



LAND ROVER **BAR**

BINDT Workshop – 27th Feb 2018

NDT Requirements for High Performance Yachts

Michel Marie, Land Rover BAR
David Jonson, Land Rover BAR

➤ The America's Cup

- The world's oldest international sporting trophy and the pinnacle of sailing technology
- The America's Cup was first offered as the Hundred Pound Cup in 1851 for a race around the Isle of Wight
- The Cup was won by the schooner 'America' from New York - who beat a fleet of British boats around the Island and it subsequently became known as the America's Cup
- American teams representing the New York Yacht Club successfully defended all challenges for 132 years - the longest winning streak in sport - until an Australian team won in 1983
- The Cup has been held in eight global locations - Cowes, New York / Newport, Fremantle, San Diego, Auckland, Valencia, San Francisco, Bermuda
- Emirates Team NZ are the current holders of the America's Cup





➤ AC35 Class

- 50 foot foiling catamaran with “wing sail”
- Overall dimensions specified in class rule
- Technical freedom – hydrofoil design, control systems, wing structure, aerodynamics
- “Flying surfaces” will be hydraulically actuated with power from 4 sailors
- Capable of speeds up to 85 km/h
- No fly by wire, the helmsman is constantly in the control loop
- All the power generation must be human



➤ AC35 Technical Team

50 Technical Staff including

- Designers and Naval Architects
- Performance Prediction and Data Analytics
- Fluid Dynamists and CFD Engineers
- Structural and Composite Engineers
- Mechanical, Hydraulic and Electrical Design



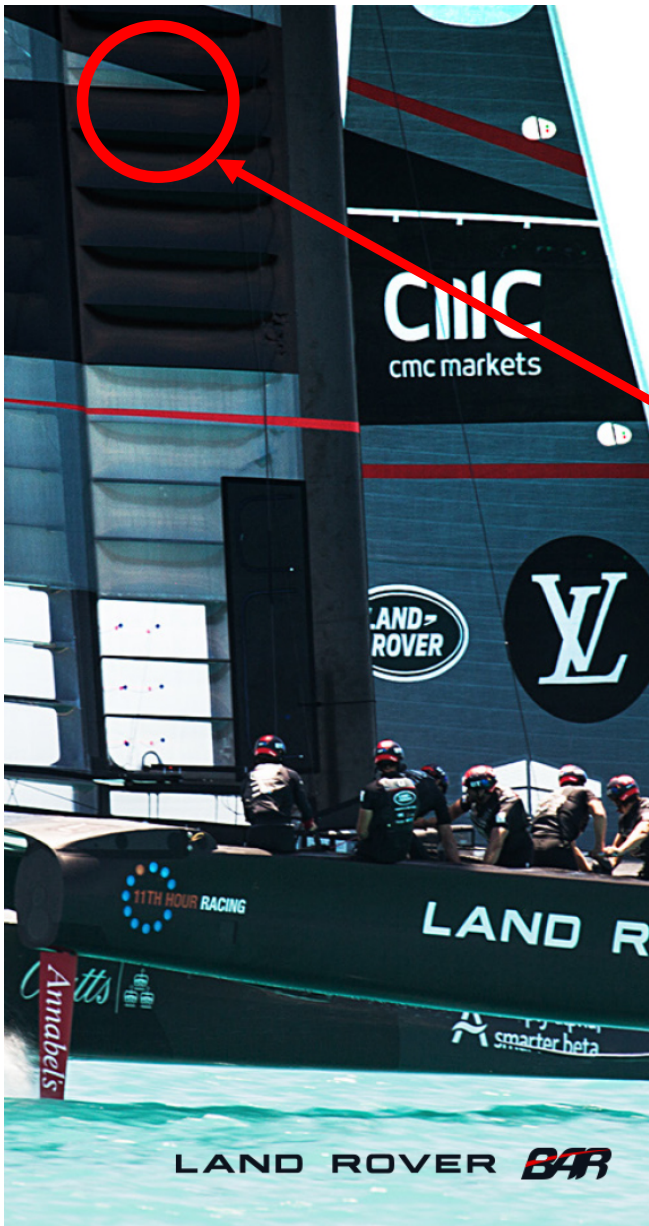
➤ The Challenge

- A 'Moon Shot'. We have one chance to get it right!
- This is a "technical race"
- Leading edge advanced technology
- Tremendous time pressures
- Limited opportunity to physically test
- Regulation constraints
- Safety critical



