PME 3543
Estruturas Mecânicas e de Veículos
Notas de Aula
Prof. Leandro V. da S. Macedo

Desempenho em “crash”
&
Processo CAE

Evolução do desempenho estrutural dos veículos em situação de Crash

Comemoração dos 50 anos do IIHS nos EUA:
1959 Chevrolet Bel Air vs. 2009 Chevrolet Malibu

50 years
INSURANCE INSTITUTE FOR HIGHWAY SAFETY

Legislações de Crash

Brasil - http://www.denatran.gov.br/resolucoes.htm
Europa - http://www.unece.org/trans/main/welcwp29.html
EUA - http://www.nhtsa.gov/

http://www.humaneticsatd.com/

Material de referência:

http://www.carhs.de/en/
http://www.carhs.de/en/training/order.php

carhs Empowering Engineers

SAFETY COMPANION 2020

NCAP

http://www.latinncap.com/po/
http://www.globalncap.org/NCAPProgrammes/Pages/USNCAP.aspx
http://www.euroncap.com/home.aspx

FIA

http://www.fia.com/sport/regulations

Segurança Veicular
Segurança Ativa e Segurança Passiva
Desempenho em "crash" – "Crashability" ➔ desenvolvimento da estrutura do veículo
Desempenho em "crash" ➔ desenvolvimento da proteção dos ocupantes

Legislação

Brasil ➔ Contran
Europa ➔ ECE
Estados Unidos ➔ NHTSA

UNECE

CONTRAN

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Além Legislação

EUA ➔ IIHS
New Car Assesment Program
Brasil ➔ LatinNCAP
Europa ➔ EuroNCAP
...

LATIN PARA AUTOS MÁS SEGUROS NCAP

GLOBAL FOR SAFER CARS NCAP

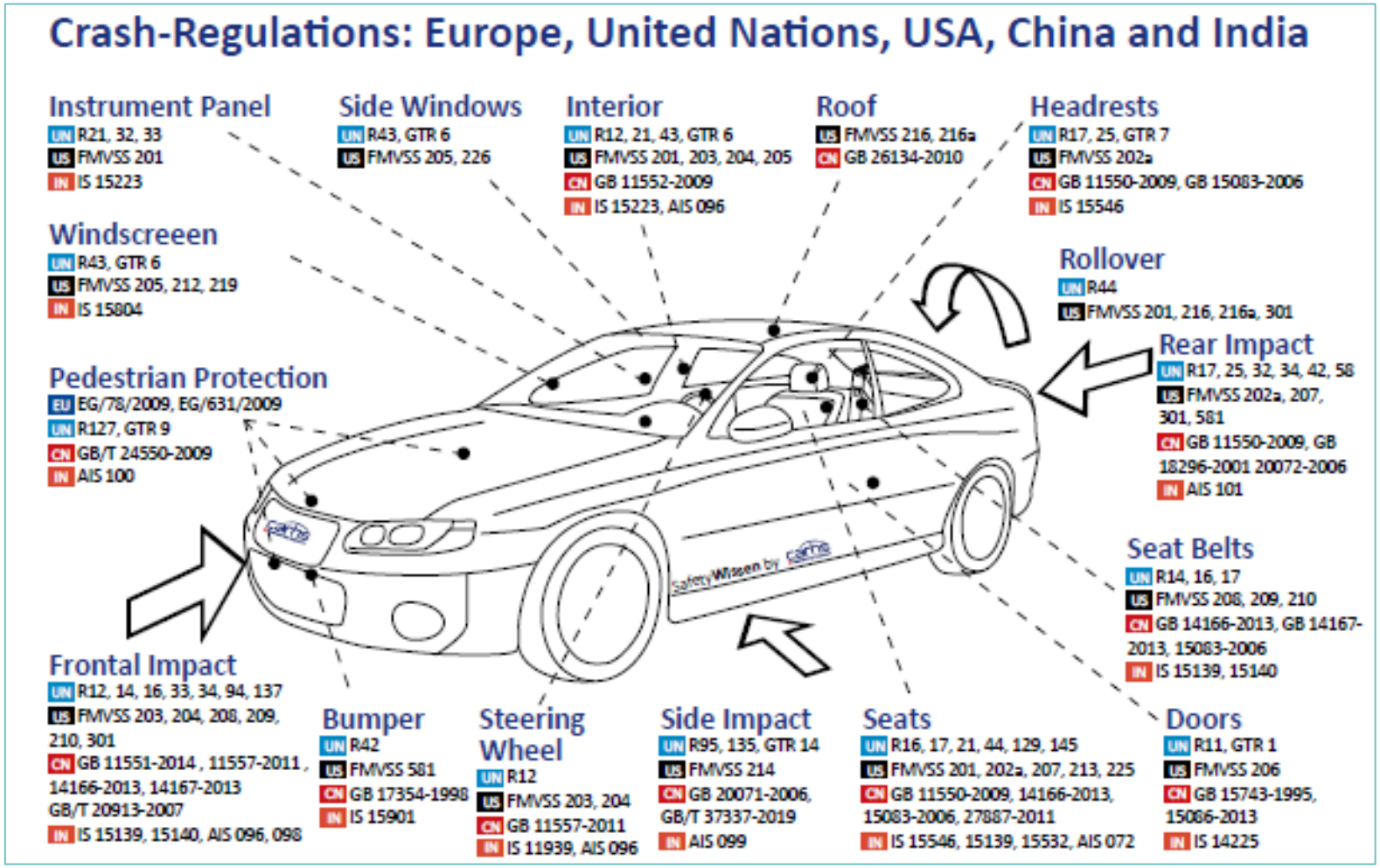
FOR SAFER CARS EURO NCAP

Japan New Car Assessment Program JNCAP

IIHS Insurance Institute for Highway Safety

C-NCAP 中国新车评价规程

Legislações de “Crash” na Europa, ONU, EUA, Chima e Índia



Legislações

Rules and Regulations on Occupant Protection

	Full Width Frontal	Offset Frontal	Side Barrier	Side Pole	Pedestrian	Rear	Head Impact	Rollover
USA	FMVSS 208	FMVSS 208	FMVSS 214	FMVSS 214		FMVSS 202a FMVSS 301	FMVSS 201	Roof Crush: FMVSS 216a Ejection Mitigation: FMVSS 226
Europe	UN R137[1]	UN R94	UN R95	UN R135[1]	R (EC) 78/2009 R (EC) 631/2009 UN R127	UN R34	UN R21	
Japan	Art. 18	Art 18	Art. 18	Art. 18	Article 18	Article 22-4	Article 20	
China	GB 11551-2014	GB/T 20913-2007	GB 20071-2006	GB/T 37337-2019	GB/T 24550-2009	GB 20072-2006	GB11552-2009	Roof Crush: GB26134-2010
India		AIS-098	AIS-099		AIS-100	AIS-101	IS15223	
South Korea	KMVSS 102-3		KMVSS 102	KMVSS 102-4[2]	KMVSS 102-2		KMVSS 88	
Australia	ADR 69/00	ADR 73/00	ADR 72/00	ADR 85/00			ADR 21	

[1] Mandatory as part of the EU type approval for new types from July 6, 2022, for new registrations from July 7, 2024.
[2] From September 2020

Legislações

FMVSS 305: Safety Requirements for Electric Vehicles

Scope:

Cars, busses, trucks with a GVWR of 4536 kg or less that use electrical components with working voltages higher than 60 volts direct current (VDC) or 30 volts alternating current (VAC), and whose speed attainable is more than 40 km/h.

Post-crash Requirements:

Under the test conditions described below (impact test and subsequent static rollover)

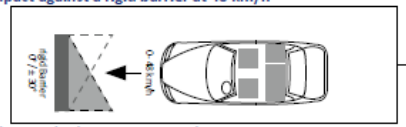
- max. 5 litres of electrolyte may spill from the batteries,
- there shall be no evidence of electrolyte leakage into the passenger compartments,
- all components of the electric energy storage / conversion system must be anchored to the vehicle,
- no battery system component that is located outside the passenger compartment shall enter the passenger compartment,
- each HV source in the vehicle must meet one of the 3 following **electrical safety requirements**
  - (1) **electrical isolation** must be greater than or equal to:
    - 500 ohms/V for an AC HV source,
    - 100 ohms/V for an AC HV source if it is conductively connected to a DC HV source, but only if the AC HV source meets the physical barrier protection requirements specified in the first 3 sub-items of (3)
    - 100 ohms/V for all DC HV sources,
  - (2) the **voltage level** of the HV source (Vb, V1, V2) must be ≤ 30 VAC for AC components or 60 VDC for DC components.
  - (3) **physical barrier protection** against electric shock shall be demonstrated by meeting the following conditions:
    - the HV source meets protection degree IPXXB
    - resistance between exposed conductive parts of the electrical protection barrier (EPB) of the HV source and the electrical chassis is < 0.1 ohms
    - resistance between an exposed conductive part of the EPB of the HV source and any other simultaneously reachable exposed conductive parts of EPBs within 2.5 meters of it must be < 0.2 ohms
    - voltage between exposed conductive parts of the EPB of the HV source and the electrical chassis is ≤ 30 VAC or 60 VDC
    - voltage between an exposed conductive part of the EPB of the HV source and any other simultaneously reachable exposed conductive parts of EPBs within 2.5 meters of it must be ≤ 30 VAC or 60 VDC

Test Conditions:

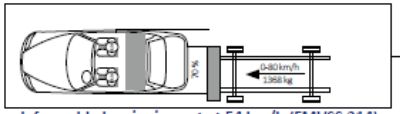
Docket No. NHTSA-2019-0009

TP-305-01

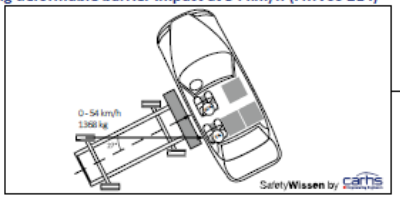
Frontal impact against a rigid barrier at 48 km/h



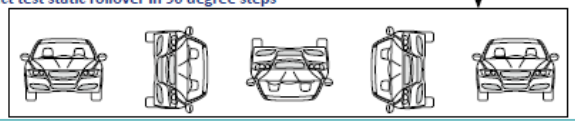
Rear moving barrier impact at 80 km/h (FMVSS 301)



Side moving deformable barrier impact at 54 km/h (FMVSS 214)



Post-impact test static rollover in 90 degree steps

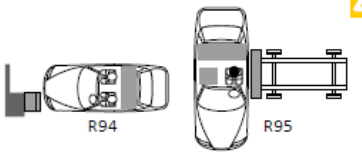


UNECE: Safety Requirements for Electric Vehicles

Extension of UN R94 / R95:

UN R94, 03 Series, Supplement 1

UN R95, 03 Series, Supplement 7

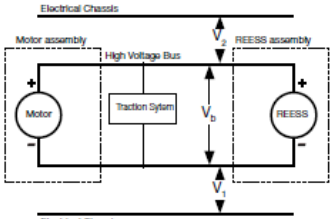


After crash tests according to UN R94 and R95 vehicles with a high voltage electrical powertrain (> 60 V DC or > 30 V AC) must meet the following requirements:

1. Protection against Electrical Shock

at least one of the four criteria specified below shall be met:

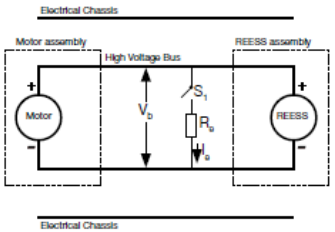
- Absence of high voltage:
  The voltages V_b, V_1 and V_2 shall be ≤ 30 V AC or ≤ 60 V DC :



- Low electrical energy:
  The total energy (TE) on the high voltage buses shall < 2.0 J.
  Prior to the impact a switch S_1 and a known discharge resistor R_e is connected in parallel to the relevant capacitance .
  Not earlier than 5 s and not later than 60 s after impact S_1 shall be closed while the voltage V_b and the current I_e are recorded.
  From this TE is caluclated as follows:

$$TE = \int_{tc}^{th} V_b \times I_e dt$$

with tc = time of closing S_1
th = time when voltage drops below 60 V DC



- Physical protection:
  For protection against direct contact with high voltage live parts, the protection IPXXB shall be provided.
- Isolation resistance:
  - If the AC HV buses and the DC high voltage buses are galvanically isolated from each other, isolation resistance between the HV bus and the electrical chassis shall be ≥ 100 Ω/V of the working voltage for DC buses, and ≥ 500 Ω/V of the working voltage for AC buses.
  - If the AC HV buses and the DC HV buses are galvanically connected isolation resistance between the HV bus and the electrical chassis shall be ≥ 500 Ω/V of the working voltage. (if the protection IPXXB is satisfied for all AC HV buses or the AC voltage is ≤ 30 V after the vehicle impact, the isolation resistance shall be R_i ≥ 100 Ohm/V)

2. Electrolyte Spillage

- In the period from the impact until 30 minutes after no electrolyte from the REESS (Rechargeable Electrical Energy Storage System) shall spill into the passenger compartment and no more than 7 % of electrolyte shall spill from the REESS.

3. REESS Retention

REESS located inside the passenger compartment shall remain in the location in which they are installed and REESS components shall remain inside REESS boundaries. No part of any REESS that is located outside the passenger compartment for electric safety assessment shall enter the passenger compartment during or after the impact test.

UN R100:

M and N class vehicles with a maximum speed > 25 km/h must also comply with UN R100 02 series.

UN R100, 02 Series, Supplement 4

NCAP

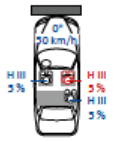
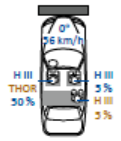
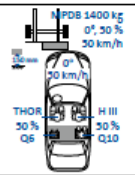
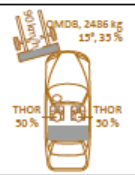
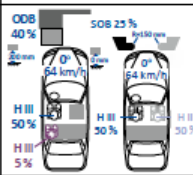
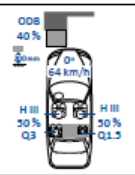
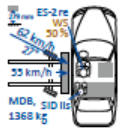
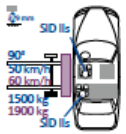
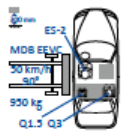
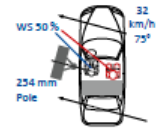
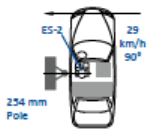
Avaliações NCAP: variam de país para país ou de região para região, vide quadro exemplo de comparação ao lado.

Status de 2020

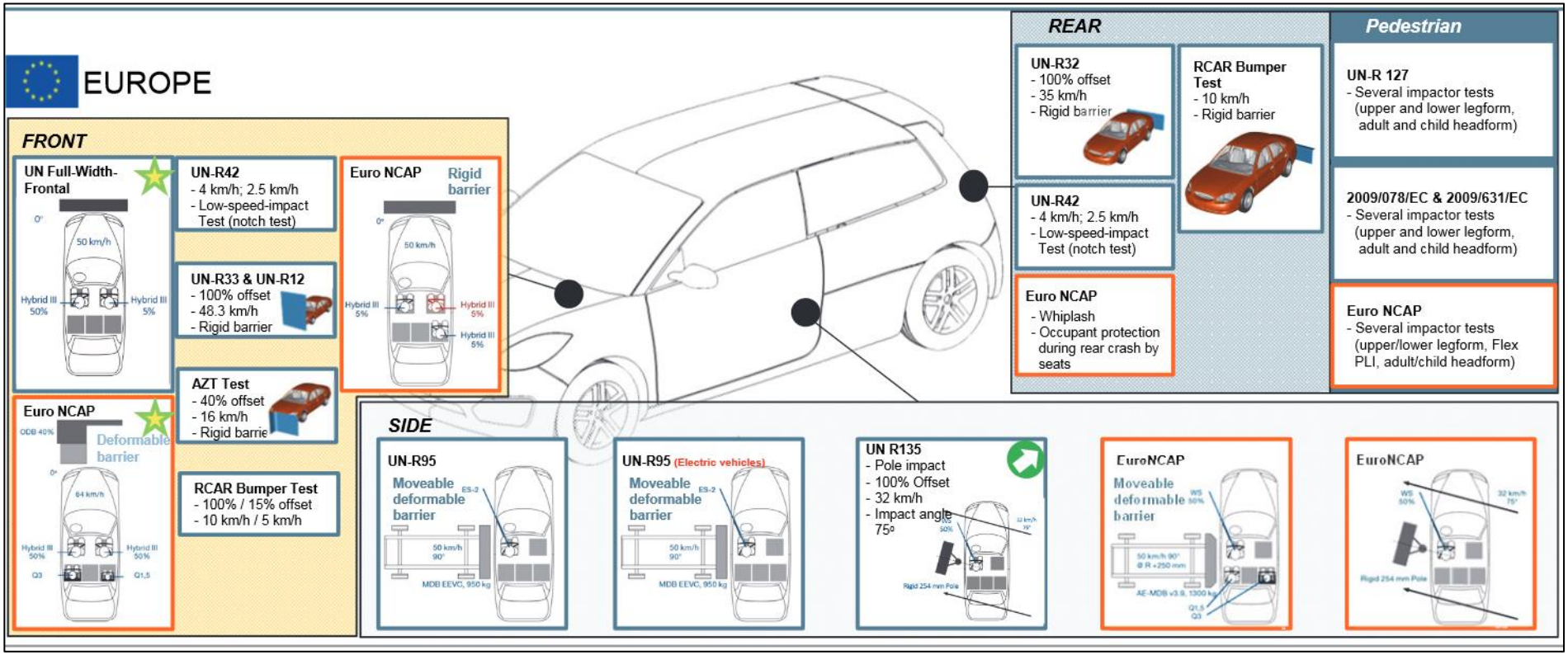
OBS.: Estes tem evoluído constantemente e assim a situação atual sempre precisa ser verificada.

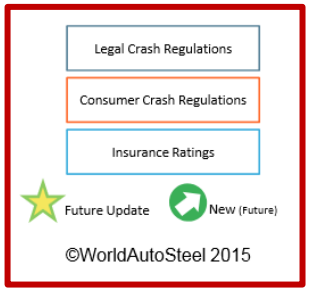
NCAP-Tests in Europe, America and Australia

Items written in italics are not part of the overall rating 2020 2021 2022 2023 date of implementation unknown

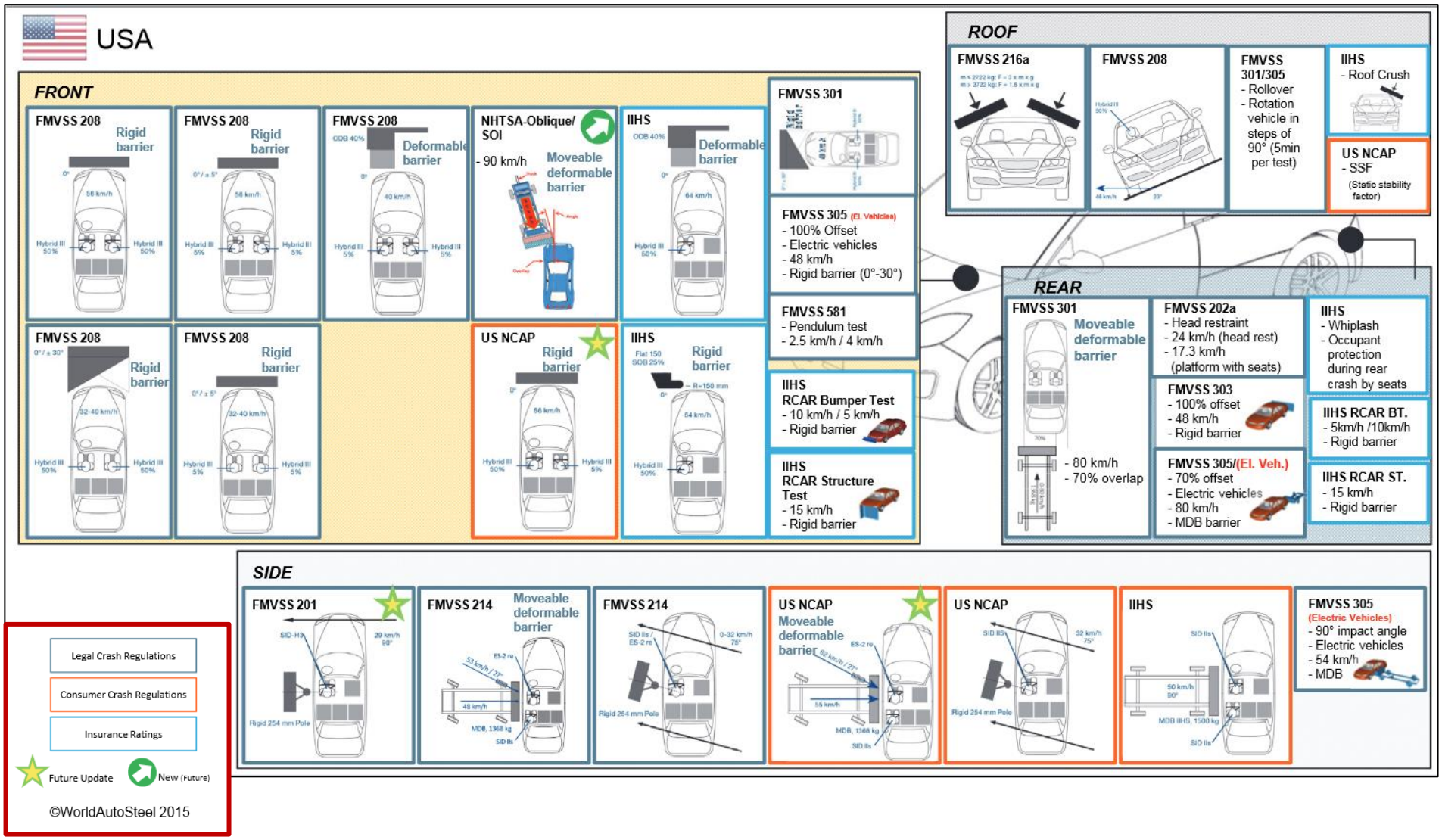
	Euro NCAP / ANCAP	U.S. NCAP	IIHS	Latin NCAP
Full Width			Get familiar with all NCAP tests in just 2 days with our seminar: **NCAP - New Car Assessment Programs: Tests, Assessment Methods, Ratings** learn more on ➲ page 30	
ODB / SOB				
MDB	 ■ Far Side Occupant Protection			
Pole	 ■ Far Side Occupant Protection			
Rollover		■ SSF	■ Roof Crush	
Pedestrian	■ Flex PLI, aPLI ■ Upper Legform ■ Headforms ■ AEB/AES VRU Ped., Cyclist, PTW ■ AEB Reverse Pedestrian	■ Flex PLI ■ Upper Legform ■ Headforms ■ AEB Pedestrian ■ Rear Automatic Braking	■ AEB Pedestrian	■ Flex PLI ■ Upper Legform ■ Headforms ■ AEB VRU
Child Safety	■ Frontal MPDB ■ Side MDB ■ CRS - Installation ■ Veh. Based Assessment, COPD		■ *LATCH (Lower Anchors and Tethers for Children)* ■ *Booster Seat Rating*	■ Frontal ODB ■ Side MDB ■ CRS - Installation ■ Veh. Based Assessment
Whiplash	■ Static Front / Rear ■ Dynamic (2 Pulses)		■ Static ■ Dynamic (1 Pulse)	■ Static ■ Dynamic (1 Pulse) ■ AEB City
Other	■ SBR, SAS, AEB, LSS, AEB, Occupant Status, AES, Rescue, *AD*	■ *FCW, LDW, AEB, DBS,* BSD, Headlights	■ AEB, FCW, SBR ■ Headlights ■ *Low Speed Bumper*	■ SBR, ESC, SAS, BSD, LSS, AEB, eCall, Rescue Sheet, Rear Impact: UN R32

Legislações + NCAP + ...





Legislações + NCAP + ...



