

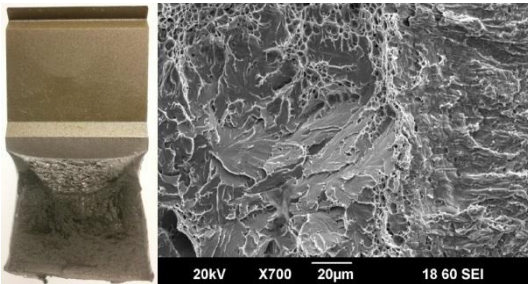


Mechanics – Corrosion Platform

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Fracture mechanics

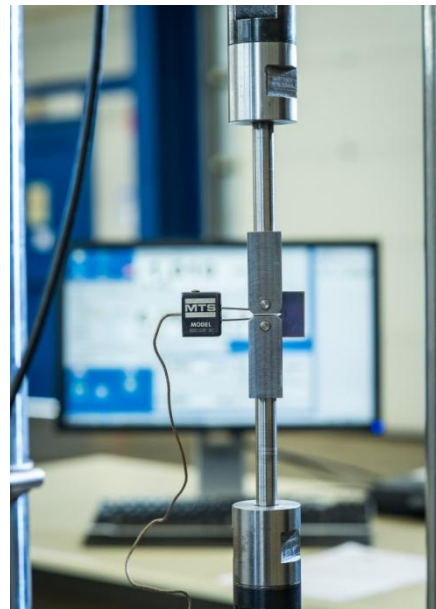
- # Determination of CTOD toughness
- # Determination of the critical stress intensity factor K_{IC} , J_{IC} (quasi-static) or K_{ID} (dynamic)
- # Determination of material resistance to cracking in presence of a defect (J-da curve)
- # da/dN and $\Delta K_{\text{threshold}}$ tests
- # Temperature ranging from -196°C to 750°C



Fractography of a specimen



Crack growth rate test on SENB Specimen



ΔK threshold test on CT specimen



CTOD Test at low temperature

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Fatigue testing

- # Measure the fatigue resistance of materials or assemblies (metallic, composite, multi-materials, which may be welded, riveted, glued...)
- # Define fatigue design curves (S-N curves)
- # Estimate the residual service life of equipments
- # Study cracking mechanisms in structures
- # Different loading conditions (tensile, compressive, bending, ...)
- # Fatigue tests from cryogenic (-196 °C) to high temperatures (1000 °C)
- # Tests in corrosive environments



Fatigue test at cryogenic temperature



Fatigue test on composite-metal assembly

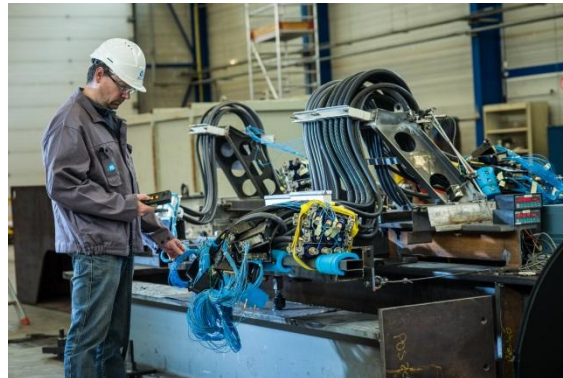
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Full scale testing

- # Measure the fatigue resistance of structures (metallic, composite, multi-materials, which may be welded, riveted, glued, etc.)
- # Validate finite element calculations experimentally
- # Optimize the design of a structure to its nominal service life
- # Stress measurement on a structure subjected to static, dynamic or vibration loading
- # Testing with simple or combined loads from 25 kN to 2,5 MN
- # Analysis of cumulated damage (rainflow method,...)



Fatigue test on a railway structure



Fatigue test on electrical cables on a railway structure

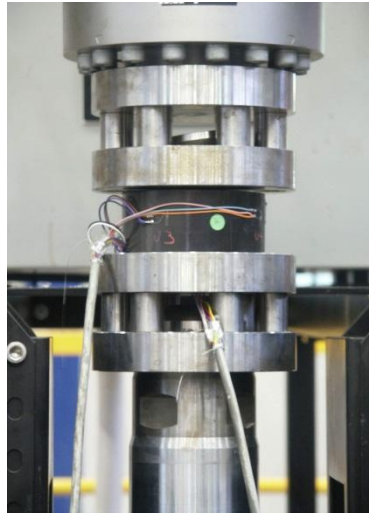


Vibration test on a metallic-composite wind tunnel blade for ONERA

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Mechanical tests

- # Determination of mechanical properties of metal or composite materials or assemblies
- # Tests performed under different loading conditions (tensile, compressive, bending, ...)
- # Temperature ranging from -196°C to 1000°C
- # Load cases may be static or dynamic, monotonic or cyclic.
- # Strain measurement equipments (strain gages, extensometers, optical equipments,...)



