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Technological innovation

Interreg 2 Seas Mers Zeeën
European Regional Development Fund

D 1.6.1 TOWARDS THE PREDICTION OF THE LIFETIME OF HYBRID STRUCTURES

CLOSURE MEETING

FRANZ BORMANN

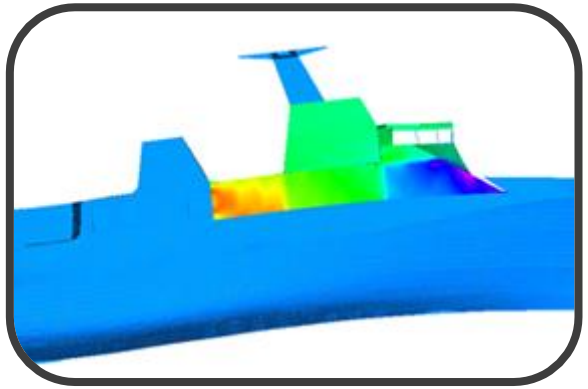
23 NOVEMBER 2021

M2i materials innovation institute

HYBRID JOINTS – THE NEED FOR A DESIGN VALIDATION METHODOLOGY

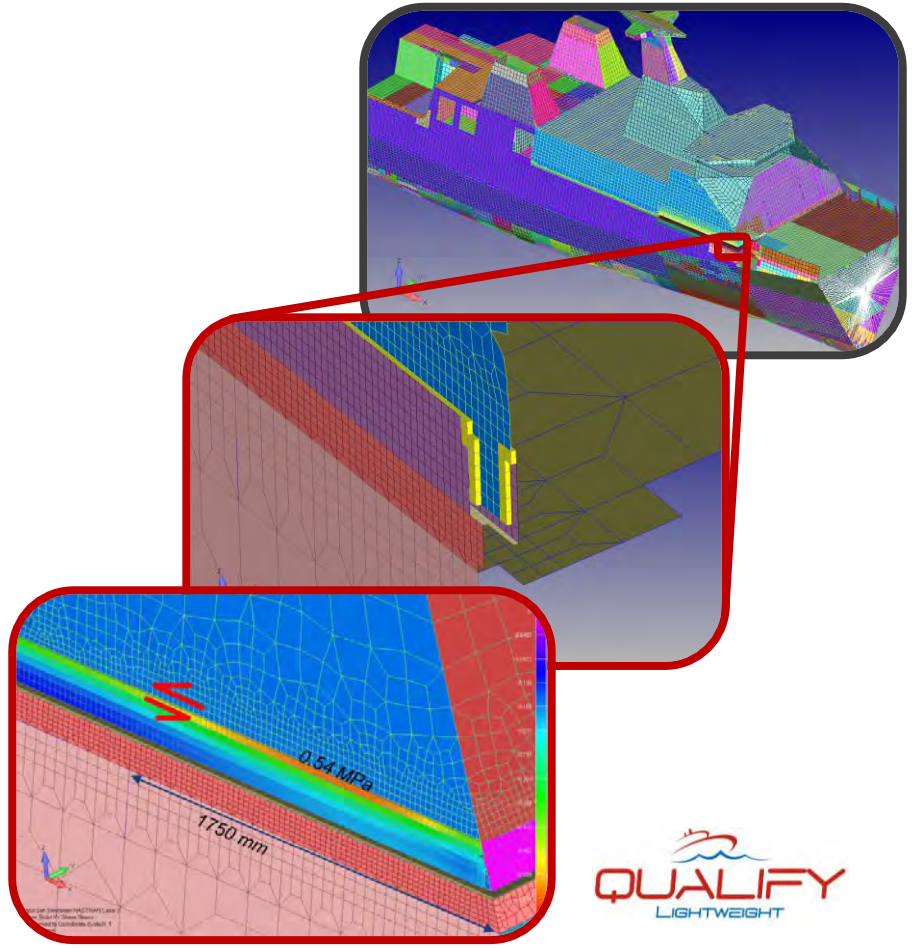
Damen Group

BAE Systems



Design validation model
(simplified joint representation)

