GDTECH engineering

Finite Element Simulation: Highlighting the need for Roadside Safety Equipment adaptation to site conditions

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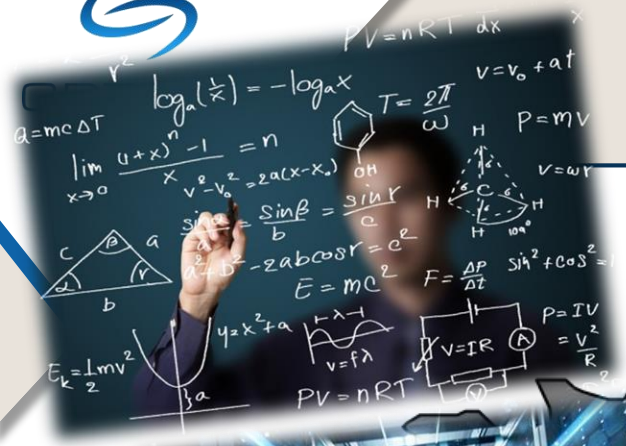
22/11/2019

GDTech: introduction



Liège

Valenciennes

Bordes

Avenue de l'Expansion, 7
B-4432 ALLEUR

Technopôle Transalley
180 rue Joseph-Louis Lagrange
F-59300 FAMARS

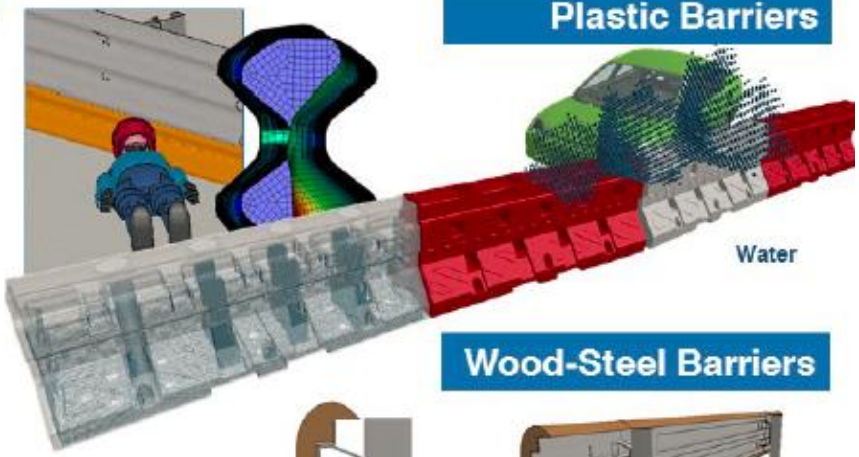
Site Aéropolis
F-64510 BORDES

200 employees including "Crash & Dynamic" department dealing with crash simulation!

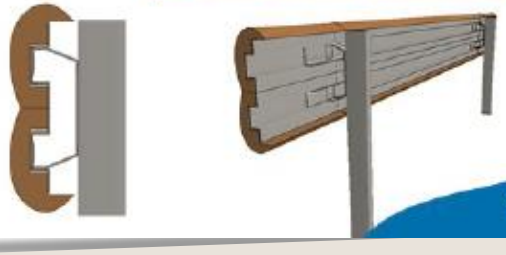
Products concerned: EN1317

Steel Barriers

Plastic Barriers



Wood-Steel Barriers



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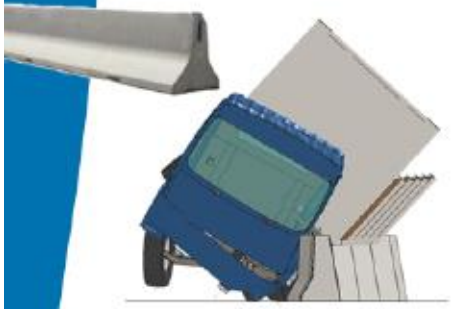
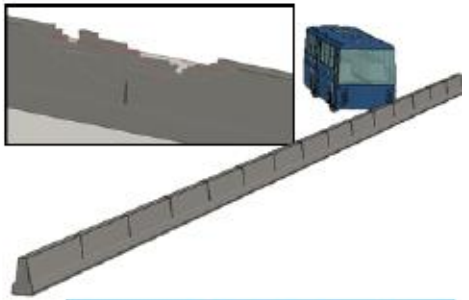
Concrete Barriers

- Prefabricated



- Cast In Place

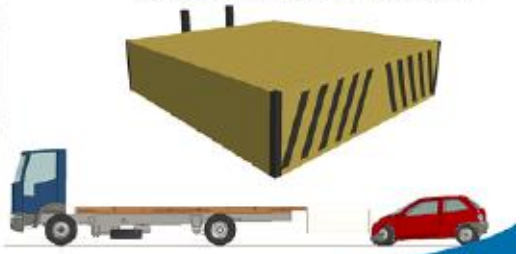


Cable Barriers

Absorbers

- Crash Cushion

- Truck Mounted Attenuator



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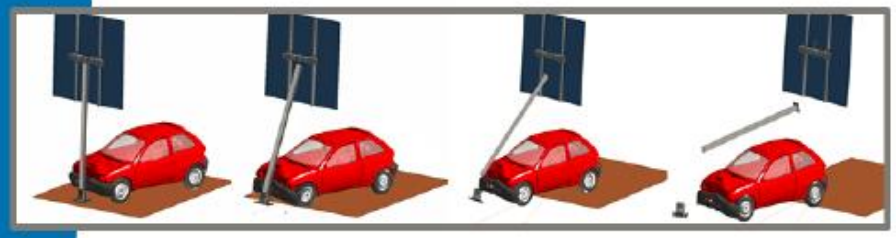
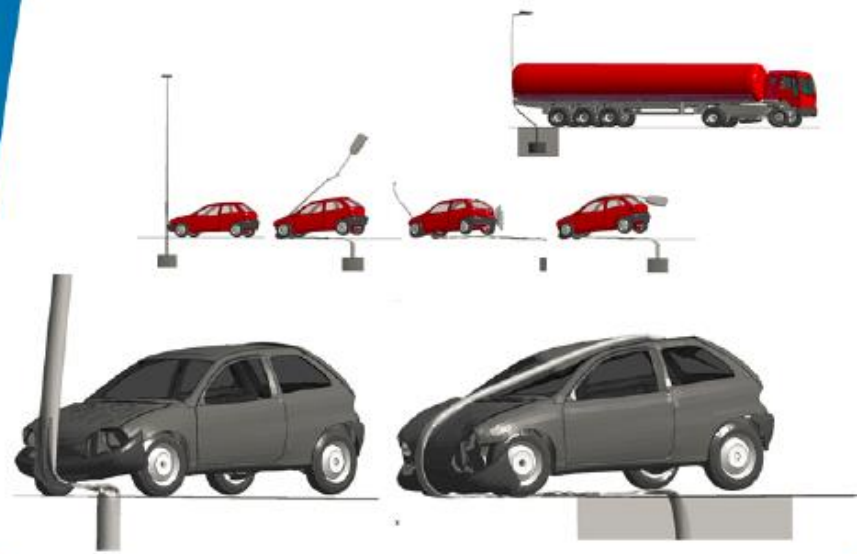
Products concerned: EN12767, IWA-14, PAS68, …

1 Safety Road signs support



2 Light Poles



EN12767, NCHRP350, MASH or equivalent

32

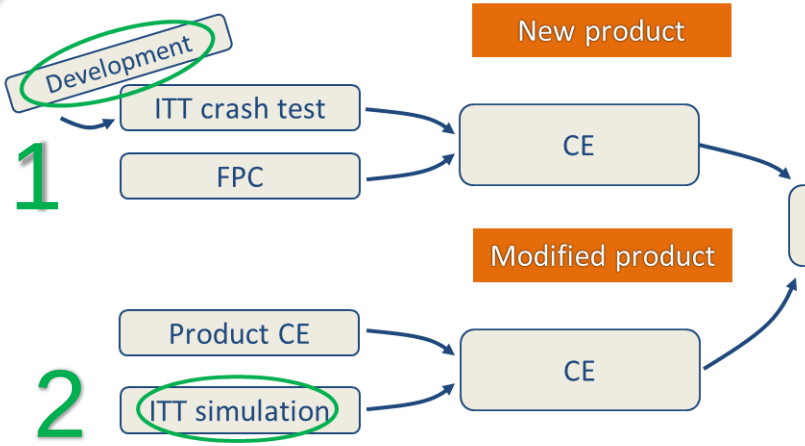
PAS 68
PAS 69
ASTM F2656
CWA 16221
IWA 14

3 Anti - Intrusion

34

Why simulations?

Before to be placed on the market



EN 1317 rules

Before installation on site

Adaptation to site conditions:

3

On site

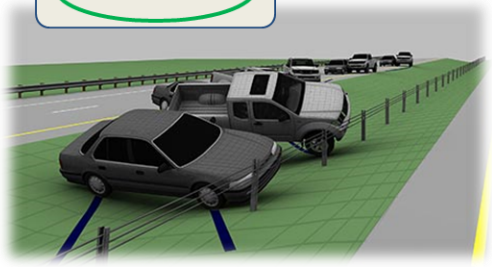
- *Soil modification*
- *Max speed limit*
- *Max CL in curve*
- *Bridge pile*
- *Gantry*
- *Bridge safety barriers*
- *Transitions*
- *Curve influence*
- *Motorcyclist protection*
- *Concrete safety barriers*
- *…*

National / Regional rules

After an accident

4

Accident



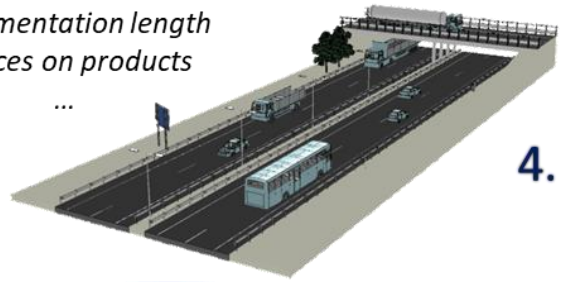
Insurance / Court

4 possible reasons for using simulations!