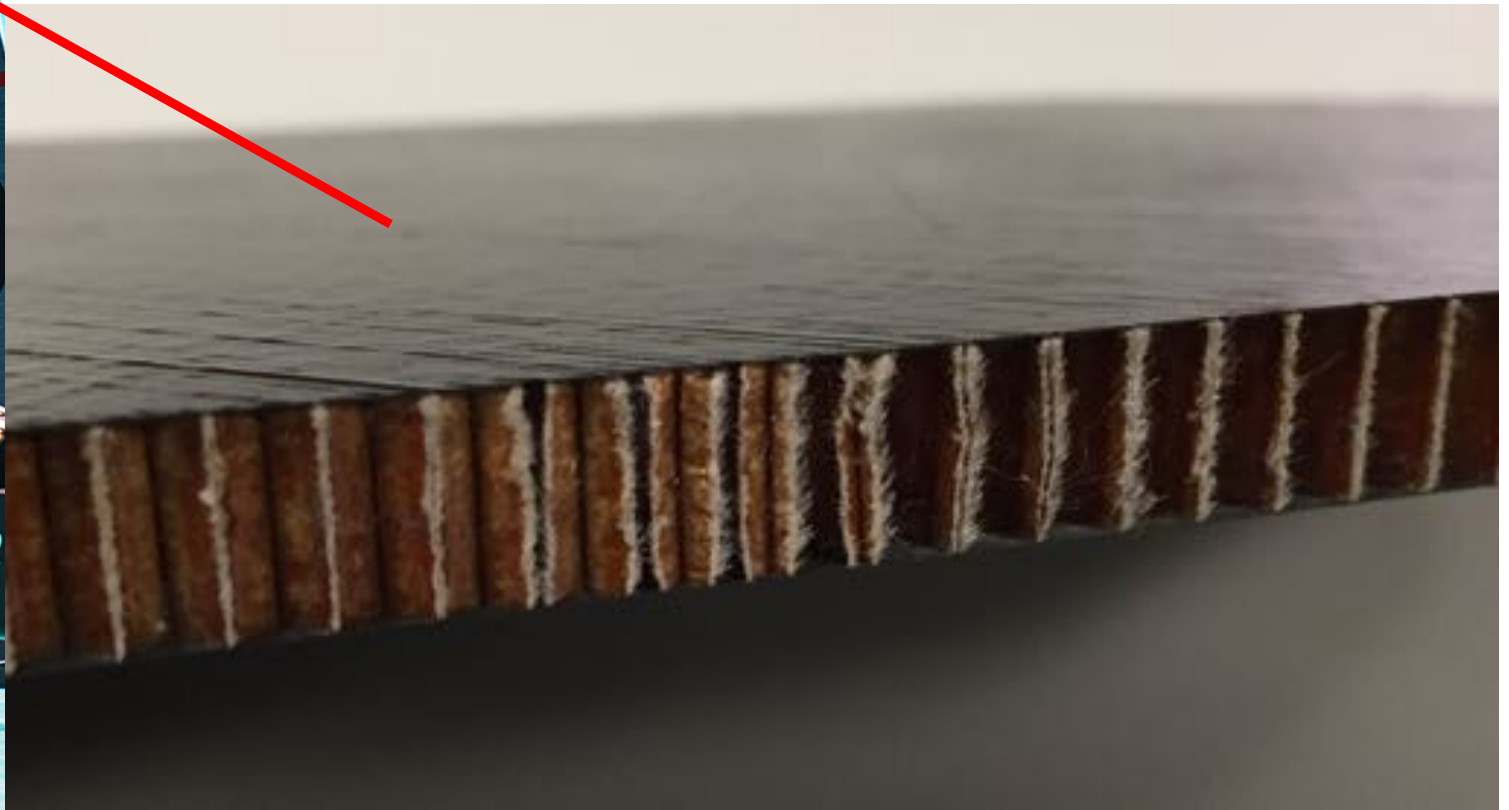
> The Challenge

- A large variety of prototype composite parts



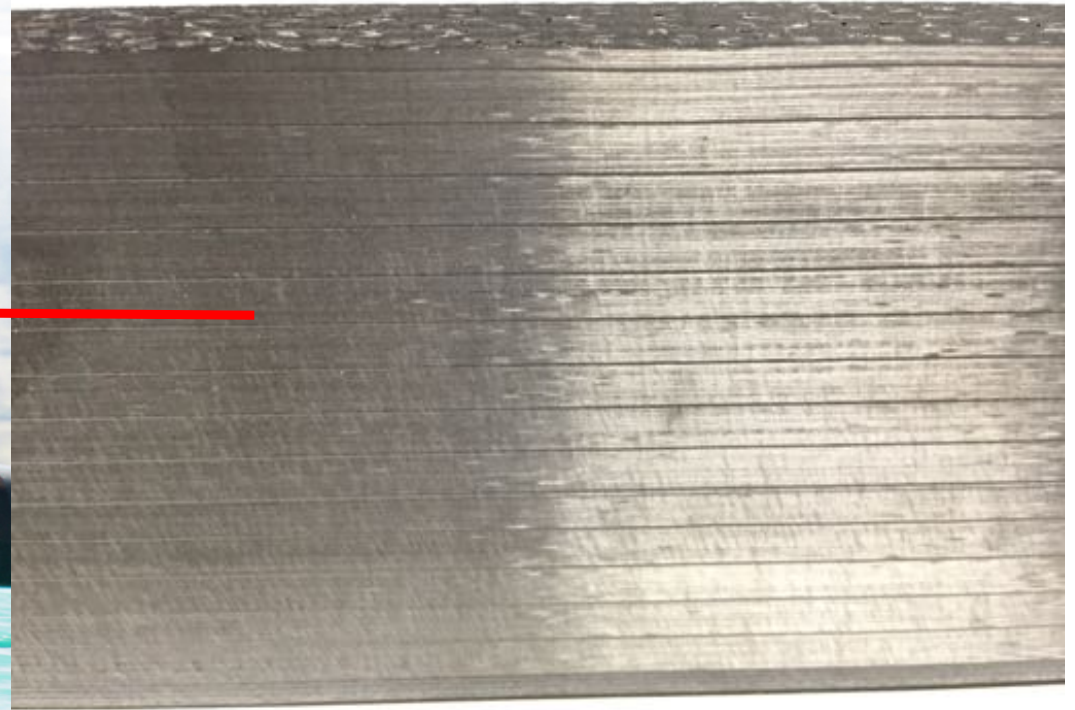
➤ The Challenge

- A large variety of prototype composite parts
