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L O N D O N

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Laser Beam Welding of 3rd Generation Al-Li-Alloys for Fuselage Applications

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Hellenic Aerospace Industry S.A.

LAWENDEL project details

THEME [JTI-CS-2012-2-ECO-01-055]

Laser welding of newly developed Al-Li alloy / LAWENDEL

Project Coordinator: Helmholtz-Zentrum Geesthacht / HZG
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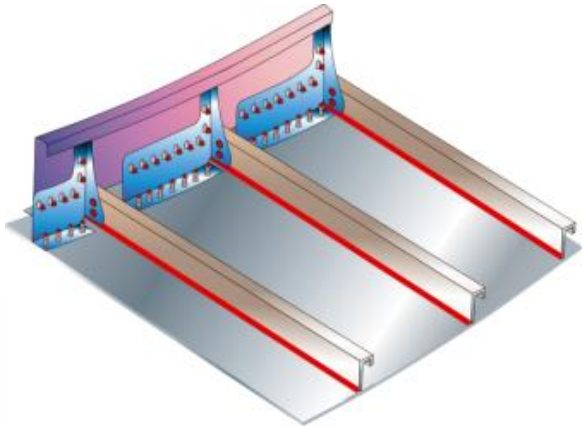
Project Partner: The University of Manchester / UMAN
Y. Tian, J. D. Robson

Topic Manager: Hellenic Aerospace Industry S.A. / HAI
A. Karanika

Project Duration: 01.01.2013 – 31.05.2015

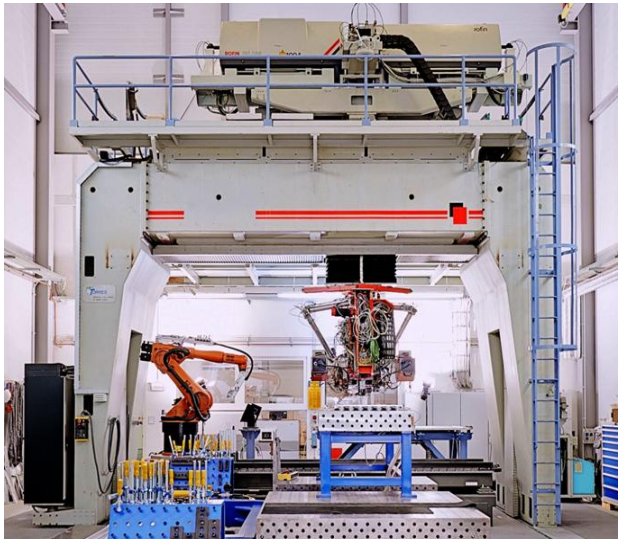
Laser beam welding of high strength Al-Li alloys



- *High strength*
- *Lightweight*
- *Cost-effective*

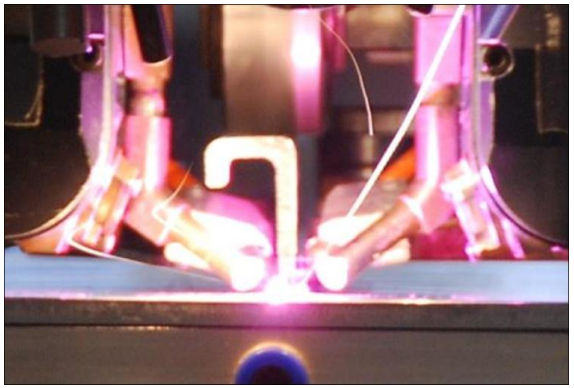
- Demand of the aircraft industry for reduction of weight and manufacturing costs of fuselage structures
  - Use of lightweight and high strength materials such as the Al-Li alloys AA2198 and AA2196
  - Use of joining technologies with high working speeds and high degree of automation such as the laser beam welding