Need for design validation criteria



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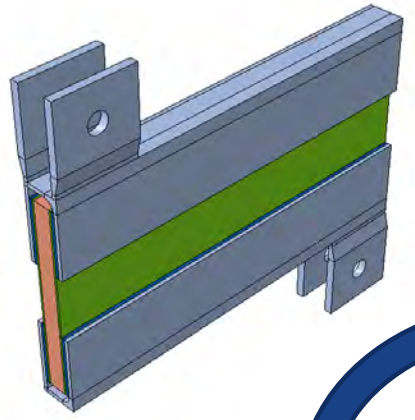
HYBRID JOINTS - DESIGN VALIDATION METHODOLOGY

Design Tool calibration



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Low-Fidelity Model

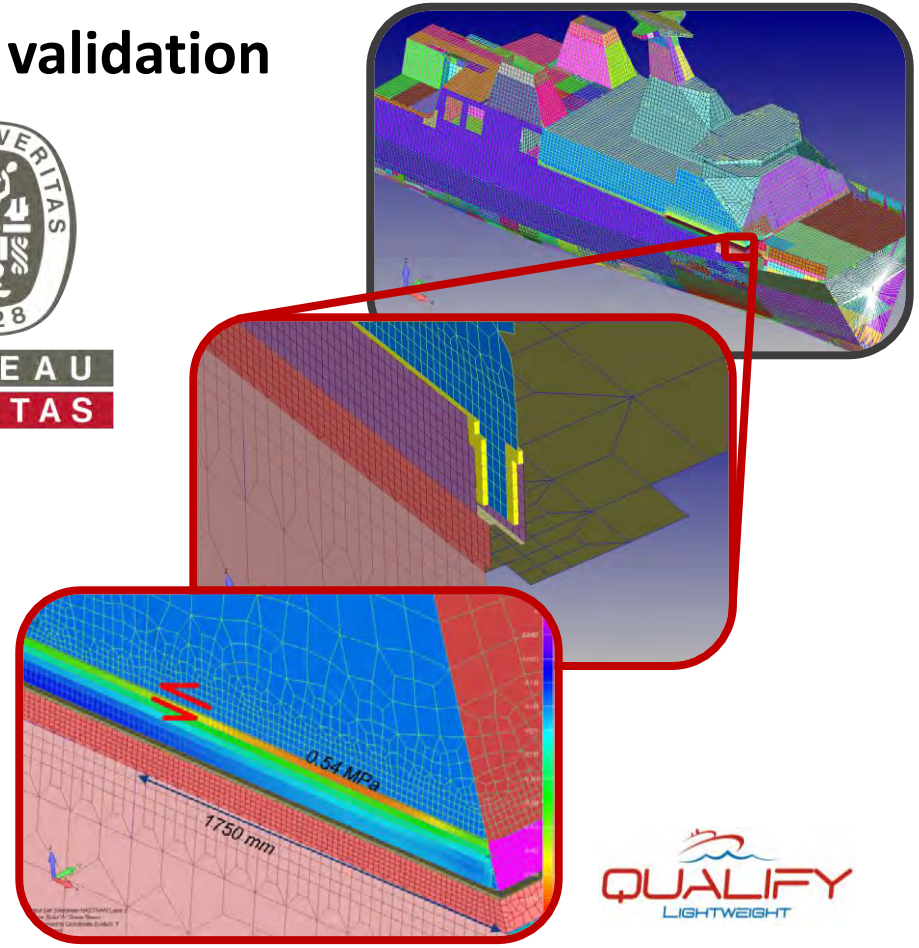