LATIN NCAP PARA CARROS MAIS SEGUROS

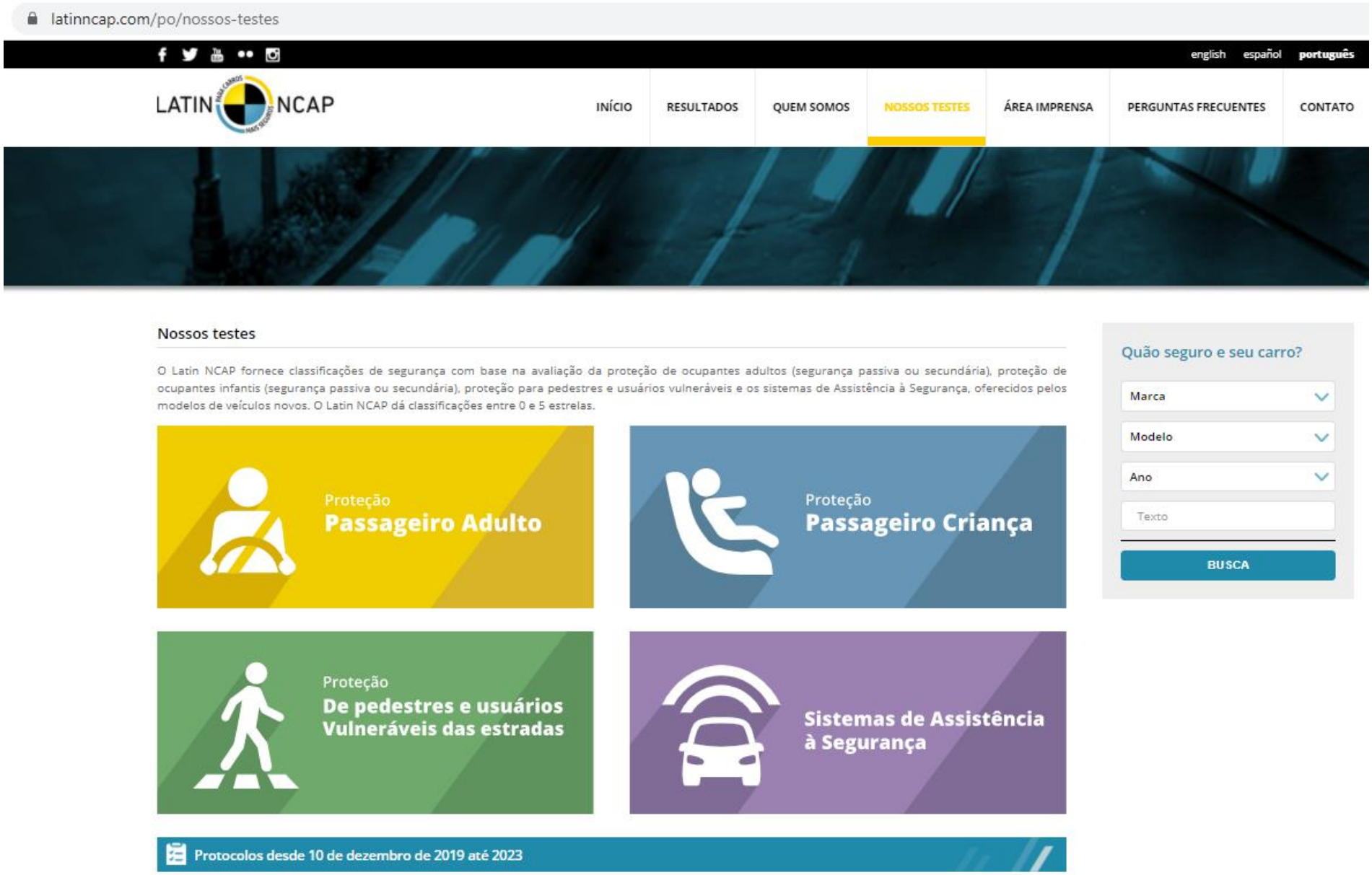
Organização não governamental composta por:

- **Representantes de órgãos de defesa do consumidor**
- **Representante de ONGs relacionadas com a segurança veicular**
- **Representante de Clubes de automóvel**
- **Representantes de Seguradoras**
- **Representantes dos governos**

SBR: seat belt reminder
ESC: Eletronic Stability Control
SRI: sistema de retenção infantil (CRS)

Primeiros testes divulgados em 2010
Exigências tem evoluido com o tempo:
2010 ➔ CRASH ODB
2016 ➔ CRASH ODB + Side Crash + SBR + ESC + Pole Test
2020 ➔ CRASH ODB + Side Crash + SBR + ESC + Pole Test + SRI + Pedestrian + Whiplash + AEB +...

Preocupações:
- **Veículos de mesmo modelo mas produzidos em regiões diferentes tenham o mesmo desempenho**
- **Veículos populares tenham desempenho seguro**


latinncap.com/po/nossos-testes
english
español
português
LATIN NCAP
INÍCIO
RESULTADOS
QUEM SOMOS
NOSSOS TESTES
ÁREA IMPRENSA
PERGUNTAS FRECUENTES
CONTATO
Nossos testes
O Latin NCAP fornece classificações de segurança com base na avaliação da proteção de ocupantes adultos (segurança passiva ou secundária), proteção de ocupantes infantis (segurança passiva ou secundária), proteção para pedestres e usuários vulneráveis e os sistemas de Assistência à Segurança, oferecidos pelos modelos de veículos novos. O Latin NCAP dá classificações entre 0 e 5 estrelas.
Proteção
Passageiro Adulto
Proteção
Passageiro Criança
Proteção
De pedestres e usuários
Vulneráveis das estradas
Sistemas de Assistência
à Segurança
Protocolos desde 10 de dezembro de 2019 até 2023
Quão seguro e seu carro?
Marca
Modelo
Ano
Texto
BUSCA

Protocolos desde 10 de dezembro de 2019 até 2023

Latin NCAP 2020 – 2023 Protocols update – COVID 19

Protocolos de avaliação

- Latin NCAP Adult Occupant Protection 2020 Assessment Protocol_v1.1.2
- Latin NCAP Child Occupant Protection 2020 Assessment Protocol v1.1.2
- Latin NCAP Pedestrian Protection 2020 Assessment Protocol v1.1.2
- Latin NCAP Safety Assist 2020 assessment protocol v1.1.2
- Latin NCAP Overall Rating 2020 V1.1.2

Protocolo de seleção, patrocínio e reteste

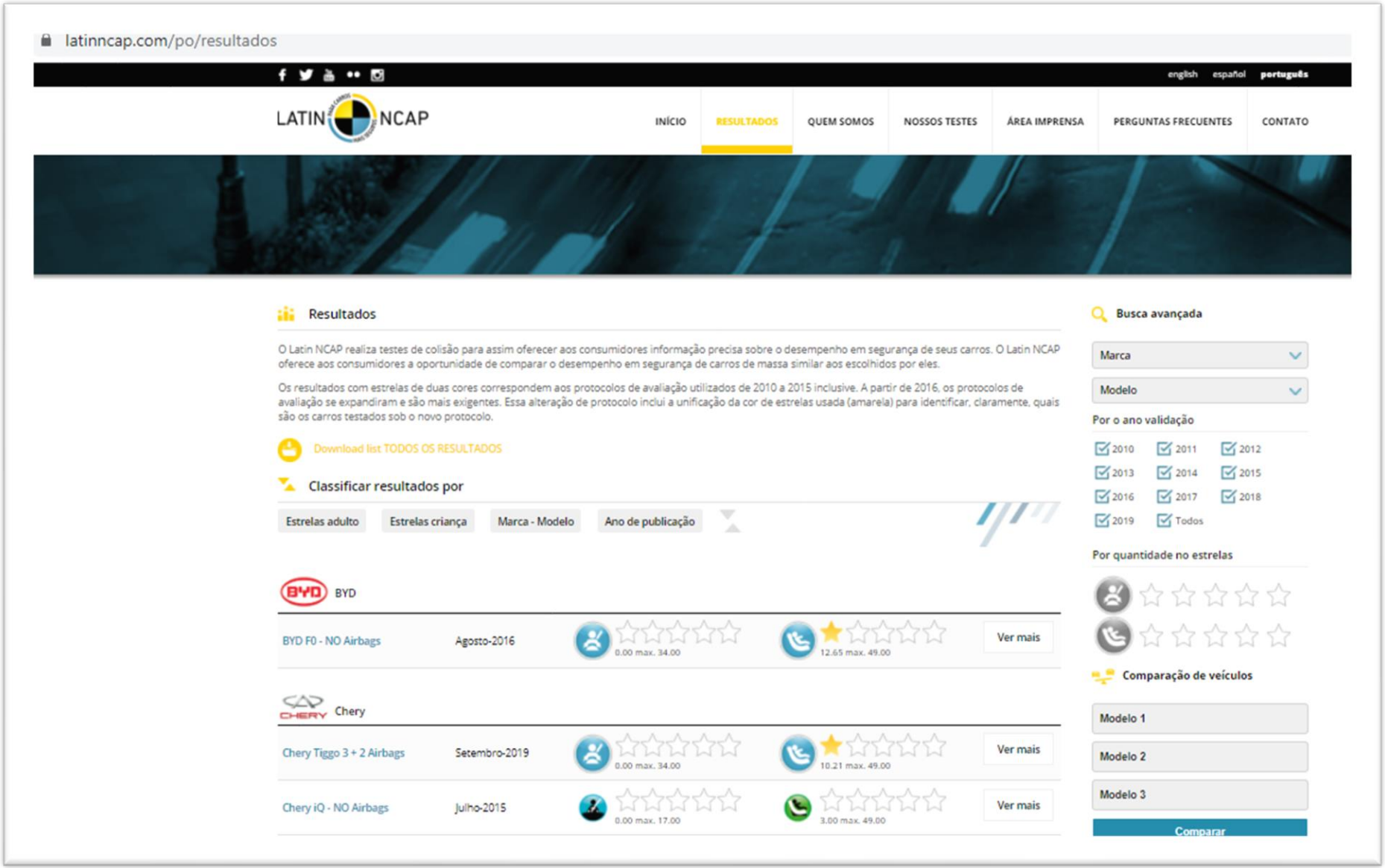
- Latin NCAP CSSTR Protocol 2020 v1.1.2

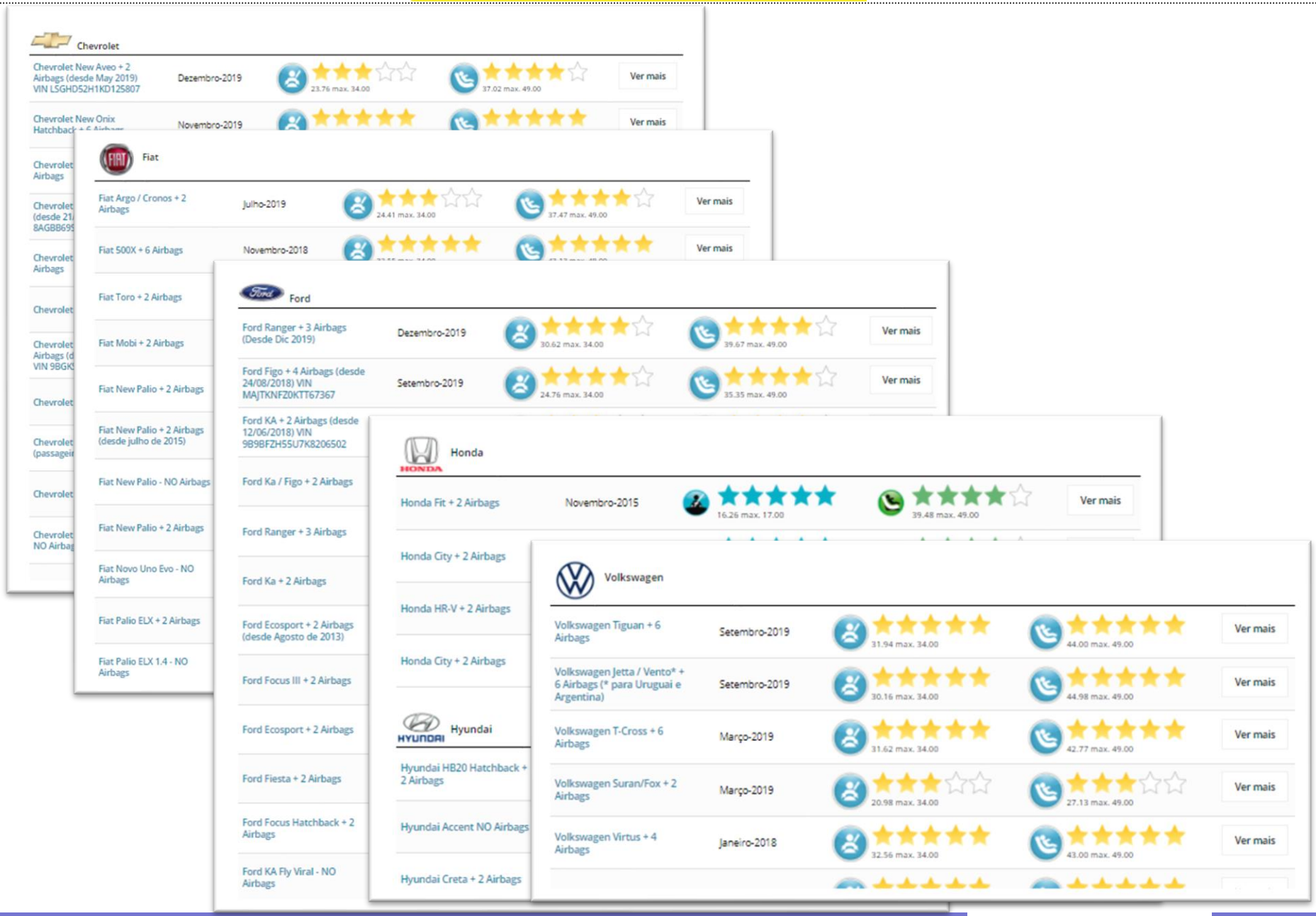
Protocolos de teste

- Latin NCAP - Testing Protocol 2020 v 1.0.2
- Latin NCAP - Moose Test Testing Protocol v1.0.1
- Euro NCAP - Whiplash Dynamic Assessment - Testing Protocol v 3.3.1Feb 2019
- Euro NCAP - Test Protocol - LSS v 3.0.2 Jul 2019
- Euro NCAP - OPSil Testing Protocol (Section 7.5) v 7.0.4 Sept 2018
- Euro NCAP - Pedestrian Testing Protocol v 8.5 Oct 2018
- Euro NCAP-Manufacturer Data For Testing And Assessment v 1.1 Nov2017
- Euro NCAP - Assessment Automatic Passenger Airbag Disabling Systems v 1.2 Dec 2016
- Euro NCAP - Test Protocol - SAS v 1.1 Jun 2015
- Euro NCAP – Test Protocol AEB systems v 1.1 Jun 2015
- Euro NCAP-ODB Frontal Impact Testing Protocol v 7.0.1 April 2015
- Euro NCAP SA assessment protocol v56 Jul 2012
- Euro NCAP – MDB Side Impact Testing Protocol v 6.0 Aug 2012
- Euro NCAP - ESC Dynamic Test Protocol v 1.2 Jun 2011
- Euro NCAP-Sled Test Procedure For Assessing Knee Impact Areas v 2.7 June 2011
- Euro NCAP-Testing of Electric Vehicles v 1.0 Oct 2010
- Euro NCAP - Pole Side Impact Testing Protocol v 5.0 Oct 2009

Boletines Técnicos

- Latin NCAP - Technical Bulletin 3 - AEB Exempt 2020
- Latin NCAP - Technical Bulletin 2 - Structural Modifier


latinncap.com/po/resultados
english español português
LATIN NCAP
INÍCIO
RESULTADOS
QUEM SOMOS
NOSSOS TESTES
ÁREA IMPRENSA
PERGUNTAS FRECUENTES
CONTATO
Resultados
O Latin NCAP realiza testes de colisão para assim oferecer aos consumidores informação precisa sobre o desempenho em segurança de seus carros. O Latin NCAP oferece aos consumidores a oportunidade de comparar o desempenho em segurança de carros de massa similar aos escolhidos por eles.
Os resultados com estrelas de duas cores correspondem aos protocolos de avaliação utilizados de 2010 a 2015 inclusive. A partir de 2016, os protocolos de avaliação se expandiram e são mais exigentes. Essa alteração de protocolo inclui a unificação da cor de estrelas usada (amarela) para identificar, claramente, quais são os carros testados sob o novo protocolo.
Download list TODOS OS RESULTADOS
Classificar resultados por
Estrelas adulto
Estrelas criança
Marca - Modelo
Ano de publicação
BYD
BYD F0 - NO Airbags
Agosto-2016
0.00 max. 34.00
12.65 max. 49.00
Ver mais
Chery
Chery Tiggo 3 + 2 Airbags
Setembro-2019
0.00 max. 34.00
10.21 max. 49.00
Ver mais
Chery iQ - NO Airbags
Julho-2015
0.00 max. 17.00
3.00 max. 49.00
Ver mais
Busca avançada
Marca
Modelo
Por o ano validação
2010 2011 2012
2013 2014 2015
2016 2017 2018
2019 Todos
Por quantidade no estrelas
Comparação de veículos
Modelo 1
Modelo 2
Modelo 3
Comparar


Chevrolet
Chevrolet New Aveo + 2 Airbags (desde May 2019) VIN LSGHD52H1KD125807
Dezembro-2019
23.76 max. 34.00
37.02 max. 49.00
Ver mais
Chevrolet New Onix
Novembro-2019
Ver mais
Fiat
Fiat Argo / Cronos + 2 Airbags
Julho-2019
24.41 max. 34.00
37.47 max. 49.00
Ver mais
Fiat 500X + 6 Airbags
Novembro-2018
Ver mais
Fiat Toro + 2 Airbags
Fiat Mobi + 2 Airbags
Fiat New Palio + 2 Airbags
Fiat New Palio + 2 Airbags (desde julho de 2015)
Fiat New Palio - NO Airbags
Fiat New Palio + 2 Airbags
Fiat Novo Uno Evo - NO Airbags
Fiat Palio ELX + 2 Airbags
Fiat Palio ELX 1.4 - NO Airbags
Ford
Ford Ranger + 3 Airbags (Desde Dic 2019)
Dezembro-2019
30.62 max. 34.00
39.67 max. 49.00
Ver mais
Ford Figo + 4 Airbags (desde 24/08/2018) VIN MAJTKNFZ0KTT67367
Setembro-2019
24.76 max. 34.00
35.35 max. 49.00
Ver mais
Ford KA + 2 Airbags (desde 12/06/2018) VIN 9B9BFZH55U7K8206502
Ford Ka / Figo + 2 Airbags
Ford Ranger + 3 Airbags
Ford Ka + 2 Airbags
Ford Ecosport + 2 Airbags (desde Agosto de 2013)
Ford Focus III + 2 Airbags
Ford Ecosport + 2 Airbags
Ford Fiesta + 2 Airbags
Ford Focus Hatchback + 2 Airbags
Ford KA Fly Viral - NO Airbags
Honda
Honda Fit + 2 Airbags
Novembro-2015
16.26 max. 17.00
39.48 max. 49.00
Ver mais
Honda City + 2 Airbags
Honda HR-V + 2 Airbags
Honda City + 2 Airbags
Hyundai
Hyundai HB20 Hatchback + 2 Airbags
Hyundai Accent NO Airbags
Hyundai Creta + 2 Airbags
Volkswagen
Volkswagen Tiguan + 6 Airbags
Setembro-2019
31.94 max. 34.00
44.00 max. 49.00
Ver mais
Volkswagen Jetta / Vento* + 6 Airbags (* para Uruguai e Argentina)
Setembro-2019
30.16 max. 34.00
44.98 max. 49.00
Ver mais
Volkswagen T-Cross + 6 Airbags
Março-2019
31.62 max. 34.00
42.77 max. 49.00
Ver mais
Volkswagen Suran/Fox + 2 Airbags
Março-2019
20.98 max. 34.00
27.13 max. 49.00
Ver mais
Volkswagen Virtus + 4 Airbags
Janeiro-2018
32.56 max. 34.00
43.00 max. 49.00
Ver mais

NCAP

Latin NCAP Rating: 2020 - 2023

Adult Occupant Protection		Child Occupant Protection		Pedestrian Protection		Safety Assist		
	2020 - 2023		2020 - 2023		2020 - 2023		2020 2021	2022 2023
	max. points		max. points		max. points		max. points	max. points
Offset Frontal Impact	16	Dyn. Tests Frontal	16	Head Impact	24	Seat Belt Reminder	10	10
Side Impact (MDB)	8	Dyn. Tests Side	8	Lower Leg Impact	6	Speed Assistance Systems	3	3
Side Impact (Pole)	8	CRS Installation	12	Upper Leg Impact	6	AEB Inter-Urban[2]	9	9
Whiplash Front Seats	3	Vehicle Based	13	AEB VRU[2]	12	ESC	15	15
AEB City[2]	3					Lane Support Syst. (LDW, LKA, RED)[2]	3	3
Rear End Impact UN R32	1					Blind Spot Detection[2]	3	3
Rescue Sheet	1					eCall		2
max. points (1)	40	max. points (1)	49	max. points (1)	48	max. points (1)	43	45
normalised score (2)	actual points / (1)	normalised score (2)	actual points / (1)	normalised score (2)	actual points[1] / (1)	normalised score (2)	actual points / (1)	actual points / (1)
Balancing: minimum normalised score (2) by box for the respective star rating:								
2020 ★★★★★	75 %		80 %		40 %		75 %	
2020 ★★★★	70 %		65 %		35 %		65 %	
2020 ★★★	60 %	+	50 %	+	30 %	+	50 %	
2020 ★★	50 %		30 %		20 %		40 %	
2020 ★	40 %		15 %		10 %		10 %	
2022 ★★★★★	**80 %**		80 %		**50 %**			80 %
2022 ★★★★	70 %		**70 %**		**40 %**			70 %
2022 ★★★	60 %	+	**55 %**	+	30 %	+		60 %
2022 ★★	50 %		**40 %**		**25 %**			50 %
2022 ★	40 %		**20 %**		10 %			50 %

[1] In 2020 and 2021 the total Pedestrian Protection score is calculated as follows:
(Head score + Upper Leg score + Lower Leg score) x 1.15 + AEB score x 0.55

[2] System will be assessed if it is offered in all Latin NCAP markets as option and meets the following fitment rates:

System	2020	2021	2022	2023
AEB City	10 %	10 %	**30 %**	**30 %**
AEB VRU	10 %	10 %	**30 %**	**30 %**
AEB Inter-Urban	10 %	10 %	**30 %**	**30 %**
BSD + LDW + LKA + RED combined	25 %	**35 %**	**45%**	**55 %**

Protocol Version 1.1.0

Bold figures indicate changes with respect to the previous year

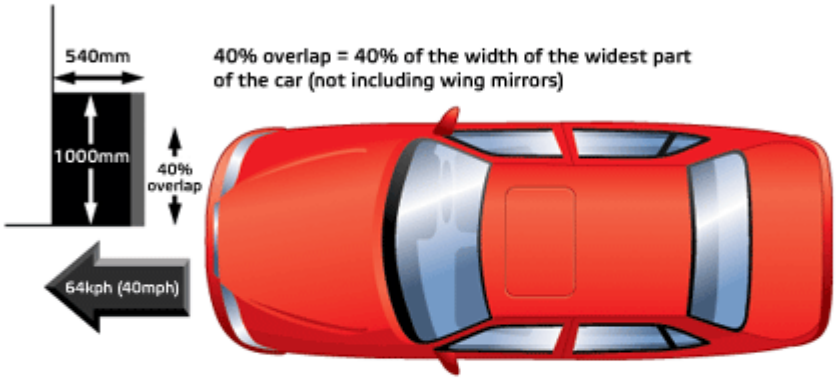
Verificar atualização
http://www.latinncap.com

Crash frontal ODB

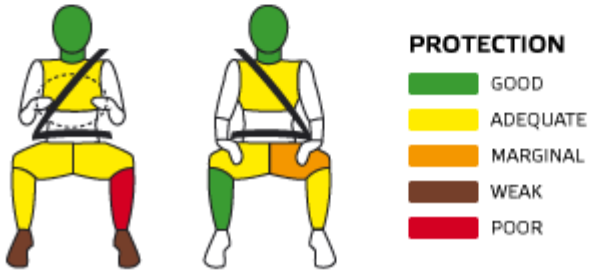
Frontal impact

Frontal impact test is based on that developed by European Enhanced Vehicle-safety Committee as basis for legislation, but impact speed has been increased by 8 km/h.

Frontal impact takes place at 64kph (40mph), car strikes deformable barrier that is offset.



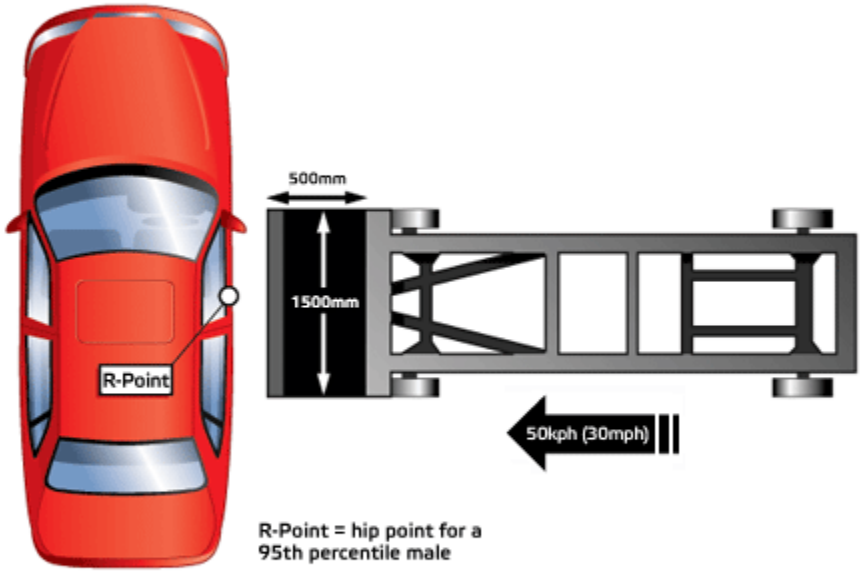
Readings taken from dummies are used to assess protection given to adult front occupants.



Crash lateral

Car to Car Side Impact

The second most important crash configuration is car to car side impact. Euro NCAP simulates this type of crash by having a mobile deformable barrier (MDB) impact the driver's door at 50 km/h. The injury protection is assessed by a side impact test dummy, in the driver's seat..