 - from sandwich 50gsm plies over 28kg/m³ Nomex



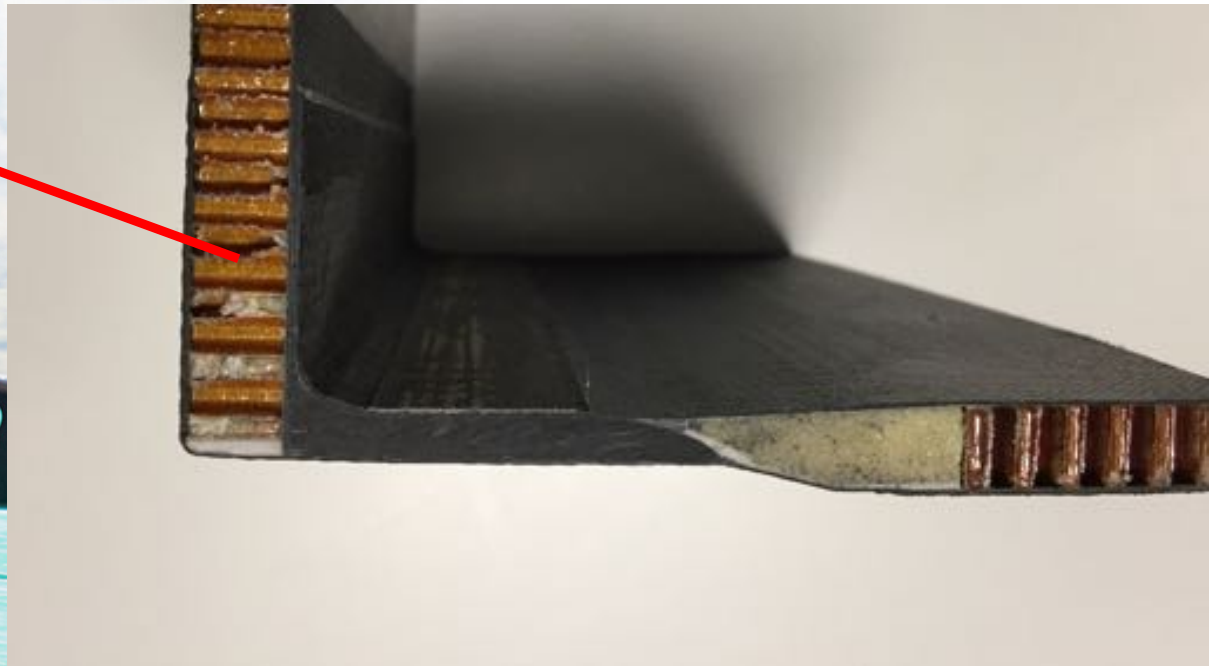
➤ The Challenge

- A large variety of prototype composite parts
 - from sandwich 50gsm plies over 28kg/m³ Nomex
 - to 70mm solid carbon foils

