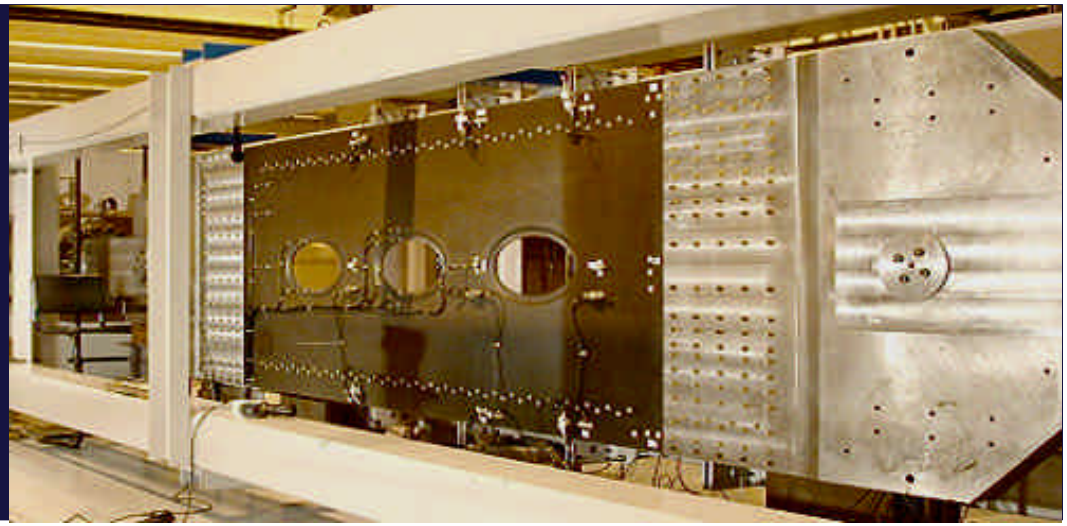
Presented by

Rob Ferguson
Structures Analysis - Composites



Large Scale Composite Testing at Airbus Filton Site

Outline

- Background
- Research Tests
  - Butt joint with bypass loading
  - Simple stiffened panel
  - Shear panel
  - Large stiffened panel
  - Composite/metallic joint panel
  - Composite/metallic joint
  - Wingbox tests
- Aircraft Tests – A340-500/600 J-nose
  - Structural proof
  - Leading edge impact

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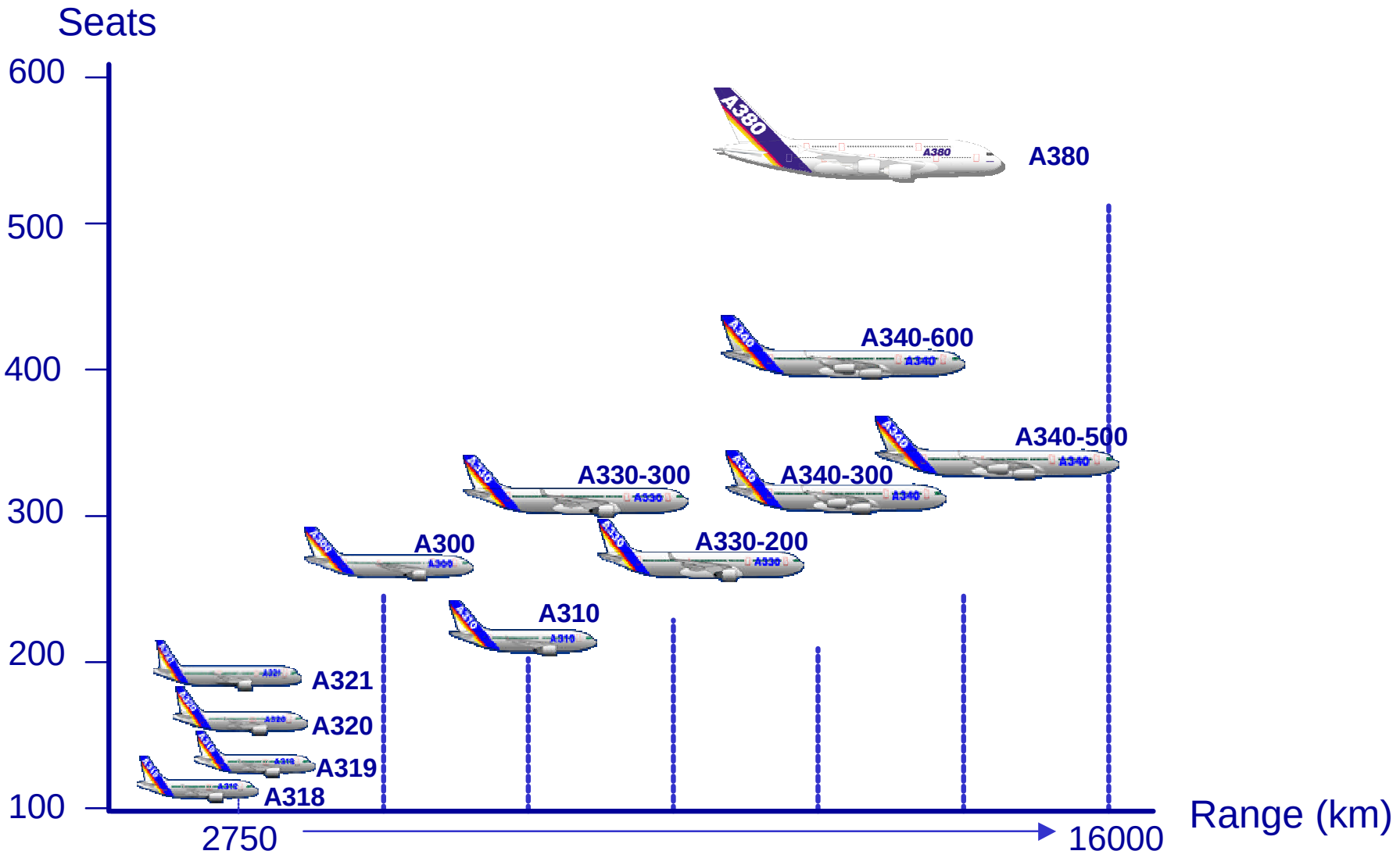
The Airbus Family – A Complete Range of Aircraft



Airbus Fleet: More than 3300 aircraft

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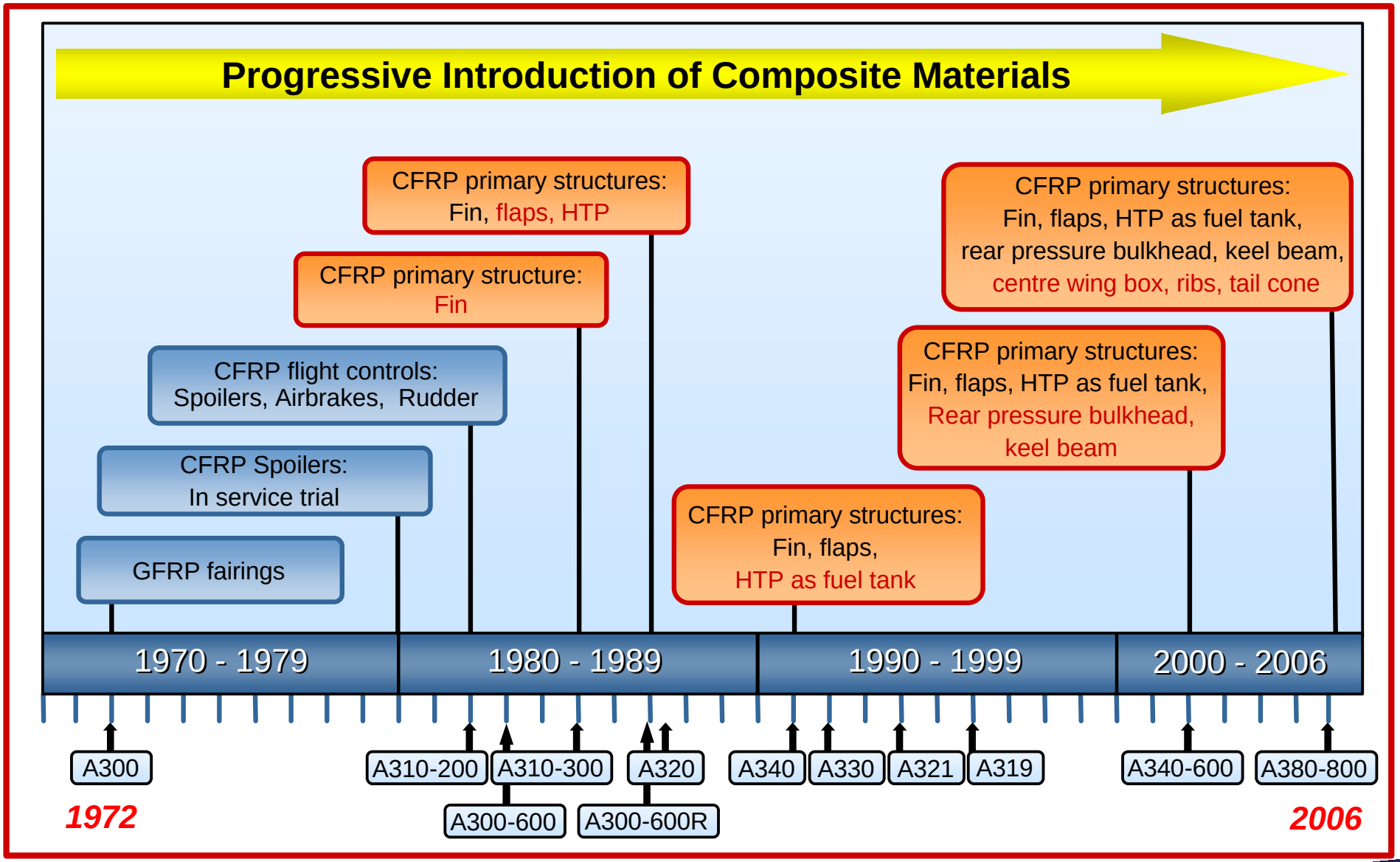
Composite Materials in Airbus Aircraft



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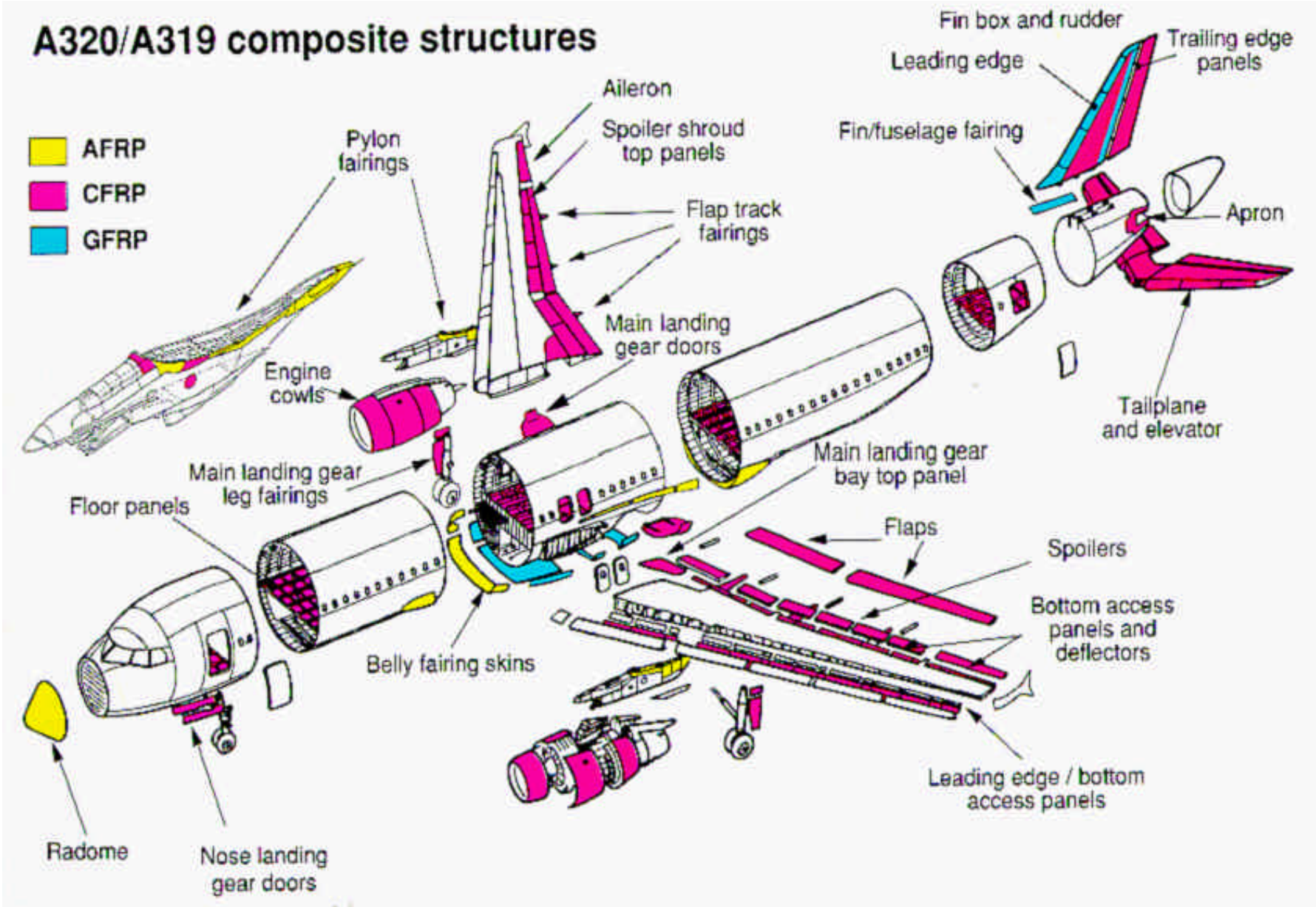
Composites on Airbus A320 Family



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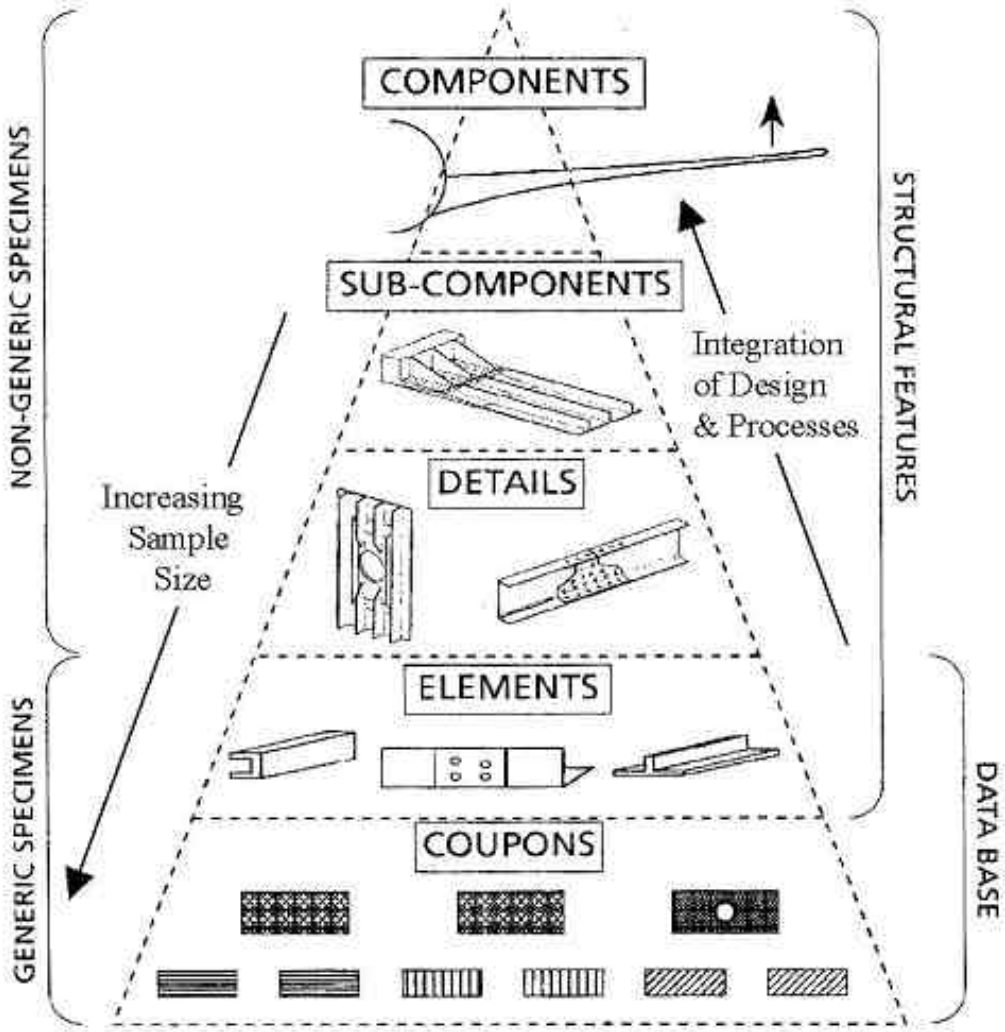
Large Scale Testing

