Development of a Biofidel-Dummy Finite Element Model

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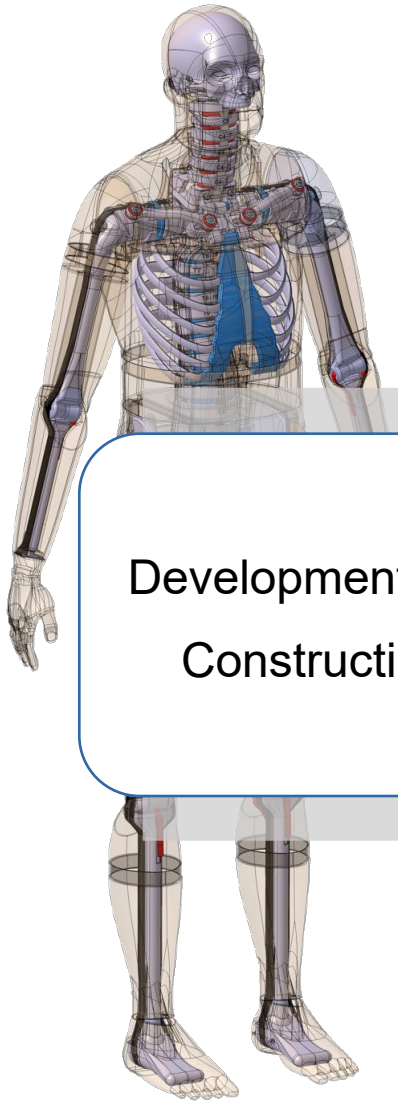
Overview

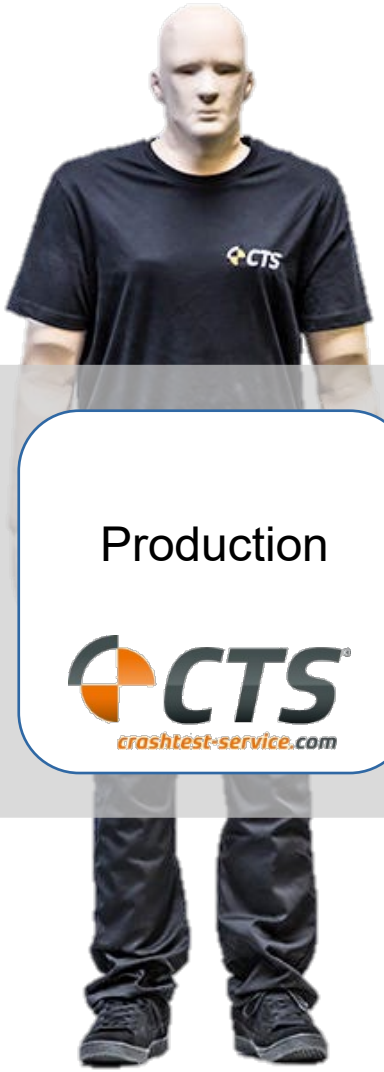
Introduction - Biofidelic-Dummy (PRIMUS breakable)

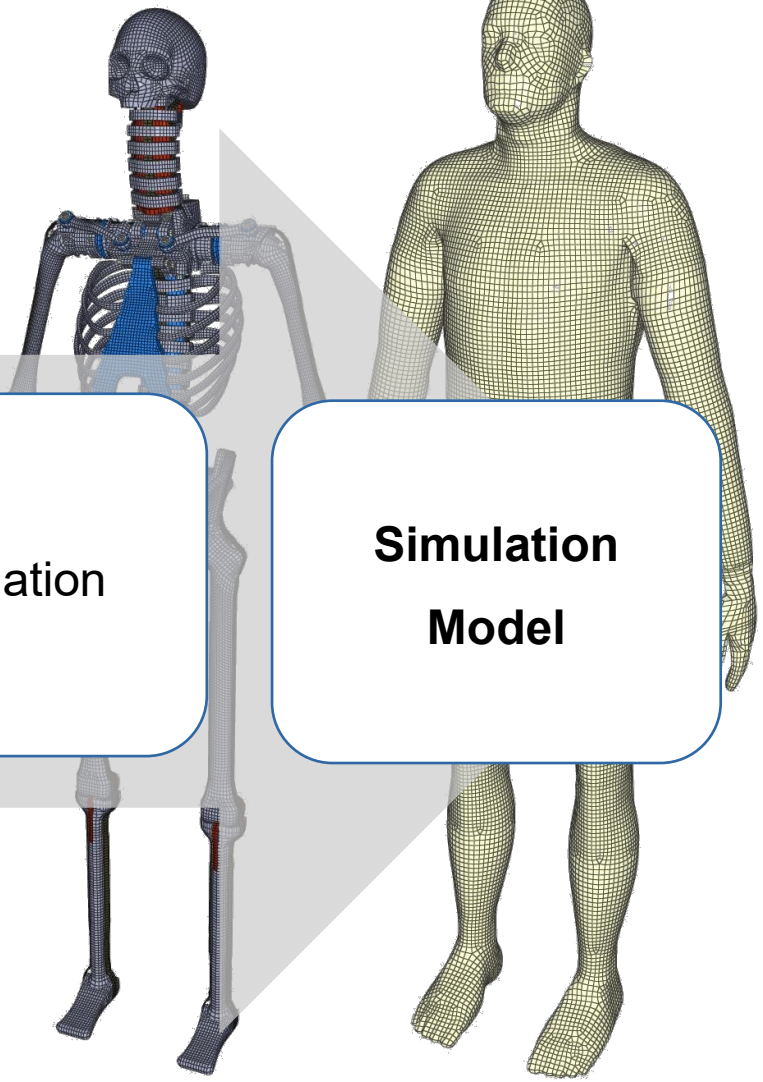
- Bone components
- Ligaments and tendons
- Soft tissue
- Anthropomorphic geometry
- Real range of motion
- Age, weight, height and mass distribution 50-percentile
- Inertial measuring unit in head, pelvis and thorax
- Correlation between **dummy damage** and **human injury**

