

Virtual testing report

STEEL CONSTRUCTIONS – CADO H2 – TB51

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-TB51/V1
Ref numerical simulation report number	/
Validation report number	/
Test type	TB51
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
Number of pages	25
Official validation report language	English



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1 SUBCONTRACTOR

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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

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4 TEST PROCEDURE

Test type	: TB51
Theoretical impact speed	: 70 km/h
Theoretical impact angle	: 20 °
Theoretical total vehicle test mass	: 13000 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	: 70 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%

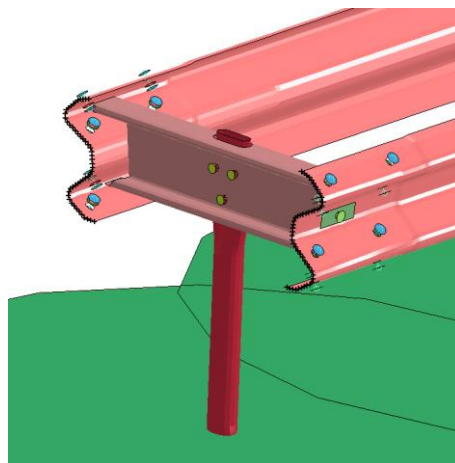
- Bolts:

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

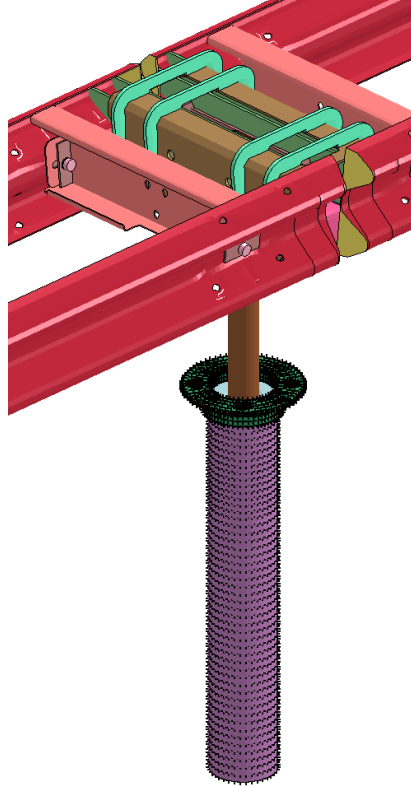
- Extremities

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.

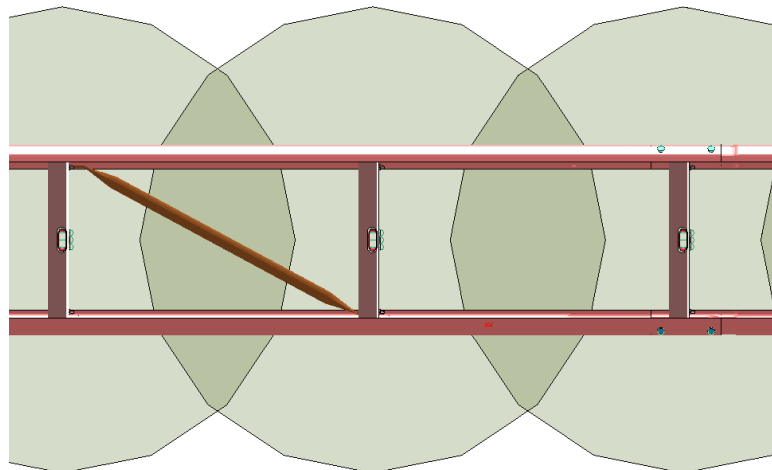


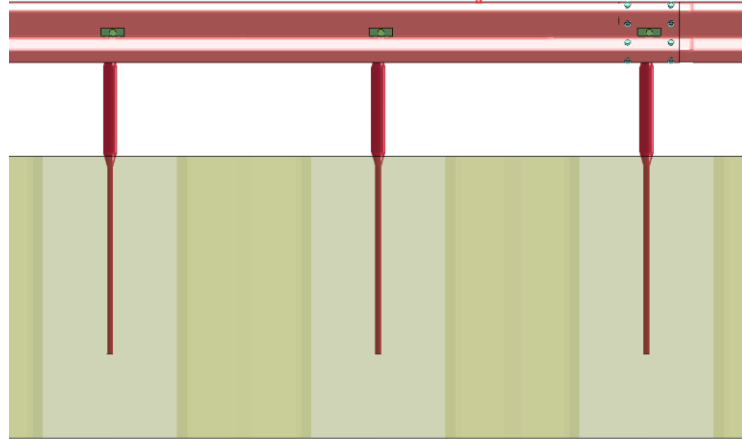
- Soil

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

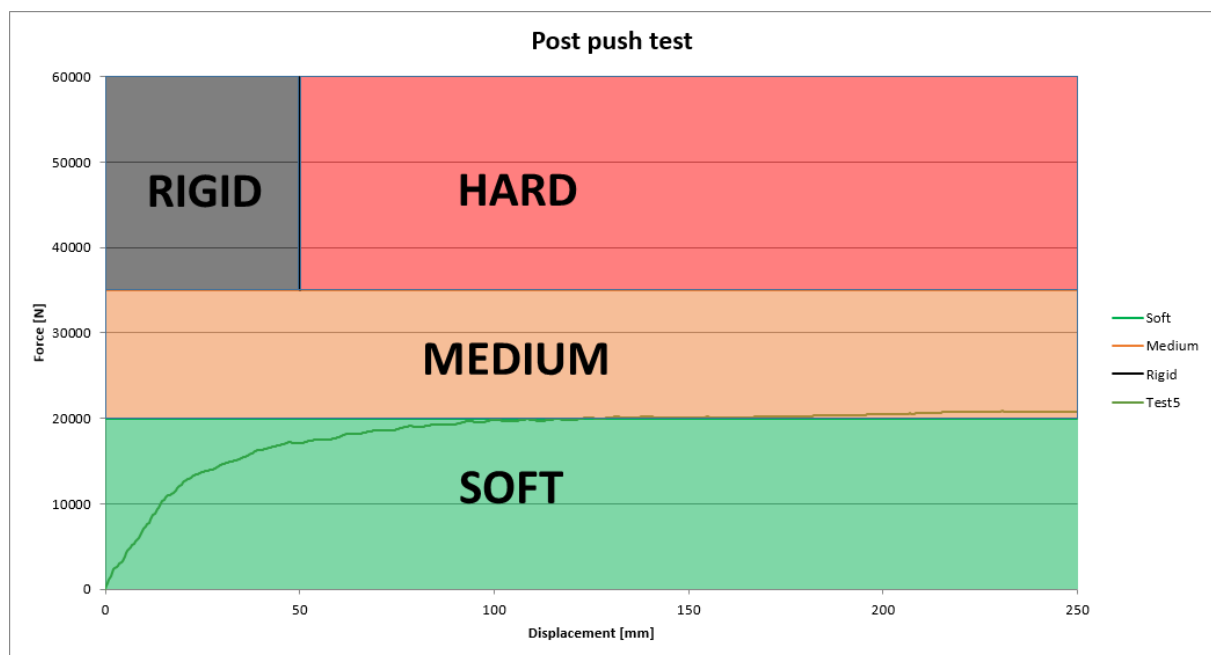


For the soil part, the posts are embedded into a soil.