- "Large Scale" =
  - Component
  - Sub-component
  - Detail
- Purpose
  - Validate structural analysis
  - Support certification
- Approach
  - Test article design is specific to a particular structure/aircraft
  - Consider multiple/complex load cases
  - Environmental effects through Load Enhancement Factors



"Pyramid of Test" from MIL-HDBK-17

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Research Tests

- Large scale testing carried out under various projects:
  - TANGO (Technology Application to Near Term Business Goals and Objectives)
  - CASCADE (Civil Aircraft Structural Composites – Application Development & Exploitation)
  - HLIE (High Load Input Element)
  - AMCAPS II (Affordable Manufacture of Composite Aircraft Primary Structure)
  - Airbus internal test programmes
- Objective:
  - Gather data to validate and enhance structural analysis methods and tools

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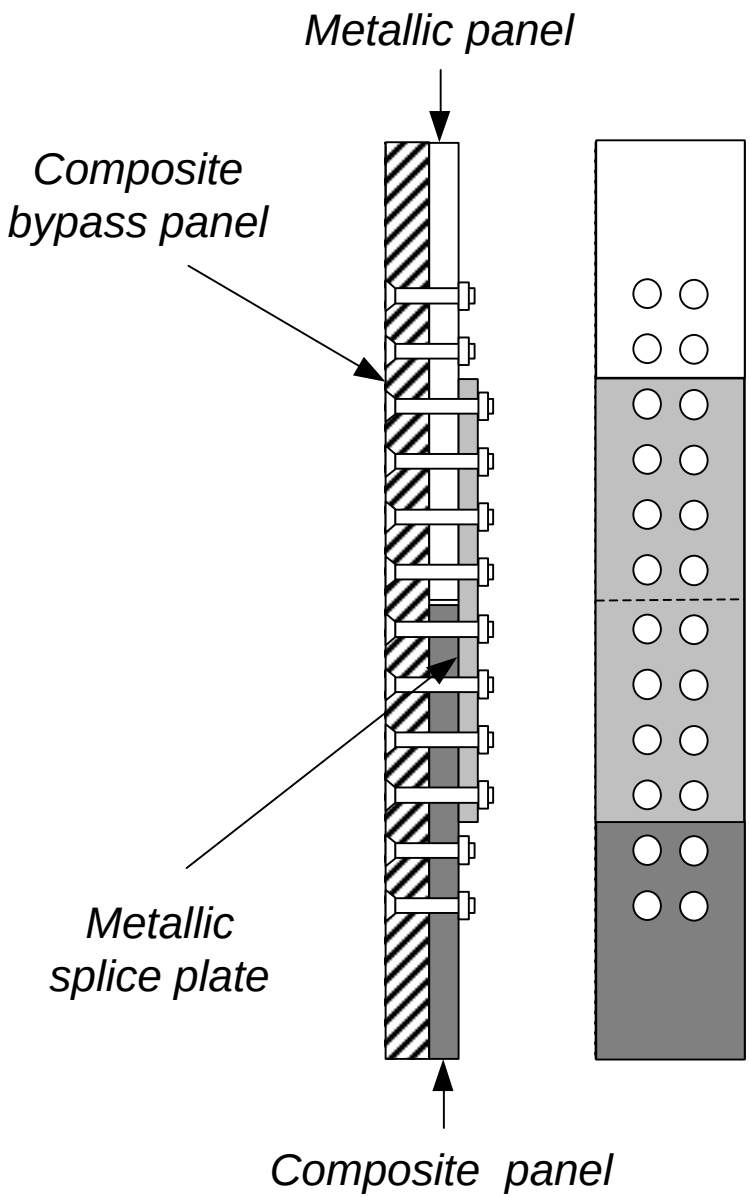
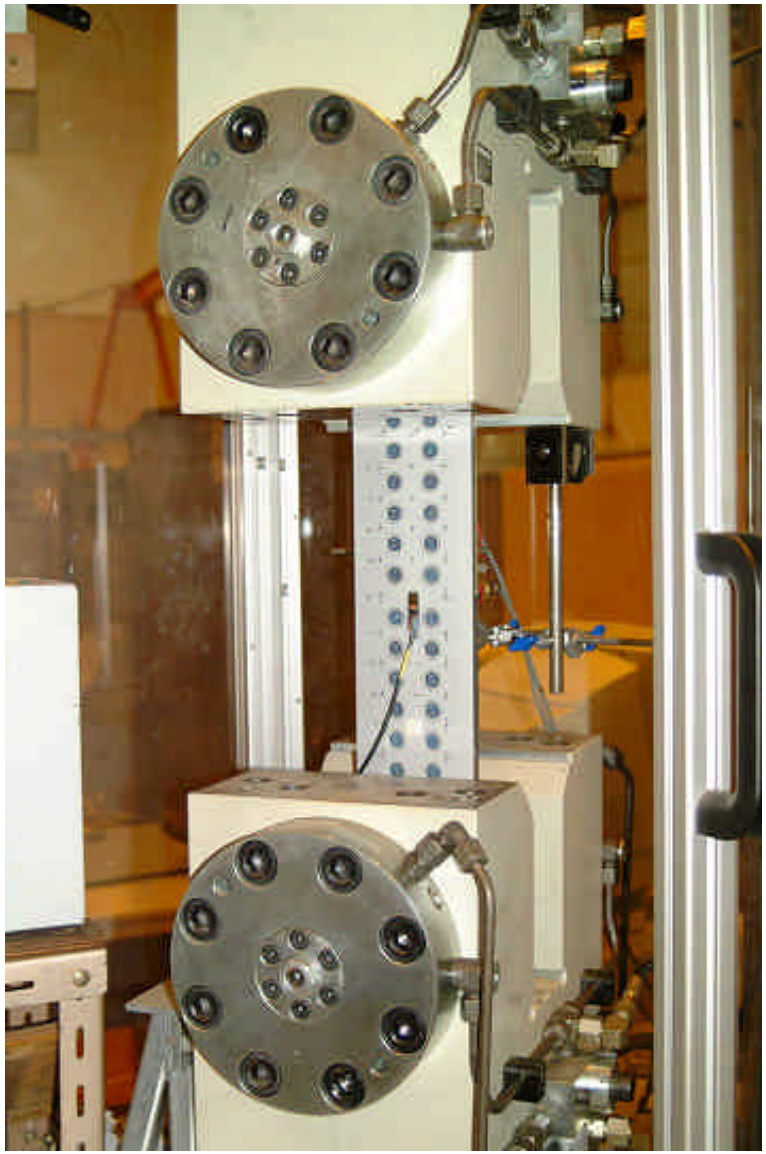
Butt Joint With Bypass: Tensile Test
(TANGO Research Project)





Test article in tensile load frame

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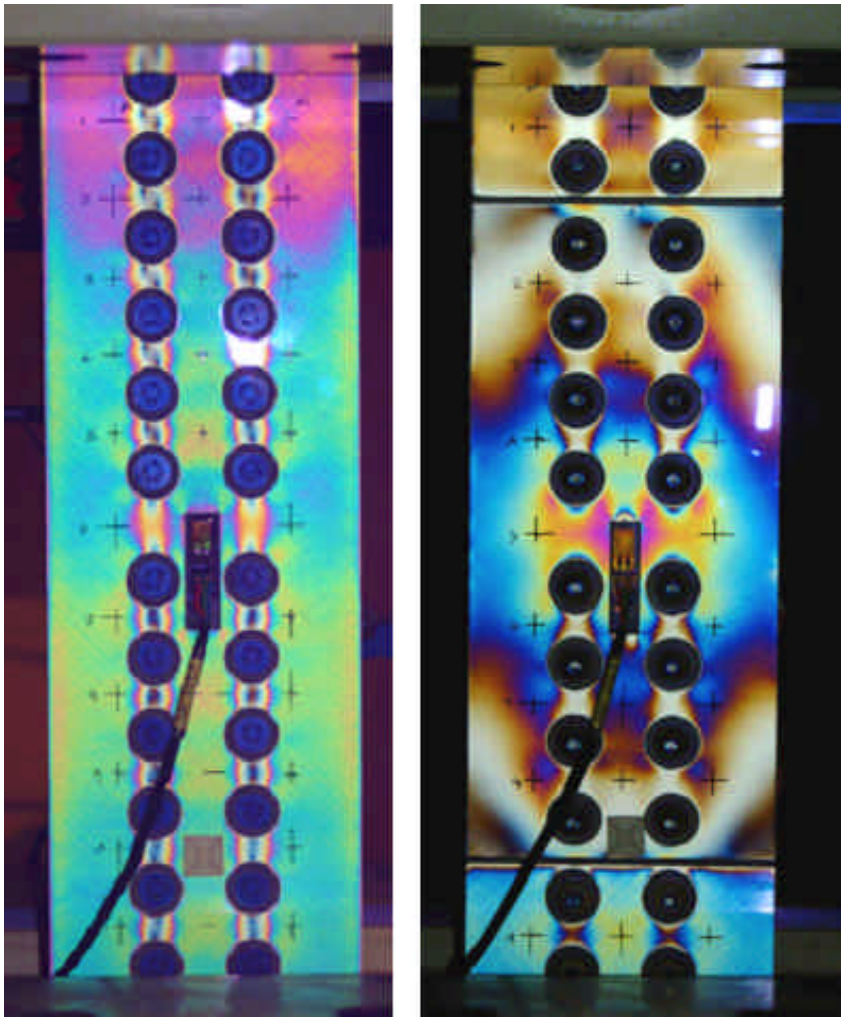
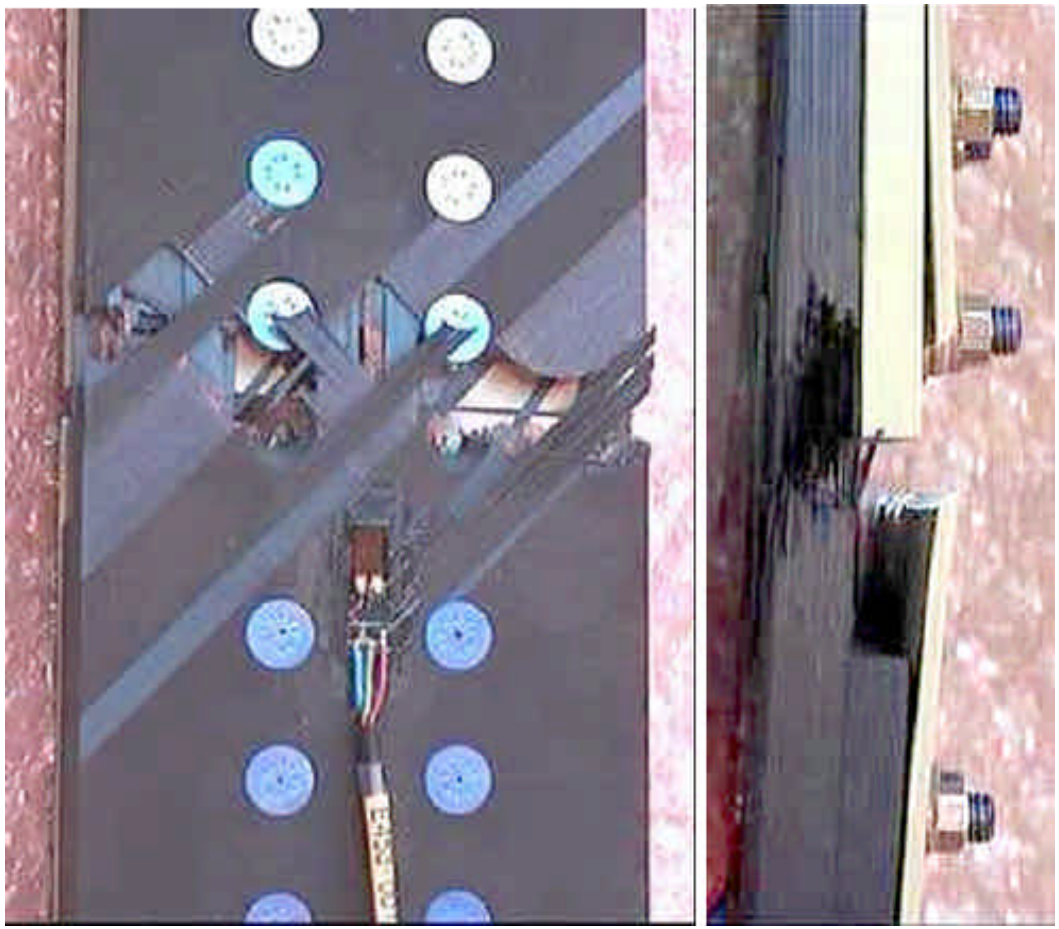
Butt Joint With Bypass: Tensile Test
(TANGO Research Project)



In-plane strain (photoelastic) response of composite face (left) and metallic face (right)



After test - composite face (left); side view (right)

