OPTIMAT BLADES

Preliminary tests Part 2

Static and fatigue tests of MD laminate with different gauge length

Research carried out by DLR within the framework of the Optimat Blades project
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DLR

1. Introduction

This report contains the graphs and photos from static and fatigue tests carried out at the Institute of Structures and Design of DLR. It consists of 2 static compression tests and 3 fatigue tests for two different geometries.

2. Material and specimens

The tested coupons are made of MD material and were provided by LM Glasfiber A/S Denmark.

Three series with different geometries are foreseen to be tested to verify the influence of free gauge length (35 mm, 40 mm, 45 mm) on test results. The nominal width was 25 mm and thickness was 6.55 mm. Tabs were 55 mm long and 2.75 mm thick.

3. Test Set-up

All specimens were tested using an servo-hydraulic test-stand. Strain gauges with gauge length of 6mm were glued on both sides of specimens to determine strain and control bending. For static tests displacement control was used whereas fatigue tests were carried out force-controlled.

4. Overview of results

Test	F_{max} [kN]	σ_{max} [MPa]	ε_{max} [%]	E [GPa]	Strain rate [%/s]	Cycles	Remarks
Compressive Tests							
S61_GL40	-85,34	-522,9	-1,95	27,66	≈0,031	-	Debonding of tabs, bending
S112_GL45	-82,54	-501,7	-2,00	29,90	≈0,043	-	Bending
Fatigue tests							
S66_GL40	±42,4	±261	+1,02 -0,95	+27,9 -25,9	10,0	168	Buckling
S71_GL40	±41,8	±261	+0,97 -0,75	+29,1 -31,8	5,0	336	Initial bending Severe buckling
S117_GL45	±32,89	±200	+0,79 -0,74	+27,4 -25,6	5,0	1897	Severe buckling

5. Test figures

For each test two figures are presented. The first figure contains strain versus stress in case of static tests, axial and bending stress versus strain for fatigue tests. The second figure shows an photograph of the failed specimen.