Source: Crashtest-Service

Introduction - Development progress







Development and Construction

Production

CTS crashtest-service.com

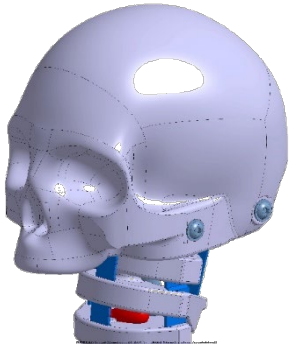
Technical Evaluation

CTS crashtest-service.com

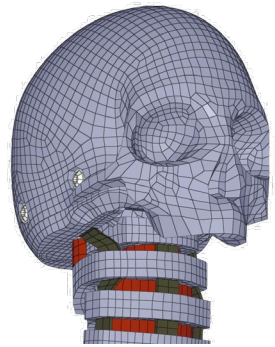
Validation

Simulation Model

From the Hardware Dummy to a CAE Model

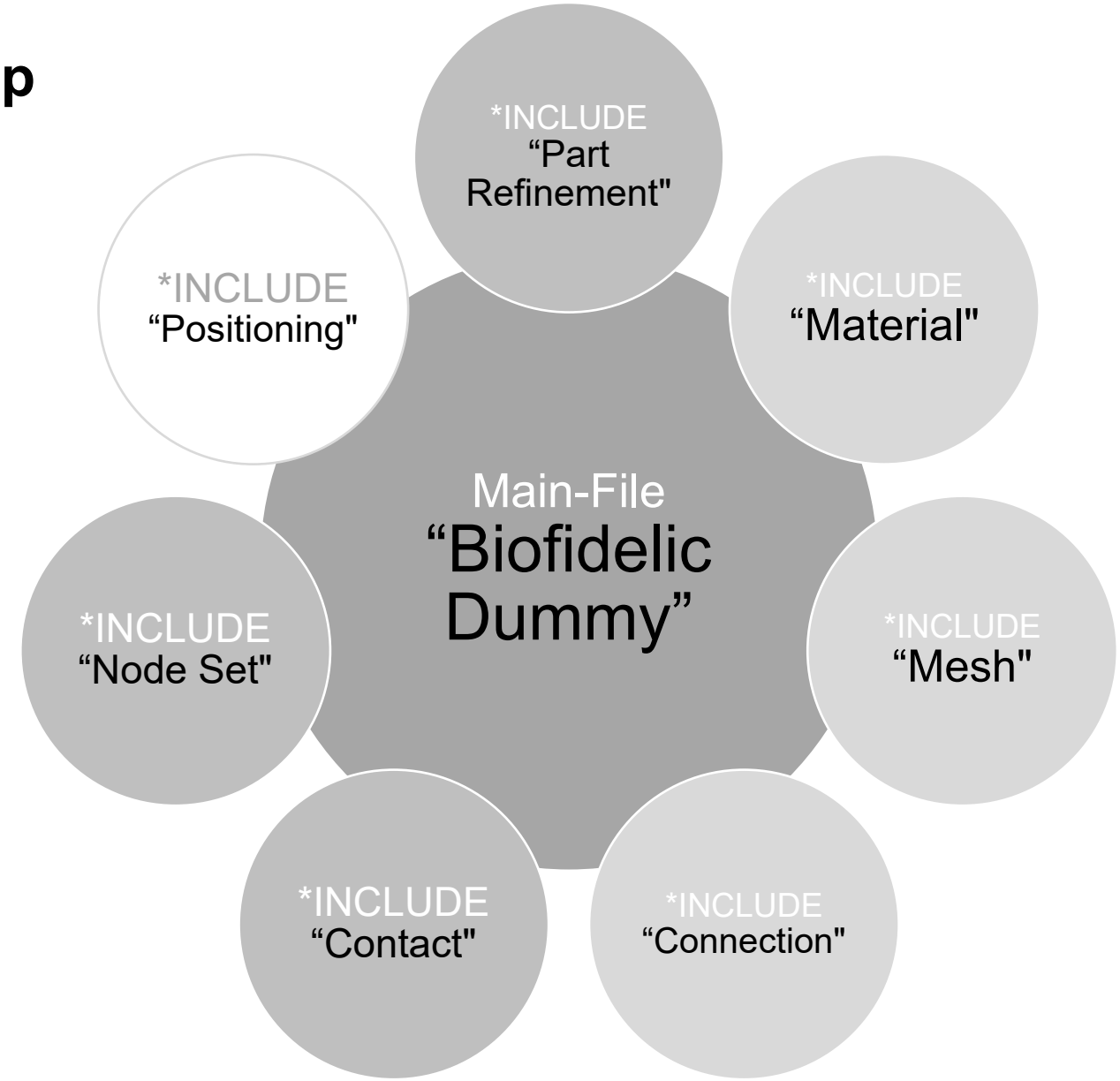


Catia → Ansa → Impetus



- Creation of the CAD geometry
- Pre-Processing
- Meshing
- CAE-Model Setup
- Solving
- Post-Processing

Model Setup


*INCLUDE
“Part Refinement"
*INCLUDE
“Positioning"
*INCLUDE
“Material"
Main-File
“Biofidelic Dummy”
*INCLUDE
“Node Set"
*INCLUDE
“Mesh"
*INCLUDE
“Contact"
*INCLUDE
“Connection"

Analysis of the Dummy Materials

*INCLUDE
“Material"

Materials

- Bone substitute material
- Skin substitute
- 6 Silicone compounds
- 3 Polypropylene
- Steel
- Epoxy resin

- 12 Material pairings

Material Tests

- Tensile test
- Continue tearing experiment
- Bending test
- Tilted plate
- Straight plate

