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Bridge anti-falling load systems: Proposal for a performance qualification procedure

Maira Cortese

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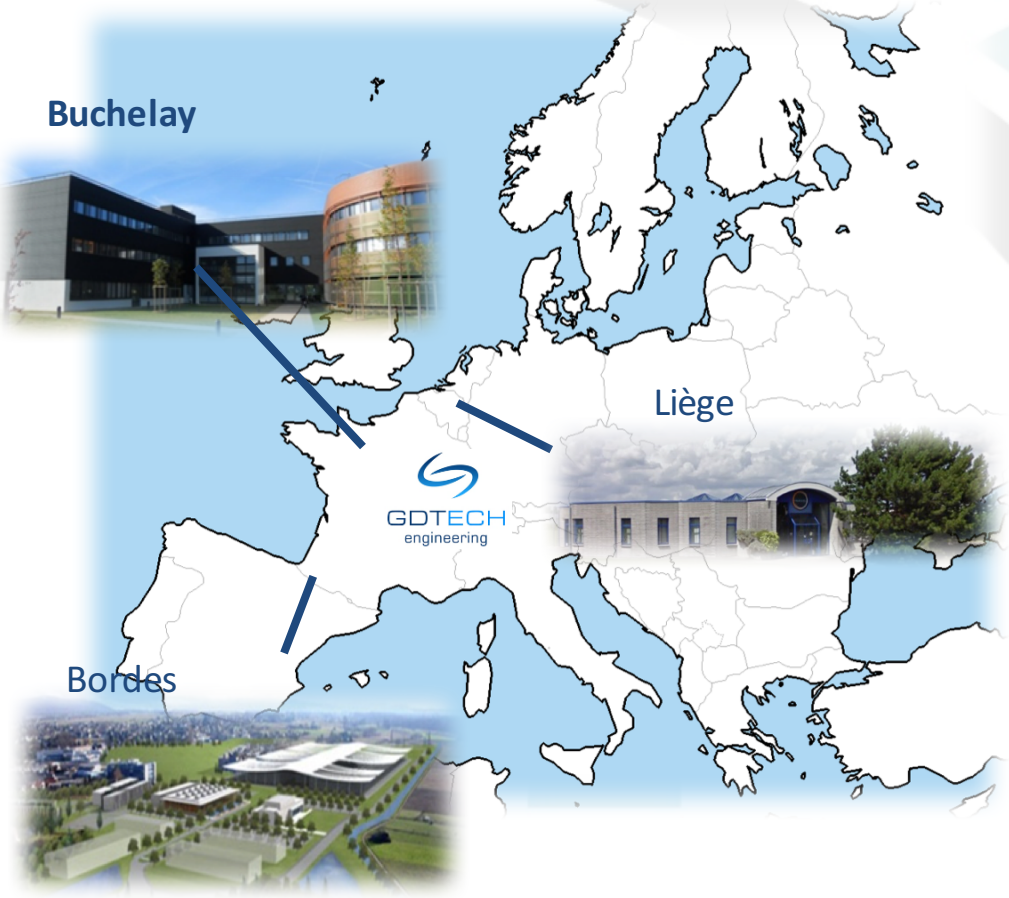
Introduction

- The companies (1/2)



Joseph.Marra@gdtech.eu (EU)
Maira.Cortese@gdtech.eu (EU)
Paul.Hansen@if3.com.au (AU)
Dane.Hansen@if3.com.au (AU)

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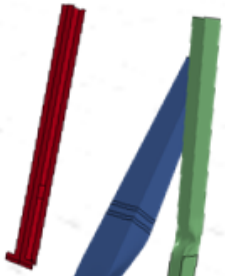
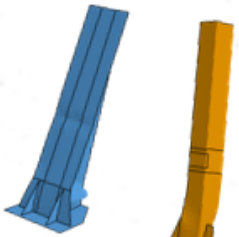
Introduction

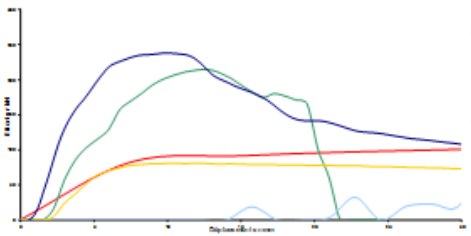
- The companies (2/2)

Numerical Simulation (FEA)

