



Preliminary tests -2

(Compression of UD specimens)

Number 10047

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1. Introduction

Three types of compression UD specimens will be tested in this test in order to find out the most optimal test geometry for the compression tests that could be used further in OPTIMAT BLADE project. Specimens of three different gauge length (the same width and thickness) will be tested in compression using two different gripping methods, and results compared.

2. Specimens

Compression test specimens with lay up [UD]4 and gauge length, GL30, GL35, GL40 are manufactured and provided by LM Glasfiber A/S. The clamping area (TABs) are kept the same length for all specimens, therefore specimens with different gauge length (GL30, GL35, GL40) have different total length, named A, B and C respectively. The length of the specimens, corresponding gauge length (GL) and numbering of the specimens are given in Table 1. The generalized drawing of the specimen is given in Figure 1. Two strain gauges, one on each side, are glued on the specimen to measure strain and control alignment during the test.

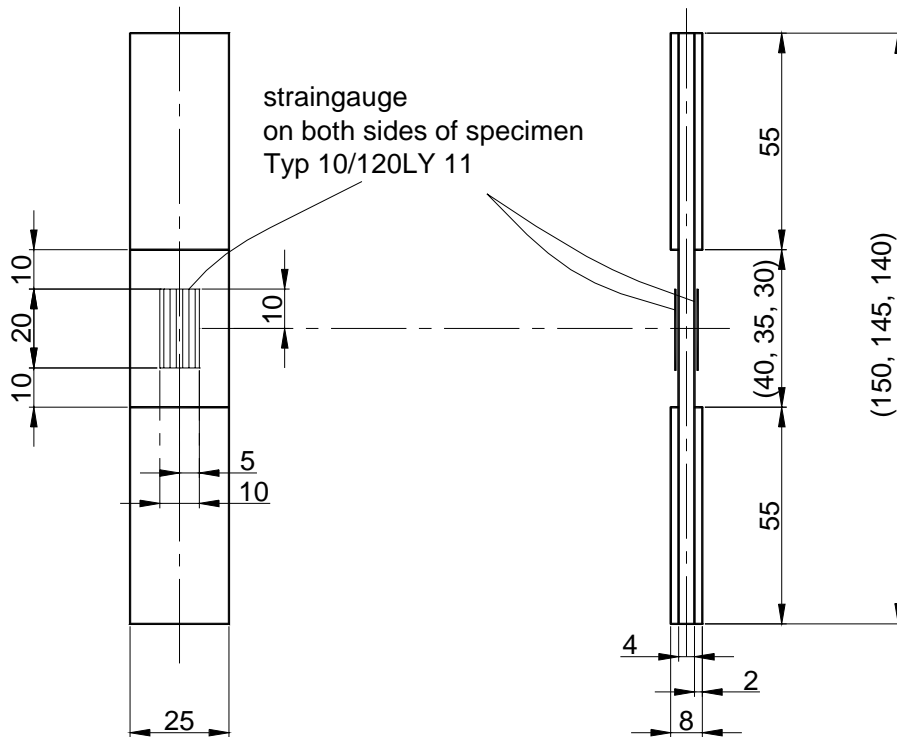


Figure 1. Specimen geometry for compression test.

Table 1. Length of the specimens.

Specimen length		Gauge length (GL)		Specimen Nr.
ID	Length (mm)	ID	Length (mm)	
A	140	GL30	30	S4, S9, S14, S19
B	145	GL35	35	S34, S39, S44, S49
C	150	GL40	40	S64, S69, S74, S79

3. Testing

Two types of grips are used. Conventional compression test fixtures are used and mechanical gripping used for fatigue tests, mounted in standard hydraulic grips. The INSTRON hydraulic testing machine, model 1333, was used for both setups. Both grips are illustrated in Figure 2, Figure 3, respectively. The cross-head speed is calculated for different gauge length so that it gives standard strain rate, calculated from cross-head speed 1 mm/min and gauge length 25 mm given in the ISO 14126. The calculated cross-head speeds are in Table 2. Loading of each specimen is listed in Table 3.



Table 2. Loading parameters.

Gauge length (mm)	Cross-head speed (mm/min)	Strain rate (sec ⁻¹)	Notes
25	1	0.0006	ISO 14126
30	1.2	0.0006	Calculated
35	1.4	0.0006	--"--
40	1.6	0.0006	--"--

According to Table 2, each specimen is loaded as listed in Table 3.

Table 3. Loading of the specimens.