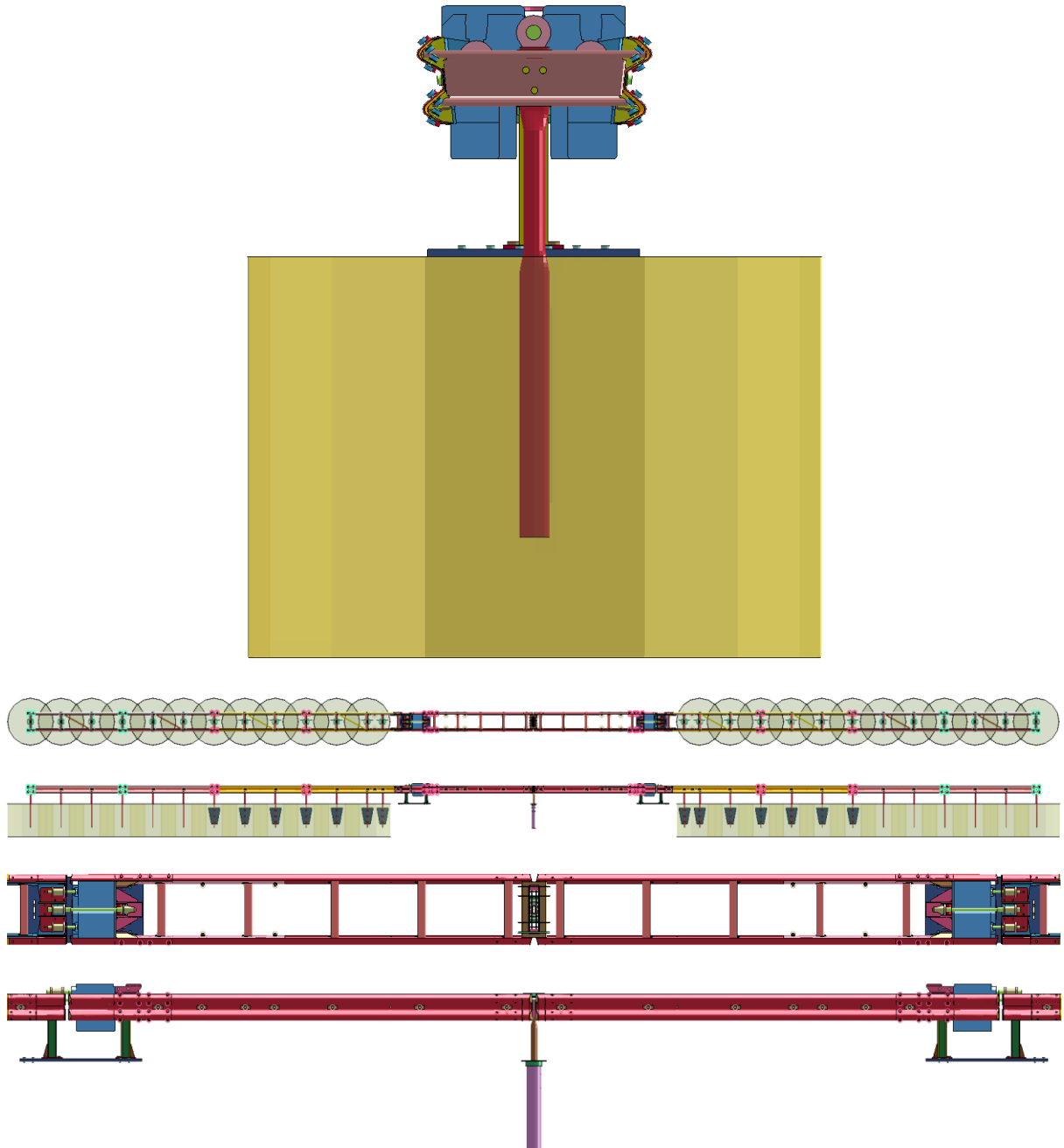


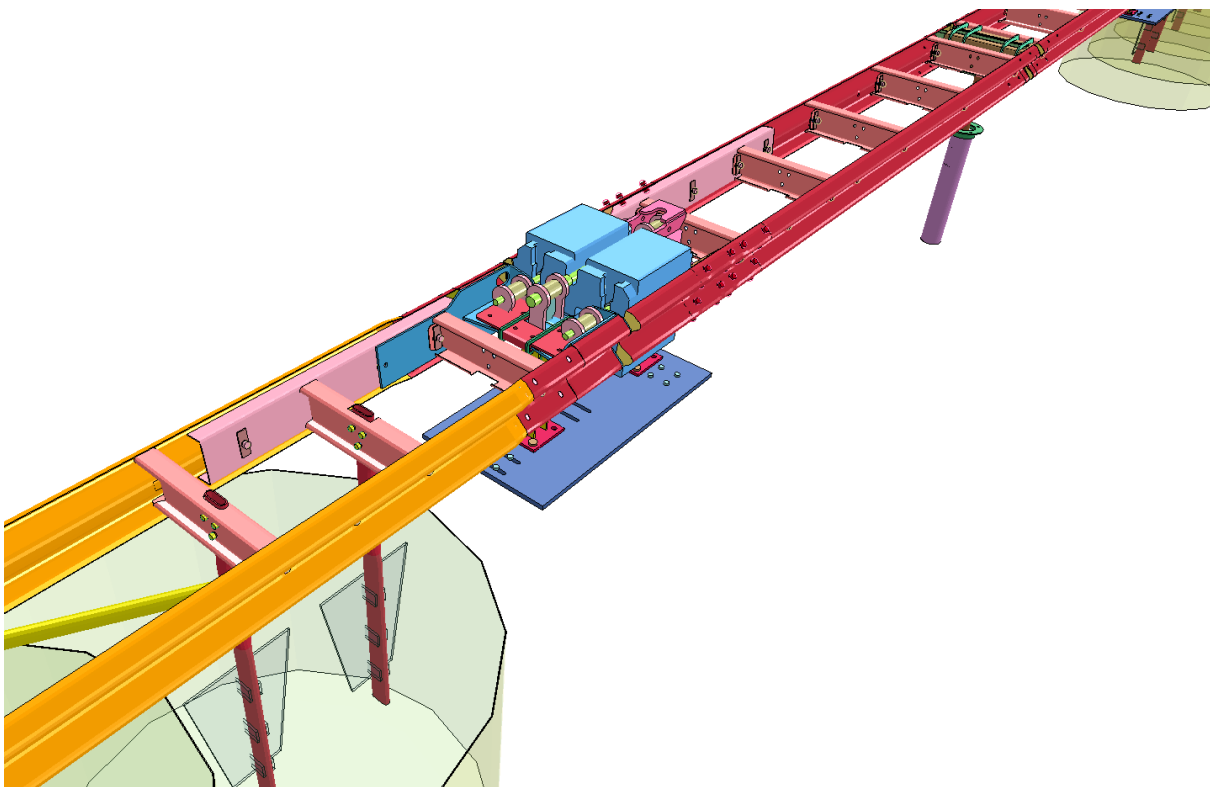
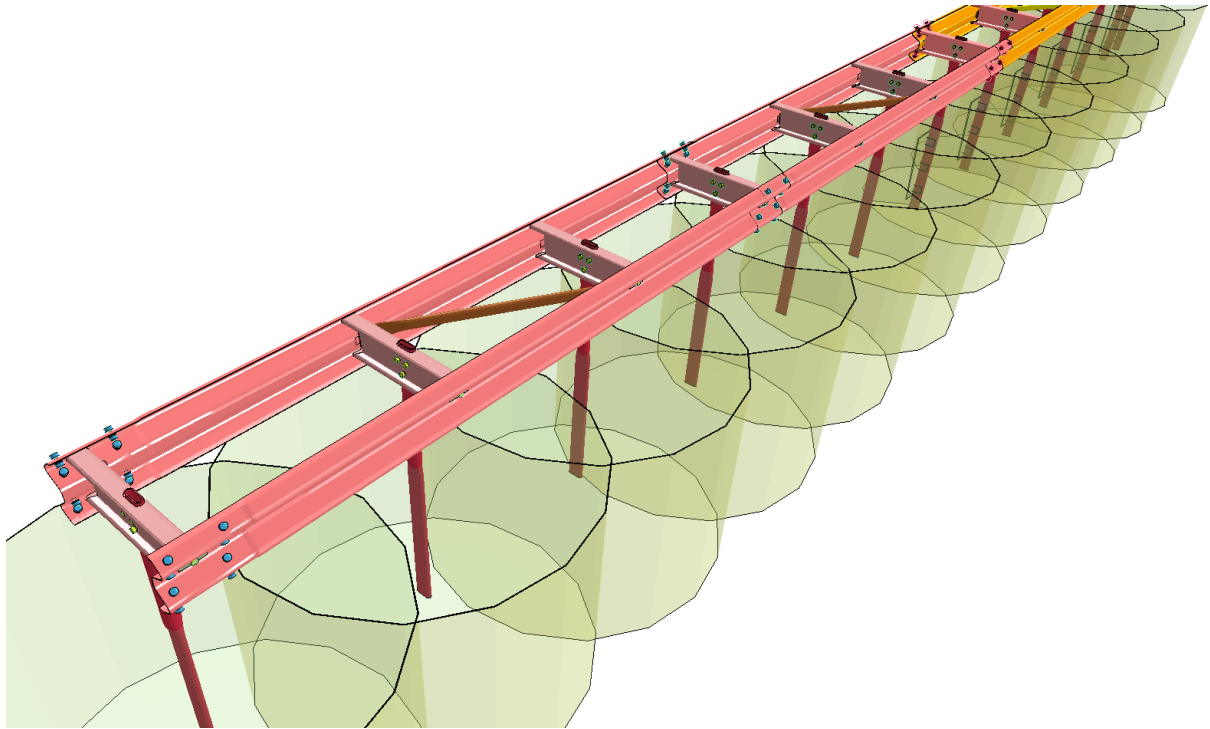
The soil strength is at the border between the soft and medium type.