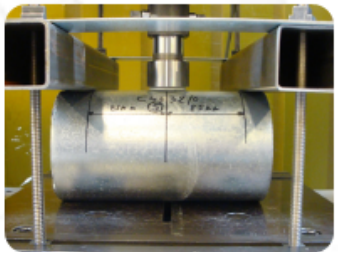


Analytical Calculation





Mechanical Tests



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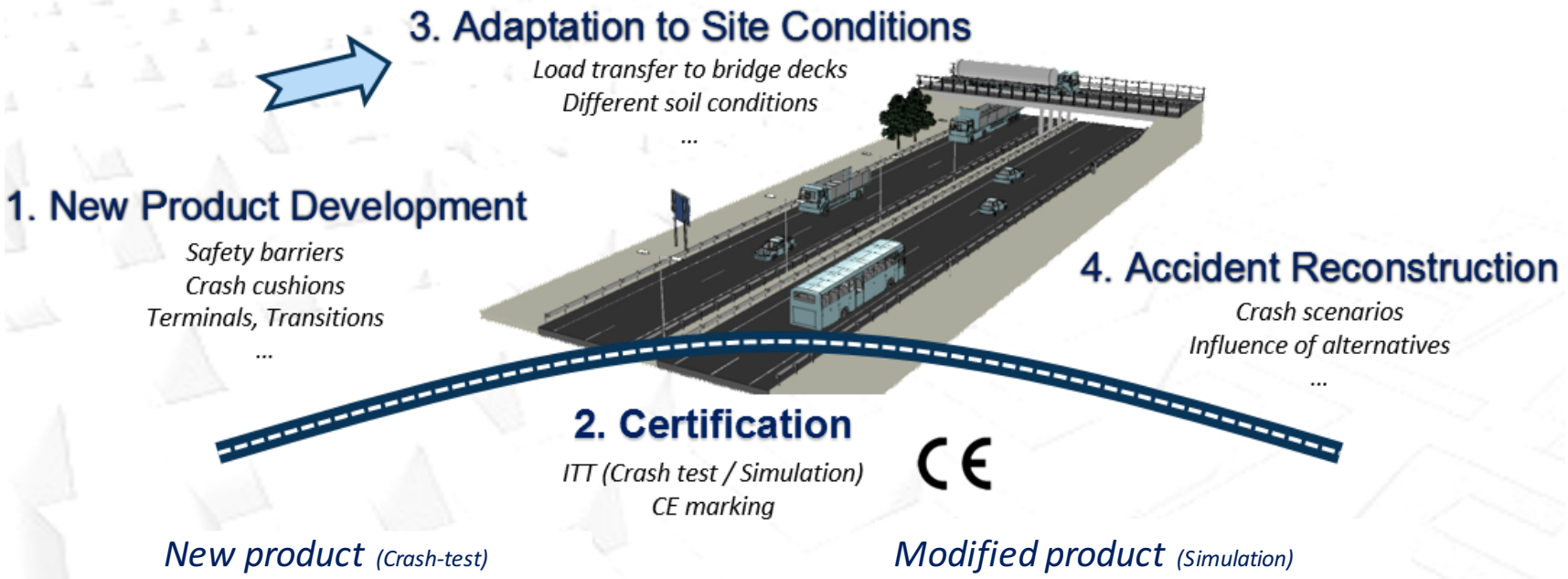
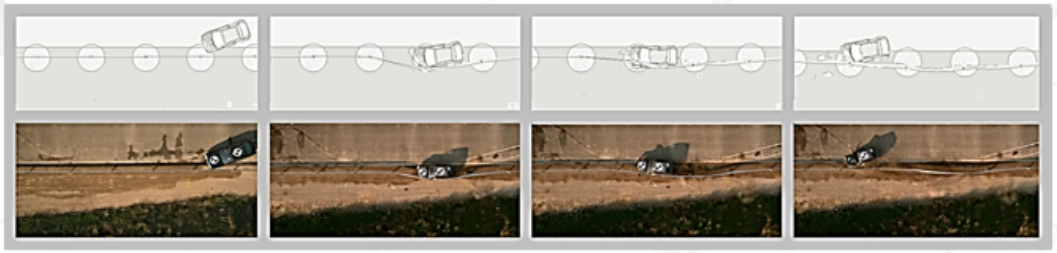
Introduction

- The use of numerical simulation





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Introduction

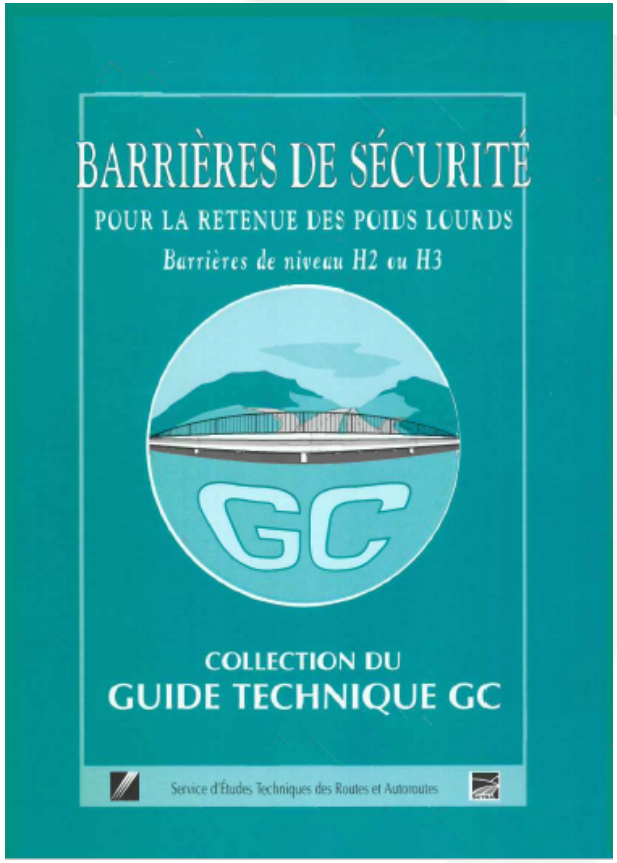
- Objectives of the collaboration

  Proposing a procedure of assessing the performances of anti-falling system installed on top of safety barriers:

  - Necessity to update national standard to European level
  - Role of the numerical simulation

Anti-falling load barrier

- Old French guidelines description (1/2)



Since 1999, the systems were owned by road authorities in France and the BN4 barrier was frequently used on bridges.

Anti-falling load systems were used on the French BN4 bridge barrier that was owned by the French Road Authorities.

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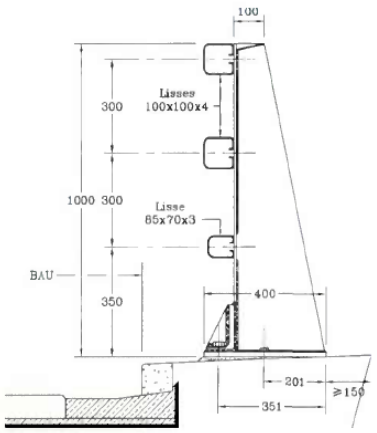
Anti-falling load barrier

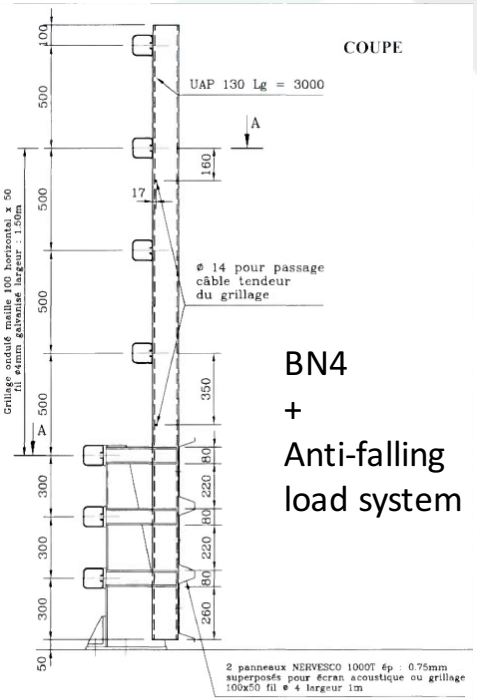
- Old French guidelines description (2/2)

Anti-falling load system developed for the BN4 barrier, crash-tested with a 26 tons truck carrying a detachable steel coil of around 12 tons that falls on the system.