Material Models

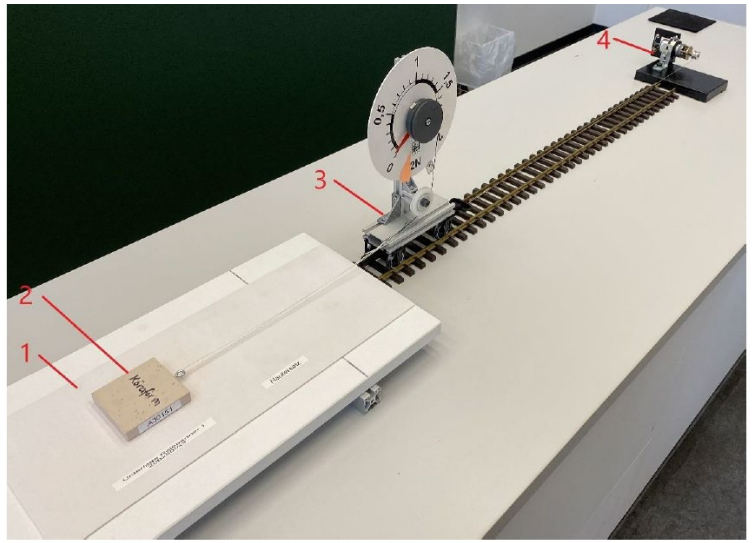
- Johnson-Cook-Material model
- Cockcroft-Latham-Damage model
- Initial pre-damage of the material (due to manufacturing)
- Fiber composite / fabric material model
- Integrated damage model
- Bergström-Boyce-Material model

Material Tests

*INCLUDE
“Material"

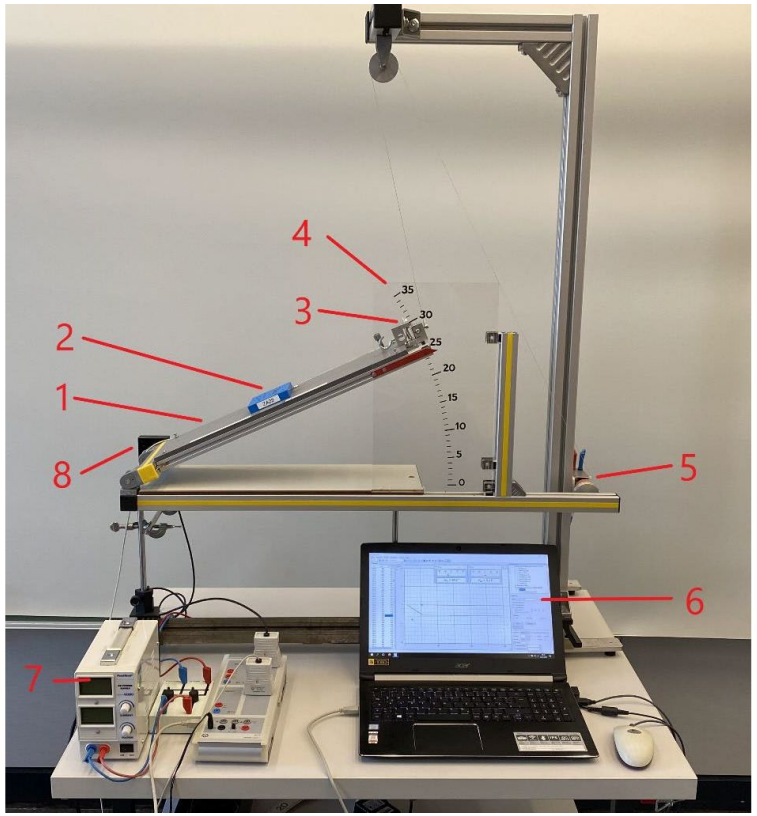
Friction value determination

Straight plate



1 Friction pad, 2 Friction block, 3 Wagon with force gauge, 4 Cable winch

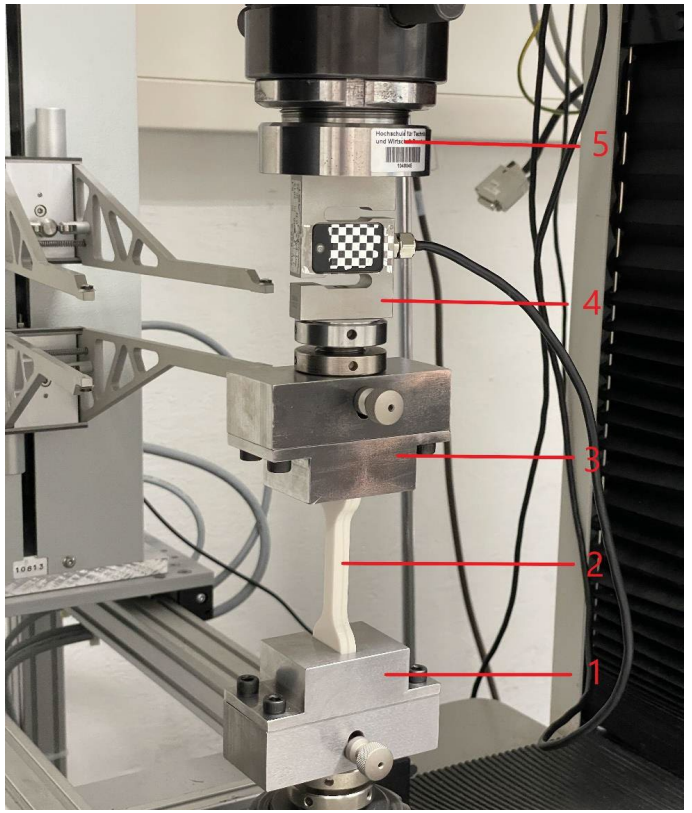
Tilted plate



1 Friction pad, 2 Friction block, 3 Force measuring element, 4 Analog angle display, 5 Cable winch with electric motor, 6 Measuring computer

