QUALIFY LIGHTWEIGHT

Technological innovation

Interreg 2 Seas Mers Zeeën
European Regional Development Fund

PROGRESS TOWARDS GUIDANCE FOR THE CERTIFICATION OF MARINE HYBRID ADHESIVE JOINTS

M2I MATERIAL CONFERENCE - ONLINE EVENT – 15TH OF DECEMBER 2020

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BUREAU VERITAS 1828

SUMMARY

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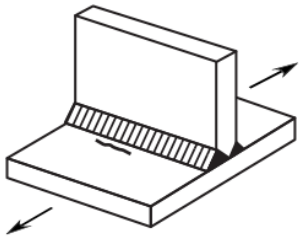
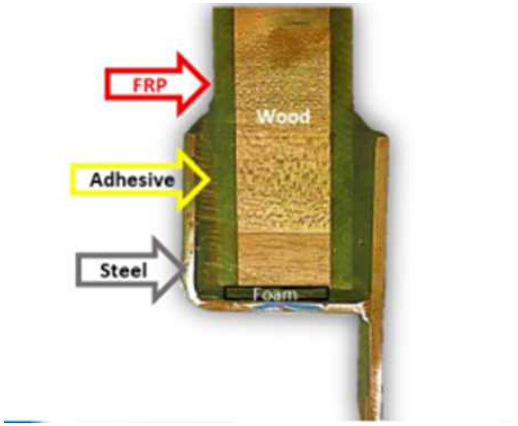
- Reminders of Motivations
- Design loop of the “competitor”: WELDED STEEL DESIGN
- Design loop for hybrid joint ⇔ QUALIFY proposal – Guideline summary





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MOTIVATIONS – WHY BONDING HYBRID JOINT

- Weight of composite

Bonding

- Non intrusiveness
- No stress concentration
- No heat
- Multi-material
- Modular
- Adapted to composite

MOTIVATIONS – WHY IS IT NOT GROWING FASTER?

- Reliability ?
- Paved way for welded steel
- Lot of possibilities AND unknown for demonstration of reliability of bonded joints

- What does it mean for the joint to be welded? ➔ road map to “Steel equivalent” solution

- Proposal of QUALIFY

Fire safety ➔ out of scope of QUALIFY
NOT the focus in what follows

STEEL WELDING SCHEMATIC DESIGN LOOP

Material choice

Grade A, AH36, 40...

Module
Yield strength,
Plastic reserve

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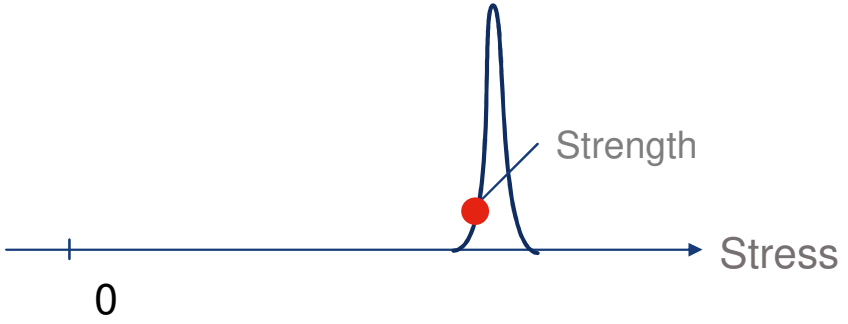
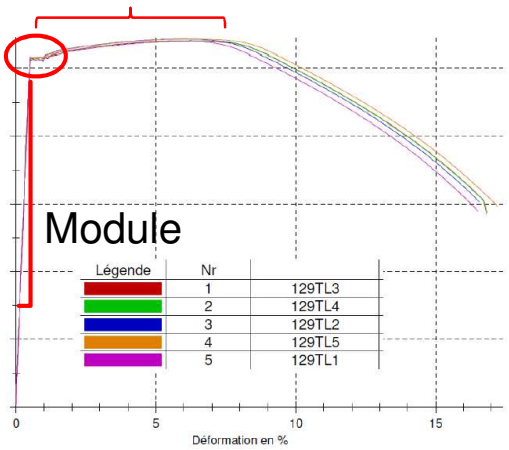