R-Point = hip point for a 95th percentile male

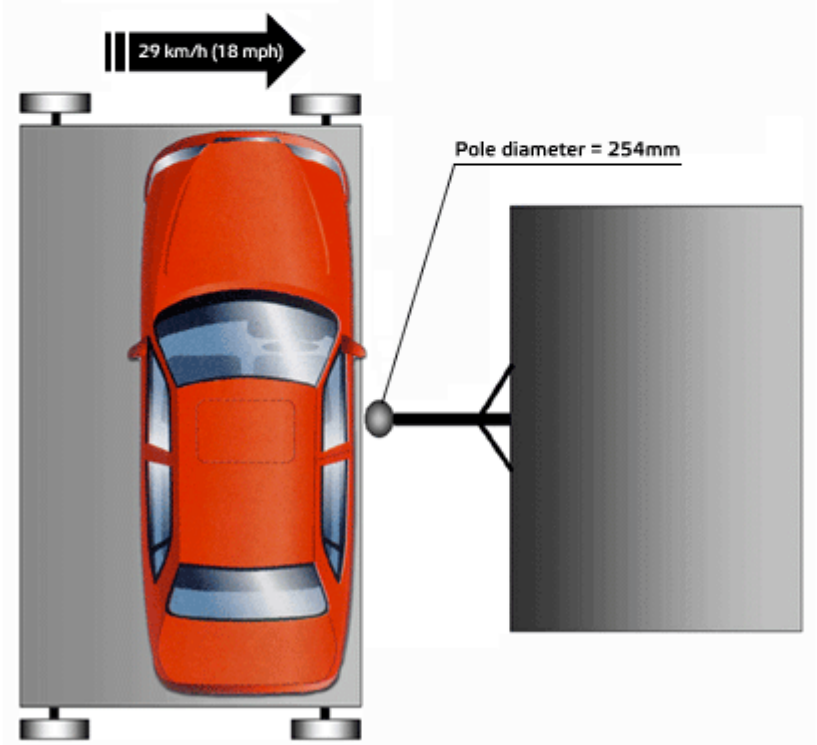
Although it is difficult to judge the level of protection provided from the extent of intrusion, control of how the car side intrudes is important. Through the programme, Euro NCAP has seen large improvements in side impact performance. The provision of side impact airbags has helped. It is now normal for the cars tested by Euro NCAP to be fitted with side impact airbags.

Impacto lateral contra poste 0º

Pole Side Impact

Accident patterns vary from country to country within Europe, but approximately a quarter of all serious-to-fatal injuries happen in side impact collisions. Many of these injuries occur when one car runs into the side of another or into a fixed narrow object such as a tree or pole.

To encourage manufacturers to fit head protection devices, pole test may be performed, where such safety features are fitted. Side impact head or curtain airbags help to protect the head and upper torso by providing a padding effect and by preventing the head from passing through the window opening. In the test, the car tested is propelled sideways at 29kph (18mph) into a rigid pole. The pole is relatively narrow, so there is major penetration into the side of the car.



Latin NCAP

Latin NCAP Protection Criteria in Frontal Impact

Dummy	Region	Criteria	4 Points	0 Points	Capping	Modifiers
Frontal Impact against ODB with 40 % Overlap @ 64 km/h						
Hybrid III 50 %	Head[1,2] Neck	HIC_{15}	< 500	> 700	> 700	Unstable airbag/steering wheel contact (-1 pt) Hazardous airbag deployment (-1 pt) Incorrect airbag deployment (-1 pt) Steering column displacement (-1 pt) Passenger head contact w/ dashboard (-1 pt)
		a_{3ms} (g)	< 72	> 80	> 80	
		$M_{y,extension}$ (Nm)	< 42	> 57	> 57	
		$F_{z,tension}$ (kN)	< 2.7 @ 0 ms < 2.3 @ 35 ms < 1.1 @ 60 ms	> 3.3 @ 0 ms > 2.9 @ 35 ms > 1.1 @ 60 ms	> 3.3 @ 0 ms > 2.9 @ 35 ms > 1.1 @ 60 ms	
		$F_{x,shear}$ (kN)	< 1.9 @ 0 ms < 1.2 @ 25-35 ms < 1.1 @ 45 ms	> 3.1 @ 0 ms > 1.5 @ 25-35 ms > 1.1 @ 45 ms	> 3.1 @ 0 ms > 1.5 @ 25-35 ms > 1.1 @ 45 ms	
	Chest	Deflection (mm)	< 22	> 42	> 42	A-pillar displacement (-2 pt) Compartment integrity (-1 pt) Steering wheel contact (-1 pt) Incorrect airbag deployment (-1 pt) Shoulder belt load > 6 kN (-2 pt)
		VC (m/s)	< 0.5	> 1.0	> 1.0	
	Femur Knee	Axial Force (kN)	< 3.8	> 9.07 > 7.56 @ 10 ms	- -	Variable contact (-1 pt) Concentrated loading (-1 pt) Incorrect airbag deployment (-1 pt)
		Displacement (mm)	< 6	>15	-	
	Tibia Foot	Tibia Index	< 0.4	> 1.3	-	Z–displacement of worst pedal (-1 pt) Footwell rupture (-1 pt) Pedal blocking (-1 pt)
		Axial Force (kN)	< 2	> 8	-	
		x–Displacement pedal (mm)	< 100	> 200	-	
						door opening (-1 pt/door) fuel leakage (-1 pt)

[1] If there is no hard head contact (i.e. $a_{res,\ peak}$ < 80 g and no other evidence of hard contact) a score of 4 points is awarded.
[2] If no steering wheel airbag is fitted and HIC15 < 700 and a_{3ms} < 80 g, 2 headform tests according to UN R12 are carried out (hub/spoke junction and rim spoke junction). Assessment is based on the following criteria:

Dummy	Region	Criteria	2 Points	0 Points	Capping
UN R12 6.8 kg headform	Head	HIC_{15}			> 700
		a_{3ms} (g)	< 65	> 80	> 80
		$a_{res,\ peak}$ (g)	< 80	> 120	> 120

Assessment Protocol AOP 2020 1.1.0

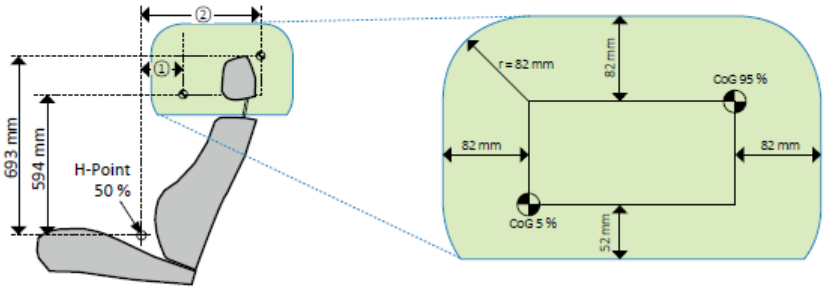
Latin NCAP Protection Criteria in Side Impact

Dummy	Region	Criteria	4 Points	0 Points	Capping	Modifiers
Barrier Side Impact @ 50 km/h & Pole Side Impact @ 29 km/h						
ES-2	Head[1]	HIC_{15}	< 500	> 700	> 700	incorrect airbag deployment (-1 pt) backplate loading F_y 1.0 ... 4.0 kN (0 ... -2 pt) T12 F_y 1.5 ... 2 kN / M_x 150 ... 200 Nm (0 ... -2pt) head protection device assessment (-2 pt front, -2 pt rear)
		a_{3ms} (g)	< 72	> 80	> 80	
	Chest	Deflection (mm)	< 22	> 42	> 42	
		VC (m/s)	< 0.32	> 1.0	> 1.0	
	Abdo-men	$Force_{compression}$ (kn)	< 1.0	> 2.5	> 2.5	
	Pelvis	Pubic Symphysis Peak Force (kN)	< 3.0	> 6.0	> 6.0	
						door opening (-1 pt/door) fuel leakage (-1 pt)

[1] Pole: no sliding scale, only capping if HIC15 > 700 or ares, peak > 80 g or direct head contact with the pole.

Modifier Side Head Protection Device

Inside the ‚Head Protection Device Assessment Zone' (green) the head protection system's coverage is assessed for both front and rear seats. If the coverage is insufficient a -2 point modifier is applied to the overall AOP score. Areas outside the Daylight Opening (FMVSS 201) are excluded from assessment. Seams are not penalized if the un-inflated area is no wider than 15 mm. Any other un-inflated areas that are no larger than 50 mm in diameter (or equivalent area) are not penalized.



The head protection device (HPD) evaluation zone (green) is defined as a rounded rectangle around the head CoG box (defined by the head CoGs of the 5 % female and 95 % male occupants) at a distance of 82 mm from the upper and fore/aft edges and 52 mm below the bottom edge. The x-position of the CoG is defined relative to the H-Point of the 50 % male:

Front seats:
① = H-Point(x) + 126 mm - seat travel (5^{th} %ile- 50^{th} %ile)
② = H-Point(x) + 147 mm + seat travel (50^{th} %ile- 95^{th} %ile)

Rear seats:
① = H-Point(x) + 126 mm - remaining seat travel
② = H-Point(x) + 147 mm + remaining seat travel

Assessment Protocol AOP 2020 1.1.0

Avaliação de resultados bio-mecânicos NCAP para crash frontal

Hybrid III: designed to gather data from frontal impacts

Each Body region gets the colour according to its assessment, i.e. points derived from the load minus modifier.

- 4,00 points
- 2,67 – 3,99 points
- 1,33 – 2,66 points
- 0,01 – 1,32 points
- 0,00 points

Head	
4 points	HIC 36 < 650; a_{3ms} < 72 g
0 points	HIC 36 > 1000; a_{3ms} > 88 g
Modifier	unstable airbag contact (-1 point), Steering column displacement (-1 point)

Neck		
4 points	$M_{y\,extension}$	< 42 Nm
	Tension:	< 2,7 kN @ 0 ms < 2,3 kN @ 35 ms < 1,1 kN @ 60 ms
	Shearing:	< 1,9 kN @ 0 ms < 1,2 kN @ 25 – 30 ms < 1,1 kN @ 45 ms
0 points	$M_{y\,extension}$	> 57 Nm
	Tension:	> 3,3 kN @ 0 ms > 2,9 kN @ 35 ms > 1,1 kN @ 60 ms
	Shearing:	> 3,1 kN @ 0 ms > 1,5 kN @ 25 – 30 ms > 1,1 kN @ 45 ms

Chest	
4 points	Deflection < 22 mm; VC < 0,5 m/s
0 points	Deflection > 50 mm; VC > 1,0 m/s
Modifier	Deformation A-Pillar (-2 points) Compartment deformed (-1 point) Contact with steering wheel (-1 point)

Femur	
4 points	Compression force < 3,8 kN
0 points	Compression force > 9,07 kN > 7,56 kN @ 10 ms

Knee	
4 points	Displacement < 6 mm
0 points	Displacement > 15 mm
Modifier	Variable contact (-1 point) Concentrated Loading (-1 point)

Tibia	
4 points	TI < 0,4; Compression force < 2 kN
0 points	TI > 1,3; Compression force > 8 kN
Modifier	z-displacement of worst pedal (-1 point)

Foot	
4 points	x-displacement braking pedal < 100 mm
0 points	x-displacement braking pedal > 200 mm
Modifier	footwell intrusion (-1 point) blocked pedal (-1 point)

SafetyWissen by carhs.

HPC – Head Performance Criterion

$$HPC = \max\left\{(t_2 - t_1)\left[\frac{1}{(t_2 - t_1)}\int_{t_1}^{t_2} a\,dt\right]^{2,5}\right\}$$

a em [g]
$(t_2 - t_1) < 36$ ms

NIC – Neck Injury Criterion

Força axial no pescoço
Força de cisalhamento entre pescoço e cabeça
Momento em torno de eixo lateral na interface pescoço/cabeça

ThCC – Thorax Compression criterion

Intrusão compressiva do peito

V*C - Viscous Criterion

Produto instantâneo da compressão e da taxa de compressão do esterno

$$V*C = \max\{1{,}3V*C\}$$

TCFC - Tibia Compressive Force Criterion

Força de compressão axial na tíbia

TI - Tibia Index

Força de compressão axial na tíbia

$$TI = \max\left\{\frac{\sqrt{M_x^2 + M_y^2}}{M_c} + \frac{F_z}{F_c}\right\}$$

Avaliação de resultados bio-mecânicos NCAP para crash lateral

ES-2: gathers side-impact data so instrumentation is very different

Euro NCAP
Protection Criteria in Side Impact

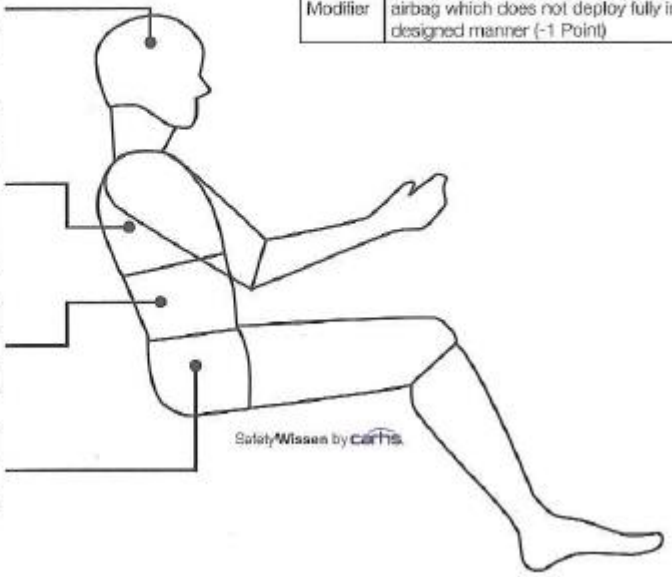
Head	
4 points	HIC 36 < 650; a_{3ms} < 72 g
0 points	HIC 36 > 1000; a_{3ms} > 88 g

Chest	
4 points	rib deflection < 22 mm; VC < 0,32 m/s
0 points	rib deflection > 42 mm; VC > 1,0 m/s
Modifier	T12 Load Modifier Backplate Load Modifier (total -2 points maximum)

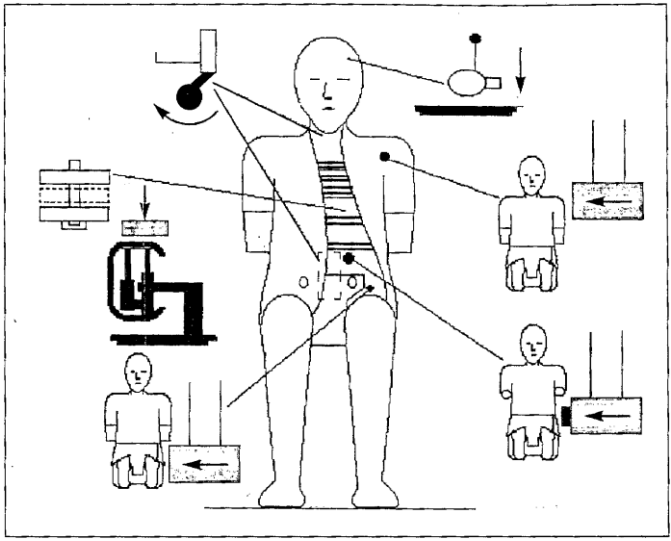
Abdomen	
4 points	abdominal peak force < 1,0 kN
0 points	abdominal peak force > 2,5 kN

Pelvis	
4 points	pubic symphysis peak force < 3,0 kN
0 points	pubic symphysis peak force > 6,0 kN

Airbag	
Modifier	Airbag Deployment Modifier for any airbag which does not deploy fully in the designed manner (-1 Point)



Avaliação de resultados bio-mecânicos NCAP para crash lateral

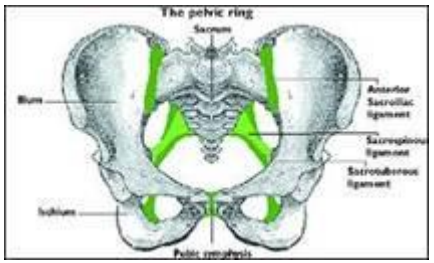


HPC – Head Performance Criterion

RDC – Rib Deflection Criterion
Deslocamento da costela

V*C - Soft Tissue Criterion
Produto instantâneo da deformação da costela (em relação a metade do comprimento original da mesma) pela taxa de deformação da costela

PSPF – Pubic Symphysis Peak Force
Força de pico na pelvis



APF – Abodimen Peak Force
Força de pico no abdomem

Exemplo de avaliação LatinNCAP

LATIN NCAP — PARA AUTOS MAIS SEGUROS

AGOSTO | 201
Válido para mercado Latin NCA

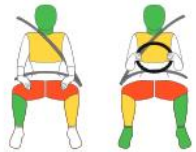
CHEVROLET - Cruze LT + 2 Airbags

FICHA TÉCNICA

★★★★☆
13.18 max. 17.00 - Passageiro Adulto

★★★☆☆
32.56 max. 49.00 - Passageiro Infantil

PETENÇÃO PARA PASSAGEIRO ADULTO



PROTEÇÃO
- BOM
- ADEQUADO
- MARGINAL
- FRACO
- POBRE

RETENÇÃO INFANTIL

	RETENÇÃO INFANTIL	CABEÇA / PEITO	TIPO SRI	AJUSTE	POSIÇÃO
Criança 18 meses	Peg Perego Primo Viaggio Tri-Fix	Protegido / Bom	0+	ISOFIX	Para trás
Criança 3 años	Peg Perego Primo Viaggio Tri-Fix	Protegido / Fraco	1	ISOFIX	Para frente

DETALHES DO CARRO

Modelo testado: **Chevrolet Cruze LT, LHD** | Ano de publicação: **2011** | Carro fabricado em: **Corea**

Tipo de carroceria: **4 door Sedan** | Peso em crash teste: **1627 kg**

EQUIPAMENTO DE SEGURANÇA

Protensores cinto da frente	SI	Airbag para o joelho do motorista	NÃO
Airbag frontal motorista	SI		
Airbag frontal acompanhante	SI		
Airbags laterais para o corpo	SI		
Airbags laterais para a cabeça	NÃO		

COMENTÁRIOS

Passageiro adulto: No impacto frontal, as cabeças do motorista e do acompanhante foram bem protegidas pelo airbag. A proteção do peito foi adequada. Não houve contato visível dos joelhos e da tíbia do motorista com o painel. Mas há estruturas perigosas na parte baixa do painel que poderiam impactar contra os joelhos de um passageiro de maiores dimensões.

Passageiro infantil: O assento infantil para um ano e me
e três anos ofereceu proteção suficiente. As instruções d
instalação, em ambas as cadeirinhas, eram insuficientes
por não estarem afixadas nos equipamentos de retenção
O manual do carro advertia sobre o risco de instalação d
cadeirinha no banco da frente voltado para trás.
Ambos os SRI contavam com sistemas de ancoragem
ISOFIX e instalados com conectores ISOFIX.

(*) O teste de impacto lateral e sua aprovação são necessários para atingir cinco estrelas. Contudo, o fabricante pode solicitar esse teste voluntariamente. Para o Latin NCAP, as qualidades de segurança dos carros só serão válidas, se forem demonstradas em um teste de batida.

Secretaria Latin NCAP
26 de Marzo 3454 Of. 102. | CP 11300. Montevideo, Urugu
T. +598 26288815 | secretaria@latinncap.co

Exemplo de avaliação LatinNCAP

LATIN NCAP

JANEIRO | 201

VOLKSWAGEN - Up! - 2 Airbags

FICHA TÉCNICA

15.86 max. 17.00 - Passageiro Adulto

39.54 max. 49.00 - Passageiro Infantil

PETENÇÃO PARA PASSAGEIRO ADULTO

ACOMPANHANTE MOTORISTA

PROTEÇÃO
- BOM
- ADEQUADO
- MARGINAL
- FRACO
- POBRE

TESTE DE IMPACTO LATERAL (UNECE 95) *

FEITO - APROVADO

ESTRUTURA DO HABITÁCULO

STÁVEL

Protegido / Bueno

Protegido / Adecuado

RETENÇÃO INFANTIL

	RETENÇÃO INFANTIL	CABEÇA / PEITO	TIPO SRI	AJUSTE	POSIÇÃO
Criança 18 meses	BOBSY G0+ ISOFIX BASE	Protegido / Bom	0+	ISOFIX	Para trás
Criança 3 años	BOBSY G1 ISOFIX	Protegido / Adecuado	0+/1	ISOFIX	Para frente

DETALHES DO CARRO

Modelo testado: **VW Up! LHD**

Ano de publicação: **2014**

Tipo de carroceria: **4 portas Hatchback**

Peso em crash teste: **1189 kg**

EQUIPAMENTO DE SEGURANÇA

Protensores cinto da frente	SI	Airbag para o joelho do motorista	NÃO
Airbag frontal motorista	SI	Sistema de Aviso de Cinto de Segurança	SI
Airbag frontal acompanhante	SI	Sistema de Frenagem Antibloqueio	SI
Airbags laterais para o corpo	NÃO	ISOFIX	SI
Airbags laterais para a cabeça	NÃO		

COMENTÁRIOS

Passageiro adulto: Tanto a cabeça quanto o pescoço receberam boa proteção no impacto frontal. Os sistemas de retenção proporcionaram uma proteção adequada ao peito do motorista e ao do acompanhante. As leituras em relação aos joelhos do motorista e do acompanhante foram aceitáveis, demonstrado uma proteção similar para passageiros de diferentes tamanhos ou sentados em diferentes lugares. A área dos pés permaneceu quase sem deformações depois do impacto. A carroceria foi considerada estável e capaz de resistir maiores cargas. O veículo foi aprovado no teste de impacto lateral UN95.

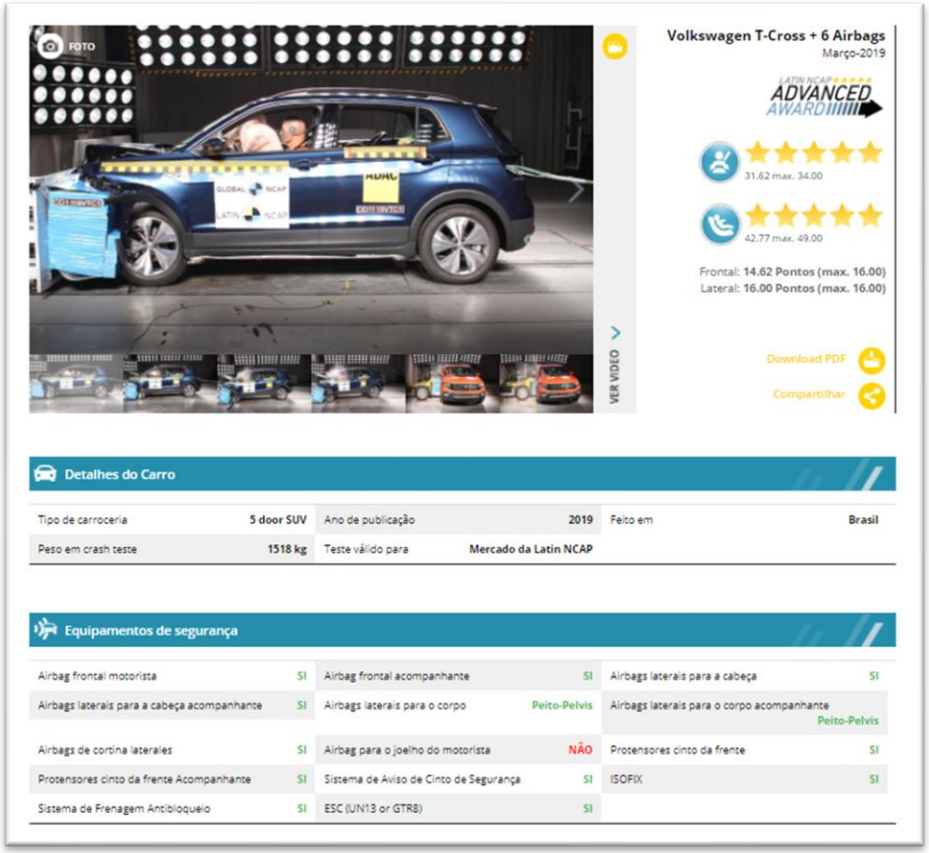
Passageiro infantil: As cadeirinhas infantis ISOFIX para crianças de três e um ano e meio foram capazes de evita um excessivo deslocamento para frente no impacto, proporcionando uma boa proteção em ambos os casos. As instruções de instalação em ambas as cadeirinhas infantis eram aceitáveis, estando unidas de maneira permanente ao assento. O veículo advertia sobre os perigos associados à instalação de uma cadeirinha infantil olhando para trás no banco do acompanhante co um airbag ativado, cumprindo com os requisitos do Latin NCAP.

(*) O teste de impacto lateral e sua aprovação são necessários para atingir cinco estrelas. Contudo, o fabricante pode solicitar esse teste voluntariamente. Para o Latin NCAP, as qualidades de segurança dos carros só serão válidas, se forem demonstradas em um teste de batida.