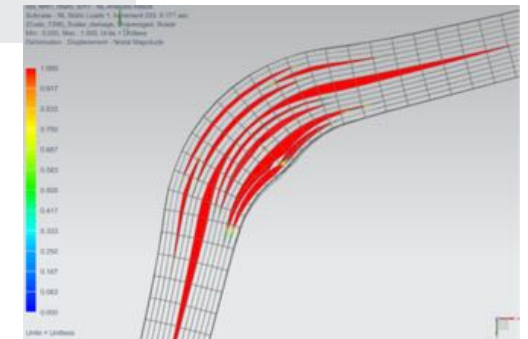
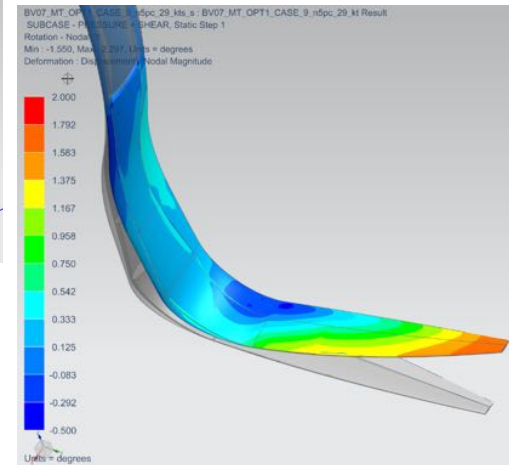
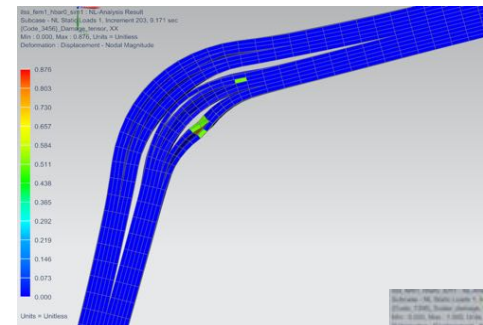
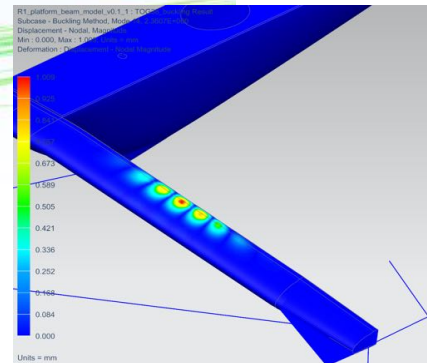
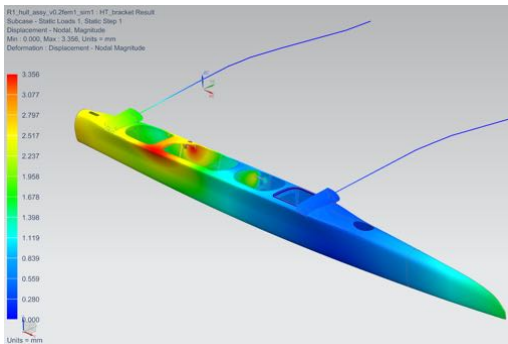
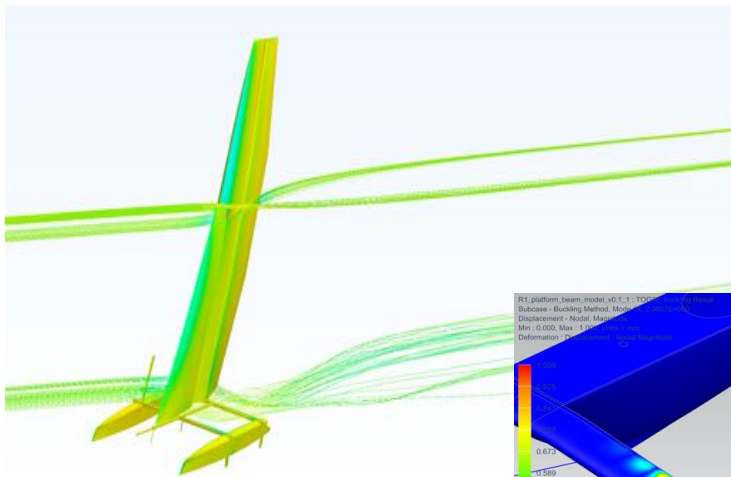