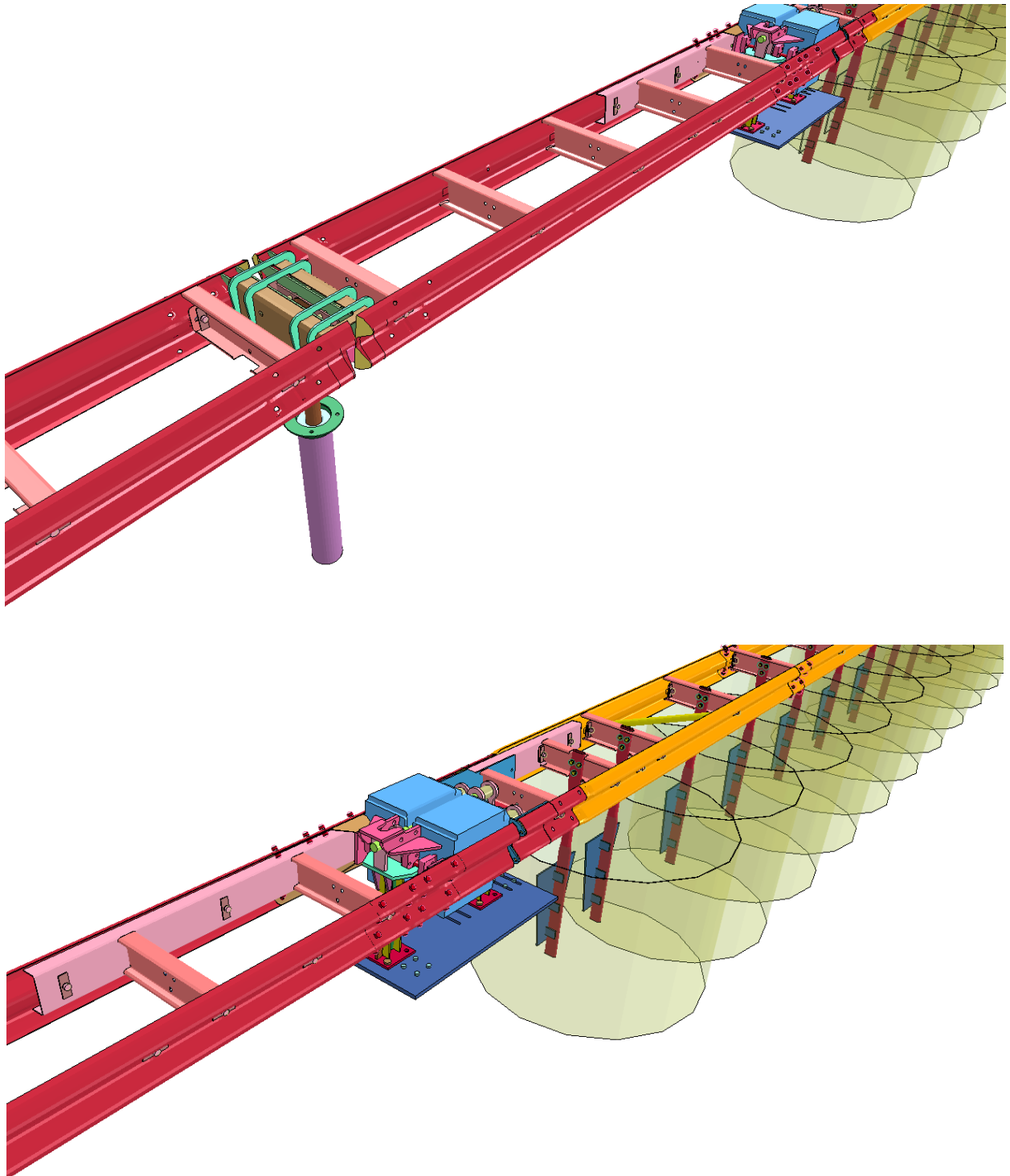


Model description

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



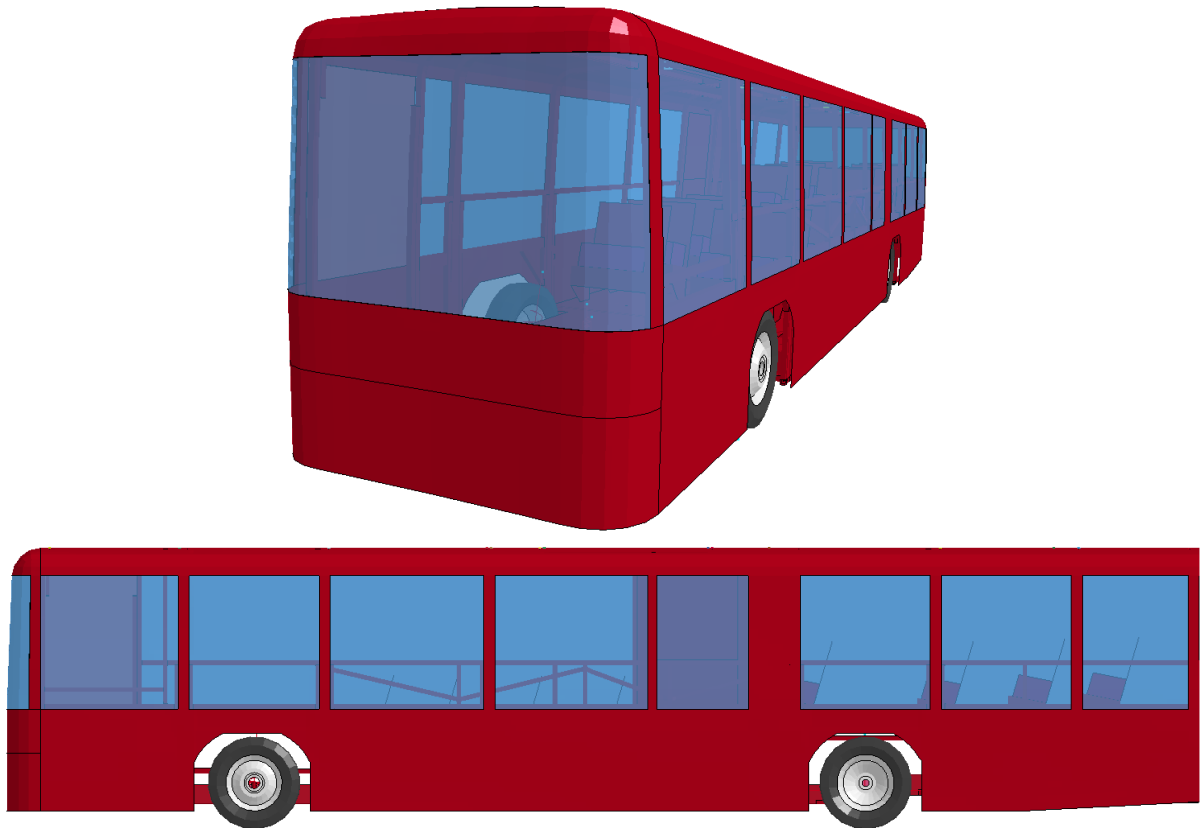




8 VEHICLE MODEL

Model

City Bus



Total test mass

	Vehicle Model	EN1317 Specification	EN1317 Tolerance	Acceptance
Vehicle + load [kg]	12998	13000	± 400	YES

Dimensions and characteristics of the vehicle

	Vehicle Model	EN1317 Specification	EN1317 Tolerance	Acceptance
Length [m]	12.67			
Width [m]	2.56			
Wheel track (front) [m]	2.10	2.0	± 15%	YES
Wheel track (rear) [m]	1.85	2.0	± 15%	YES
N of axles	2			
Wheel radius [m]	0.49	0.52	± 15%	YES
Wheel base [m]	6.50	6.50	± 15%	YES
Height (platform) [m]	0.64			

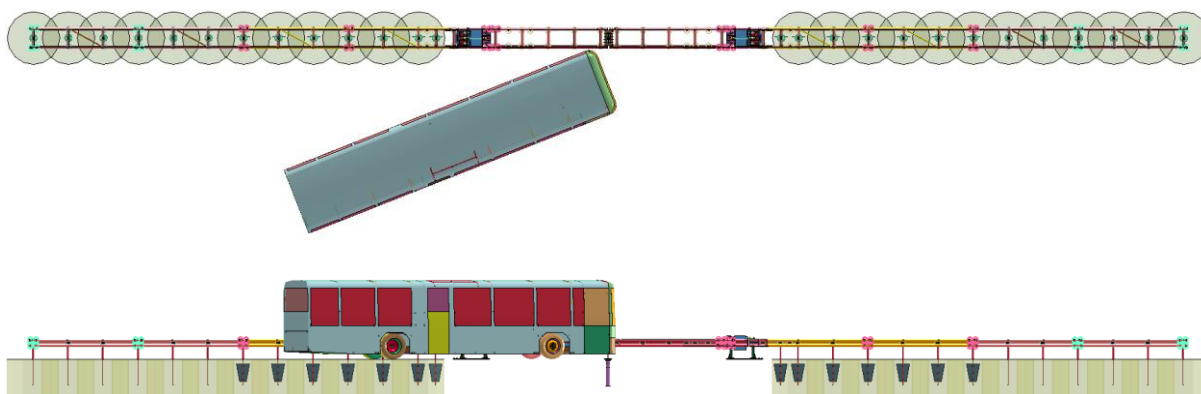
Location of the center of gravity

	Vehicle Model	EN1317 Specification	EN1317 Tolerance	Acceptance
CGx [m]	3.64	3.80	±10%	YES
CGy [m]	-0.02	±0.10		YES
CGz [m]	/	1.40	±10%	/

9 VALIDATION

9.1 CRASH-TEST CONDITIONS

Measure	Virtual test
Impact speed [km/h]	70
Impact angle [°]	20
Impact point	Middle post



9.2 RESULTS

General

Measure	Virtual test
Working Width [m]	1.98
Normalised working width [m]	2.0 (1.98)
Class of normalised working width	W6
Vehicle Intrusion [m]	1.34
Normalised vehicle intrusion [m]	1.30 (1.34)
Class of vehicle intrusion	VI4