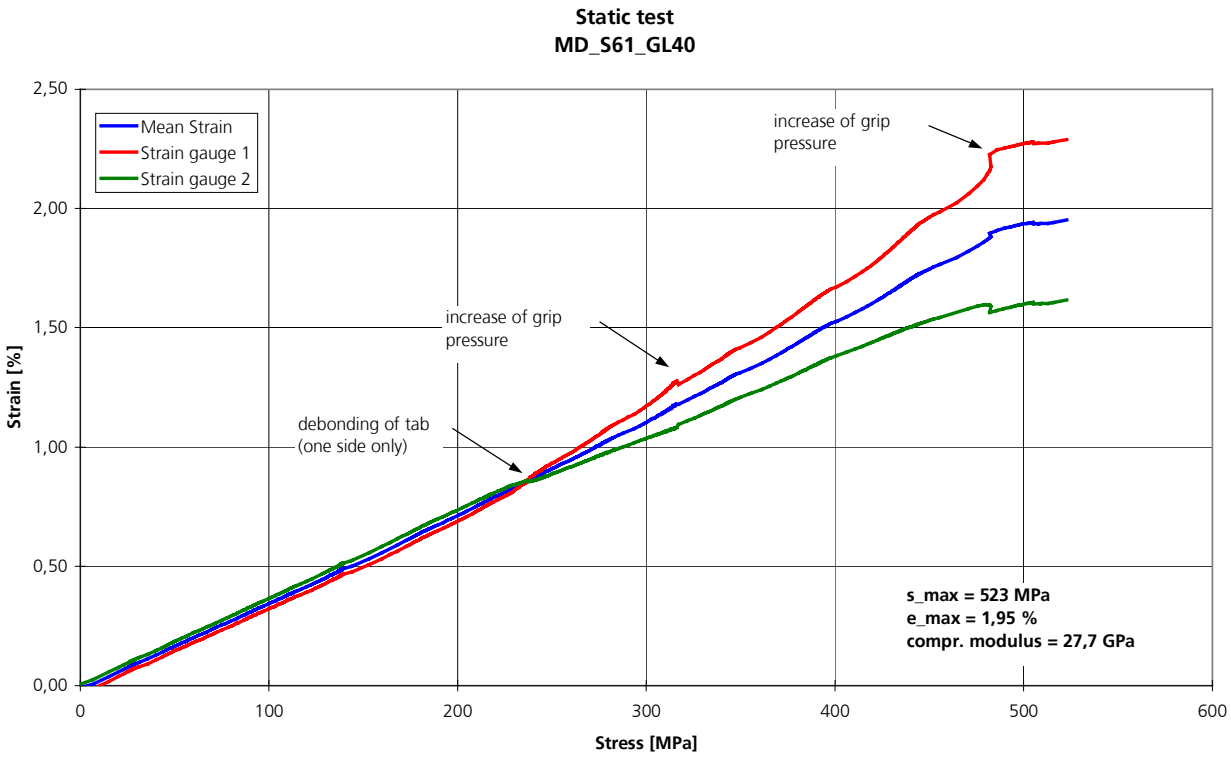

Figure 1: S61_GL40 - Strain gauge measurement, static test

Figure 2: Specimen MD_S61_GL40

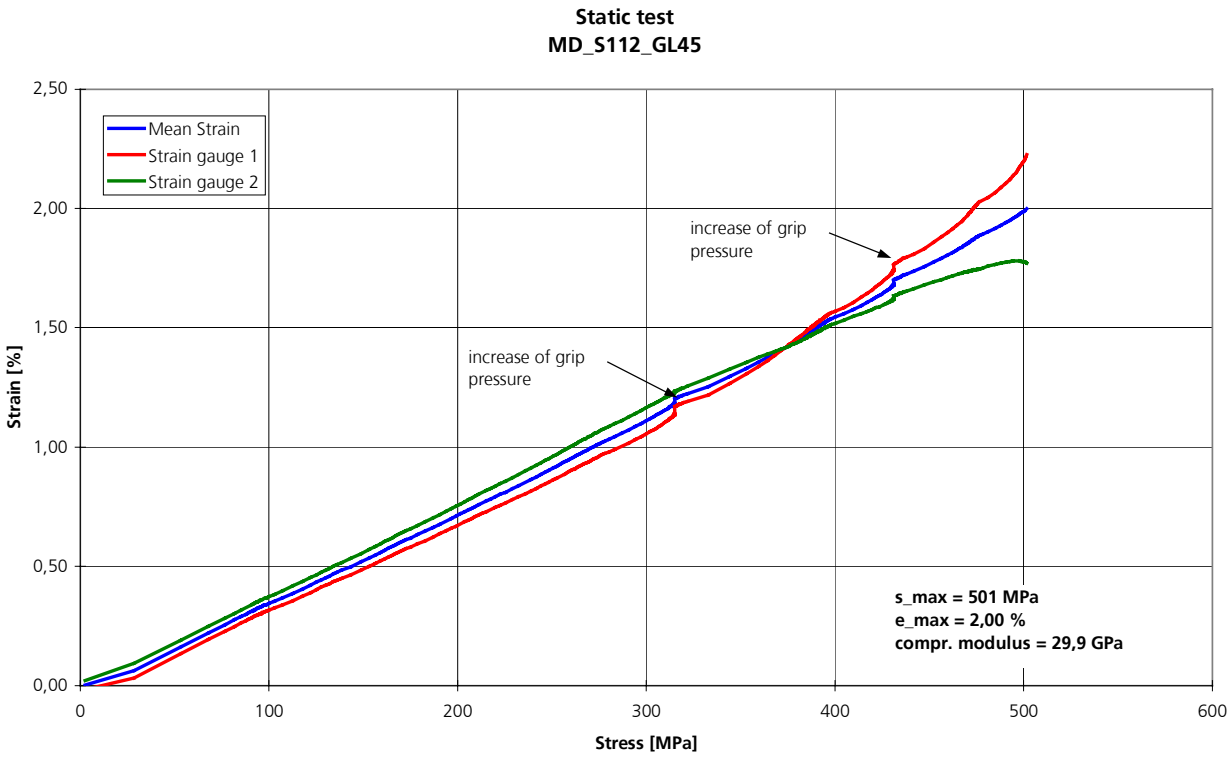

Figure 3: S112_GL45 - Strain gauge measurement, static test