High-Fidelity Model

Transfer Methodology

Design validation

BUREAU VERITAS 1828

BUREAU VERITAS



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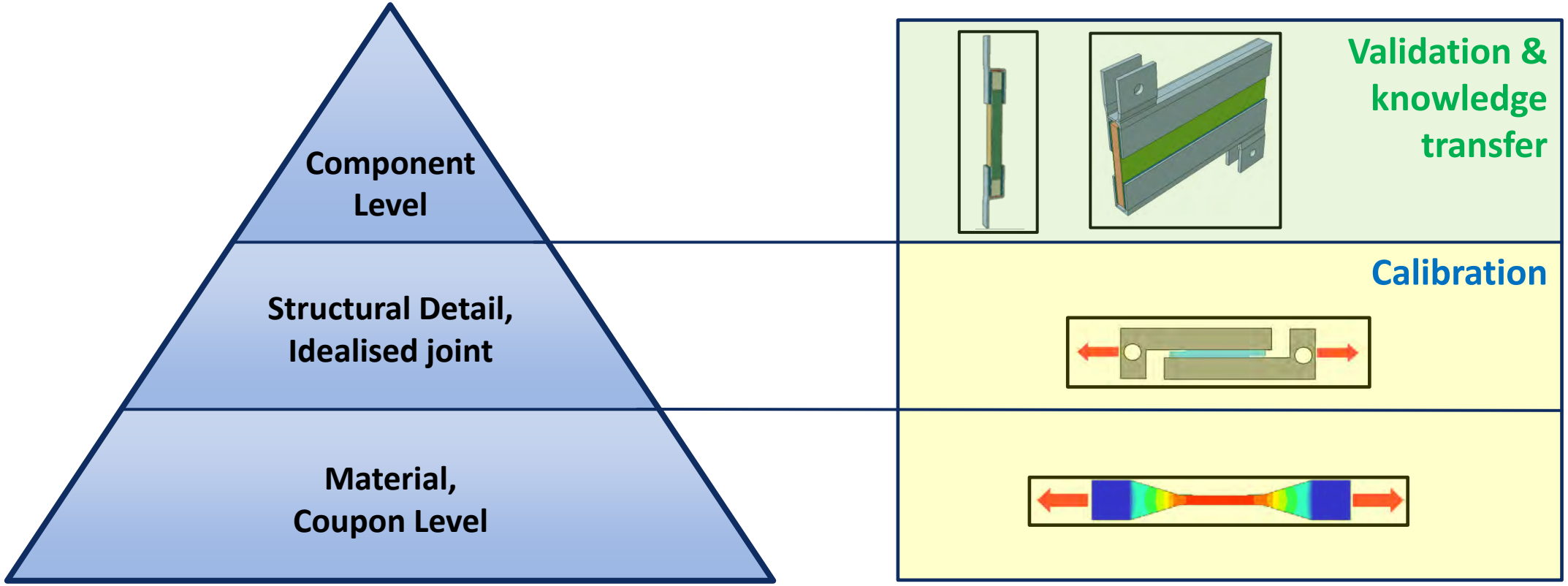
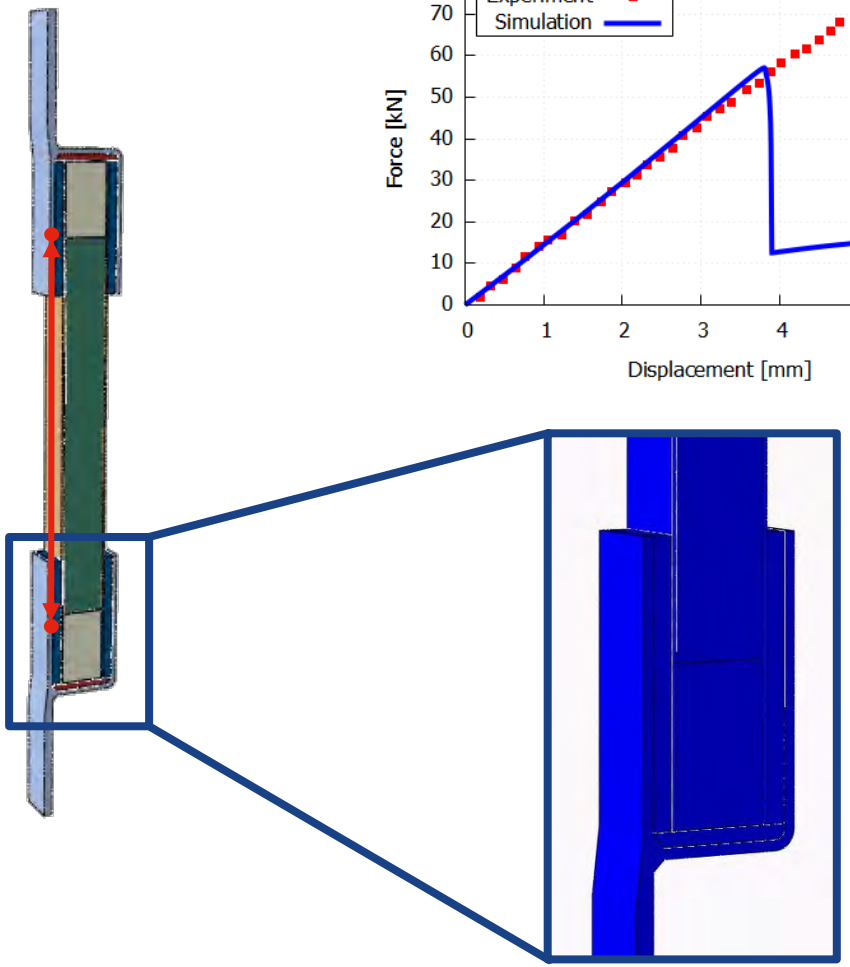
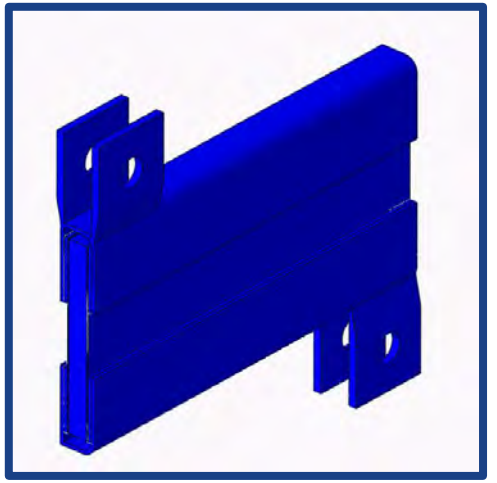
EXPERIMENTAL AND MODELING STRATEGY



