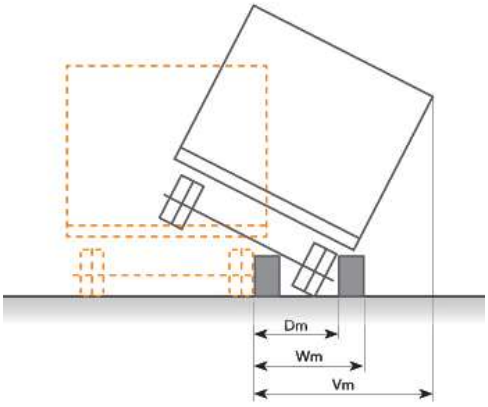


Acceleration severity index

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	/	$VI_N \geq 3,5$

MASH (NCHRP350)

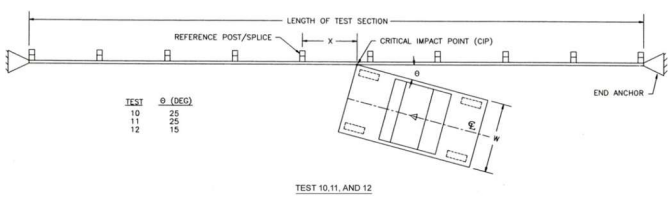
Containment level

Test Level	Vehicle designation	Impact severity [KJ]	Impact conditions	
			Speed mph (km/h)	Angle (deg.)
T1-10	1100C	18,9	31 (50.0)	25
T1-11	2270P	39,1	31 (50.0)	25
T2-10	1100C	37,1	44 (70.0)	25
T2-11	2270P	76,6	44 (70.0)	25
T3-10	1100C	75,8	62 (100.0)	25
T3-11	2270P	156,4	62 (100.0)	25
T4-10	1100C	75,8	62 (100.0)	25
T4-11	2270P	156,4	62 (100.0)	25
T4-12	10000S	209,3	56 (90.0)	15
T5-10	1100C	75,8	62 (100.0)	25
T5-11	2270P	156,4	62 (100.0)	25
T5-12	36000V	595,4	50 (80.0)	15
T6-10	1100C	75,8	62 (100.0)	25
T6-11	2270P	156,4	62 (100.0)	25
T6-12	36000T	595,4	50 (80.0)	15

Geo Metro *[820C] (N)* — Toyota Yaris *[1100C] (M)* — Chevrolet C2500 *[2000P] (N)* — Chevrolet Silverado *[2270P] (M)*

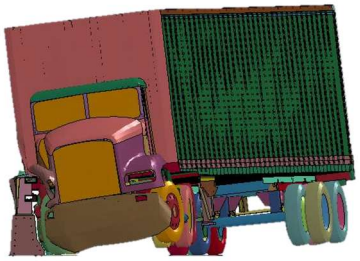
Truck *[8000S] (N) [10000S] (M)* — Van trailer *[36000V] (N,M)* — Tank trailer *[36000T] (N,M)*

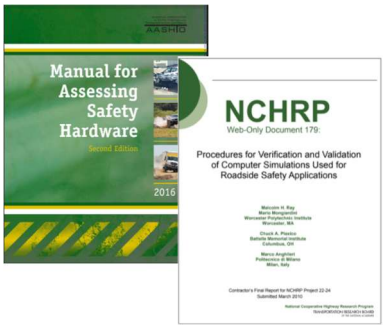
Test Level	Vehicle designation	Impact Conditions	
		Speed mph (km/h)	Angle (deg)
1-10	820C	31 (50)	20
1-11	2000P	31 (50)	25
2-10	820C	44 (70)	20
2-11	2000P	44 (70)	25
3-10	820C	62 (100)	20
3-11	2000P	62 (100)	25
4-10	820C	62 (100)	20
4-11	2000P	62 (100)	25
4-12	8000S	50 (80)	15
5-10	820C	62 (100)	20
5-11	2000P	62 (100)	25
5-12	36000V	50 (80)	15
6-10	820C	62 (100)	20
6-11	2000P	62 (100)	25
6-12	36000T	50 (80)	15