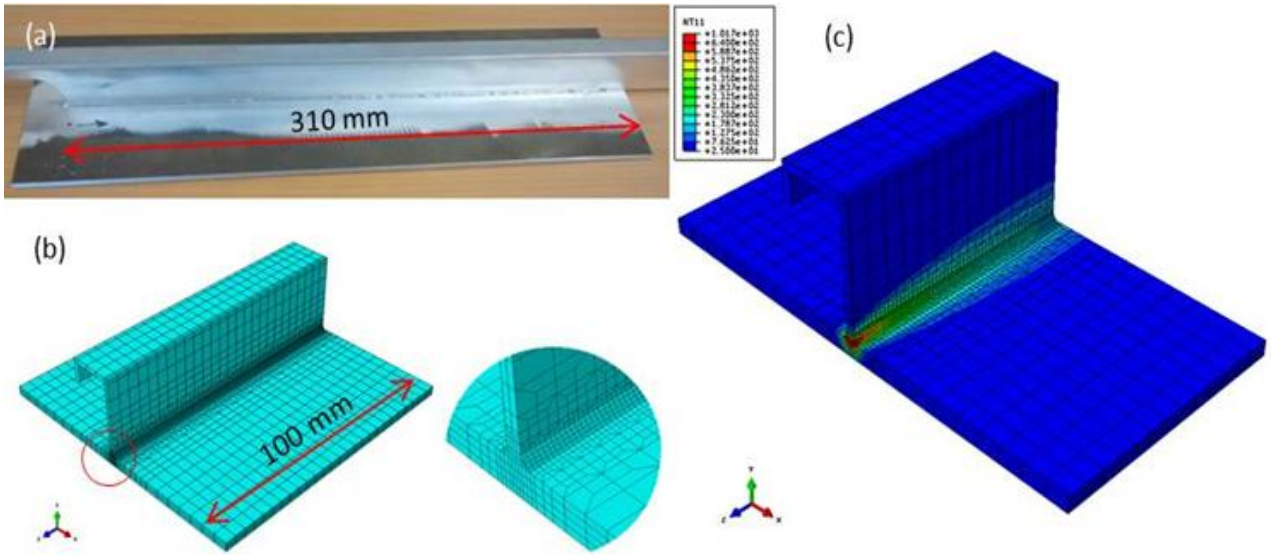
LBW process development by a combination of modelling and experiments.



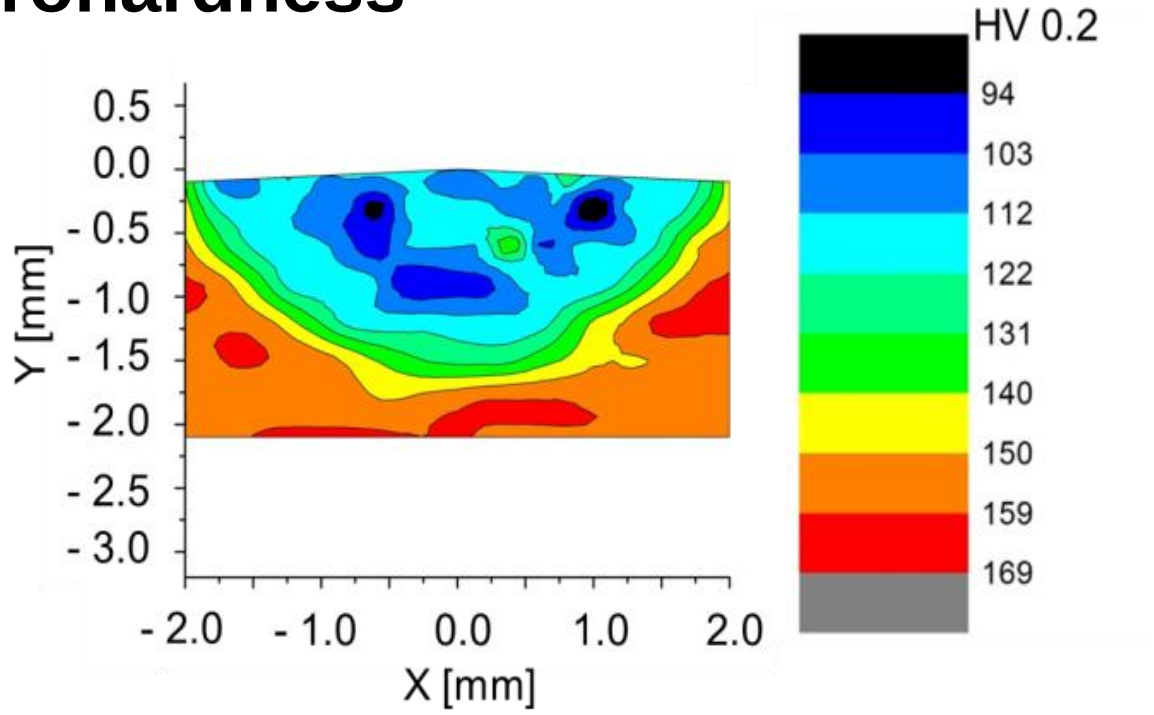
- 2 x 3.5 kW CO_2-Laser
- working space: 8.5 m x 3.5 m x 1 m