BN4



1 m height



3 m height

BN4
+
Anti-falling
load system

Anti-falling load barrier

- Old French guidelines description vs. EN1317

The BN4 system (1977) was not tested according to EN1317
(only "deemed to comply" with a supposed containment level H2)

With the recent wider use of EN1317 in Europe, this French system is more and more abandoned for the following reasons:

- "Deemed to comply" is not anymore accepted
- Obligation to open the market to any tested products
- Higher weight and loads transferred to the bridge decks
- Request to increase containment levels on bridges (use of H4b)
- Too high ASI (assumed ASI C)
- ……

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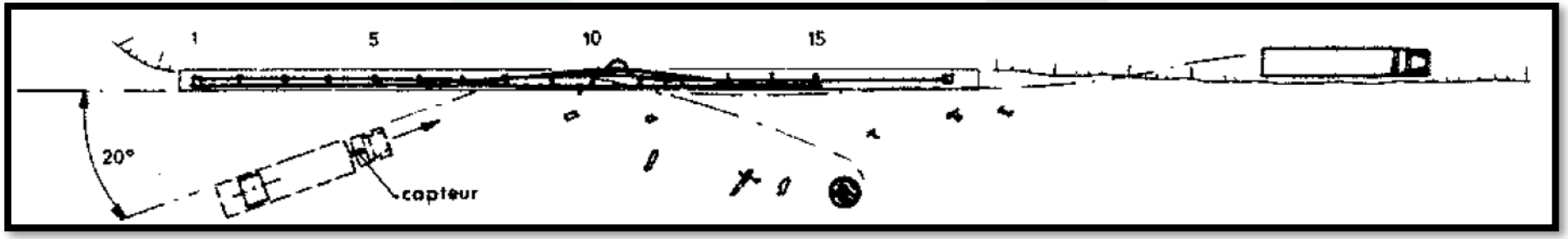
Anti-falling load barrier

- Evolution of the French guideline (1/3)

Before 2004, only one real crash test has been performed: anti-falling load system placed on BN4.

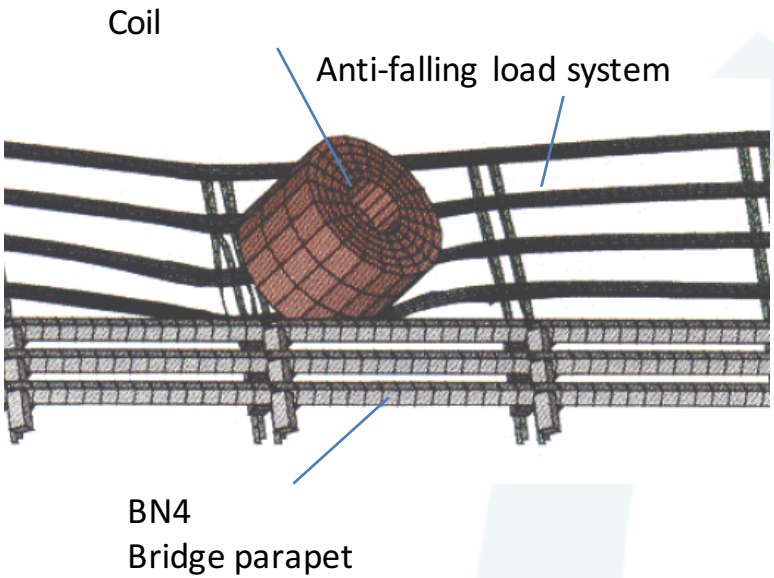
Essai Poids Lourd	Véhicule	Chargement	Choc théorique	Choc réel
57-BLE-02 / 393 16 Mars 1976	Semi-remorque tracteur SCANIA Remorque : TITAN	bobine de feuillard de 12 t sur berceau et petits objets	vitesse = 60 km/h (limitée sur viaduc) Angle = 20°	59,5 km/h 20 °
	masse totale = 26, 67 t			



Anti-falling load barrier

• Evolution of the french guidelines (2/3)

In 2004, simulation was used as well to accredit anti-falling load system installed on BN4 public bridge barrier.



That simulation was however:

- Using simulation technologies of 2004
- Not involving the impact of the vehicle
- …

but led to an accepted evaluation of the performances of the system by the French Road Authorities.

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Anti-falling load barrier

- Evolution of the French guideline (3/3)

Currently, a French Working Group is revising the regulation on the anti-falling load barriers
performance assessment which would require simulation.

This desicion has been taken due to the following reasons:

- The existence of numerous new bridge barriers developed in Europe
- The use of the anti-falling load barriers is only required in specific locations

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Anti-falling load barrier

- GDTech and IF3 proposal (1/3)

Procedure to assess anti-falling load systems installed on top of a barrier (already tested with EN1317) in two steps:

- Simulations to assess → reliability of the numerical model of the bridge parapet H4b
- Simulations to assess → perfomances of the anti-falling load system (heavy vehicles,TB81)

This procedure would be applicable to all the bridge parapet classified as H4b by the EN1317.

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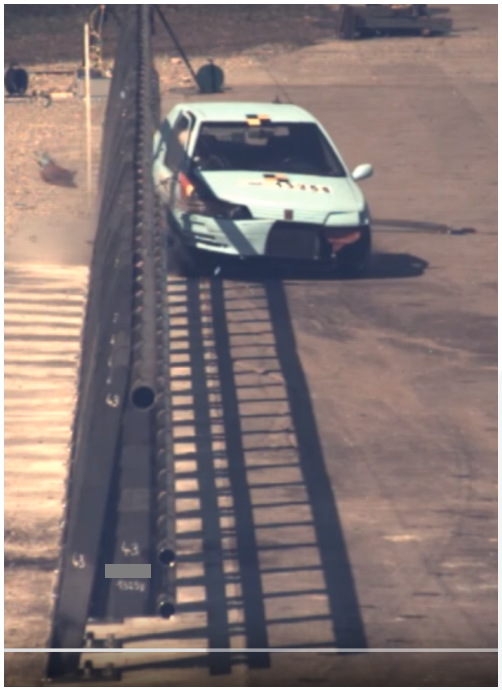
Anti-falling load barrier

- GDTech and IF3 proposal (2/3)

Why anti-falling load system on the H4b ?

In Belgium, H4b barriers are the most used barriers in correspondence of very dangerous area like railways or bridges.

Anti-falling load barrier



- GDTech and IF3 proposal (3/3)

Why only heavy vehicles (TB81) and not light ones (TB11) also?

TB11 crash test involves only the lower part of the barrier that is not modified by the introduction of the anti-falling load screen.

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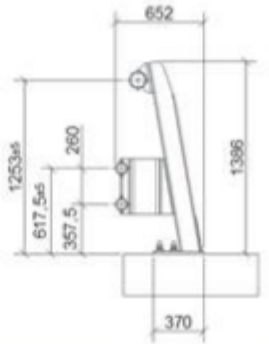
Example

- APLUS Van Eycken H4b W4

This system obtained the European certification (technical report 0627/0002).