Example of recommended assessment summary page for individual crash tests

Evaluation Criteria	Test Results	Assessment
Structural Adequacy A. Test article should contain and redirect the vehicle; the vehicle should not penetrate, underride, or override the installation, although controlled lateral deflection of the test article is acceptable.	Vehicle contained and smoothly redirected.	Pass
Occupant Risk H. Occupant Impact Velocities (OIV) (see Appendix A, Section A5.2.2 for calculation procedure) should satisfy the following limits: Occupant Impact Velocity ft/s (m/s) Component / Preferred / Maximum Longitudinal and Lateral / 30 (9) / 39 (12)	Longitudinal OIV = 33 ft/s (10 m/s) Lateral OIV = 8 ft/s (2.5 m/s)	Pass
Vehicle Trajectory N. Vehicle trajectory behind the test article is acceptable.	Not applicable	Pass





END TERMINALS CEN/TS 1317-7

*New draft for terminals : **CEN/TC 226/WG1N575:2022***

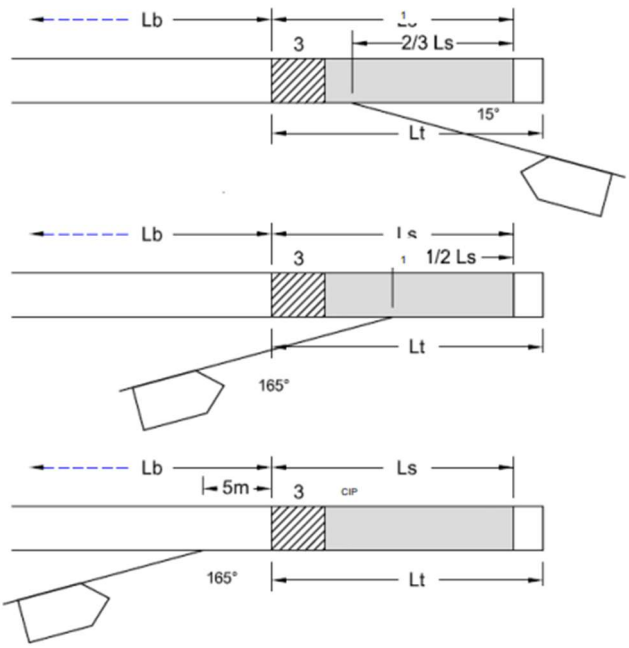
Restraint Category (T)	Direction Category		Performance class (P)	Test					
T50	UTA				TT2.1.50				
T80/3	UTA		P1		TT2.1.80				
T80/2	UTA	BDT	P2		TT2.1.80		TT4.2.80		
	UTD							TT5.1.80	
T80/1	UTA	BDT			TT2.1.80		TT4.2.80		
	UTD							TT5.1.80	TT6.2.80
T80	UTA	BDT		TT1.2.80	TT2.1.80	TT3.2.80	TT4.2.80		
	UTD							TT5.1.80	TT6.2.80
T100/1	UTA	BDT	P3	TT1.2.100	TT2.1.100		TT4.2.100		
	UTD							TT5.1.100	
T100	UTA	BDT		TT1.2.100	TT2.1.100	TT3.2.100	TT4.2.100		
	UTD							TT5.1.100	TT6.2.100
T110/1	UTA	BDT	P4	TT1.3.110	TT2.1.100		TT4.3.110		
	UTD							TT5.1.100	
T110	UTA	BDT		TT1.3.110	TT2.1.100	TT3.3.110	TT4.3.110		
	UTD							TT5.1.100	TT6.3.110