Stringer: AA2198
Skin: AA2196
Filler wire: AA4047



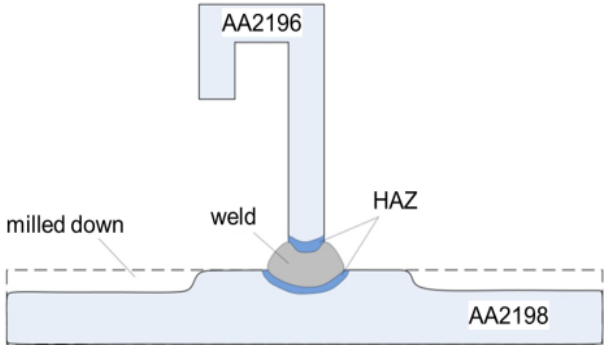


Microhardness



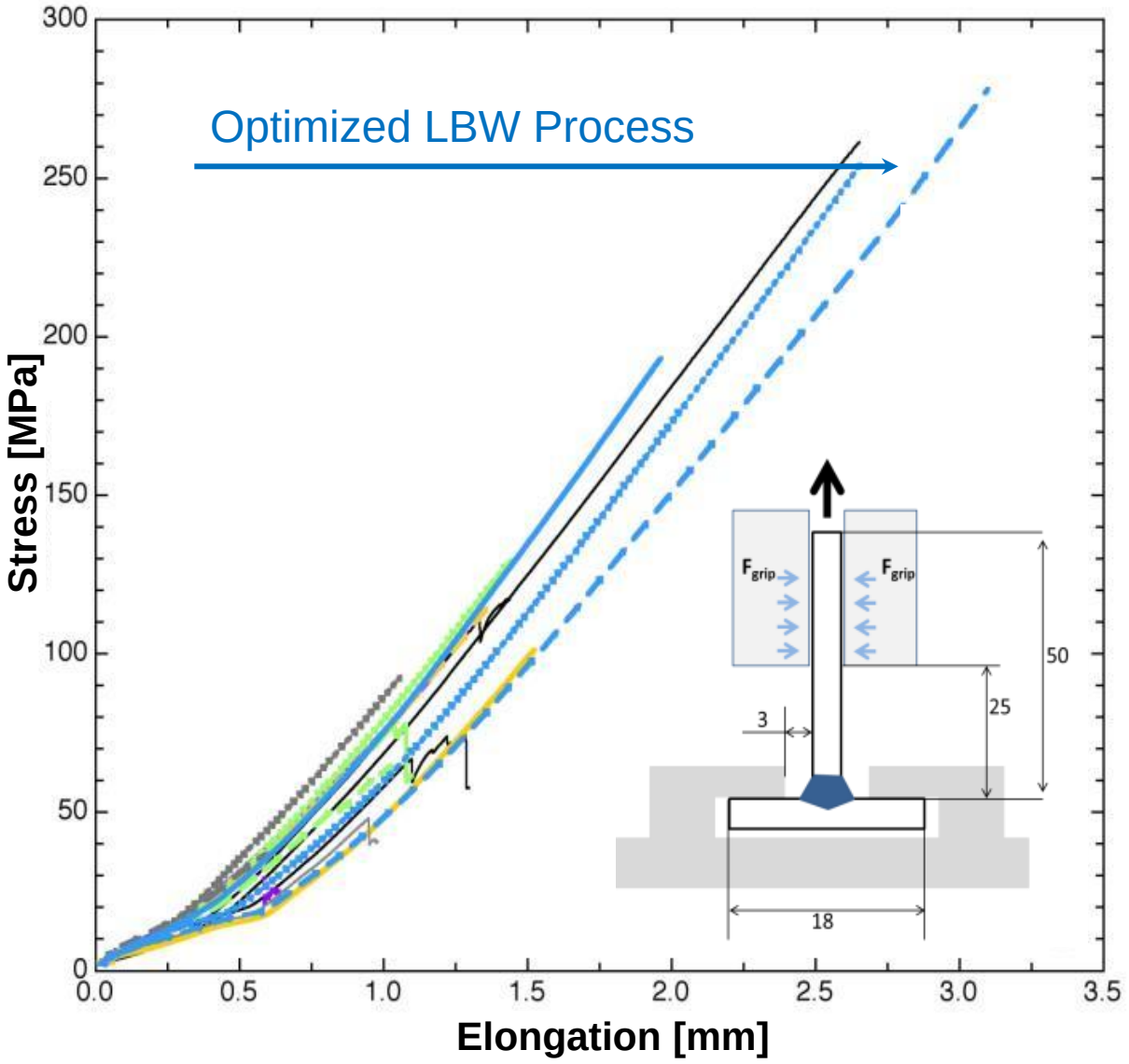
LBW:
P = 1720 Watt
V_W= 6.2 m/min
V_D= 7.0 m/min
a = 0.2 mm