Système	
Hauteur:	1386 mm (1253/617,5 mm)
Largeur:	654 mm
Entraxe des poteaux:	1500 mm
Longeur de l'essai:	65,3 m



Example

- Set up of the standard stand alone model (1/7)

EN1317 – TB81	
Mass [kg]	38000
Speed [Km/h]	65
Angle [°]	20

Example

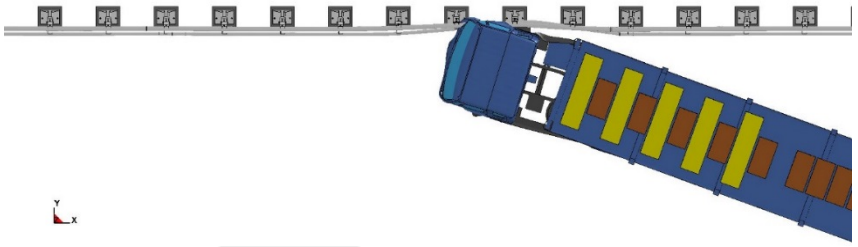
- Set up of the stand alone model (2/7)

Comparison between real and numerical test

Example

- Set up of the stand alone model (3/7)

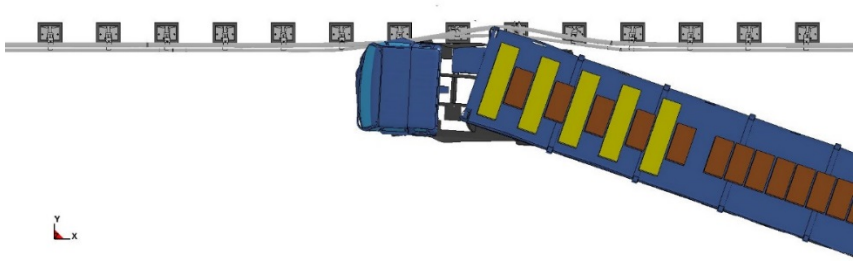
Comparison between real and numerical test



Example

- Set up of the stand alone model (4/7)

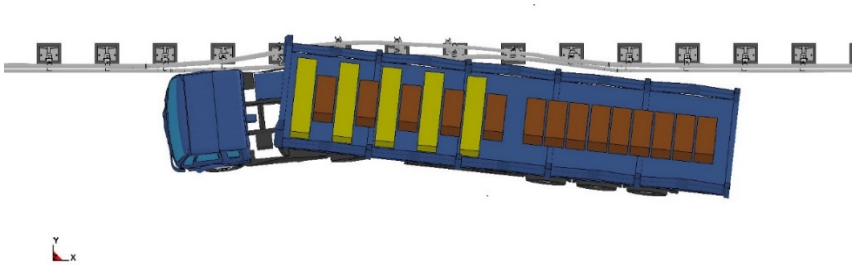
Comparison between real and numerical test



Example

- Set up of the stand alone model (5/7)

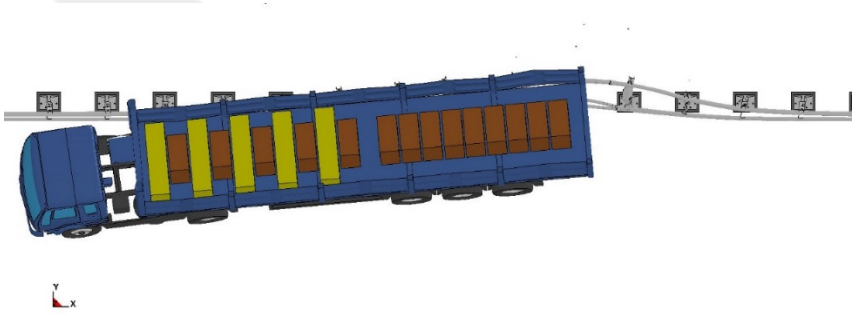
Comparison between real and numerical test



Example

- Set up of the stand alone model (6/7)

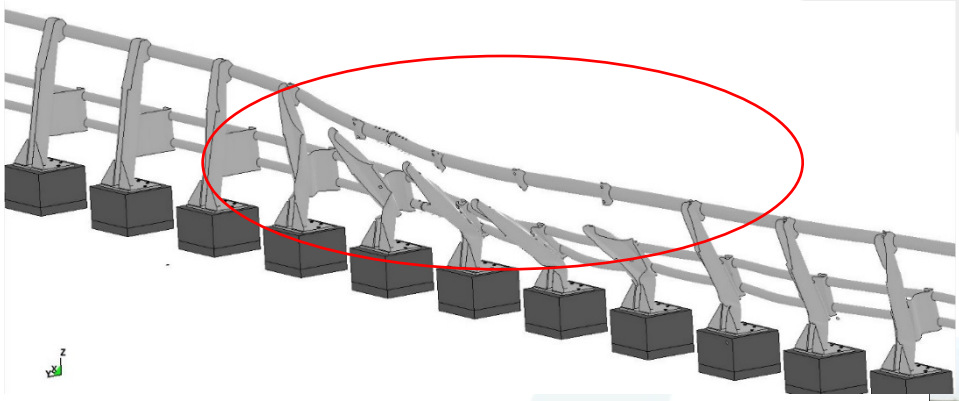
Comparison between real and numerical test



Example

- Set up of the stand alone model (7/7)

Disconnection



Same behaviour for the detachment of the posts.