UTA : Uni-direction terminal approach
UTD : Uni-direction terminal departure
BDT : Bi-directional terminal (All BDT's can be tested in both categories UTA and UTD)

Different types of teminals




Example of different restraint level



Impact severity

Impact severity categories	Index values		
A	ASI ≤ 1,0	and	THIV ≤ 44 km/h in Approach 1, 2 and 3 THIV ≤ 33 km/h in Approach 4, 5 and 6
B	ASI ≤ 1,4	and	THIV ≤ 44 km/h in Approach 1, 2 and 3 THIV ≤ 33 km/h in Approach 4, 5 and 6

NOTE 1 Impact severity category A affords a greater level of safety for the occupants of an errant vehicle than category B.
NOTE 2 The limit value for THIV is higher in Approach 1, 2 and 3 because experience has shown that higher values can be tolerated by occupants in frontal impacts (also because of better passive safety in this direction). Such a difference in human tolerance between frontal and lateral impacts is already considered in the ASI parameter, which therefore does not need to be changed.

TS 16786 : Truck Mounted Attenuator

Peugeot 205
[900kg]

Condition of mobil carrier prior to test

Mobile carrier (where applicable)		
Transmission	**Parking brake**	**Steering Angle**
Neutral	On	0 ± 5°

Impacting Vehicle Specification

Mass kg	
Total mass	2 000 ± 75
Test inertial mass	2 000 ± 75
Maximum ballast[a]	200
Dimensions m Limit deviation (± 15%)	
Wheel track (front and rear)	1,6
Centre of mass location m[b]	
Longitudinal distance from front axle (CGX) ± 10%	1,4
Lateral distance from vehicle centre line (CGY)	± 0,10
Height above ground of vehicle mass (CGZ) ± 10%	0,65
Type of vehicle	Motor Vehicle
Number of axles[c]	1S+1

a Including measuring and recording equipment.
b The centre of mass of vehicles with two axles shall be determined in conformity with ISO 10392.
c S: steering axle

Speed Class 80 Test matrix

Speed Class	Test Designation	Impacting vehicle			Total mass of the whole system
		Total Test Mass kg	Impact Speed km/h	Approach angle and location of impact point, see Figure 1	
80	T-TMA80-1	900	80	head-on, centre	Maximum specified by the manufacturer
	T-TMA80-2	2 000	80	head-on, centre	10 000 kg or maximum specified by the manufacturer if less than 10 000 kg, or minimum specified by the manufacturer if greater than 10 000 kg
	T-TMA80-3 Additional Test	2 000	80	head-on, centre	Maximum specified by the manufacturer
	T-TMA80-4	2000	80	nose ¼ offset, at 10°	Minimum specified by the manufacturer

Speed Class 100 Test matrix

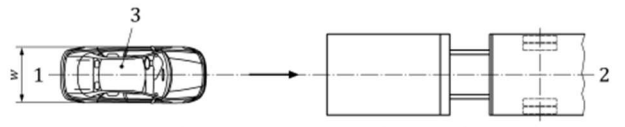
Speed Class	Test Designation	Impacting vehicle			Total mass of the whole system
		Total Test Mass kg	Impact Speed km/h	Approach angle and location of impact point, see Figure 1	
100	T-TMA100-1	900	100	head-on, centre	Maximum specified by the manufacturer
	T-TMA100-2	2 000	100	head-on, centre	10 000 kg or maximum specified by the manufacturer if less than 10 000 kg, or minimum specified by the manufacturer if greater than 10 000 kg
	T-TMA100-3 Additional Test	2 000	100	head-on, centre	Maximum specified by the manufacturer
	T-TMA100-4	2 000	100	nose ¼ offset, at 10°	Minimum specified by the manufacturer