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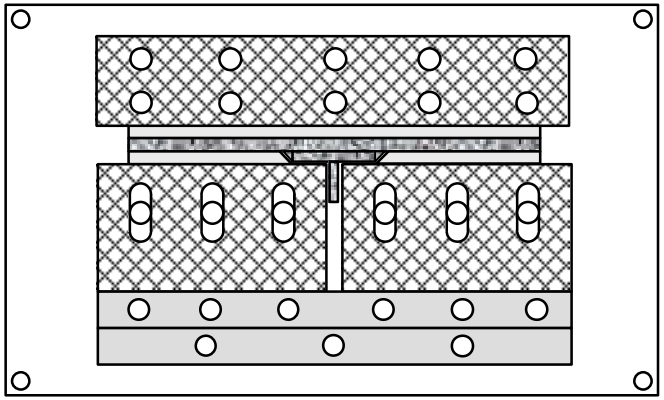
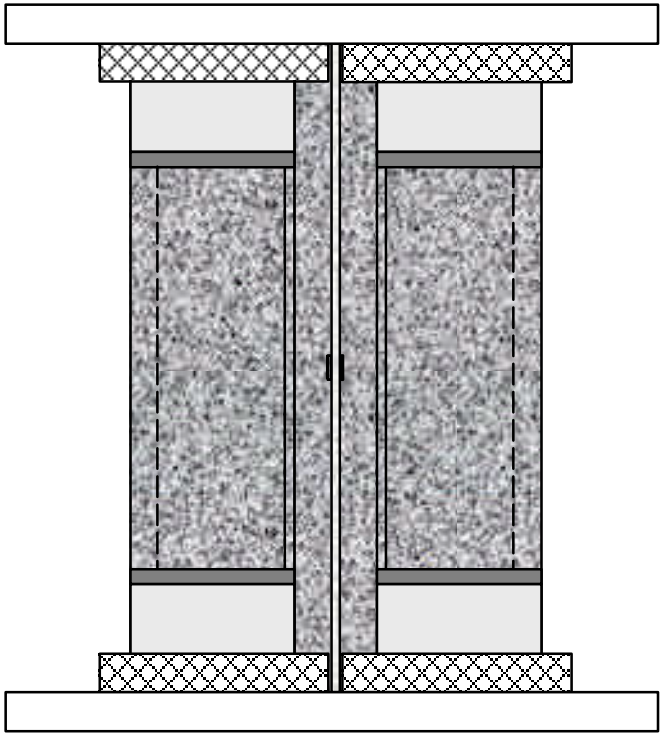
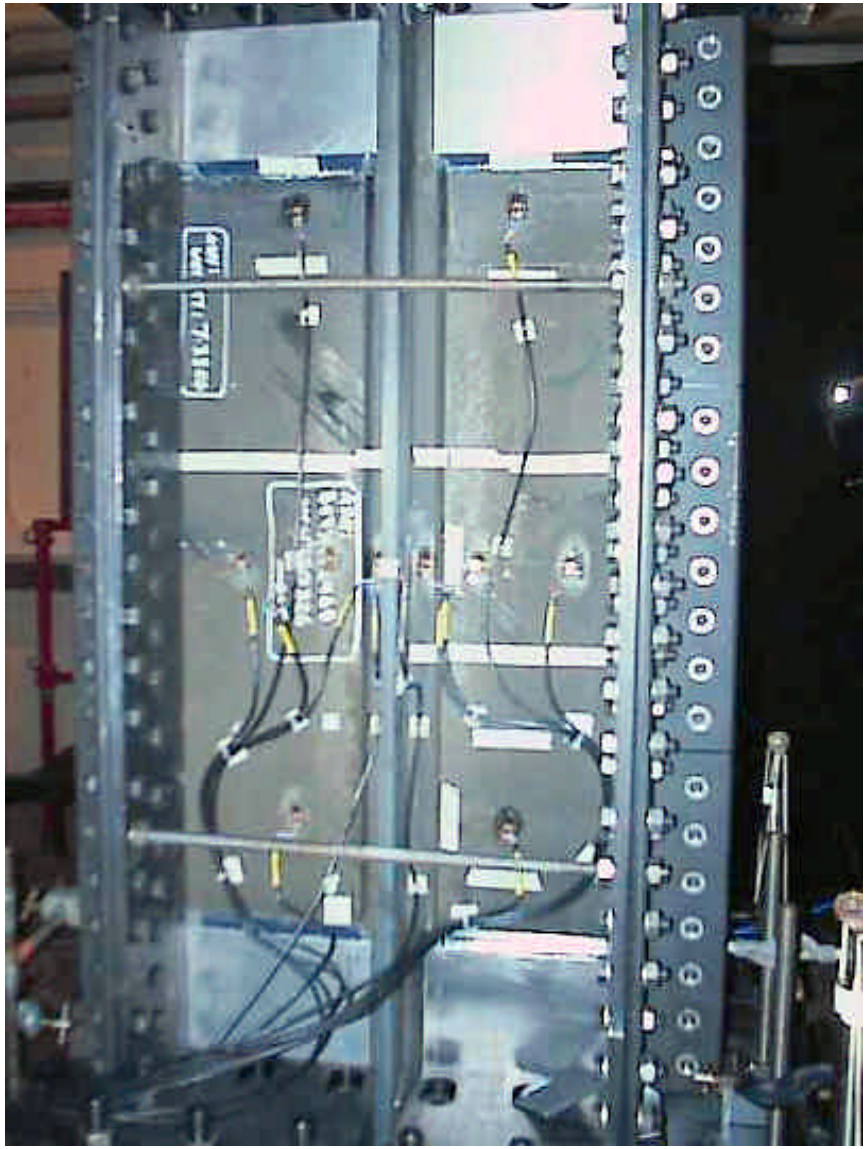
Simple Stiffened Panel: Compression Test
(Airbus Internal Research Project)







Test article showing anti-buckling guides

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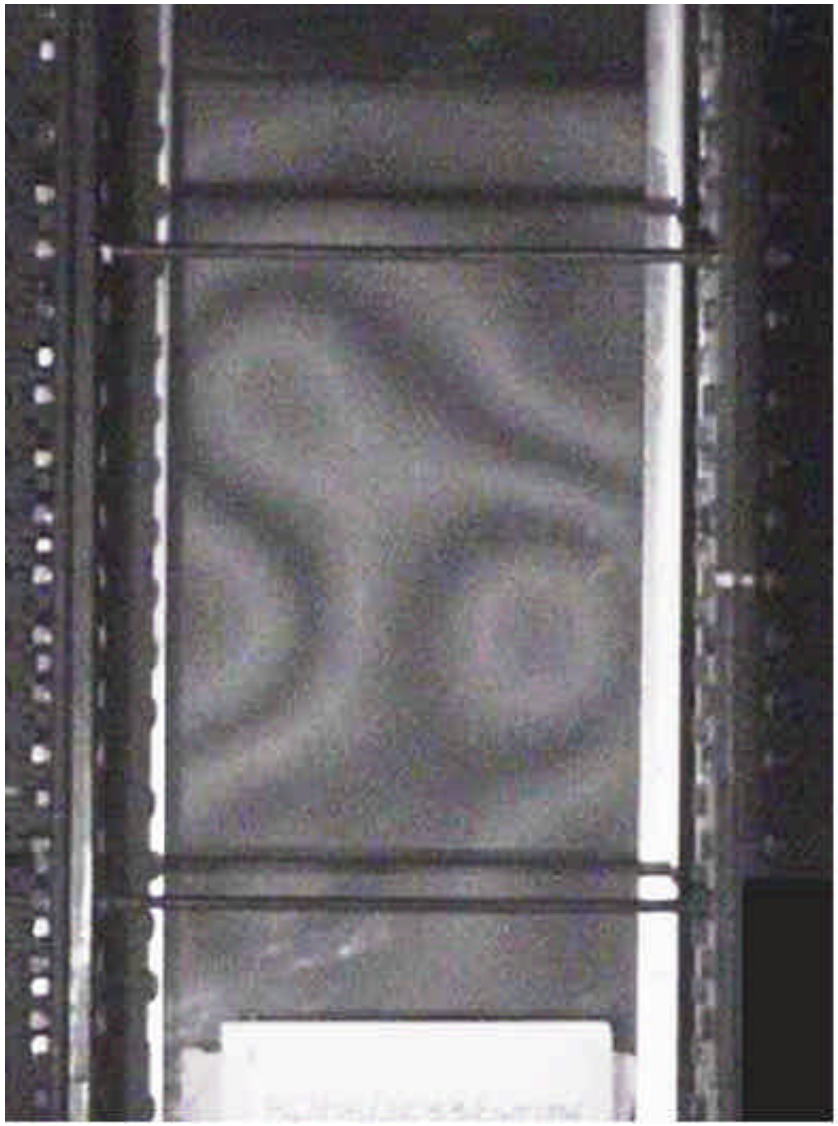
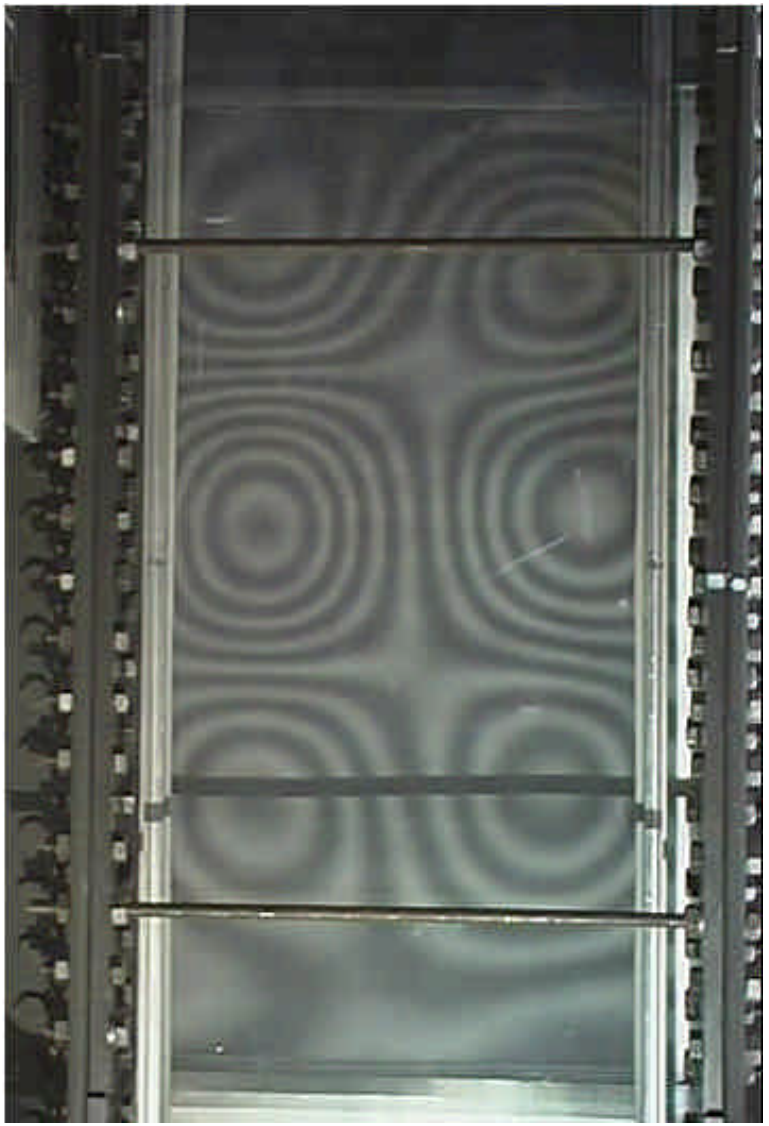
Simple Stiffened Panel: Compression Test
(Airbus Internal Research Project)





Out-of plane displacement (Moiré fringe) response of flat face showing development of buckling modes

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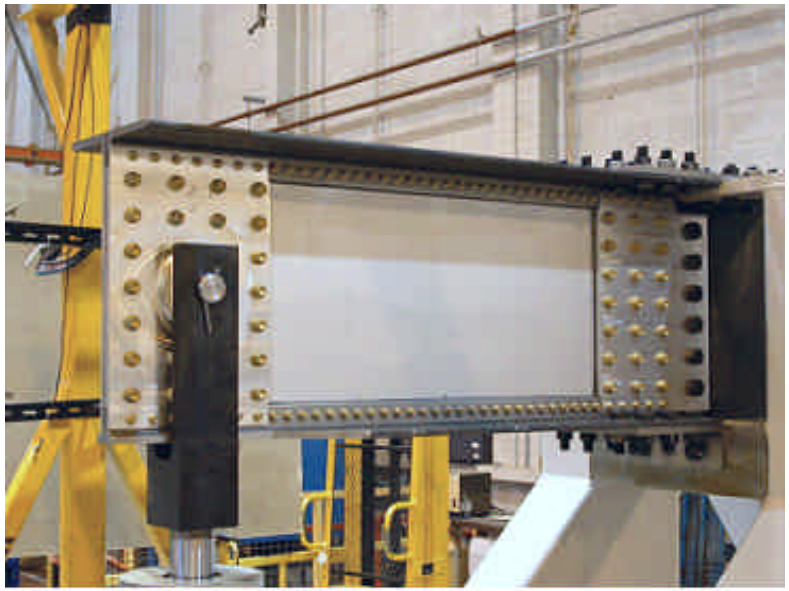
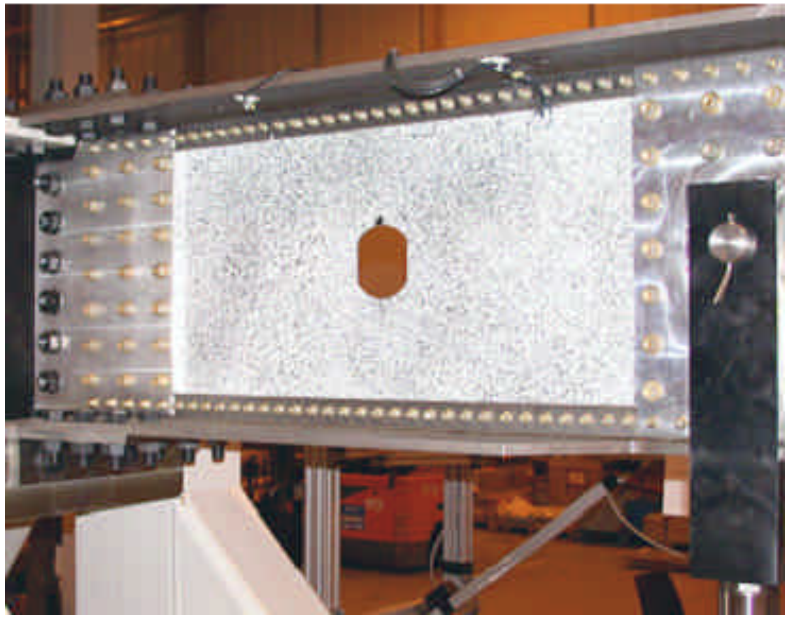
Shear Panel: Cantilever Bend Shear Test
(TANGO Research Project)





Shear panel in cantilever bend rig – plain panel (top left) and panel with access hole (left and above)

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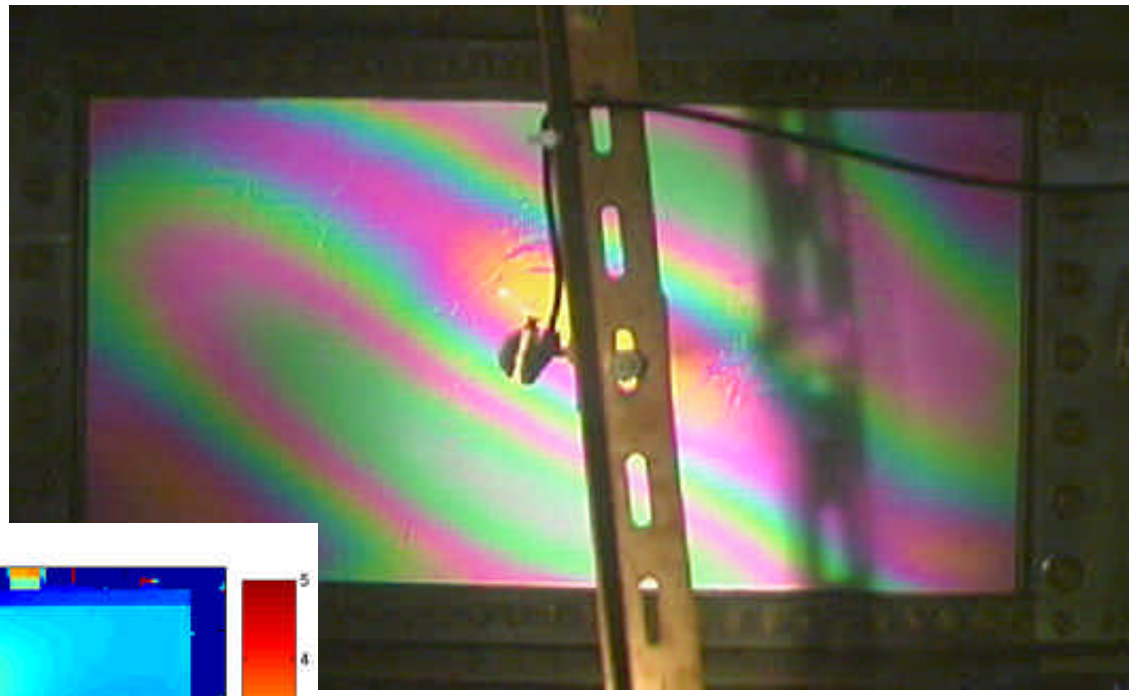
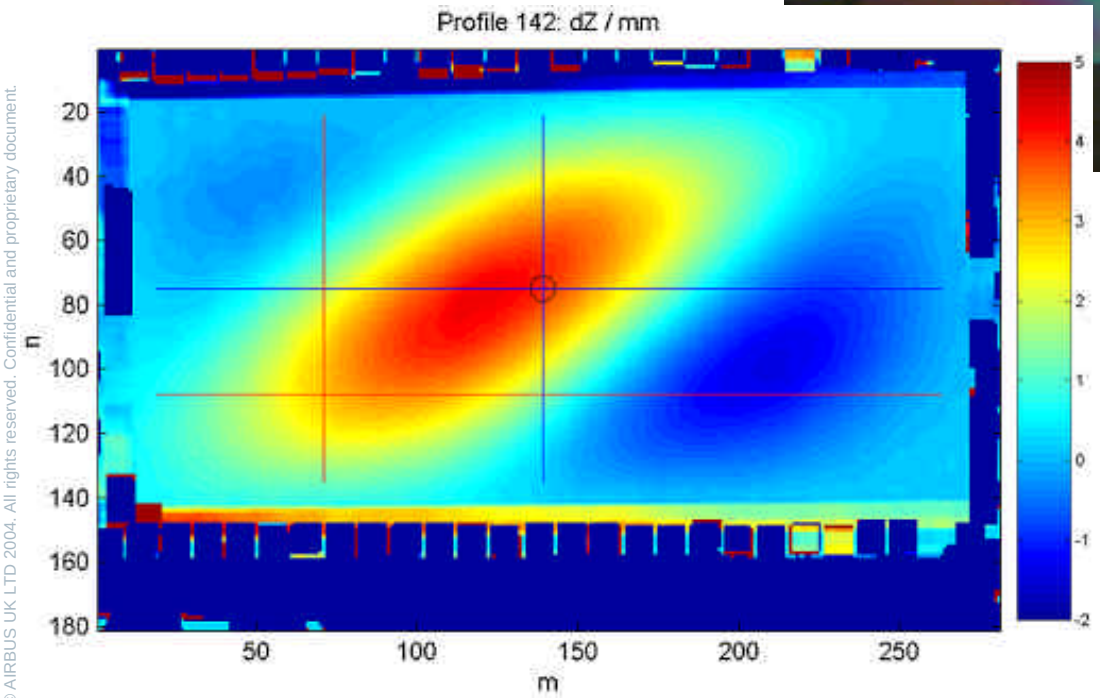
Shear Panel: Cantilever Bend Shear Test
(TANGO Research Project)

