ES6 Carbon Fibre Floor

CAE led development process

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UK ATC 2019

Agenda

0

Introduction

NIO production vehicles
ES6 body structure
Carbon fibre floor

1

Simulation inputs

Coupon tests
Material card generation
Validation

2

Design optimisation

Layup optimisation
Conclusion


NIO EP9


355
NEDC Range
4.4
0-100 km/h
650
Maximum Horse Power
NIO es8
es8

NIO ES6

510

NEDC Range

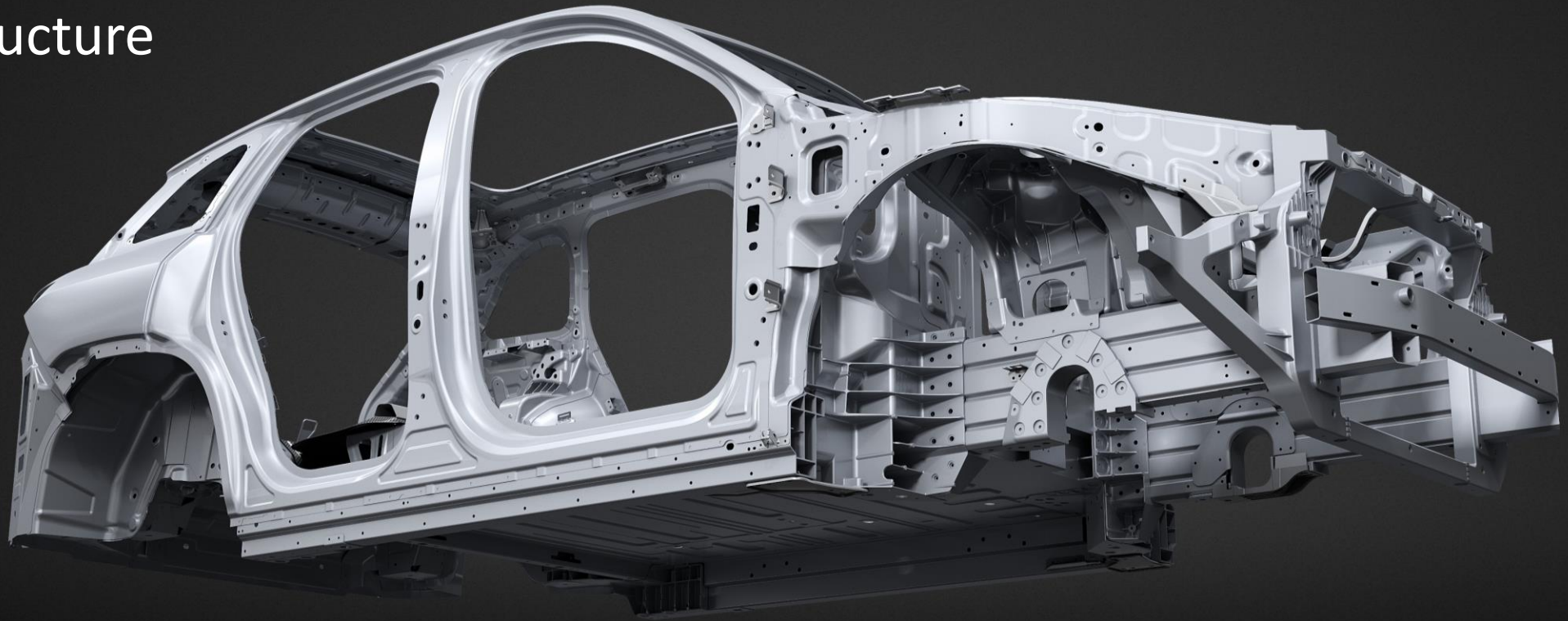
4.7

0-100 km/h

544