#	Specimen length (mm)	Gauge length (GL)	Nr.	Cross-head speed (mm/min)
A	140	GL30	S4, S9, S14, S19	1.2
B	145	GL35	S34, S39, S44, S49	1.4
C	150	GL40	S64, S69, S74, S79	1.6

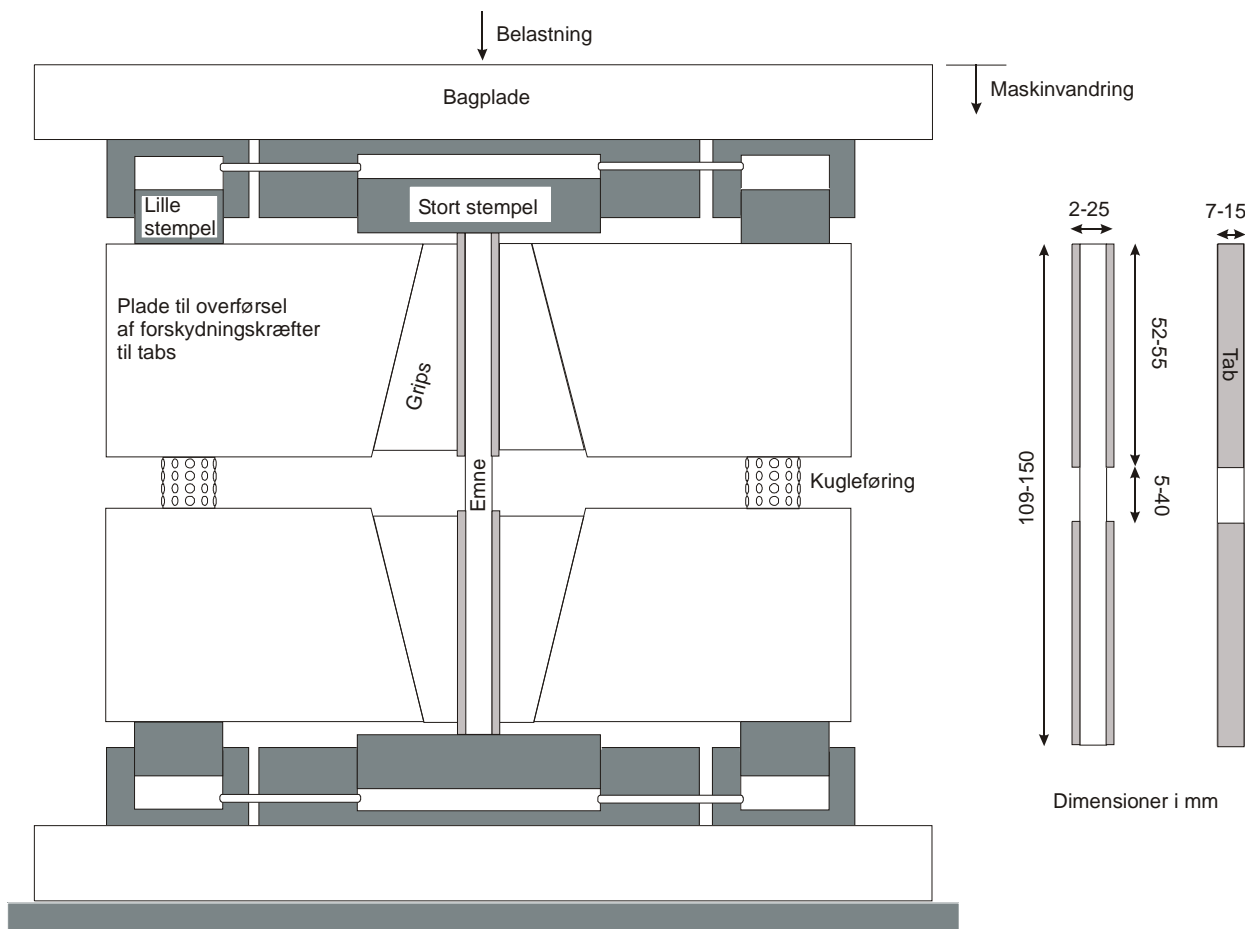


Figure 2. Compression test fixture with combined, shear and end loading. Setup-1.