In-plane strain (photoelastic) response of plain shear panel





Out-of-plane displacement (Shape Measurement System) response of plain shear panel

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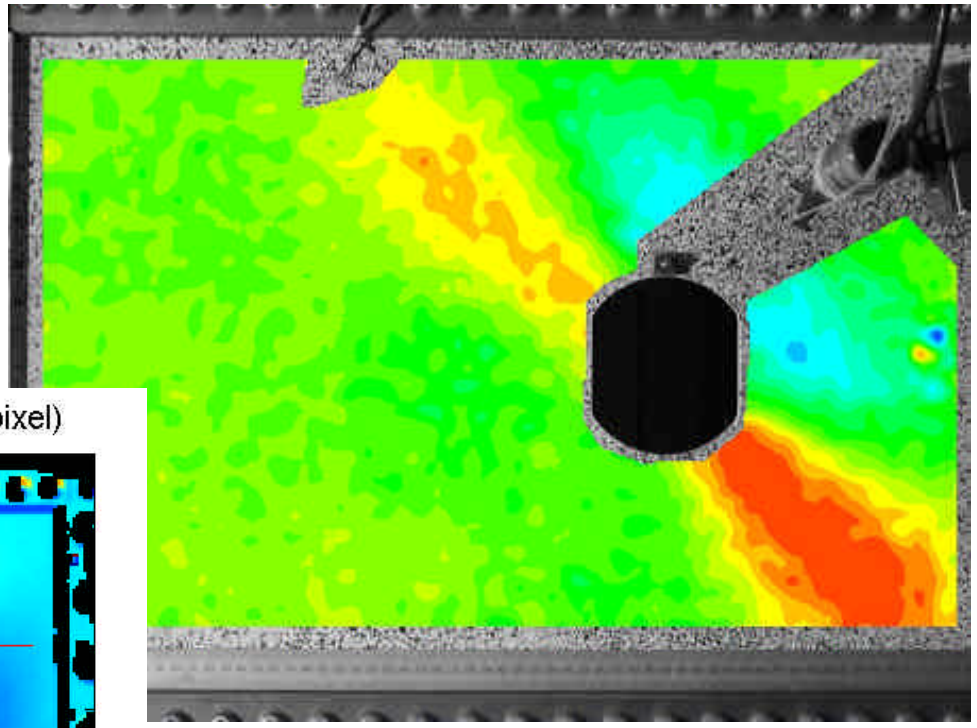
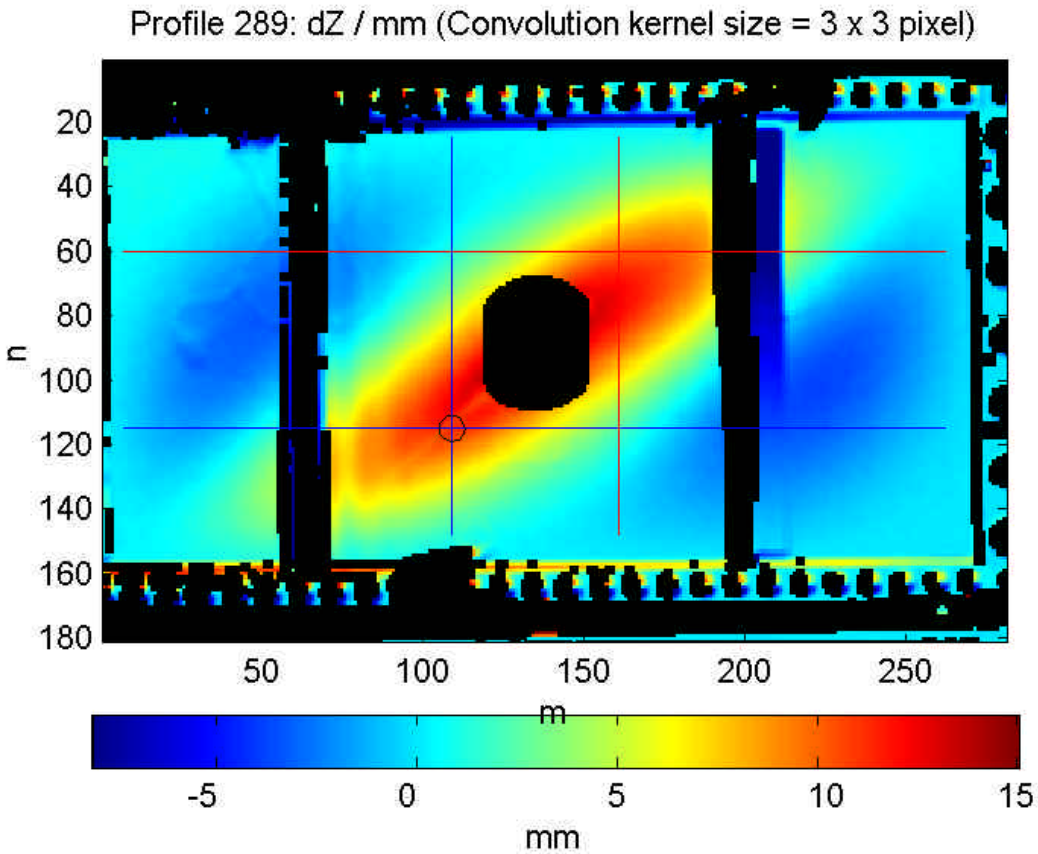
Shear Panel: Cantilever Bend Shear Test
(TANGO Research Project)

In-plane shear strain (Image Correlation) response of panel with access hole





Out-of-plane displacement (Shape Measurement System) response of panel with access hole

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Large Stiffened Panel: Tensile Test
(CASCADE Research Project)

Large stiffened panel – flat and stiffened faces

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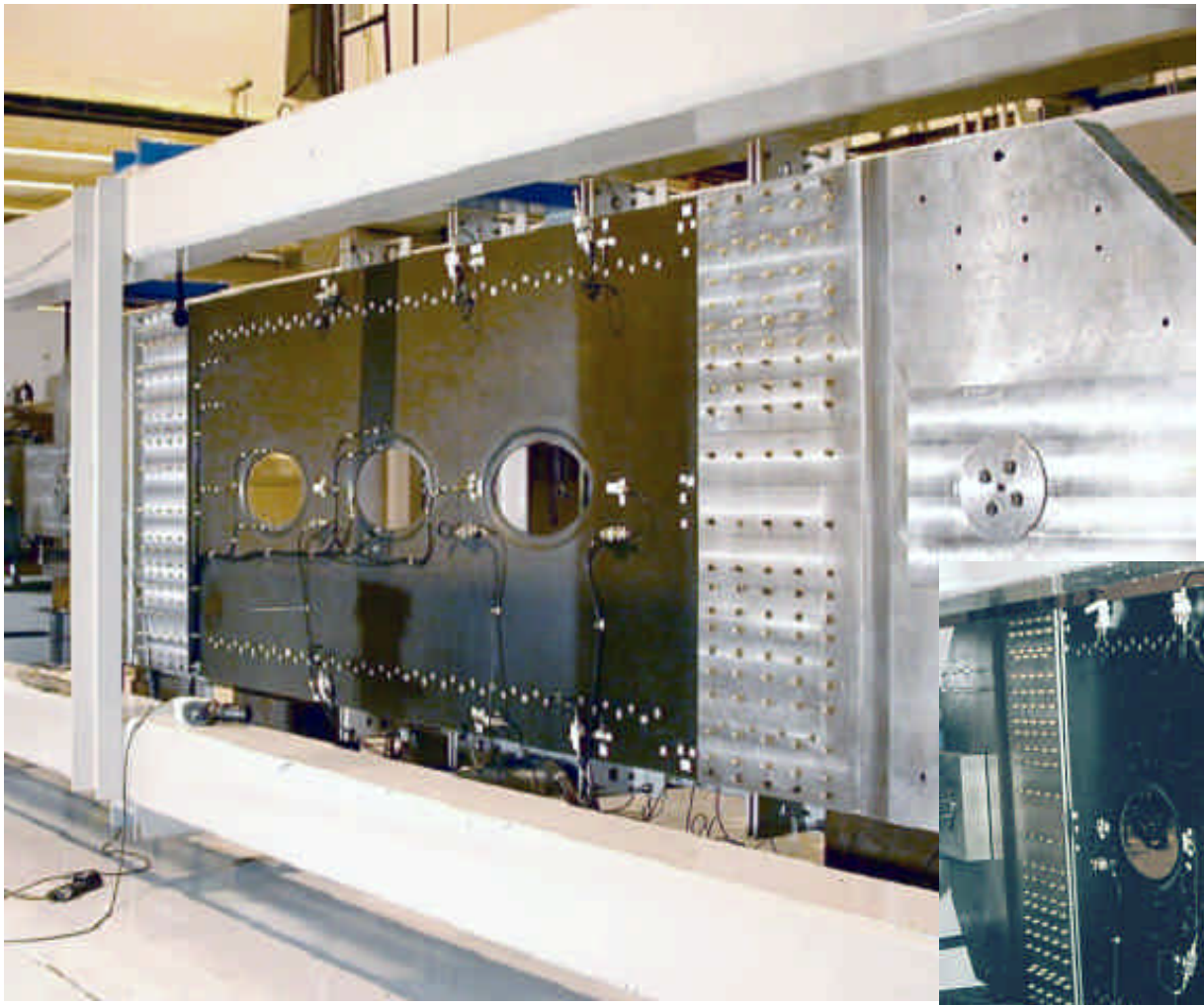
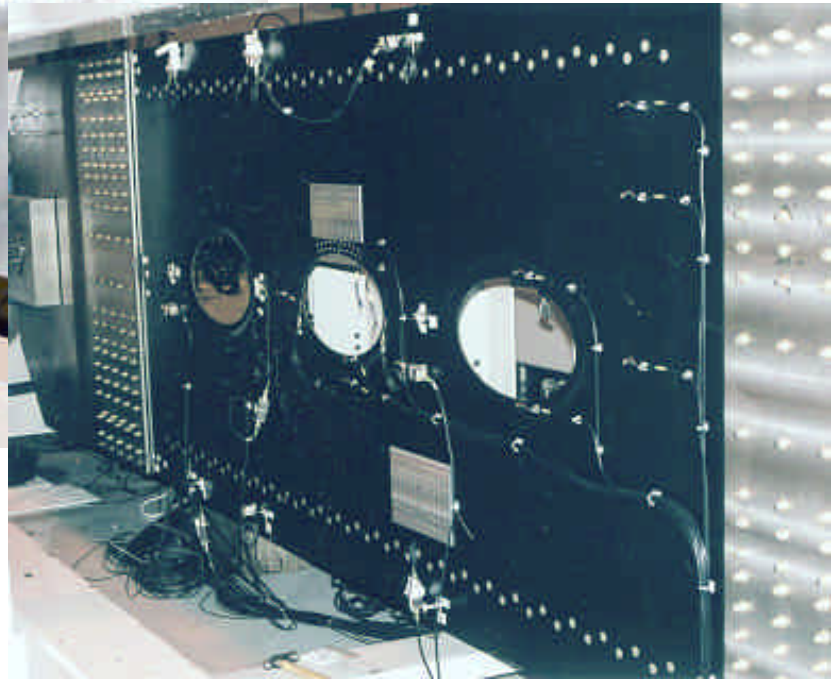
Large Stiffened Panel: Tensile Test
(CASCADE Research Project)





Panel ready for proof test (above) and with artificial damage and repairs (right)

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Composite / Metallic Panel Joint: Compression Test
(Airbus Internal Research Project)

Front and rear views of test article in compression load frame

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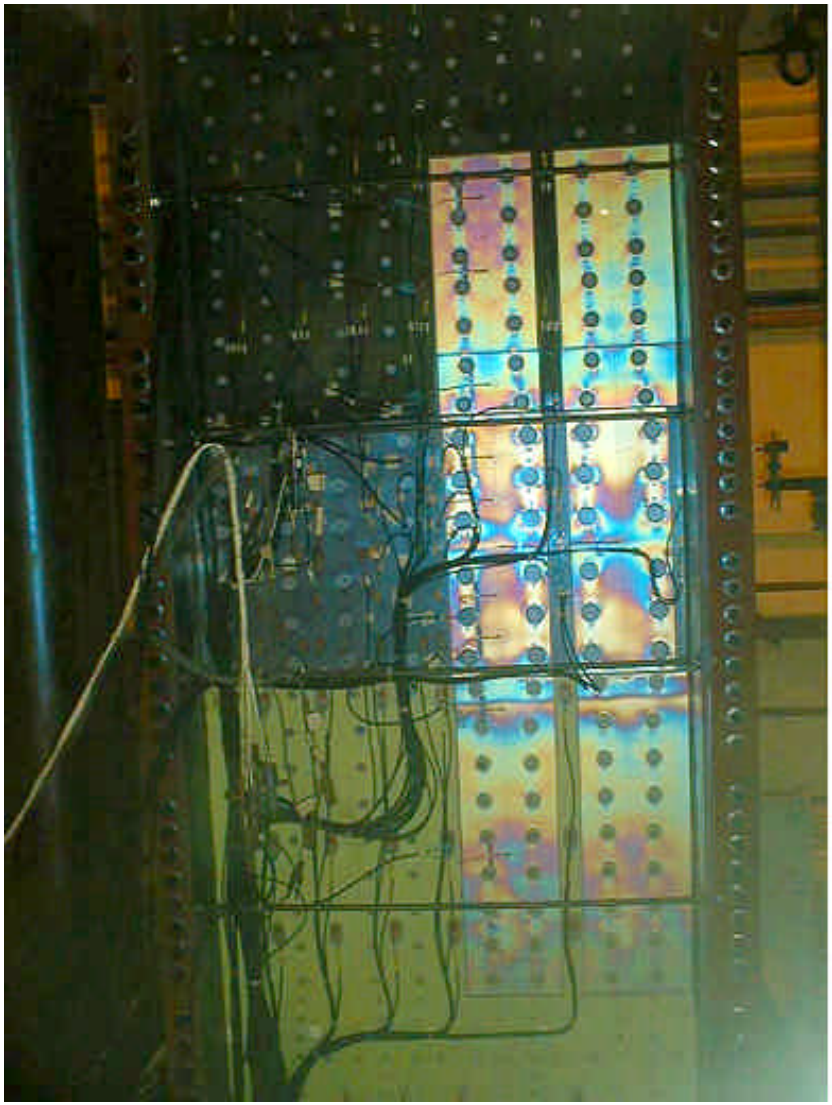
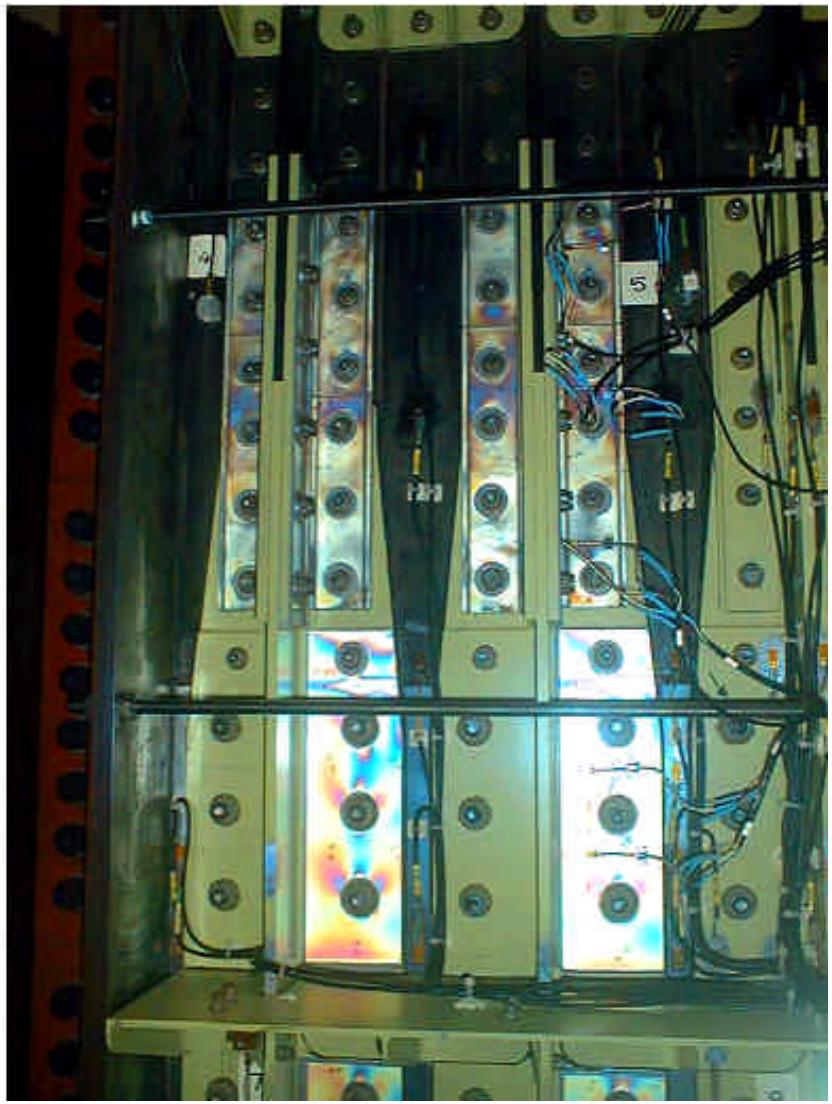
Composite / Metallic Panel Joint: Compression Test
(Airbus Internal Research Project)