➤ The Challenge

- A large variety of prototype composite parts
 - from sandwich 50gsm plies over 28kg/m³ Nomex
 - to 70mm solid carbon foils
 - via cored and solid composite assemblies



➤ Structures – the simulated world

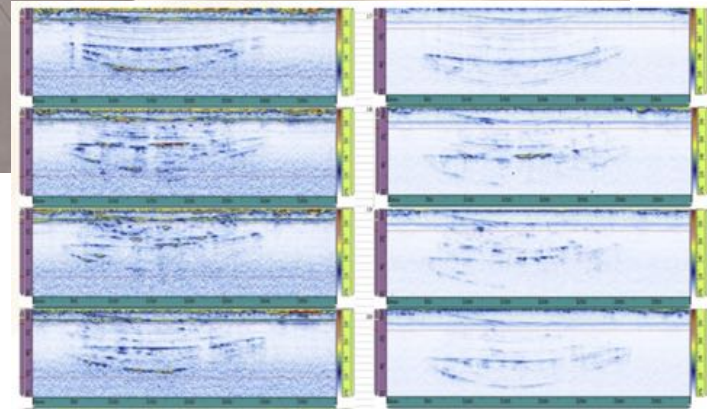
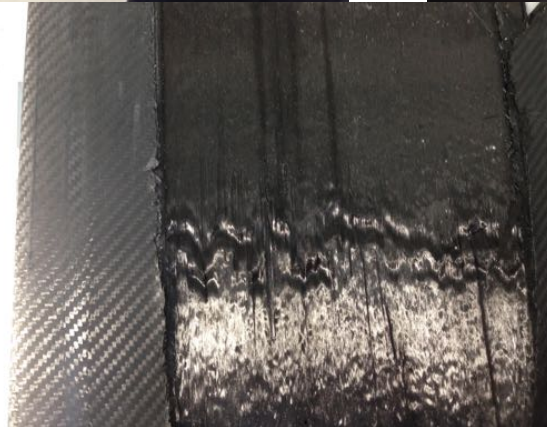
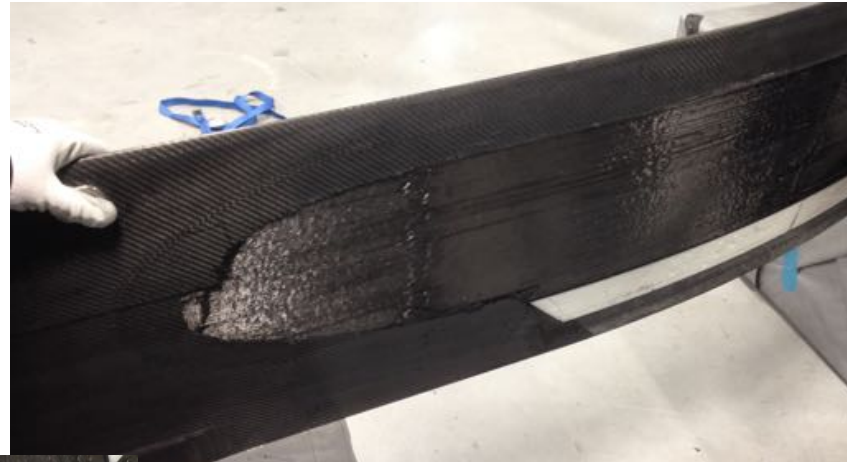


