

Test report

Number: 2018-11-4922-04

Client: TPI All Seasons Company Limited
26/56 TPI Tower, Chan Tat Mai Rd.
10120 Tungmahamek, Sathorn, Bangkok
Thailand

Commission: Tests on laminated safety glass for building application

Number of pages: 7

Fundamental guidelines and test procedures:

- DIN EN ISO 12543-4** Glass in building - Laminated glass and laminated safety glass - Part 4: Test methods for durability
- prEN 16613** Glass in building - Laminated glass and laminated safety glass - Determination of interlayer mechanical properties
- DIN ISO 34-1** Rubber, vulcanized or thermoplastic - Determination of tear strength - Part 1: Trouser, angle and crescent test pieces

Rohrbach, 13. May 2019


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The test results in this test report exclusively refer to the test material as indicated in this report.

Reprinting this test report requires our written approval.

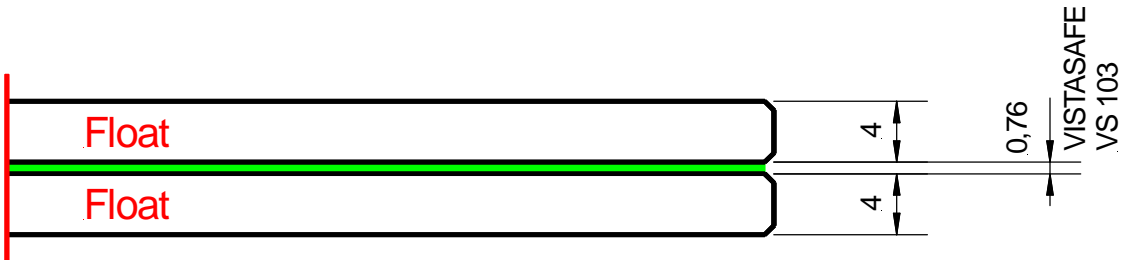

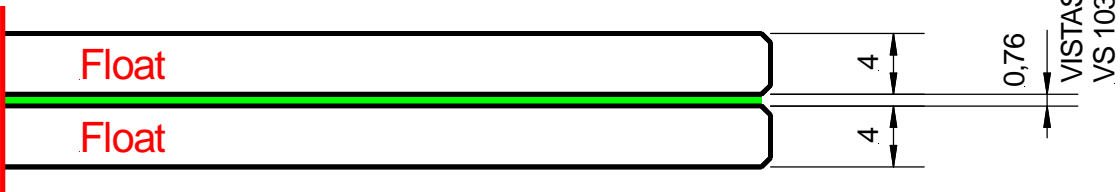
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1 Test material

Basic glass:	Float glass DIN EN 572-2
Processed to:	Laminated safety glass
Test specimen:	<p>8 Glass panes 100 x 300 mm Glass structure 4 Float / 0,76 VISTASAFE VS 103 / 4 Float</p>  <p>PK-Number PK 16 - 23</p>
	<p>3 Glass panes 150 x 300 mm Glass structure 3 Float / 0,76 VISTASAFE VS 103 / 3 Float</p>  <p>PK-Number PK 24 - 26</p>
	<p>5 Glass panes 360 x 1100 mm Glass structure 4 Float / 0,76 VISTASAFE VS 103 / 4 Float</p>  <p>PK-Number PK 1 - 8, 27 - 37, 46 - 52</p>
Receipt of specimen:	11. January 2019
	6 pieces of foil VISTASAFE VS 103 50 x 100 mm
	PK-Number 40 - 45
Receipt of specimen:	07. February 2019

2 Test equipment

- P085 Digital calliper
- P023 Digital micrometre
- P126 Metal ruler
- P105 Laboratory kiln Heraeus
- P108 Water bath
- Ultravitalux test setup
- Bending rig with temperature control

The test equipment is subject to test equipment surveillance.

The bending rig with temperature control consist of a thermally isolated chamber into which a bending rig had been mounted. The geometry of the test stand is in conformity with prEN 16613.

The load applied onto the test panes had been chosen taking into consideration the tensions provided. It had been applied shock-free by electromechanical device.

The flexion of the test panes had been monitored digitally.