Why simulations?

3. Adaptation to Site Conditions

Implementation length
Advices on products
...



1. New Product Development

Safety barriers
Crash cushions
Terminals, Transitions
...

4. Accident Reconstruction

Crash scenarios
Influence of alternatives
...

2. Certification

ITT (Crash test / Simulation)
CE marking

CE

4 possible reasons for using simulations!

Why simulations?

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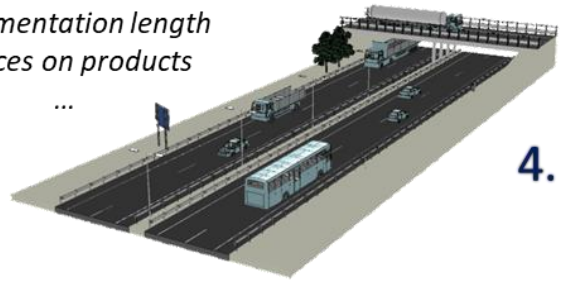

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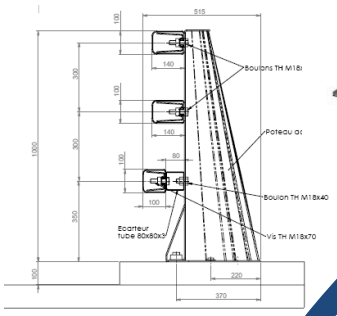
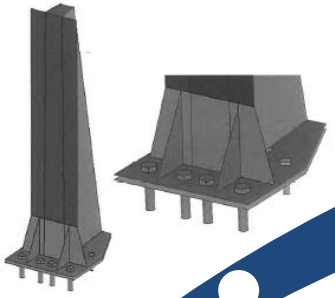
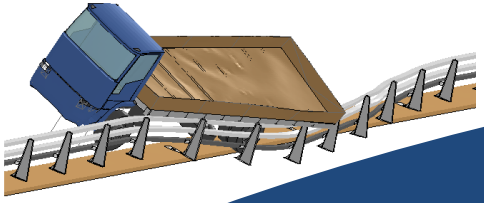
Reason n°1: New product development

1. New product development







Experimental crash test

Yes

Simulation → Positive results?

No

Digital model

Drawings

Simulation

Increase probability to pass the crash tests

Increase performance and/or decrease costs

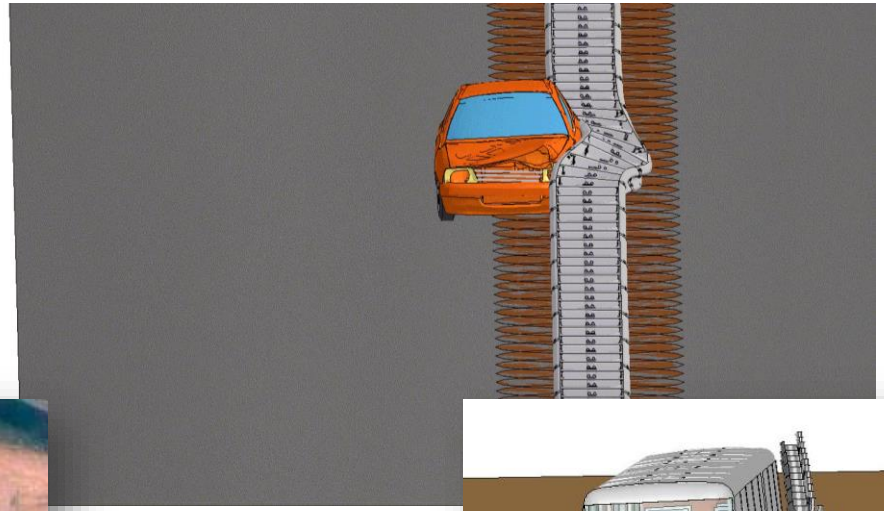
1. New product development

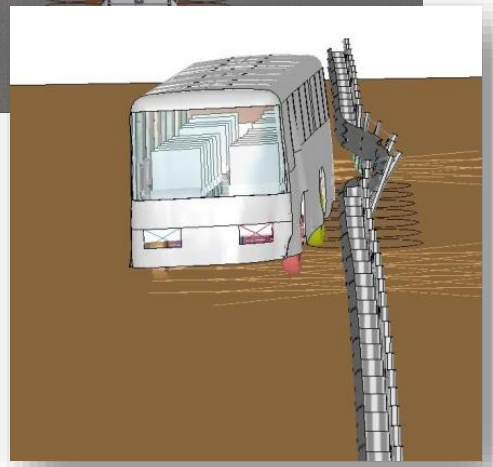
Ref: https://www.youtube.com/watch?v=aRf0IsLCmWU

Ref: https://www.youtube.com/watch?v=eWrN3t1805w

Goal n°1: Increase probability to pass the crash tests!

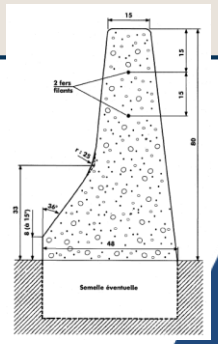
1. New product development

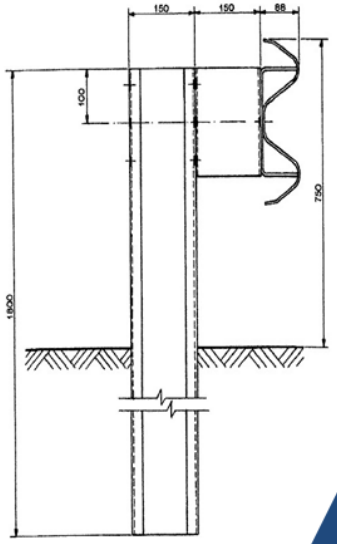


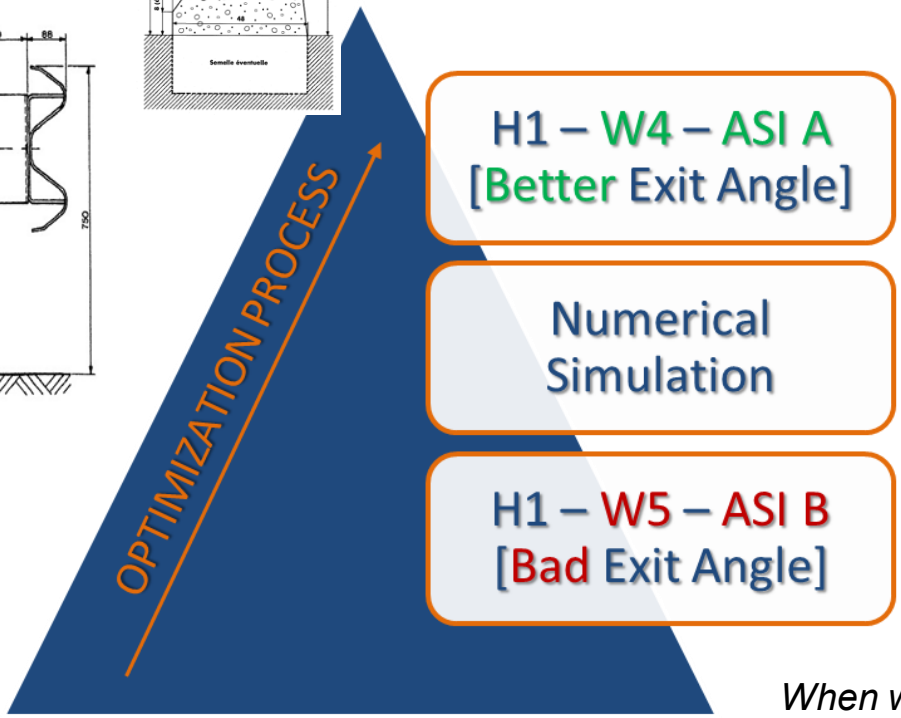


Goal n°1: Increase probability to pass the crash tests!