Plastic reserve

Yield strength



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STEEL WELDING SCHEMATIC DESIGN LOOP

Material choice — Grade A, AH36, 40…

Strength Evaluation — Linear calculations, up to yield

Module
Yield strength,
Plastic reserve

Rules loads
Safety factors

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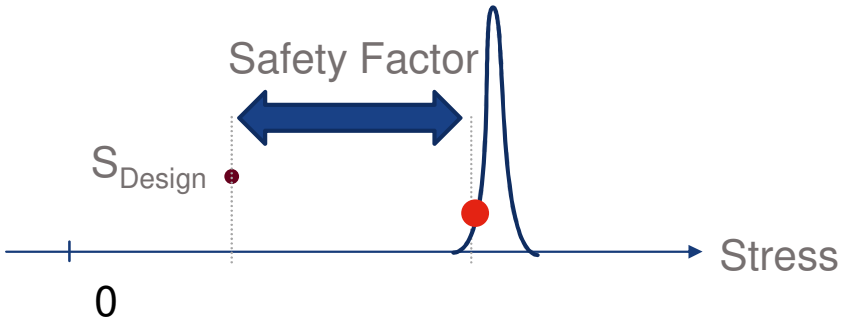

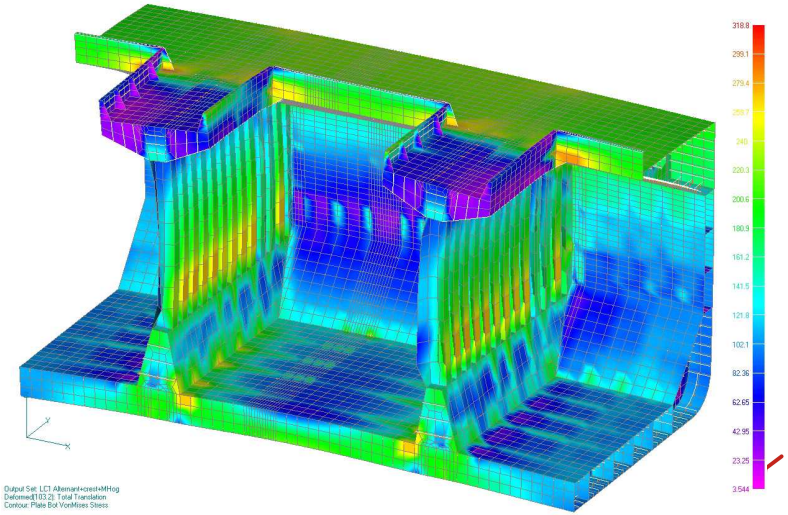

STEEL WELDING SCHEMATIC DESIGN LOOP

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Material choice	Grade A, AH36, 40…	Module Yield strength, Plastic reserve
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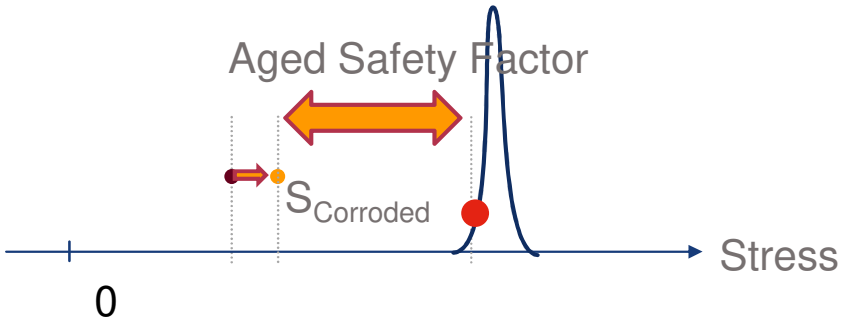
Long term	Corrosion	Corrosion thickness addition Cathodic protection