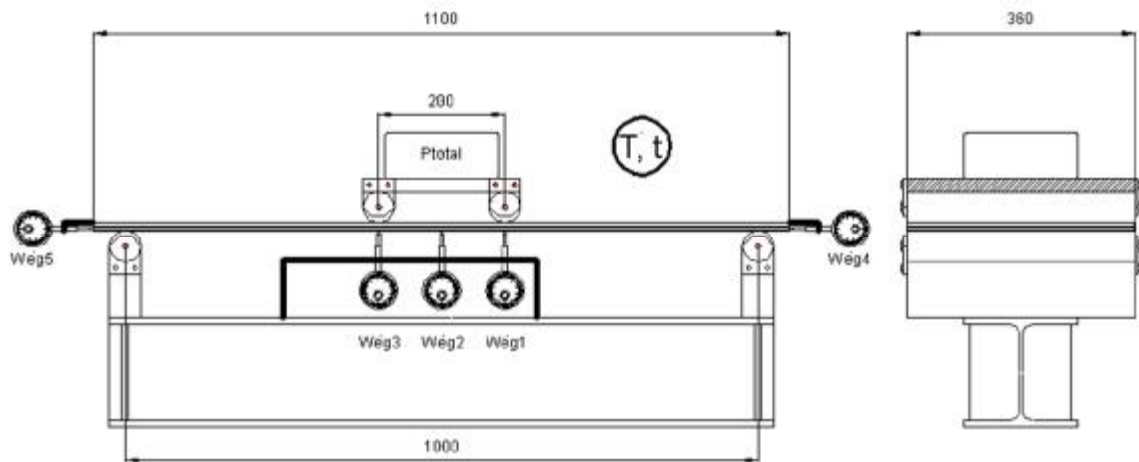


Fig. 1: Geometry bending rig

3 Tests and results

3.1 Determination of shear modulus

The test specimen had been loaded with 166 N. The examination had been carried out in short-term range at temperatures of 25 °C, 30 °C, 40 °C, 50 °C and 60 °C. The long-term examination had been carried out at 25 °C.

In short-term range, each single test specimen had been loaded in three intervals of one hour each. Between the loadings, relaxation intervals of 1,5 hours each had been observed. For the long-term examination, the loading period had been 4 days.

For determination of the shear modulus in view of the measured deflections, the relation between the shear modulus – deflection for the geometry and loading at hand had been determined by means of a FE-calculation.

With the relation evaluated that way, the related values of the shear modulus for discrete loadings had been determined from the characteristic values of the test series – which describe the 5% fractile of the maximum deflection at a level of confidence of 75%.

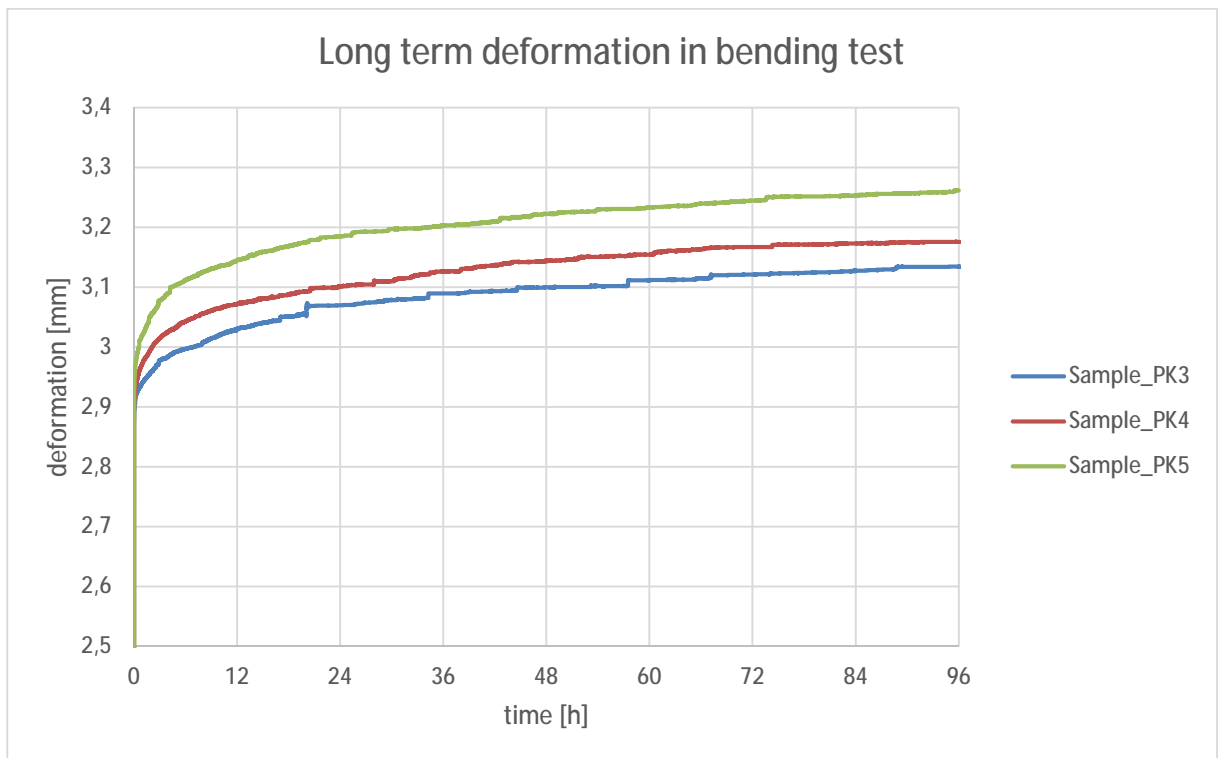
Deflections					
Glass composition:		4 Float / 0,76 VISTASAFE VS 103 / 4 Float			
Test temperature:		25 °C			
Test load:		166 N			
Time	Number of values	Average deflection	Coefficient of variation	Characteristic deflection	Shear modulus
[s]	[-]	[mm]	[%]	[mm]	[N/mm ²]
3	15	2,813	0,44	2,837	8,364
60	15	2,866	0,54	2,897	7,233
600	15	2,909	0,66	2,947	6,403
3600	15	2,947	0,69	2,988	5,796