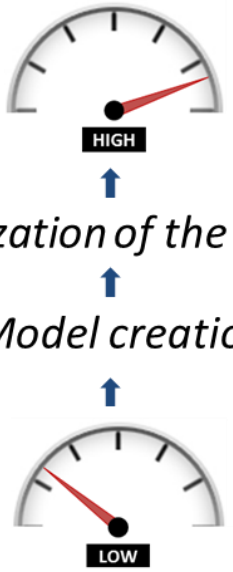
1. New product development







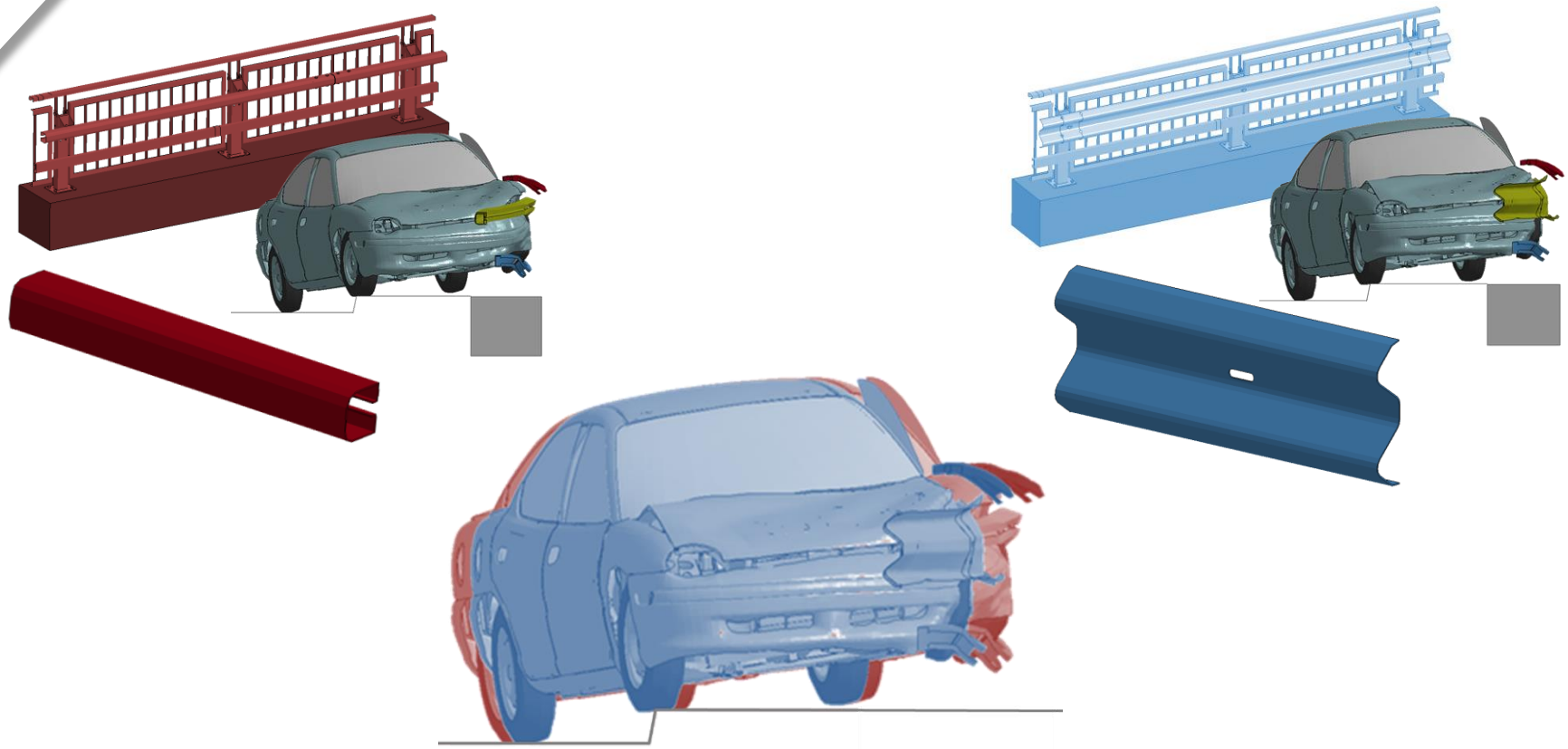
Weight reduction of ~ 25%



When working on design, grade of material, …

Goal n°2: Increase performance & / or decrease costs!

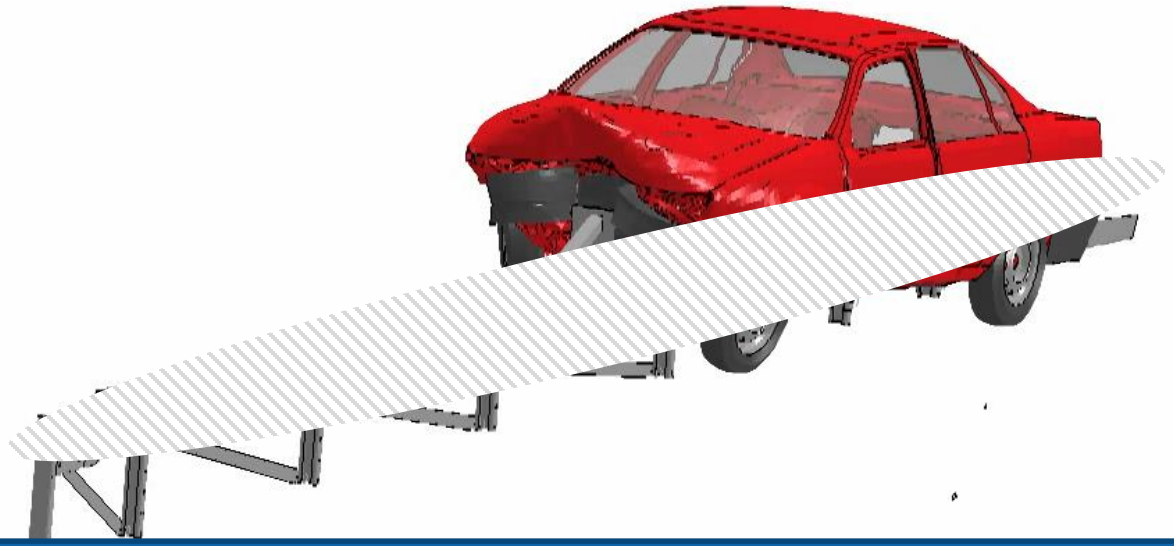
1. New product development

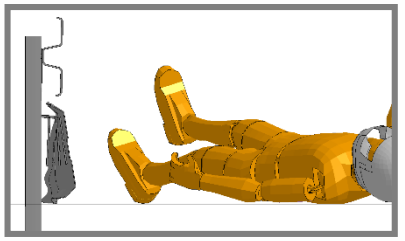


Goal n°2: Increase performance & / or decrease costs!

Ref: https://www.lemoniteur.fr/article/homologation-et-conditions-d-emploi-du-modele-de-barriere-garde-corps-double-fonction.2099

1. New product development



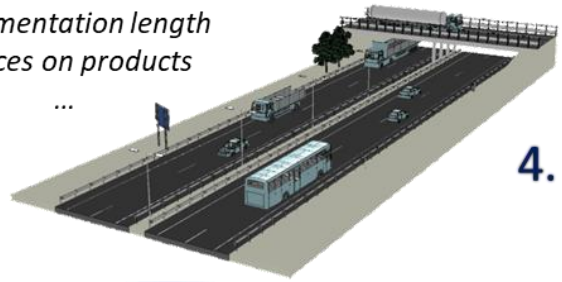


Example of simulation results compared to real tests

Why simulations?

3. Adaptation to Site Conditions

Implementation length
Advices on products
...



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2. Certification

ITT (Crash test / Simulation)
CE marking

CE

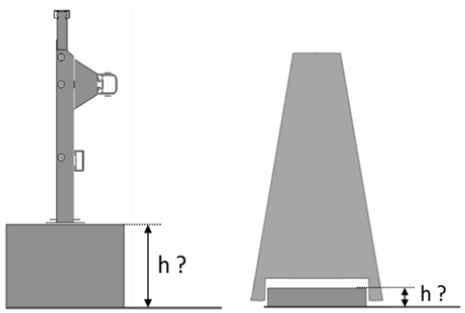
Reason n°2: Get a CE marking for a modified product

2. Product certification

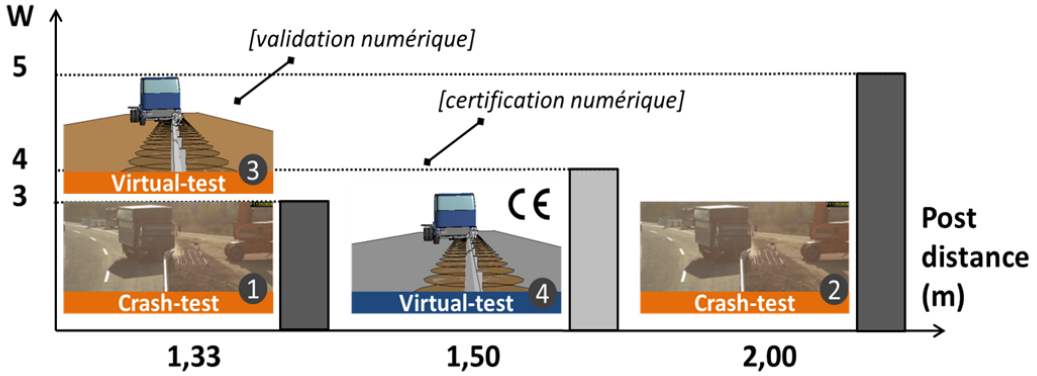
EN1317 (2010) standard for roadside protections (safety barriers, …) allows to use simulations to assess performances of modified products.
(the reference product should be tested with real crash test)

What you have :	What you want :	What you need :
• A product that passed the necessary crash-tests (which is CE) • A simulation reproducing the successful crash-tests	• adapting your product without having to perform new crash tests	• A simulation of the modified product using proven models according to EU best-practices (TR16303, …)

Examples: Concrete foundation height



Family of products



2. Product certification

BY WHOM?

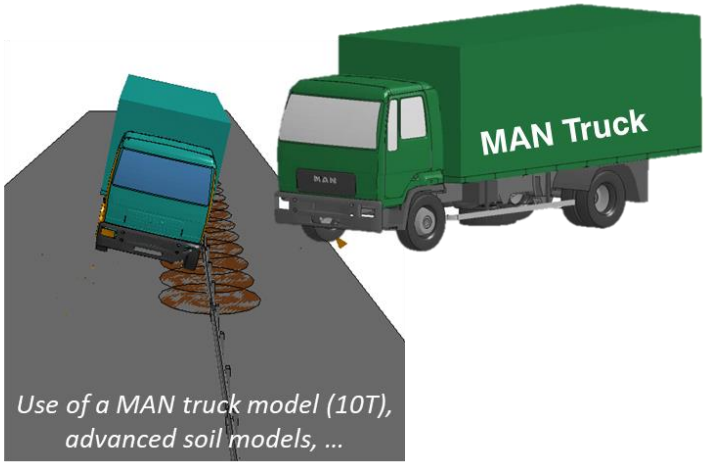
Advanced, qualified and specialized Engineering office in Finite Element Simulation (LS-DYNA)!
Following latest recommendations (TR16303, pr-EN1317-5, …).

2. Product certification

BY WHOM?

Advanced models and lab Tests

Vehicle models validated according to TR16303



Why simulations?