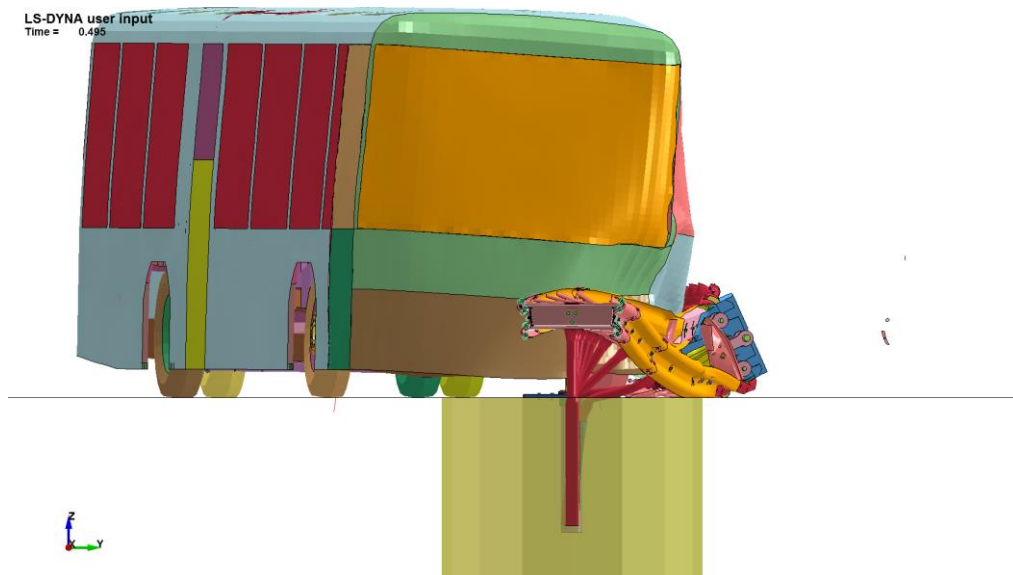


Figure 1 - Vehicle Intrusion

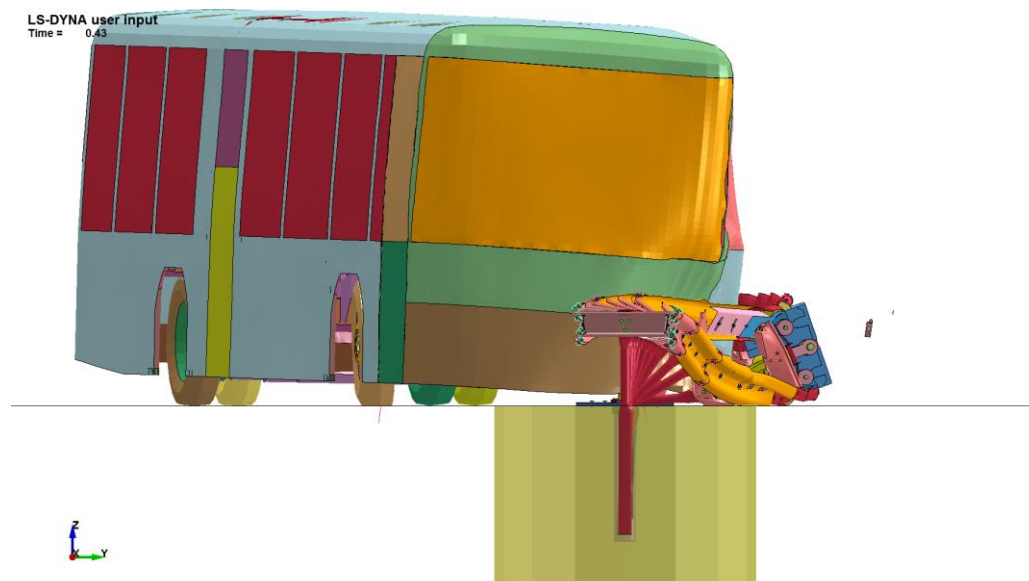


Figure 2 - Working Width

9.3 VERIFICATION CRITERIA

Criteria	Change (%)	Pass?
Total energy of the analysis solution must not vary more than 10%	1	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