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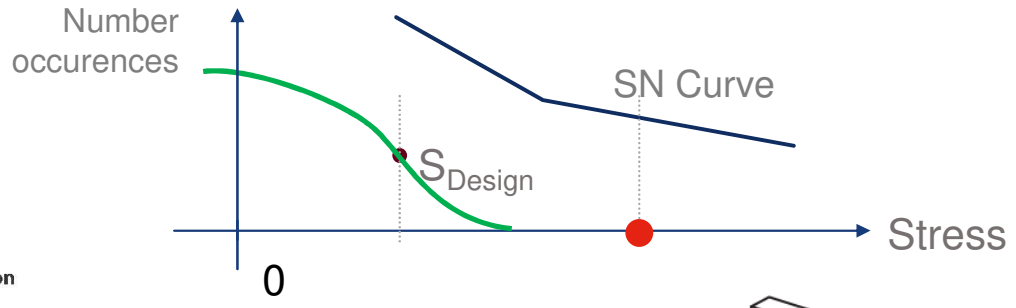

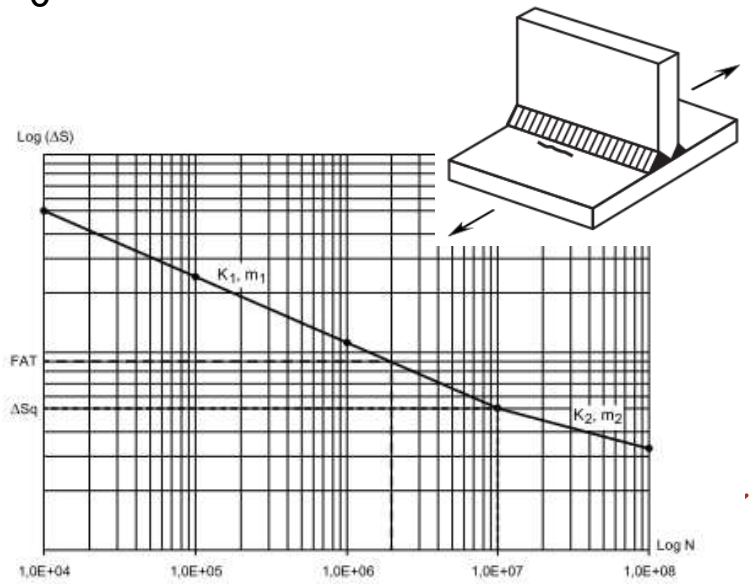

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Damage tolerance	Criticity of structural element	Grade EH, DH…

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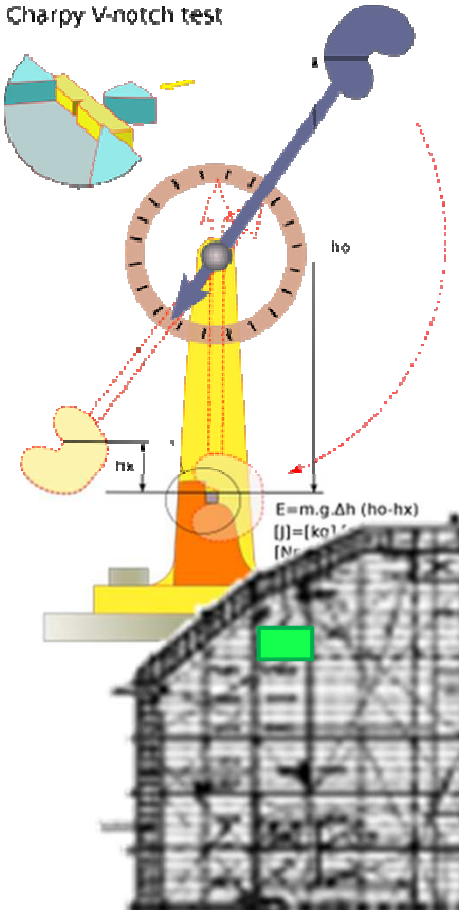
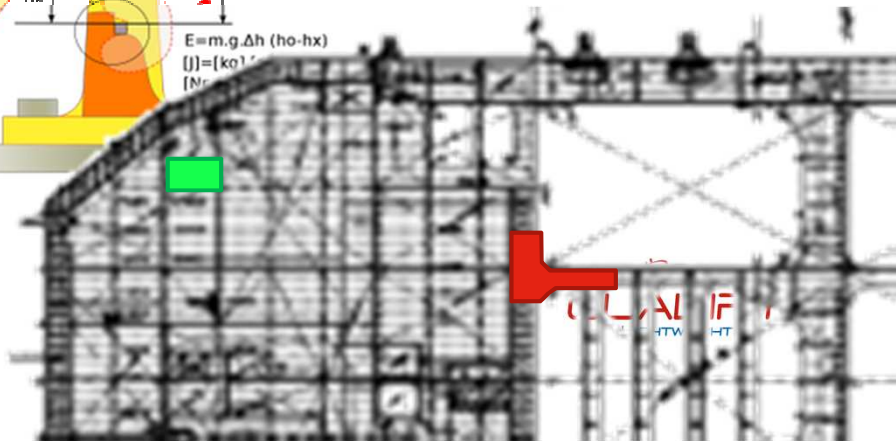
https://commons.wikimedia.org/wiki/File:Charpy_V-notch_test.svg