3. Adaptation to Site Conditions

Implementation length
Advices on products
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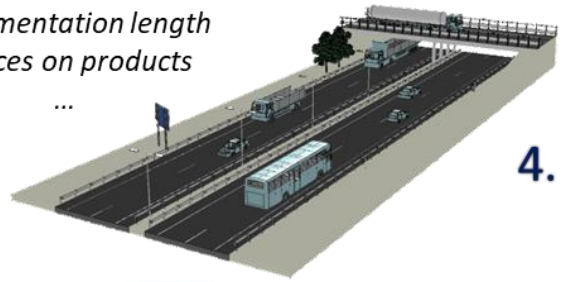

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Safety barriers
Crash cushions
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...

4. Accident Reconstruction

Crash scenarios
Influence of alternatives
...

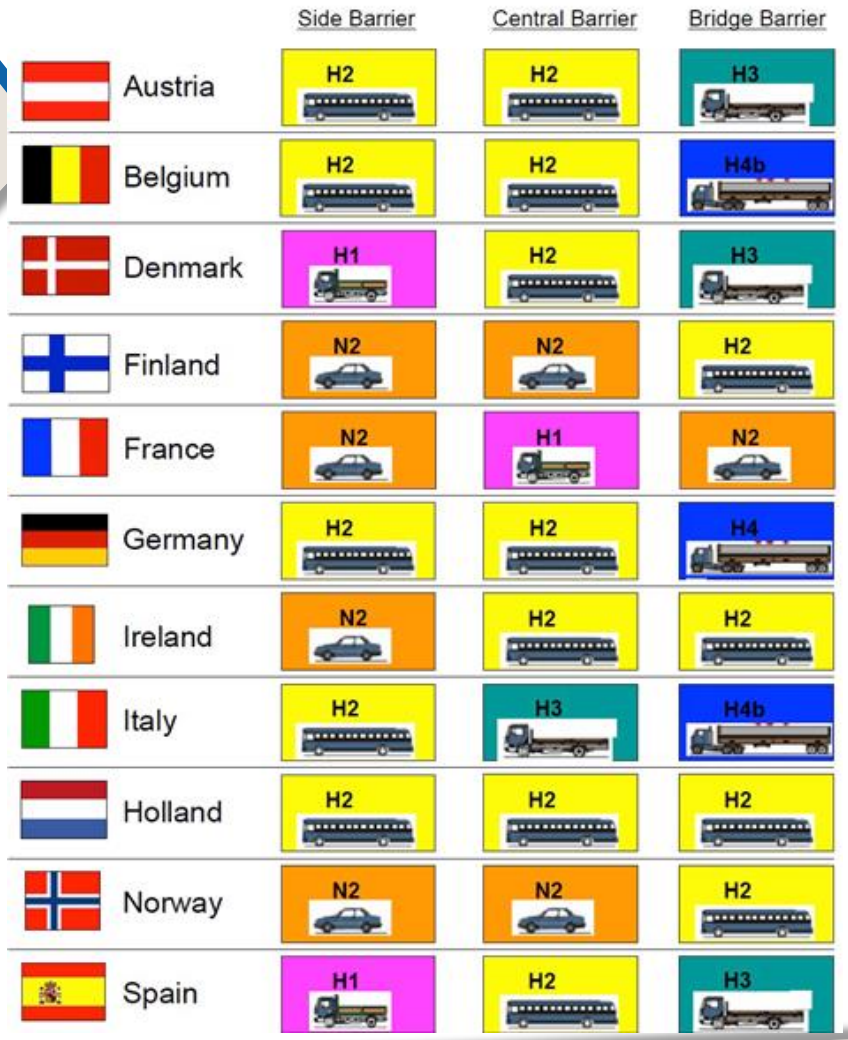
2. Certification

ITT (Crash test / Simulation)
CE marking

CE

Reason n°3: Adapt the product to the site conditions (case by case)

3. Adaptation to site condition



	Side Barrier	Central Barrier	Bridge Barrier
Austria	H2	H2	H3
Belgium	H2	H2	H4b
Denmark	H1	H2	H3
Finland	N2	N2	H2
France	N2	H1	N2
Germany	H2	H2	H4
Ireland	N2	H2	H2
Italy	H2	H3	H4b
Holland	H2	H2	H2
Norway	N2	N2	H2
Spain	H1	H2	H3

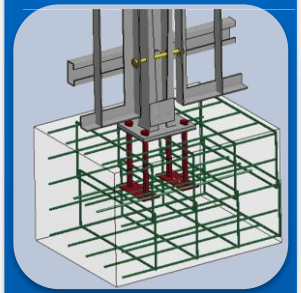
Different National regulations
(all based on EN1317)
in each EU countries …

… which results in
different safety levels!

Source: www.erf.be

3. Adaptation to site condition

Some loads are not or badly attached to the vehicle



The anchoring conditions on site are different than tested

The bridge deck needs to be reinforced

A transition between two different barriers is needed

Motorcyclist protection is added

… What if? …

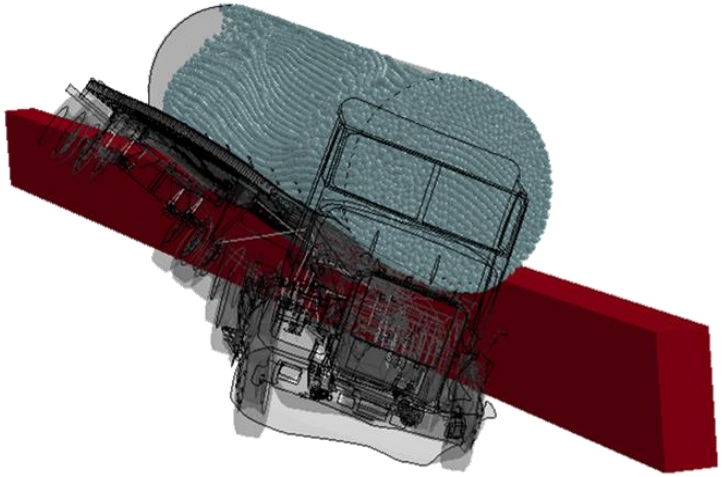
3. Adaptation to site condition

Tested 38 Tons

Tank trailer

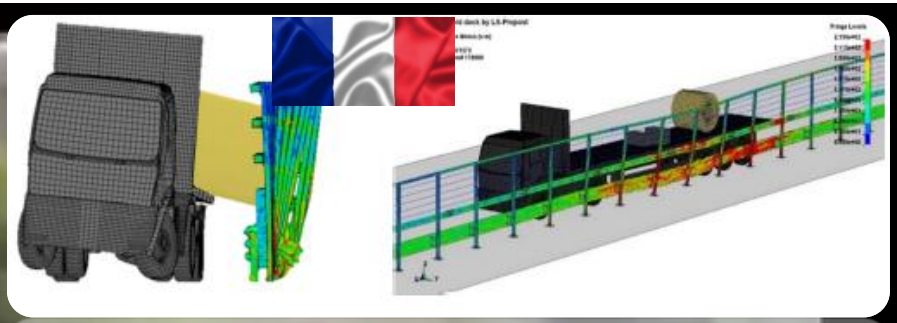
60 Tons

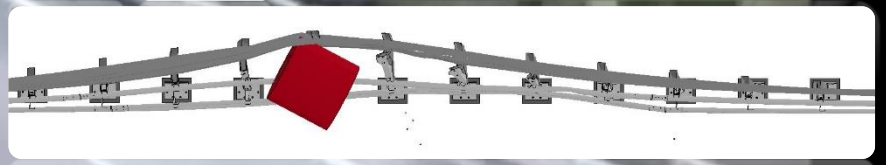
Trailer with coil

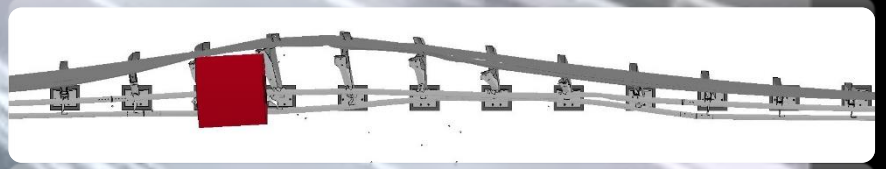


Example n°1: What if the load is not or badly attached to the trailer?