Penetration depth of HAZ 1.6 mm



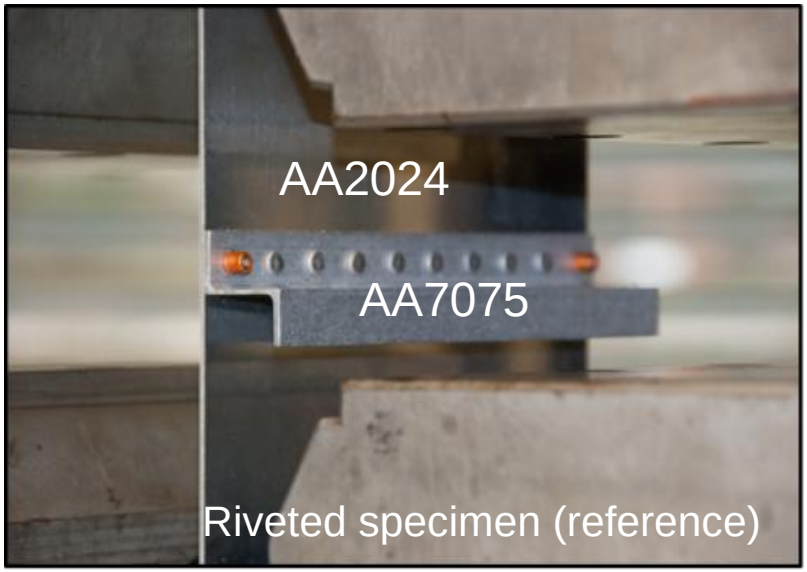
- Due to the heat input the T8 temper state will be lost, the skin is weakened
- The penetration depth will influence the hoop-strength

