

Virtual testing report

STEEL CONSTRUCTIONS – CADO H2 – TB11

Simulation report

Subcontractor	GDTECH s.a.
Date of report	22/06/2017
Client	STEEL CONSTRUCTIONS
Test item	CADO H2
Numerical simulation report number	SC.TR-CADO-H2-TB11/V1
Ref numerical simulation report number	/
Validation report number	/
Test type	TB11
Test standards	EN1317:2010 Road restraint systems - Part 1: Terminology and general criteria for test methods - Part 2: Performance classes, impact test acceptance criteria and test methods for safety barriers - Part 4: Performance classes, impact test acceptance criteria and test methods for terminals and transitions of safety barriers - Part 5: Product requirements, test and assessment methods and acceptance criteria (DRAFT) CEN/TR 16303-4:2012
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Official validation report language	English



Avenue de l'Expansion, 7
B-4432 Alleur
+32 4 367 87 11
TVA: BE 0464.528.050

	Writer	Reviewer
Name	Himpe Jeffrey	Marra Joseph
Visa		

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1 SUBCONTRACTOR

GDTech s.a.

Avenue de l'Expansion, 7
B-4432 ALLEUR
Belgium

Tel. +32 4 367 87 11
Fax. +32 4 376 68 22
www.gdtech.eu

2 APPROVAL OF REPORT

Name of authorised and responsible person of virtual testing institute:

Joseph Marra

Position:

Project leader of crash department

Date:

22/06/2017

3 CLIENT

STEEL CONSTRUCTIONS

Gerdina's Hof 31
4191 MX Geldermalsen
HOLLAND

Tel. 0031 (0) 345 580 324
Fax. 0031 (0) 345 570 696

www.steelconstructions.nl

Contact : Doede de Vries

4 TEST PROCEDURE

Test type	: TB11
Theoretical impact speed	: 100 km/h
Theoretical impact angle	: 20 °
Theoretical total vehicle test mass	: 900 kg

5 SOFTWARE

Type and release version of software

LS-DYNA: LS-PREPOST V4.3 – SOLVER R8.0.0 MPP

Post processing of severity index

TRAP Test Risk Assessment Program Version 2.3.10

Reference to software used for pre-processing, analysis and post-processing

LS-PrePost 4.3 x64 Developing 2015 (Copyright © 1988-2015 Livermore Software Technology Corporation)

6 VIRTUAL TEST CONDITIONS

Impact speed	: 100 km/h
Impact angle	: 20 °

7 TEST ITEM MODEL

Characteristics

Characteristics	Test item model
Length [mm]	9000 / 12080
Height [mm]	770
Width [mm]	800
Distance between posts [mm]	4500

Description of each VRS component

Element description	Dimensions [mm]	Material
Beam	See drawings	S235JR
Post		S235JR
Spacer		S235JR
Others		S235JR

Description of each connection

Location	Type
Beam-beam	M16 4.6
Beam-spacer	M16 8.8
Spacer-middle post	M16 8.8
Spacer-other posts	M16 4.6
Foot plate-ground plate	M24 4.6

Ground plate-ground

M16 8.8

Description of material models and material properties specifications

- Steel:

Name	Density [T/mm ³]	Young's modulus [MPa]	Poisson ratio	Yield stress [MPa]	Tensile stress [MPa]	Elongation
Beam	7.85e-9	2.1e5	0.3	363	550	24%
Post	7.85e-9	2.1e5	0.3	365	497	20%
Spacer	7.85e-9	2.1e5	0.3	312	494	28%
Others	7.85e-9	2.1e5	0.3	310	509	25%

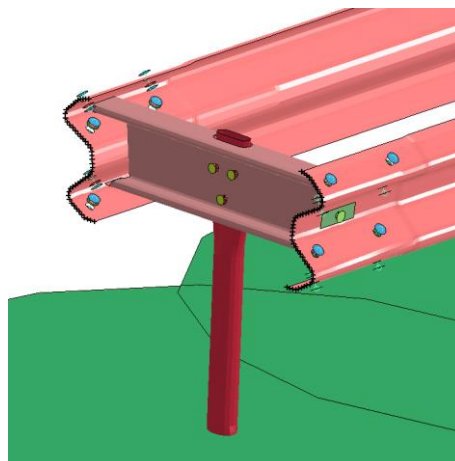
- Bolts:

Class	Density [T/mm ³]	Young's Modulus [MPa]	Poisson ratio	Tension [MPa]	Shear [MPa]	Elongation
4.6	7.85e-9	2.1e5	0.3	400	230	/
8.8	7.85e-9	2.1e5	0.3	800	460	/

Boundary conditions and constraints including ground/soil anchoring where applicable

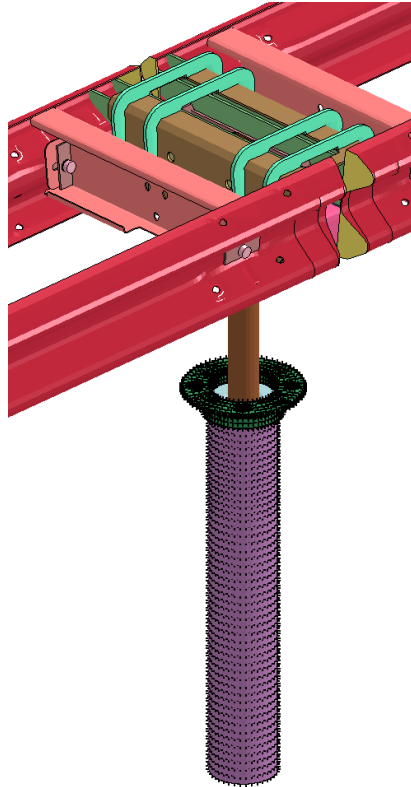
- Extremities

In order to simulate the tension induced by the continuity of the system, the extremities of the barrier are numerically blocked: the 6 DOFs of the extremity nodes are blocked.