Maximum Horse Power

Aluminium intensive body structure

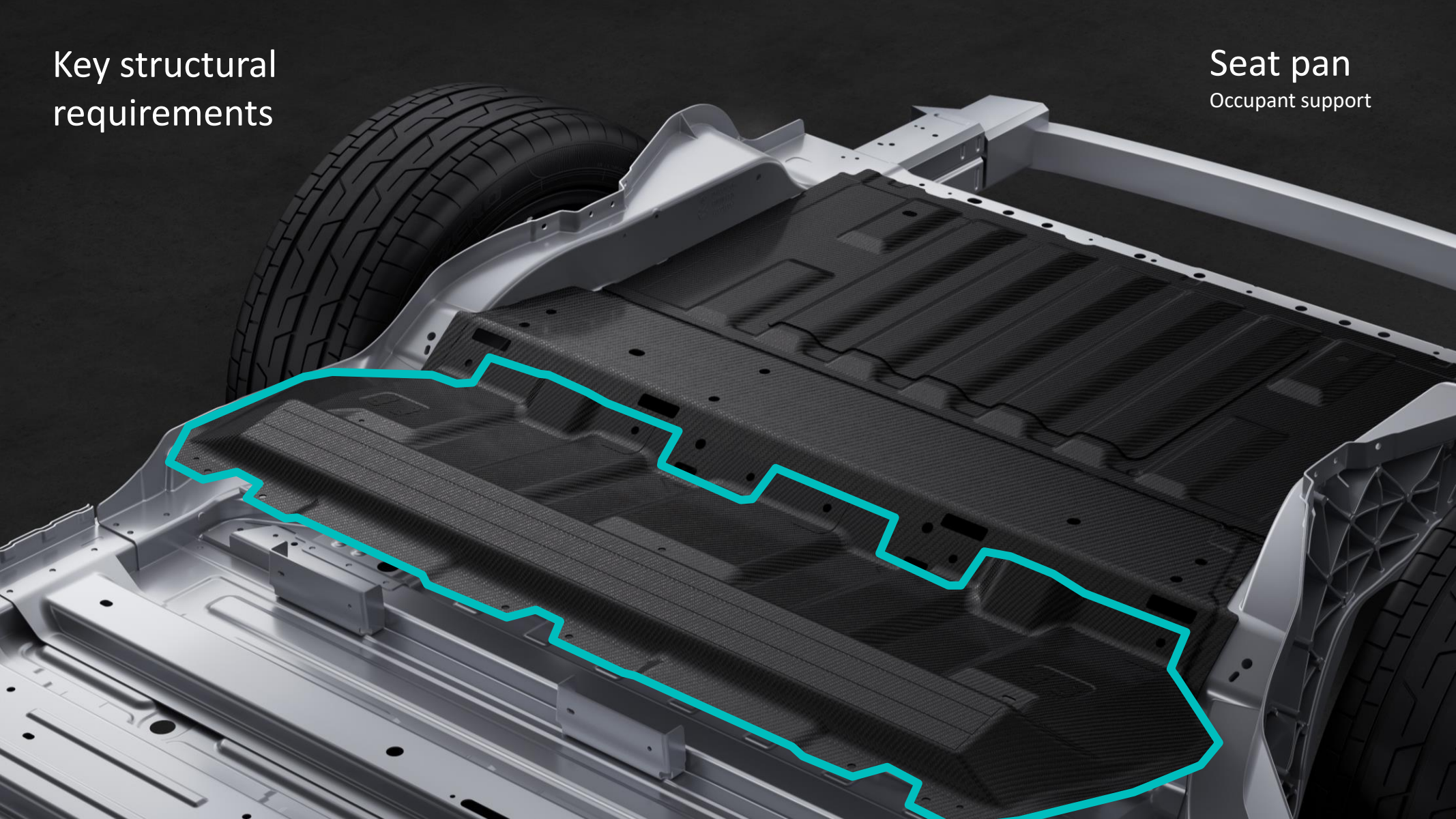


ES6 Carbon fibre floor

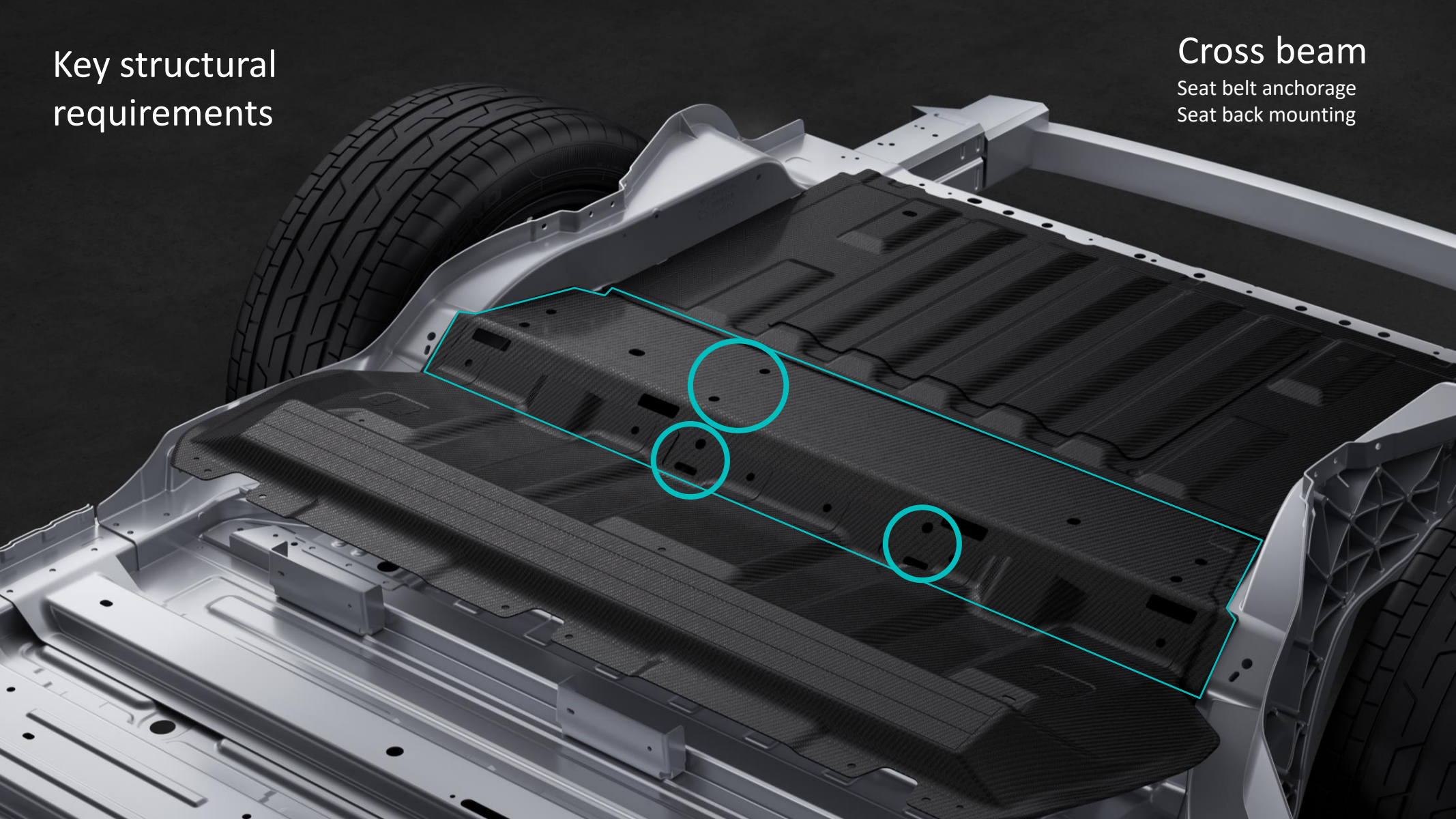
Key structural requirements

Seat pan

Occupant support



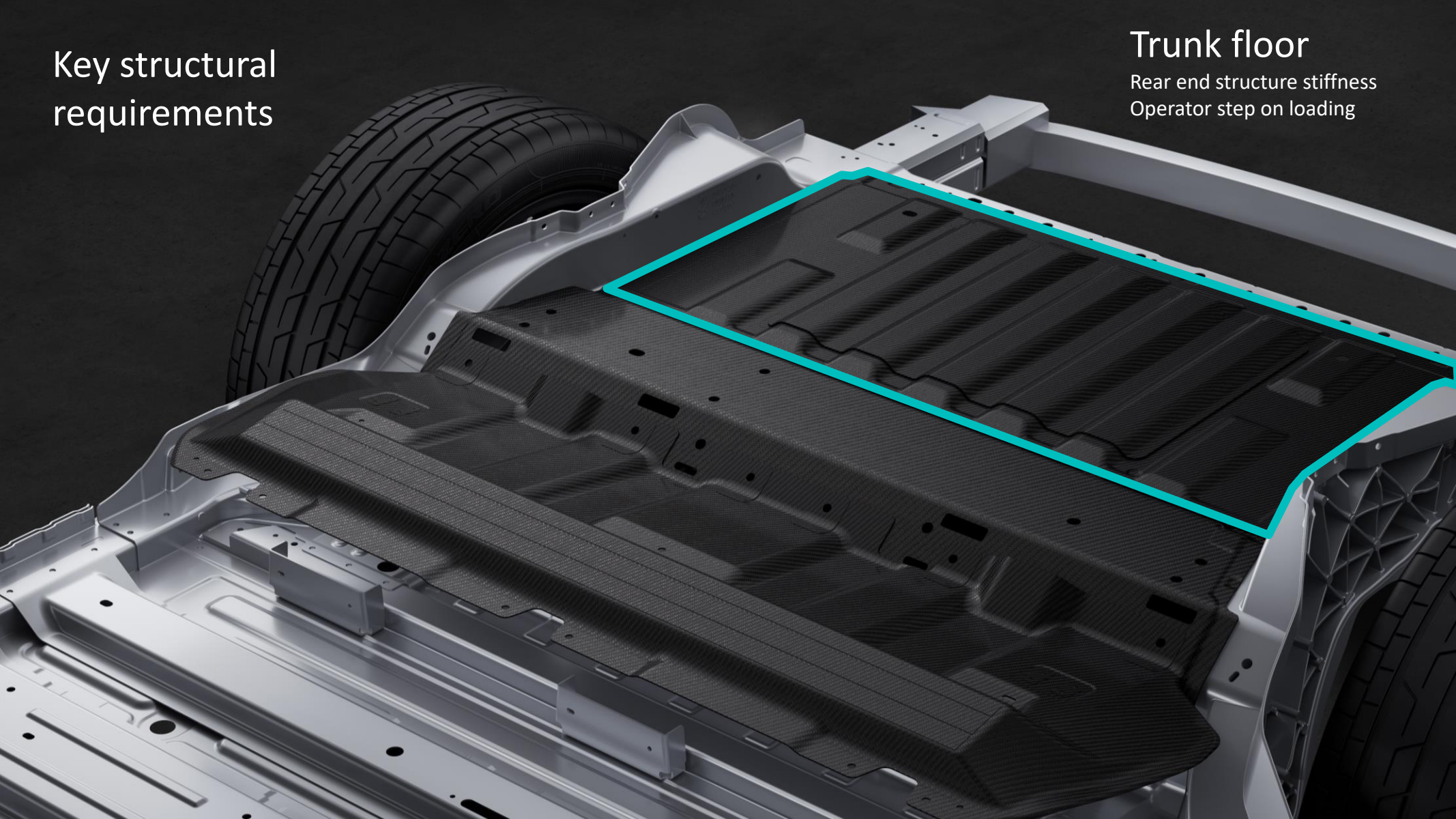
Key structural requirements



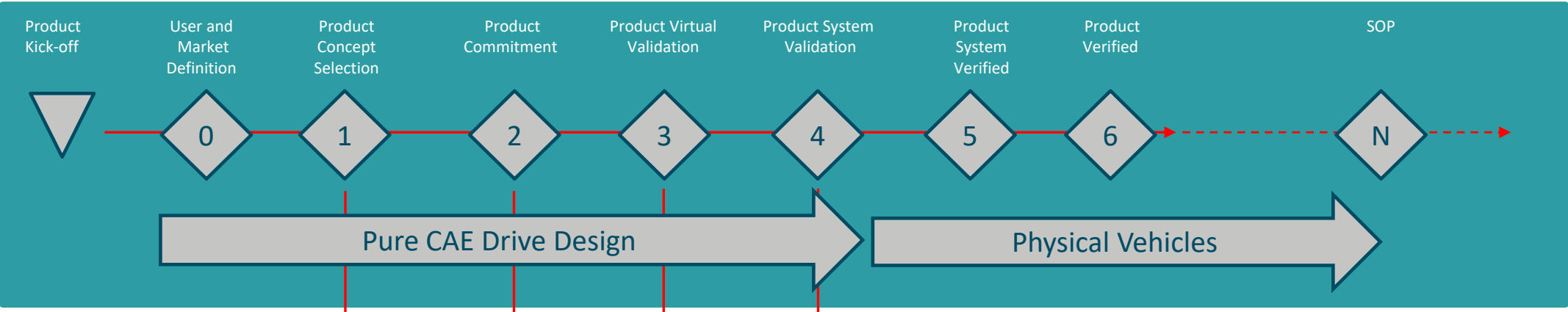
Key structural requirements

Trunk floor

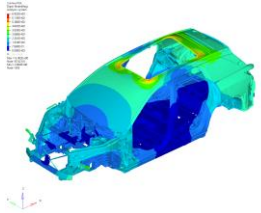
Rear end structure stiffness
Operator step on loading



NIO Vehicle Development Process