Secretaria Latin NCAP

26 de Marzo 3454 Of. 102. | CP 11300. Montevideo, Urugu
T. +598 26288815 | secretaria@latinncap.co

Exemplo de avaliação LatinNCAP



FOTO

VER VIDEO

Volkswagen T-Cross + 6 Airbags
Março-2019

LATIN NCAP ADVANCED AWARD

31.62 max. 34.00

42.77 max. 49.00

Frontal: **14.62 Pontos (max. 16.00)**
Lateral: **16.00 Pontos (max. 16.00)**

Download PDF

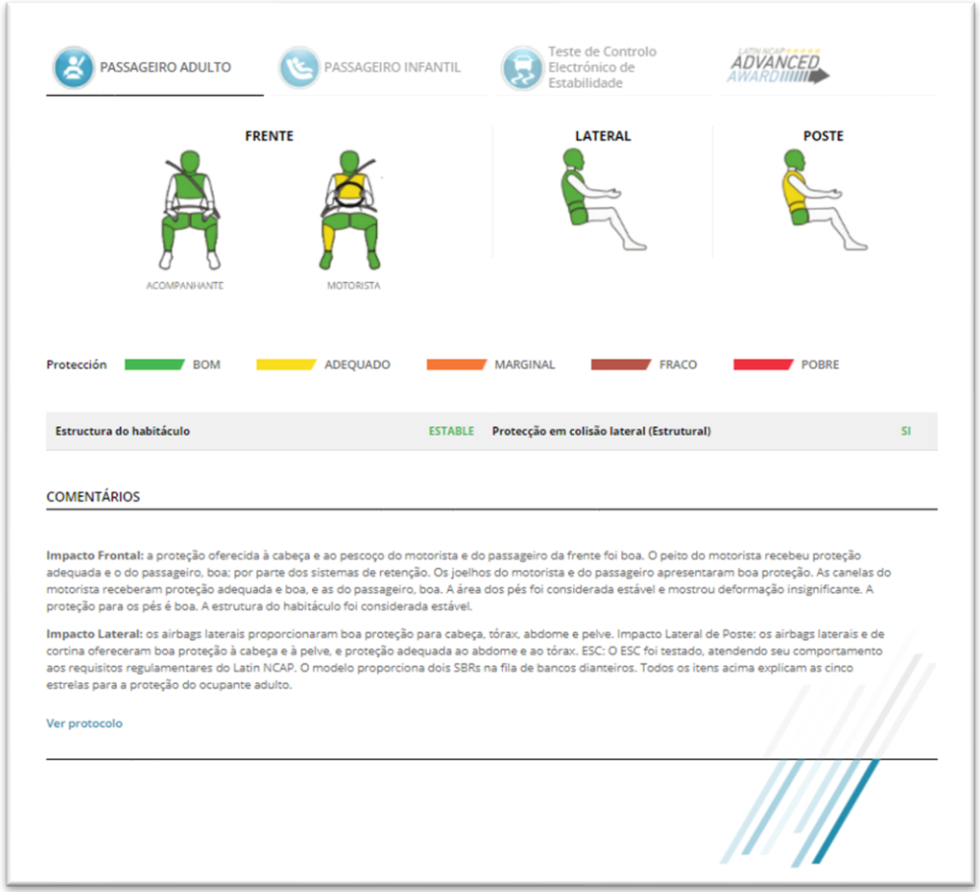
Compartilhar

Detalhes do Carro

Tipo de carroceria	5 door SUV	Ano de publicação	2019	Feito em	Brasil
Peso em crash teste	1518 kg	Teste válido para	Mercado da Latin NCAP		

Equipamentos de segurança

Airbag frontal motorista	SI	Airbag frontal acompanhante	SI	Airbags laterais para a cabeça	SI
Airbags laterais para a cabeça acompanhante	SI	Airbags laterais para o corpo	Peito-Pelvis	Airbags laterais para o corpo acompanhante	Peito-Pelvis
Airbags de cortina laterales	SI	Airbag para o joelho do motorista	NÃO	Protensores cinto da frente	SI
Protensores cinto da frente Acompanhante	SI	Sistema de Aviso de Cinto de Segurança	SI	ISOFIX	SI
Sistema de Frenagem Antibloqueio	SI	ESC (UN13 or GTR8)	SI		



PASSAGEIRO ADULTO | PASSAGEIRO INFANTIL | Teste de Controlo Electrónico de Estabilidade | ADVANCED AWARD

FRENTE | **LATERAL** | **POSTE**

ACOMPANHANTE | MOTORISTA

Protección: BOM | ADEQUADO | MARGINAL | FRACO | POBRE

Estructura do habitáculo	ESTABLE	Protecção em colisão lateral (Estrutural)	SI

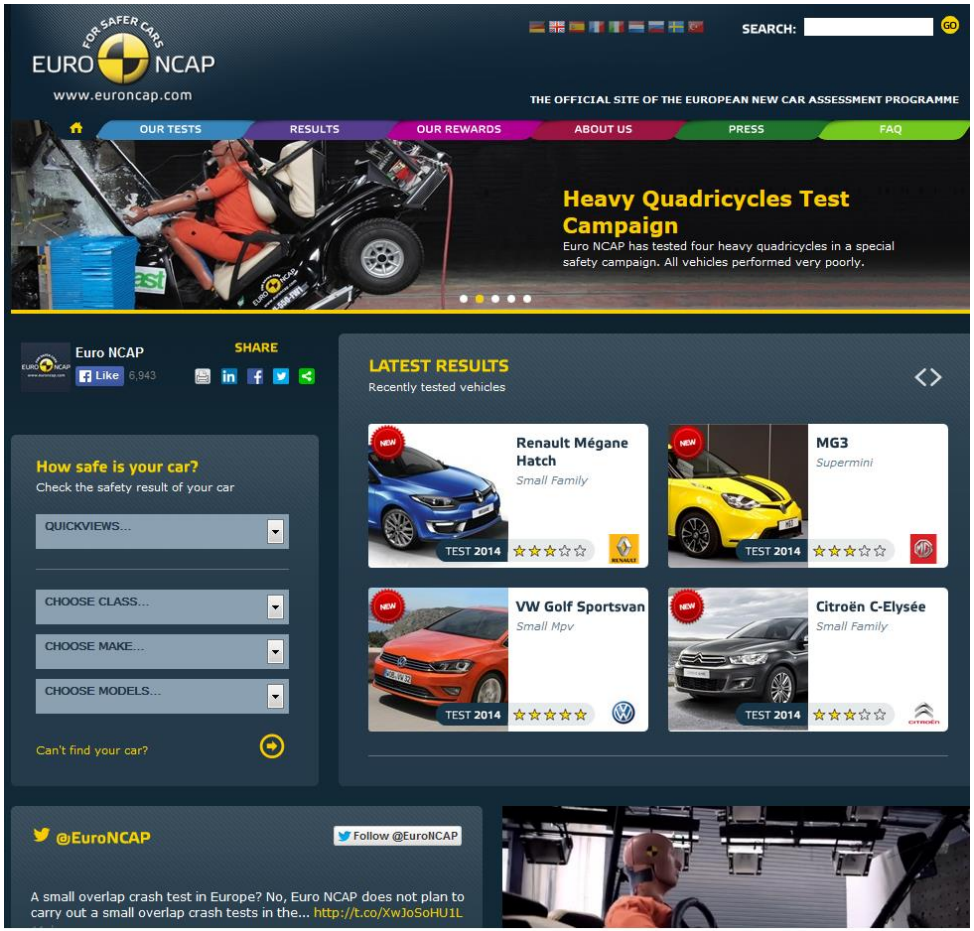
COMENTÁRIOS

Impacto Frontal: a proteção oferecida à cabeça e ao pescoço do motorista e do passageiro da frente foi boa. O peito do motorista recebeu proteção adequada e o do passageiro, boa; por parte dos sistemas de retenção. Os joelhos do motorista e do passageiro apresentaram boa proteção. As canelas do motorista receberam proteção adequada e boa, e as do passageiro, boa. A área dos pés foi considerada estável e mostrou deformação insignificante. A proteção para os pés é boa. A estrutura do habitáculo foi considerada estável.

Impacto Lateral: os airbags laterais proporcionaram boa proteção para cabeça, tórax, abdome e pelve. Impacto Lateral de Poste: os airbags laterais e de cortina ofereceram boa proteção à cabeça e à pelve, e proteção adequada ao abdome e ao tórax. ESC: O ESC foi testado, atendendo seu comportamento aos requisitos regulamentares do Latin NCAP. O modelo proporciona dois SBRs na fila de bancos dianteiros. Todos os itens acima explicam as cinco estrelas para a proteção do ocupante adulto.

Ver protocolo

Exemplo de avaliação EuroNCAP



Testes

Autonomous Emergency Braking
Impacto frontal ODB 64 km/h
Impacto lateral
Impacto lateral contra poste
Whiplash
Proteção de Pedestres
ESC
Avisto de uso do cinto
Speed Assistance Systems

Avaliações

Proteção Passageiros adultos
Proteção Infantil
Proteção de Pedestres
Sistemas de Segurança

EURO NCAP FOR SAFER CARS

About Euro NCAP · Ratings & Rewards · Vehicle Safety · Press & Media · For Engineers

THE RATINGS EXPLAINED

Home > Vehicle Safety > The Ratings Explained

- Safety Campaigns
- The Ratings Explained
  - Adult Occupant Protection
  - Child Occupant Protection
  - Pedestrian Protection
  - Safety Assist
- Quadricycle Ratings Explained
- The Rewards Explained
- Glossary

HOW SAFE IS YOUR CAR ?

Select one or more vehicles among the following possibilities.

Make

Model

The Ratings Explained

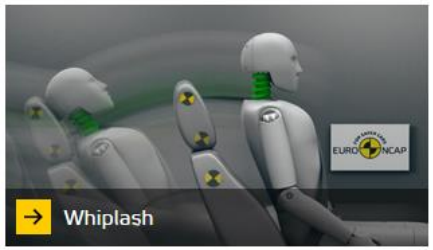
Euro NCAP introduced the overall safety rating in 2009, based on assessment in four important areas: Adult protection (for the driver and passenger); Child protection; Pedestrian protection and Safety Assist technologies. The overall star rating was introduced to add more flexibility to the ratings' scheme, which had been used since 1997.

http://www.euroncap.com

Adult Occupant Protection

The Adult Occupant Protection score is determined from frontal impact, side impact and whiplash tests, which are carried out to evaluate the protection of adult driver and passengers offered by the vehicle.

Click below to learn more about the tests.

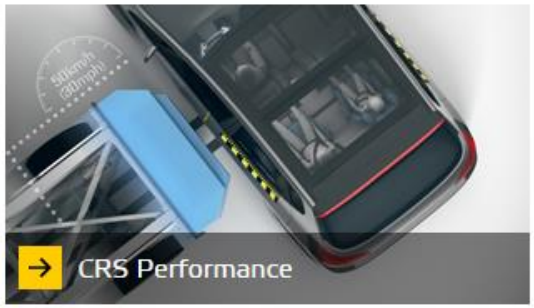


http://www.euroncap.com

Child Occupant Protection

The assessment of Child Occupant Protection covers three aspects: the protection offered by the child restraint systems in the frontal and side impact tests; the vehicle's ability to accommodate child restraints of various sizes and designs; and the availability of provisions for safe transport of children in the car.

Click below to learn more about the tests.



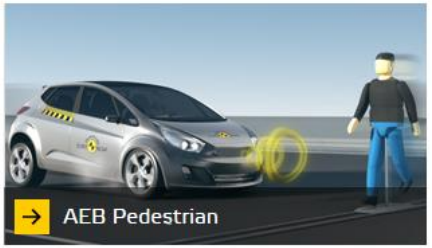
http://www.euroncap.com

Pedestrian Protection

The Pedestrian Protection score is determined from tests to the most important vehicle front-end structures such as the bonnet and windshield, the bonnet leading edge and the bumper.

In these tests, the potential risk at injuries to pedestrian head, pelvis, upper and lower leg are assessed. Cars which perform well can gain additional points if they have an autonomous emergency braking (AEB) system which recognises pedestrians.

Click below to learn more about the tests.

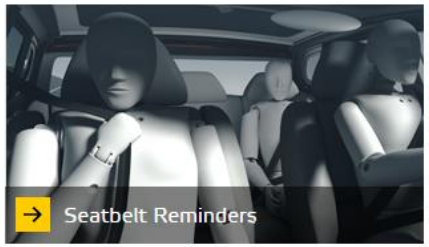


http://www.euroncap.com

Safety Assist

The Safety Assist score is determined from tests to the most important driver assist technologies that support safe driving to avoid accidents and mitigate injuries. In these tests, Euro NCAP tests system functionality and/or performance during normal driving and in typical accident scenarios.

To learn more about the tests included in the Safety Assist area, please click on the following illustrations.



Exemplo de avaliação EuroNCAP

TEST RESULTS

Adult Occupant — Total 27 pts | 76%

Driver / Passenger

Car / Pole

GOOD
ADEQUATE
MARGINAL
WEAK
POOR

FRONTAL IMPACT	13.7 pts
SIDE IMPACT CAR	8.0 pts
SIDE IMPACT POLE	5.8 pts
REAR IMPACT (WHIPLASH)	0.0 pts

Pedestrian — Total 16 pts | 43%

GOOD
ADEQUATE
MARGINAL

HEAD	6.5 pts
PELVIS	3.1 pts
LEG	6.0 pts

Safety Assist — Total 5 pts | 71%

SPEED LIMITATION ASSISTANCE	0.0 pts
- Not available	
ELECTRONIC STABILITY CONTROL (ESC)	3.0 pts
- Standard	
SEATBELT REMINDER	2.0 pts
- driver	
- passenger	

Child Occupant — Total 39 pts | 79%

PERFORMANCE	12.0 pts
INSTRUCTIONS	4.0 pts
INSTALLATION	2.0 pts

18 month old child

Restraint	Britax Römer Baby Safe ISOFIX Plus
Group	0, 0+
Facing	Rearward
Installation	ISOFIX anchorages

PERFORMANCE	11.7 pts
INSTRUCTIONS	4.0 pts
INSTALLATION	2.0 pts

3 year old child

Restraint	Britax Römer Duo Plus Universal
Group	1
Facing	Forward
Installation	ISOFIX anchorages

Details of tested car

Specifications

Tested model	Mazda CX-7 2.2 diesel, RHD
Body type	5 door SUV
Year of publication	2010
Kerb weight	1865kg
VIN from which rating applies	Applies to all applies CX-7s of the specification tested
Class	SMALL OFF-ROAD 4×4

Safety equipment

Front seatbelt pretensioners	
Front seatbelt load limiters	
Driver frontal airbag	single stage
Front passenger frontal airbag	single stage
Side body airbags	
Side head airbags	

Exemplo de avaliação EuroNCAP

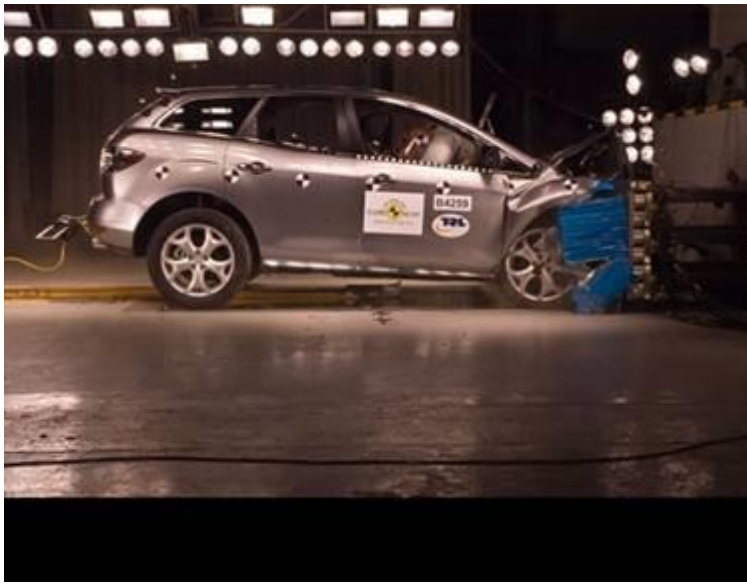
Comments

Adult occupant
The passenger compartment remained stable in the frontal impact. The driver and passenger were well protected in most areas but structures in the dashboard posed a risk of injury to the knees and femurs of both front seat passengers. In the side barrier test, the CX-7 scored maximum points. In the more severe side pole test, dummy readings of rib deflections indicated weak protection of the chest. The seat and head restraint provided poor protection against whiplash injuries in a rear-end collision.

Child occupant
Based on dummy readings in the frontal and side impact tests, the CX-7 scored maximum points for its protection of the 18 month dummy. Forward movement of the head of the 3 year dummy, sat in a forward facing seat, was not excessive. In the side impact, both child dummies were properly contained by their respective restraints. The passenger airbag cannot be disabled to allow a rearward facing child restraint to be used in that seating position and the label warning of the dangers of doing so is not sufficiently clear.

Pedestrian
While the bumper scored maximum points for its protection of pedestrians' legs, the bonnet provided predominantly poor protection in the areas likely to be struck by an adult's head.

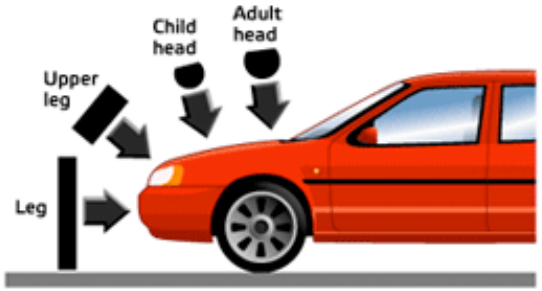
Safety assist
Electronic stability control is standard equipment on the CX-7, along with a seatbelt reminder system for the driver and front passenger seats.

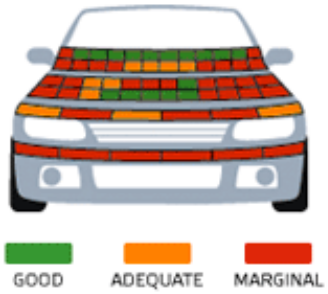


Proteção de Pedestres

Pedestrian protection

A series of tests are carried out to replicate accidents involving child and adult pedestrians where impacts occur at 40kph (25mph). Impact sites are then assessed and rated fair, weak and poor. As with other tests, these are based on European Enhanced Vehicle-safety Committee guidelines





It is very difficult to assess pedestrian protection using a full dummy. Although it is possible to control the point of impact of the bumper against the pedestrian's leg, it is impossible to control where the dummy's head will subsequently strike. To overcome this problem, individual component tests are used. A Legform test assesses the protection afforded to the lower leg by the bumper, an Upper Legform assesses the leading edge of the bonnet and child and adult Headforms are used to assess the bonnet top area.

Protection can be improved with pedestrian friendly bumpers, which deform when they hit a pedestrian's leg. Protection is improved if the leg is impacted low down, away from the knee, and if the forces are spread over a longer length of leg. For the leading edge of the bonnet, improvements can result from the removal of un-necessarily stiff structures. To protect the head, the bonnet top area needs to be able to deflect. It is important that sufficient clearance is provided above the stiff structures beneath, which would stop this deflection.

Euro NCAP released a separate star rating for pedestrian valid from 1997 to 2009. The pedestrian protection rating was based on the adult and child head form tests and the two legform tests. As of 2009, the pedestrian score has become integral part of the overall rating scheme, however the technical assessment has remained the same.

SAFETY WISSEN

Pedestrian Protection

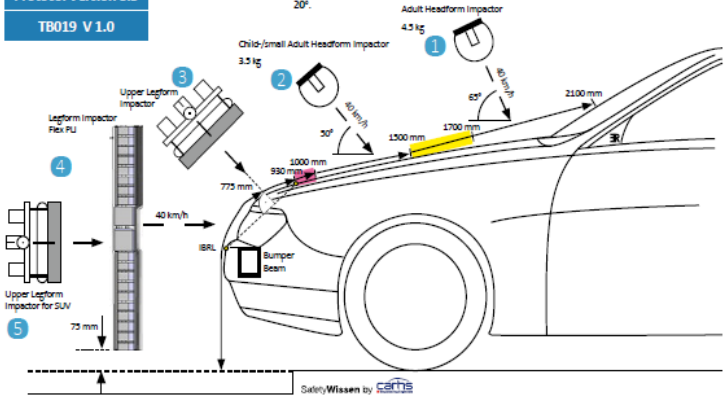
Pedestrian Protection Test Procedures in Euro NCAP / ANCAP

Protocol Version 8.5

TB019 V 1.0

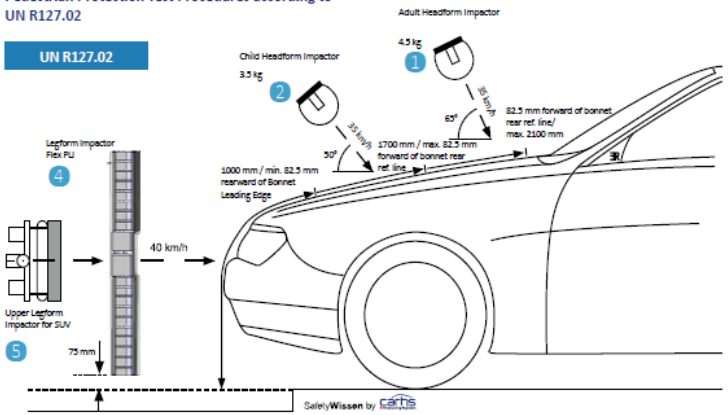
Where the bonnet leading edge reference line (BLERL) is located between WAD 930 mm and WAD 1000 mm, an additional test with the child headform will be performed on the BLERL at a speed of 40 km/h under 20°.

Points to be tested that lie between WAD 1500 und 1700 are tested with child-/small adult headform impactor, if the points are on the moveable/hinged bonnet top. Otherwise the adult headform is used.



Pedestrian Protection Test Procedures according to UN R127.02

UN R127.02



SAFETY WISSEN

UPDATE

Euro NCAP / ANCAP Pedestrian Protection: Head and Leg Impact Grid Method

Head Impact

Between WAD 1000 and WAD 2100 impact points are located on a fixed 100 mm grid, the selection of "Worst Case" points by the test institute is no longer required. The manufacturer provides a result prediction (points) for the Grid-Points. Euro NCAP verifies 10 randomly selected points, the manufacturer can nominate up to 10 additional randomly selected points. A tolerance of 10 % is applied to the verification tests, i.e. even if the actual HIC is 10 % above or below the margins of the predicted score, the predicted score is applied. At the verification points the actual test result is divided by the manufacturer's prediction. This so called correction factor is applied to all the grid points to obtain the final score:

$$\frac{\text{Actual tested score}}{\text{Predicted score}} = \text{Correction Factor}$$

Per Grid-Point 0 - 1 points are available according to the following scheme:

	HIC_{15}	< 650	1.00 Point
650 ≤	HIC_{15}	< 1000	0.75 Points
1000 ≤	HIC_{15}	< 1350	0.50 Points
1350 ≤	HIC_{15}	< 1700	0.25 Points
1700 ≤	HIC_{15}		0.00 Points

„Default" Results

Grid points on the A-pillars are defaulted to red = 0 points. Grid points on the windscreen that have distance of more than 165 mm from the windscreen base are defaulted to green = 1 point. Defaulted locations are not included in the random selection of verification tests. Where the vehicle manufacturer can provide evidence that shows an A-pillar is not red, those grid points will be considered in the same way as other points.

Unpredictable Grid Locations: Blue Zones

In the following areas

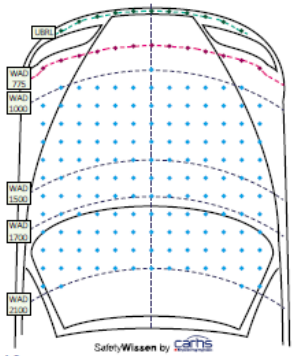
- Plastic scuttle
- Windscreen wiper arms and windscreen base
- Headlamp glazing
- Break-away structures

the manufacturer may define a "blue zone" consisting of up to 2 adjacent grid points, for which no prediction is made. A maximum of eight zones may be blue over the entire headform impact area.

The laboratory will choose one blue point to assess each zone. The test results of blue points will be applied to all the grid point(s) in each zone.

Assessment Protocol Version 10.0.2

Testing Protocol Version 8.5



Total Score:

The total score will be calculated as follows:

	ΣPredicted Score x Correction Factor
+	ΣDefault Scores
+	ΣScores from Blue Zones
=	Total
÷	Number of Grid Points
=	Percentage of max. achievable score
x	24 (Maximum achievable score)
=	Total Score for Headform Test

Leg Impact

For leg impact a 100 mm grid on WAD 775 (Upper Legform) respectively on Upper Bumper Reference Line (Flex PLI Legform) is used. Euro NCAP selects either the centerline point or an adjacent point as a starting point for testing. Starting from this position every second grid point will be tested. Symmetry is applied across the vehicle. Grid points that have not been tested will be awarded the worst result from one of the adjacent points. Manufacturers may sponsor additional test for those points that are not tested (in advance). Per Grid point up to 1 point is awarded. For the Upper Legform the score is based upon the worst performing parameter (Sum of Forces / Bending moment). For the Legform the 1 point per grid point is divided into two independent assessment areas of equal weight (0.5 Pts. / each): Tibia moments and ligament elongations.