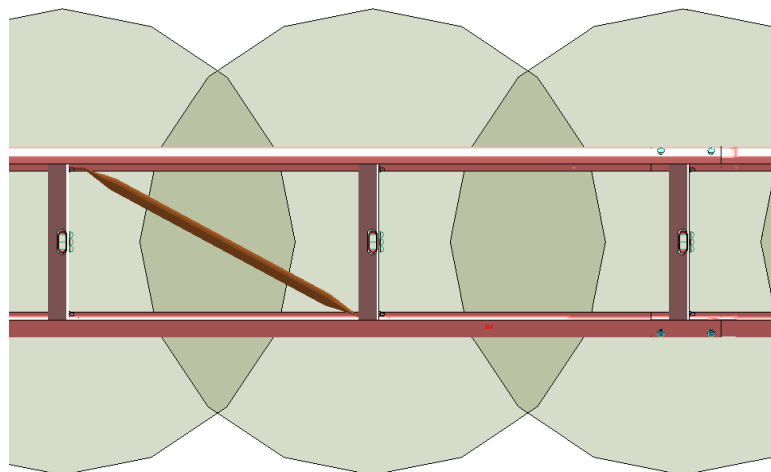


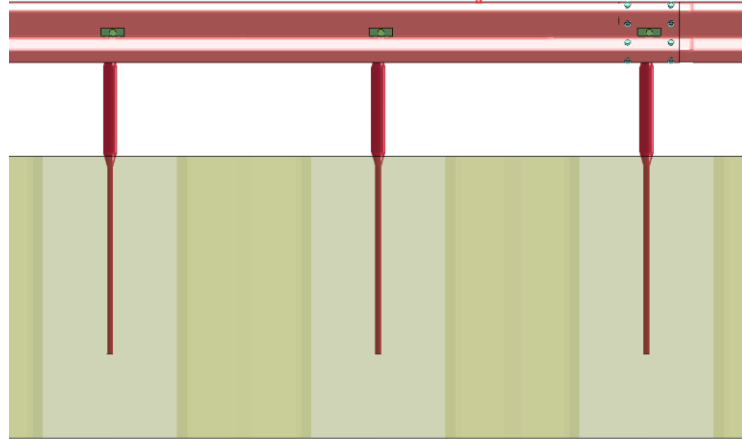
- Soil

For the gate part, the middle post's socket is numerically blocked: the 6 DOFs of all the nodes of the socket are blocked.

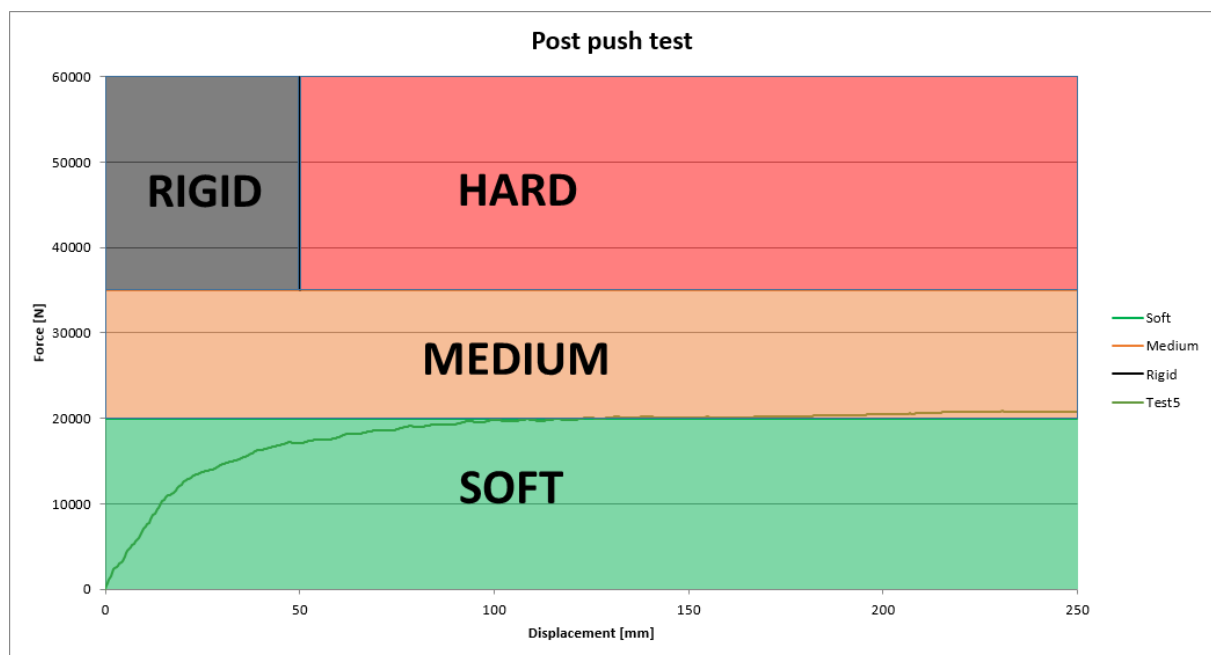


For the soil part, the posts are embedded into a soil.