VPT1 VPT2 VPT3 VPT4



Virtual Prototype Gateways

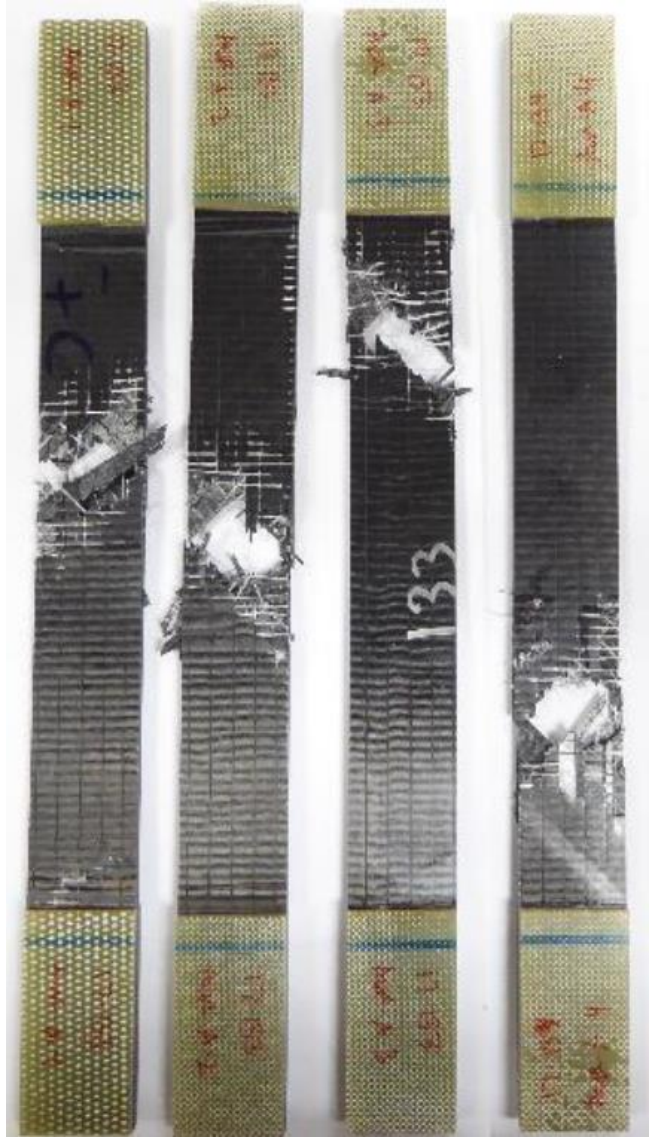
NIO

Material card generation

	Tension	Compression
0°	ASTM D3039	ASTM D3039
90°	ASTM D6641	ASTM D6641
+45°/-45°	ASTM D3518	ASTM D6641

Step one

Build material card using base ply level mechanical properties



NIO

Material card generation

	Tension	Compression
0°	ASTM D3039	ASTM D3039
90°	ASTM D6641	ASTM D6641
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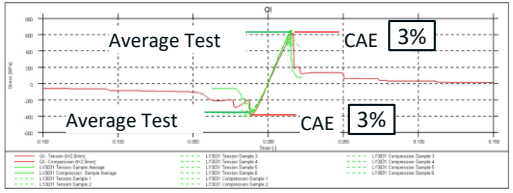
Step one