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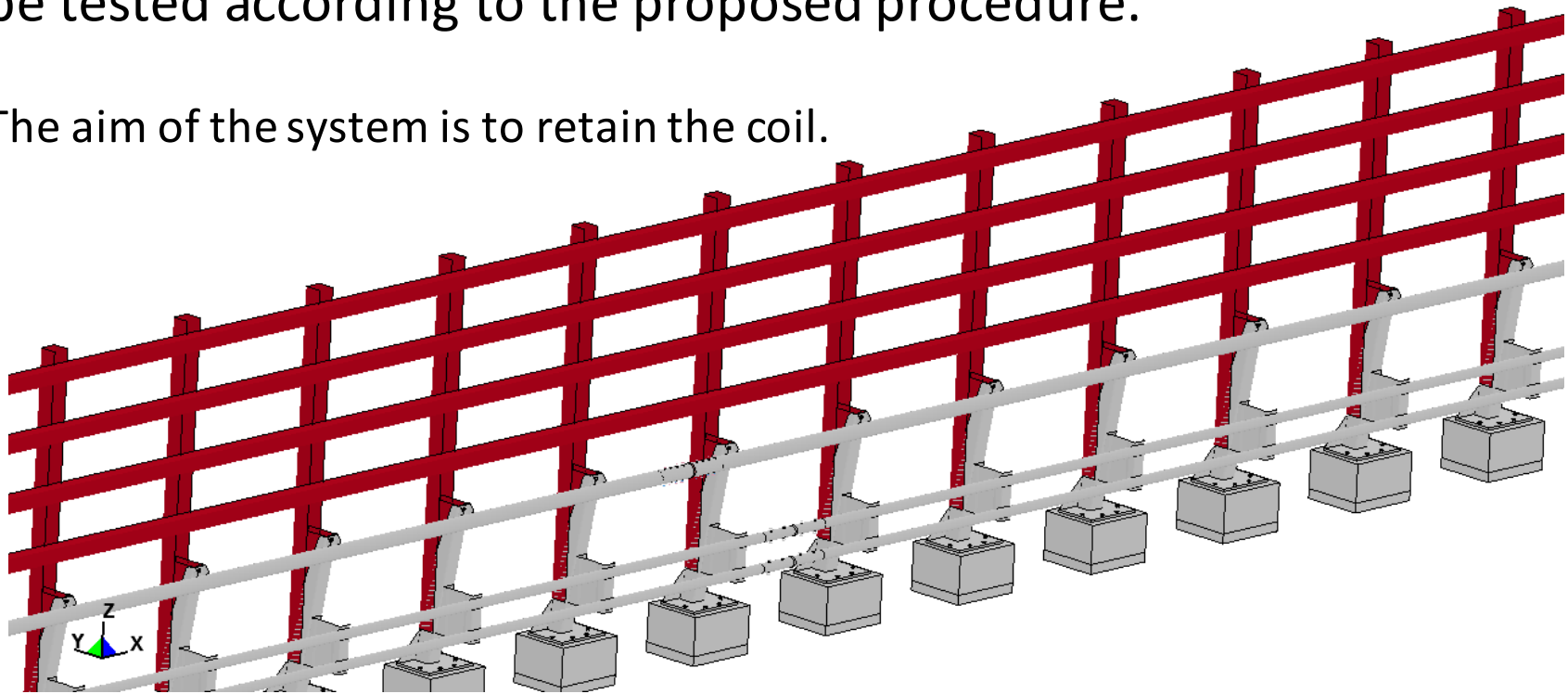
Example

- Anti-falling load system performance assessment (1/13)

An anti-falling system has been preliminary designed and modelled to be tested according to the proposed procedure.

The aim of the system is to retain the coil.



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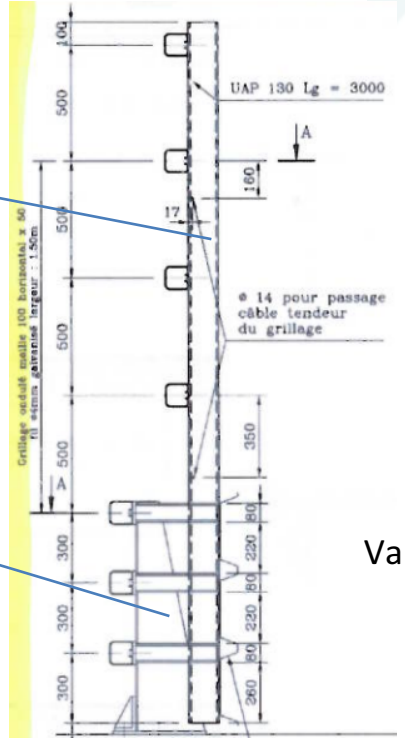
Example

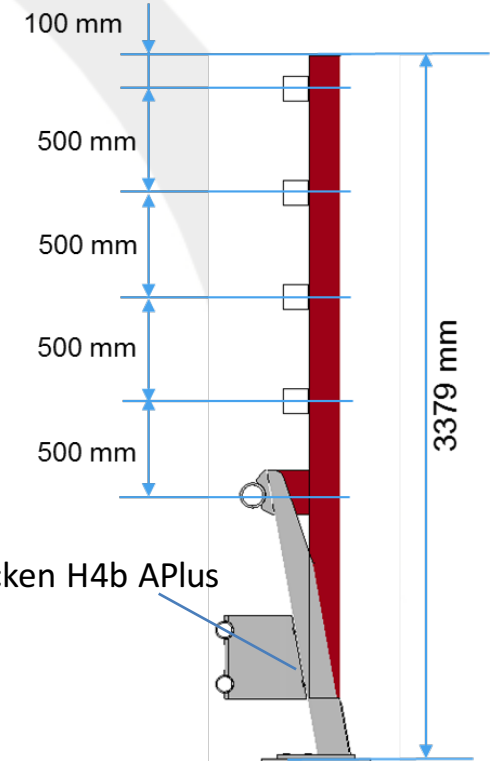
- Anti-falling load system performance assessment (2/13)

The fence has been inspired from the French Public design.