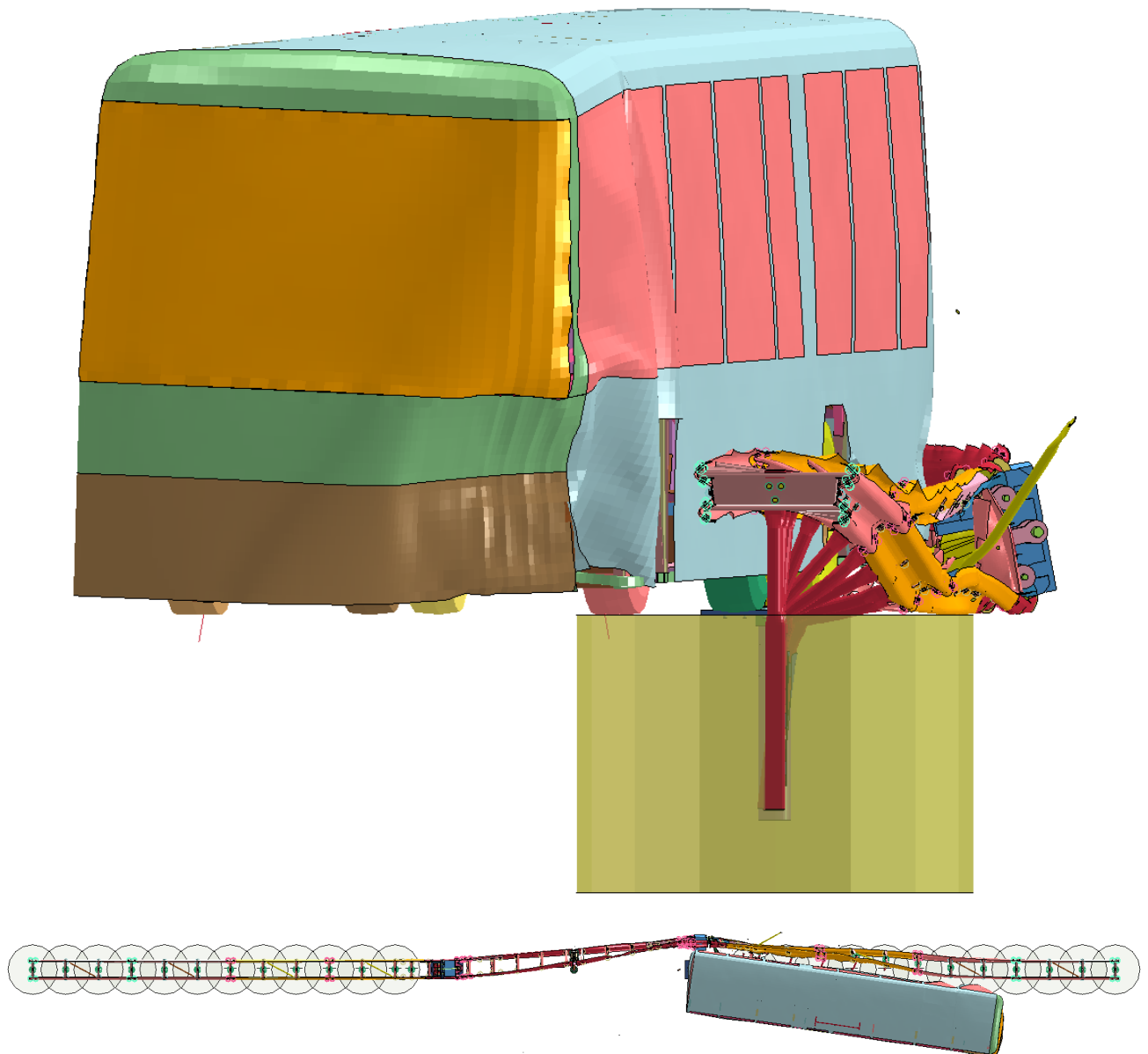
9.4 CONCLUSION

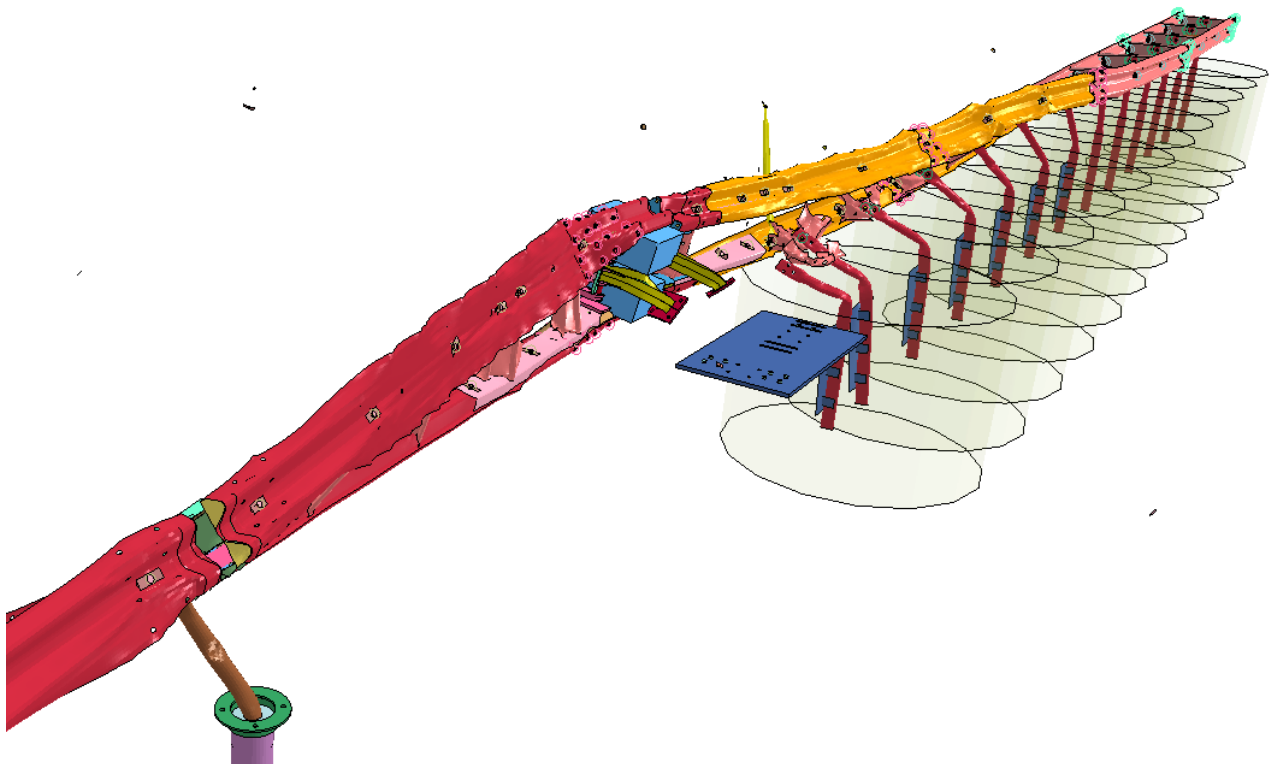
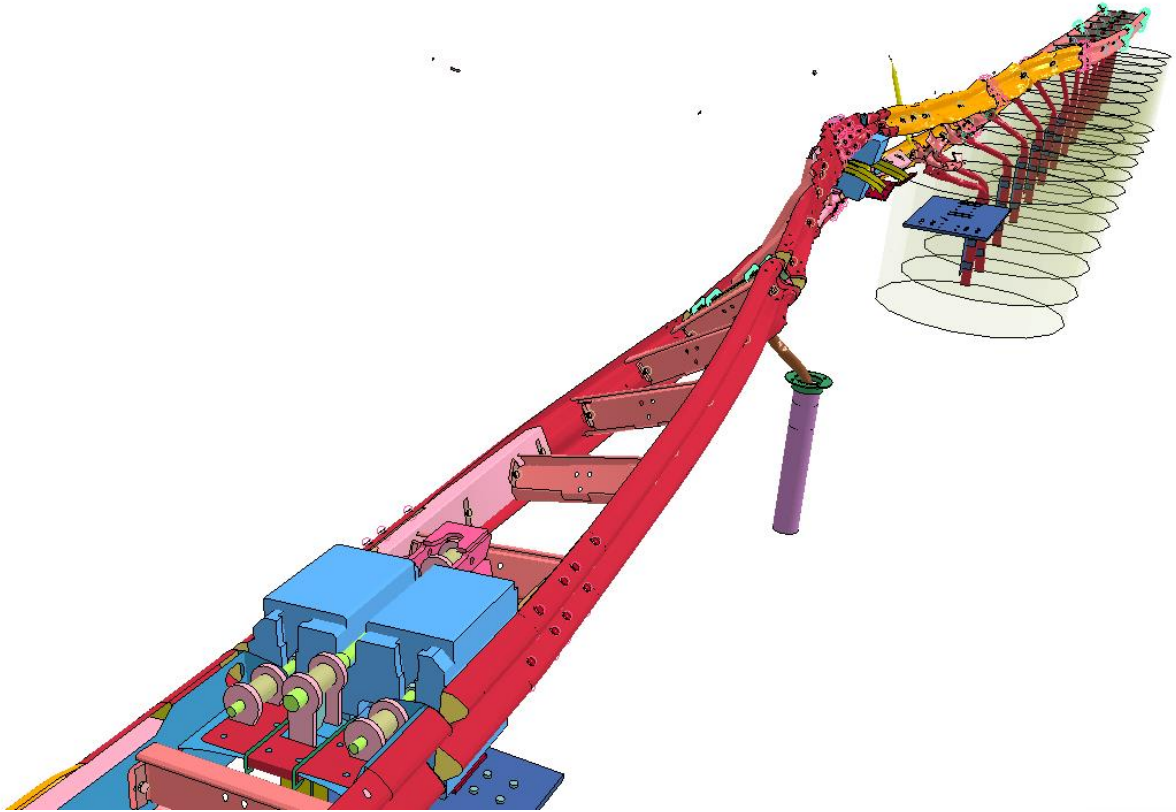
This virtual test simulates a TB51 impact against the finite element model of the CADO system. Based on the results of this report and the one about the TB11 (SC.TR-CADO-H2-TB11/V1), the CADO system would reach the containment level H2.