Build material card using base ply level mechanical properties

Quasi Isotropic	ASTM D3039	ASTM D6641

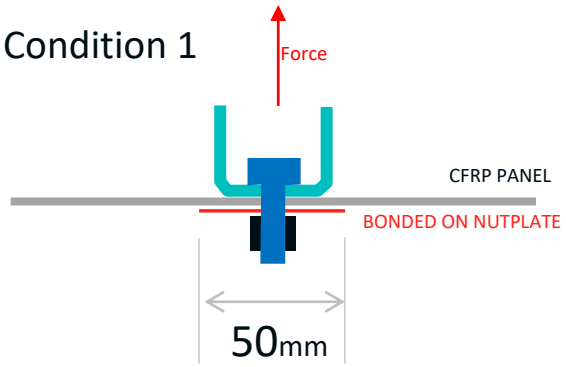
Step two

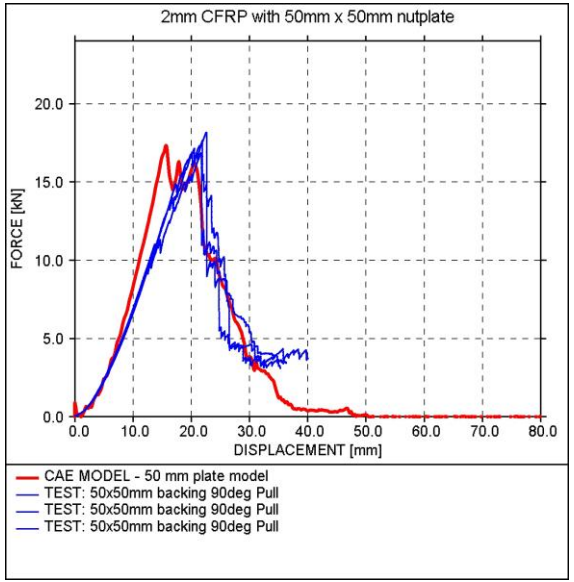
Validate ply level material card against QI laminate coupon test results

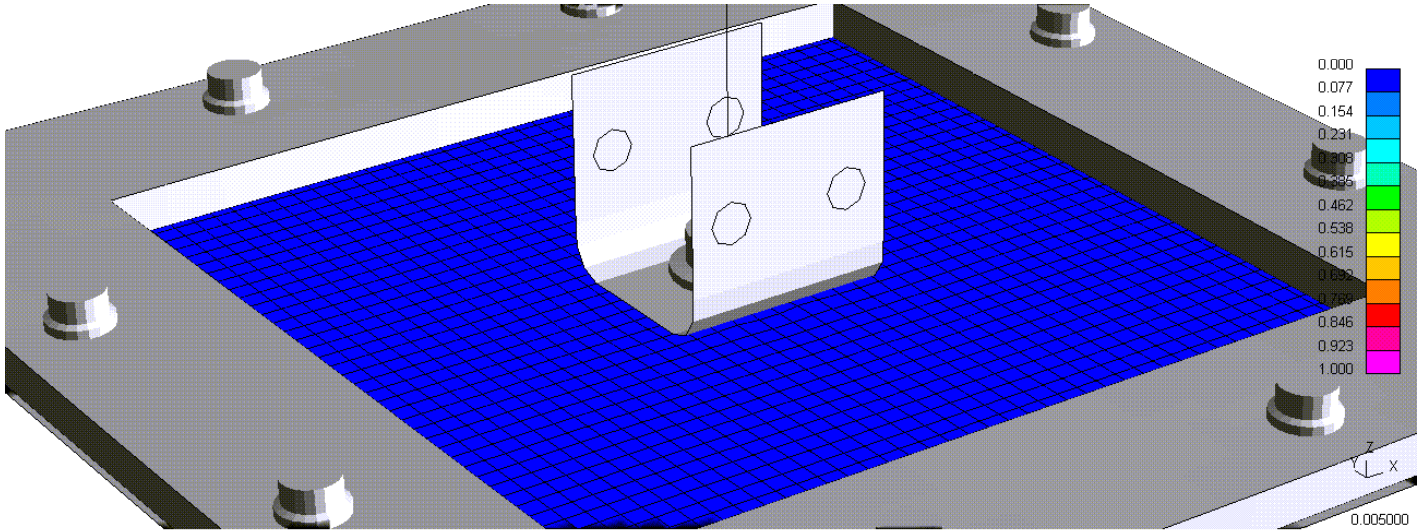


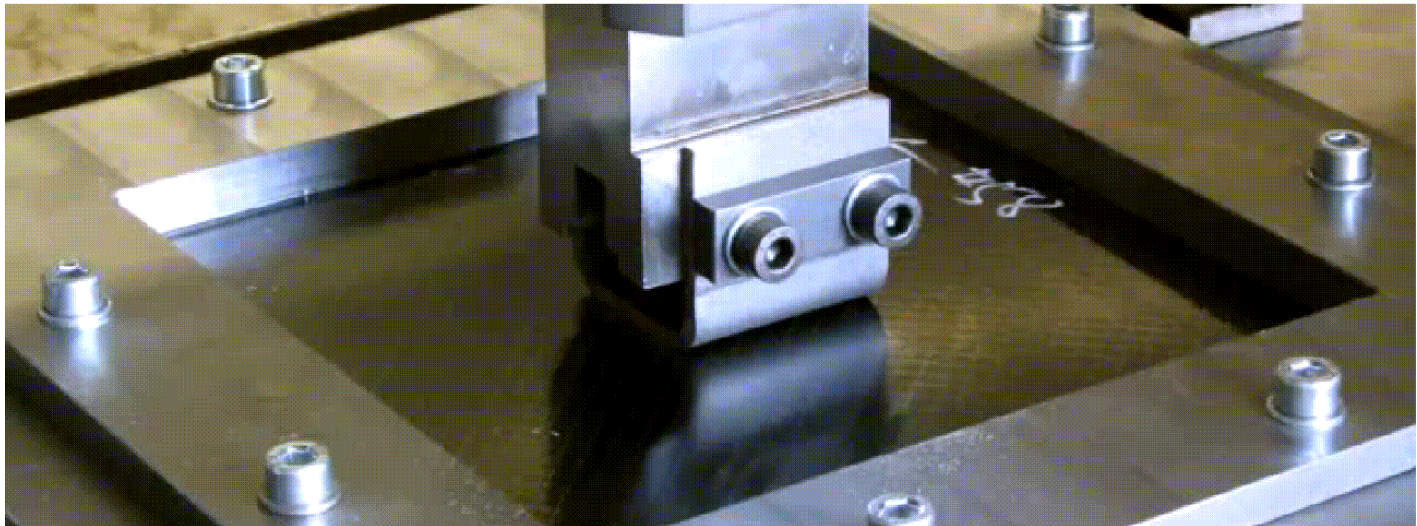
NIO

Material card validation - Bolted joint pull out test









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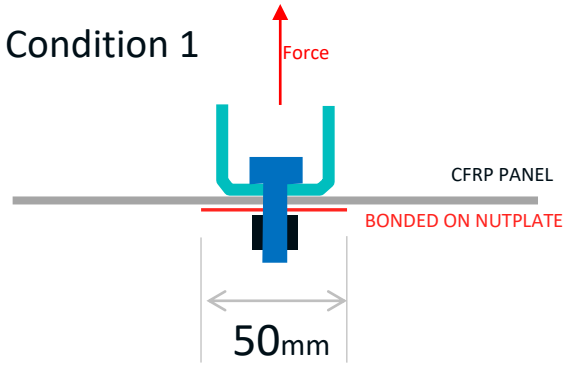