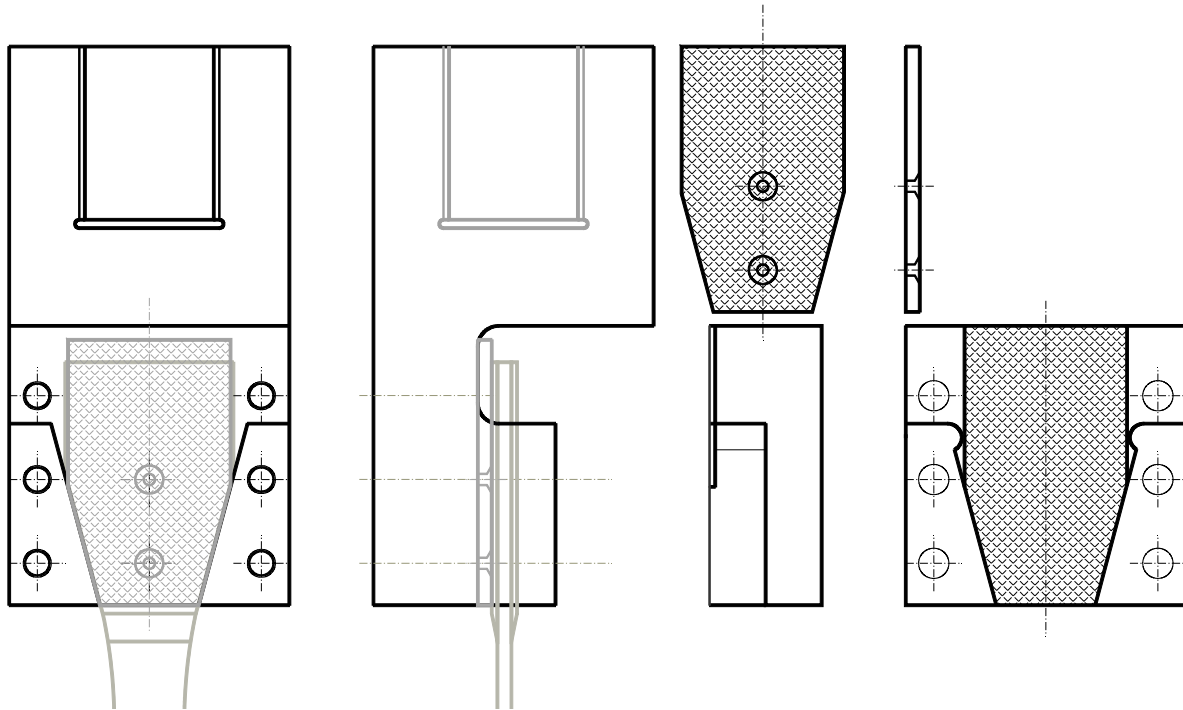


Figure 3. Fatigue fixture used for compression tests. Setup-2.

4. Results

Specimens with the same gauge length, GL30, are tested in compression using two different gripping methods, setup-1 and setup-2. Results are given in Table 4. There are obvious difference in measured compression strength between setup-1 and setup-2. The difference is due to the buckling in case of setup-2. It is believed, that buckling takes place due to general compliance of testing machine. Better gripping methods must be used to minimize the effect of the compliance of the machine on measurements. It is achieved in setup-1, where four stiff rods on bearings keep grips perfectly aligned during the test.

Specimen, AS-09, gave unexpected low value for the strength. It could be just a bad coincidence.

Table 4. Compared results of compression tests using setup-1 and setup-2.

Specimen type	GL (mm)	Specimen	E (GPa)	UCS (MPa)	Means (MPa)	Notes
A	30	AS-04	35.9	-612.125		
		AS-09	37.8	-499.506	-555.82	expected appr. 600 Mpa
		AS-14	35.5	-412.469		Fatigue grips
		AS-19	35.5	-476.421	-444.44	Fatigue grips

Further tests were performed on setup-1 only to measure compression strength and Young's modulus using specimens with three different gauge lengths. The results are given in Table 5.



Table 5. Results of compression tests using setup -1.

Specimen type	GL (mm)	Specimen	E (GPa)	UCS (MPa)	Means (MPa)	Notes
A	30	AS-04	35.9	-612.125		
		AS-09	37.8	-499.506	-555.82	expected appr. 600 Mpa
B	35	BS-34	36.7	-587.393		
		BS-44	36.8	-581.254		
		BS-39	35.7	-581.895		
		BS-49	36.8	-556.069	-576.65	
C	40	CS-64	36.9	-544.102		
		CS-69	36.9	-532.035		
		CS-74	36.0	-509.035		
		CS-79	36.5	-554.509	-534.92	
Average			36.6	-555.792	-555.796	
STD			0.61	35.837		

Because of limit of four specimens of each kind, there are only two measurements for GL30 with setup-1. Two specimens were tested with setup-2, se results Table 4 before. From two measurements for GL30 we could expect that compression strength could be around 600 MPa and possibly more for shorter gauge length (ISO standard specimen). It is difficult to comment the stability or repeatability of the test because of two measurements only.

The measured compression strength is decreasing as longer gauge length is used.

The measure ultimate compression strain given in Table 6.

Table 6. Ultimate compression strain (%)

	A	B	C
	1.16	1.67	1.39
	1.32	1.65	1.48
	1.73	1.49	1.43
	1.24	1.52	1.53
Average	1.36	1.58	1.46
STDV	0.25	0.09	0.06