Anti-falling load screen

BN4





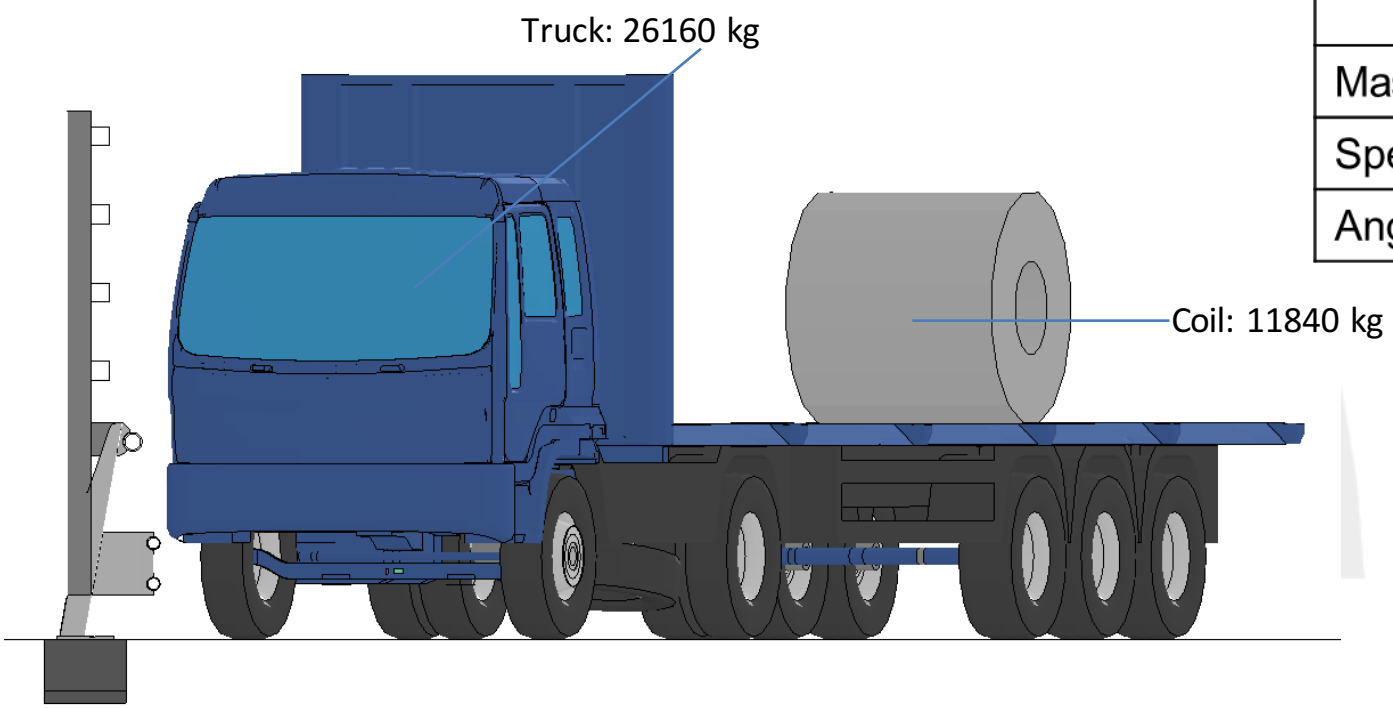
Van Eycken H4b APlus

Example

• Anti-falling load system performance assessment (3/13)

The test proposed is again a TB81 but in this case the truck carries a detachable mass of around 12 tons.

EN1317 – TB81	
Mass [kg]	38000
Speed [Km/h]	65
Angle [°]	20



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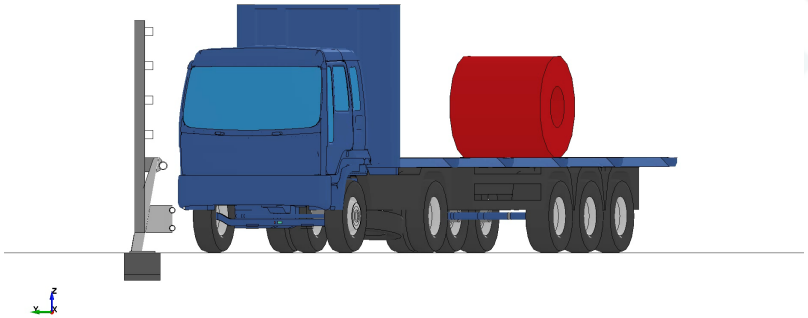
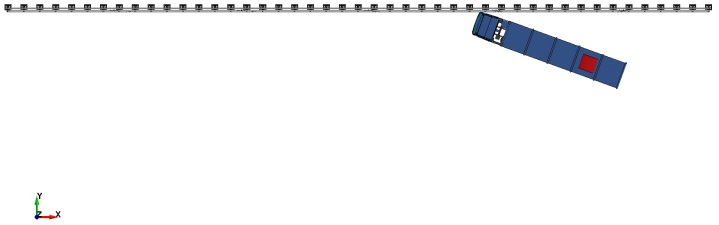
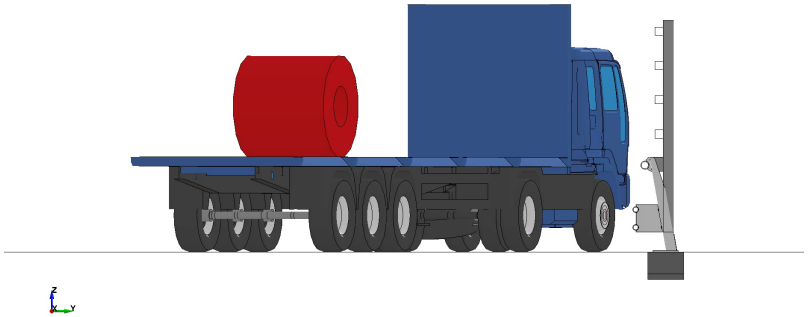
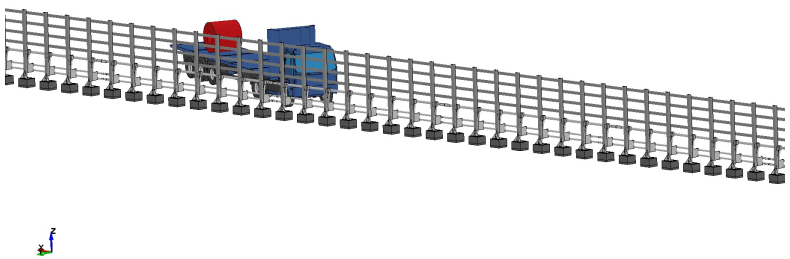
Example

- Anti-falling load system performance assessment (4/13)









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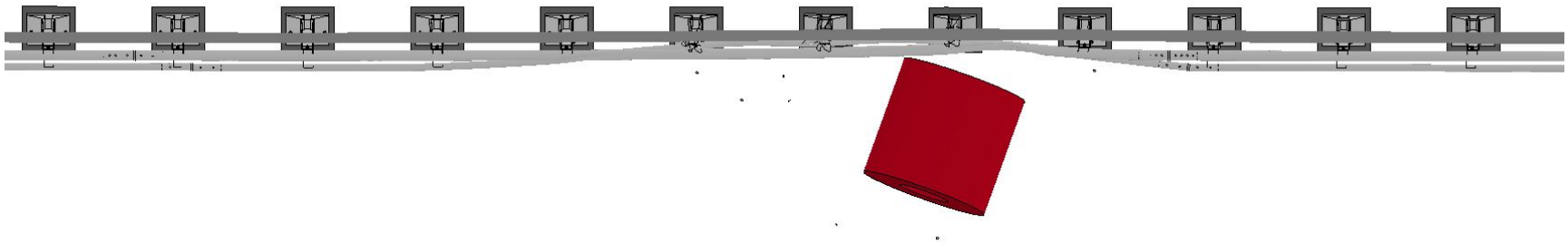
Example