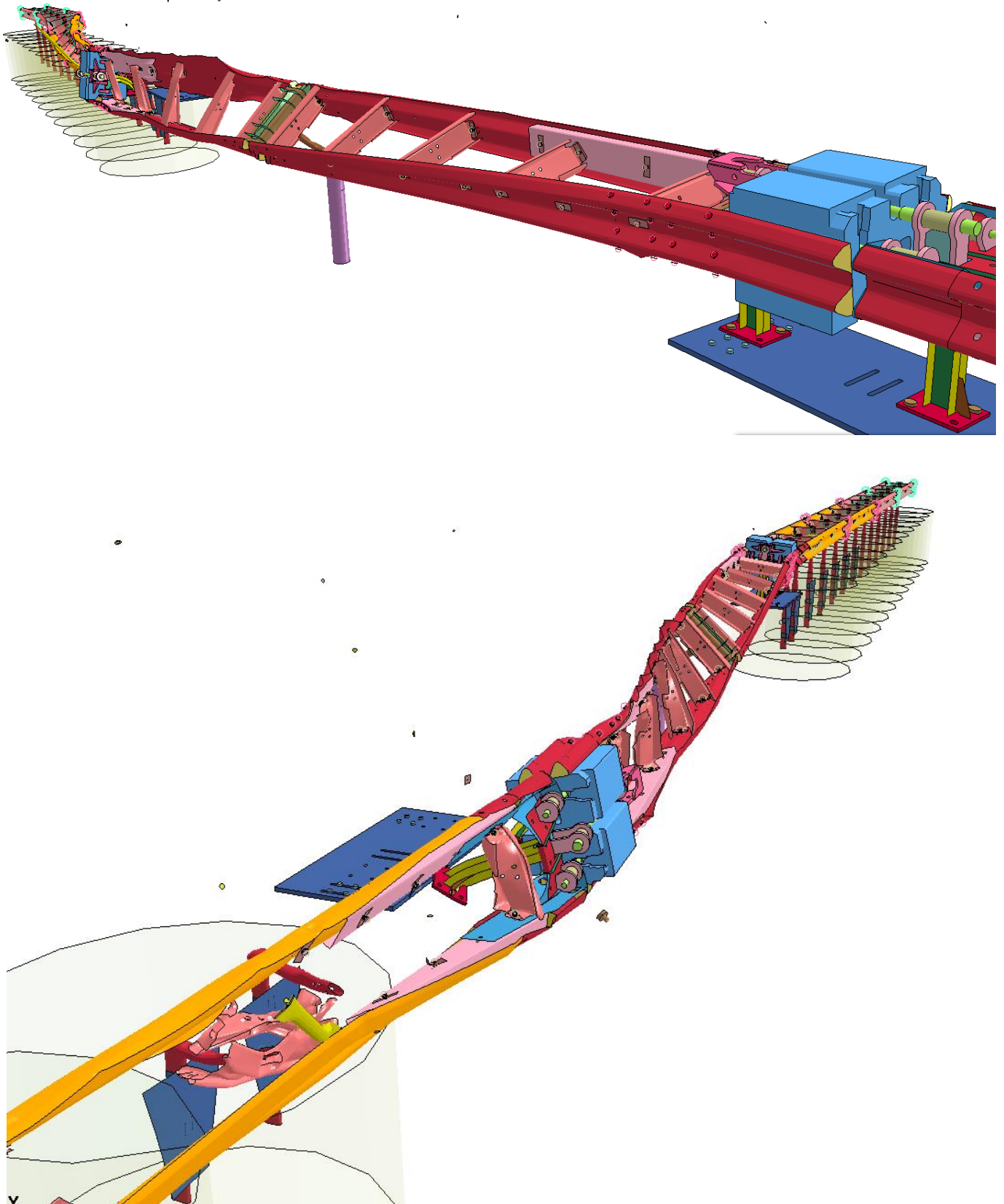
10 APPENDICES

10.1 PHOTOS

After crash-test

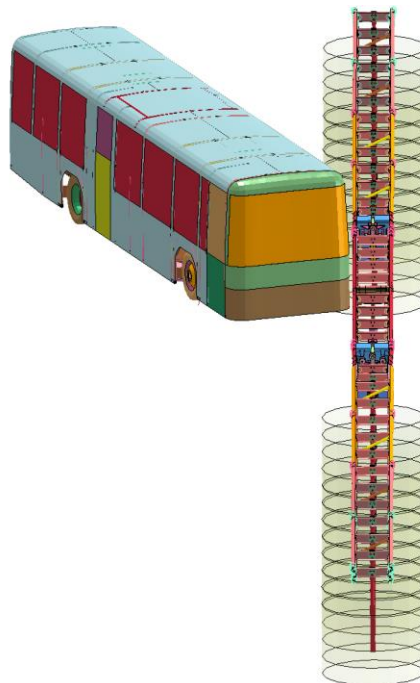




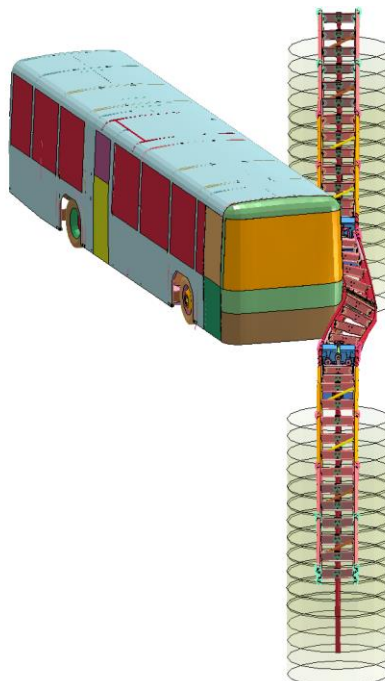


During crash-test

LS-DYNA user input
Time = 0



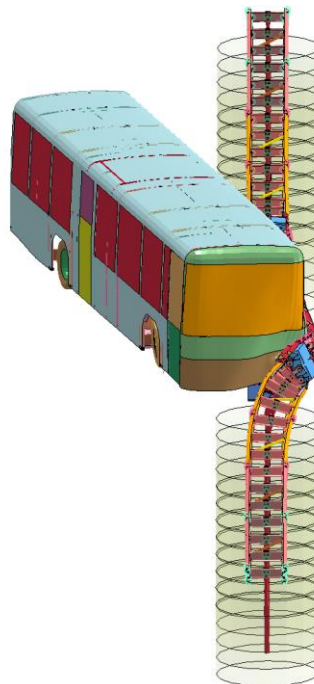
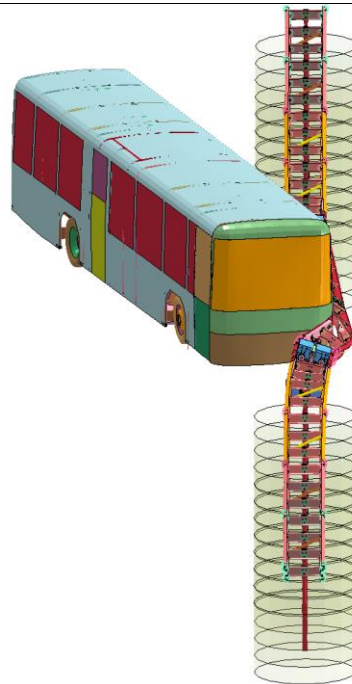
LS-DYNA user input
Time = 0.1