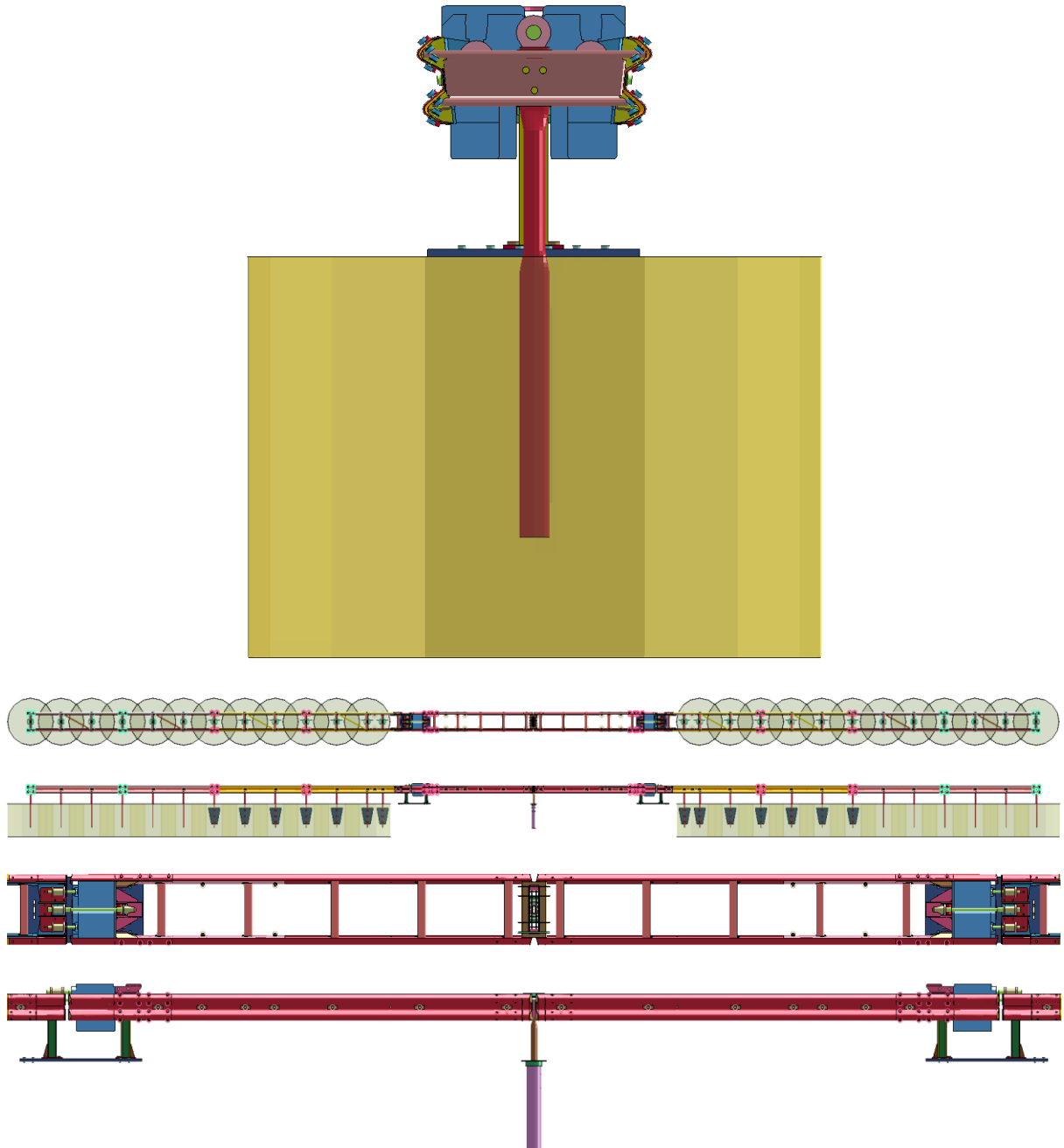


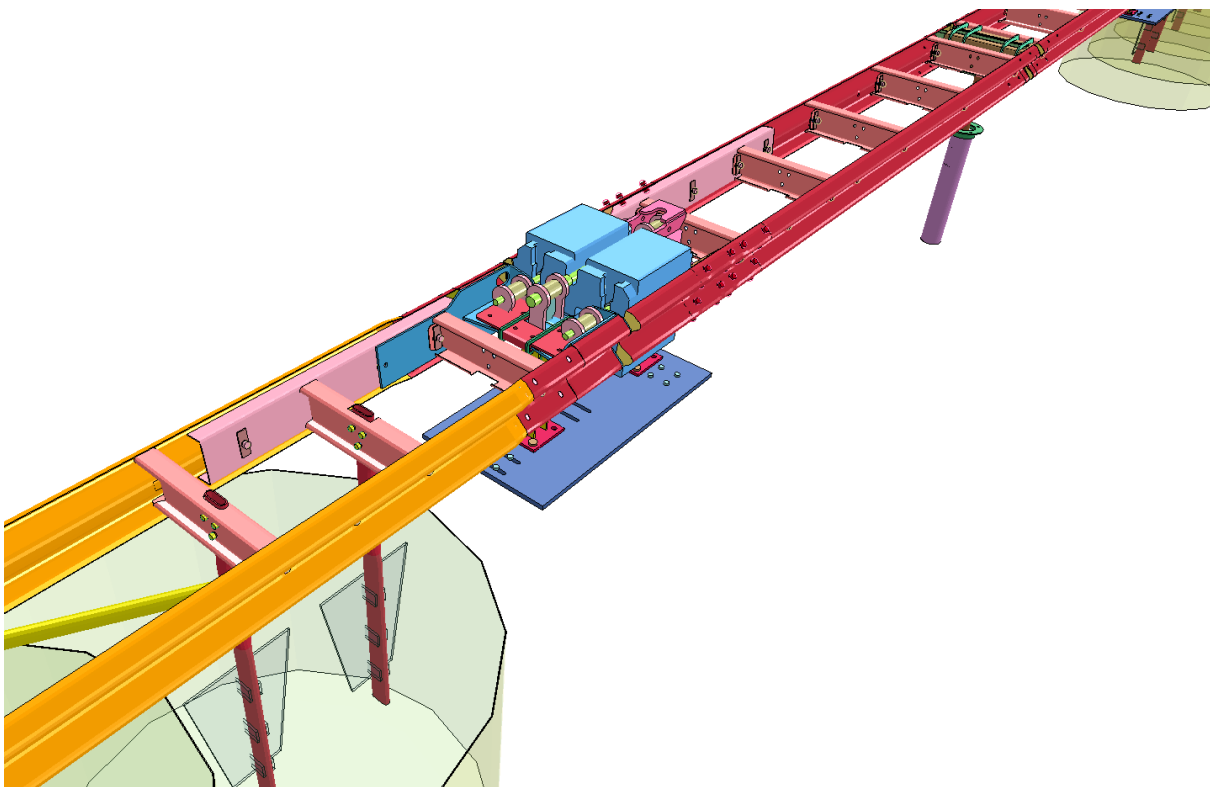