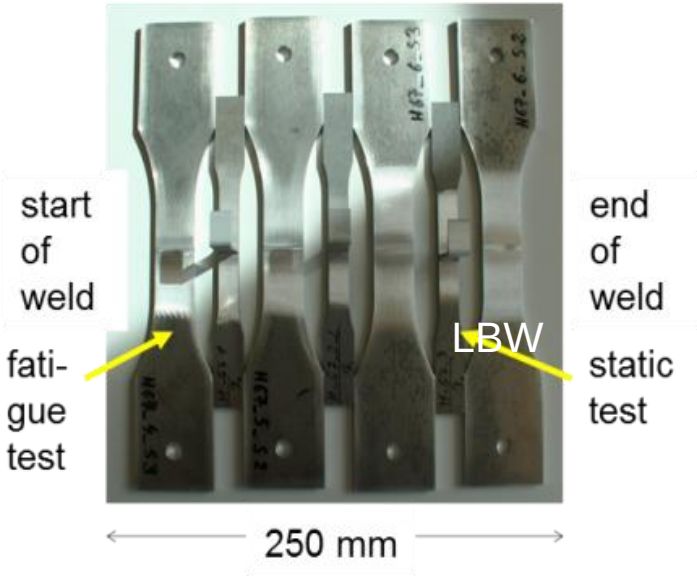
Pull-out test



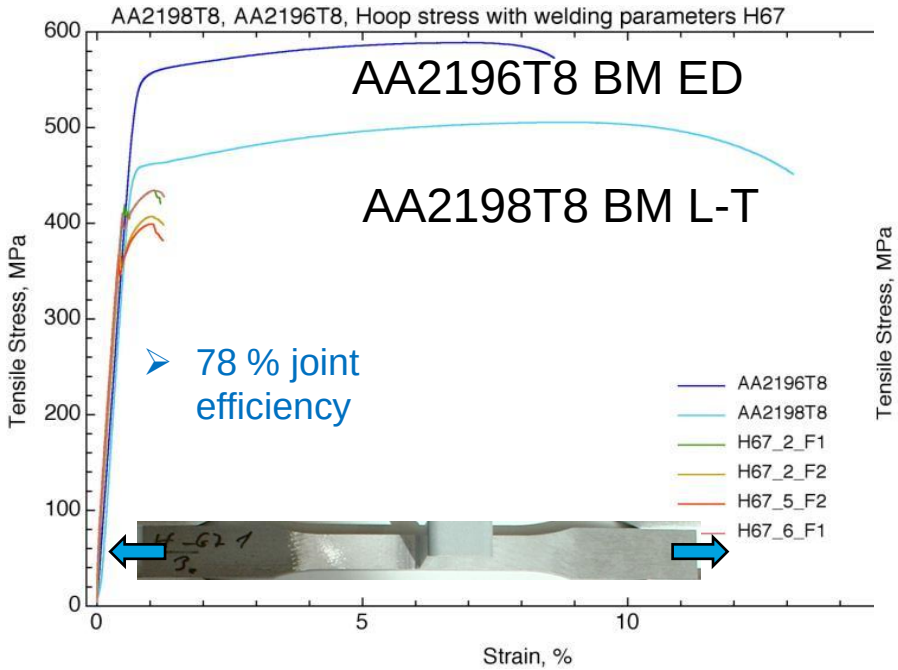
- LBW process optimized in terms of pull-out resistance