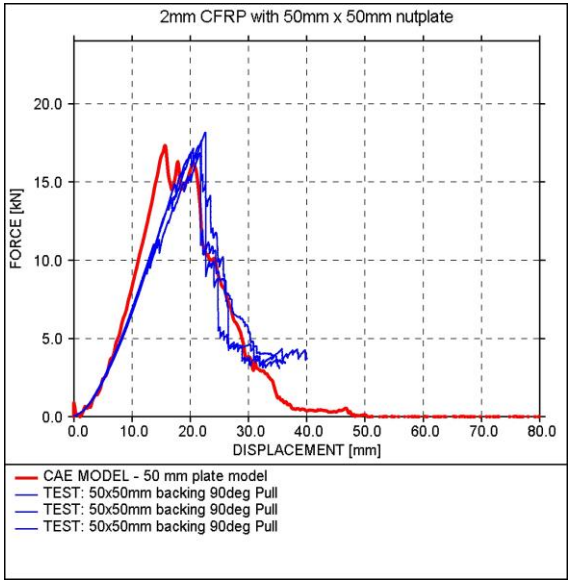

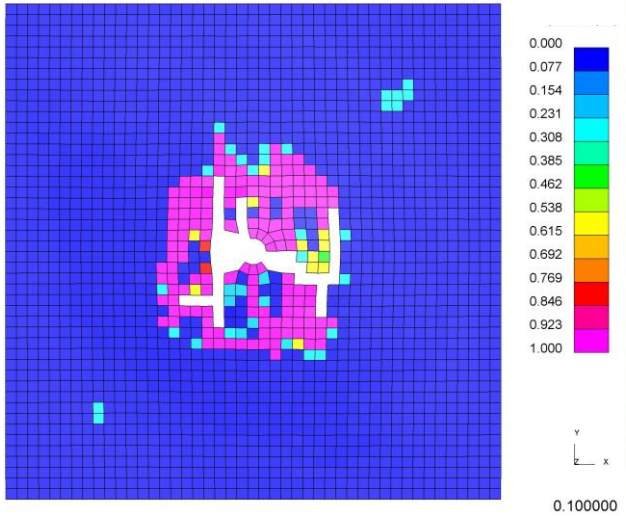

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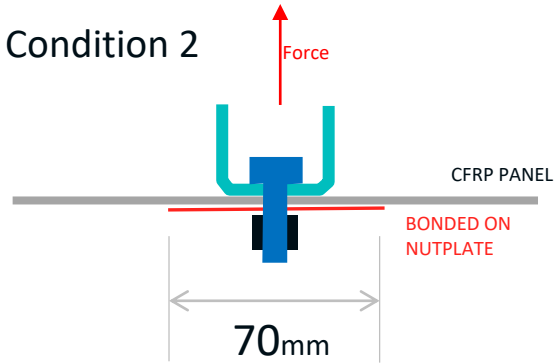