Speed Class 50 Test matrix

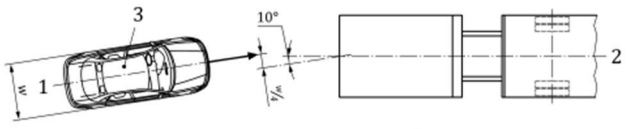
Speed Class	Test Designation	Impacting vehicle			Total mass of the whole system
		Total Test Mass kg	Impact Speed km/h	Approach angle and location of impact point, see Figure 1	
50	T-TMA50-2	2 000	50	head-on, centre	10 000 kg, or maximum specified by the manufacturer if less than 10 000 kg, or minimum specified by the manufacturer if greater than 10 000 kg
	T-TMA50-4	2 000	50	nose ¼ offset, at 10°	Minimum specified by the manufacturer

Impact severity values

Impact severity index	Maximum index values
ASI A	≤ 1.0
ASI B	≤ 1.4
ASI C	≤ 1.9
THIV	44 km/h



a) Head-on Centre Impact (Approaches 1, 2, and 3)



b) Nose ¼ Offset, at 10° (Approach 4)

Key
1 centre line of impacting vehicle
2 centre line of TMA
3 location of driver's side of vehicle

TS 17342 : Motorcycle road restraint system

Tests

Test	MPS type	Launch configuration (see 6.9)	Speed km/h
TM.1.60	CMPS and DMPS	Post-Centred (1)	60
TM.2.60	DMPS	Post offset (2)	60
TM.3.60	CMPS	Mid-span (3)	60
TM.1.70	CMPS and DMPS	Post-Centred (1)	70
TM.2.70	DMPS	Post offset (2)	70
TM.3.70	CMPS	Mid-span (3)	70

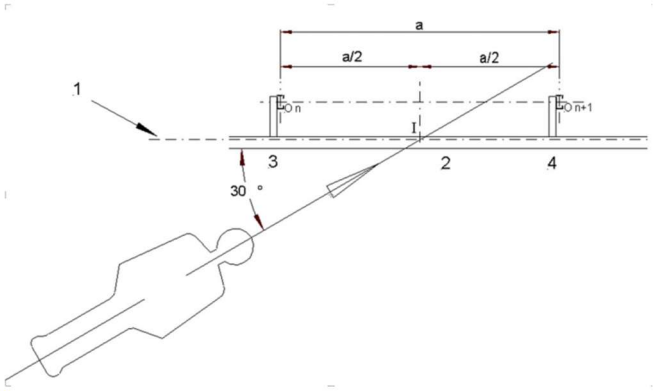
CMPS Continuous Motorcyclist Protection System
DMPS Discontinuous Motorcyclist Protection System
MPS Motorcyclist Protection System

Speed classes for DMPS

Class	Tests required	
D60	TM.1.60	TM.2.60
D70	TM.1.70	TM.2.70

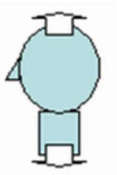
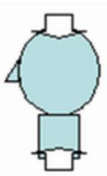
Speed classes for CMPS

Class	Tests required	
C60	TM.1.60	TM.3.60
C70	TM.1.70	TM.3.70



Key
1 Contact surface of system
2 Continuous system
3 Post n
4 Post n+1

Severity levels

Severity level	Maximum admissible values						
	Head	Neck					
		F_x N	$F_{Z\ tension}$ N	$F_{z\ compression}$ N	MOC_x Nm	$MOC_{y\ extension}$ Nm	$MOC_{y\ flex}$ Nm
	HIC_{36}						
I	650	Figure 7	Figure 8	Figure 9	134	42	190
II	1 000	Figure 10	Figure 11	Figure 12	134	57	190

EN 12767: PASSIVE SAFETY OF SUPPORT STRUCTURES


Peugeot 205 *[900kg]*

Impact speeds

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

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

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	$5 < v_e \le 50$	$30 < v_e \le 70$	$70 < v_e \le 100$

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]	

VEHICLE SECURITY BARRIER SYSTEMS

PAS 68 (PAS 69)