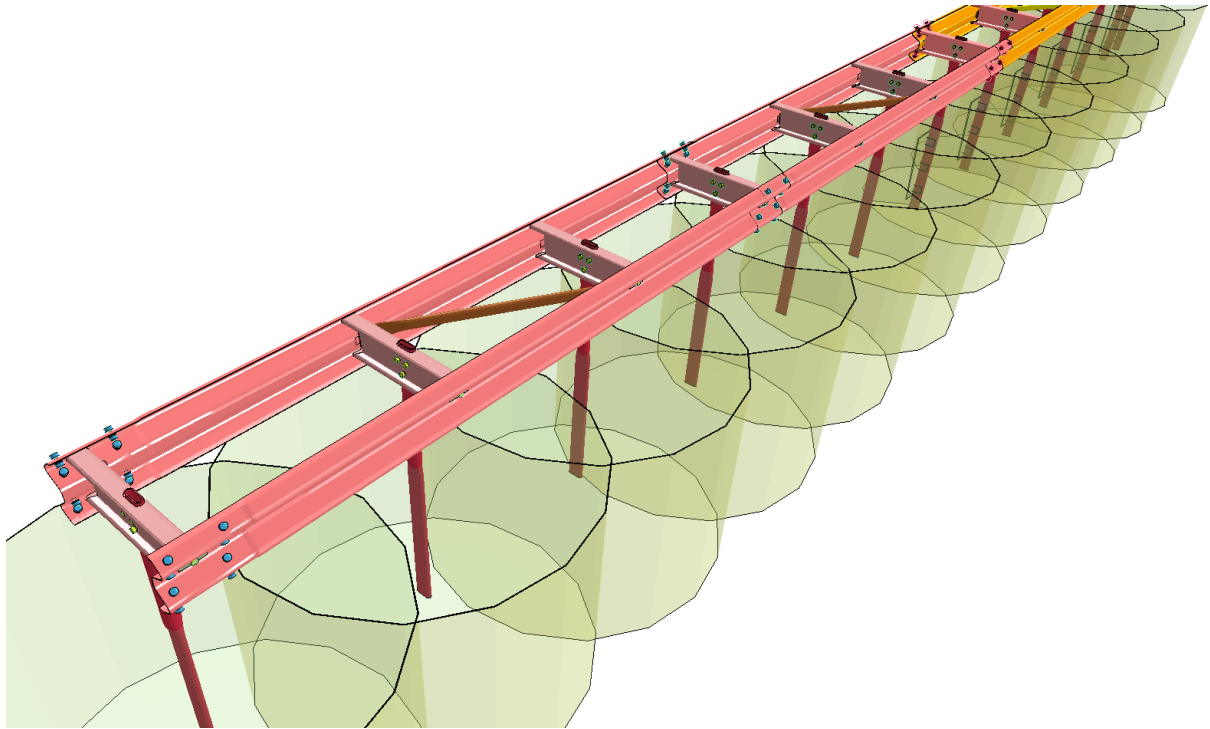
The soil strength is at the border between the soft and medium type.