Deflections					
Glass composition:		4 Float / 0,76 VISTASAFE VS 103 / 4 Float			
Test temperature:		30 °C			
Test load:		166 N			
Time	Number of values	Average deflection	Coefficient of variation	Characteristic deflection	Shear modulus
[s]	[-]	[mm]	[%]	[mm]	[N/mm ²]
3	15	2,901	0,69	2,941	6,504
60	15	2,956	0,52	2,987	5,811
600	15	2,998	0,41	3,023	5,328
3600	15	3,043	0,55	3,076	4,685

Deflections					
Glass composition:		4 Float / 0,76 VISTASAFE VS 103 / 4 Float			
Test temperature:		40 °C			
Test load:		166 N			
Time	Number of values	Average deflection	Coefficient of variation	Characteristic deflection	Shear modulus
[s]	[-]	[mm]	[%]	[mm]	[N/mm ²]
3	15	3,052	0,68	3,093	4,490
60	15	3,115	0,69	3,158	3,852
600	15	3,167	0,84	3,220	3,337
3600	15	3,230	1,14	3,303	2,776

Deflections					
Glass composition:		4 Float / 0,76 VISTASAFE VS 103 / 4 Float			
Test temperature:		50 °C			
Test load:		166 N			
Time	Number of values	Average deflection	Coefficient of variation	Characteristic deflection	Shear modulus
[s]	[-]	[mm]	[%]	[mm]	[N/mm ²]
3	15	3,256	0,91	3,315	2,709
60	15	3,346	1,07	3,417	2,219
600	15	3,439	1,24	3,524	1,859
3600	15	3,565	2,24	3,724	1,480

Deflections					
Glass composition:		4 Float / 0,76 VISTASAFE VS 103 / 4 Float			
Test temperature:		60 °C			
Test load:		166 N			
Time	Number of values	Average deflection	Coefficient of variation	Characteristic deflection	Shear modulus
[s]	[-]	[mm]	[%]	[mm]	[N/mm ²]
3	15	3,587	2,41	3,759	1,441
60	15	3,691	2,39	3,866	1,352
600	15	3,819	1,68	3,947	1,305
3600	15	4,028	2,26	4,210	1,194



The average shear modulus for long term loads up to four days can be estimated 3,3 N/mm².

3.2 High-temperature test

The test had been carried out according to DIN EN ISO 12543-4 chapter 5, method A.

PK-Number	Visual testing	Details
16	no abnormalities	-
17	no abnormalities	-
18	no abnormalities	-

3.3 Humidity test

The test had been carried out according to DIN EN ISO 12543-4 chapter 6, method 6.3.1.

PK-Number	Visual testing	Details
20	no abnormalities	-
21	no abnormalities	-
22	no abnormalities	-

3.4 Radiation test

The test had been carried out according to DIN EN ISO 12543-4 chapter 7, method 7.3.1.

PK-Number	Visual testing	Details
24	no abnormalities	-
25	no abnormalities	-
26	no abnormalities	-

3.5 Tear resistance test

The test had been carried out according to DIN ISO 34-1.

PK-Number	thickness [mm]	minimal peak [N]	median peak [N]	maximal peak [N]	amount of peaks [-]
40	0,78	2,75	7,87	10,64	11
41	0,79	6,01	6,76	10,52	14
42	0,82	2,95	7,13	9,84	15
43	0,83	2,93	6,04	10,91	18
44	0,81	4,47	6,54	12,42	12
45	0,72	4,07	6,01	8,88	14