Courtesy http://testlabs.ca/mechanical-testing/



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Long term	Corrosion	Corrosion thickness addition Cathodic protection
Fatigue	Hot spot stress Fatigue detail	SN-Curve Damage
Damage tolerance	Criticity of structural element	Grade EH, DH...
Inspection	Inspection schedule	Dye penetrant, visual, magneto....,

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STEEL WELDING SCHEMATIC DESIGN LOOP

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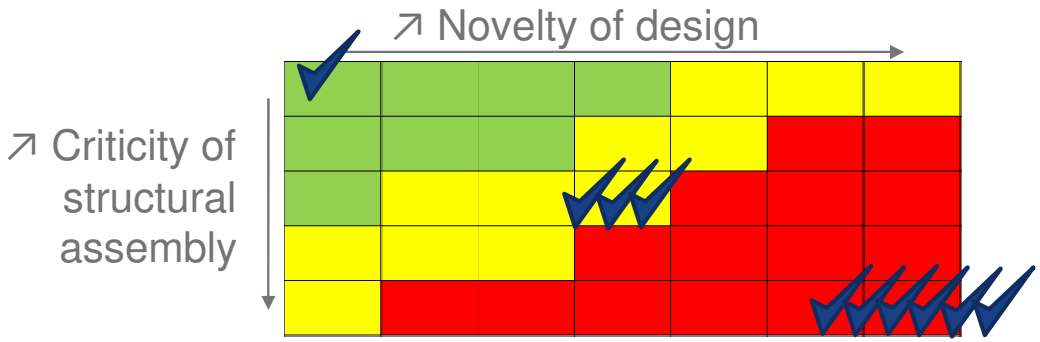
Steel welding ➔ Target reliability

Road map for bonding qualifications

All validation are not always necessary



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QUALIFY GUIDELINES SUMMARY

Part A Design Specifications

- Identify :

Relevant Safety Class

Novel / known components and techniques

Design envelope

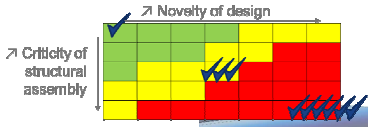
- Loads Magnitude and durations,temperature
- Environment, Moisture, UV, chemicals…
- Potential redundancy

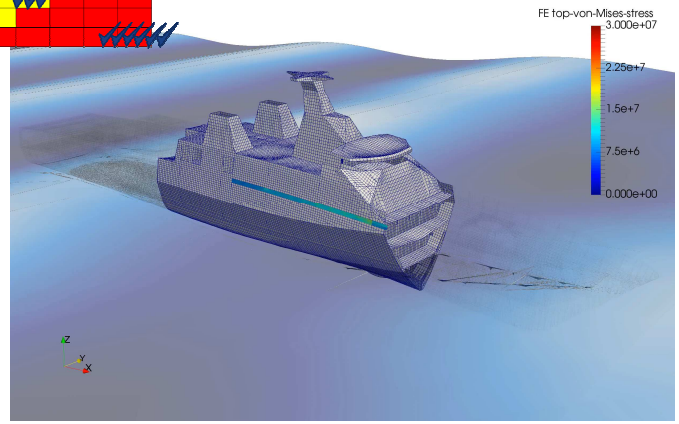
Potential redundancy

Design life?