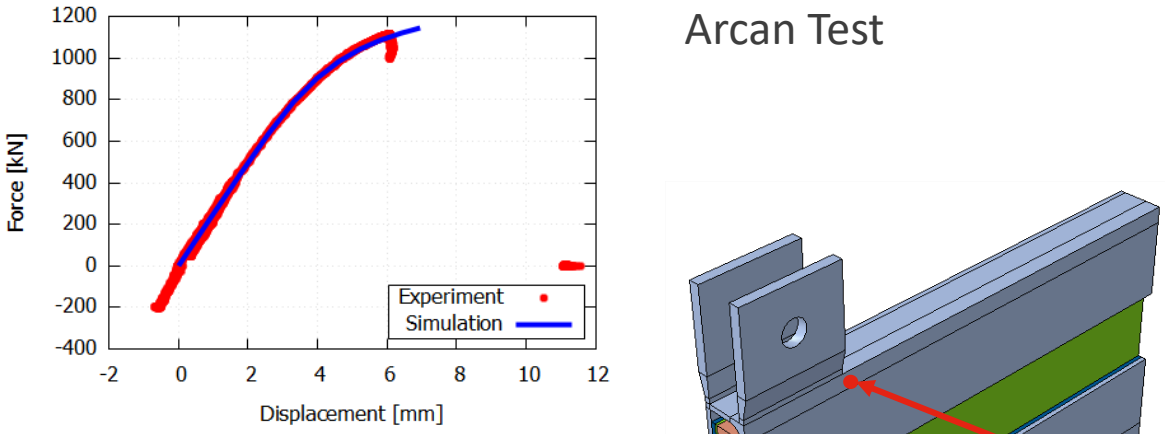
DAMEN JOINT - VALIDATION

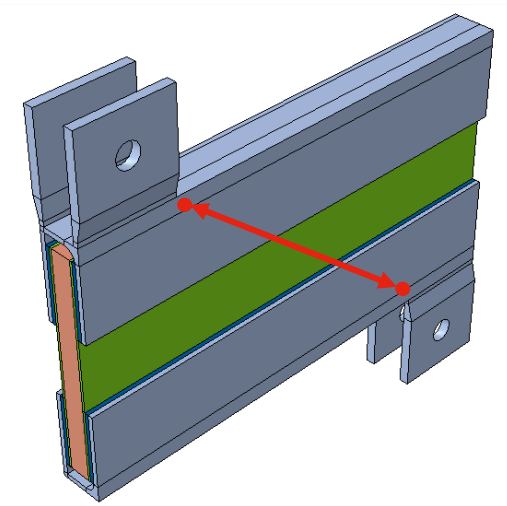
Tensile Test



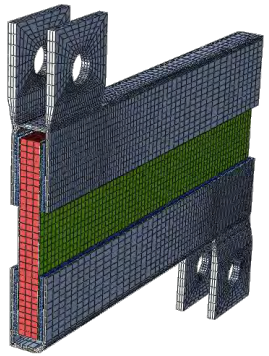


Arcan Test





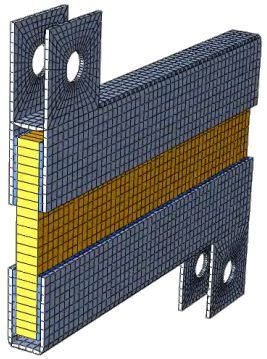