Total Score:

The total score for the Upper/Lower Legform tests will be calculated as follows:

	ΣScores of all Grid Points
÷	Number of Grid Points
=	Percentage of max. achievable score
x	6 (Maximum achievable score)
=	Total Score for Legform Test

more about the impactors ➲ page 124

Mais um exemplo de complexidade para o desenvolvimento: Diversidade de Dummies

SafetyWissen

carhs

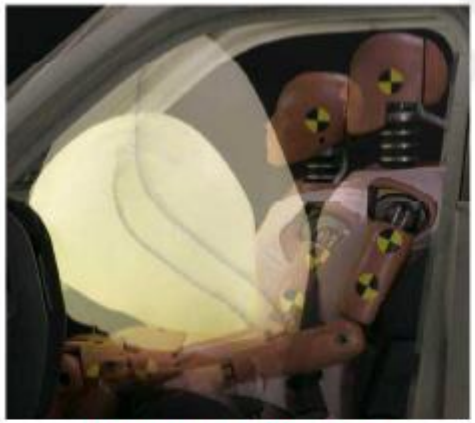
Current Dummy Landscape

		Frontal Impact Dummies			Side Impact Dummies					Rear Impact Dummies		Child Dummies				
		HIII 50%	HIII 5%	HIII 95%	ES-1	ES-2	ES-2re	SID-IIs	World SID	HIII 50%	BioRID II	Crabi	Cami	HIII	P Series	Q Series
Europe	UN R94	•														
	UN R95					•										
	UN R44														•	1)
	UN R129															•
	Euro NCAP	•	•			•			•		•					•
USA	FMVSS 208	•	•									•		•		
	FMVSS 214						•	•	1)							
	FMVSS 213											•	•	•	•	1)
	FMVSS 202a									•						
	U.S. NCAP	•	•				•	•	1)							
	IIHS	•						•			•					
	Latin NCAP	•				•										•
Asia	Japan Legal Regulations	•				•										
	Japan NCAP	•	•			•					•					
	China Standards	•				•										
	China NCAP	•	•			•		•			•				•	
	KMVSS 102	•			•											
	Korean NCAP	•	•			•			•		•					•
	India AIS (Frontal, Side)	•			•	•										
	ASEAN NCAP	•													•	•
AUS	ADR (Frontal, Side)	•			•											
	Australasian NCAP	•				•					•				•	
GTR	GTR 7 Head Restraints										•					
	GTR 14 Pole Side Impact								•							

2015 2016 2017

1) planned (no date specificed)

Desenvolvimento de novos conceitos de “airbag”



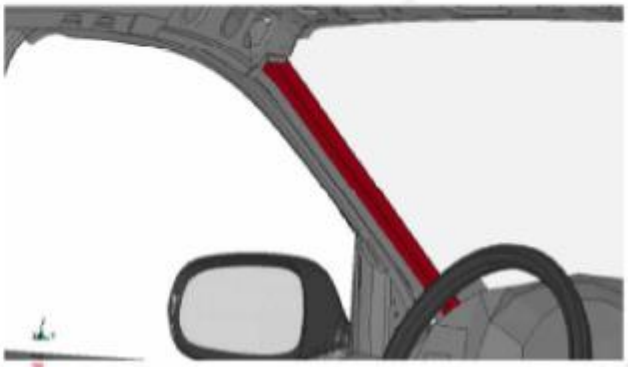
TRW Dual contour airbag

Ford Seatbelt Airbag

GM Front Center Airbag

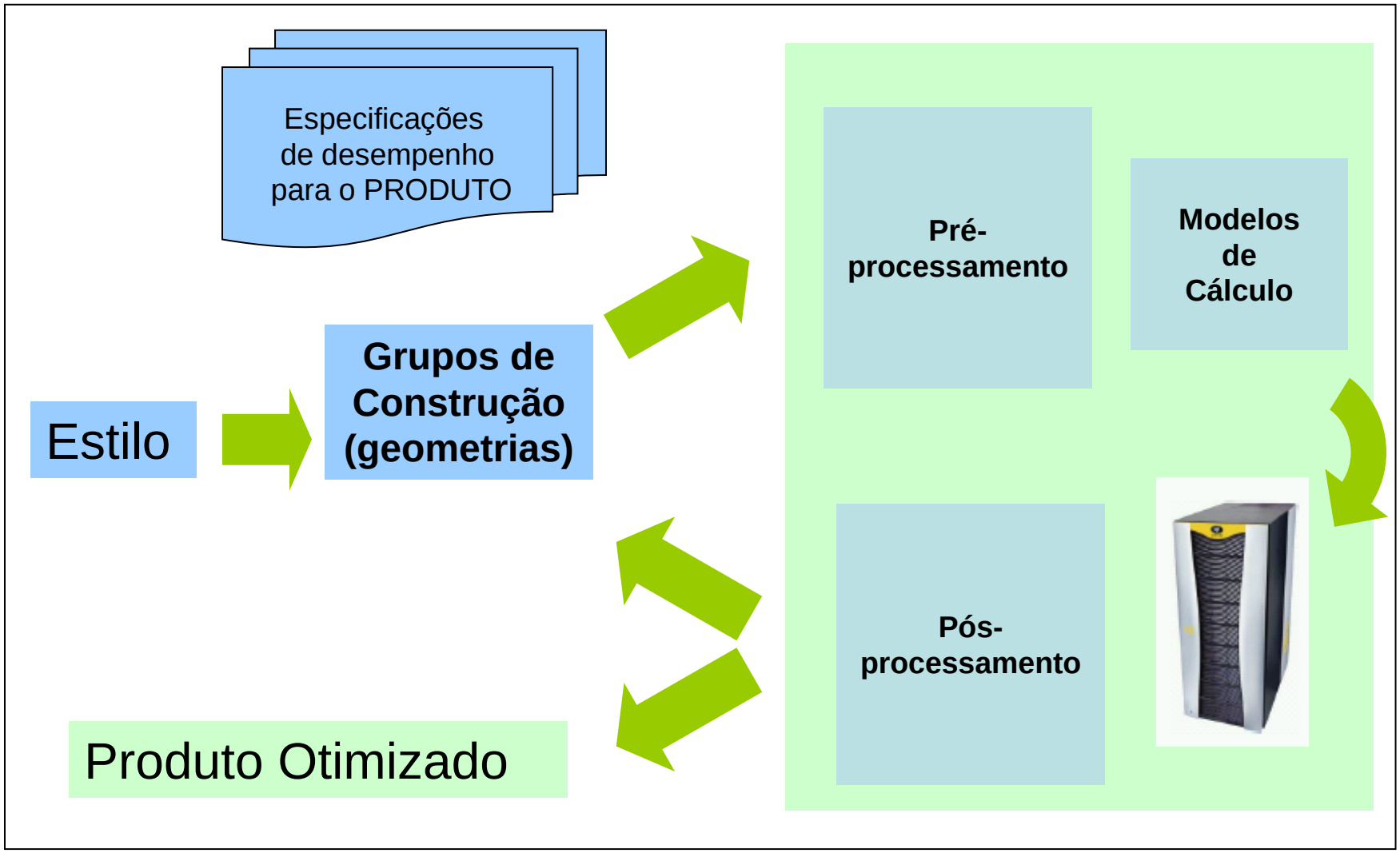
Typical airbag setting in new vehicle

Volvo Pedestrian Impact Airbag



Autolilv: A-pillar Airbag

Processo de CAE



Processo de CAE
Software / Hardware

Softwares

Solvers:

…

Pré-processadores:

….

Pós-processadores:

….

Hardware

Para análises de crash, multiprocessamento com até centenas de processadores.

Processo de CAE

Modelos de Cálculo:

- **Rigidez de carroceria (torção, flexão, modal, colunas...)**
- **Rigidez de partes móveis**
- **Resistência, rigidez e durabilidade de ancoragens**
- **Cálculos de rigidez e resistência locais**
- **Análises de Crash – frontal, lateral, traseiro, custo de reparo, proteção de pedestres, amassamentos de portas e teto...**
- **...**

Processo de CAE
Fluxo de Trabalho Típico

- Acessar modelo CAD no banco de dados
- Corrigir, simplificar geometria
- Gerar malha de elementos finitos
- Atender critérios de qualidade da malha
- Montar modelo de cálculo – unir peças; condiçôes de contorno; carregamentos...
- Submeter cálculo
- Pós-processamento
- Analisar resultados
- Emitir pareceres
- Desenvolver propostas de melhorias

Processo de CAE

Critérios/técnicas de modelagem para malha de elementos finitos

Objetivos:

- malha unificada para cálculos estáticos e cálculos de crash (quando possível)

- qualidade do modelo matemático

Critérios: ➔ ATENDER 100% !!

- critérios de qualidade dos elementos (warp, ângulos mínimos, proporção de triângulos, razão de aspecto...)

- manter tamanho mínimo – critério p/ time-step crash

- discretização/distância entre flanges de solda

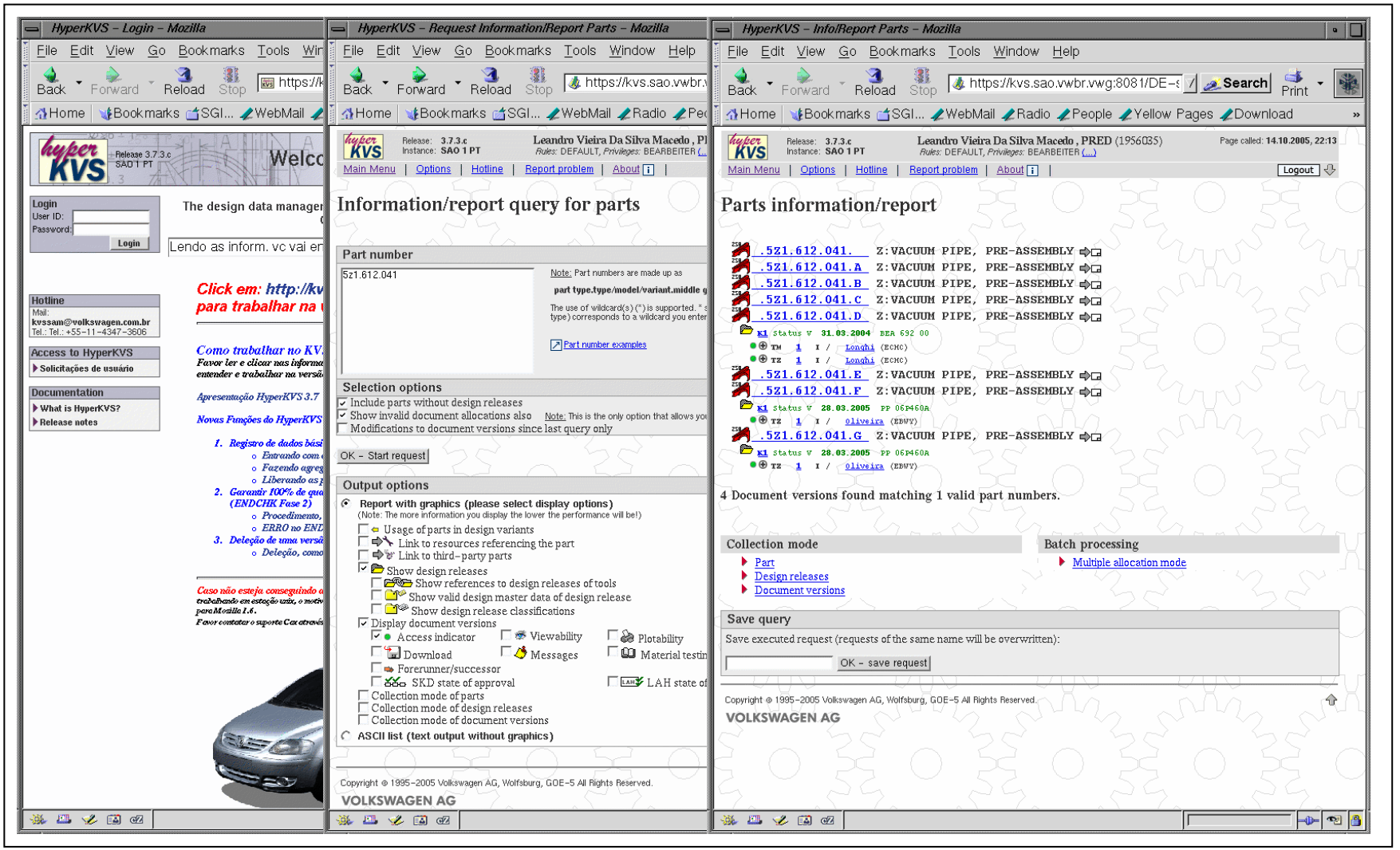
- eliminar interferências iniciais indevidas

- técnicas de modelagem de pontos de solda, grafagens, articulações...

- regras de numeração: peças, nós, elementos, etc...

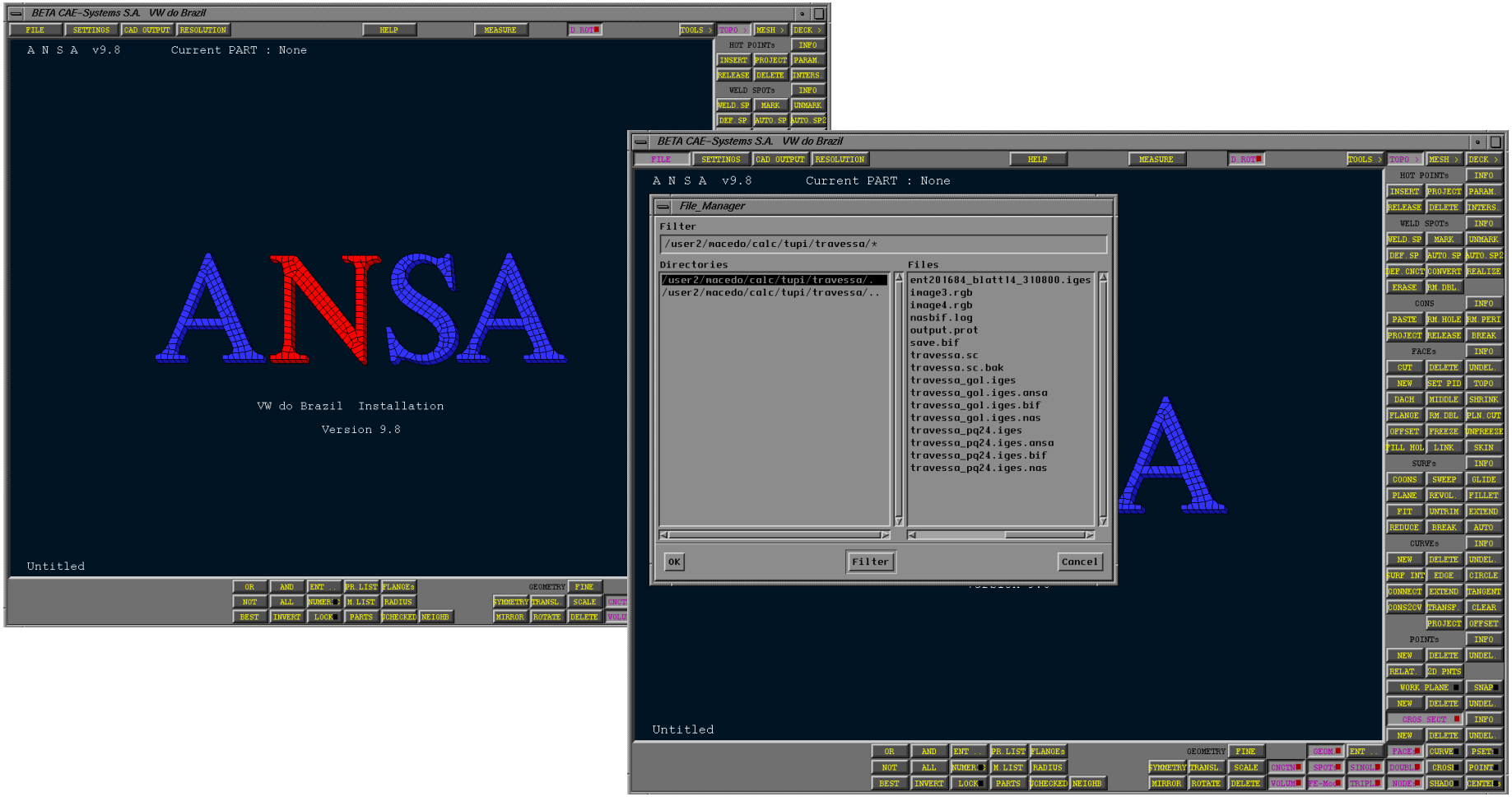
Processo de CAE

Banco de Dados de Engenharia ➔ acesso às geometrias 3D, desenhos, etc...