In-plane strain (photoelastic) response of flat face (left) and stiffened face (right)

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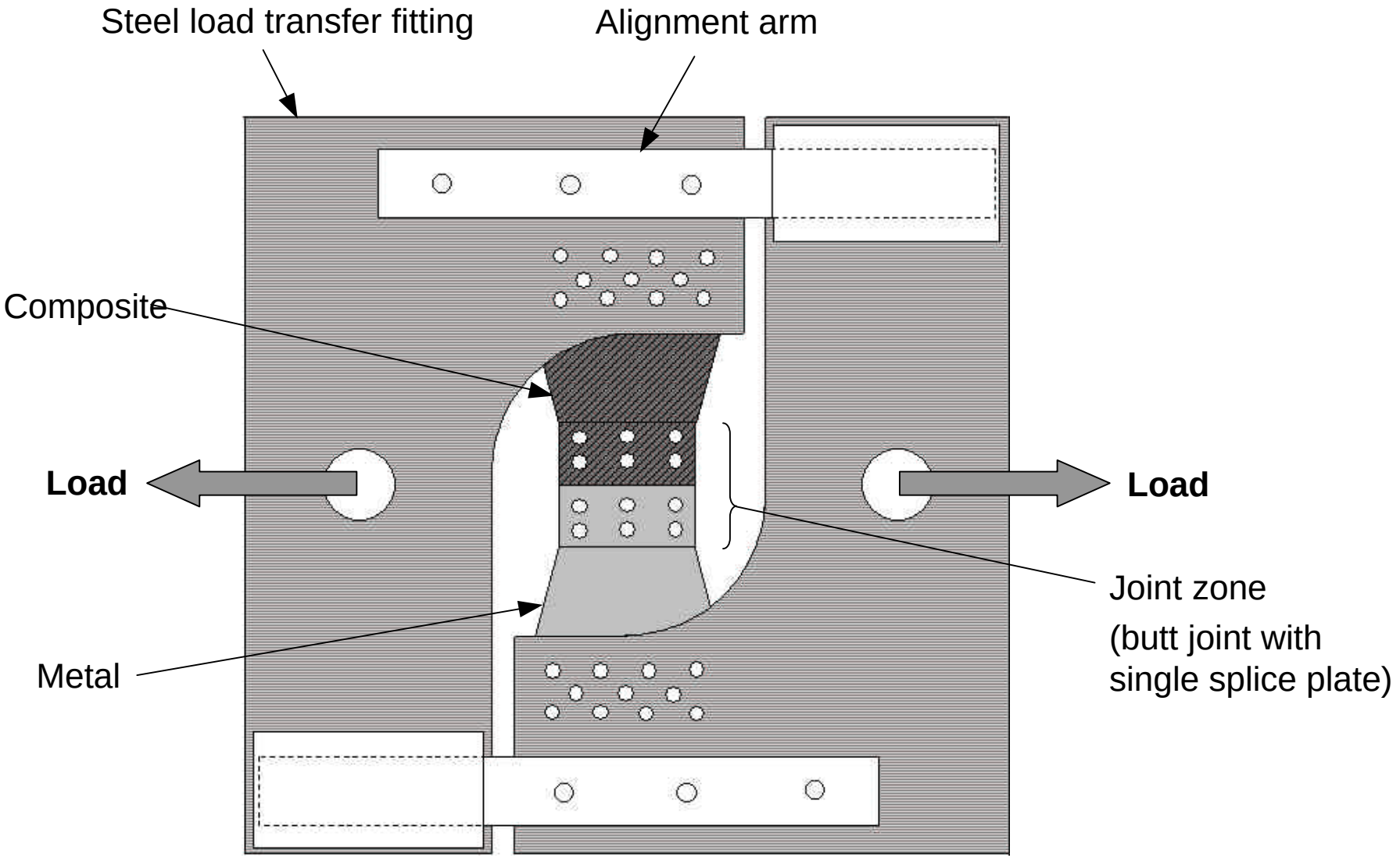
Composite / Metallic Joint: “Glyn Jones” Shear Test
(TANGO Research Project)



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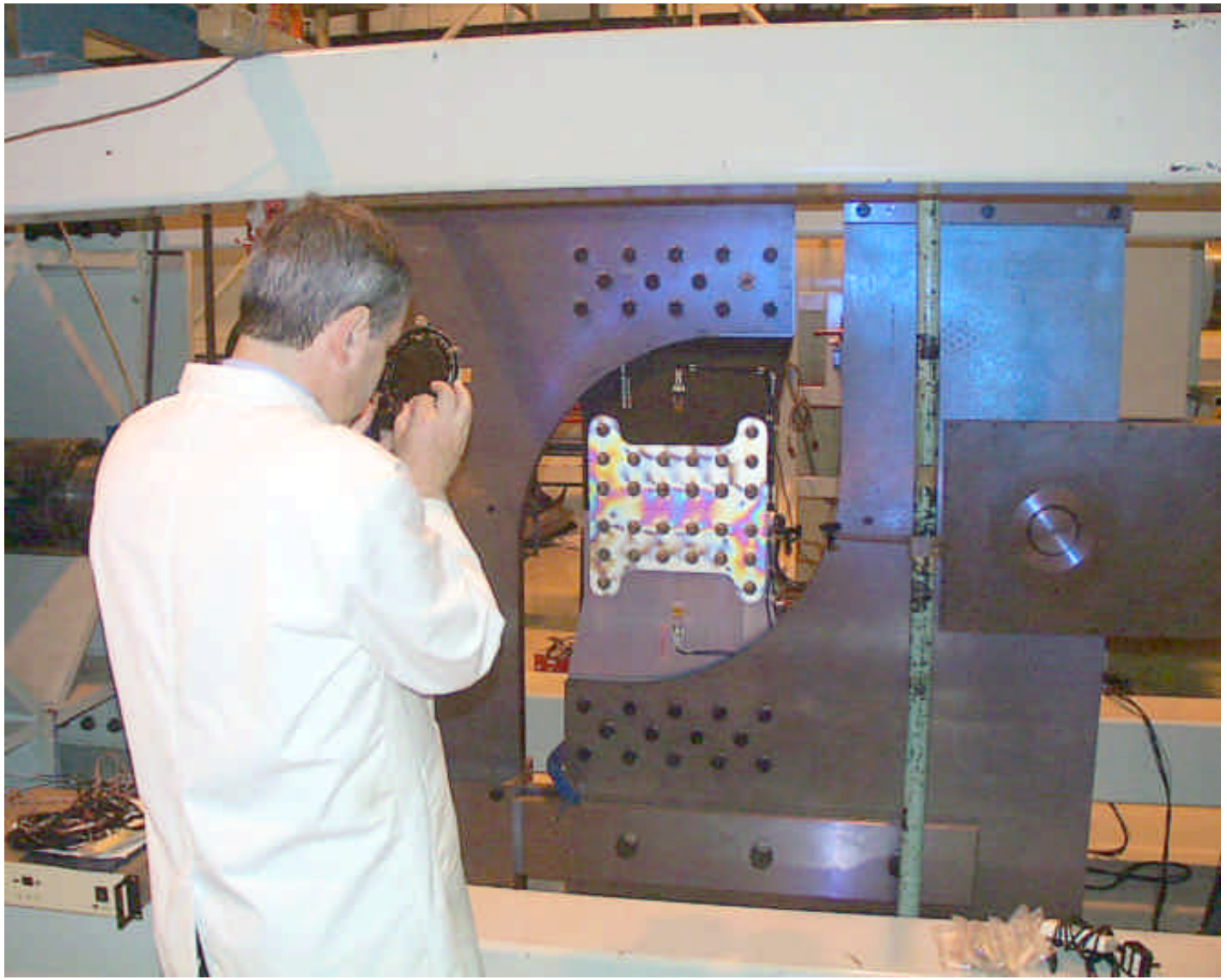
Composite / Metallic Joint: “Glyn Jones” Shear Test
(TANGO Research Project)



Test article in loading rig

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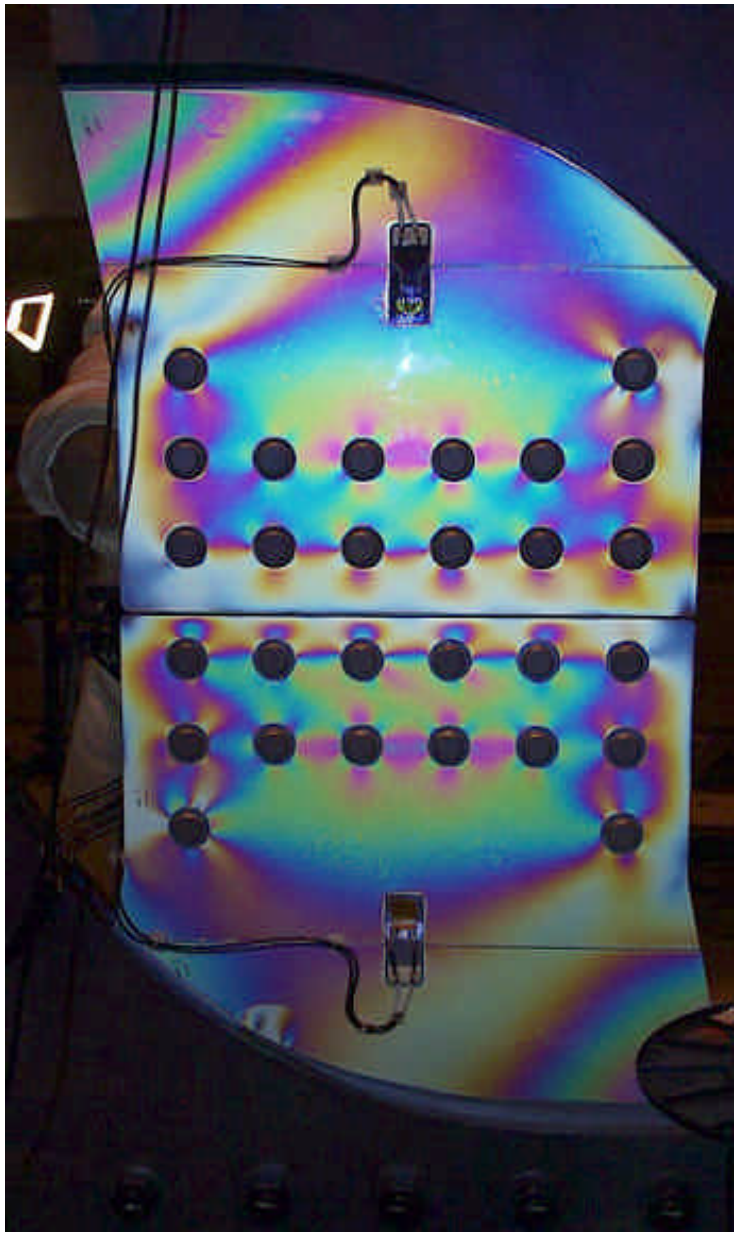
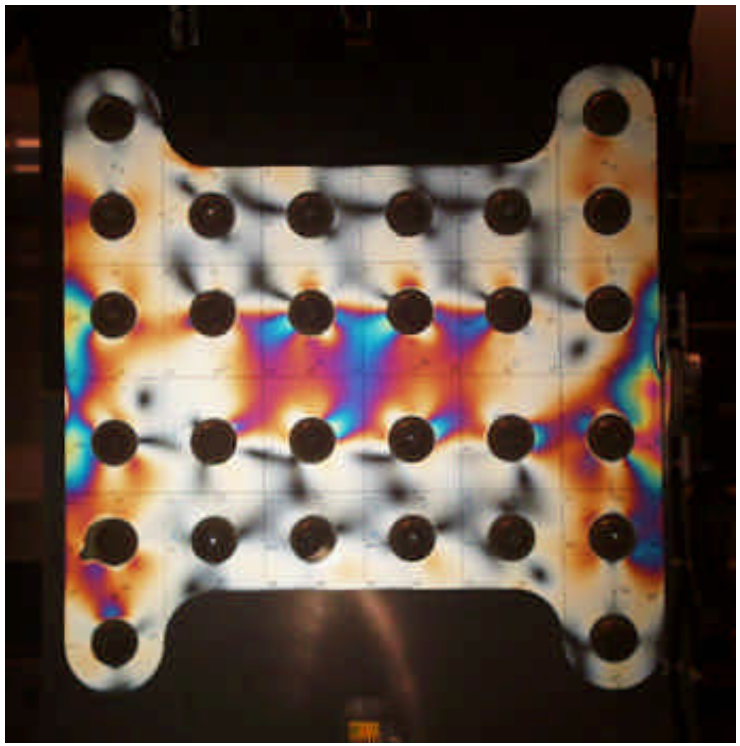
Composite / Metallic Joint: “Glyn Jones” Shear Test
(TANGO Research Project)



Composite panel

Metallic panel



In-plane strain (photoelastic) response of butt joint (left) and splice plate (right)