DAMEN JOINT – TRANSFER METHODOLOGY



High-Fidelity Model

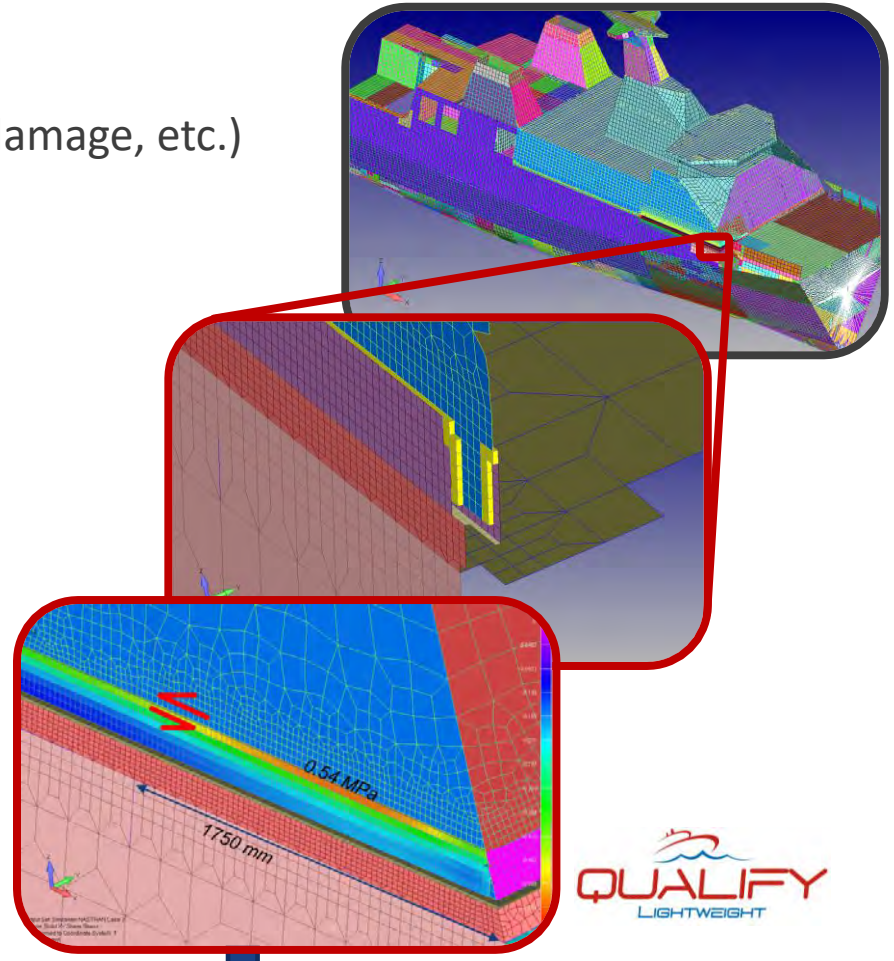
- Extraction of the load at failure initiation (e.g. yielding, damage, etc.)
  → failure load