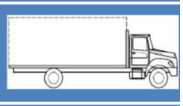
Test vehicle classification	Vehicle type	Weight (kg)	Speed (km/h)	Impact angle
Car	M1 	1500	16, 32, 48, 64, 80, 96, 112	0° to 90° in 5 intervals
4x4 pick-up (crew cab design)	N1G 	2500	16, 32, 48, 64, 80, 96, 112	0° to 90° in 5 intervals
Day cab vehicles	N1 flat bed (RWD) 	3500	16, 32, 48, 64, 80, 96	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

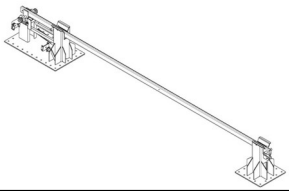
Interpreting the PAS 68 classification code

V/7500[N2]/64/90:1.7/0.0

Test Method / Test Weight [Vehicle Class] / Speed [kph] / Angle:Penetration / Dispersion

ASTM F 2656 - 07(US)

Type of test vehicle (kg)	Condition designation	Nominal minimun test velocity (km/h)	Kinetic energy (kj)
Small passenger car (C) 1100 	C40	65	179
	C50	80	271
	C60	100	424
Pick up truck (P) 2300 	PU40	65	375
	PU50	80	568
	PU60	100	887
Medium-duty truck (M) 6800 	M30	50	656
	M40	65	1110
	M50	80	1680
Heavy goods vehicle (H) 29500 	H30	50	2850
	H40	65	4810
	H50	80	7280

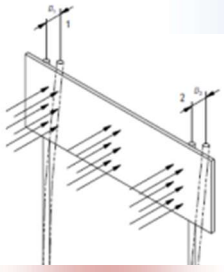


Penetration rating

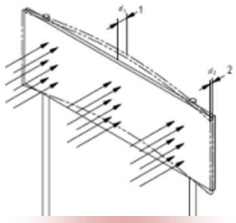
Penetration designation	Dynamic penetration rating
P1	≤1m
P2	1,01m to 7m
P3	7,01m to 30m
P4	30m or greater

EN 12899-1: ROAD SIGNS MECHANICAL RESISTANCE

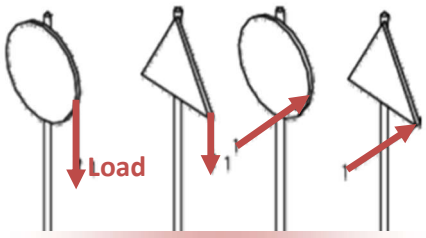
Application point



Deflection of supports



Deflection of sign plate



Bi-directional testing

Table 8 — Wind pressure

Class	Wind pressure kN.m^{-2}
WL0	No performance determined
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

EN 40

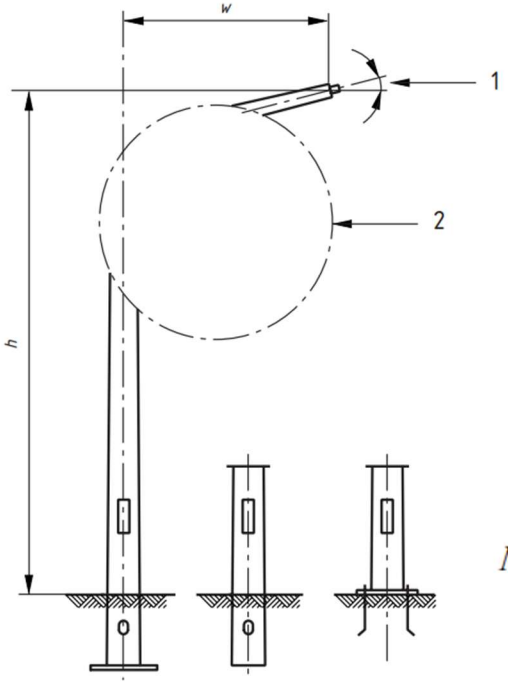


Table 1 — Description of terrain category

Category	Description
I	Rough open sea. Lakeshore with at least 5 km fetch upwind. Smooth flat country without obstacles.
II	Farmland with boundary hedges, occasional small farm structures, houses or trees.
III	Suburban or industrial areas and permanent forests
IV	Urban areas in which at least 15 % of the surface is covered with buildings and their average height exceeds 15 m.