➤ Structures – the real world



LAND ROVER **BAR**

➤ Structures – the real world



LAND ROVER **BAR**

➤ NDT use in the America's Cup world

- **Design Phase**

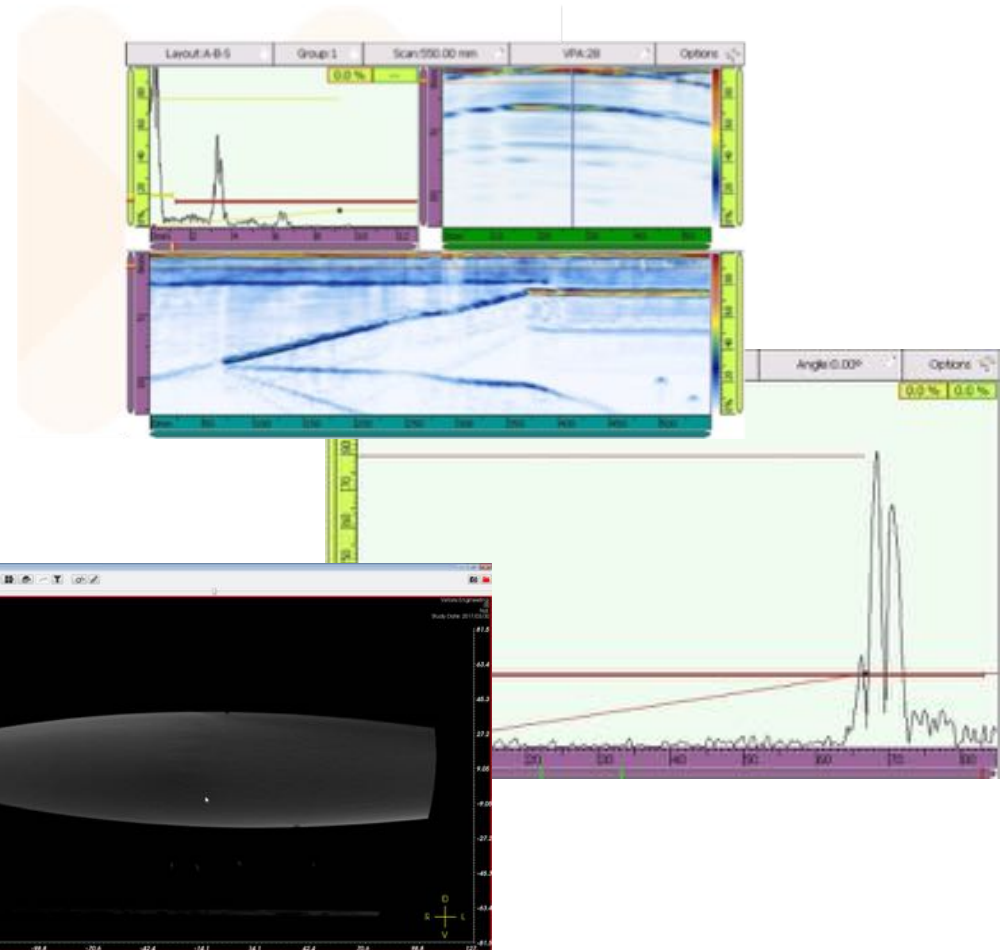
- Characterize designed defect sizes
- Calibration of NDT equipment reading at coupon level
- Setting acceptance criterias

- **Manufacturing Phase**

- Manufacturing process sign off
- Measurement of defects for further FEA analysis
- Support during the proof loading/acceptance structural testing

- **Service Phase**

- Health monitoring of structural components
- Assessments of damage areas
- Sign off of repairs



LAND ROVER BAR

> NDT toolbox

- **Ultrasonic equipment**

- A-scan and phase array scan
- Primary NDT tool for spotting defects requiring further analysis
- Referenced phase array scan created for service phase monitoring

- **AE equipment**

- Use as support during the proof loading/acceptance structural testing

- **Thermography**

- Part of the tool box for final acceptance at the end of the manufacturing phase