Static compressive test on a composite cylinder



Compressive test on a ceramic specimen



Tensile test on a 50 μm thickness glass fiber specimen



3 points bending specimens

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Corrosion testing

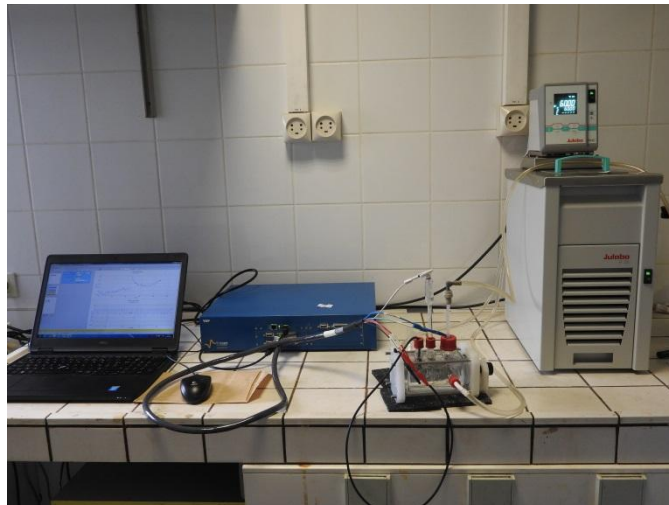
- # Polarization curves plot ($i=f(E)$) to understand electrochemical behavior, calculate corrosion rate or determine pH depassivation (crevice corrosion)
- # Pitting or crevice corrosion tests according to ASTM (G48, G150) or ISO standards
- # Intergranular corrosion tests for stainless steels or aluminum alloys (ASTM or ISO)
- # Assessment of galvanic corrosion
- # Exfoliation corrosion tests for aluminum alloys (ASTM G66)
- # Stress/Load corrosion cracking tests
- # Filiform corrosion tests



Electrochemical measurements on a pipe



Macrograph of pitting corrosion specimen



Cyclic polarization test in high temperature solution

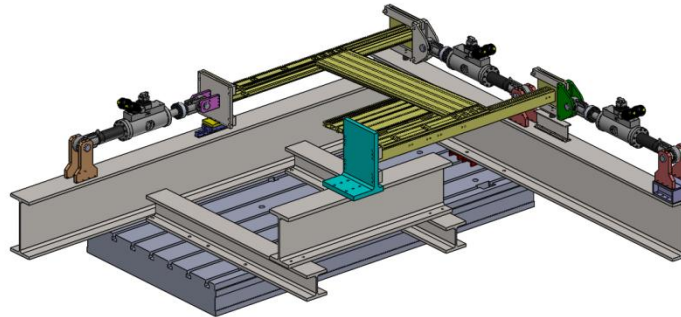


Macrograph of a filiform corrosion specimen after test

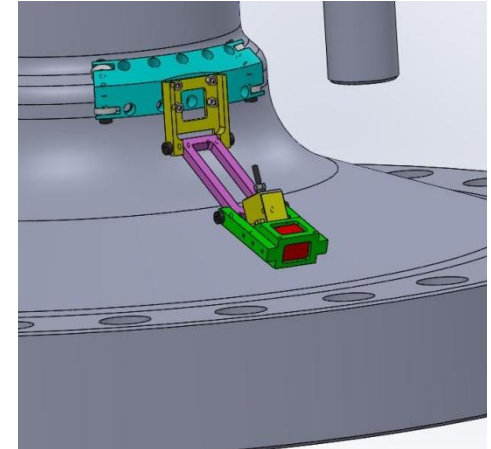
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Engineering and Design Activities

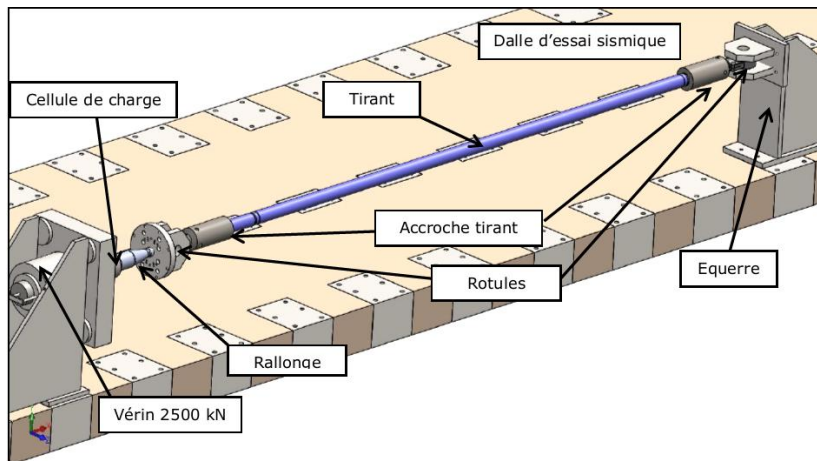
- # Design and installation of test benches
- # Design and implementation of tools
- # Validation of tooling designs by finite element calculations
- # manufacturing monitoring among subcontractors, final assembly