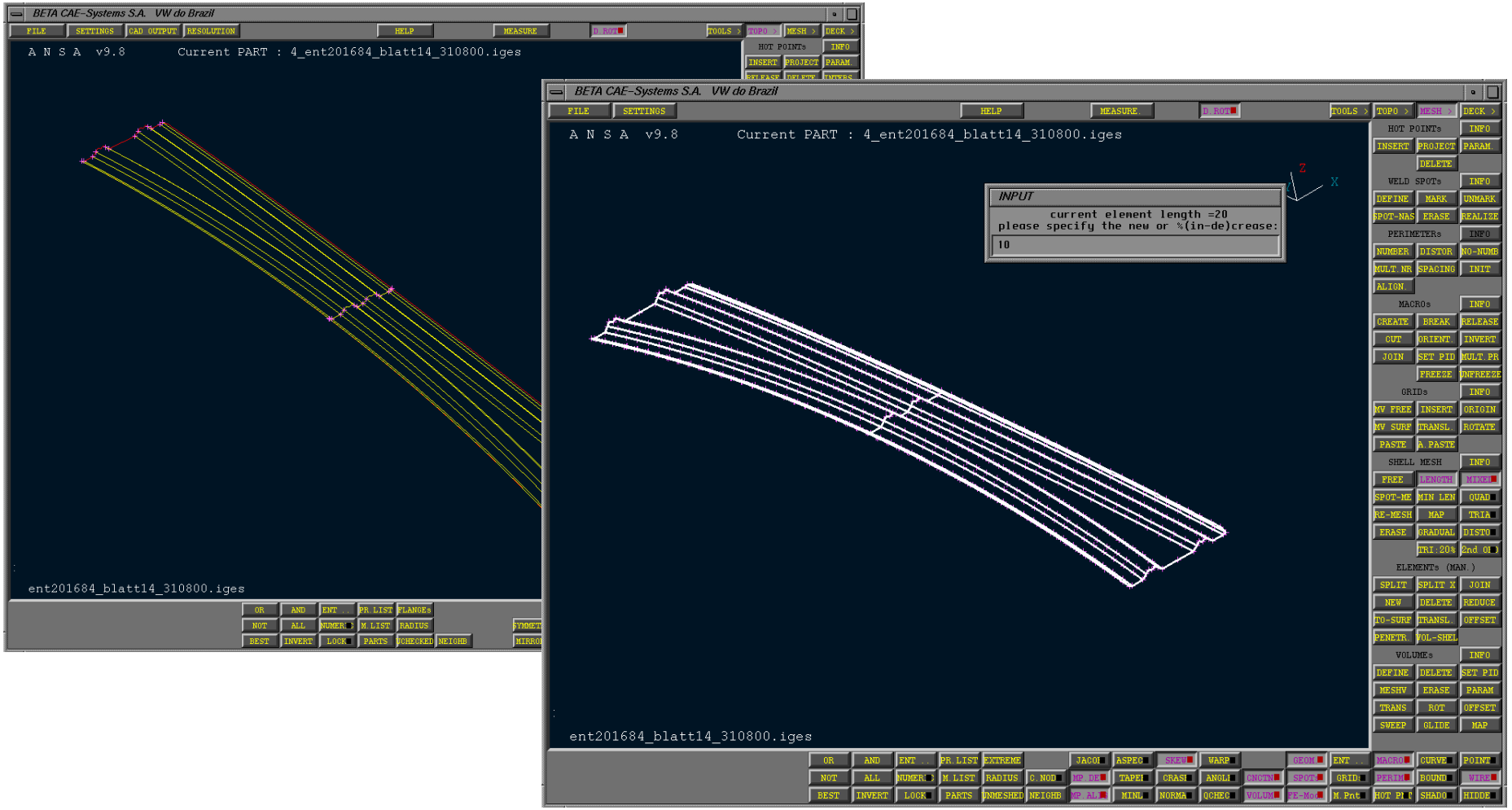
Processo de CAE

Correção da geometria e geração de malha nas peças unitárias



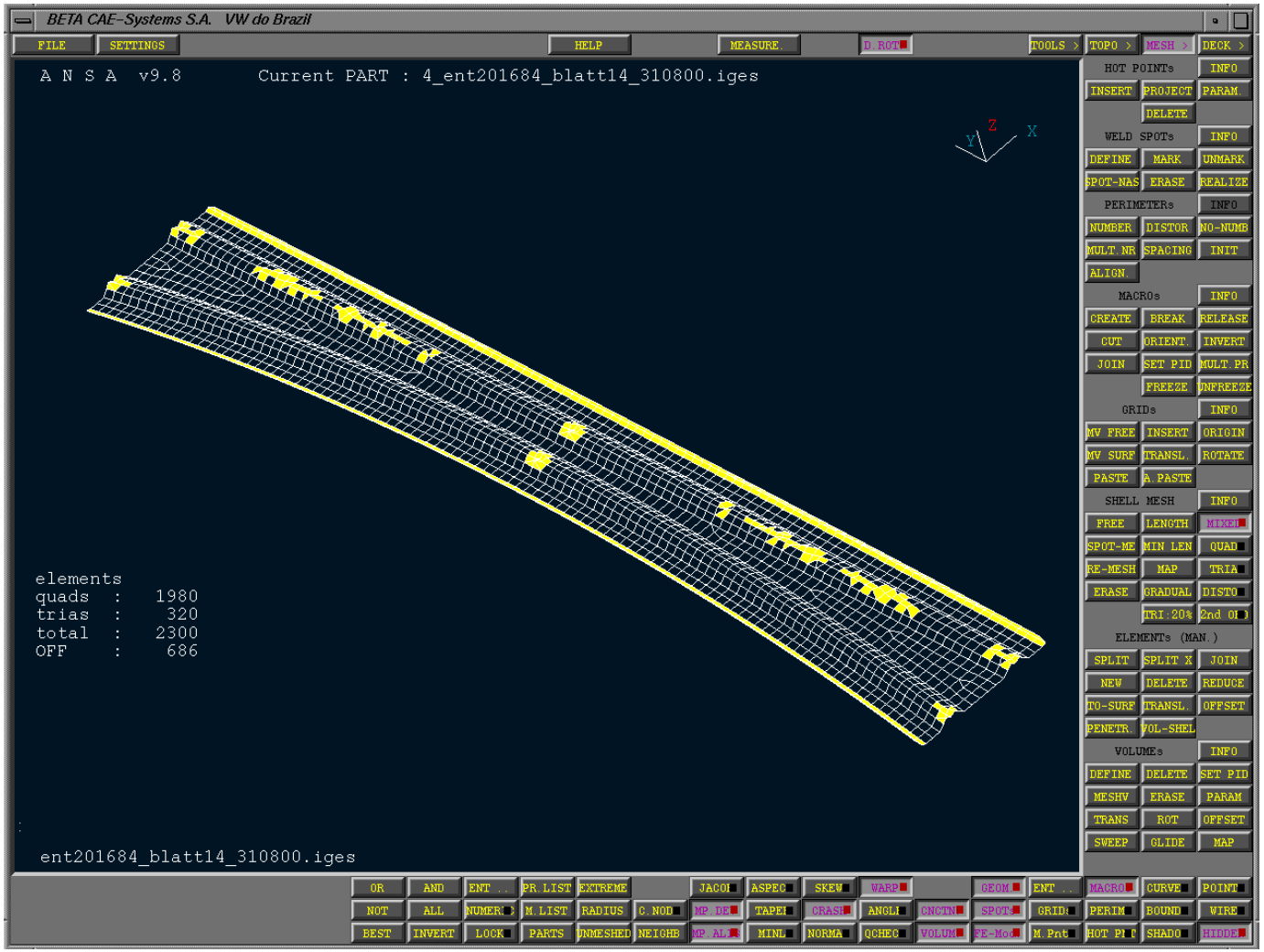
Processo de CAE

Correção da geometria e geração de malha nas peças unitárias



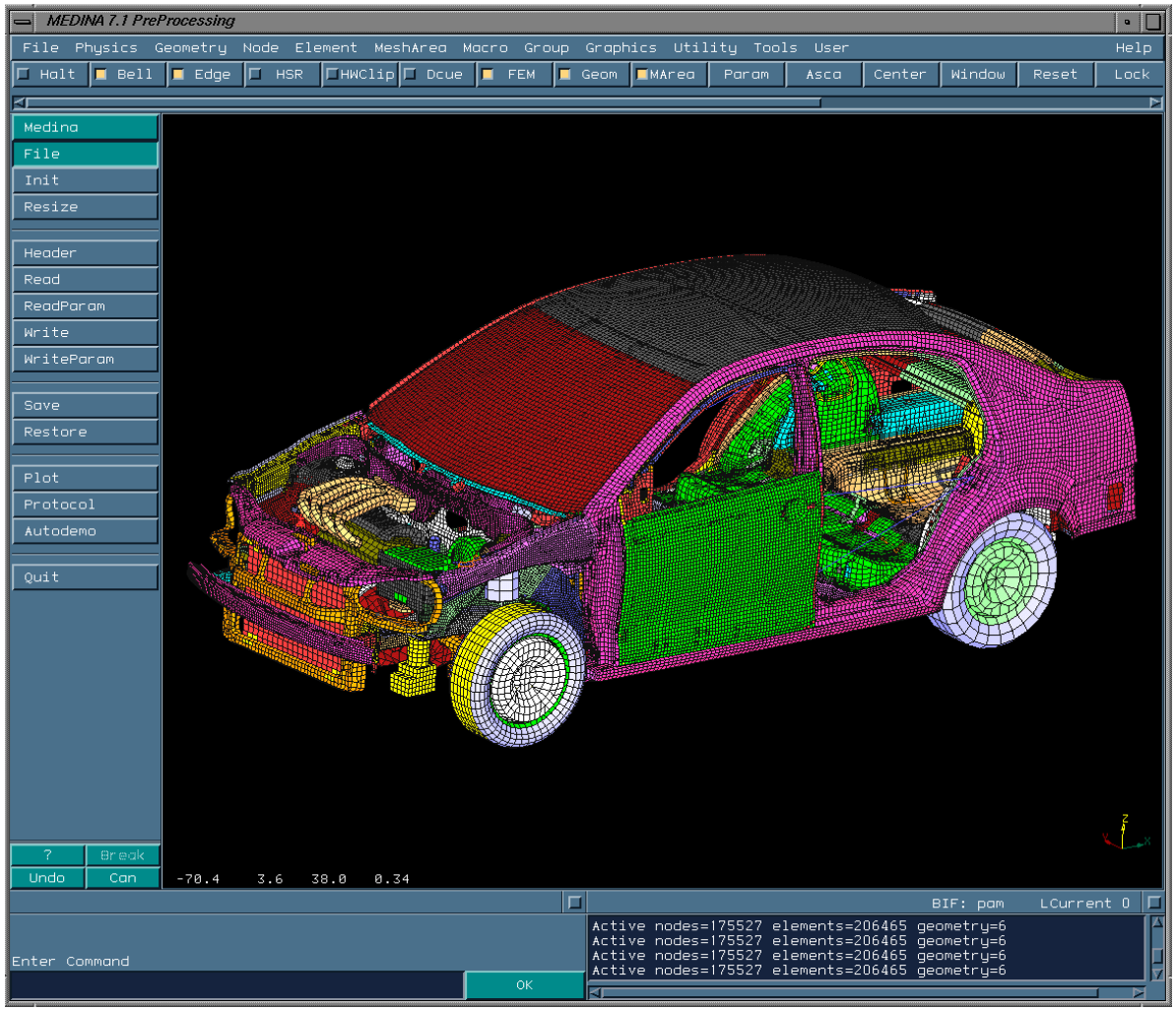
Processo de CAE

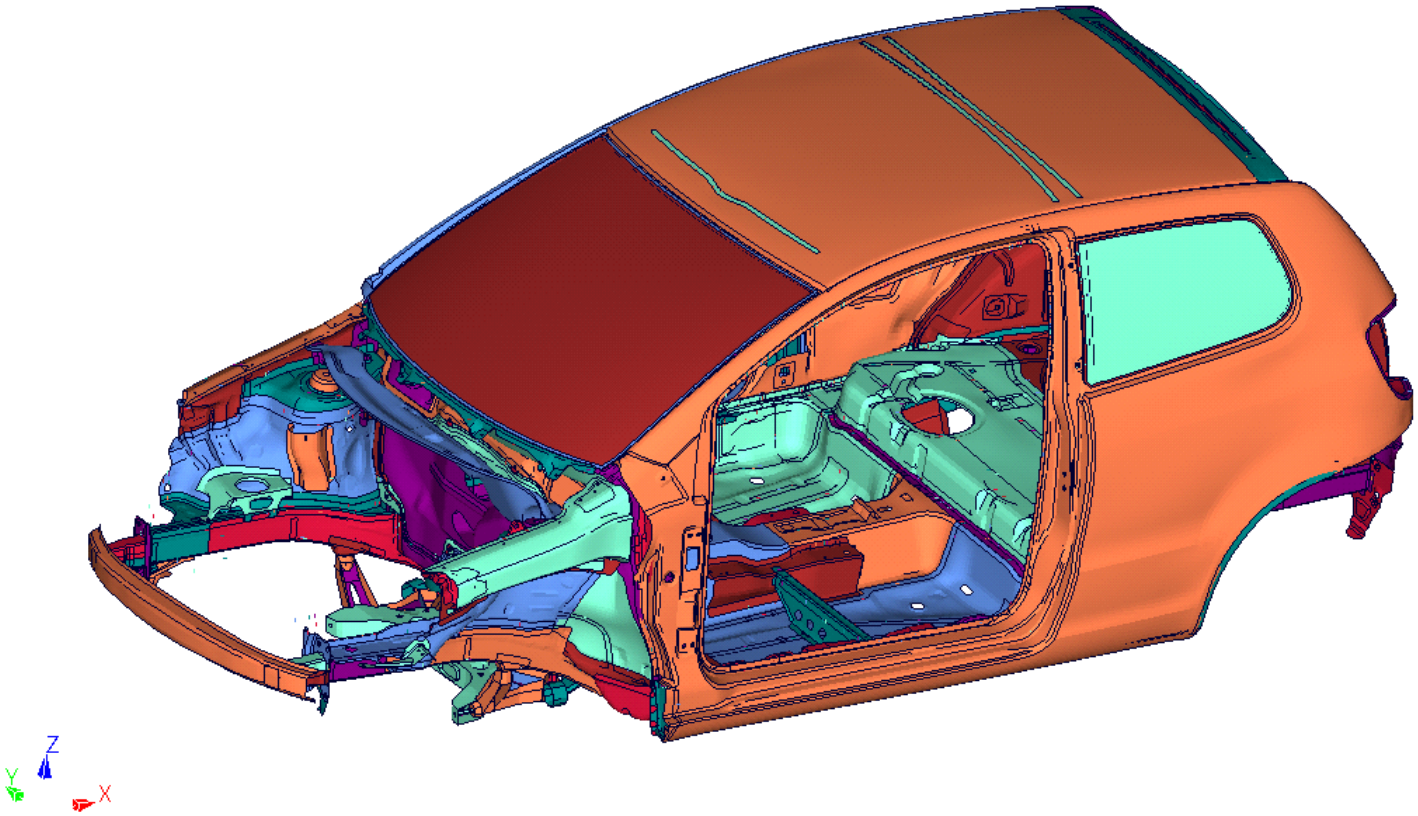
Atendimento aos critérios de qualidade de malha



Processo de CAE

Montagem do modelo de cálculos




Z
Y
X

Análise Rigidez da Tampa Dianteira

Objetivo:

Aqui vai uma breve descrição do objetivo...

Conclusão:

Aqui vai a conclusão da análise...

(Indicativo do Status da análise...)

LEGENDA:
> Verde – ok
> Amarelo – não ok (solução já antevista)
> Vermelho=não ok (ainda sem solução)

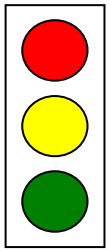
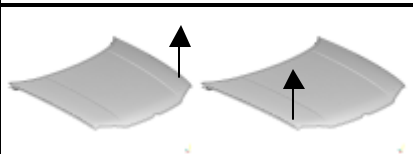
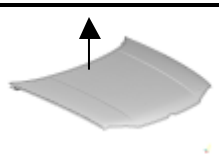
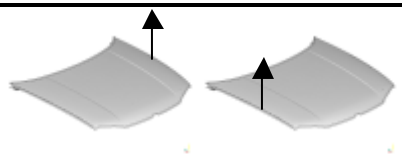
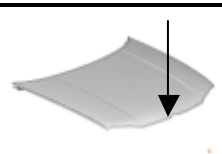


Tabela 1: Resultados

Carregamento	EP xx *Flexão da Travessa Frontal* F = xxx N		EP xx *Flexão da Travessa Traseira* F = xxx N	EP xx *Flexão da Travessa Lateral* F = xx N		EP xx *Tensão no Suporte da Fechadura* F = xx N
	Lado Dir.(LD)	**Lado Esq.(LE)**		**Lado Dir.(LD)**	**Lado Esq.(LE)**	
Ilustração						
Critério	> kk Nm/mm		> kk Nm/mm	< uu mm		> kk Nm/mm
v00 - Original /user2/fronco/marco/w340/2p/tt/w340_TT_00_00.dat	**xx**	**xx**	**xx**	**xx**	**xx**	**xx**
v02 - Proposta /user2/fronco/marco/w340/2p/tt/w340_TT_00_00.dat	**xx**	**xx**	**xx**	**xx**	**xx**	**xx**

Preparado por: Autor
Aprovador por:

Análise de resultados para o cálculo estrutural de "crash"

Curvas em função do tempo:

➔ energias (cinética, interna, "hourglass")
➔ time-step de integração
➔ energia interna absorvida pela barreira
➔ acelerações em diversas posições correspondentes a acelerômetros
➔ forças em determinadas seções transversais (elementos de deformação, longarinas, soleiras, curvão de teto...)
➔ energia interna absorvida pelas peças principais (também tabela com a energia interna de cada peça ao final do evento)

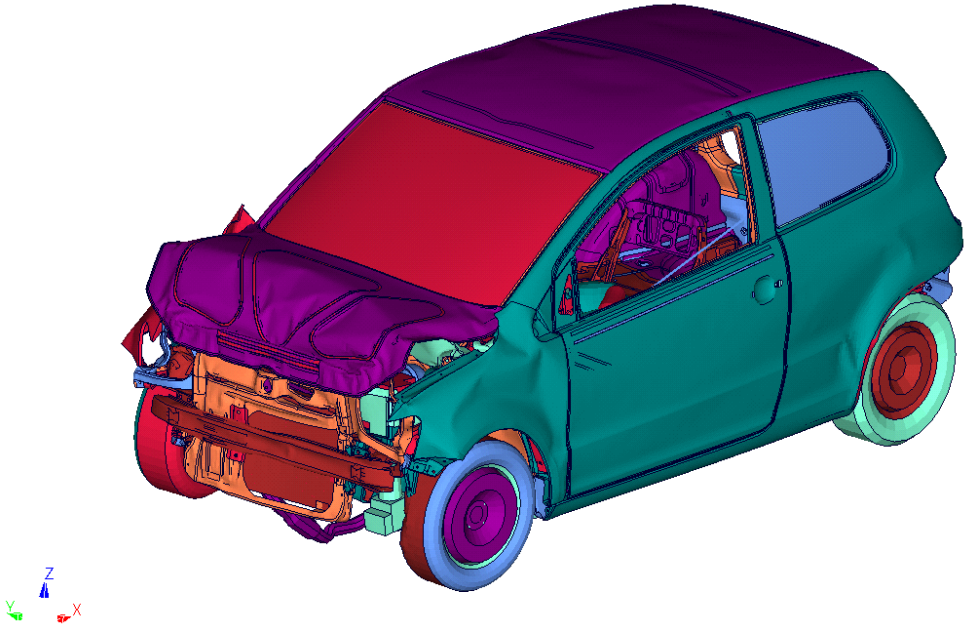
Análise de resultados para o cálculo estrutural de "crash"

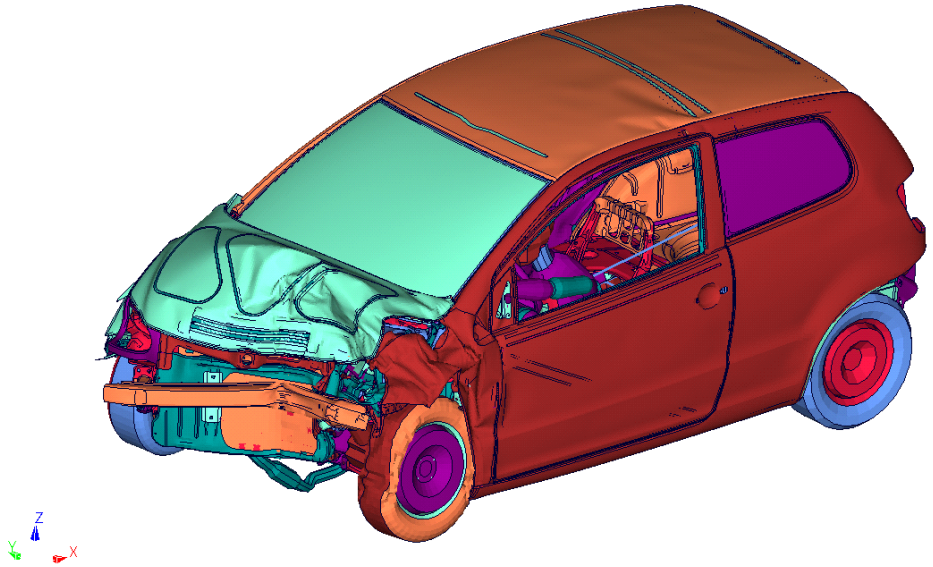
Crash frontal:

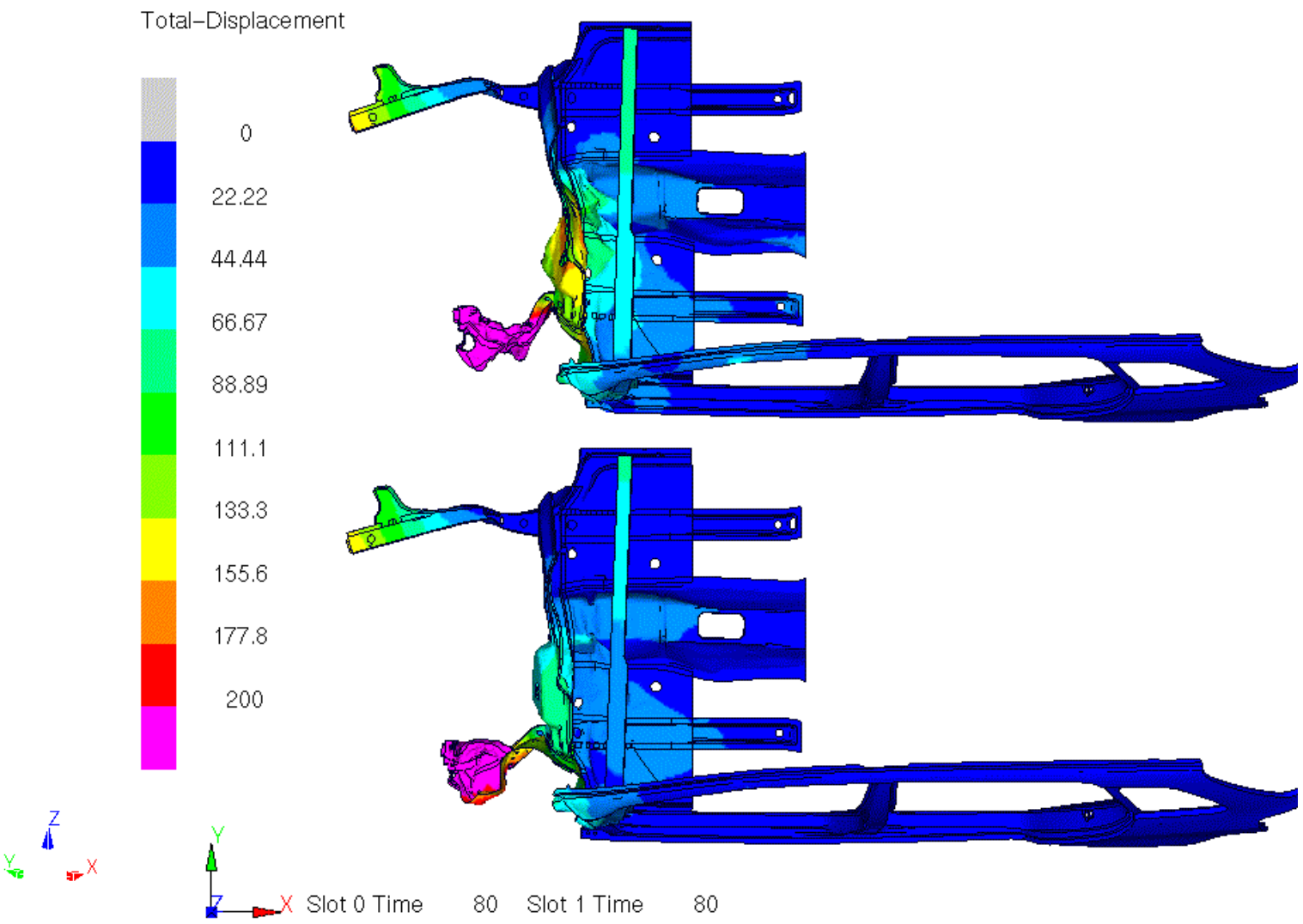
➔ resultados de dummy

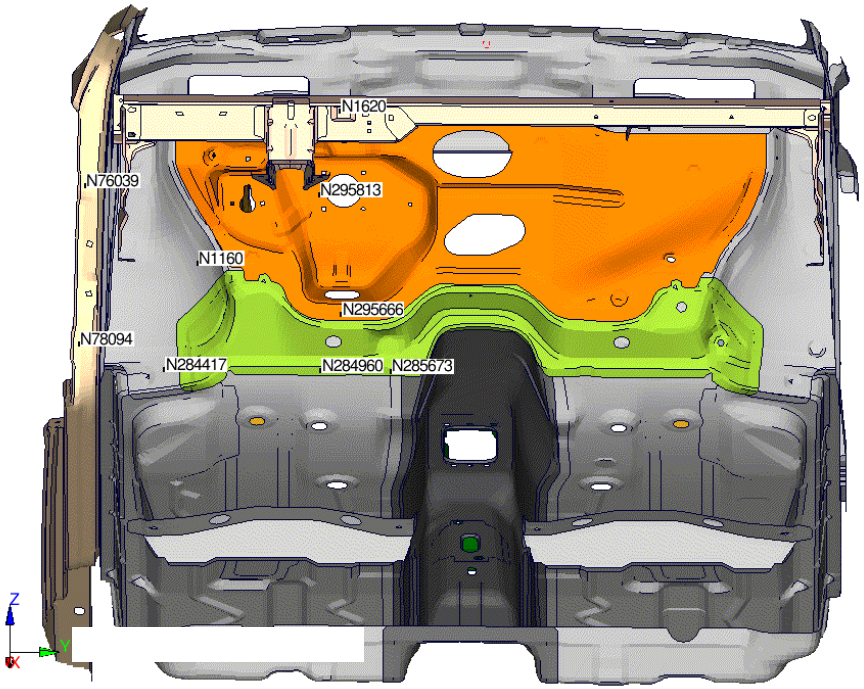
Intrusões

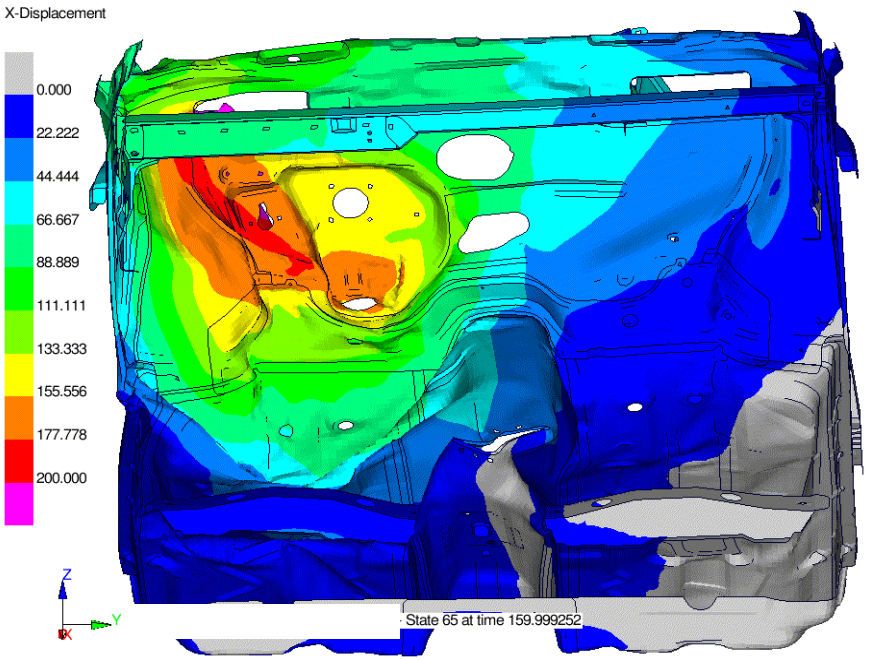
➔ intrusões no assoalho
➔ deslocamento de pedais
➔ deslocamento de coluna de direção
➔ encurtamento do vão da porta
➔ estabilidade do habitáculo (dobramento do curvão do teto)
➔ deformação no assoalho (ancoragem do banco)
➔ deformações excessivas com risco de rasgamento (na chapa ou nas soldas)

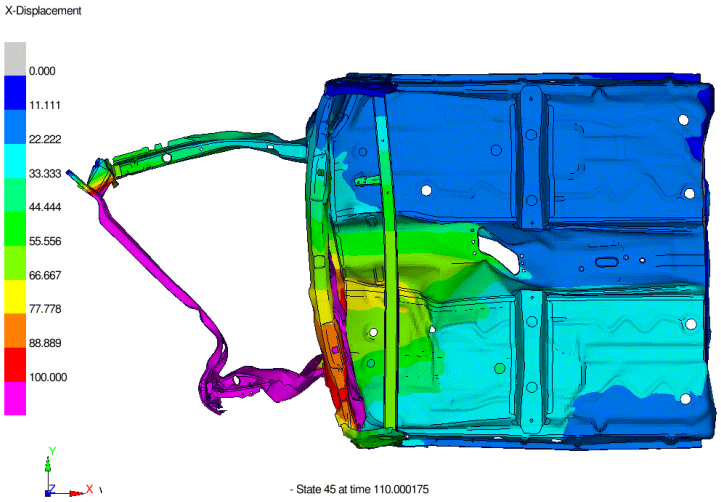

Z
Y
X

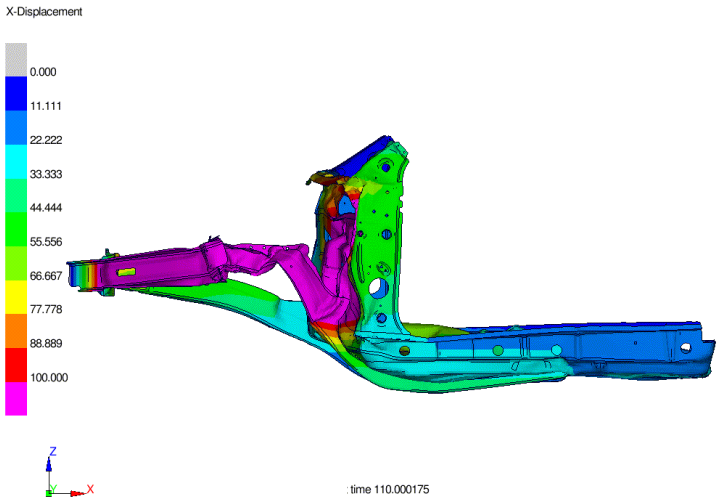

Z
Y
X

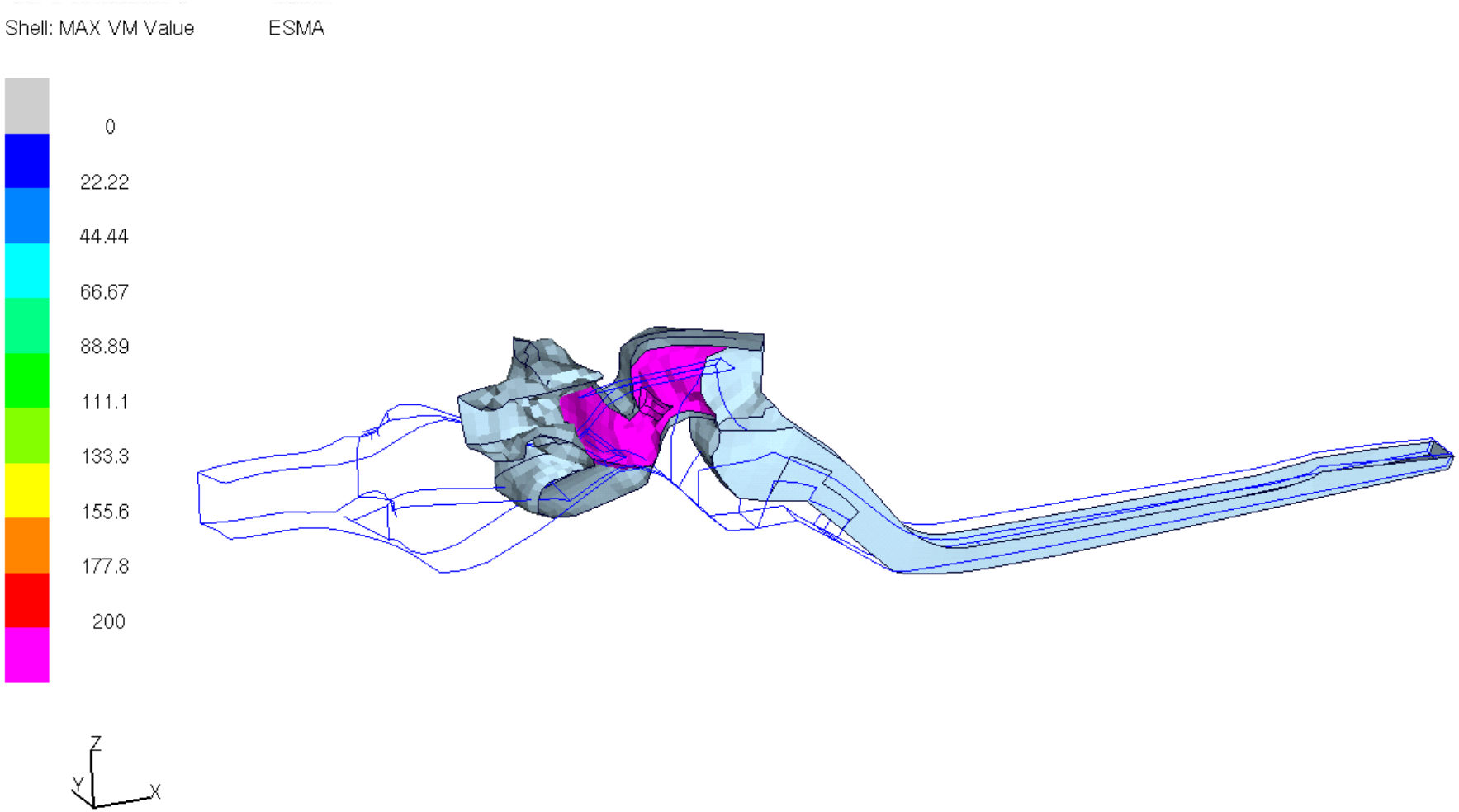

Total–Displacement
0
22.22
44.44
66.67
88.89
111.1
133.3
155.6
177.8
200
Z
Y
X
Y
Z
X
Slot 0 Time 80
Slot 1 Time 80