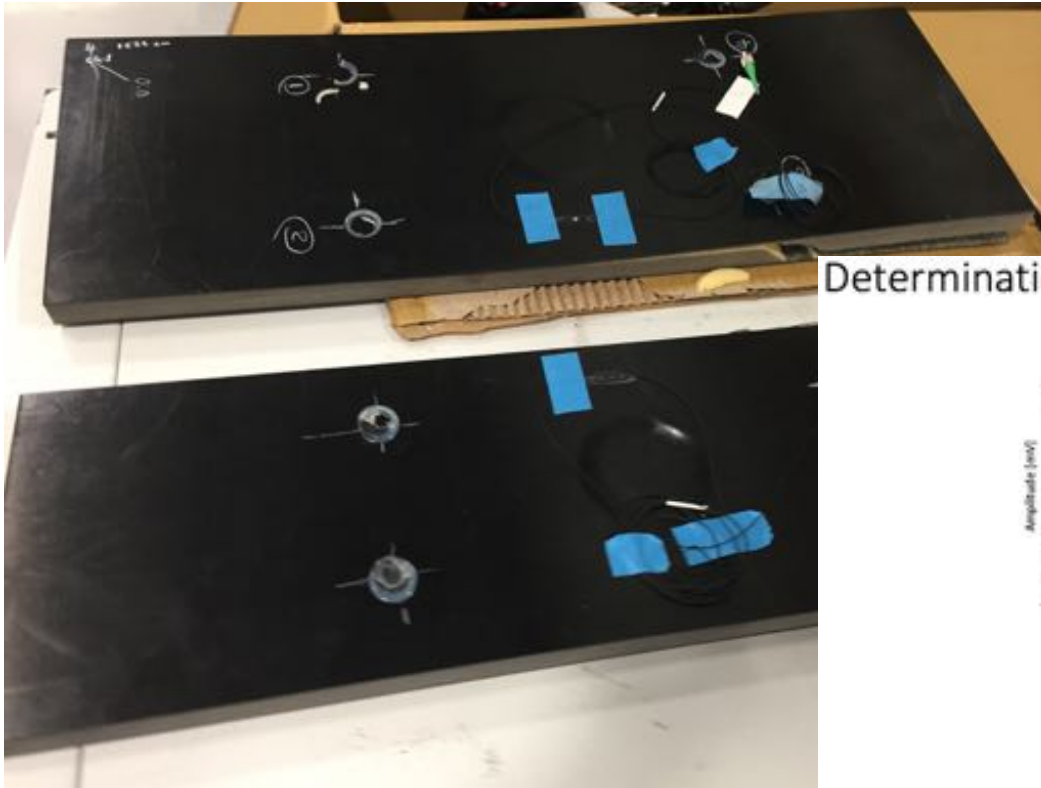
- **Tomography**

- Part of the tool box for final acceptance at the end of the manufacturing phase
- Results used as support for UT A-scan

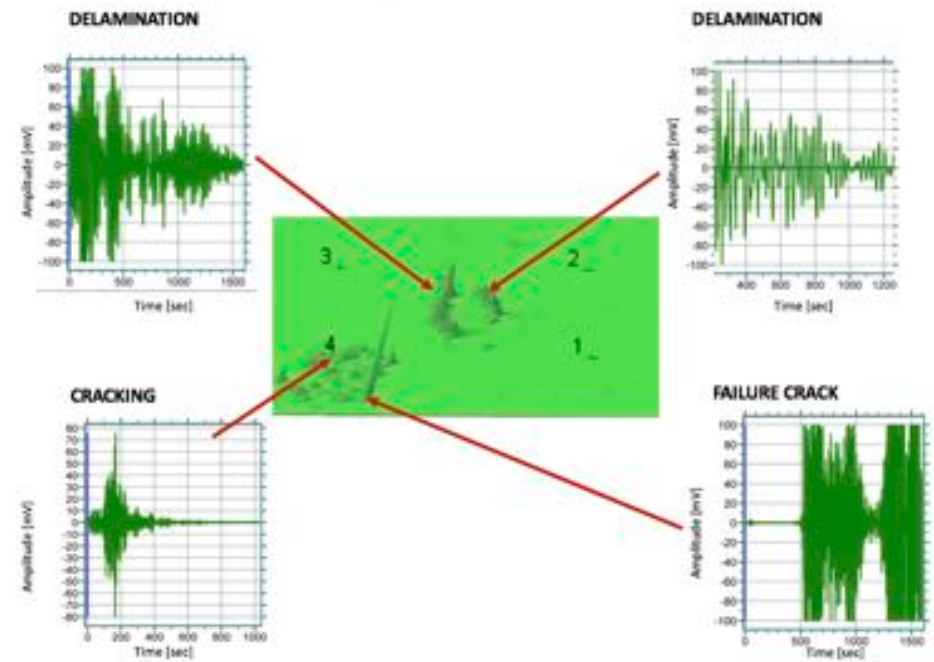


LAND ROVER BAR

➤ NDT toolbox – defect characterization



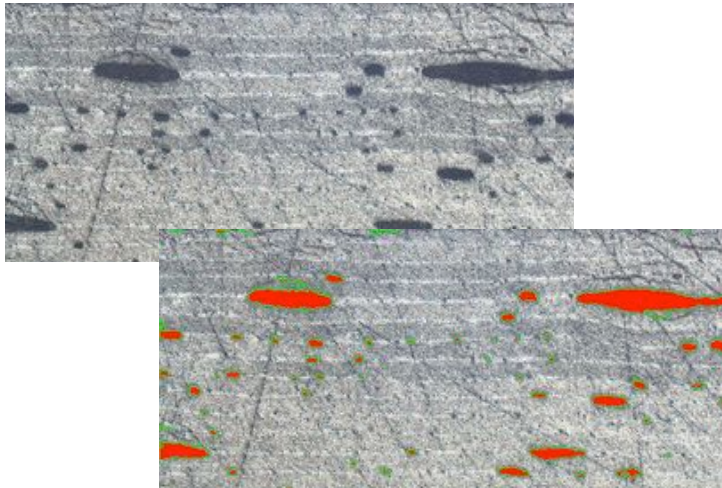
Determination of Mechanism by Acoustic Emission Waveform Analysis