- Anti-falling load system performance assessment (5/13)

Coil sequence (the truck has been hidden)

T = 0.65 s



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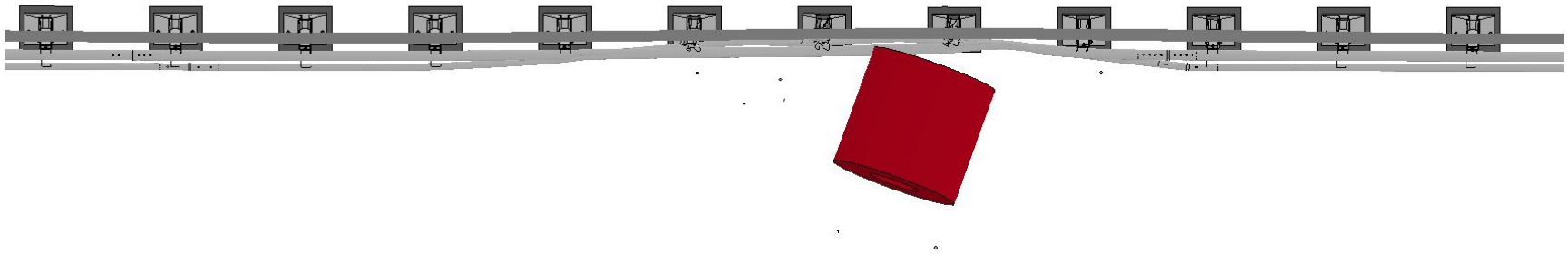
Example

- Anti-falling load system performance assessment (6/13)

Coil sequence (the truck has been hidden)

T = 0.7 s



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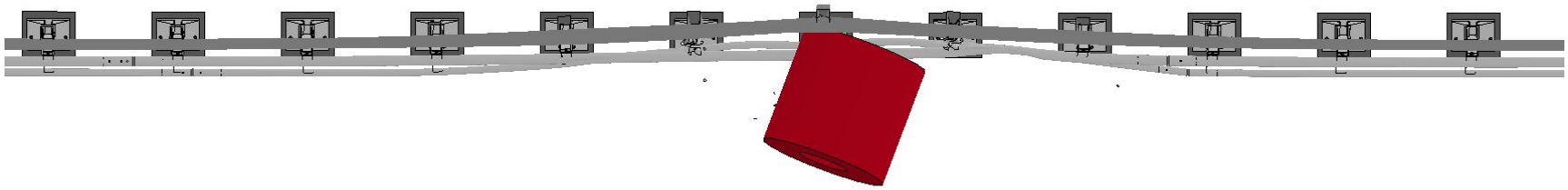
Example

- Anti-falling load system performance assessment (7/13)

Coil sequence (the truck has been hidden)

T = 0.75 s



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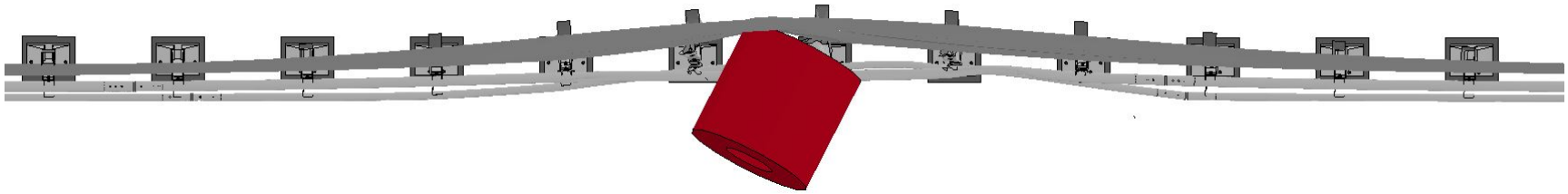
Example

- Anti-falling load system performance assessment (8/13)

Coil sequence (the truck has been hidden)

T = 0.8 s



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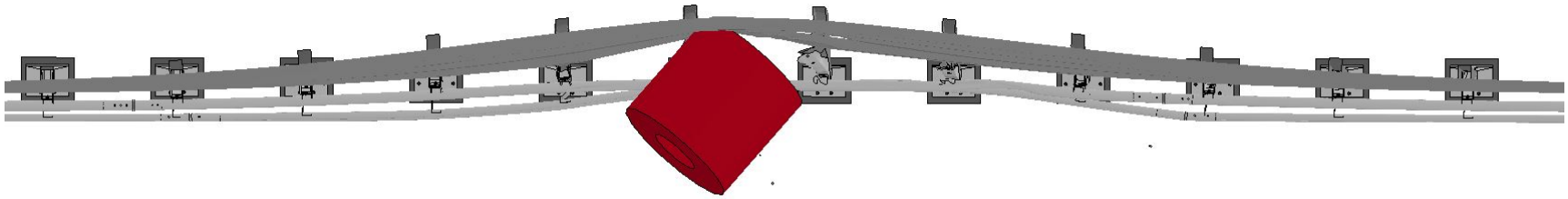
Example

- Anti-falling load system performance assessment (9/13)

Coil sequence (the truck has been hidden)

T = 0.85 s



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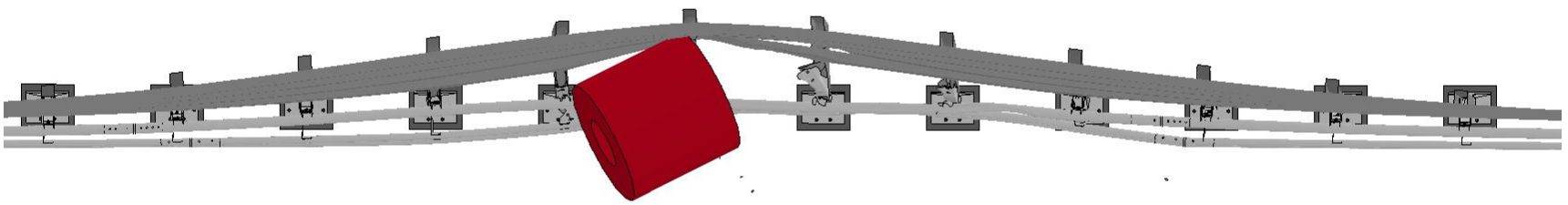
Example

- Anti-falling load system performance assessment (10/13)

Coil sequence (the truck has been hidden)