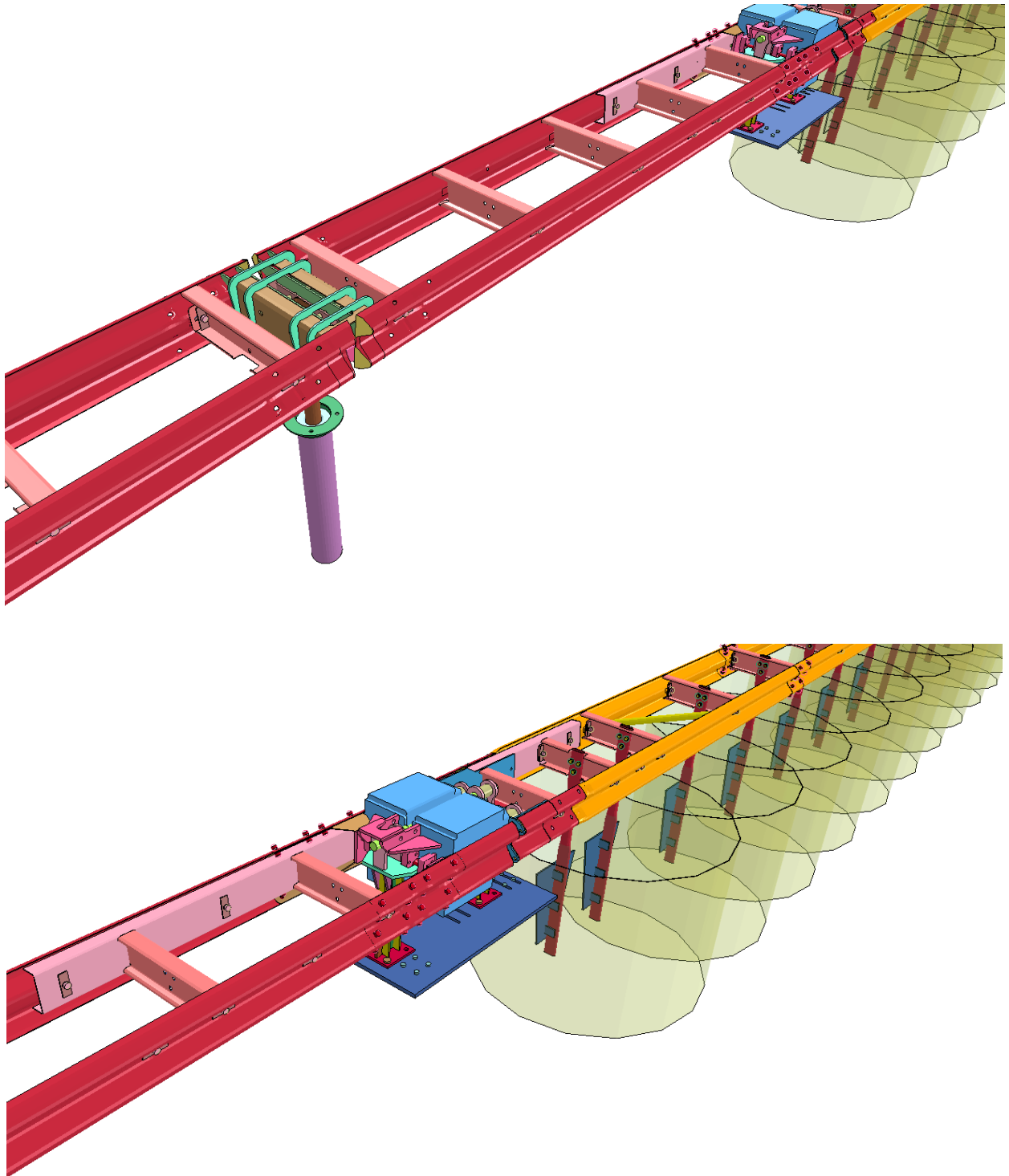


Model description

The model is in compliance with the client's drawing number *GEL13001369*.



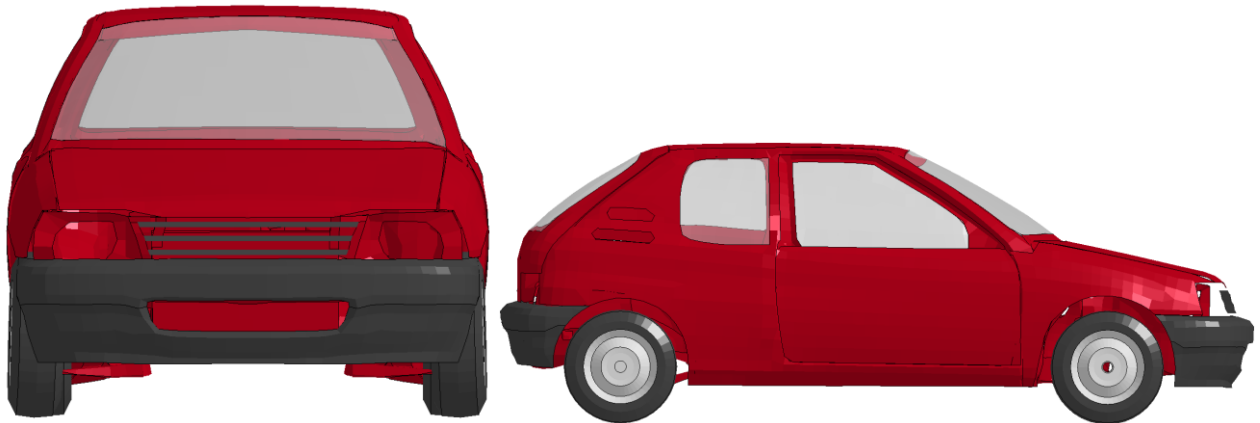




8 VEHICLE MODEL

Model

Peugeot 205



Total test mass

	Vehicle Model	EN1317 Specification	EN1317 Tolerance	Acceptance
Vehicle + load [kg]	862	900	± 40	YES

Dimensions and characteristics of the vehicle

	Vehicle Model	EN1317 Specification	EN1317 Tolerance	Acceptance
Length [m]	3.64			
Width [m]	1.59			
Wheel track (front) [m]	1.41	1.35	± 15%	YES
Wheel track (rear) [m]	1.33	1.35	± 15%	YES
N of axles	2			
Wheel radius [m]	0.27			
Wheel base [m]	2.35			
Height (platform) [m]	/			

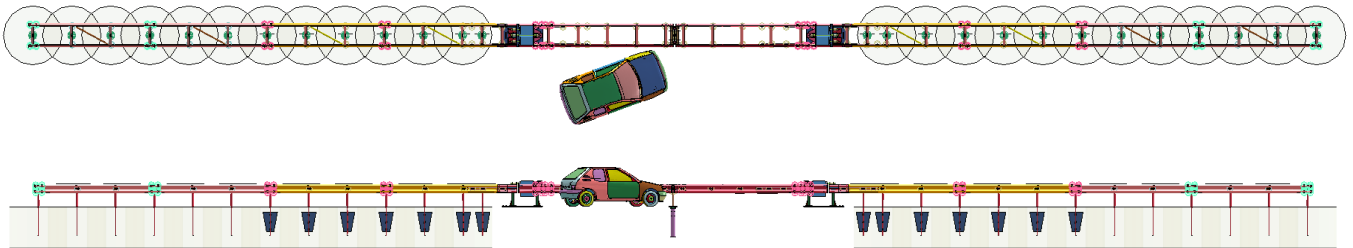
Location of the center of gravity

	Vehicle Model	EN1317 Specification	EN1317 Tolerance	Acceptance
CGx [m]	0.94	0.90	±10%	YES
CGy [m]	0.003	±0.07		YES
CGz [m]	0.5	0.49	±10%	YES

9 VALIDATION

9.1 CRASH-TEST CONDITIONS

Measure	Virtual test
Impact speed [km/h]	100
Impact angle [°]	20
Impact point	Middle post