3. Adaptation to site condition

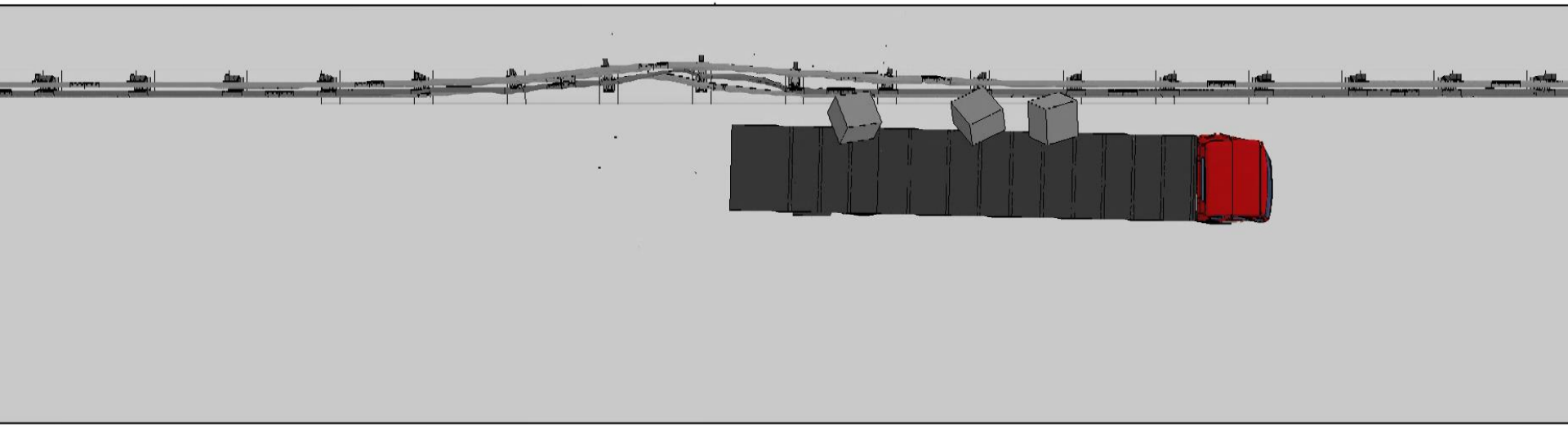


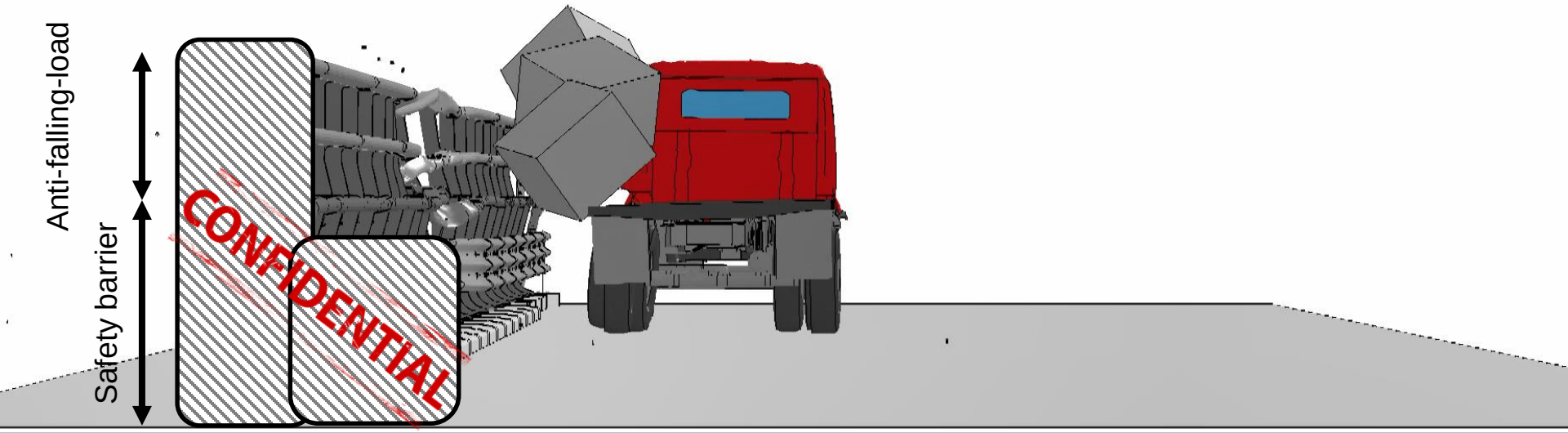




A National qualification procedure using simulation in discussion in France.

3. Adaptation to site condition

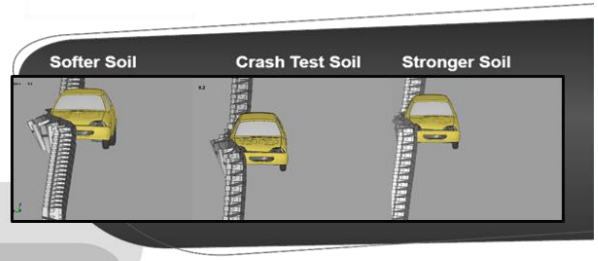


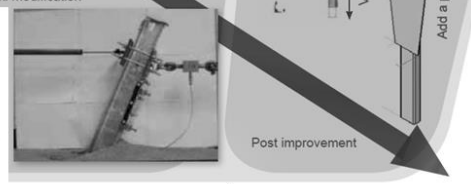


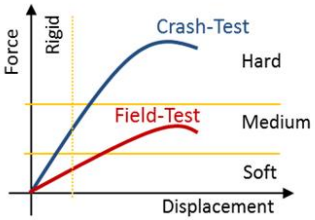
Example n°1: What if the load is not or badly attached to the trailer?

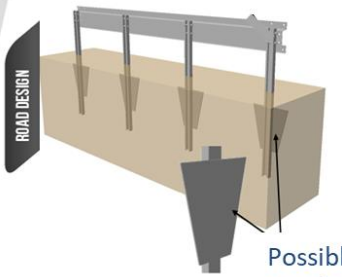
3. Adaptation to site condition

Anchoring Modification

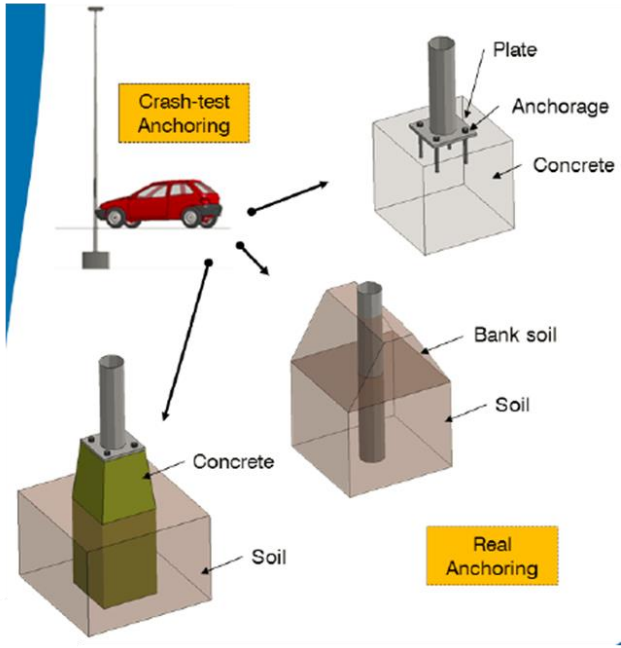








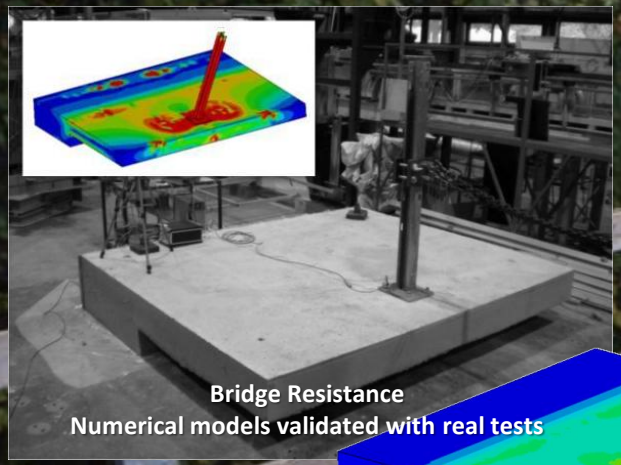
Possible Reinforcement



Example n°2: What if the soil is different from tested?

3. Adaptation to site condition

Bridge load tranfer

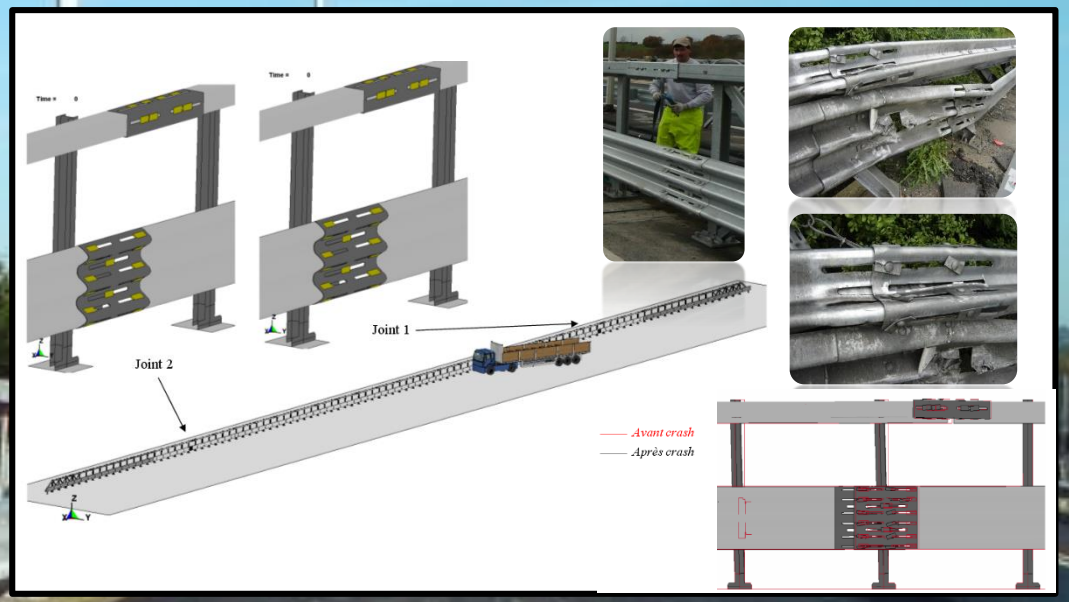


Bridge deck reinforcement

Example n°3: What if the barrier is installed on a bridge?

