Testing Composites: Lessons Learnt from Glider Certification

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Agenda

- Background
- Aviation in South Africa
- Applicant & Product
- Certification requirements
- Wing Tests
- Lessons Learnt

Background

- Previously worked for the South African CAA (SACAA) for 8 years in Aircraft Certification
- Involved in the certification program of a new 18 metre class sailplane
- Focal CE for amendment of TC to include new 21 metre class and jet sustainer version

Aviation in South Africa

- South Africa developed an indigenous aviation industry, primarily to support the military during the UN arms embargo…

Denel AH-2 Rooivalk – attack helicopter

Denel Cheetah C – ultimate Dassault Mirage III upgrade

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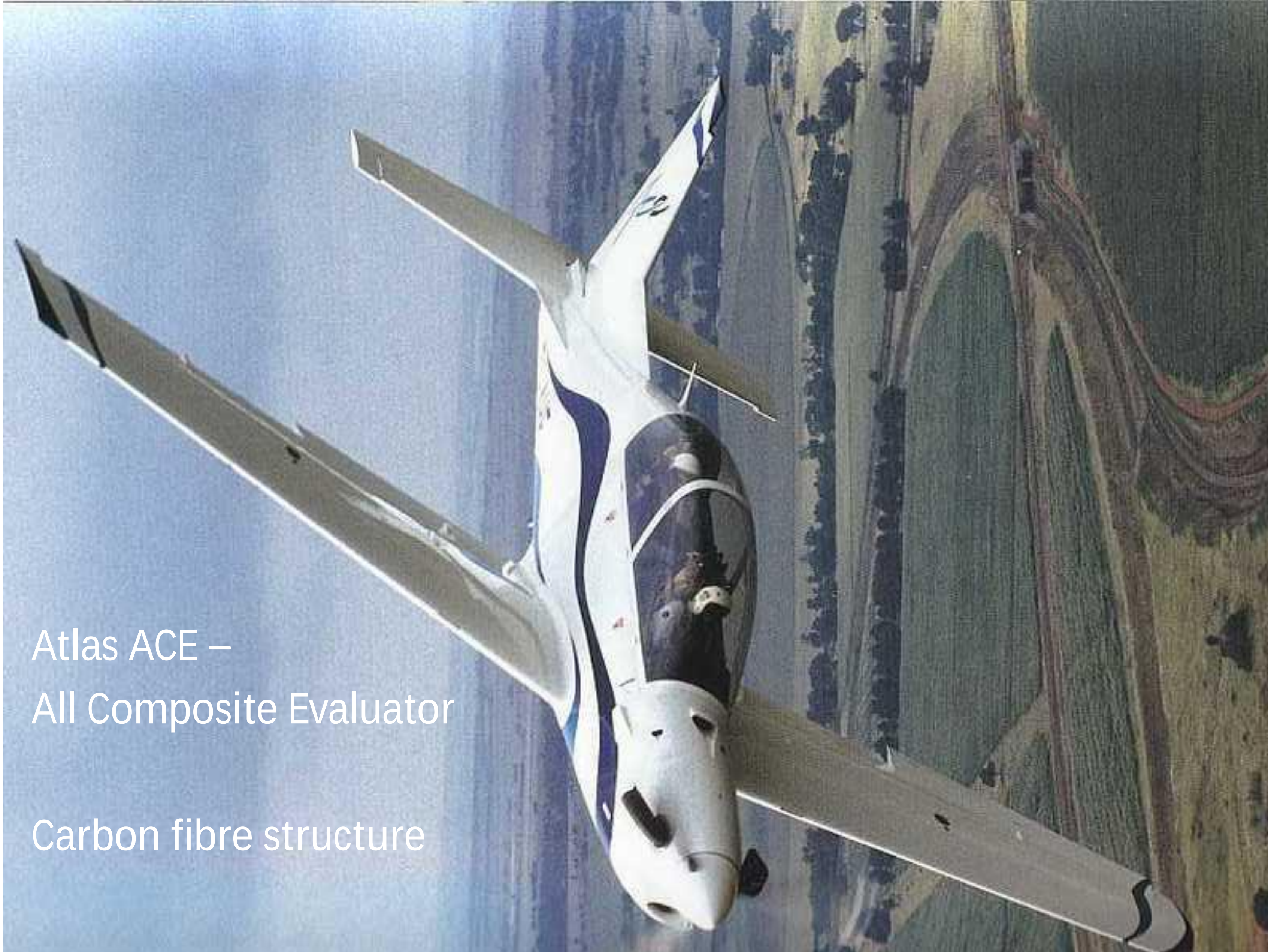
Atlas ACE –
All Composite Evaluator
Carbon fibre structure