9.2 RESULTS

General

Measure	Virtual test
Working Width [m]	1.18
Normalised working width [m]	1.2 (1.20)
Class of normalised working width	W4
ASI	0.93
Time of ASI [s]	0.16
Class of ASI	A
THIV [km/h]	22.3
Time of THIV [s]	0.12

LS-DYNA keyword deck by LS-PrePost
Time = 0.24

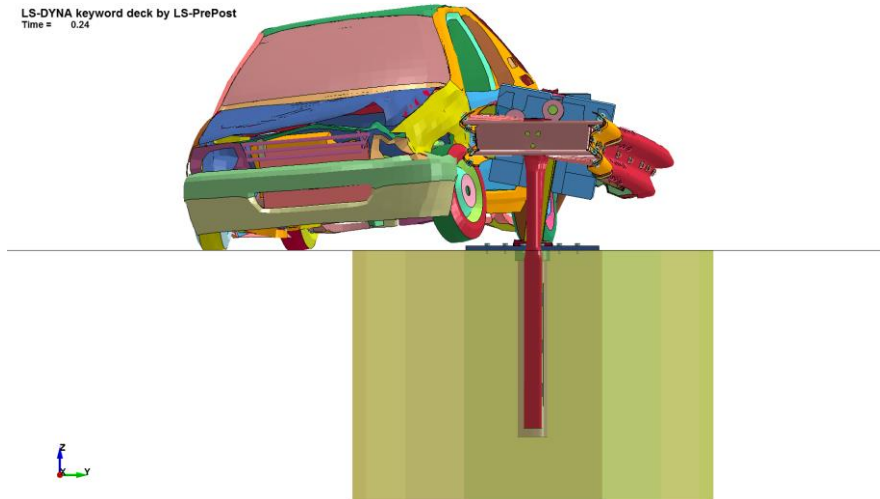


Figure 1 – Working Width

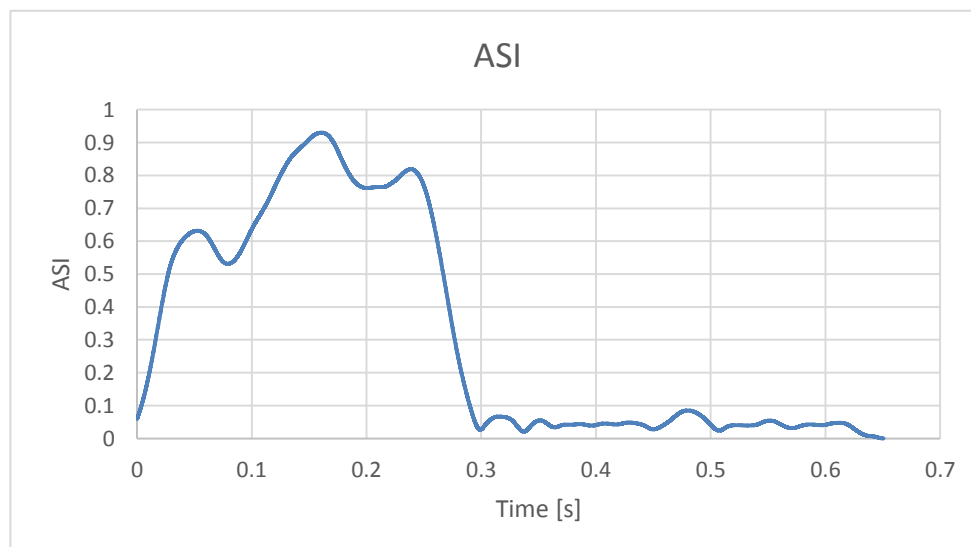


Figure 2 – ASI

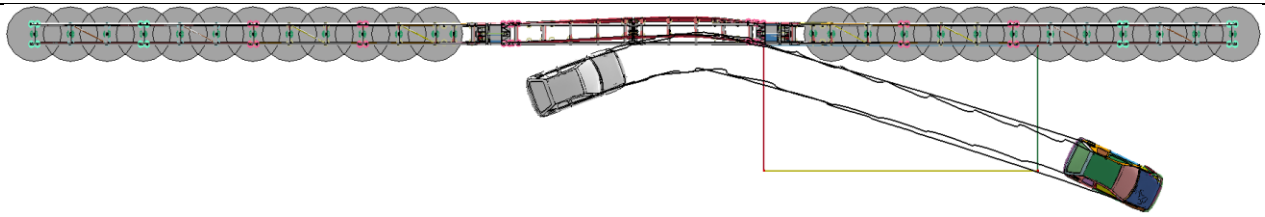


Figure 3 – Exit Box

9.3 VERIFICATION CRITERIA

Criteria	Change (%)	Pass?
Total energy of the analysis solution must not vary more than 10%	5	YES
Hourglass energy of the analysis solution is less than 5% of the total internal energy at the beginning of the run	0	YES
Hourglass energy of the analysis solution is less than 10% of the total internal energy at the end of the run	0	YES
Mass added to the total model is less than 5% of the total model mass at the beginning of the run	0	YES
The part/material with the most mass added had less than 10% of its initial mass added	0	YES
The moving parts/materials in the model have less than 5% of mass added to the initial moving mass of the model	0	YES
There are no shooting nodes in the solution	0	YES
There are no solid elements with negative volumes	0	YES