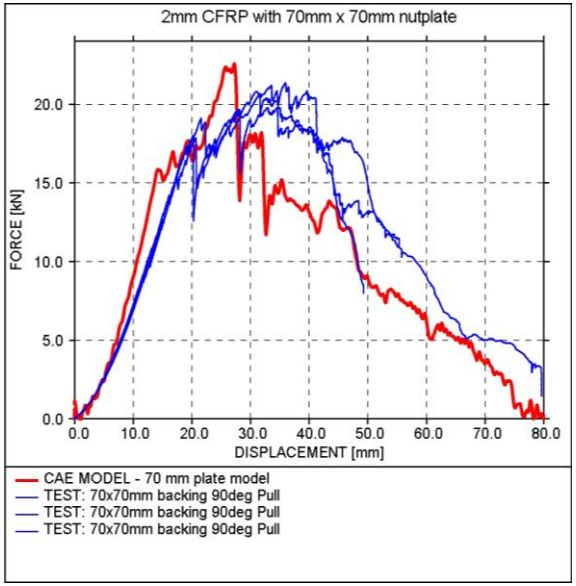

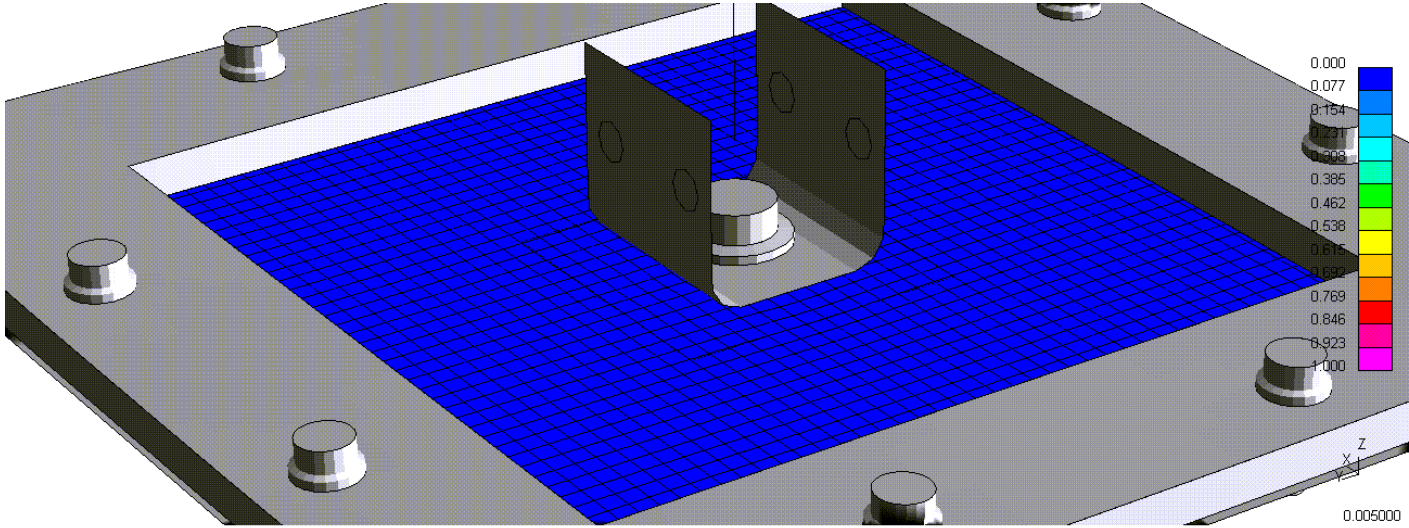

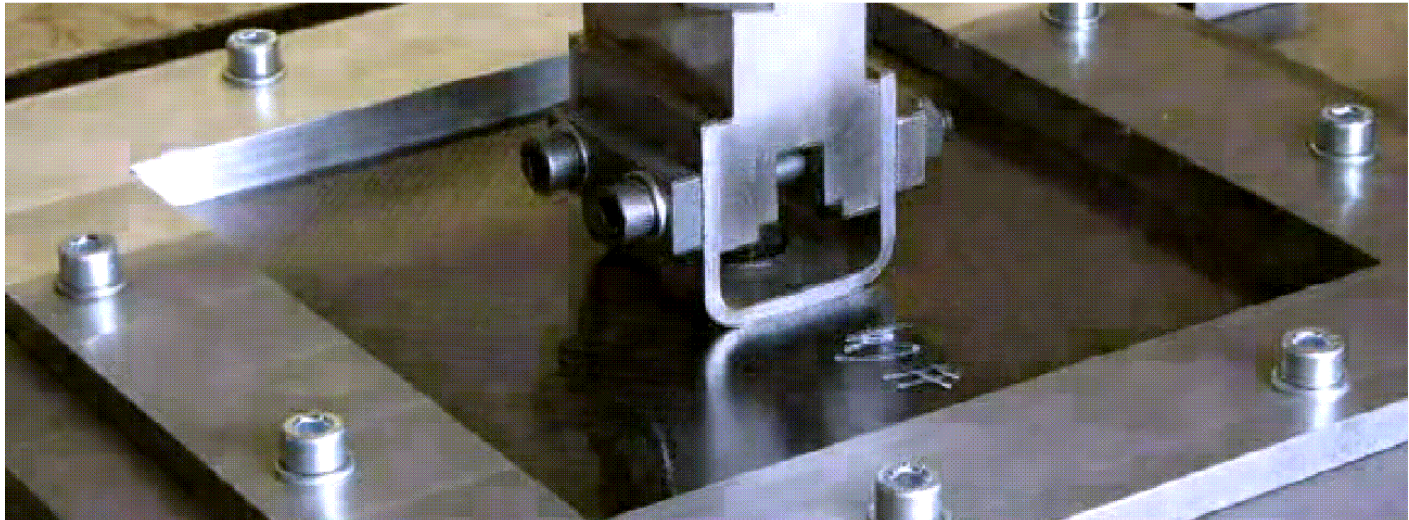

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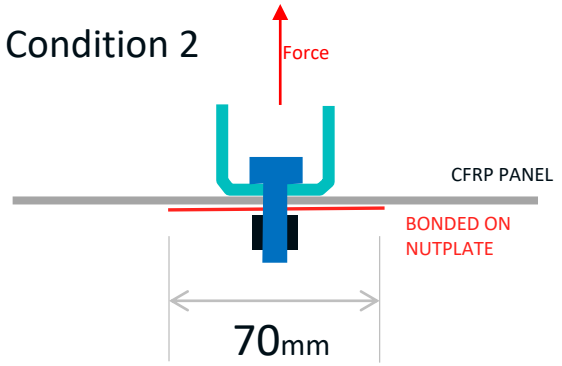
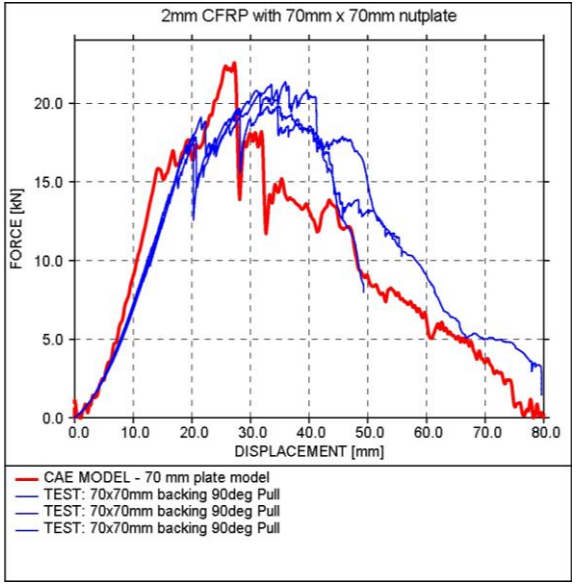
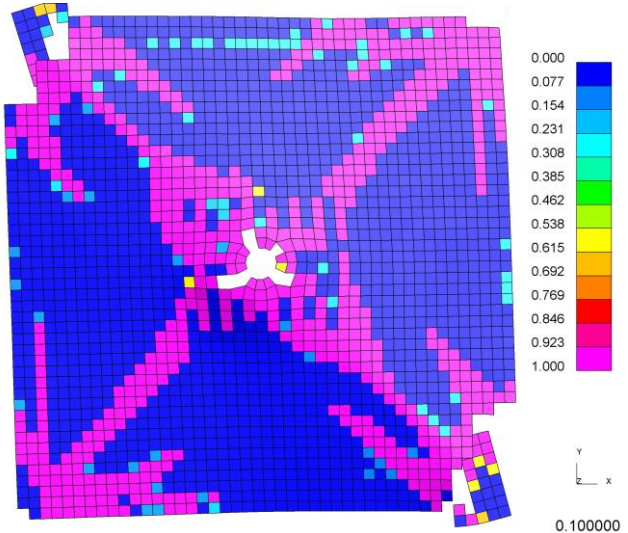