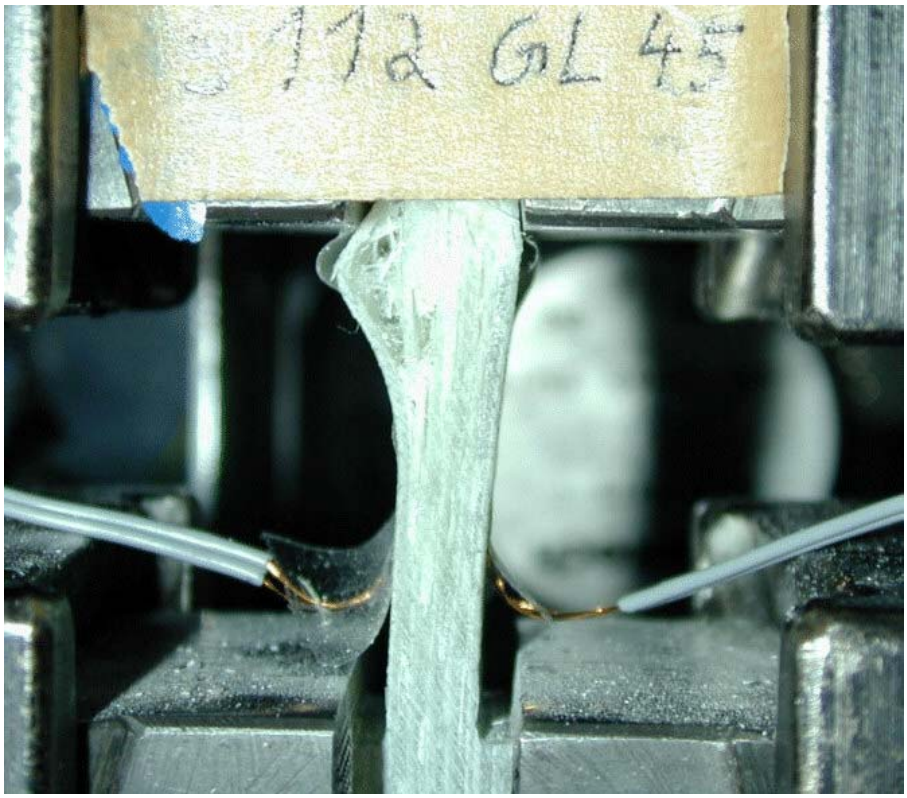

Figure 4: Specimen MD_S112_GL45

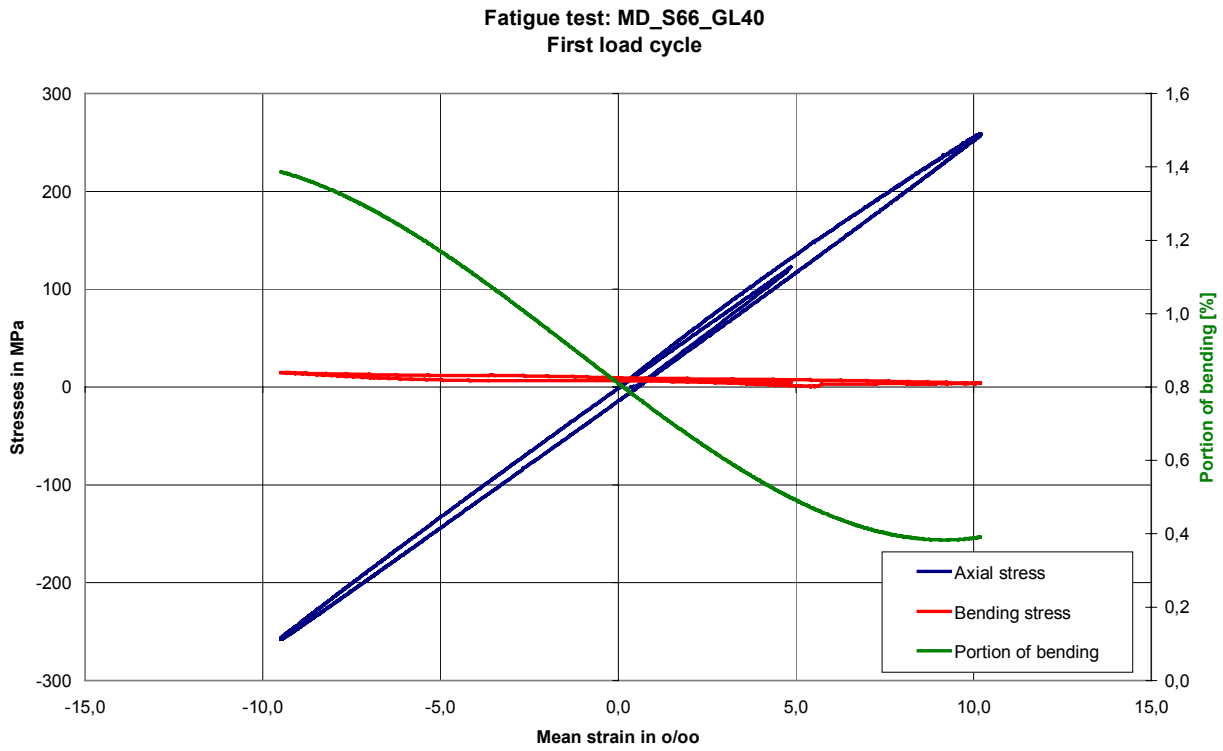

Figure 5: MD_S66_GL40 - Evaluation of bending

Figure 6: Specimen MD_S66_GL40

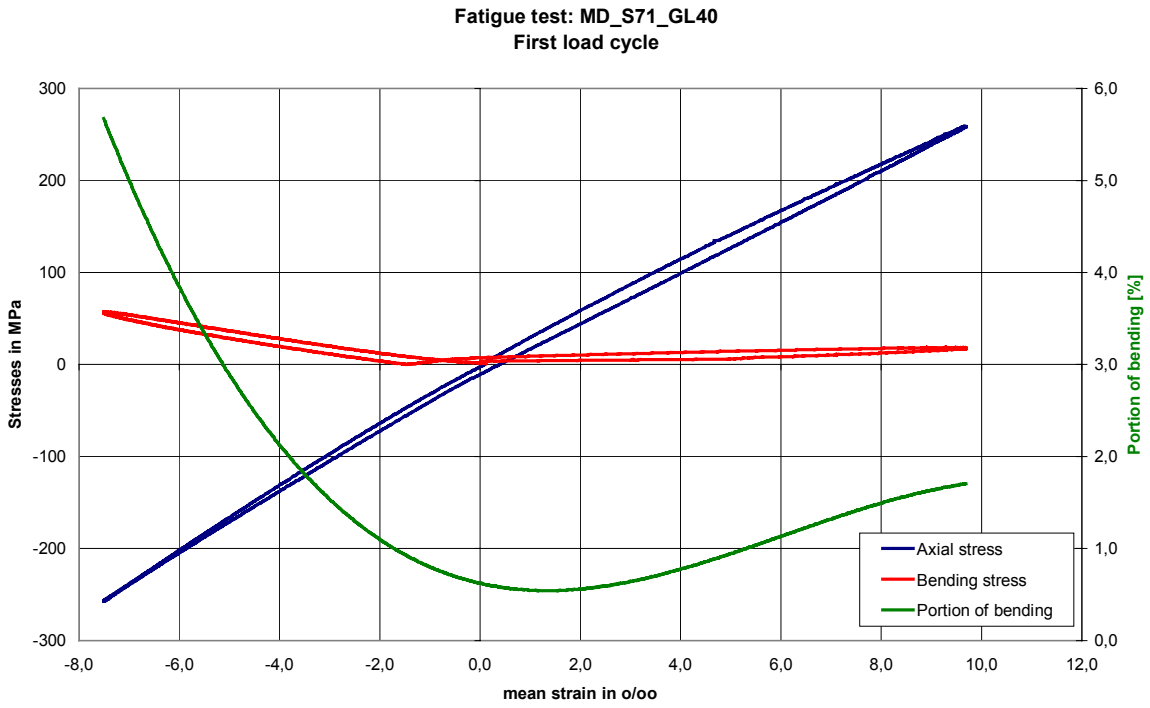