Unreinforced openings in regular cross-sections

Bending moment of resistance, in Nm :

$$M_{ux} = \frac{f_y g \phi_3 Z_{pn}}{10^3 \gamma_m} \qquad M_{uy} = \frac{f_y g \phi_3 Z_{py}}{10^3 \gamma_m}$$

Torsional moment of resistance, in Nm :

$$T_u = \frac{f_y g \phi_4 \phi_5 R^3 t}{10^3 \gamma_m L}$$

EN 12966: VARIABLE MESSAGE SIGNS

CLASS DESIGNATION

Environmental parameters

Environmental parameters	Class designation	Remarks
Temperature	T1, T2, T3	
Protection	P1, P2, P3	P3 is the most restrictive

Class	ambient temperature (°C)	
	Minimum	Maximum
T1	-15	+60
T2	-25	+55
T3	-40	+40

Test modules containing exposed electrical equipment shall be protected :

Class	Ingress Protection Level
P1	IP44
P2	IP54
P3	IP56

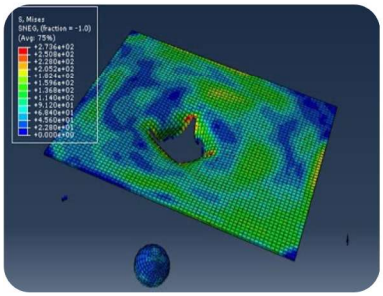
Photometric parameters

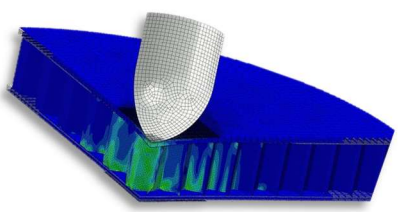
Photometric parameter	Class designation	Remarks
Colour	C1, C2	C2 is the more restrictive
Luminance (L_a)	L1, L2, L3, L3(*)	L3 has the highest luminance (*) for specific situations
	L1(T), L2(T), L3(T)	These classes are for tunnel use
Luminance ratio (LR)	R1, R2, R3	R3 has the highest luminance ratio
Beam width	B1, B2, B3, B4, B5, B6, B7	B7 has the widest beam

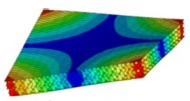
MECHANICAL TEST METHODS

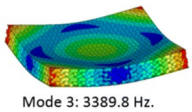
Table 13 — Impact Test

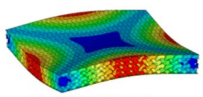
Impact tests shall be conducted on horizontally mounted test module front panel using a steel ball of 50 mm diameter with a mass of 0.51 kg dropped from a height h (1.3 m) to produce an impact energy of 6.5 Nm.
The test module shall be conditioned at a temperature of 20 °C (± 2 °C) and then be subject 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.






Mode 1: 1868.0 Hz.


Mode 3: 3389.8 Hz.


Mode 2: 2781.5 Hz.