T = 0.9 s



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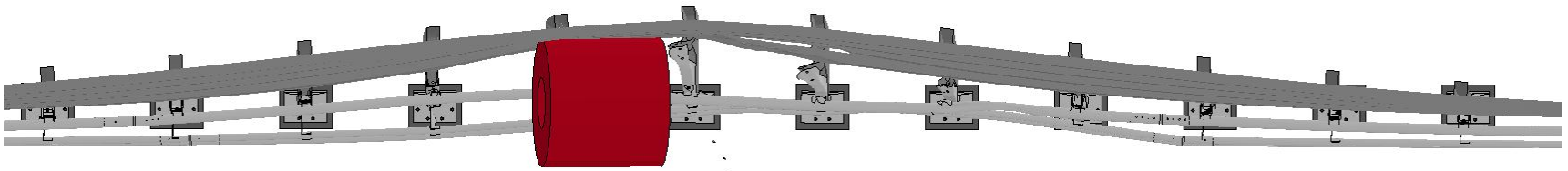
Example

- Anti-falling load system performance assessment (11/13)

Coil sequence (the truck has been hidden)

T = 0.95 s



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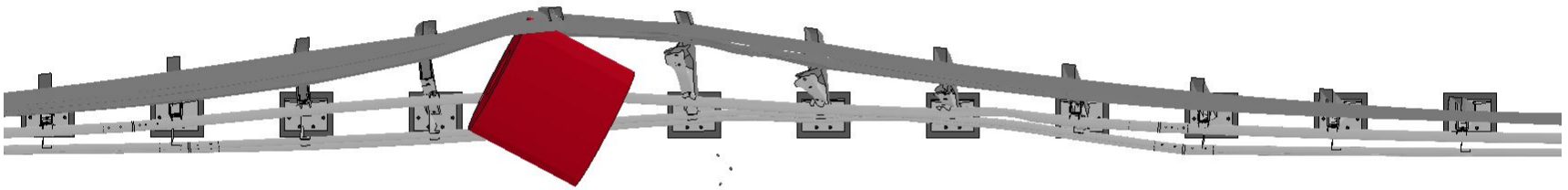
Example

- Anti-falling load system performance assessment (12/13)

Coil sequence (the truck has been hidden)

T = 1 s



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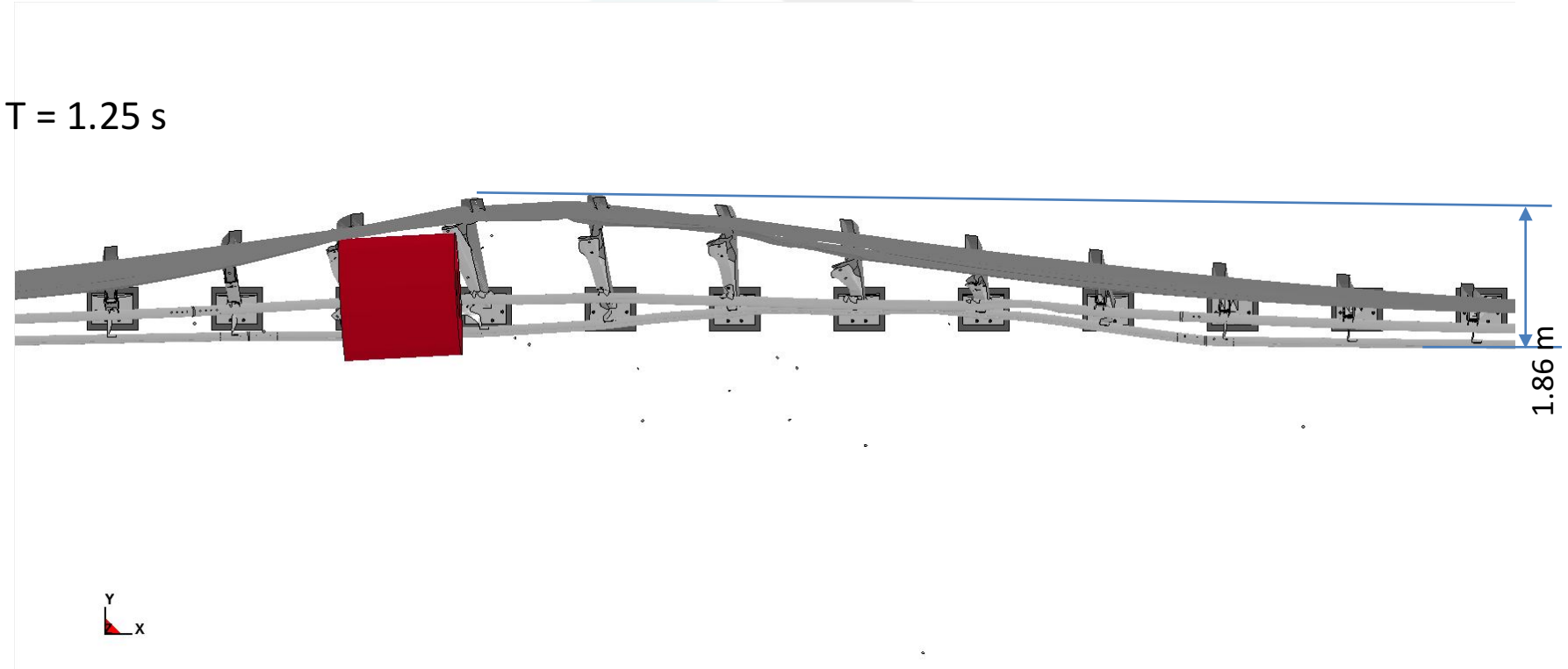
Example

- Anti-falling load system performance assessment (13/13)

Coil sequence (the truck has been hidden)



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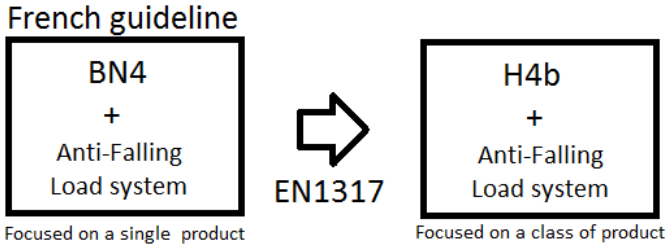
Conclusion

- Generalization of the old french procedure



- Procedure based on 2 steps.

  Step 1. Demonstrate the reliability of the numerical model (TB81)

  Step 2. Assess the performances of the anti-falling load screen installed on top of the barrier (TB81)

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THANK YOU FOR YOUR ATTENTION

40 Gracechurch Street
London EC3V 0BT
(United Kingdom)
Tel: +44 20 37690538

Email: info@smart-transportation.org

www.smart-transportation.org