Figure 7: MD_S71_GL40 - Evaluation of bending

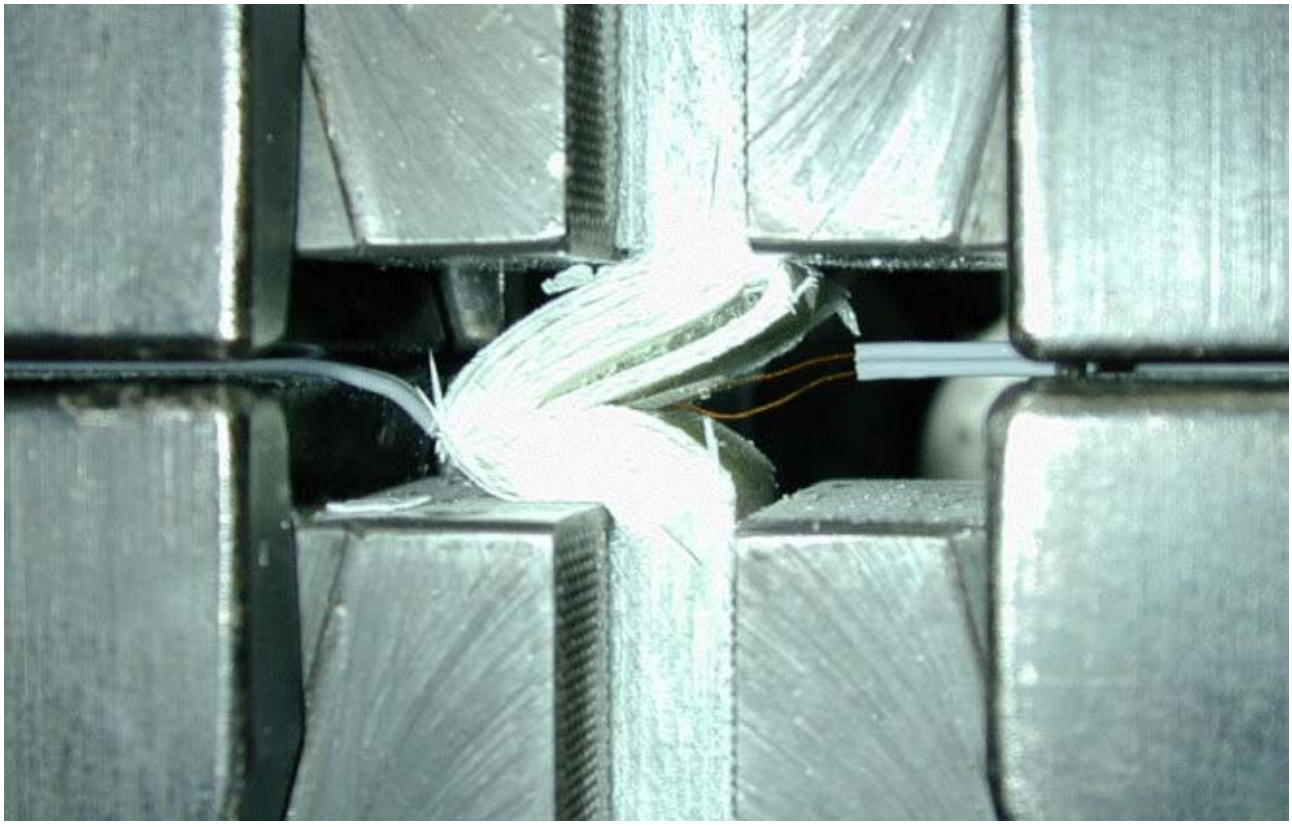

Figure 8: Specimen MD_S71_GL40

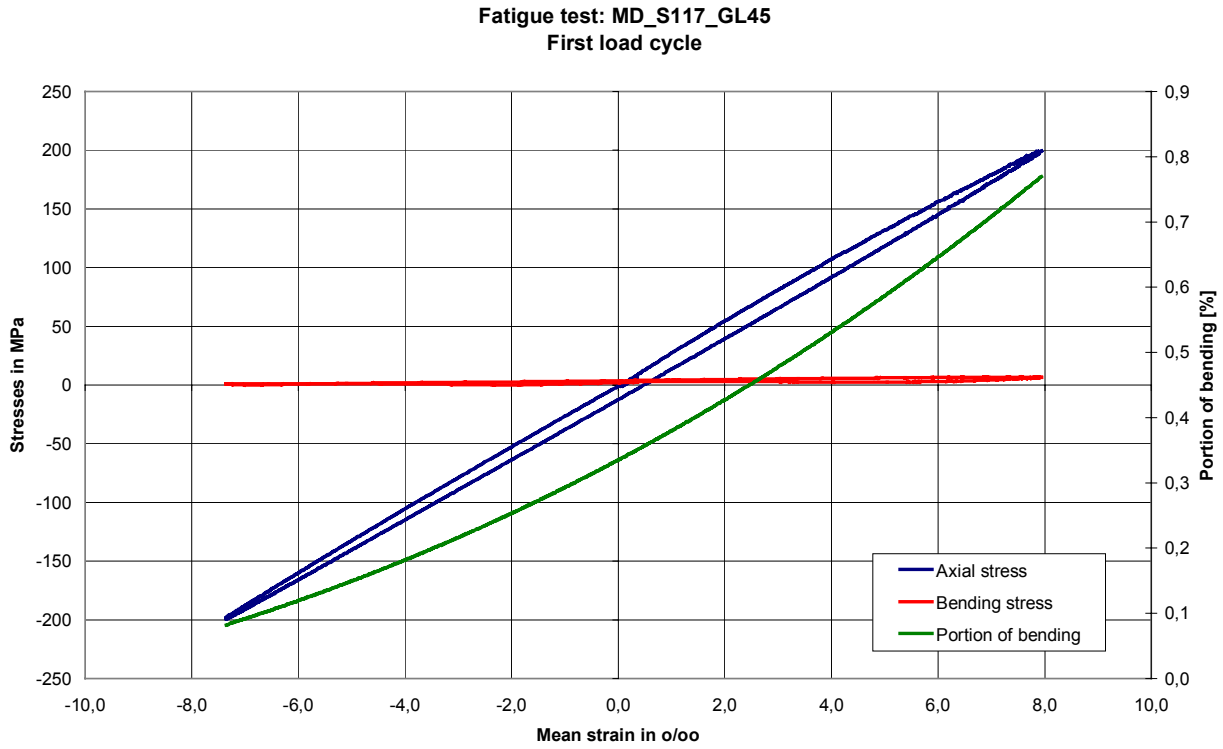

Figure 9: MD_S117_GL45: Evaluation of bending

Figure 10: Specimen MD_S117_GL45

6. Conclusions

Since only a few specimen could be tested, the results don't allow any statistical evidence. But the presence of severe buckling for specimen MD_S117_GL45 already at a low stress level and low strain rate indicates that this gauge length is definitely too long.
Although the specimen with 35 mm gauge length could not be tested, it should be considered that the load introduction on one side might influence the other side and causes premature failure.