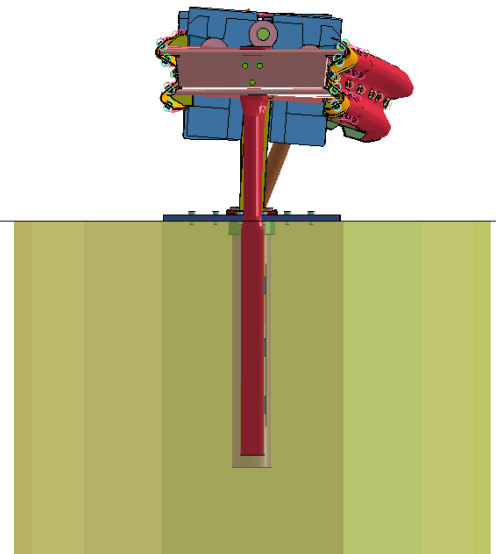
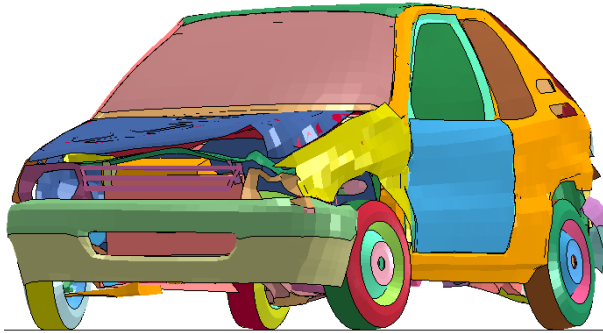
9.4 CONCLUSION

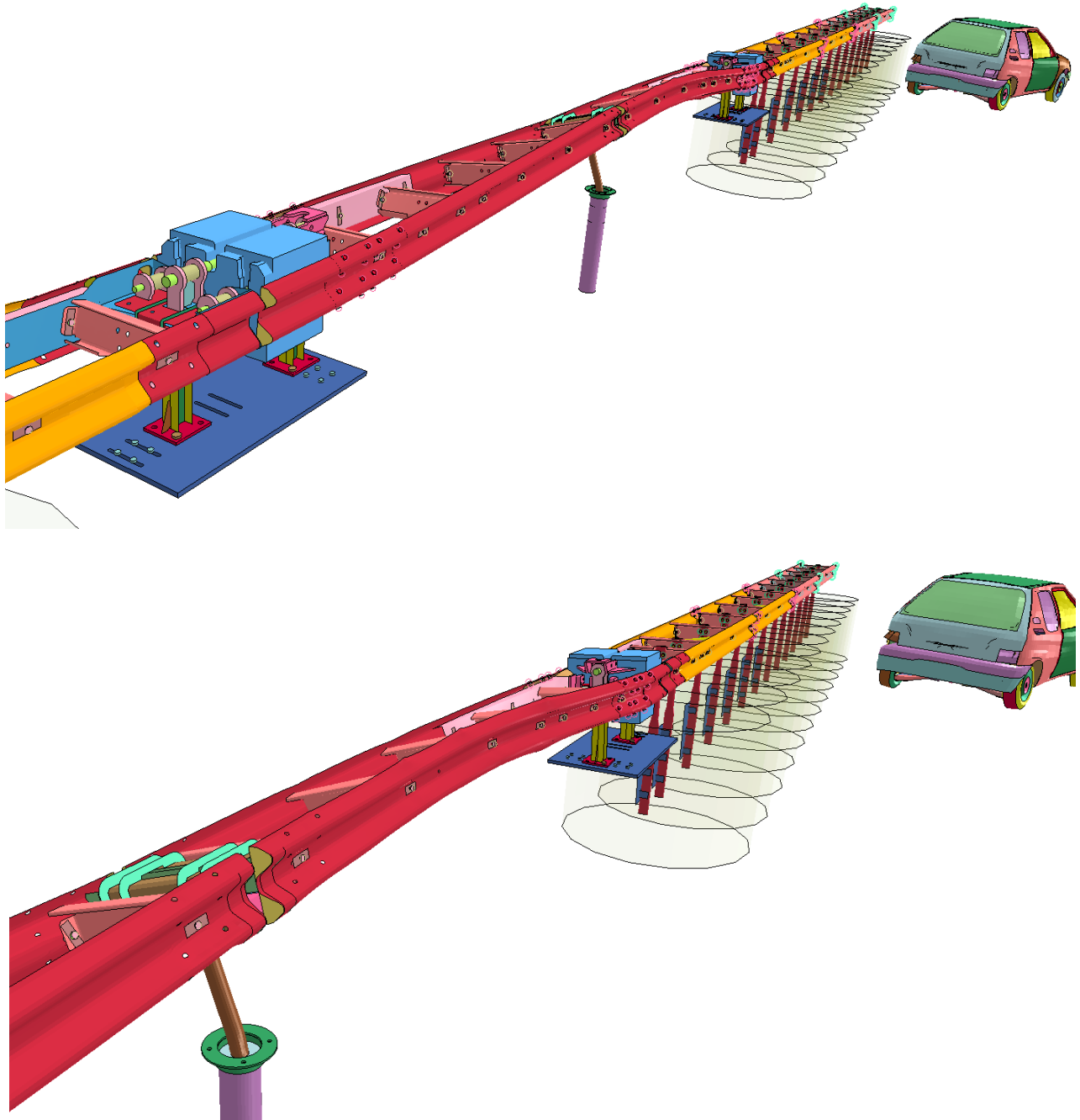
This virtual test simulates a TB11 impact against the finite element model of the CADO system. Based on the results shown in this report and the one about the TB51 (SC.TR-CADO-H2-TB51/V1), the CADO system would reach the containment level H2.