Tensile test

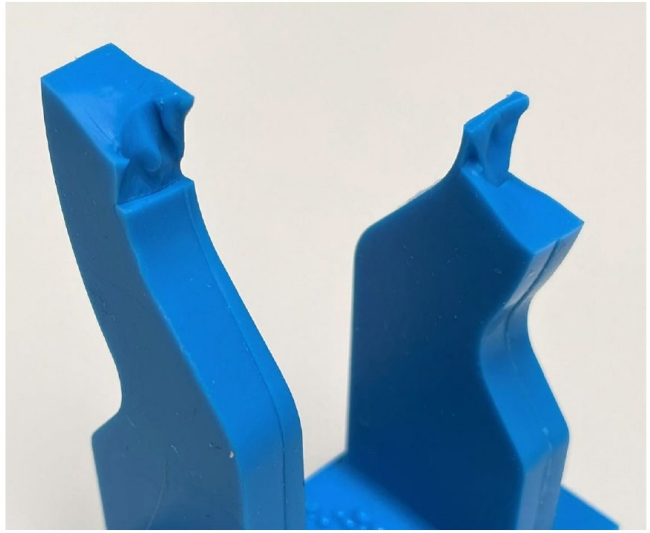
Continue tearing experiment

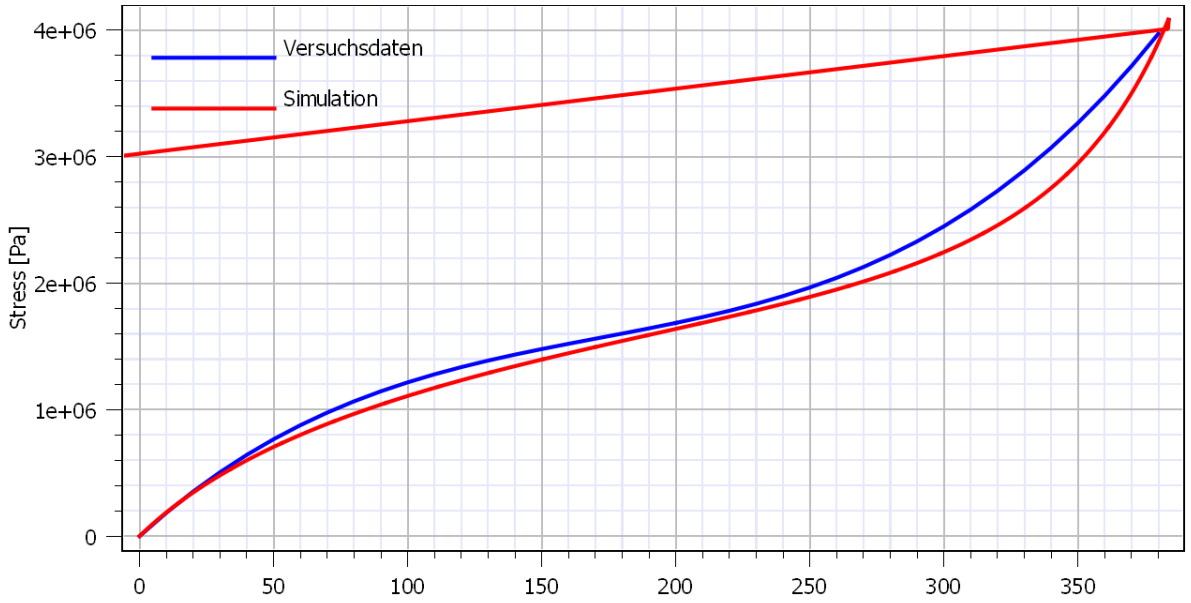


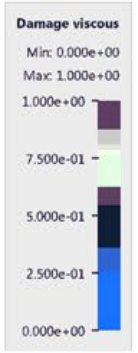
1 lower clamping device, 2 tensile test block , 3 upper clamping device, 4 force measuring element, 5 traverse

Stress-Strain Diagram Soft Tissue Replacement Material

*INCLUDE
“Material"



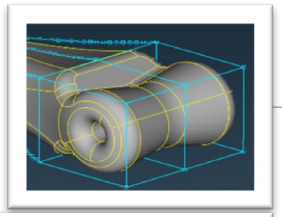




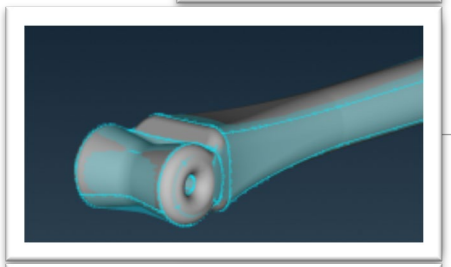
Source: EDAG

Mesh Generation Process

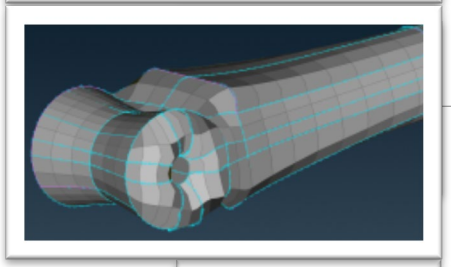
*INCLUDE
“Mesh"



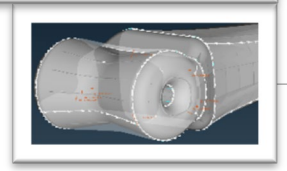
Hexa-Box-Creation



Attaching the Hexa-Boxes to the Geometry



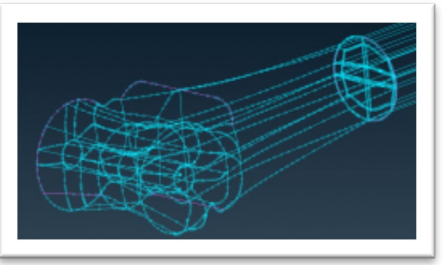
Creation Pure Hexa Mesh



Quality check of the boxes and the network with the help of the quality criteria and the implemented check tools

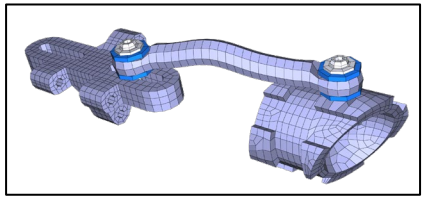
Mesh refinement (Smooth, Reconstruct, Fix Quality, ...)