Failure modes? former experience, representative tests

…





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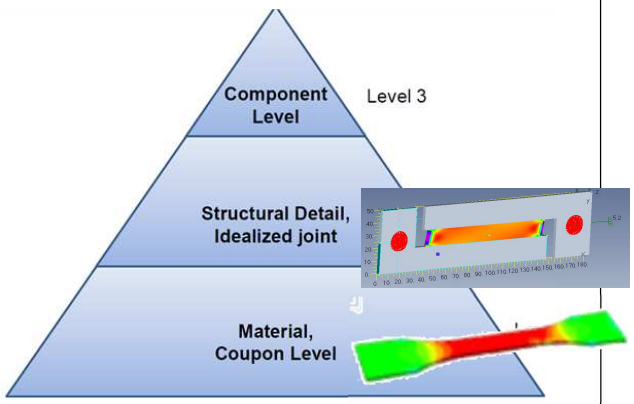
Part B Characterization of the constituents



Toolbox for design assessment and durability

Mechanichal Stiffeness and strength (tensile, and or shear)

Thermal, Tg

Long term ? (relaxation, creep)

Behaviour facing water, chemical agent, D, M%

Mechanical properties in

Interfacial strength

Creeping corrosion, and associated interfacial strength

Material choice

Epoxy, PU, MMA, MS Polymer, ...

Risk

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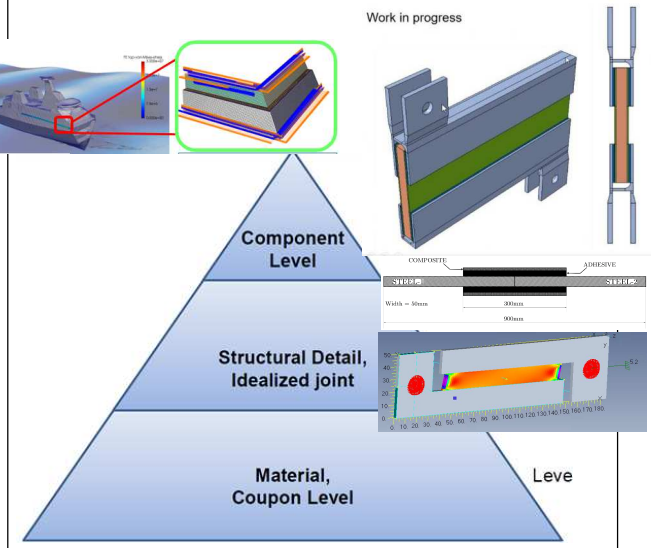
Part C Design assessment



- Definition of strength assessment tools
- Robustness of assessment tools
- Validation of design:

Strength calculations	Linear calculations ? Plastic Visco-elasticity?...
Fatigue	Littérature provide average stress data ➔ How to compare with design?
Damage tolerance	Depends on toughness What damage size?

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Part D Durability & protection

- Ageing/conditioning – material and geometry specific:

  Identify degradation mechanism;

  Diffusion / Hydrolysis

  Diffusion creeping corrosion, …

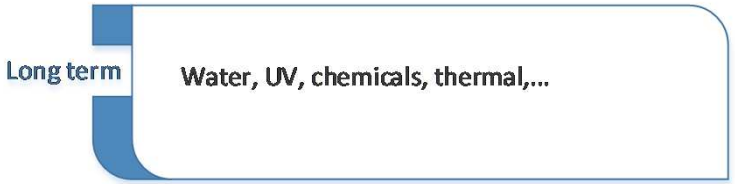
- Guidance establishment of scenario for realistic design test conditions

  Assessment of Knock down factors on strength properties

  Creeping corrosion still under investigation

- Protection of joint

  Assessment of actual protection level



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Part E Manufacturing

- Site inspection -assessment as per current FRP manufacturing surveys
- Manufacture with survey
- Quality control – intermediate (including surf prep) and final testing
- Realistic workshop/shipyard environment of manufacture test samples (lab quality validation)
- Bonder qualification Under discussion