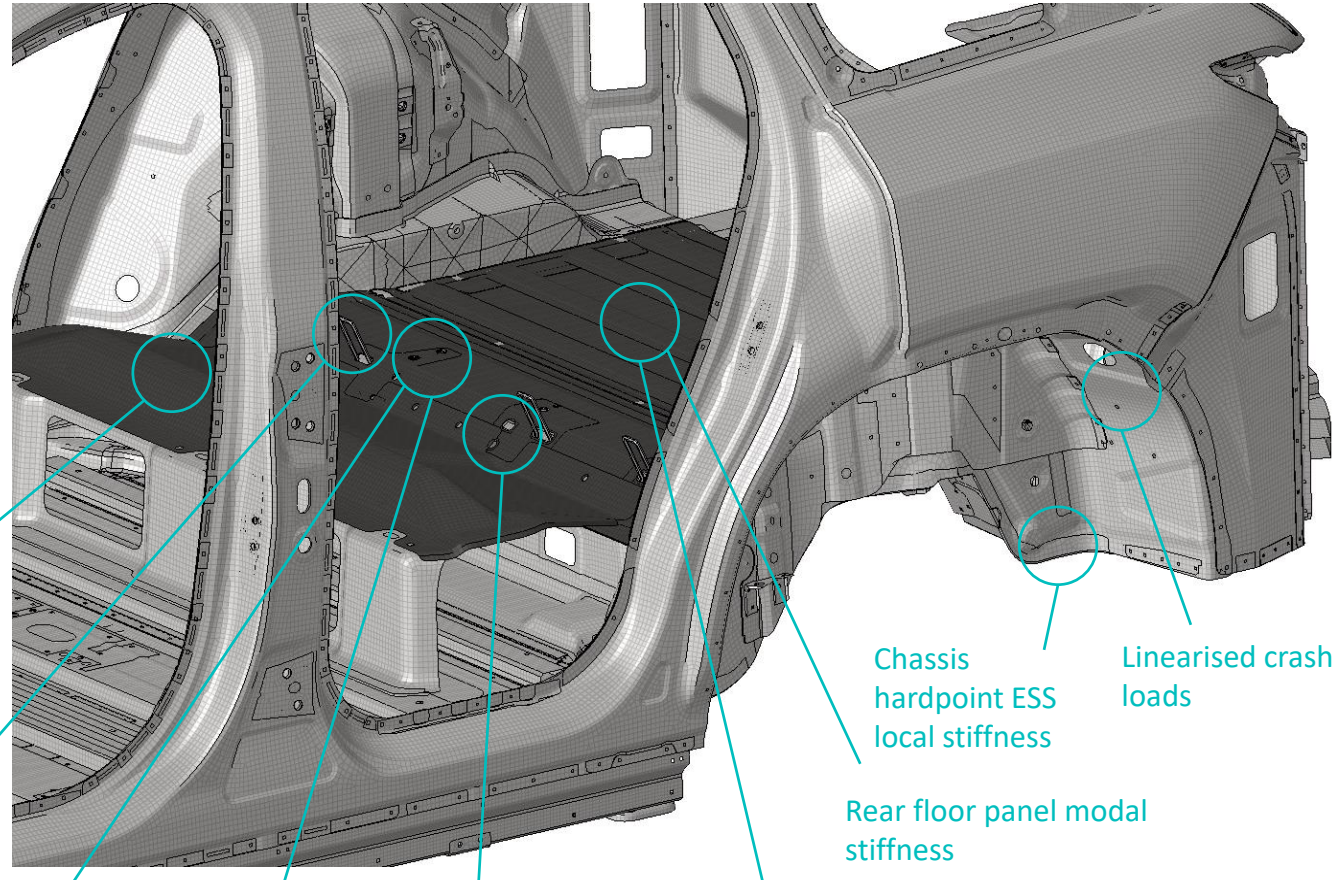




CAE led design optimisation

Step one

Combine all structural loadcases into single Optistuct model



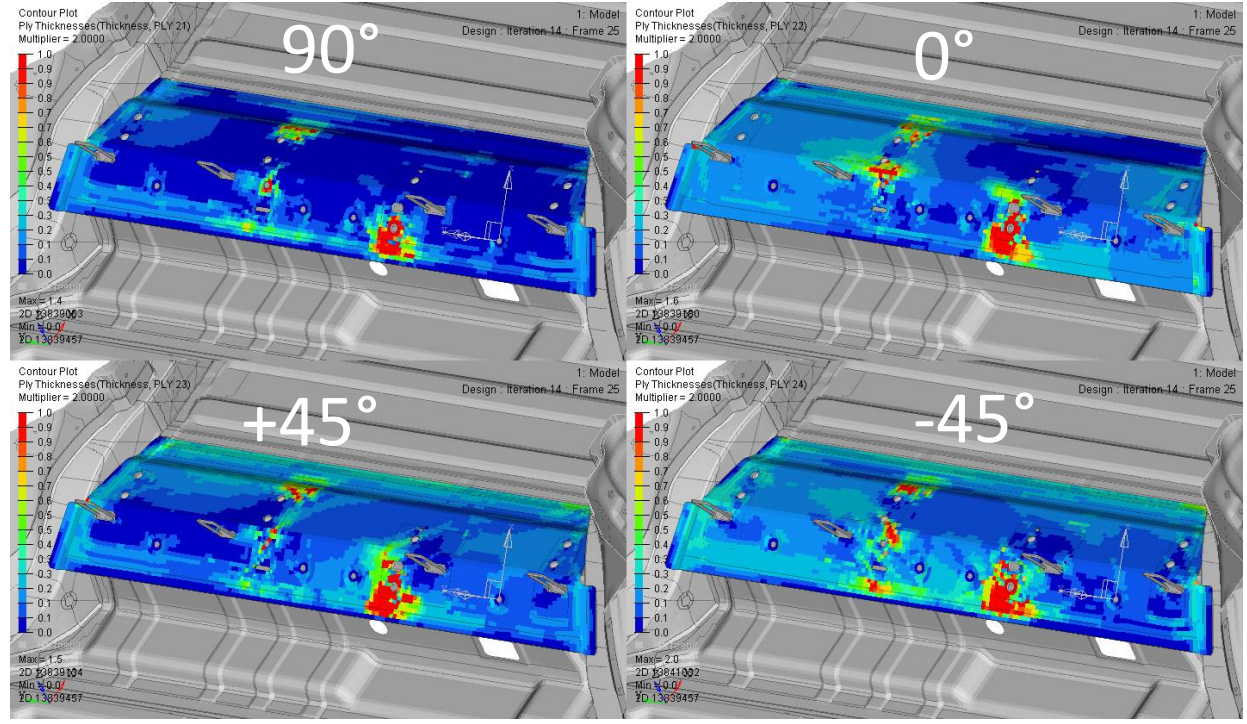
CAE led design optimisation

Step one

Combine all structural loadcases into single Optistuct model

Step two

Element level optimisation of fibre orientation



Find local requirements for fibre quantities.

Highlight hotspots / weaknesses in the design.