Aviation in South Africa

- SACAA was formed in 1998
- Previously the Department of Civil Aviation (DCA)
- DCA had issued 2 Type Certificates…

Atlas C4M Kudu – all-metal FAR 23 type aircraft –scout and light transport/medevac

11.2 m wingspan, aerobatic glider

Glass fibre & aramid structure

Tested to 10g

Aviation in South Africa

- South African CAA had limited exposure to extensive certification projects

Composite structures for Experimental Category aircraft used for recreational/private use.

STCs involving composite structures for Restricted Category aircraft used for geophysical survey aerial work.

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Applicant

- 1st Type Certificate to be issued by the SACAA
- Chief Engineer – Engineering Lecturer at a university in South Africa
- Flight Test and Certification Engineer – previously worked on military programs
- Extensive composite and gliding experience

Product

- Jonker Sailplanes JS1A and JS1B
- 18 metre wingspan class (later also 18/21 metre version)
- Glass, Carbon and Aramid (Kevlar) -fibre composites structure
- Very thin wing profile section (12.7% - max. thickness 100mm at the root)
- Best Lift to Drag ratio of 53 (18 m) and 60 (21 m).

Certification Requirements

- SACAA adopted EASA rules for sailplanes – CS-22
- Certification basis agreed EASA CS-22 at Initial Issue

- CS-22 requires :
  - No permanent deflection after limit load
  - No damage after limit load
  - No interference of control surfaces at limit load
  - FS = 1.5 ultimate load static strength – hold load for 3s minimum
  - Fatigue – stress concentrations to kept to a minimum

- LBA recommends using max. allowable of 400 MPa for carbon fibre, FS = 1.725 for fatigue concerns

Certification Requirements

- Using their University links – developed a Composite Material Test Report for the initial TC project.
- Used same manufacturing methods
- Obtained strength and stiffness requirements for each type of material used in the JS1.
- Complied with CS22.613.

- Currently building a new composite materials database.

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Validate FEM models used in the structural analysis

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Cannot use “sandbagging”

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Need to pre-heat composite structure to ensure structure is at 54°C in order to comply with AMC 22.613(c)