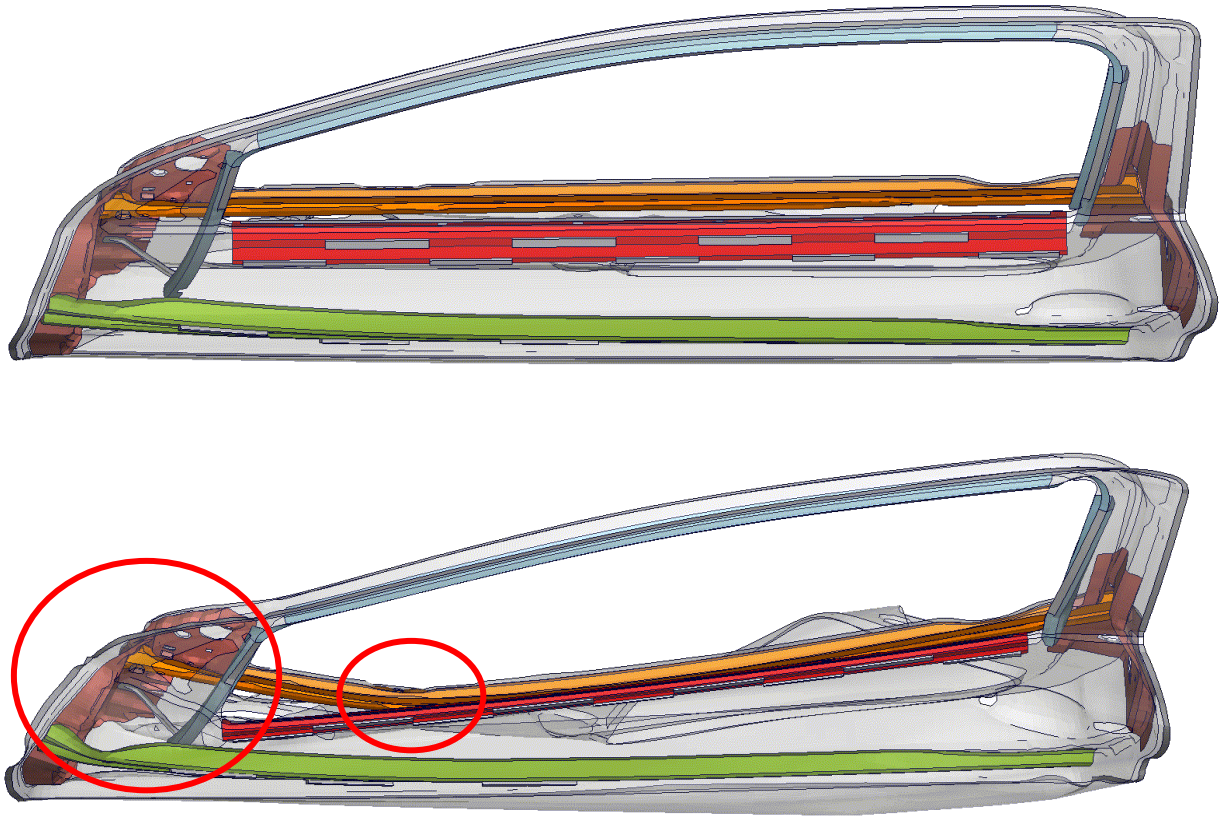

N1620
N76039
N295813
N1160
N295666
N78094
N284417
N284960
N285673
Z
Y
X


X-Displacement
0.000
22.222
44.444
66.667
88.889
111.111
133.333
155.556
177.778
200.000
Z
Y
X
State 65 at time 159.999252


X-Displacement
0.000
11.111
22.222
33.333
44.444
55.556
66.667
77.778
88.889
100.000
Y
Z
X
- State 45 at time 110.000175


X-Displacement
0.000
11.111
22.222
33.333
44.444
55.556
66.667
77.778
88.889
100.000
Z
Y
X
time 110.000175


Shell: MAX VM Value
ESMA
0
22.22
44.44
66.67
88.89
111.1
133.3
155.6
177.8
200
Z
Y
X



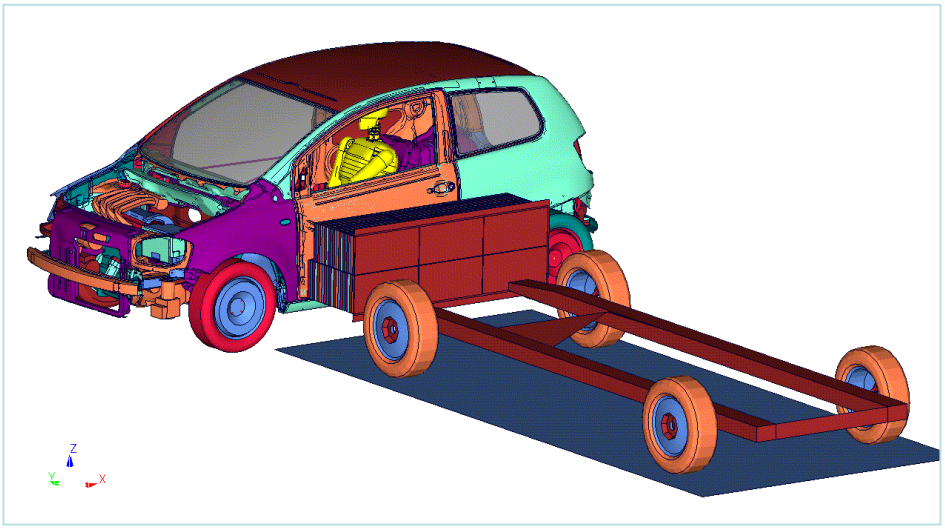
Análise de resultados para o cálculo estrutural de "crash"

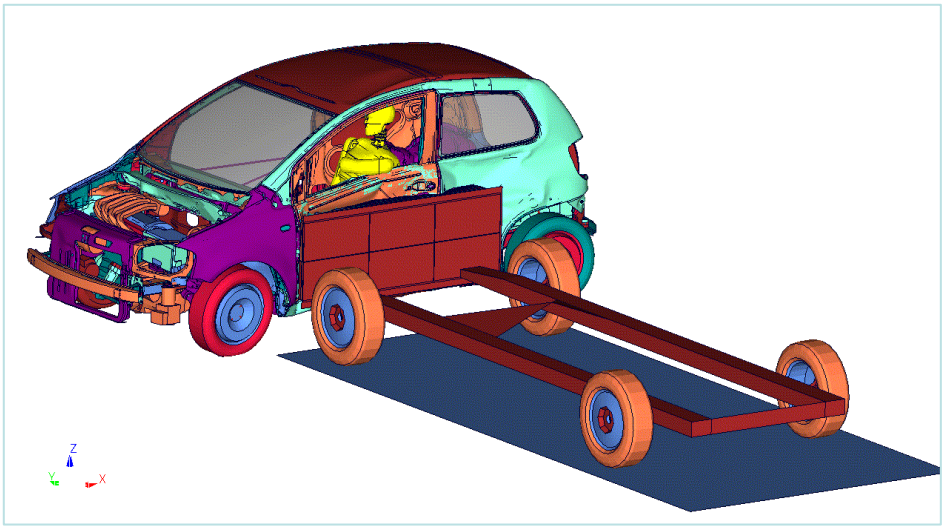
No Crash lateral:

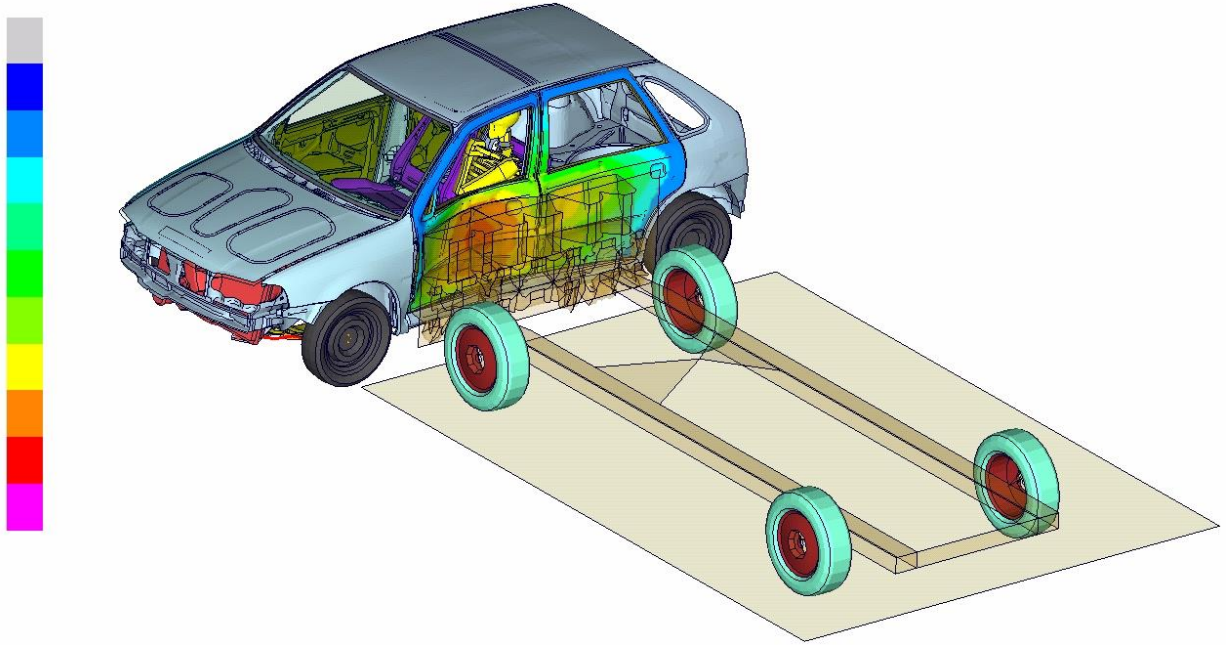
- ➔ resultados de dummy com objetivo de desempenho
- ➔ resultados de dummy para validação da cinemática

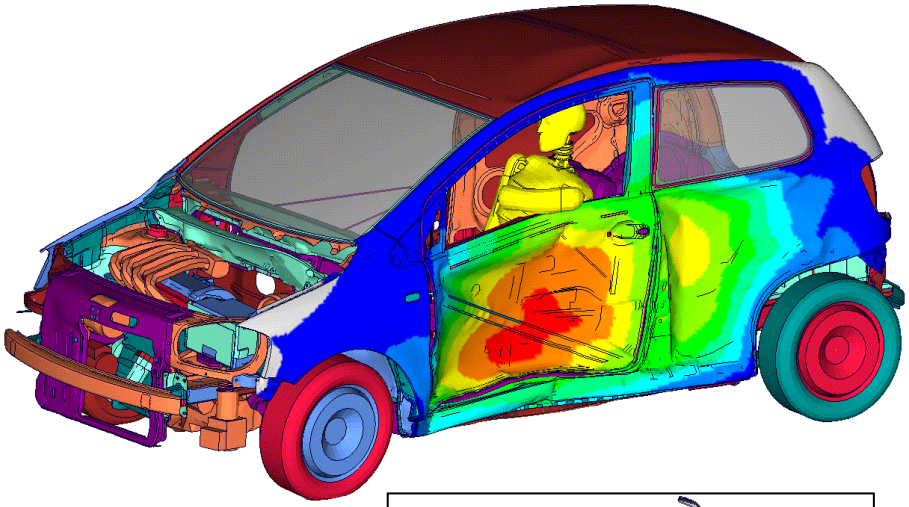
Intrusões:

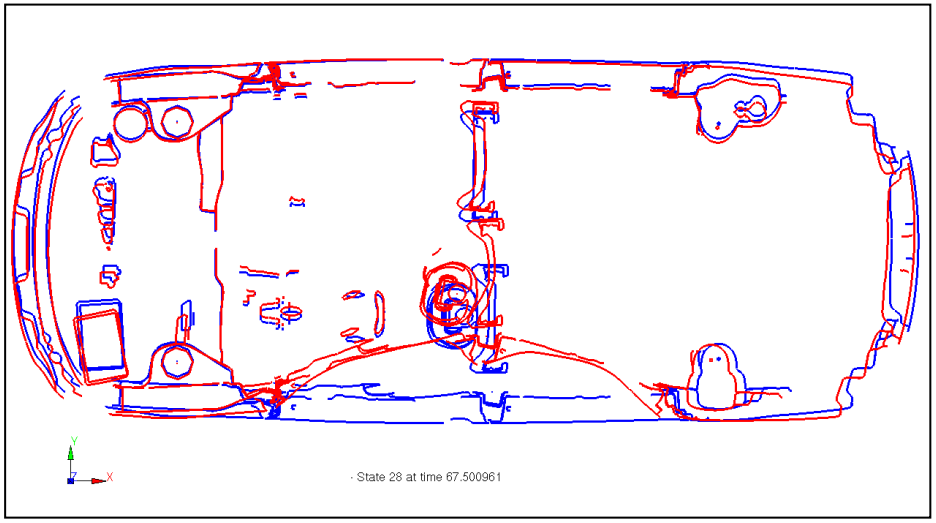
- ➔ deslocamentos na porta (quadril, costelas)
- ➔ deslocamentos na coluna B
- ➔ velocidades de intrusão na porta e coluna B
- ➔ comportamento do banco (compressão da estrutura do assento)
- ➔ comportamento do airbag (diferença entre crash contra veículo e contra poste)

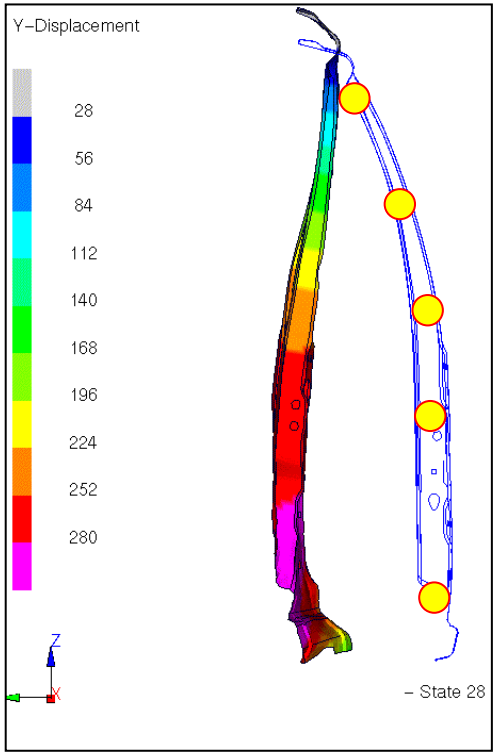


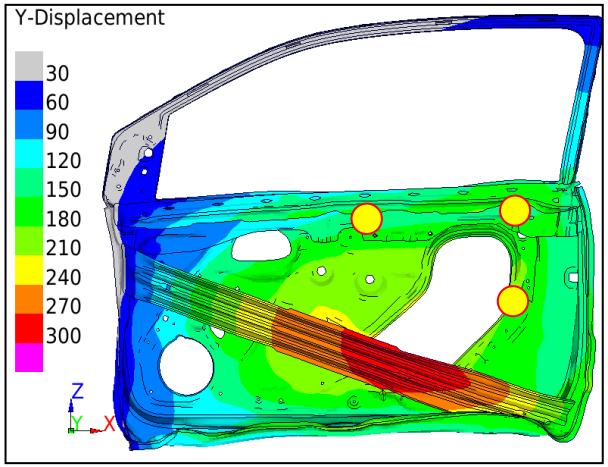


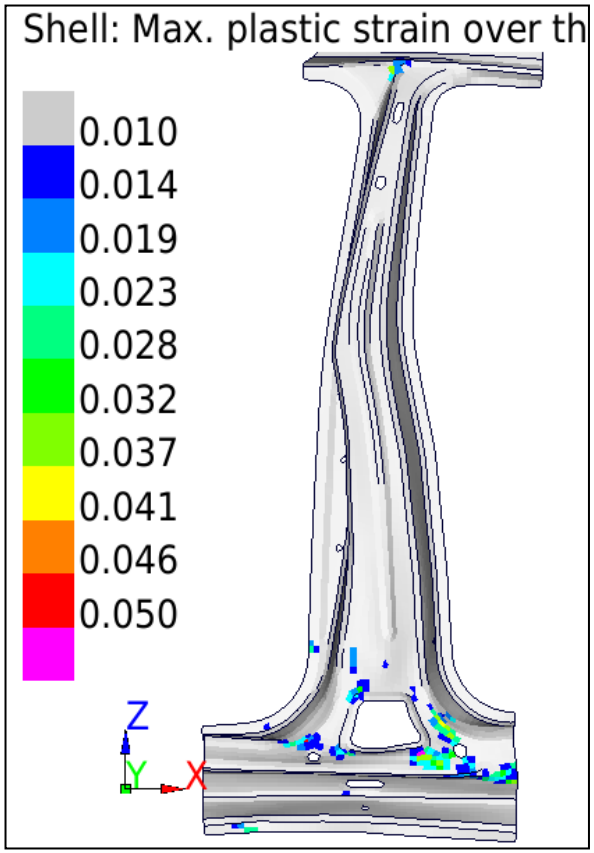


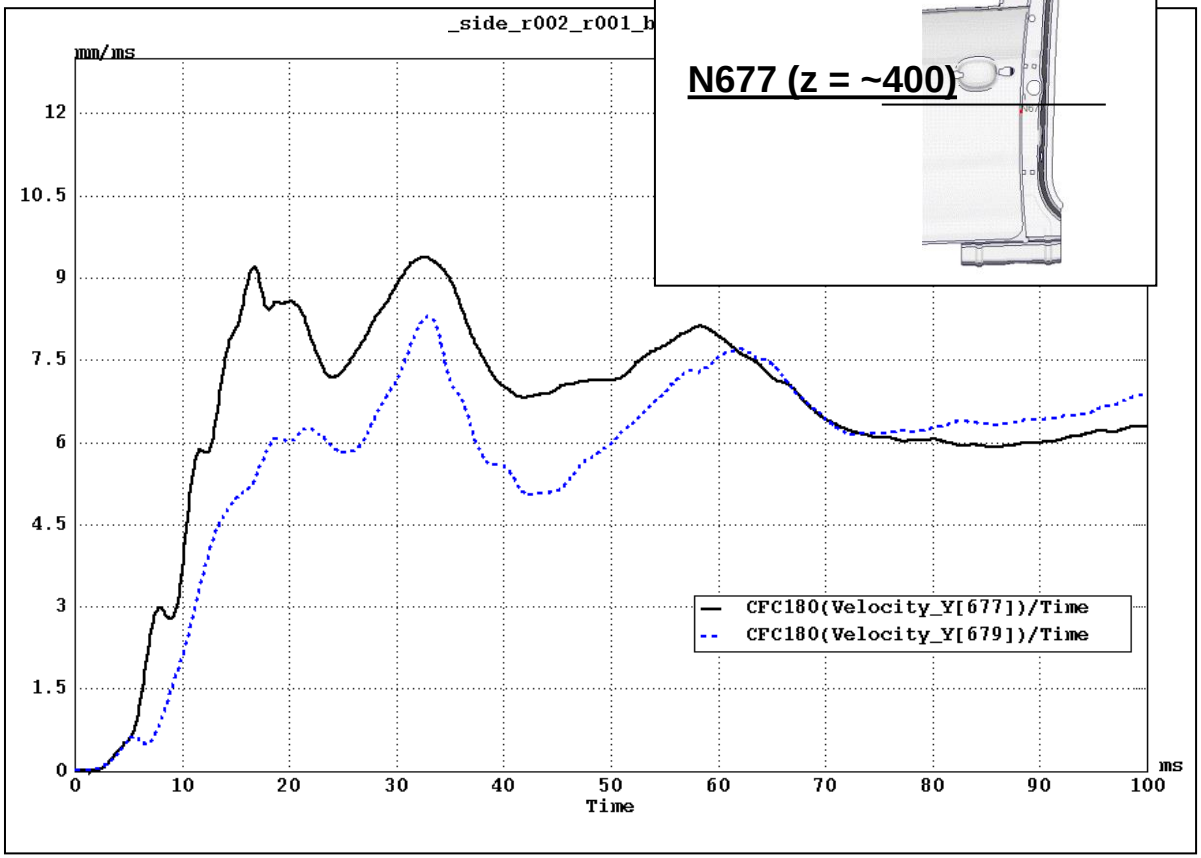



State 28 at time 67.500961

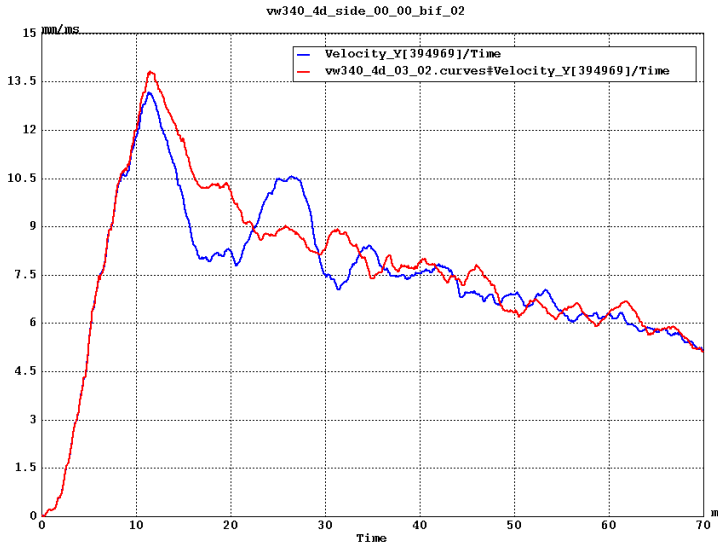

Y–Displacement
28
56
84
112
140
168
196
224
252
280
State 28

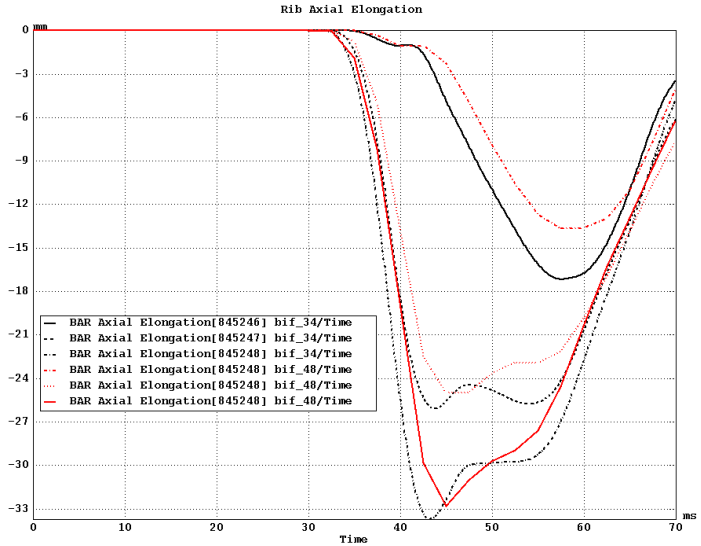

Y-Displacement
30
60
90
120
150
180
210
240
270
300

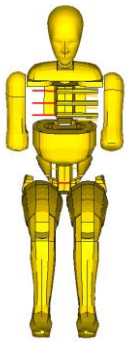

Shell: Max. plastic strain over th
0.010
0.014
0.019
0.023
0.028
0.032
0.037
0.041
0.046
0.050
Z
Y
X


_side_r002_r001_b
mm/ms
12
10.5
9
7.5
6
4.5
3
1.5
0
0
10
20
30
40
50
60
70
80
90
100
ms
Time
CFC180(Velocity_Y[677])/Time
CFC180(Velocity_Y[679])/Time

N679 (z = ~750)
N677 (z = ~400)







Rib deflection and APF:

Bar 845246 upper rib
Bar 845247 middle rib
Bar 845248 lower rib

PSPF:
Beam 876598 pubis

Análise de resultados para o cálculo estrutural de "crash"

No Crash traseiro:

➔ forças em determinadas seções transversais (elementos de deformação, longarinas)

➔ intrusões no assoalho traseiro

➔ espaço residual para o tanque de combustível

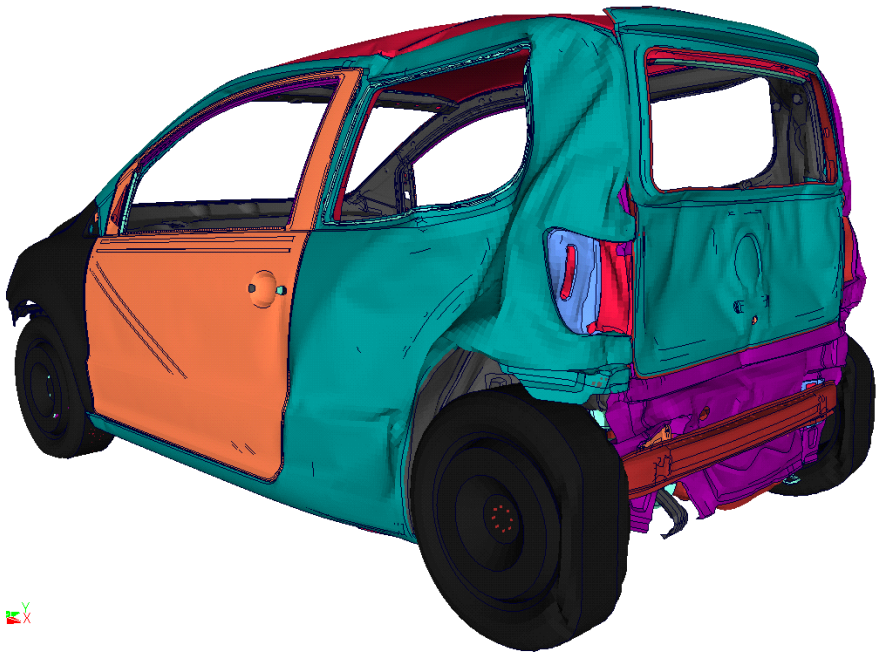
➔ proteção do gargalo de combustível

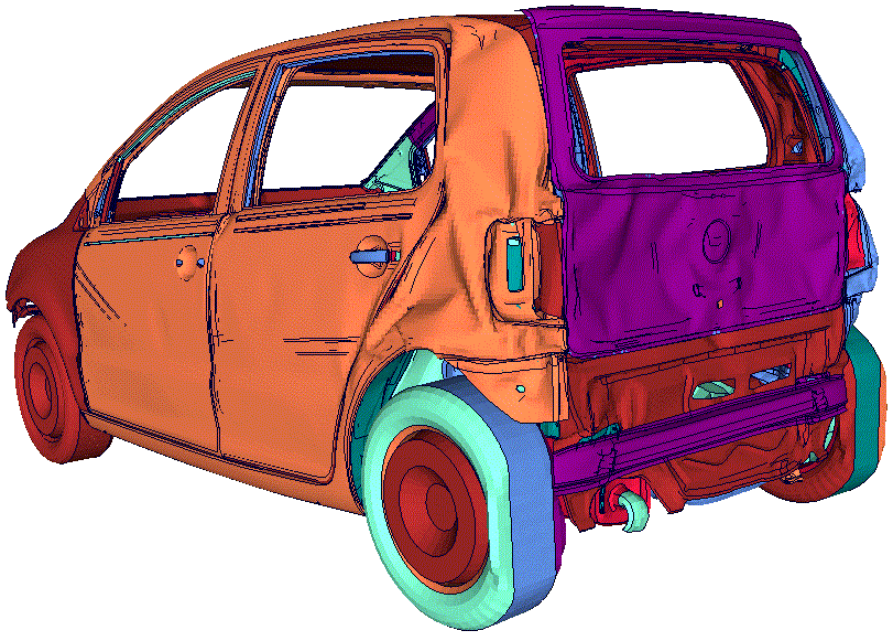
➔ conexão gargalo com o tanque

➔ fixações do gargalo na carroceria

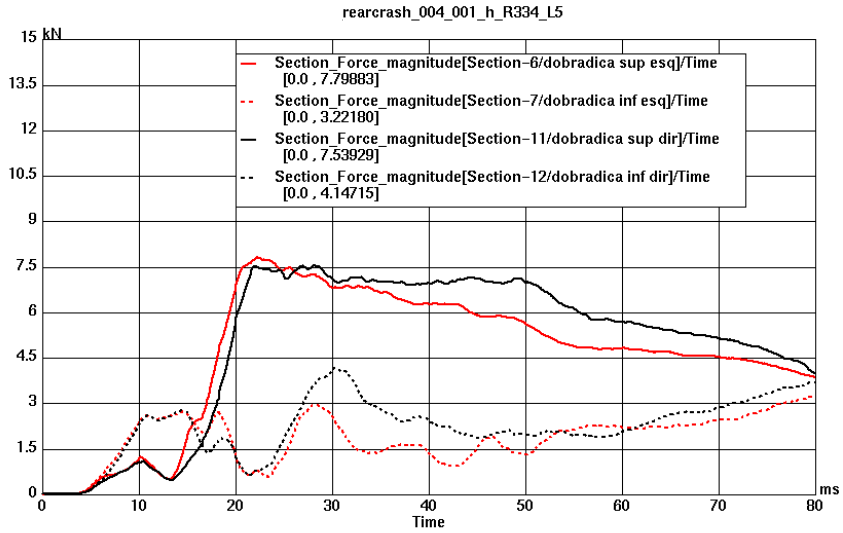
➔ levantamento do assoalho traseiro anterior na posição do banco traseiro