Refinement of geometry replication, if necessary

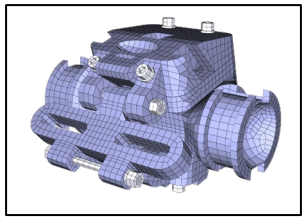


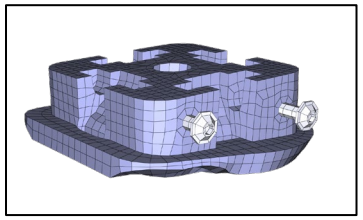
Connection Types

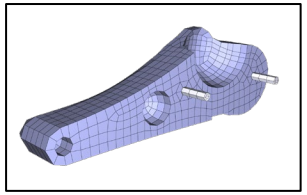
*INCLUDE “Con-nection"



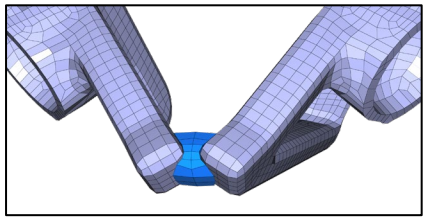
Screw Connections



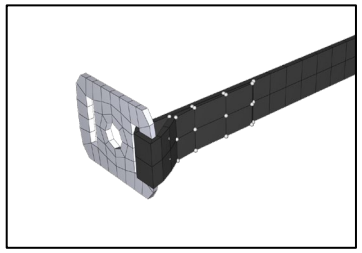




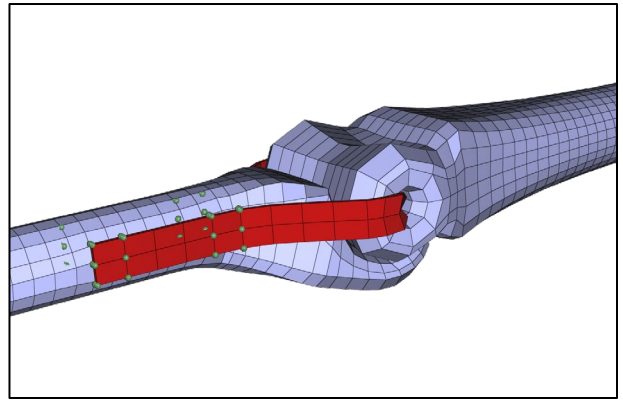
Clamp Connections



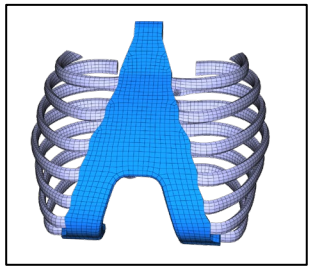
Adhesive Bonds Belt/Belt



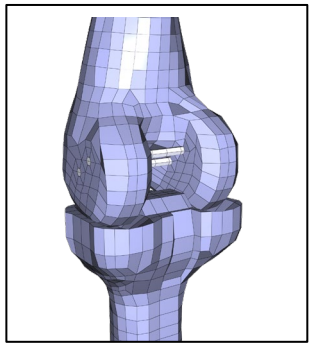