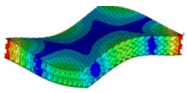
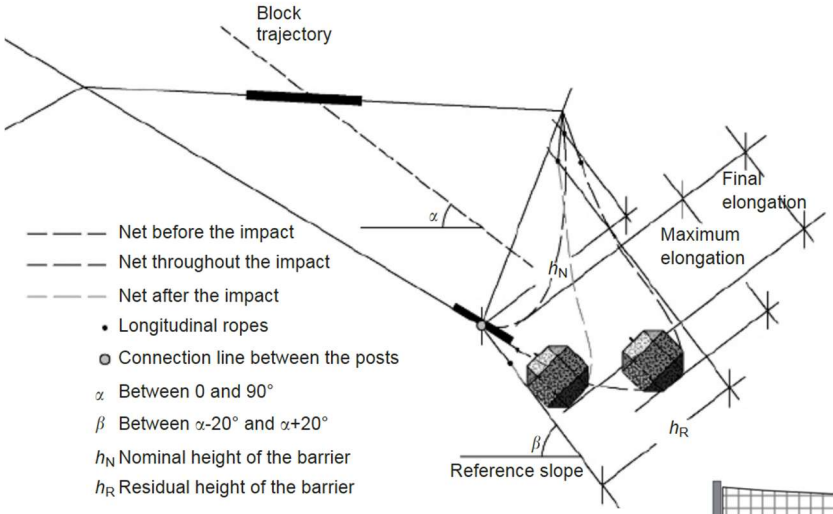

Mode 4: 4391.2 Hz.

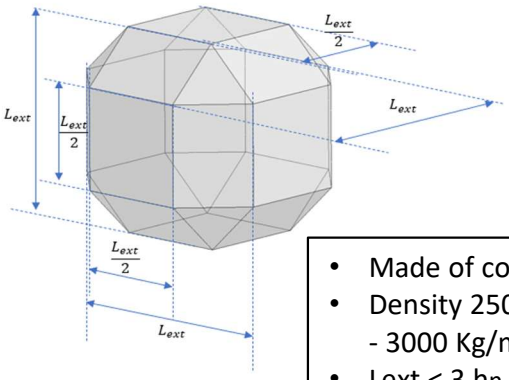
Table 14 — Vibration Test

Mounting :	The test module shall be securely fixed to the vibrating table.
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 g^2/Hz (10 Hz to 50 Hz). 0.013 g^2/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.

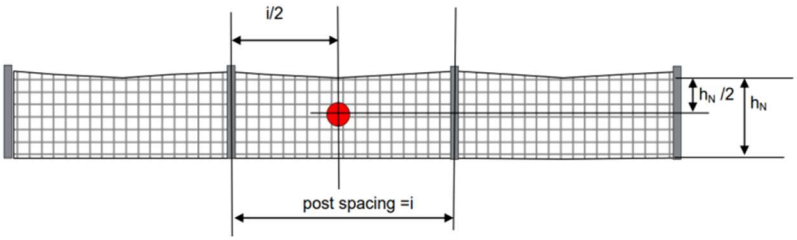
EAD340059: FALLING ROCK PROTECTION

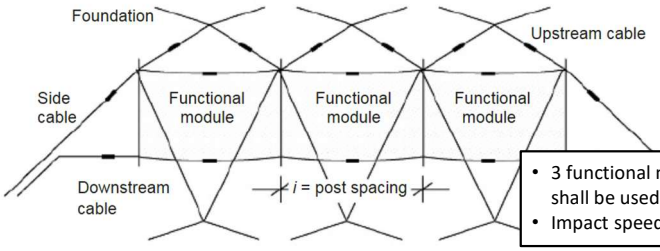
Energy absorbtion test





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





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

Impact test parameters

Barrier energy level	Test energy level	m: kg	L_{ext}: m	v_m: m/s	E_{km}: kJ
500 kJ	Maximum (MEL)	1610	0·85	25·44	521
	Service (SEL)	540	0·65	25·49	175
3000 kJ	Maximum (MEL)	9560	1·60	25·60	3136
	Service (SEL)	3430	1·10	25·80	1141
5000 kJ	Maximum (MEL)	16 200	1·96	25·45	5246

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

Note

MEL (100%) = Maximum Energy Level
SEL1, SEL2 (33%) = Service 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 shall be measured and declared during the MEL and SEL tests.

	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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