3. Adaptation to site condition

Expansion Joints & Step



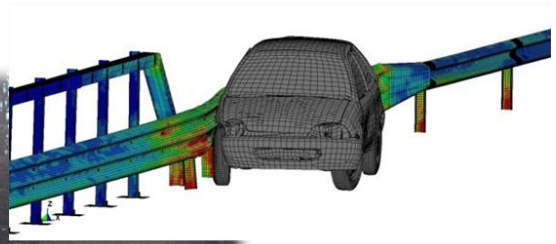
EXPANSION JOINTS

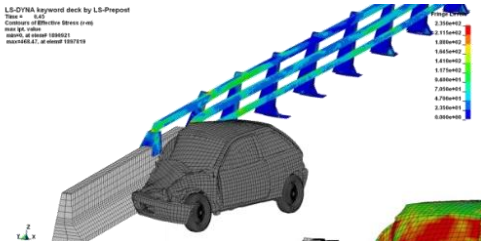
STEP

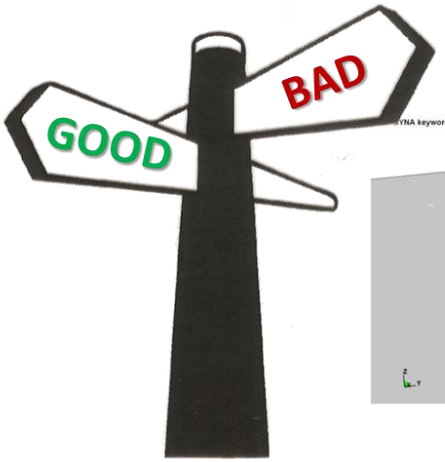
Example n°3: What if the barrier is installed on a bridge?

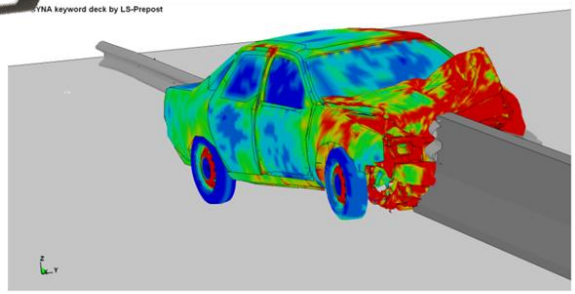
3. Adaptation to site condition

Transitions





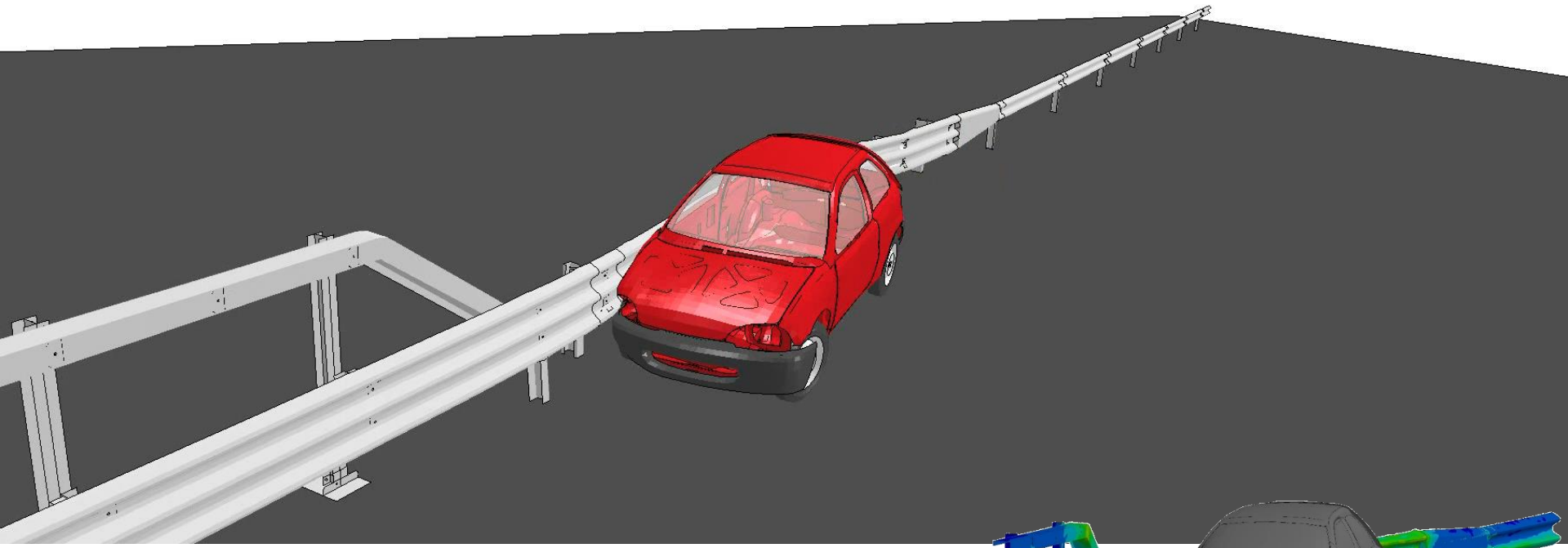




Example n°4: What if a transition between two different barriers is needed?

3. Adaptation to site condition

LS-DYNA keyword deck by LS-Prepost
Time = 0.22



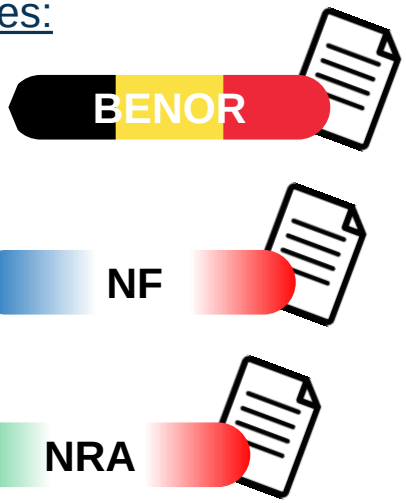
3. Adaptation to site condition

In Belgium (PTV 869, BENOR):

Famille de produit (1)	Niveau de retenue	Exemple *(indicatif)*	ΔDm TB51 (2)	ΔDm TB11 (3)	Pièce de liaison (4)	Action
Identique	Identique	H2 W5 sur H2 W4	< 0,4 m	/	Non	Aucune action
		H2 W6 sur H2 W3	> 0,4 m	/	Non	Simulation (5)
	Différent (3)	H2 W4 sur H4b W4 H1 W4 sur H2 W5	/	< 0,2 m	Non	Aucune action
		H2 W6 sur H4b W3	/	> 0,2 m	Oui/ Non	Simulation (5)
Différent	Identique		< 0,4 m	/	Non	Aucune action
		H2 W5 3-w sur H2 W4			Oui	Simulation (5)
		H2 W6 sur H2 W3 3-w	> 0,4 m	/	Oui / Non	Simulation (5)
	Différent (3)	H1 W4 - H2 W5 H2 W4 - H4b W4 H2 W6 - H4b W4	/	/	/	Simulation (5)

Simulations widely used to assess transitions

Examples:

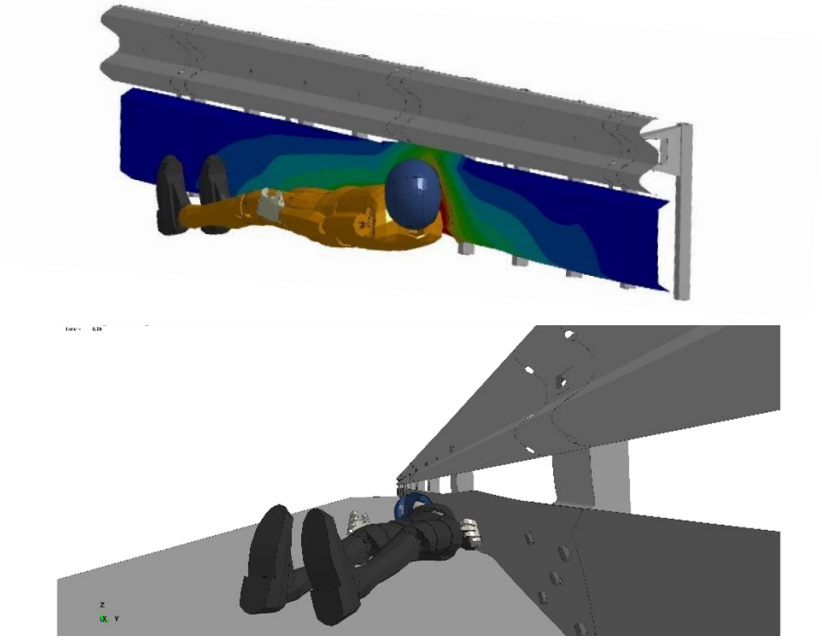


Example n°4: What if a transition between two different barriers is needed?

3. Adaptation to site condition

EN 1317 - 8

European norm concerning motorcyclist protection



Example n°5: What if a motorcyclist protection is added?

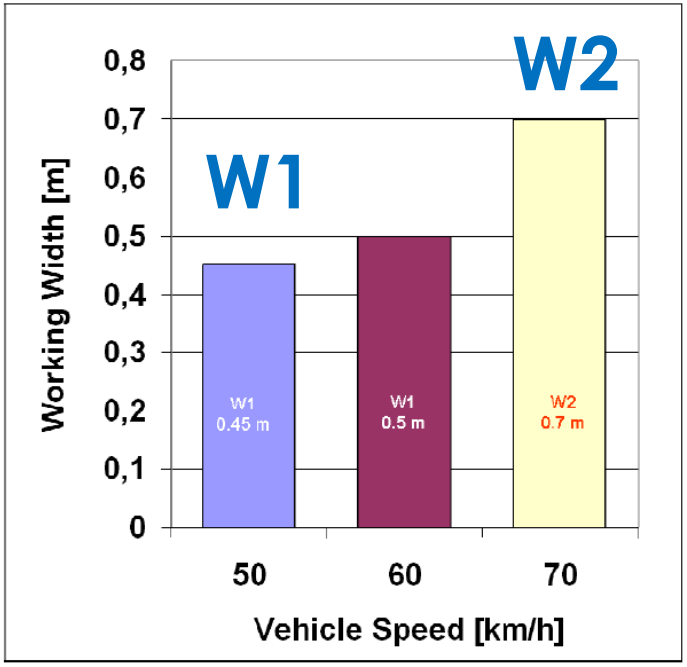
3. Adaptation to site condition

Example n°5: What if a motorcyclist protection is added?

3. Adaptation to site condition

As different MPS could be placed on different RRS, simulation would be a good tool to assess the vehicle impacts!