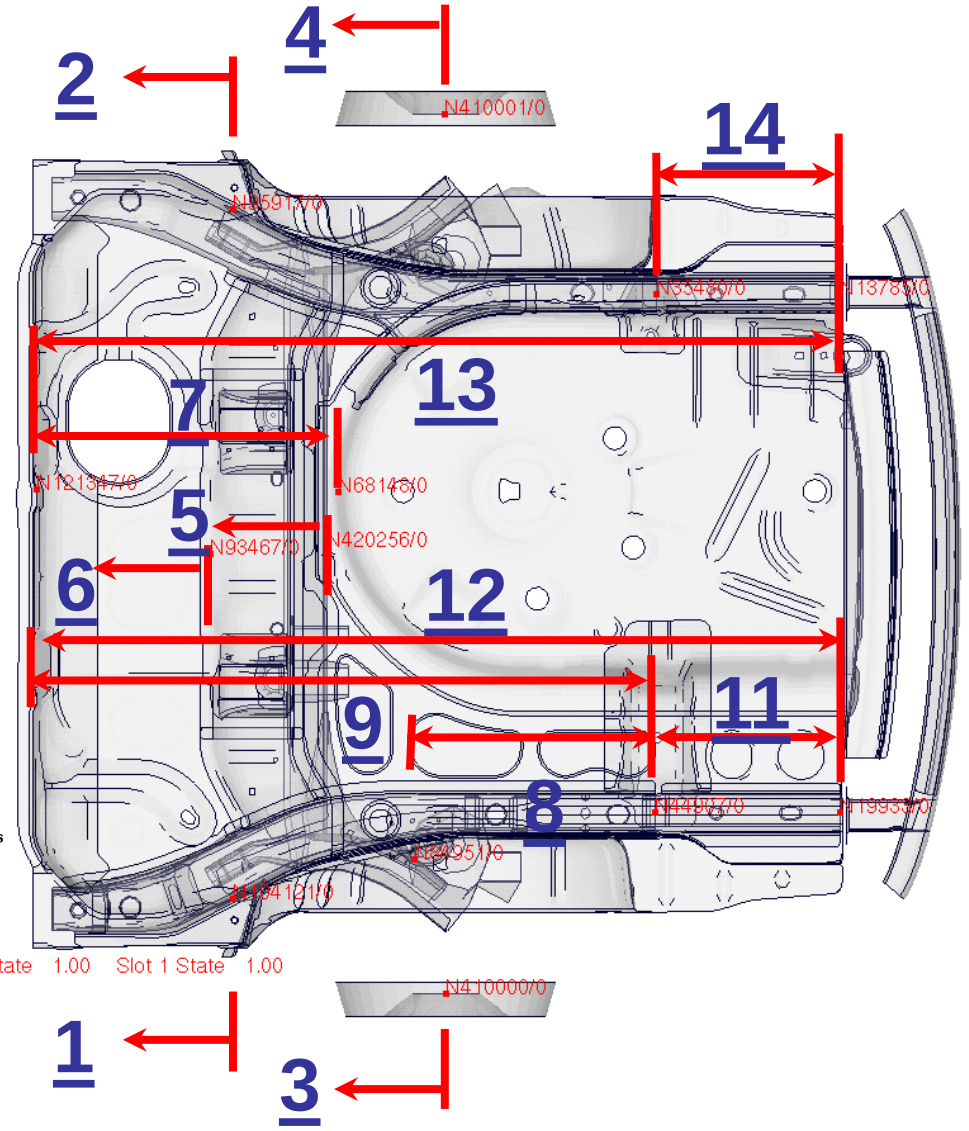
➔ solução de compromisso entre minimizar custo de reparo em colisão a baixa velocidade e proteção para a condição de colisão a alta velocidade

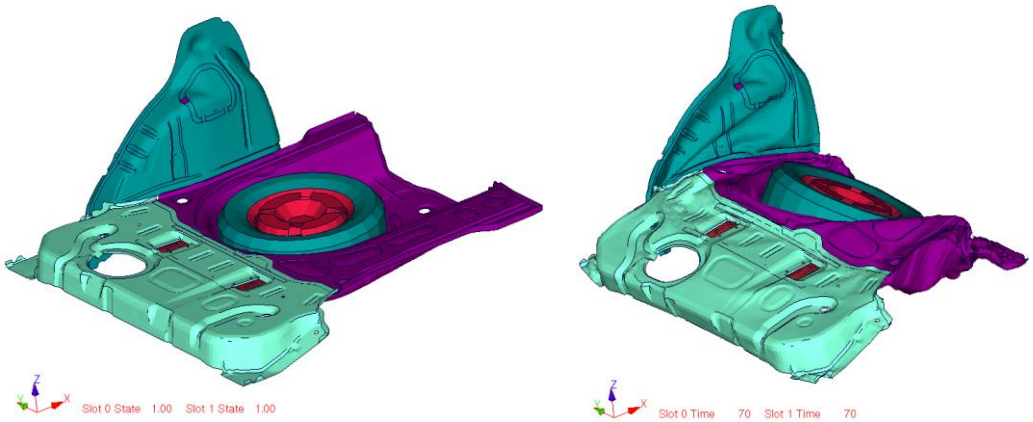


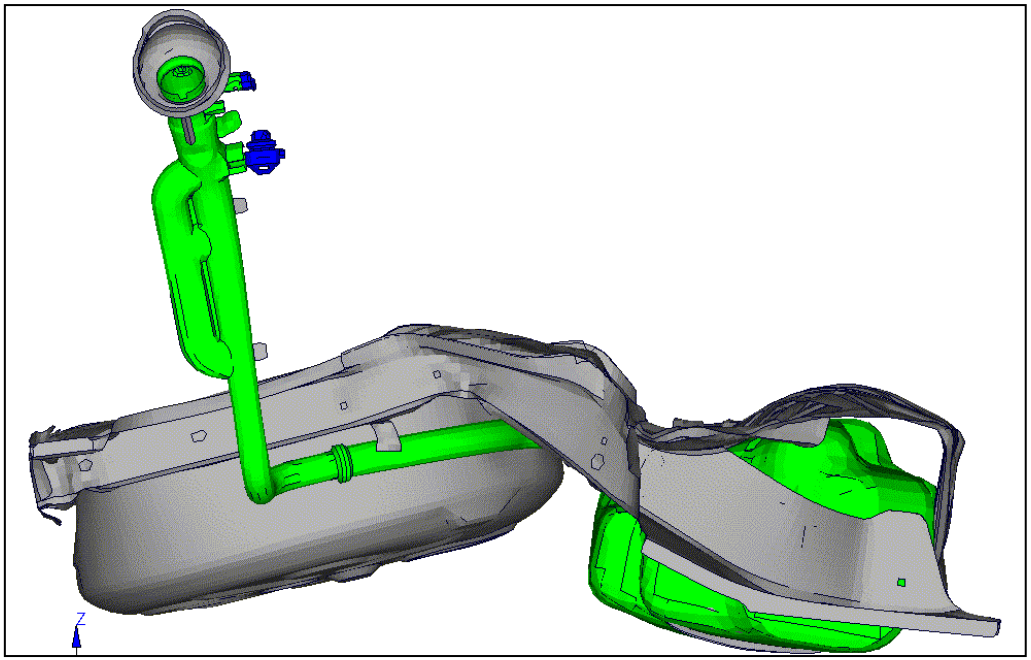


		mod. 70	var. 45_44	_004_	_005_	_008_
1	mancal eixo tras esq	23	34	21	21	22
2	mancal eixo tras dir	26	33	35	35	36
3	roda esq	66	57	22	22	22
4	roda dir	68	57	30	30	29
5	eixo tras	16	23	21	21	22
6	trav interm	133	112	87	88	88
7	aloj estepe-assoalhodiant	187	140	108	108	104
8	extr long-prato mola	158	192	237	235	237
9	extr long-assoalho diant	238	255	271	270	274
11	compl long esq			107	108	101
12	assoalho tras total esq			378	378	376
13	assoalho tras total dir			375	375	374
14	compl long dir			213	213	219

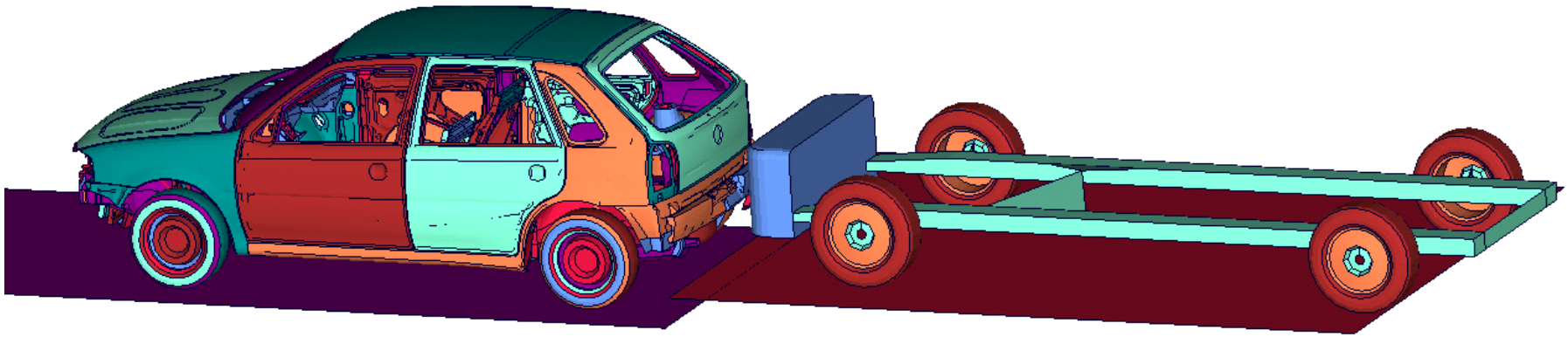




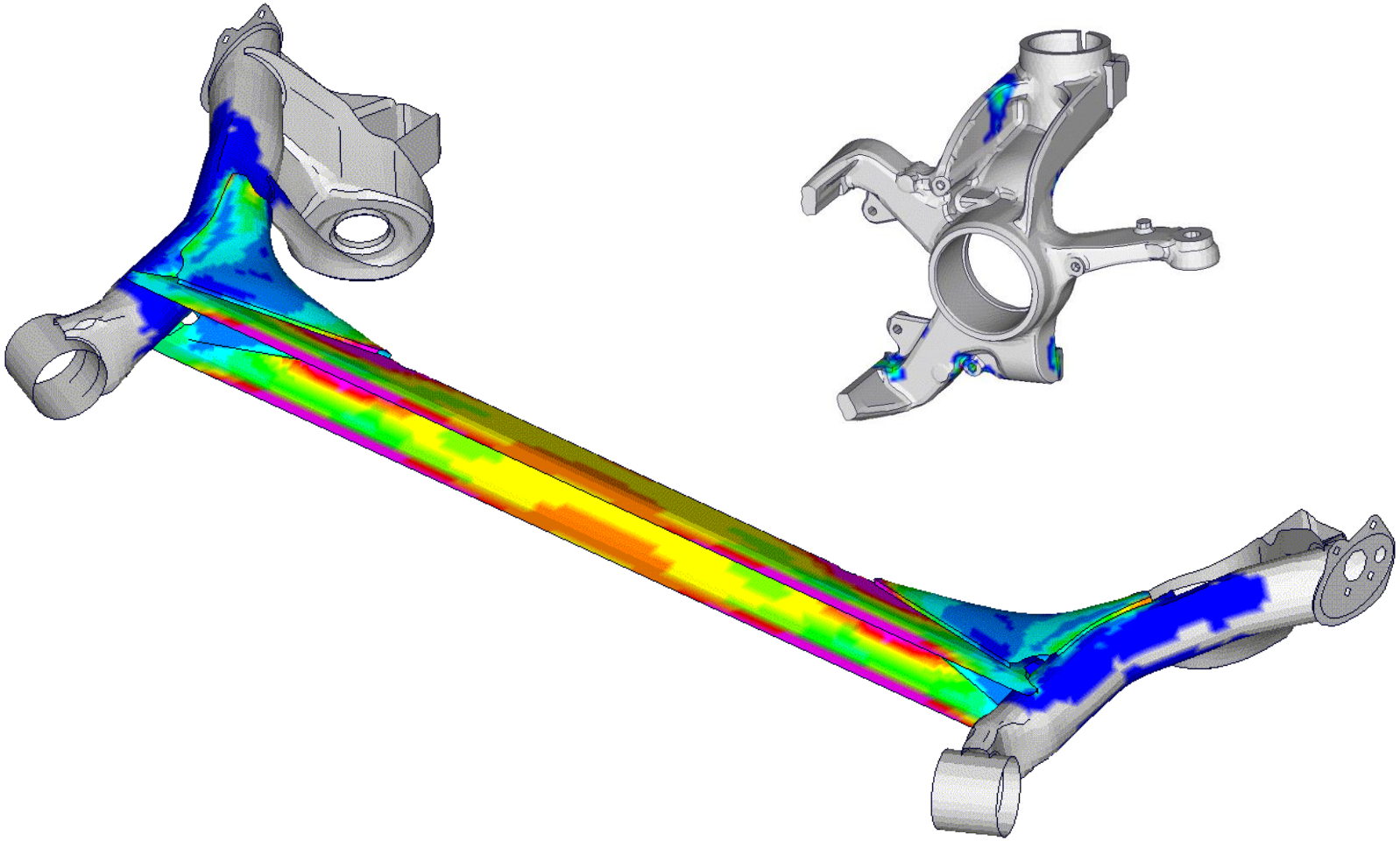

Slot 0 State 1.00 Slot 1 State 1.00
Slot 0 Time 70 Slot 1 Time 70



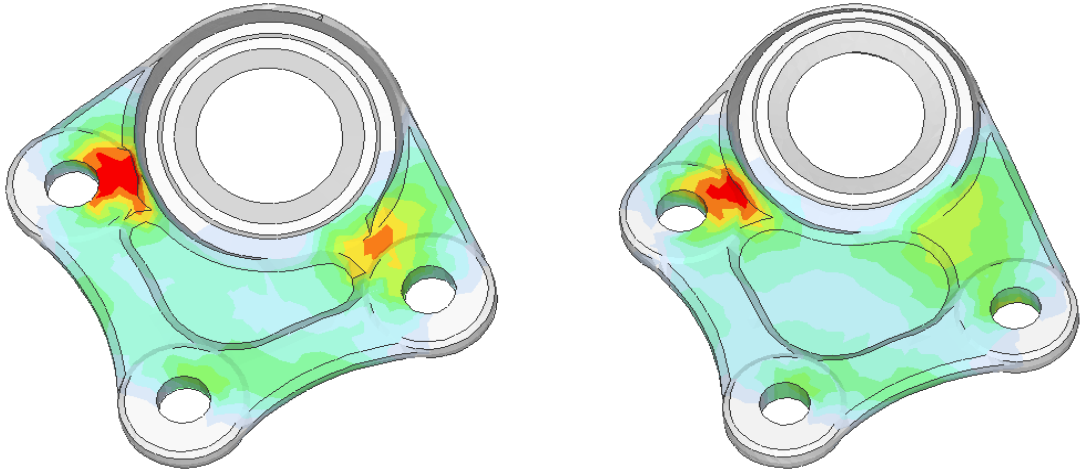
Custo de Reparo Traseiro

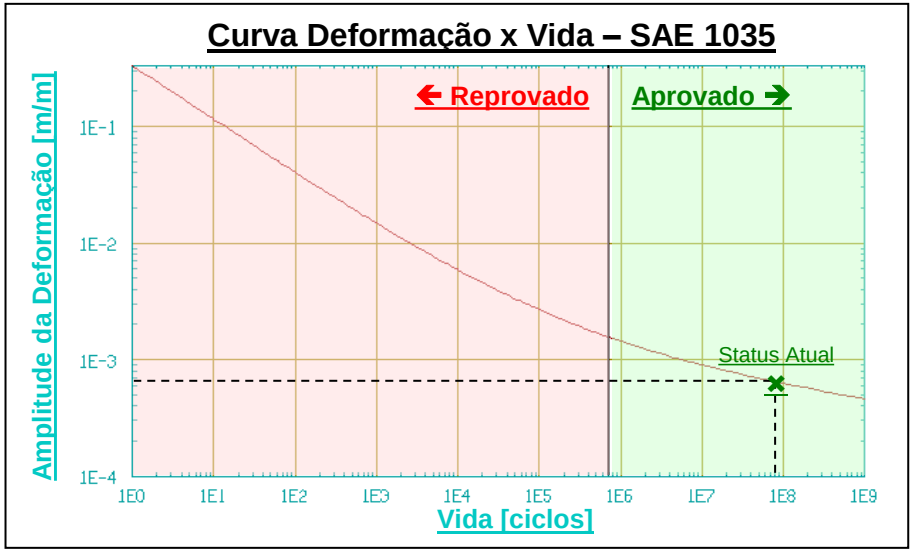


Outros exemplos de desenvolvimentos de componentes com auxílio de CAE

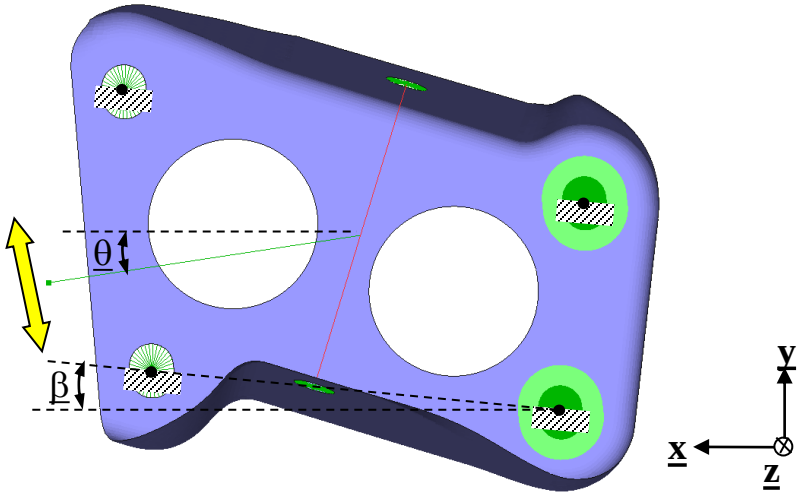


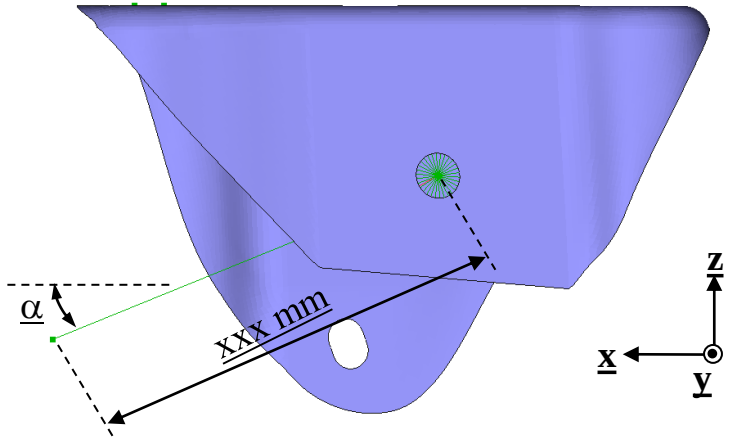
Outros exemplos de desenvolvimentos de componentes com auxílio de CAE

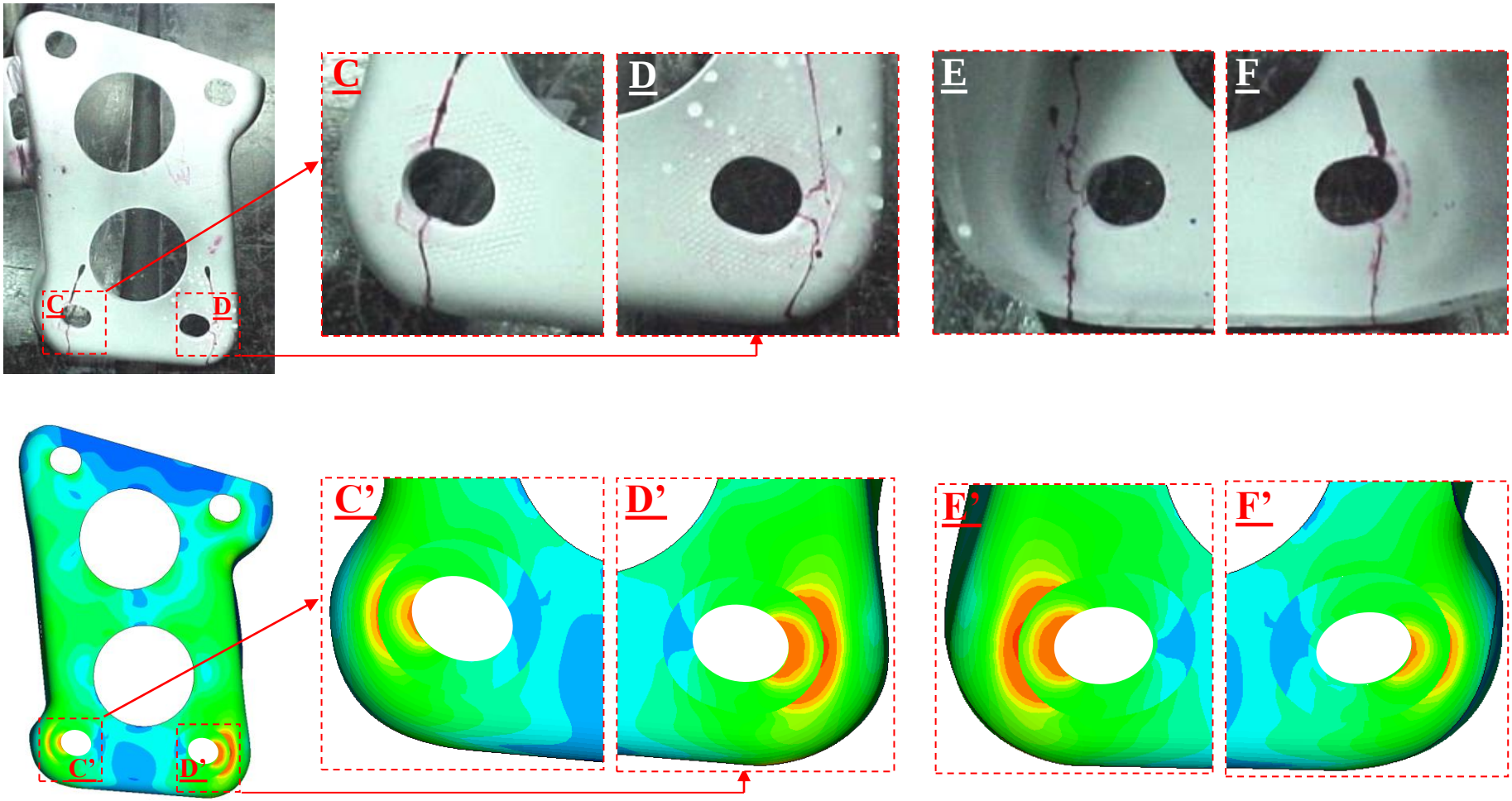




Outros exemplos de desenvolvimentos de componentes com auxílio de CAE






C
D
C
D
E
F
C'
D'
C'
D'
E'
F'