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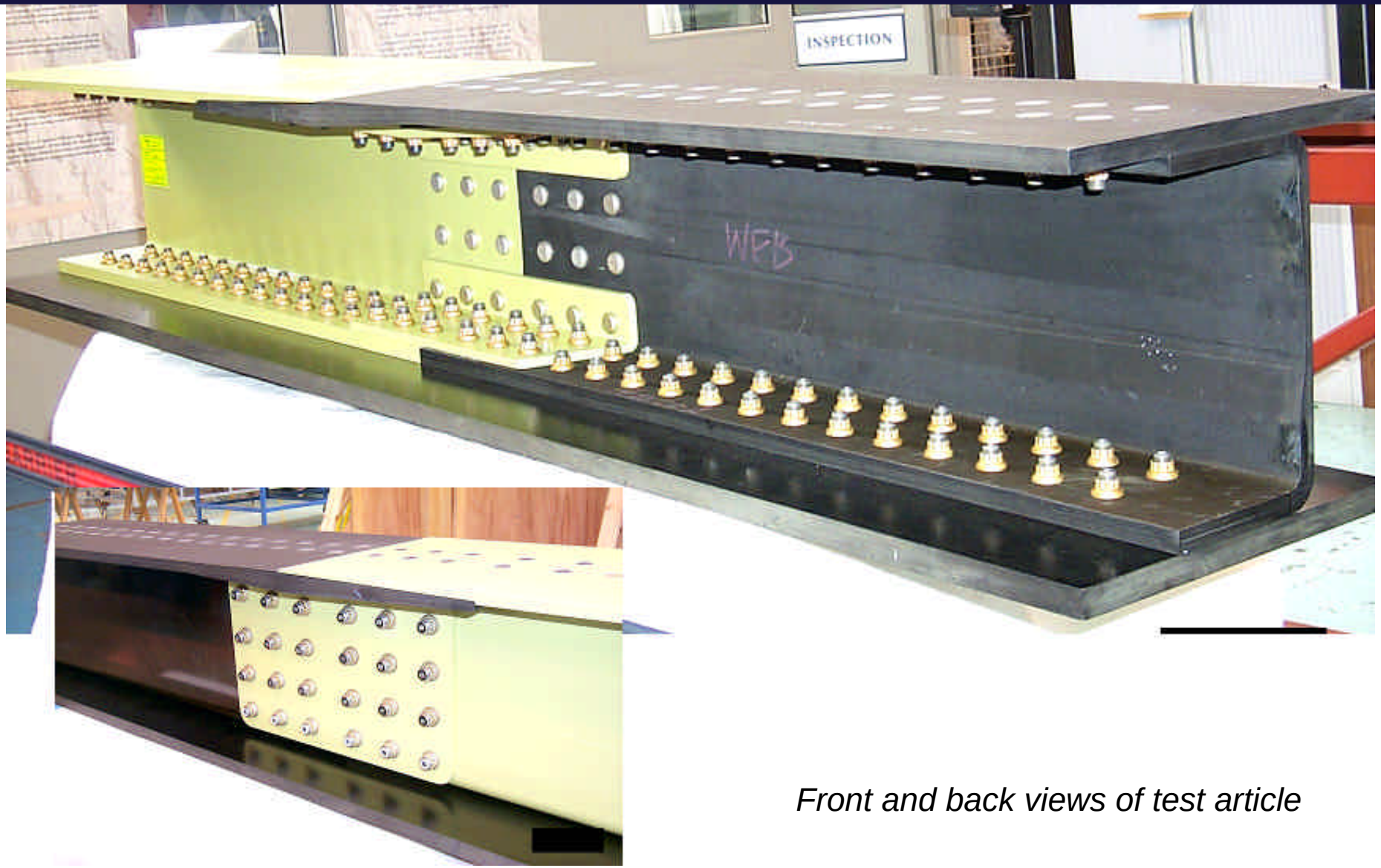
Composite / Metallic Joint: 3 & 4 Point Bend Tests
(TANGO Research Project)



Front and back views of test article

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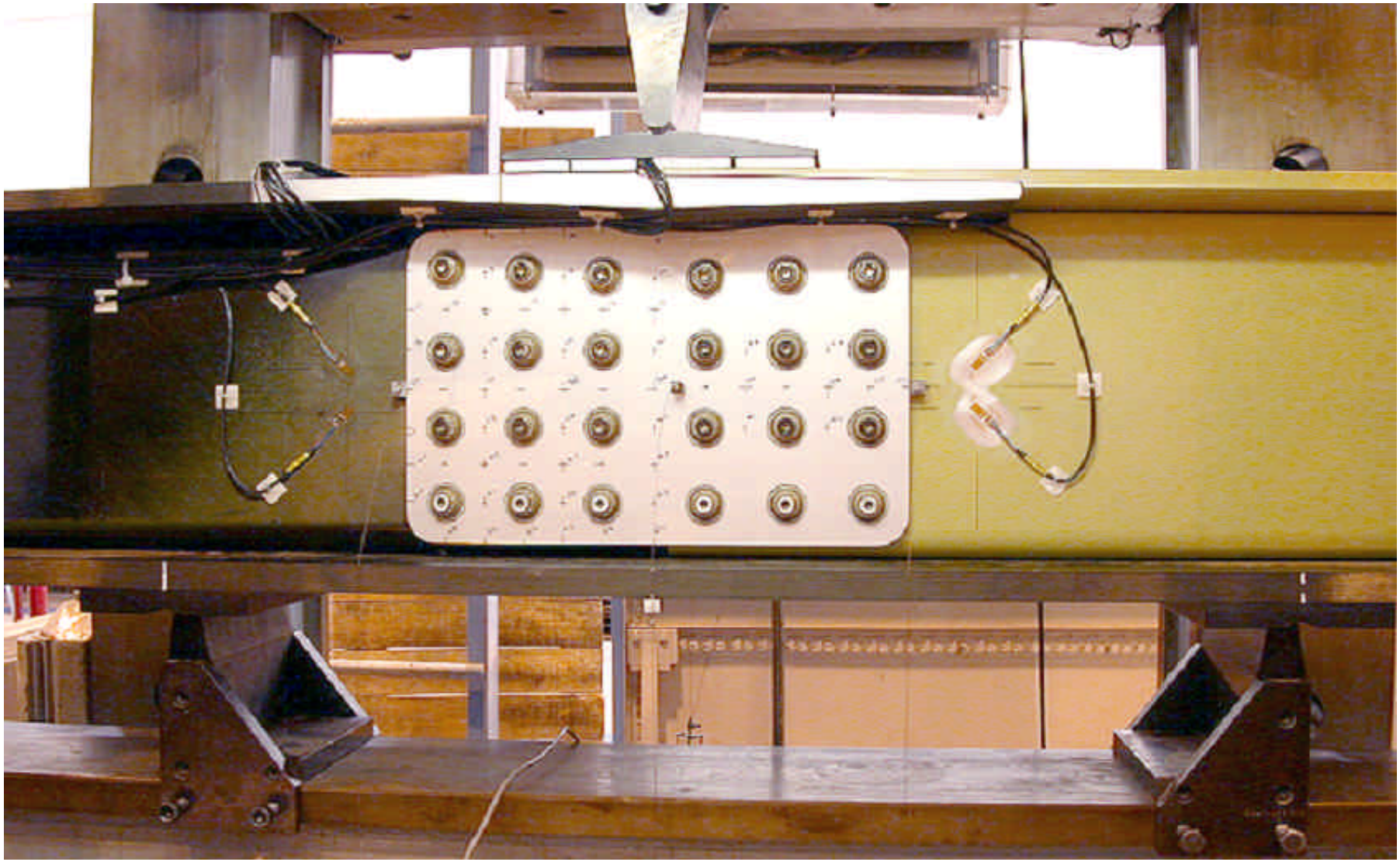
Composite / Metallic Joint: 3 & 4 Point Bend Tests
(TANGO Research Project)



Test article in three point bending rig

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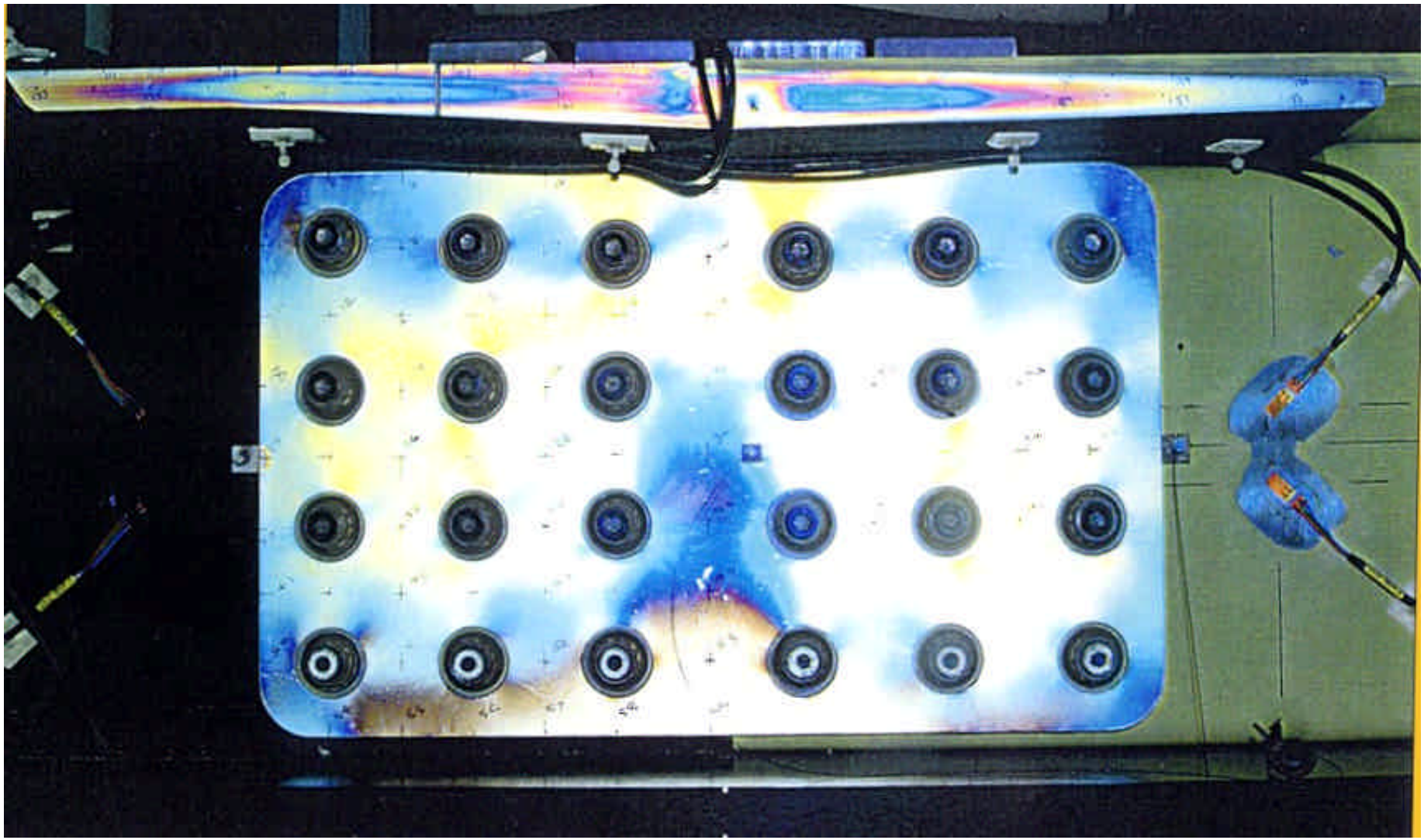
Composite / Metallic Joint: 3 & 4 Point Bend Tests
(TANGO Research Project)

Composite component | Metallic component



In-plane strain (photoelastic) response of splice plate – three point bend loading

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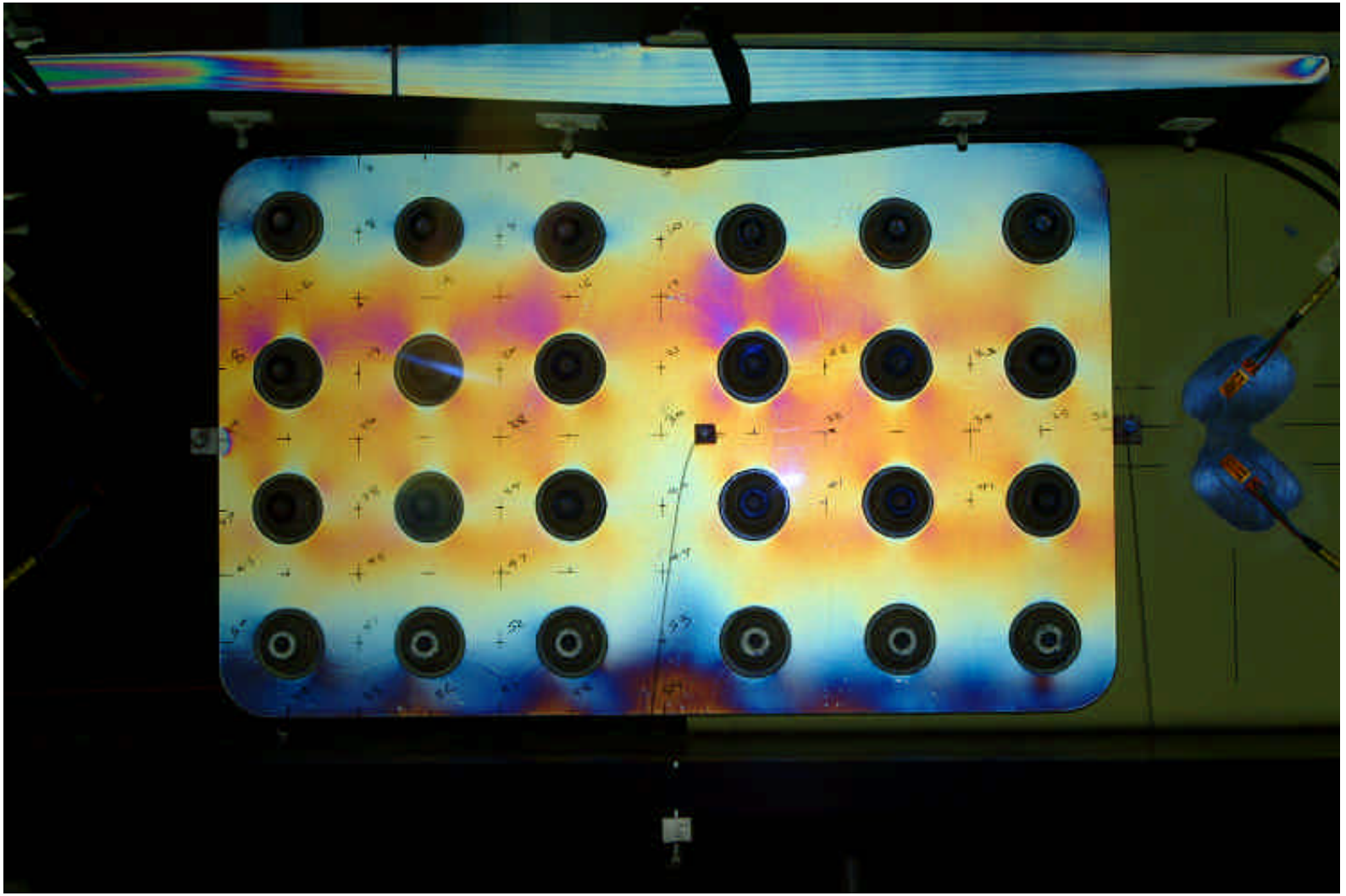
Composite / Metallic Joint: 3 & 4 Point Bend Tests
(TANGO Research Project)

Composite component | Metallic component



In-plane strain (photoelastic) response of splice plate – four point bend loading

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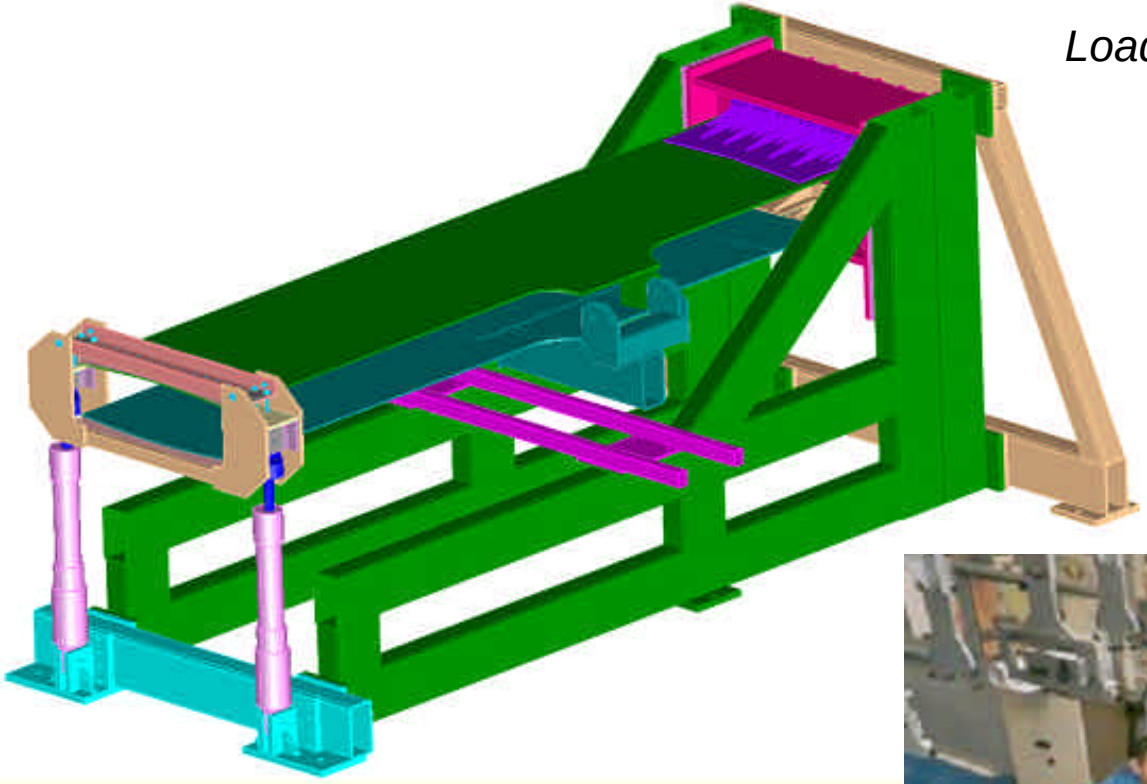
Partial Wingbox: Structural Test
(High Load Input Element Research Project)