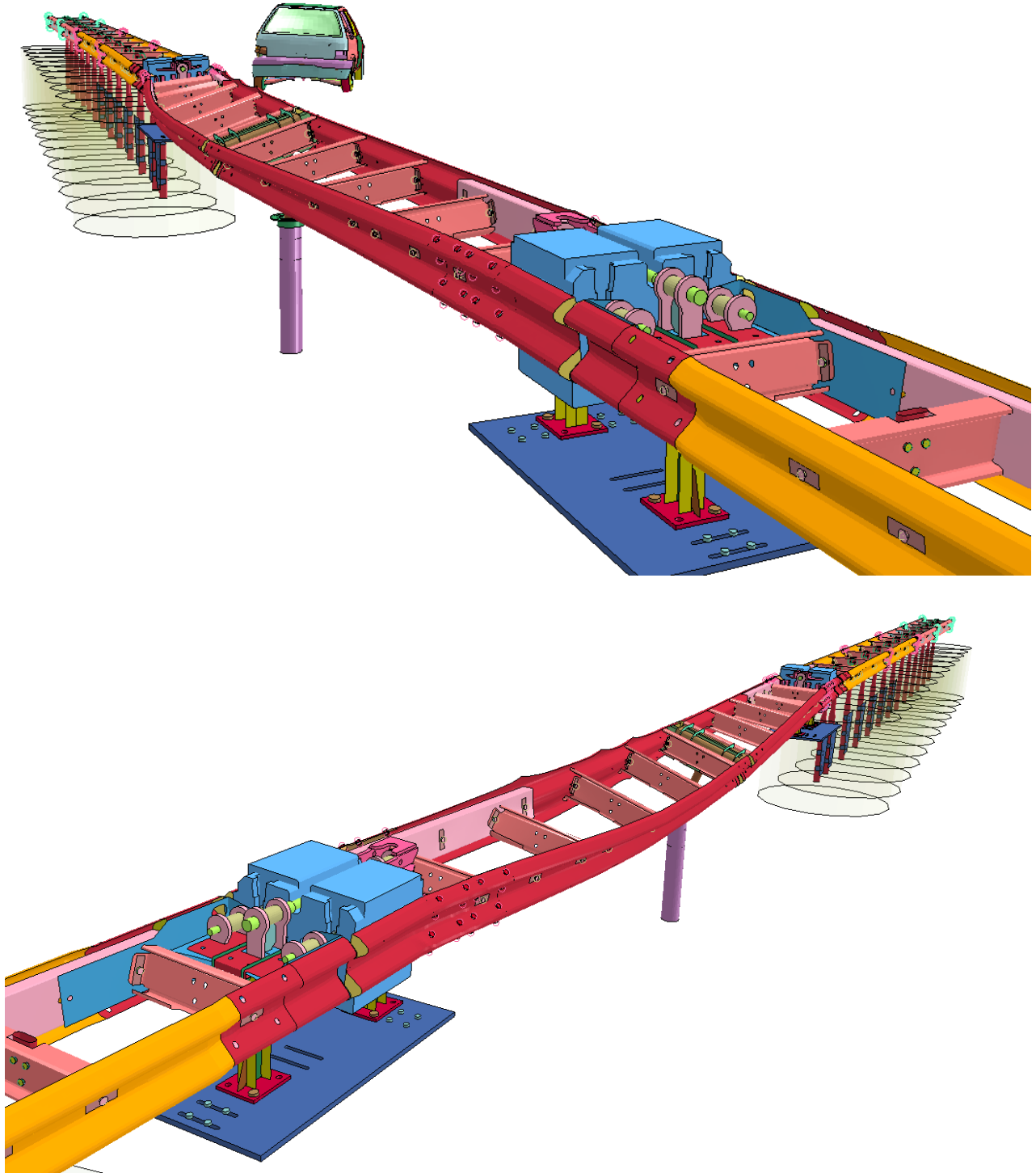
10 APPENDICES

10.1 PHOTOS

After crash-test

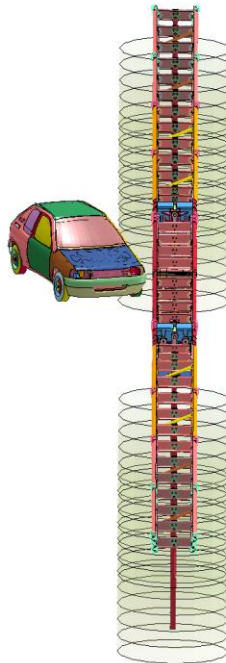






During crash-test

LS-DYNA keyword deck by LS-PrePost
Time = 0



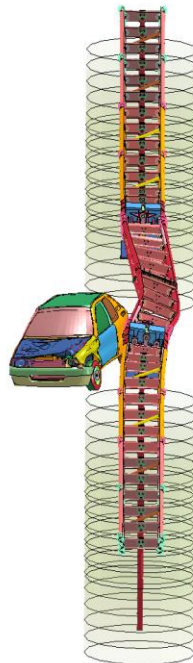
LS-DYNA keyword deck by LS-PrePost
Time = 0.1



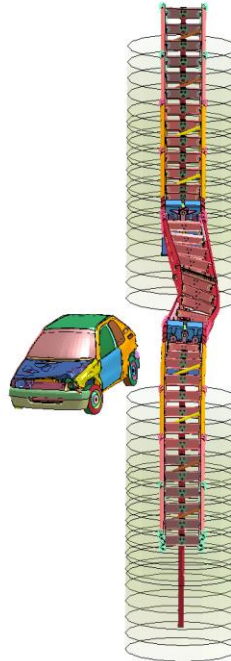
LS-DYNA keyword deck by LS-PrePost
Time = 0.2



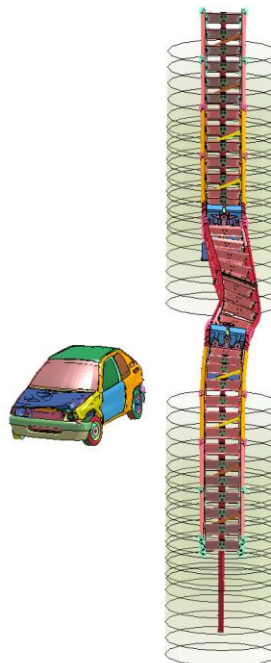
LS-DYNA keyword deck by LS-PrePost
Time = 0.3



LS-DYNA keyword deck by LS-PrePost
Time = 0.4



LS-DYNA keyword deck by LS-PrePost
Time = 0.5



10.2 ENERGY BALANCE