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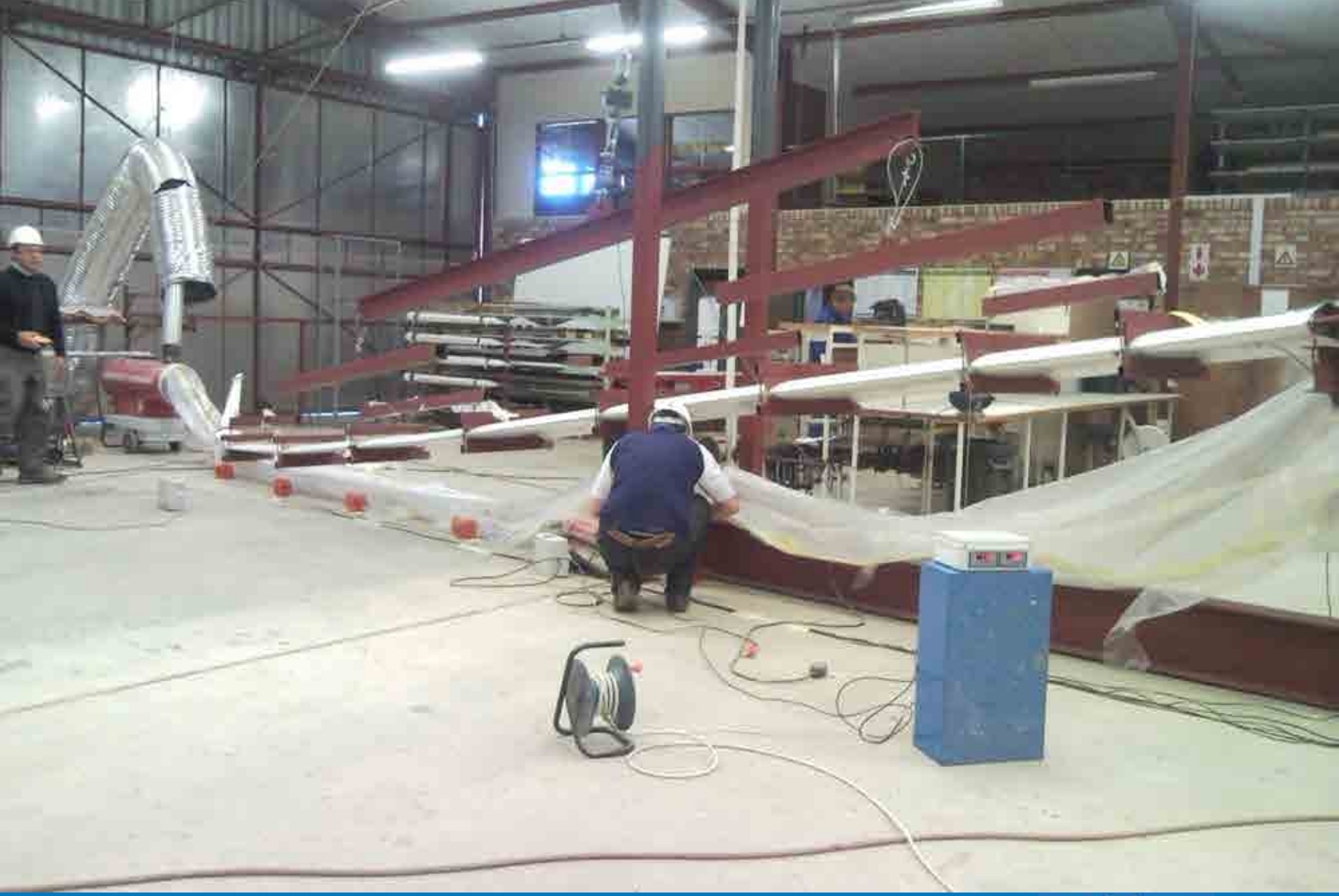