3. Adaptation to site condition



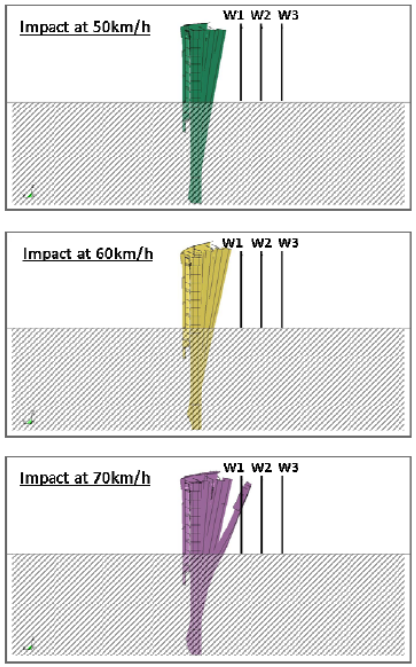


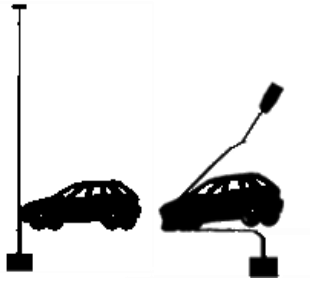
Figure 11: WW values from the simulation with reduced speed

N2-W2 being W1
when speed limited to 60km/h

Example n°6: Smart use of EN1317 !

3. Adaptation to site condition

Passive safe posts inside the W:



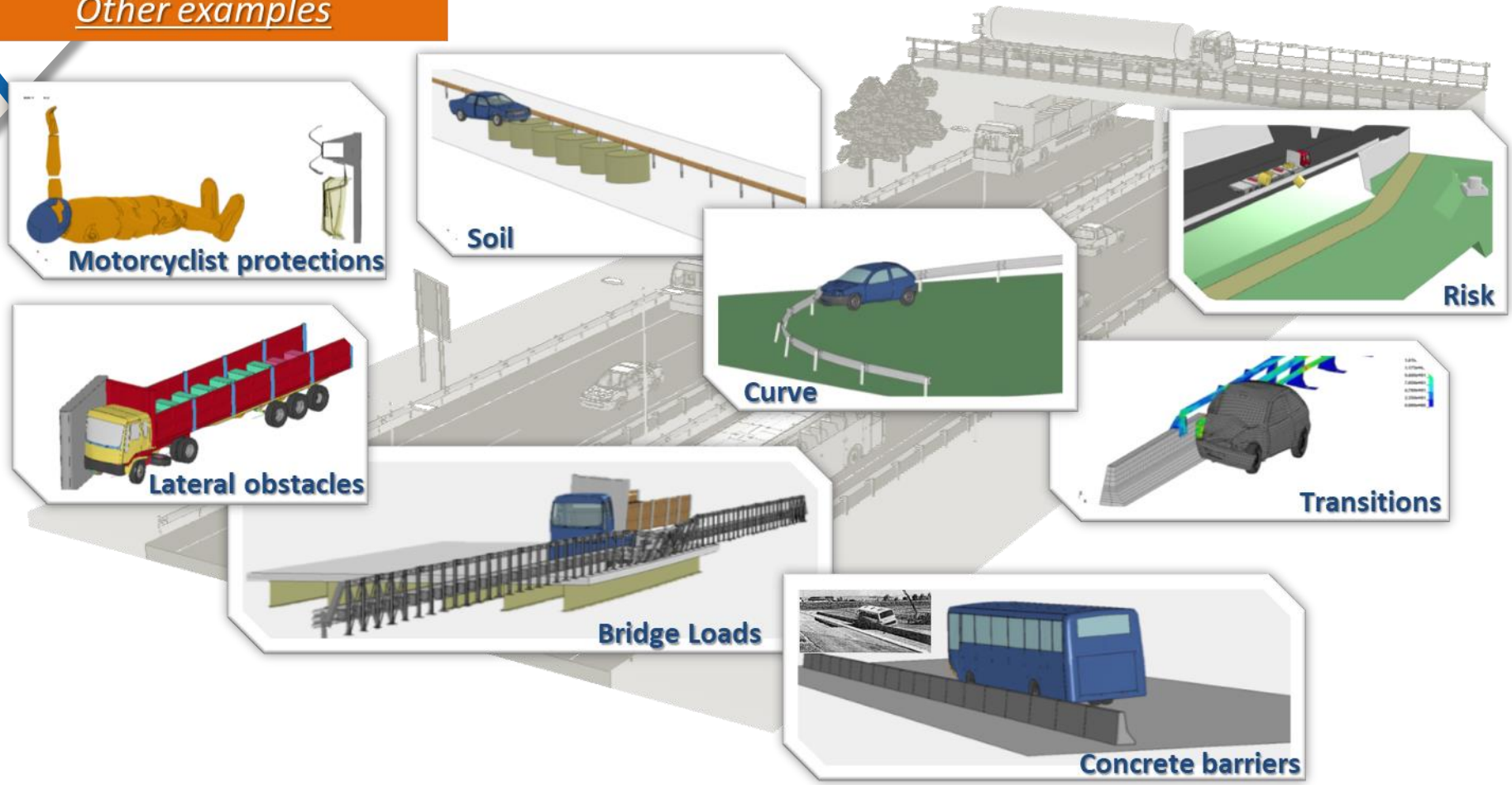
Passive safe post inside Working Width (W)
Compliant EN12767

N2-W5 Safety Barrier Compliant EN1317

Example n°6: Smart use of EN1317 !

3. Adaptation to site condition

Other examples

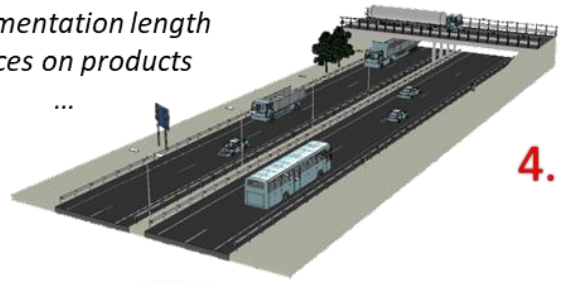


… and many other examples or "adaptation to side conditions" considerations!

Why simulations?

3. Adaptation to Site Conditions

Implementation length
Advices on products
...



1. New Product Development

Safety barriers
Crash cushions
Terminals, Transitions
...

4. Accident Reconstruction

Crash scenarios
Influence of alternatives
...

2. Certification

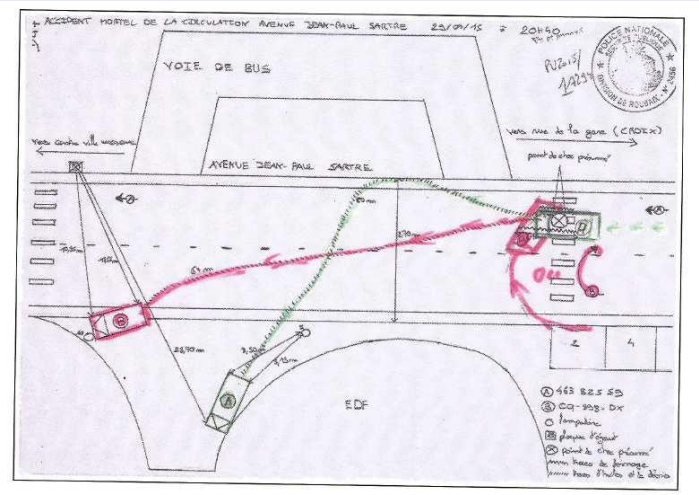
ITT (Crash test / Simulation)
CE marking

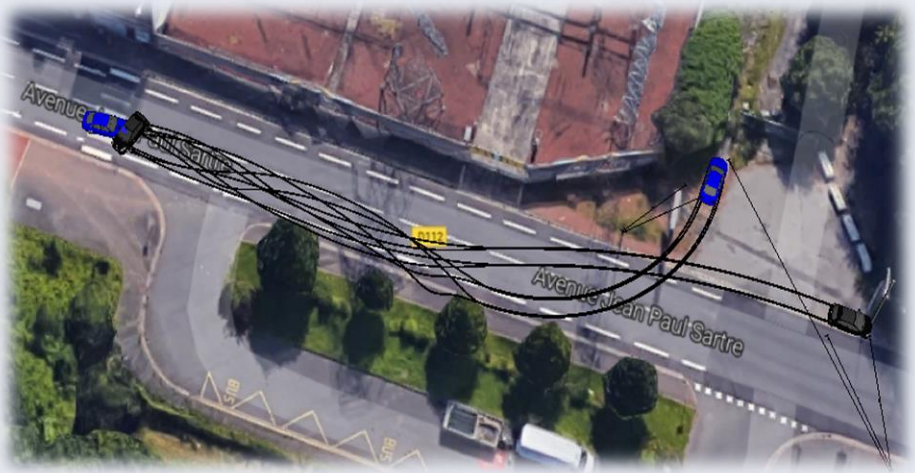
CE

Reason n°4: Reconstruct an accident that happened

4. Accident reconstruction

Usually “multi-body” is preferred to analytical calculations





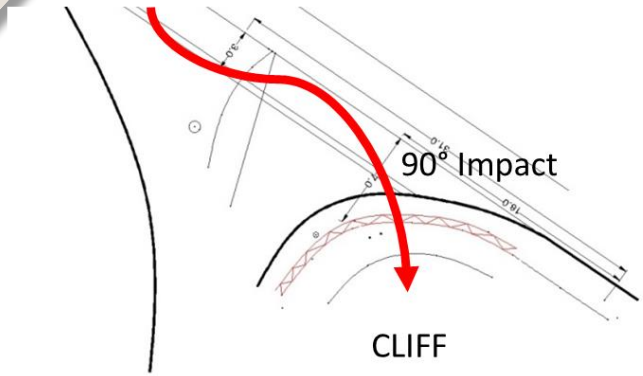
	Analytical calculation	PC-Crash calculation
Calculated Energy	585 kJ	1251 kJ
Calculated speed	103 km/h	149 km/h

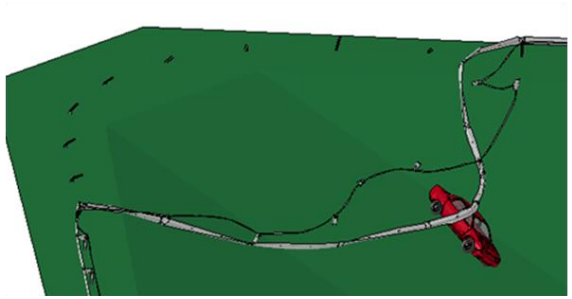
But PC-Crash has some limitations when roadside equipment are involved.