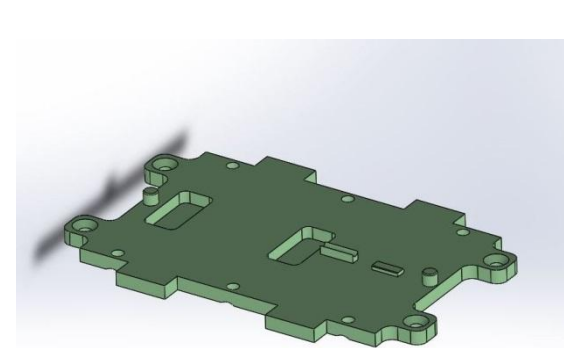
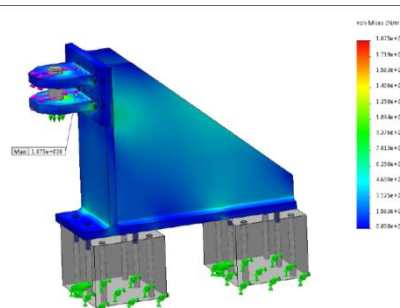
Design of a multi-axial test bench



Design of a NDT tool



Design and calculation of a tensile test bench



Specimen manufactured by rapid prototyping

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Equipments

Full Scale Test bench

Test plate of 24m * 5m with 70 tonnes capability

15 servo hydraulic actuators with loads ranging from 25 kN to 2,500 kN

Electronics and softwares ensuring the servo-control of the actuators

Design and 3D calculation softwares for test bench engineering (design and sizing of tools)

Corrosion

Single and Multi-channels potentiostats simples for electro-chemical tests

Static test benches for strain-stress corrosion tests

Cryothermostats and hot plates for high temperature testing



Engineering activity

SolidWorks Professionnal and Premium, SW Simulation Premium

4 axis rapid prototyping machine

Fatigue and Fracture Mechanics

9 servo-hydraulic test machines with loads ranging from 10 kN to 1.600 kN

1 electrical linear motor test machine (frequency up to 100 Hz) with a load capacity of 10 kN

Thermal chambers and furnaces with a testing temperature range from -196 °C to 1000 °C

Crack growth monitoring equipments (extensometers, strain gauges,...)

Measurement

Data acquisition equipment for static and dynamic measurements (strain gages, pressure, acceleration, displacement, ...)

Optical and electronical analysis equipments

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Industrial study



Objectives

Design new blade in order to increase its ventilation performance

Design and machining of a test bench with the capability to perform durability and vibration tests until 400 millions of cycles

Perform tests with a good level control and applying of the targeted ranges of displacement at the end of the blade (± 10 mm and ± 15 mm)

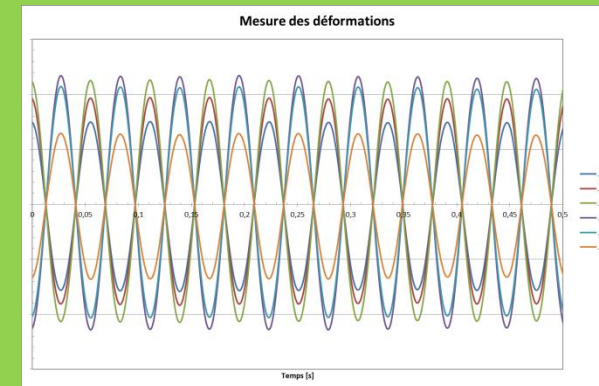
Monitoring of strains and accelerations and retention at the right level by using sensors and strain gauges.



Results

The design of the test bench has permitted to perform vibration tests during 260 millions of cycles without damages at a frequency of 18 Hz (near the natural frequency).

Data acquisitions showed a good control capacity and a good correlation between measured load and targeted displacement.



Success

Validation of the concept of bi-material assembly.

Manufacturing of 22 blades.



Informations

Customer: ONERA
Sector: aéronautic
Duration : 18 months (2014/2015)