Model simplifications:
Geometry
Mesh
Material behaviour



Low-Fidelity Model (matching the design validation model)

- Application of the failure load
  - Extraction of critical stresses in the adhesive
  - Safety evaluation of the proposed design (3-hold model)



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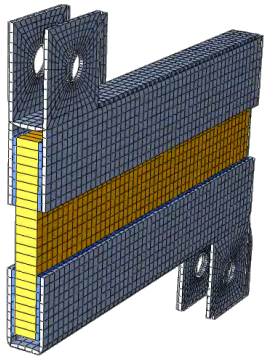
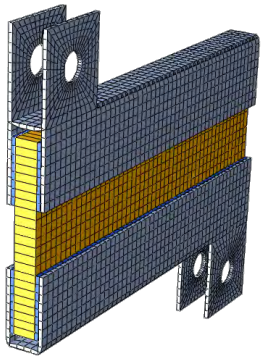
DAMEN JOINT – DEFINING THE FATIGUE SPECTRUM



Low-Fidelity Model

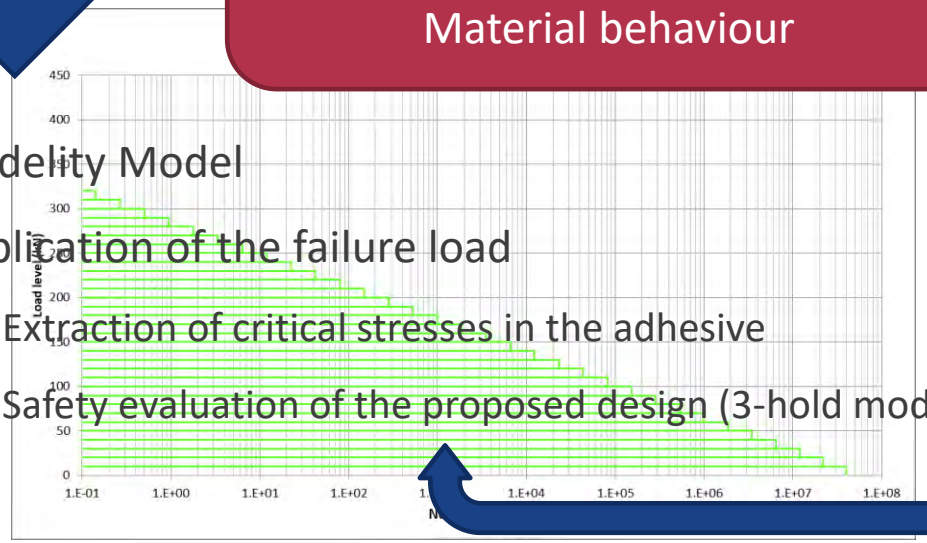
- Extraction of the load at failure initiation for the 3-hold model