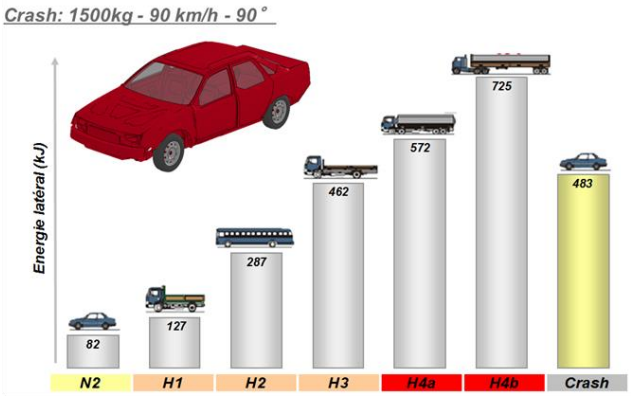
4. Accident reconstruction

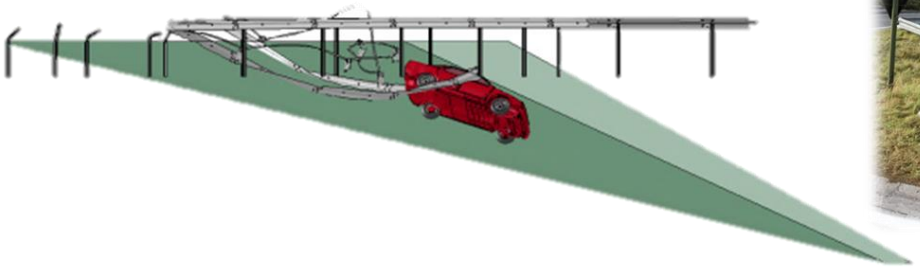
Sometimes, “FEM” could be required

Frontal impact on N2





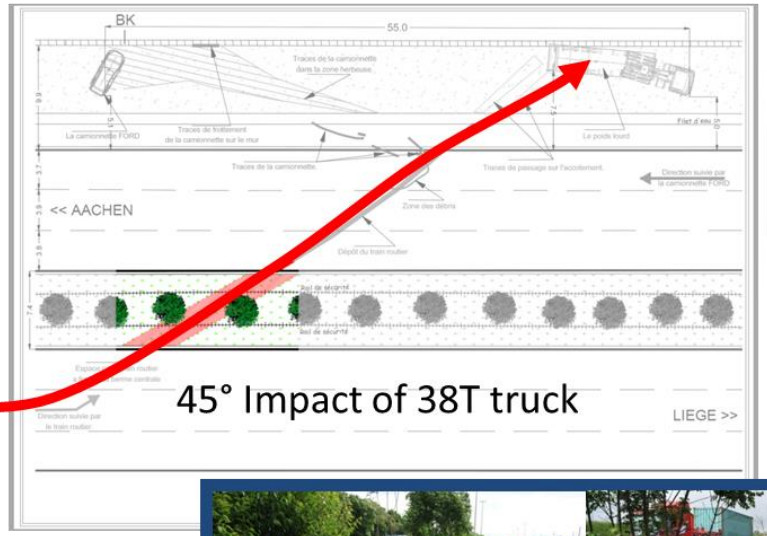


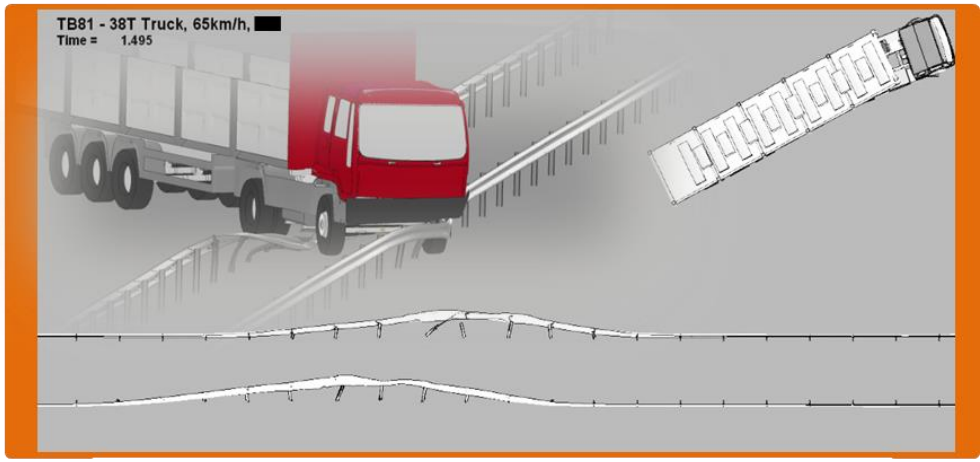


Example n°1: Frontal impact on a N2 (non-maintained vs. maintained version)

4. Accident reconstruction

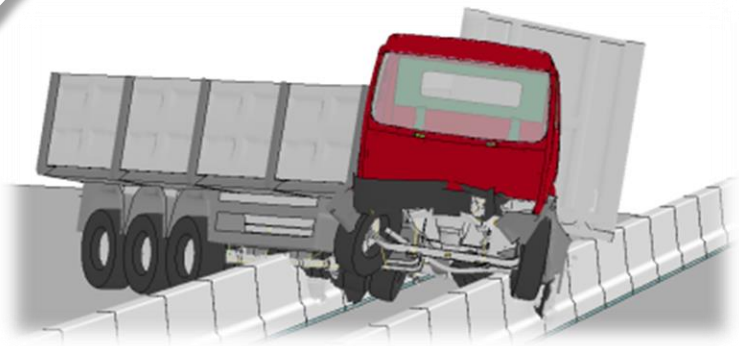
Crossing of central reserves

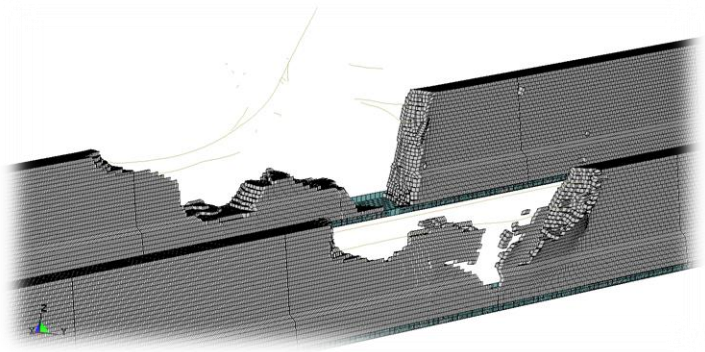


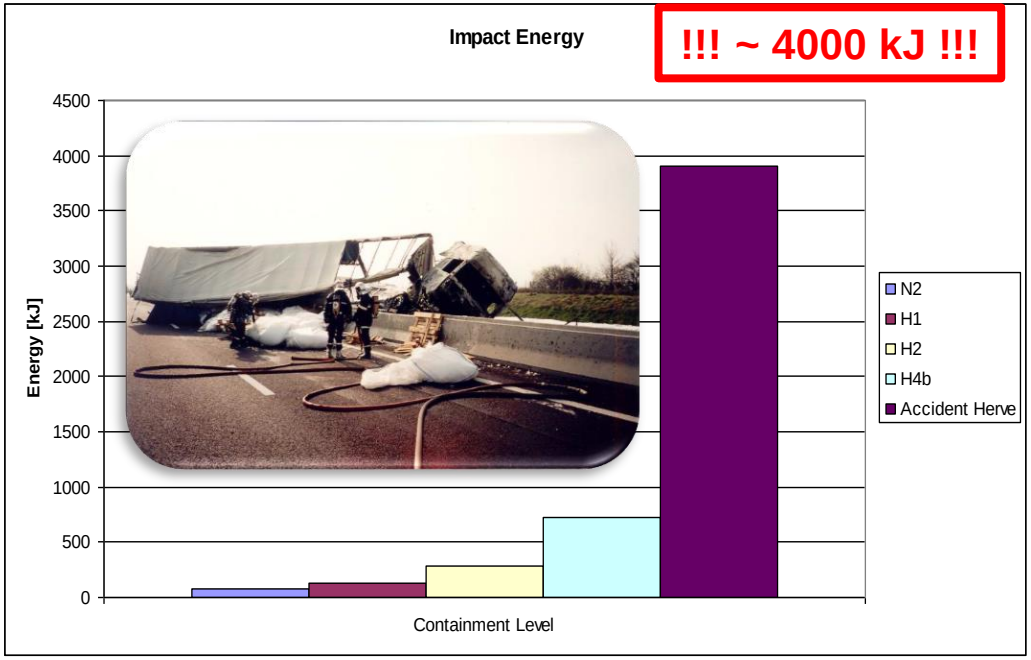


Example n°2: Crossing of central reserves & simulations from N2 …

4. Accident reconstruction







Example n°2: Crossing of central reserves & simulations from N2 to H2

Thank you for your attention!

Joseph MARRA - 0032 479 43 04 59

Joseph.Marra@GDTech.eu

Ask for our brochure!

1. New Product Development

2. Certification

3. Adaptation to Site Conditions

4. Accident Reconstruction