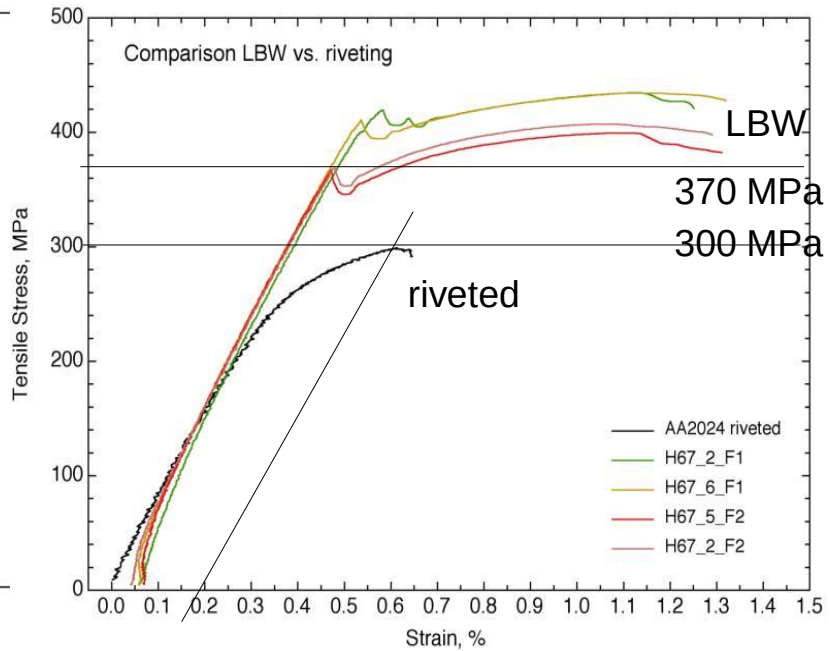
Hoop tests



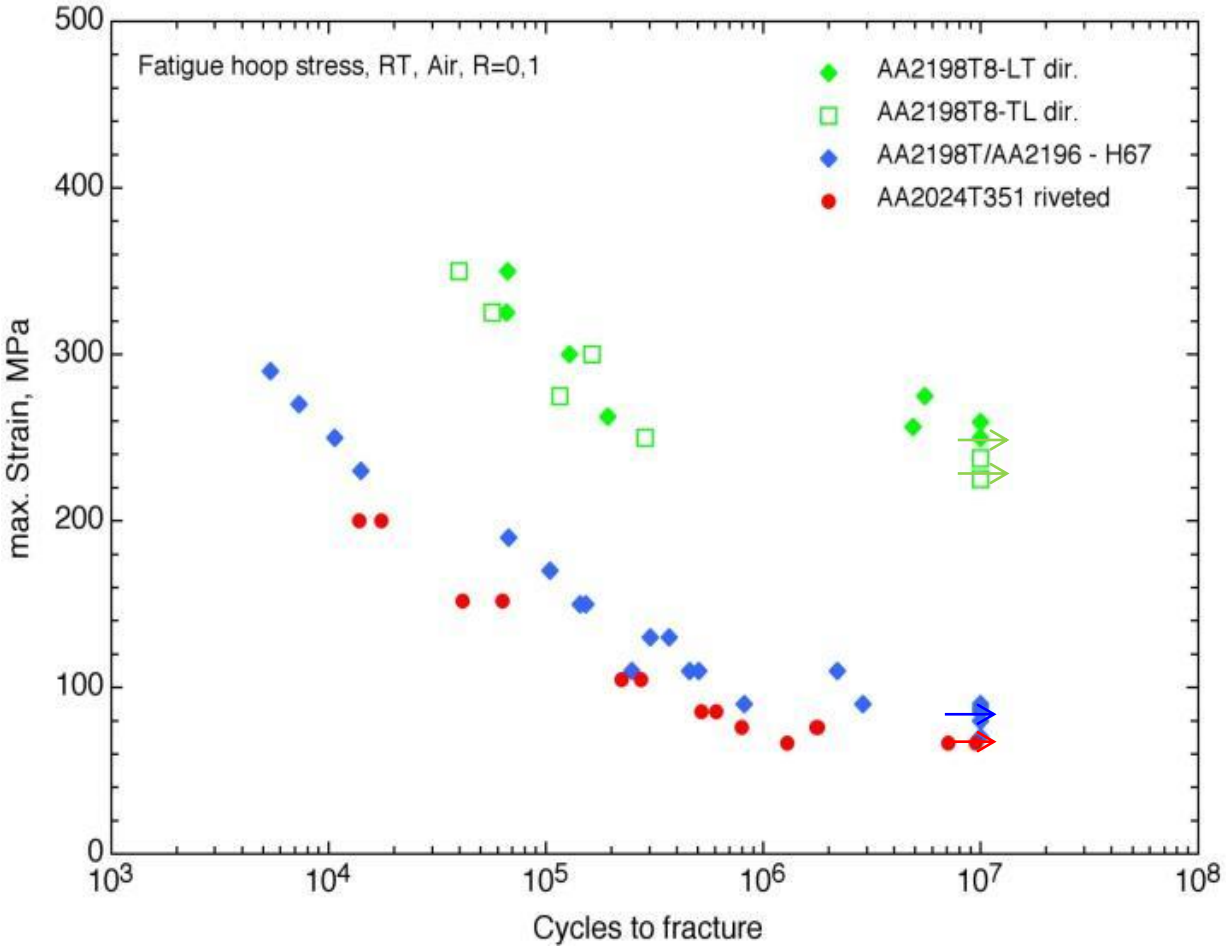


- LBW joints show higher stiffness and higher strength than riveted joints
- Fracture occurs in both cases in the joining zone