Load frame and test article design

Partial wingbox under construction

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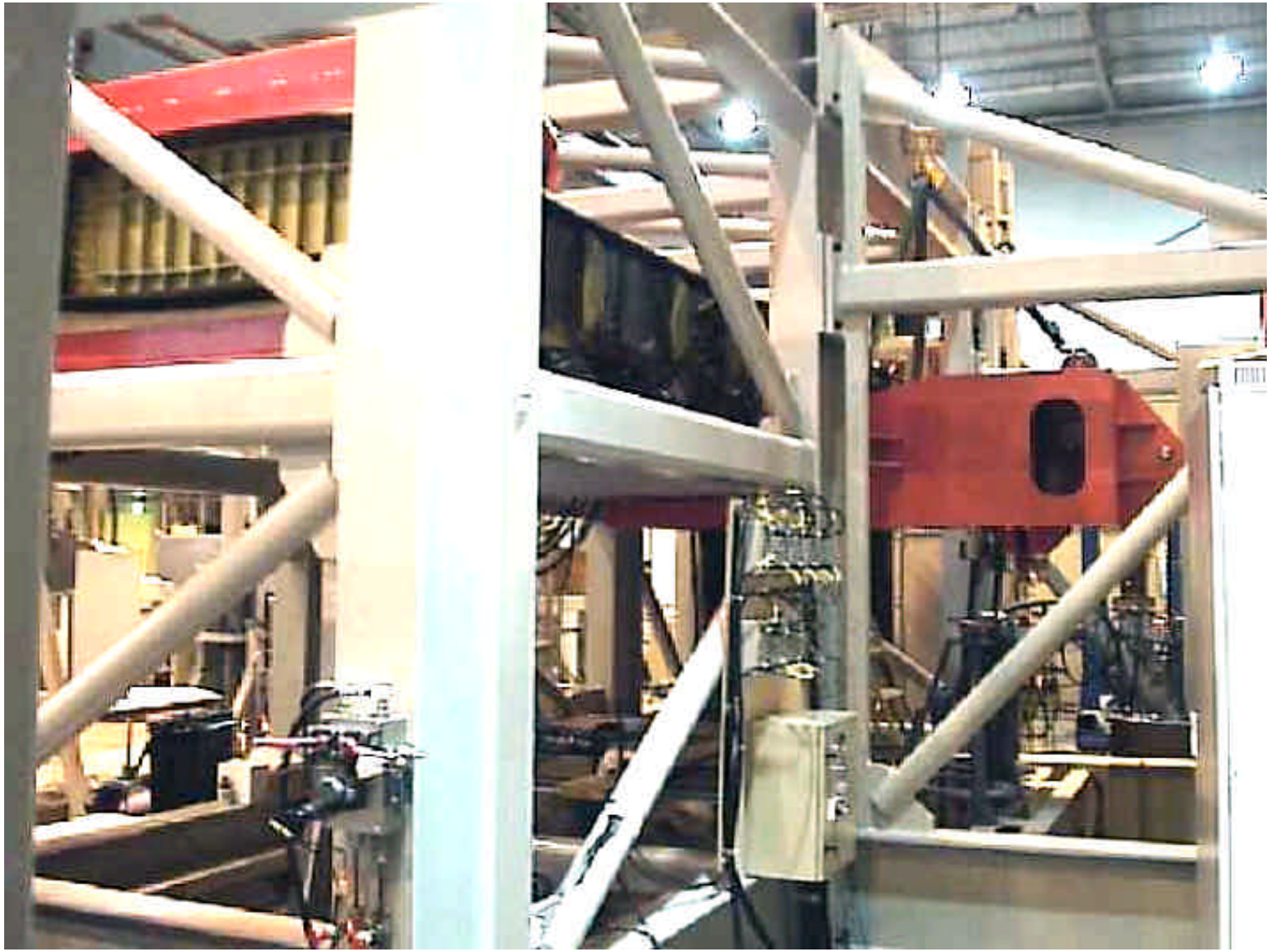
Partial Wingbox: Structural Test
(High Load Input Element Research Project)



Partial wingbox in loading jig

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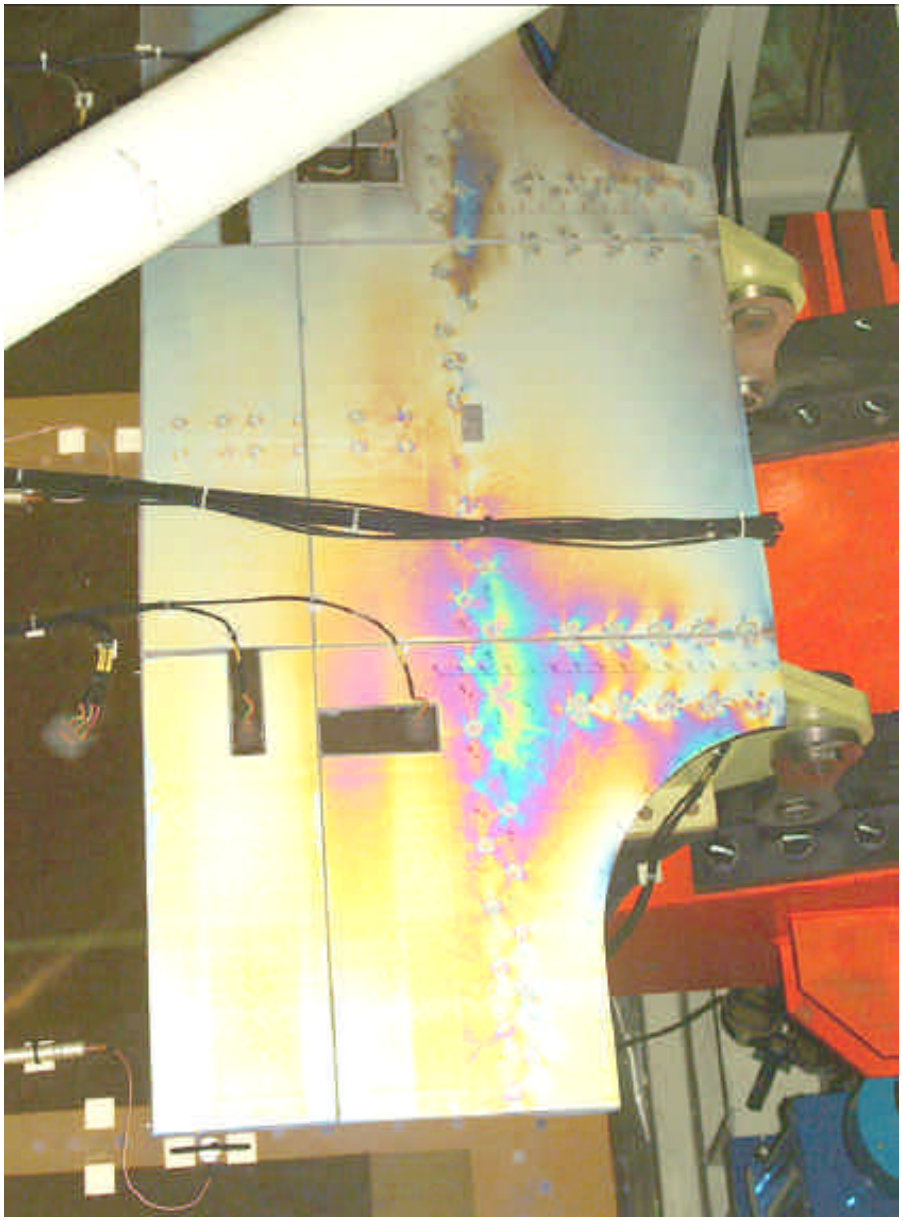
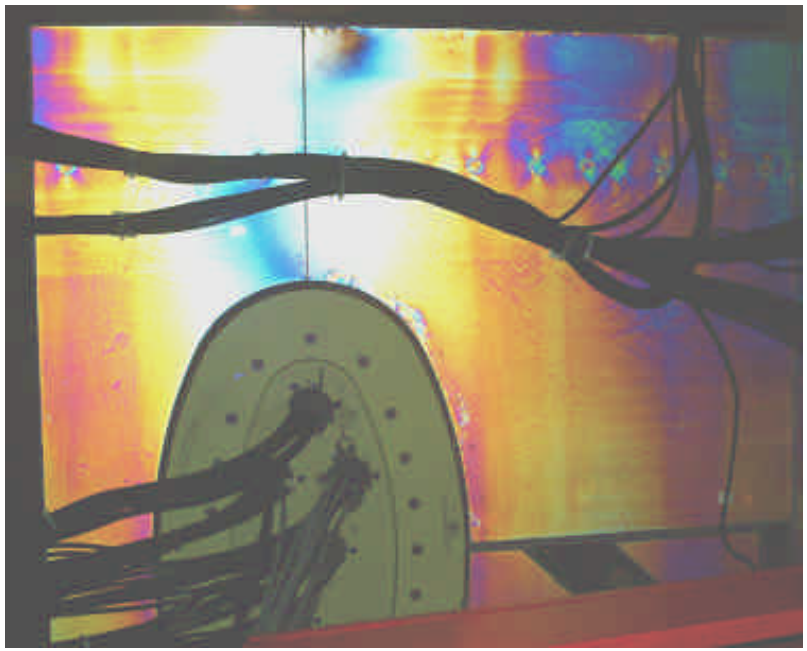
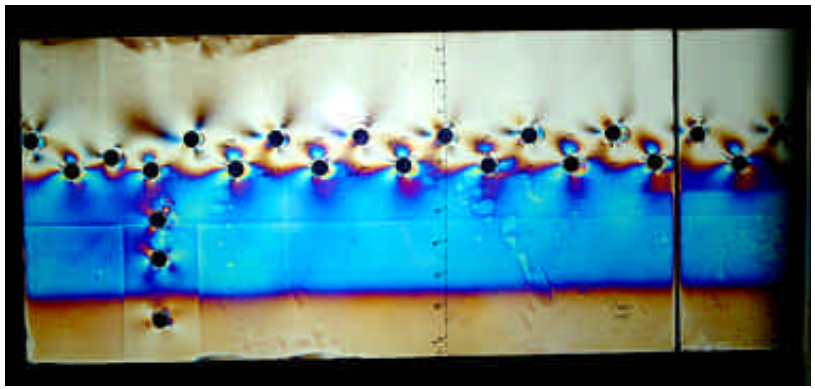
Partial Wingbox: Structural Test
(High Load Input Element Research Project)







In-plane strain (photoelastic) response of selected areas of upper skin (left) and lower skin (above)

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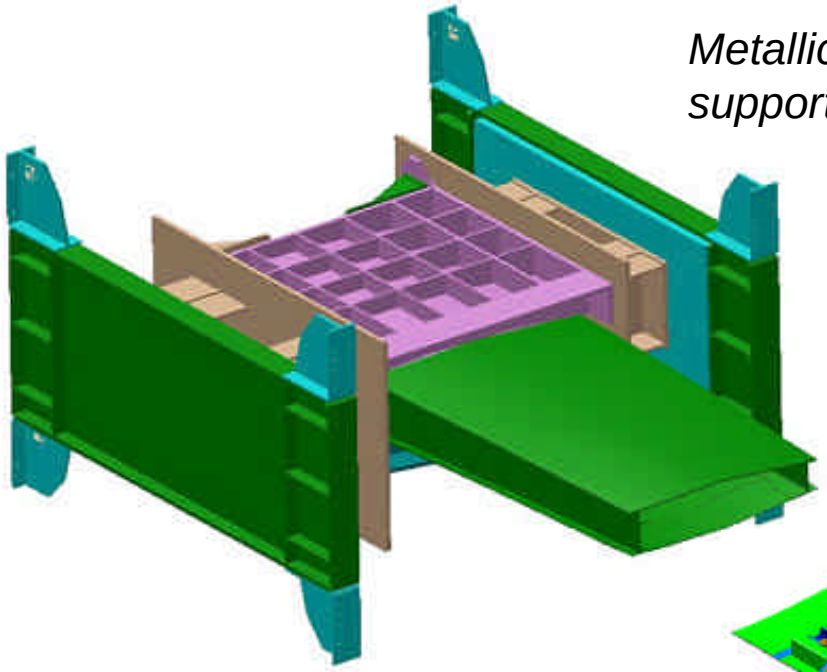
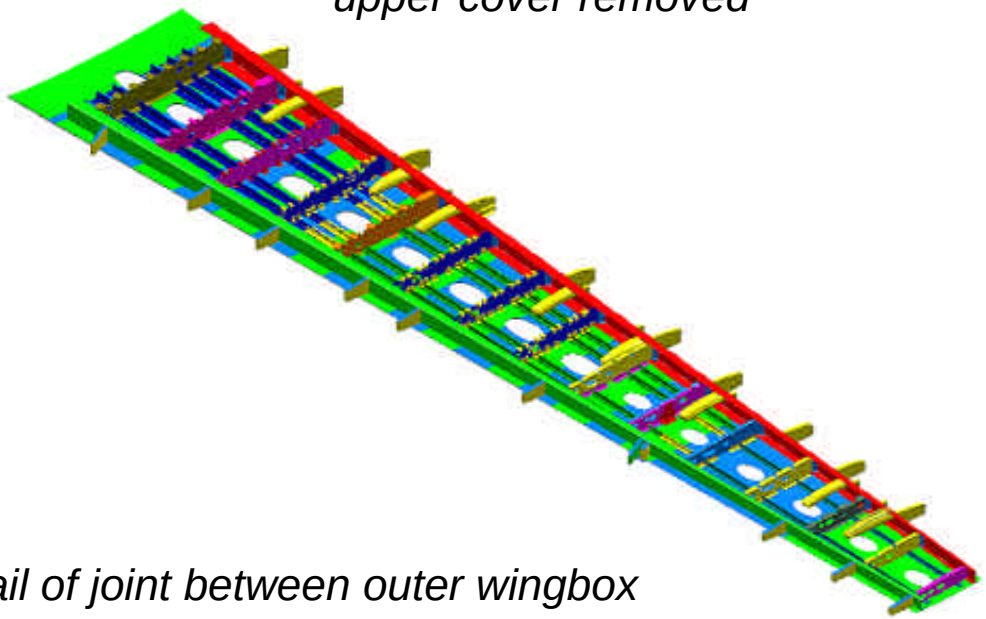
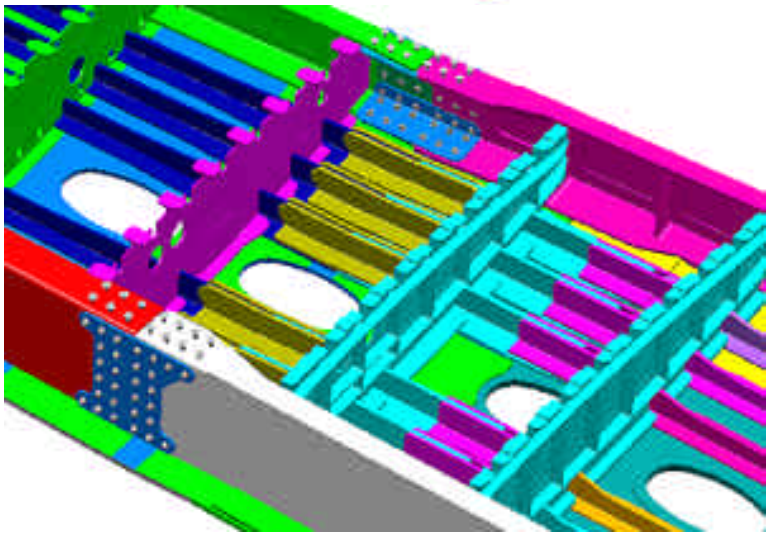
Outer Wingbox: Structural Test
(TANGO Research Project)