Adhesive Bonds Bone/Belt



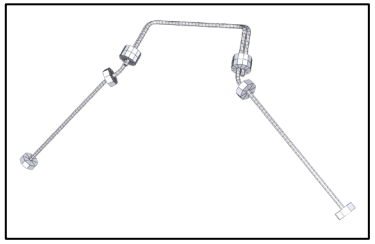
Glued plug connections



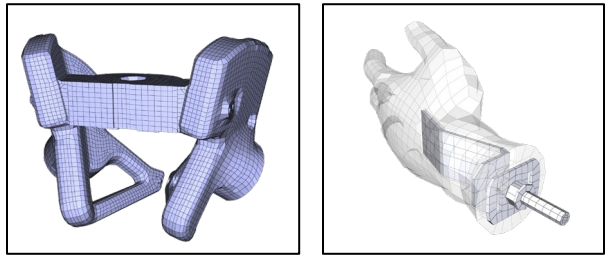
Pin connections



Rigid connection steel cable



Rigid Connections



Adhesive Bonds Bone/Belt

*INCLUDE
“Con-
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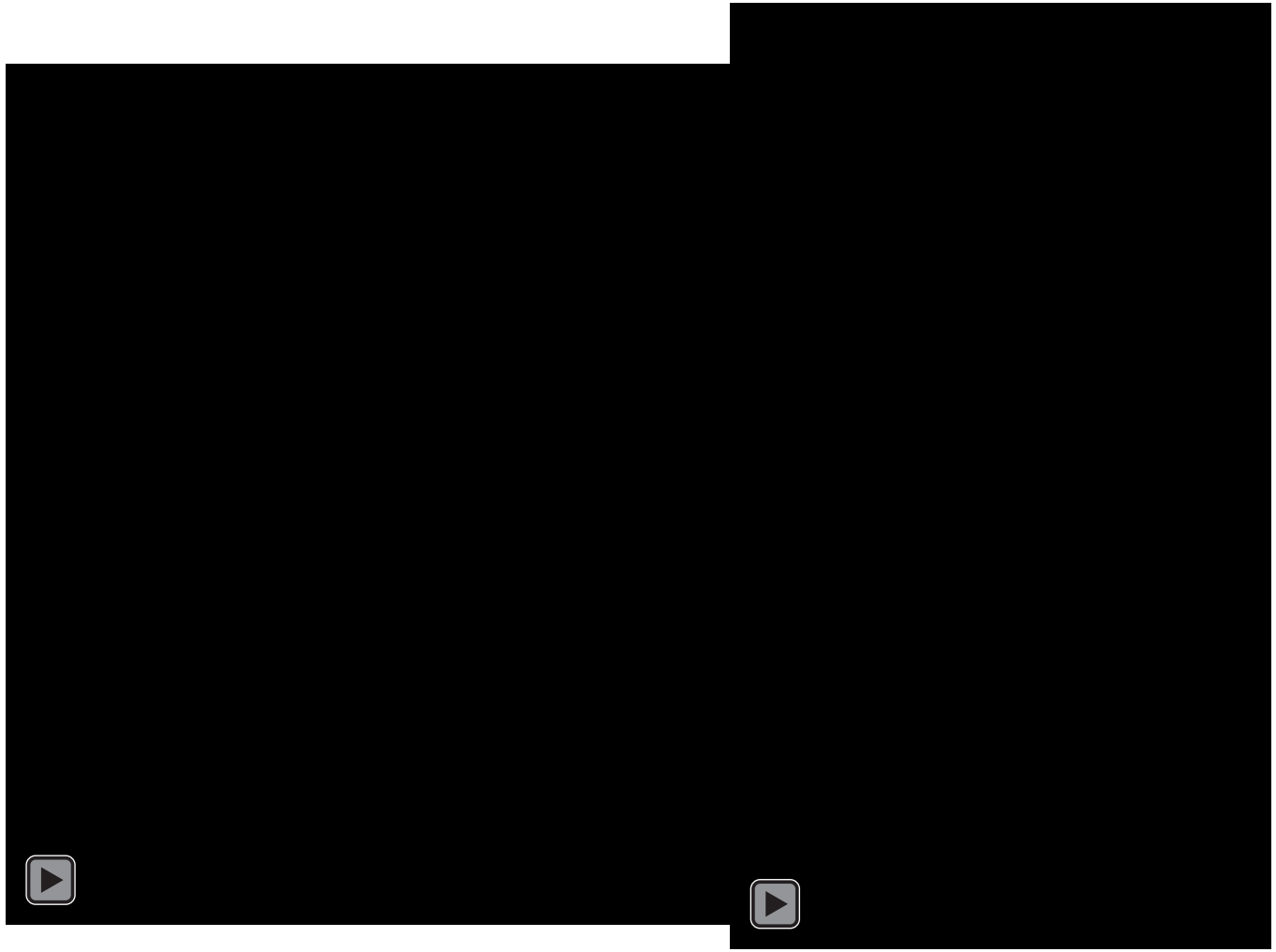
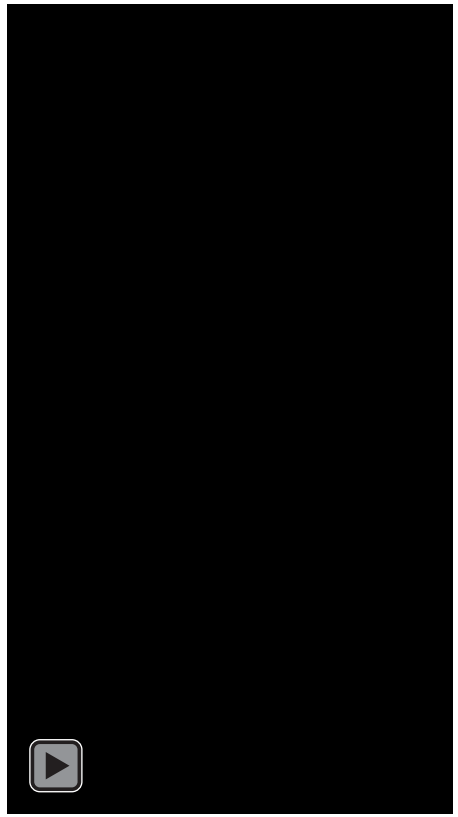




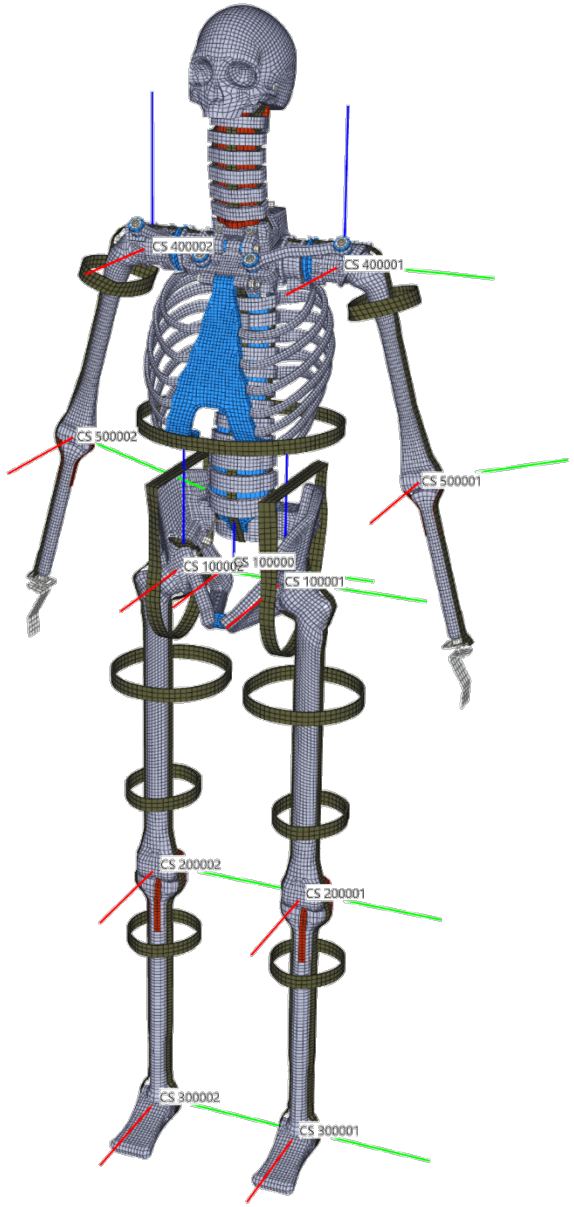
Positioning

Variants

This object consists of 2 variants.