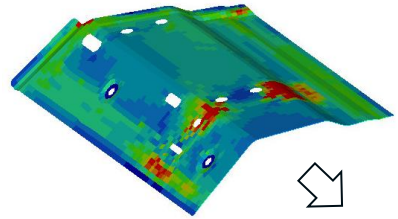
CAE led design optimisation

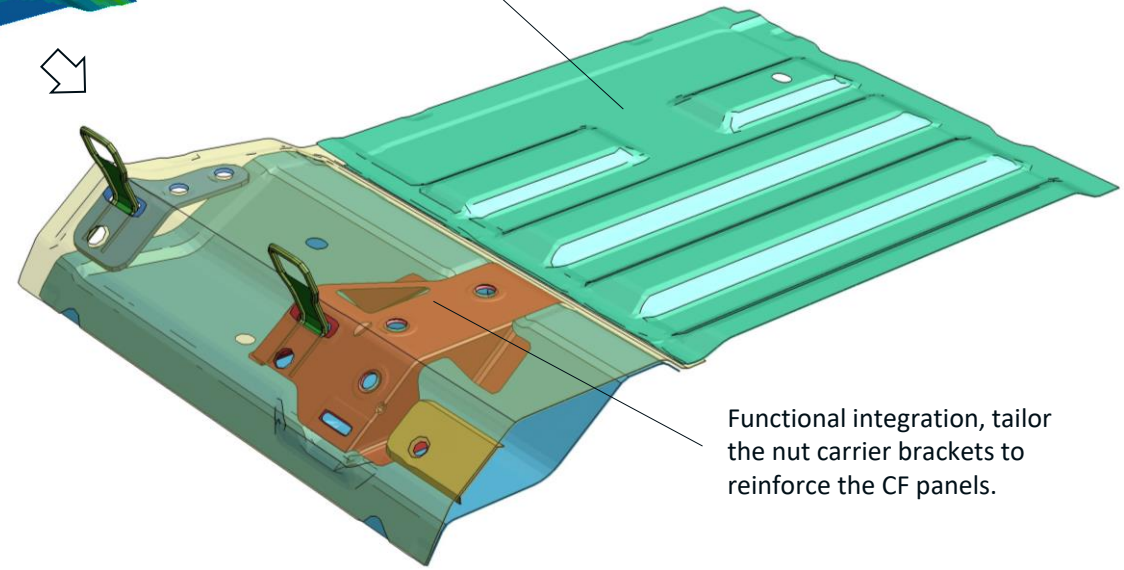
Step one

Combine all structural loadcases into single Optistuct model

Step two

Element level optimisation of fibre orientation





Use the element level results to improve the topology in order to obtain a more uniform layup.

Simplify, not complicate.

CAE led design optimisation

Step one

Combine all structural loadcases into single Optistuct model

Step two

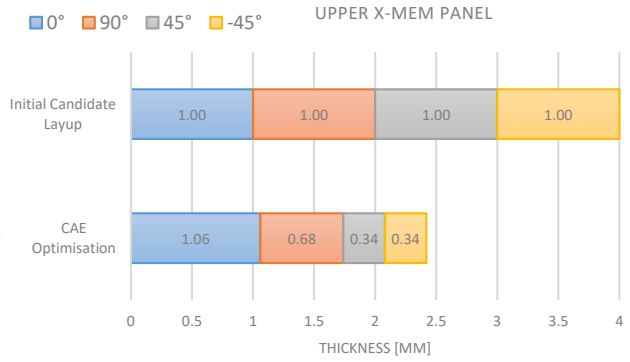
Element level optimisation of fibre orientation

Step three

Ply level optimisation of fibre orientation

Determine the quantity of fibre required for each ply and the optimum stacking sequence

- Discrete ply thicknesses
- Balanced +45° and - 45°



Part layup

Ply	Fabric	Thickness	Angle
1	300gsm	0.34	0
2	300gsm	0.34	90
3	150gsm	0.19	0
4	150gsm	0.19	45
5	300gsm	0.34	-45
6	150gsm	0.19	45
7	150gsm	0.19	0
8	300gsm	0.34	90
9	300gsm	0.34	0

CAE led design optimisation

Step one

Combine all structural loadcases into single Optistuct model

Step two

Element level optimisation of fibre orientation

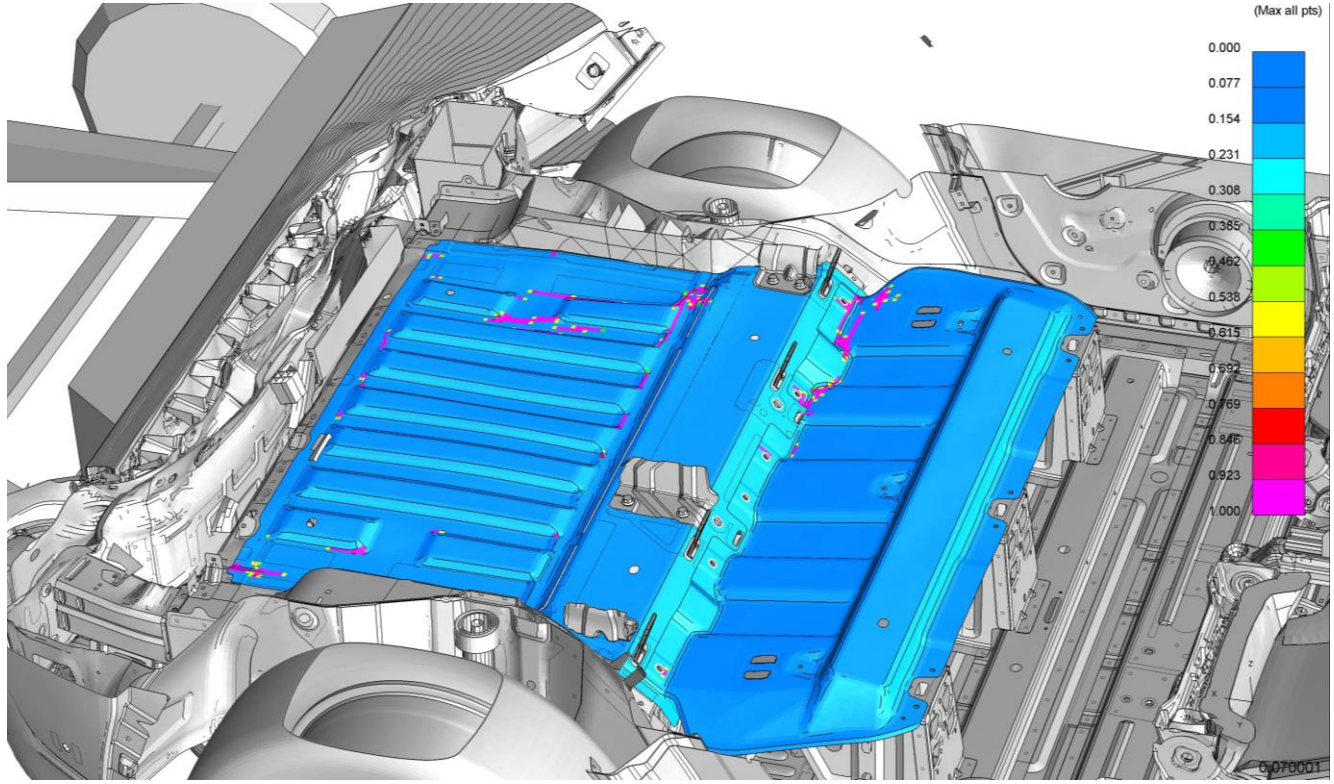
Step three

Ply level optimisation of fibre orientation

Step four

Non linear validation of each loadcase

If necessary, update loads or boundary conditions of linear model and re-optimise



Conclusion

NIO

Acknowledgements

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Thank you