LS-DYNA user input
Time = 0.2



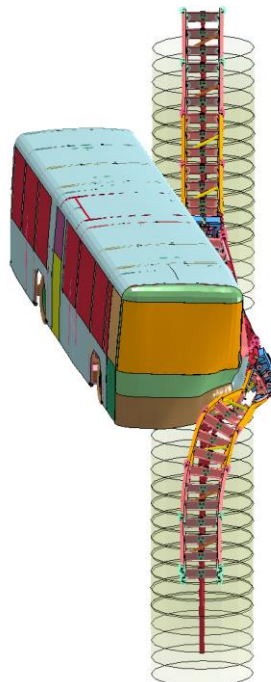
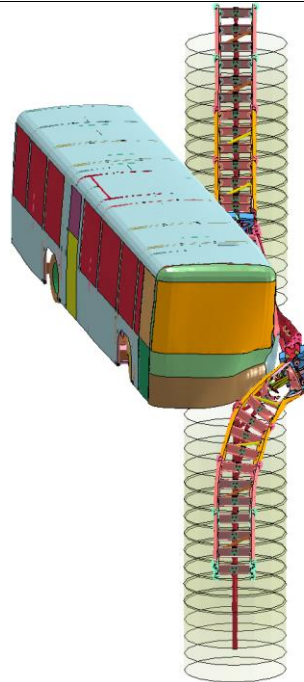
LS-DYNA user input
Time = 0.3



LS-DYNA user input
Time = 0.4



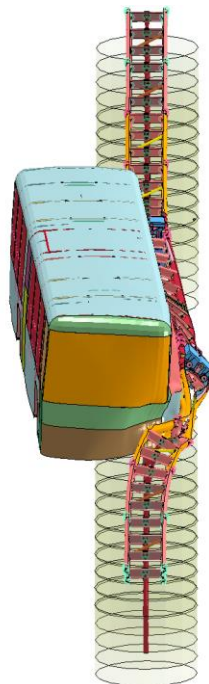
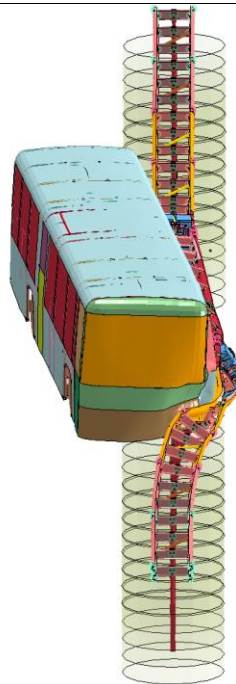
LS-DYNA user input
Time = 0.5



LS-DYNA user input
Time = 0.6



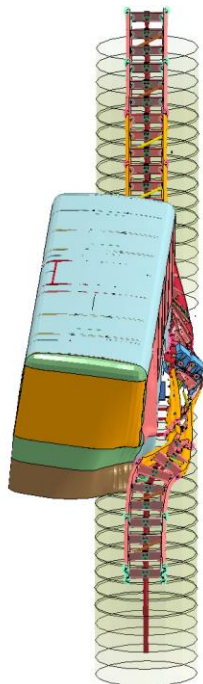
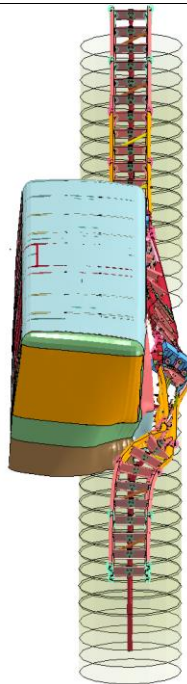
LS-DYNA user input
Time = 0.7



LS-DYNA user input
Time = 0.8



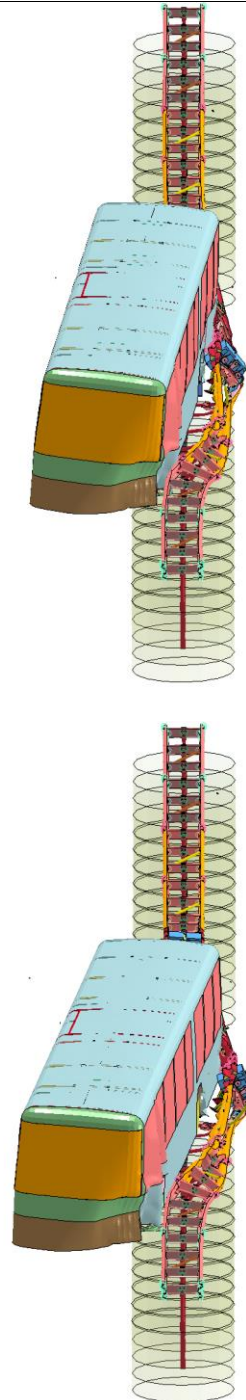
LS-DYNA user input
Time = 0.9



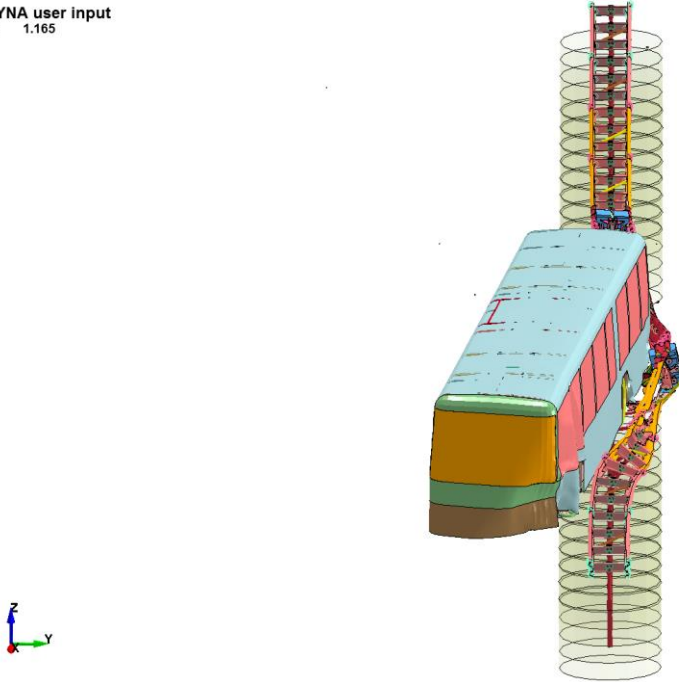
LS-DYNA user input
Time = 1



LS-DYNA user input
Time = 1.1



LS-DYNA user input
Time = 1.165



10.2 ENERGY BALANCE