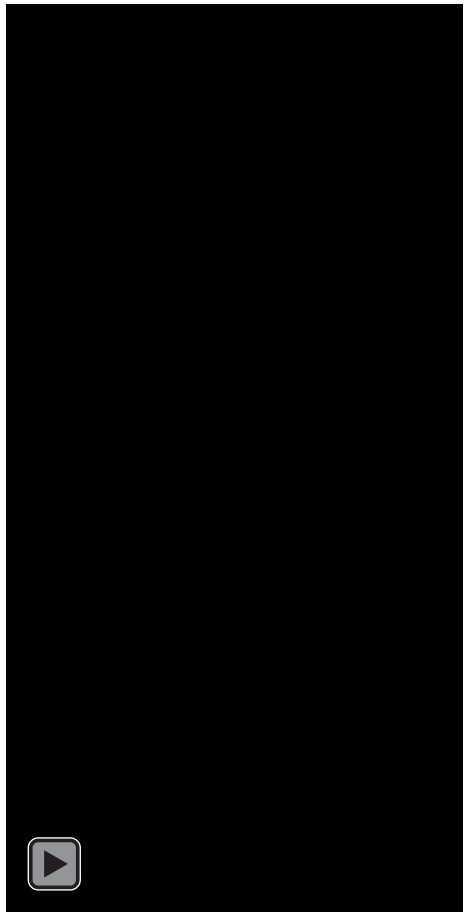
Variant 1 - Standing Dummy Position

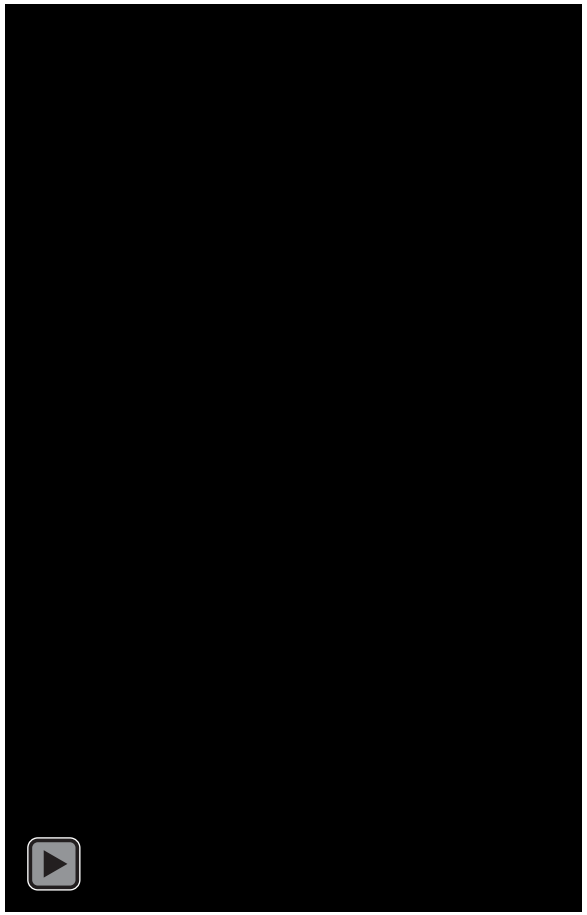
Variant 2 - Seated Dummy Position

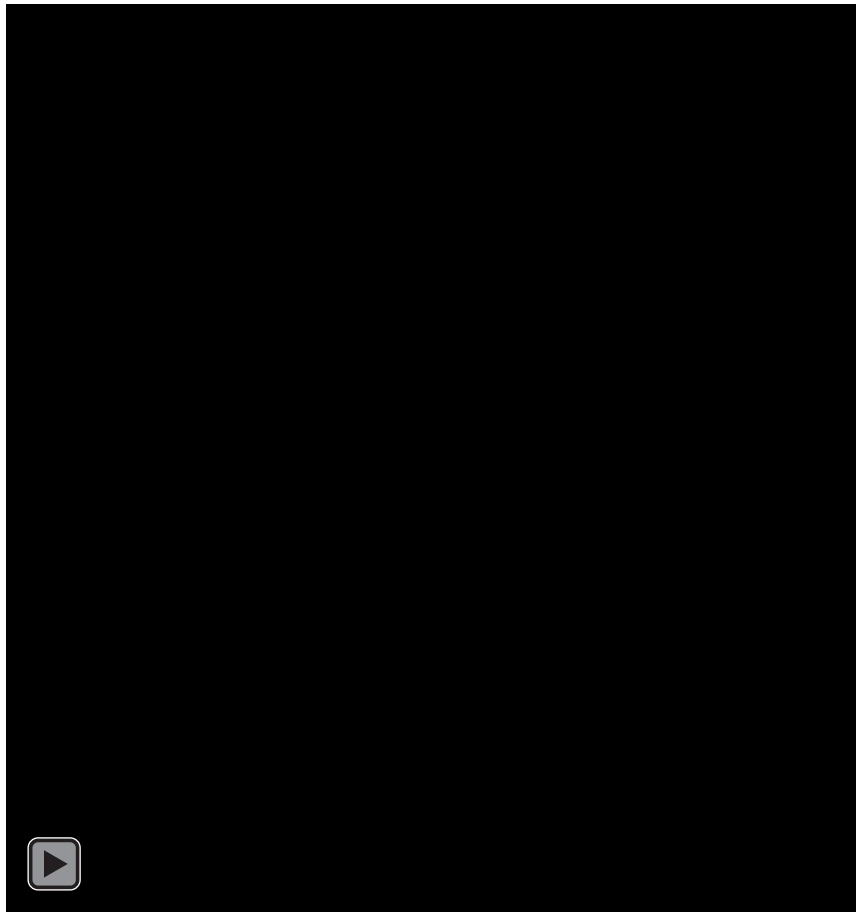


*INCLUDE
“Positioning"