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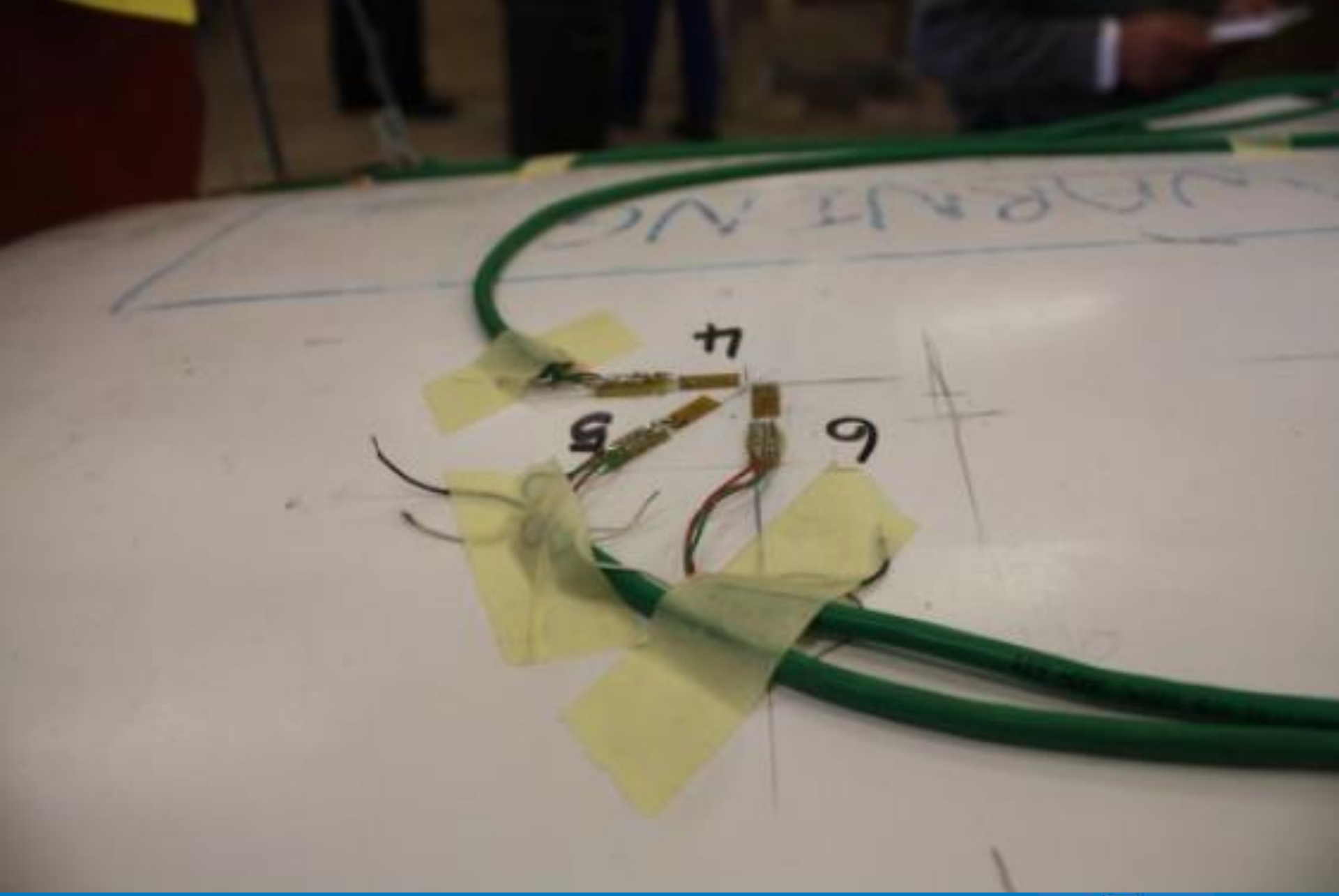
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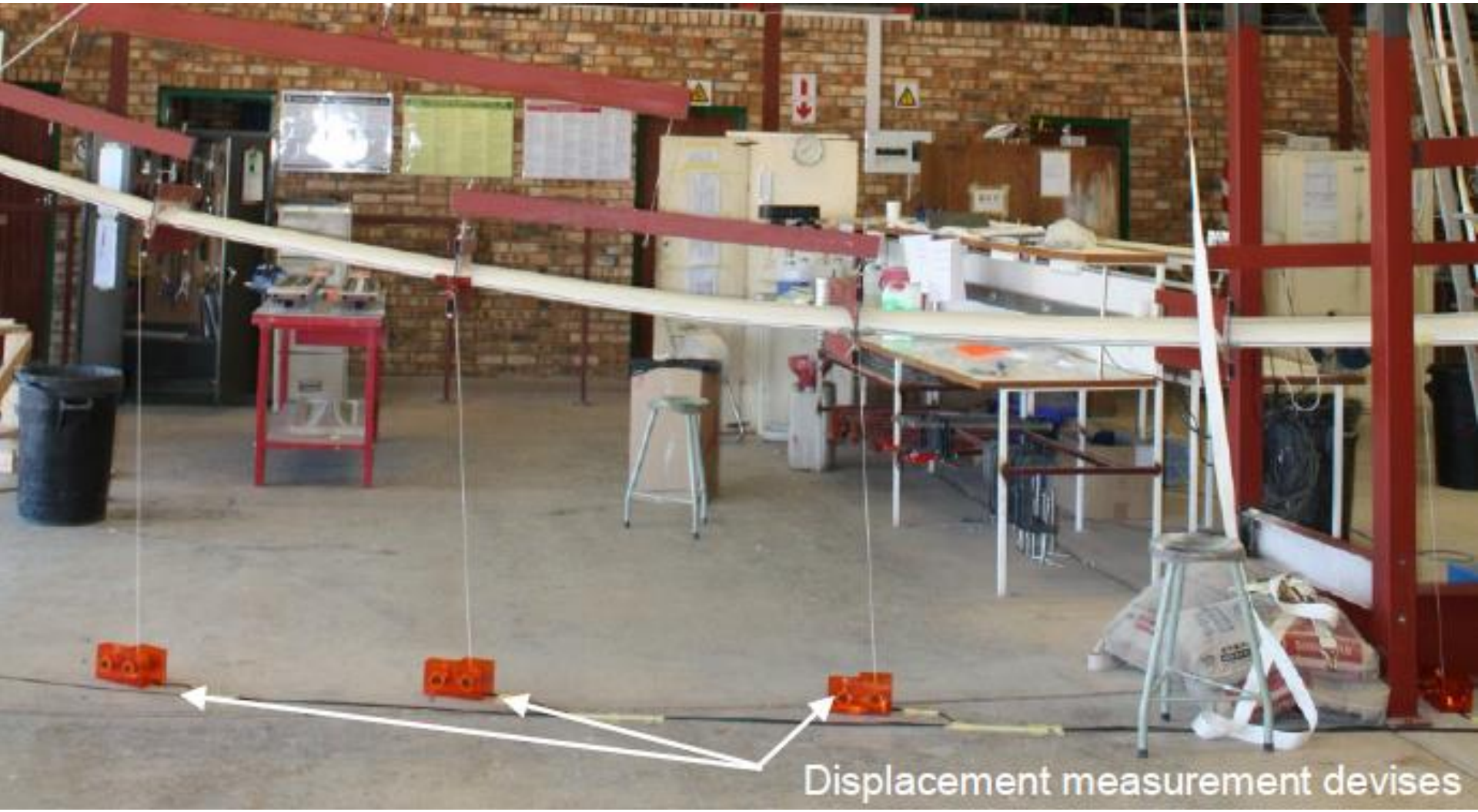
Displacement measurement devises

Heat soaked at 57°C for 2.5 hours. Test to be completed within 5 minutes

Limit load FS = 1.0

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Wing Test 1

Test rig failed well below ultimate load required @ FS=1.3

Wiffle tree beams intact – failure initiated in steel cables between beams causing the wiffle tree to collapse onto the wing

Outer wing was damaged beyond repair – no determination could be made regarding delamination/damage post event

Deflections measured prior to failure were consistent with model, but showed wing slightly stiffer than expected

Wing Test 2

https://www.youtube.com/watch?v=Dp1fYUrtVHU

FS = 2.0

Rig failed at FS = 2.01

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Wing Test 2

Test rig failed well above ultimate load required @ FS=2.01

Some delamination had occurred, wing held ultimate load far in excess of 3 seconds required @ FS=2.0.

Wiffle tree beam designed to fail first – buckling failure to avoid damage to wing

Tailplane deflections within 0.5 % of FEM predictions

Lessons Learnt

Certification requirements are the bare minimum – look for the hidden requirements

Don’t forget the basics

Don’t forget the test rig

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