➤ Structural testing

- **Coupon level**

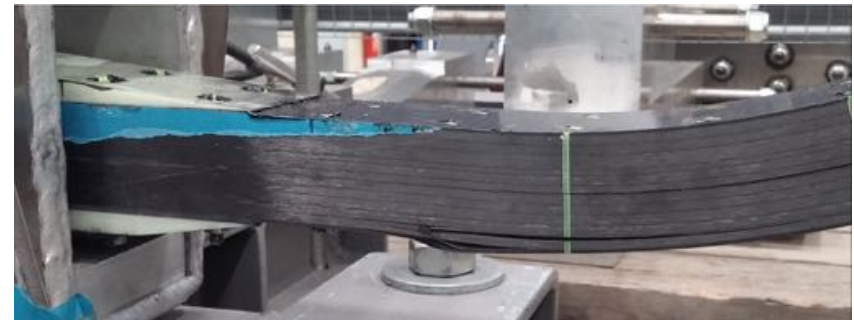
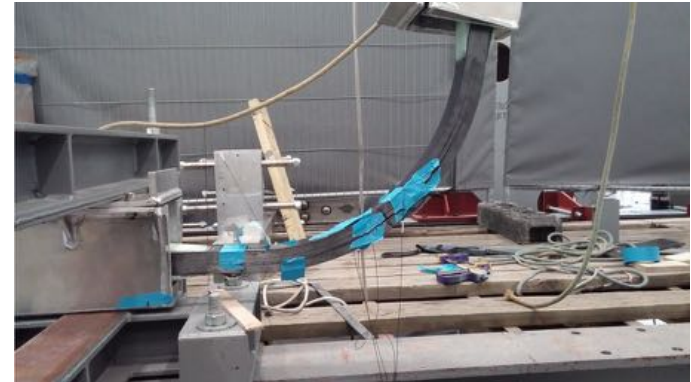
- Characterize materials
- Material properties/allowables
- Quality checks



LAND ROVER **BAR**

Structural testing

- **Coupon level**
 - Characterize materials
 - Material properties/allowables
 - Quality checks
- **Substructure level**
 - Manufacturing/processing methods
 - Analysis correlation



LAND ROVER **BAR**

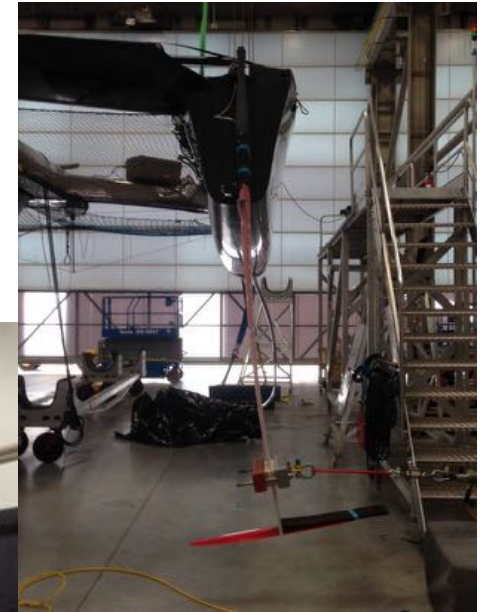
➤ Structural testing

- **Coupon level**
 - Characterize materials
 - Material properties/allowables
 - Quality checks
- **Substructure level**
 - Manufacturing/processing methods
 - Analysis correlation
- **Component level**
 - Proof loading/acceptance testing
 - Performance correlation
 - Instrumentation calibration



➤ Structural testing

- **Coupon level**
 - Characterize materials
 - Material properties/allowables
 - Quality checks
- **Substructure level**
 - Manufacturing/processing methods
 - Analysis correlation
- **Component level**
 - Proof loading/acceptance testing
 - Performance correlation
 - Instrumentation calibration
- **Assembly level**
 - Proof loading
 - Systems testing



> What's Next - AC36

- 2021, New Zealand
- 75 foot foiling Monohull
- More restrictions on physical testing- Further emphasis on simulation



LRBAR NDT collaborator

- Pierrepont Analysis Ltd (UK)
- Vetorix Engineering (IT)
- Pancom Ltd (UK)

LAND ROVER **BAR**



LAND ROVER **BAR**

Contact

Land Rover BAR

The Camber
East Street
Portsmouth
Hampshire
PO1 2JJ
United Kingdom

t. +44 (0)2392 287814

www.landroverbar.com