Simulation Example







Validation

General Verification of FE Components

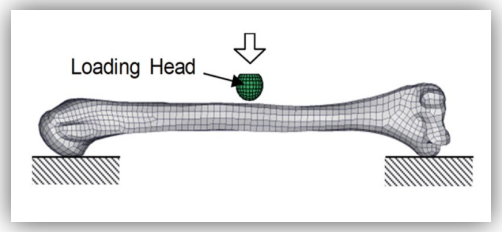
General Verification of the Complete Model

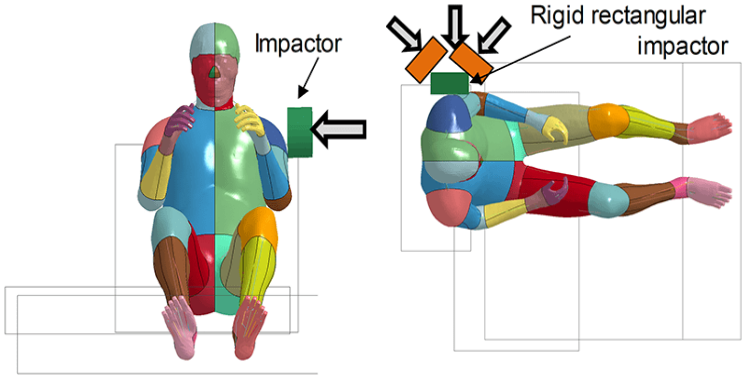
Bending and Pendulum Tests

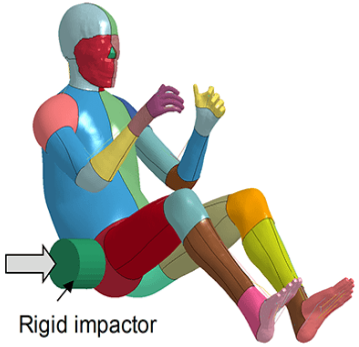
Validation - Bending and Pendulum Tests

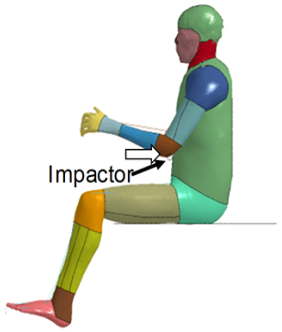
m: 1.63 kg - 64 kg

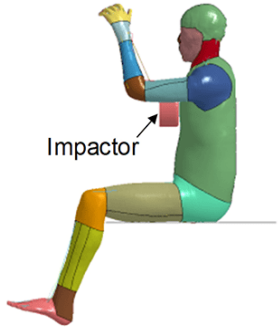
v: 4.4 m/s - 14.3 m/s

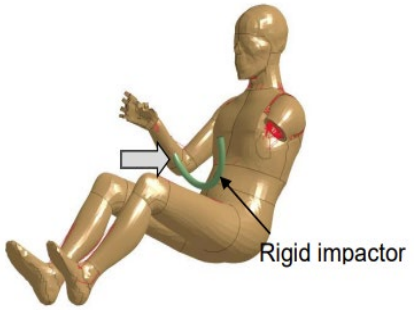


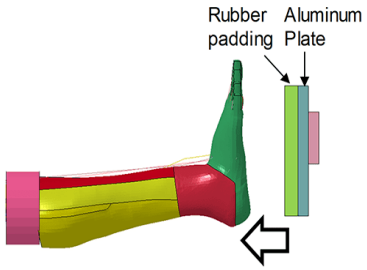


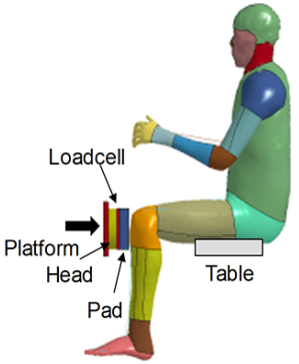






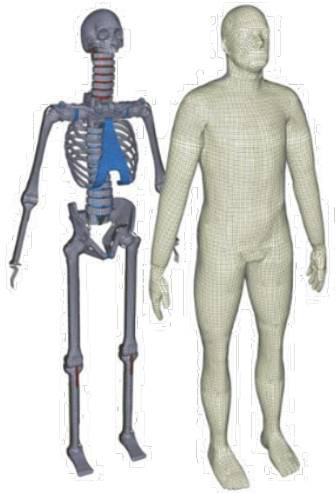






Source: TOYOTA MOTOR CORPORATION, TOYOTA CENTRAL R&D LABS, NHTSA

Market



AFUS GmbH

Biofidelic-Dummy (PRIMUS breakable)

GENERIC **Created:** 2022-05-13 **Updated:** 2022-06-20

ID: 96ac9ba4-3768-4dde-bdd7-276052a96030 **Revision:** 2

Required products: No required modules **Unit system:** SI

Variants

This object consists of 2 variants.

Variant 1 - Standing Dummy Position

Variant 2 - Seated Dummy Position

Attachments

Development Biofidelic-Dummy (PRIMUS breakable) Finite Element Model.pdf (265.8 KB)

Validation - Biofidelic-Dummy (PRIMUS breakable).pdf (268.4 KB)

Thank you very much for your attention!

The project of AFUS Research Company was developed in close cooperation with EDAG Engineering, Crashtest-Service and the University of Applied Sciences Dresden. Special thanks to IMPETUS Afea and their team for the support in modeling.

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