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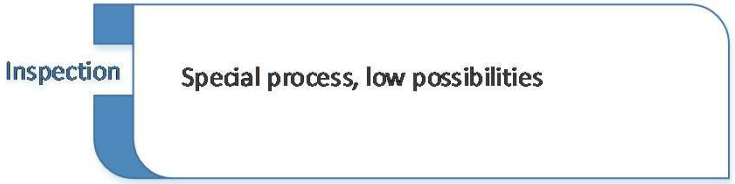
Part F Inspection - Monitoring

- Guidelines not prescribe NDE techniques, appart visual (coating / composite inspection protocol)
- Specific NDE/SHM technique ➔ calibrated against known defects
- Efficiency of NDE / SHM? Change in Detectable defect? ➔ Validation



GUIDELINE FOR QUALIFICATION OF HYBRID JOINTS

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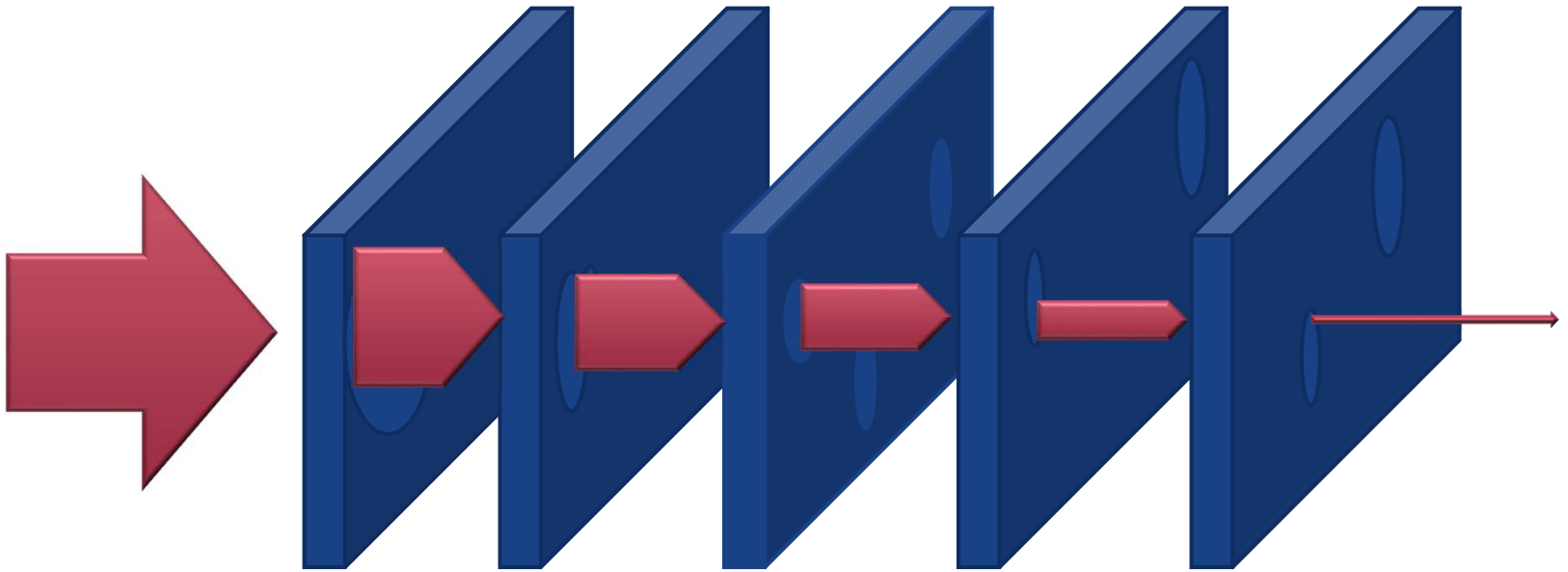
Threat:
-Loads,
-Cycling
-Agression
-Damages
/ Defect



Acceptable risk

Manufacturing quality

Strength, Fatigue, Damage tolerance

Sealant protected joint

Durability study

Monitoring inspection

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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

PROGRESS TOWARDS GUIDANCE FOR THE CERTIFICATION OF MARINE HYBRID ADHESIVE JOINTS