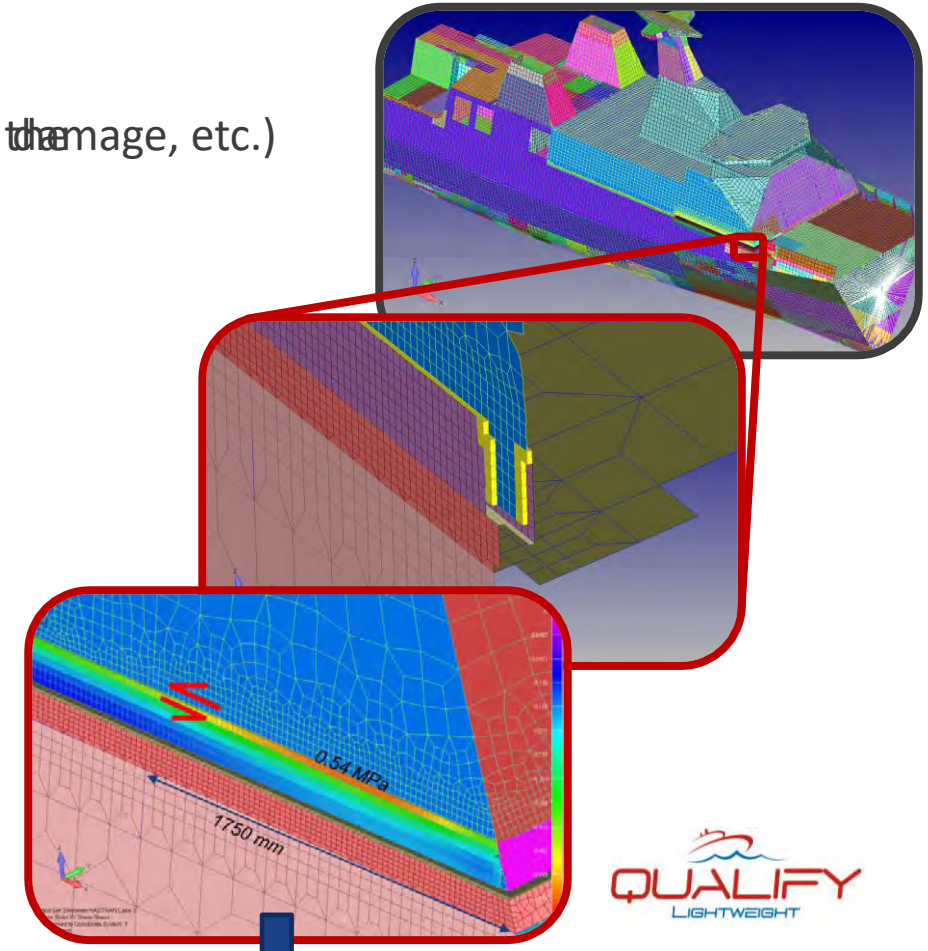
Model simplifications:
Geometry
Mesh
Material behaviour



Low-Fidelity Model

- Application of the failure load
  - Extraction of critical stresses in the adhesive
  - Safety evaluation of the proposed design (3-hold model)





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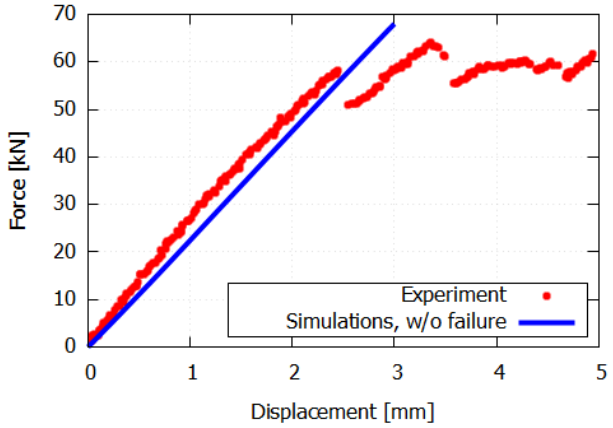
BAE JOINT – PRELIMINARY RESULTS



Interface calibration will enable the failure assessment

SUMMARY – JOINT SPECIFICS

- Lessons learned about the DAMEN JOINT DESIGN:
  - The bulk adhesive is unlikely to break under different loading conditions
  - Failure of the joint initiates (often non-visible by eye) with the yielding of the bulk adhesive
  - The ultimate failure is likely to happen near the interface adhesive to composite in the composite, especially in the presence of peel stresses

- Lessons learned about the BAE JOINT DESIGN
  - The critical joint area is at the steel-hardwood wedge transition zone
  - Preliminary tests indicate failure initiation before first visible drop in the experiments

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CONCLUSION – HIGH- AND LOW-FIDELITY MODEL

High-Fidelity Model

- Well-calibrated models enable a detailed insight into
  - The failure mechanism
  - The load at failure
- Useful for studying alternative material combinations
- Easy extension to prior damage and an aged condition

Low-Fidelity Model

- Easy to implement
- Efficient tool for the design validation of different kinds of joints
- Efficient tool for the definition of the fatigue spectrum
- Can be combined with the influence of prior damage and an aged condition

Valuable tools for studying and evaluating almost any joint design

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This research was carried out within the project "QUALIFY – Enabling Qualification of Hybrid Joints for Lightweight and Safe Maritime Transport", co-funded by the INTERREG 2SeasMers Zeeën programme
http://www.interreg2seas.eu/qualify