Metallic diffusion structure and support rig design

Schematic of outer wingbox with upper cover removed





Detail of joint between outer wingbox and metallic diffusion structure

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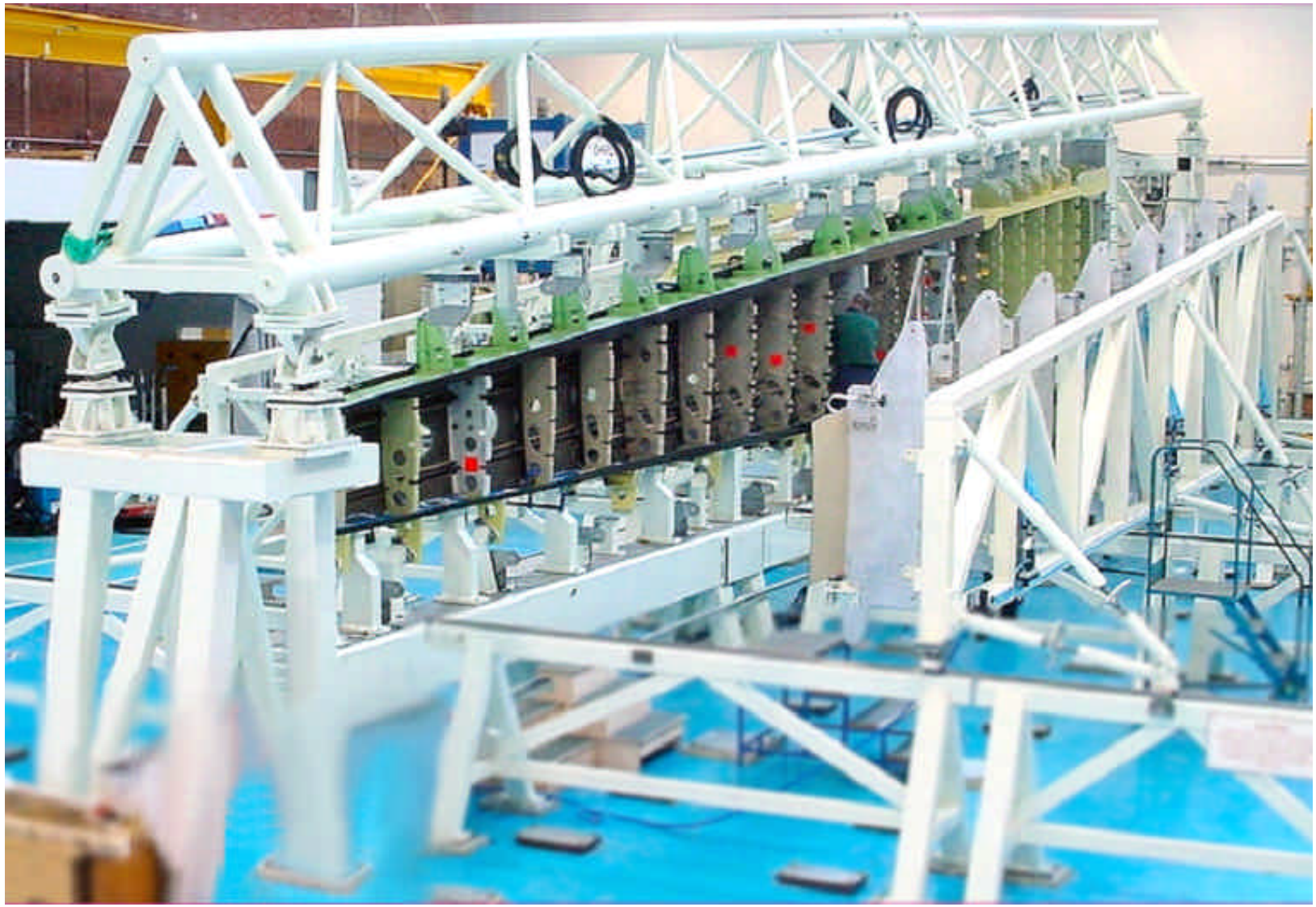
Outer Wingbox: Structural Test
(TANGO Research Project)



Assembly of outer wingbox

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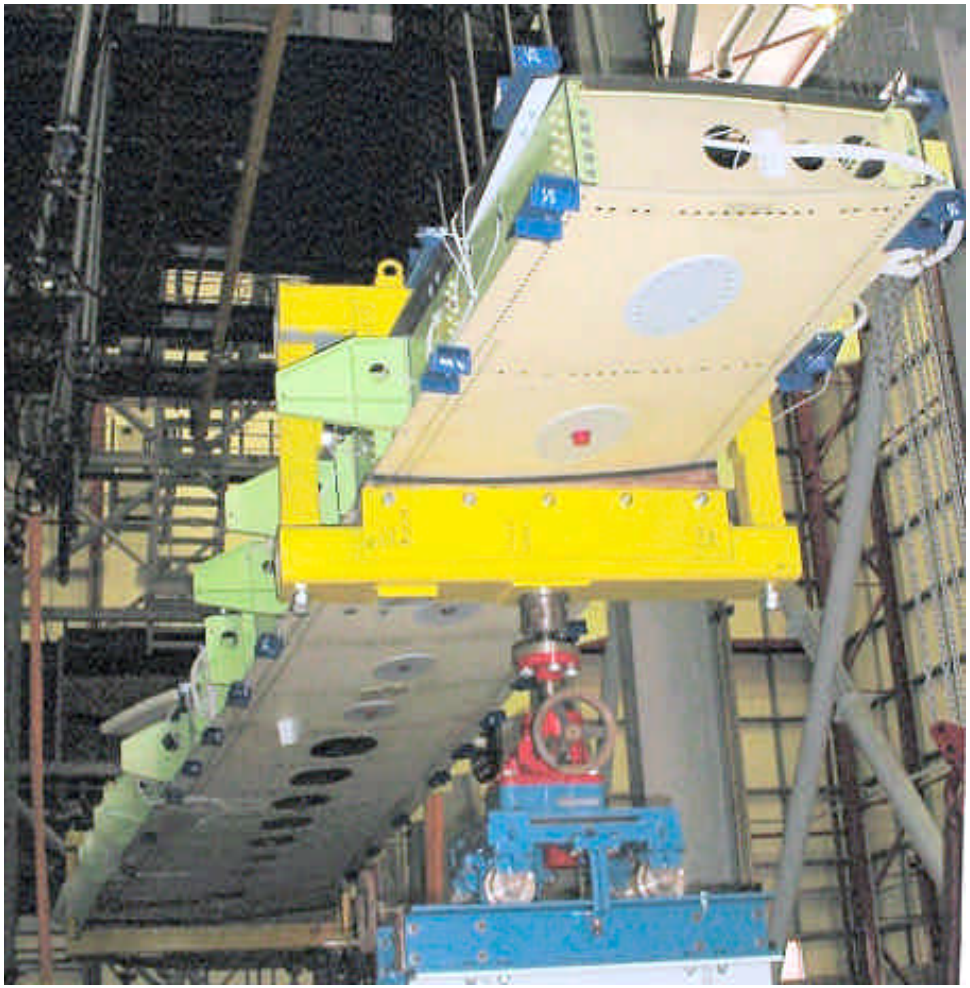
Outer Wingbox: Structural Test
(TANGO Research Project)



Outer wingbox in loading frame (above) and with loading jacks attached (right)

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Aircraft Tests

- Testing carried out to support A340-500/600 J-nose design :
  - Glass fibre / thermoplastic resin leading edge structure
- Objective:
  - Demonstrate satisfactory structural static strength
  - Demonstrate satisfactory impact response

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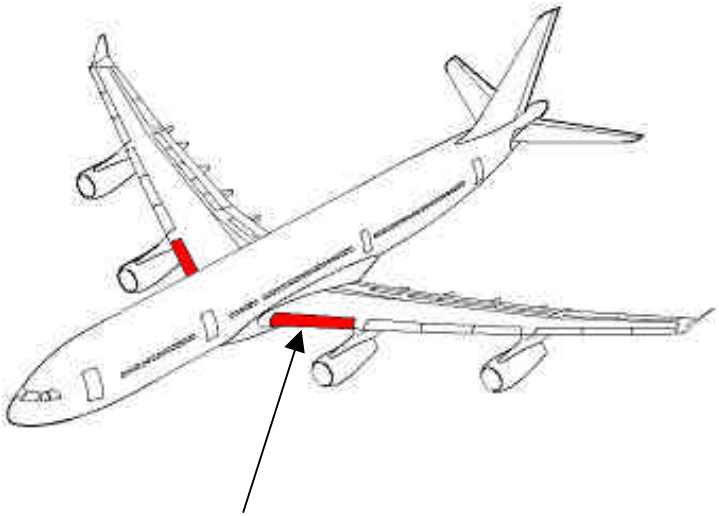
Composite J-Nose Tests
(A340-500/600)



"J-nose" is fixed leading edge structure

J-nose structure for A340-600

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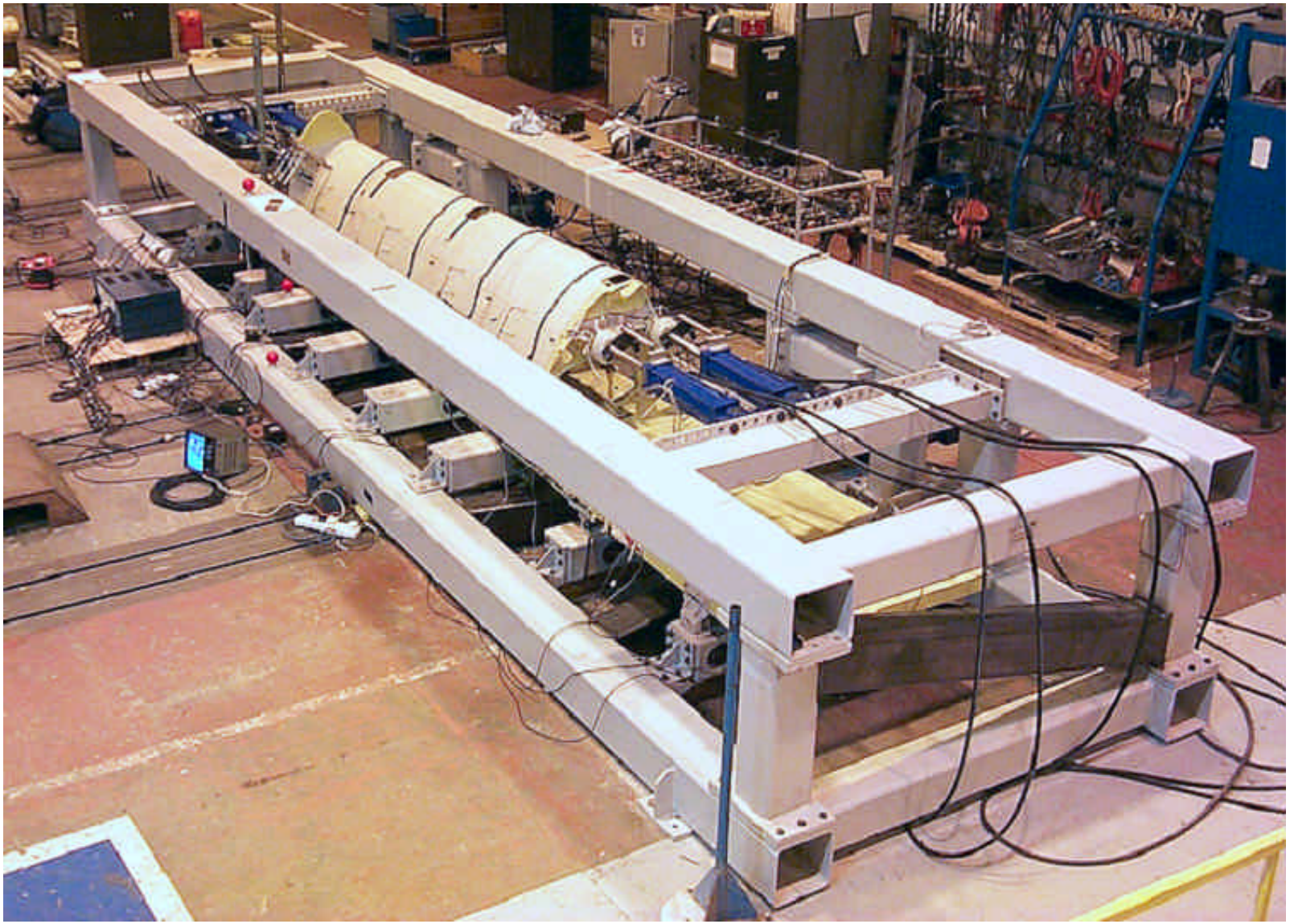
Composite J-Nose: Structural Test
(A340-500/600)



J-nose structural test

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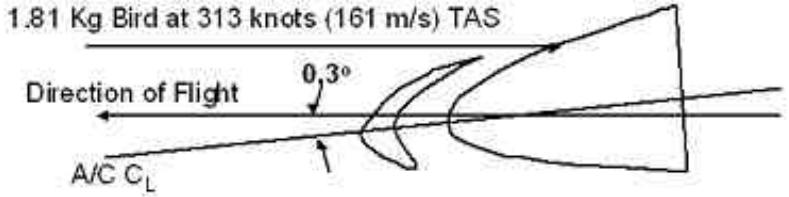
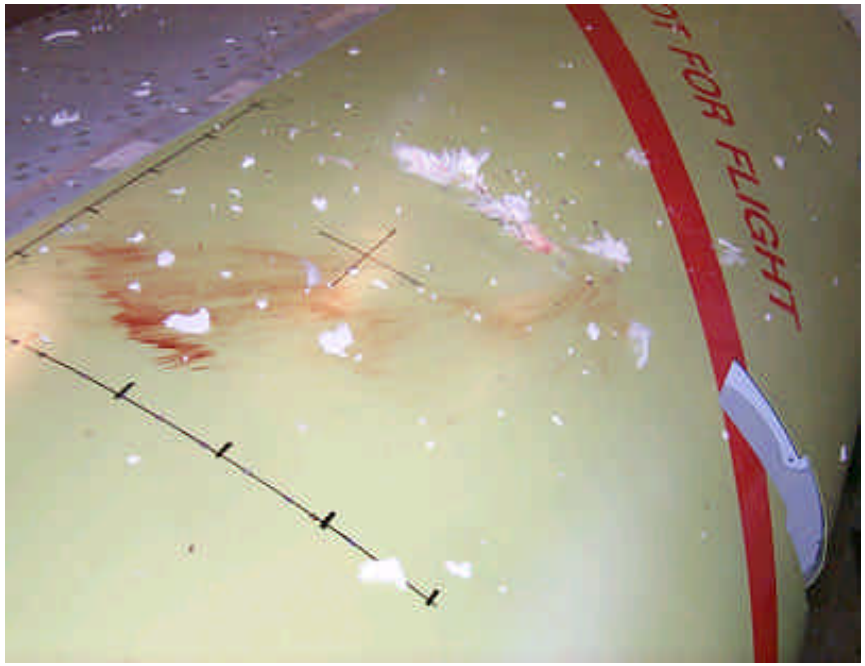
Composite J-Nose: Impact Test
(A340-500/600)



With Slat 1 Deployed at 23° - Upper Panel Impact



First upper panel test

Second upper panel test

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Conclusions

- A selection of large scale composite tests carried out at Airbus Filton site have been presented, including
  - Research tests from TANGO, CASCADE, HLIE and AMCAPS II
  - A340-500/600 leading edge structure
- Structural tests are carried out to the highest possible standards using state of the art instrumentation and data acquisition techniques
- Research and certification testing is on track to support aircraft projects
- Future work includes
  - Further testing on the TANGO wingbox including fatigue, repair etc.
  - ALCAS main landing gear support structure, pylon and supporting tests

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