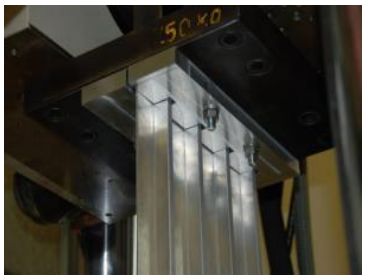
SN curves



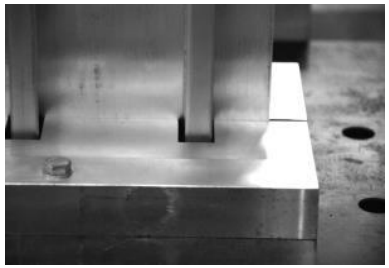
- Fatigue life: AA2024-AA7075 riveted = 66.5 MPa,
  AA2198-AA2196 LBW = 87.3 MPa

B1 demonstrator compression test

front view of B1 demonstrator

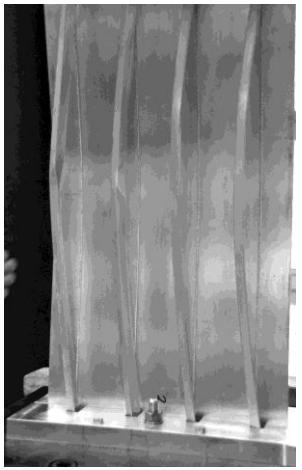


upper grip

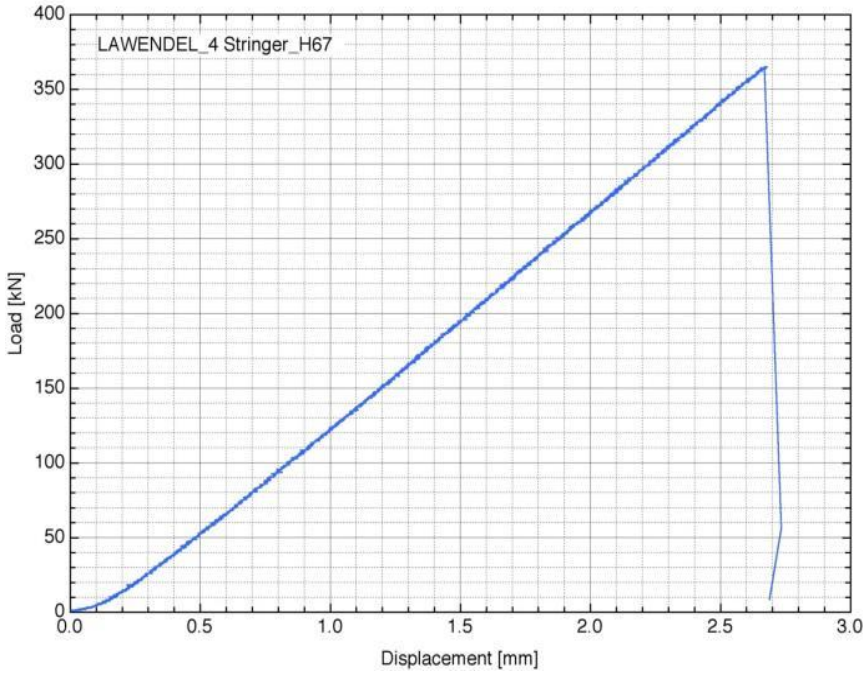


lower grip

- Welds with very low porosity level and no detectable transverse cracks can be realized by CO_2-laser beam welding in AA2198T8 / AA2196T85 T-joint.



F – ΔL curve



- The demonstrator B1 reached a load of 365 kN than skin buckled and stringers broke away on full length.
- no plastic deformation before failure

Summary

- For the LBW joints YS and UTS are minimum 76% of the AA2198T8 base materials
- Fatigue strength of AA2198/AA2196 reaches 85 MPa, that are 33% of AA2198T8 base materials fatigue strength (perpendicular to rolling direction (TL))

- Compared to a riveted joint of AA2024/AA7075 YS and UTS of the welded AA2198/AA2196 joint are 25% higher
- Fatigue strength of LBW AA2198T8/AA2196T8 is 23% higher than that of riveted AA2024T3

- **Theoretically a weight saving of 25 % could be possible when using LBW of AA2198T8 / AA2196T8 instead of riveting AA2024T3.**

Thank you for your attention