MONASH University

TEST REPORT
BASIC WORKING LOADS AND CHARACTERISTIC STRENGTHS FOR WILMAPLEX TAP-IN PLATES WITH MGPA0 RADIATA PINE IN ACCORDANCE WITH AS 1649-2001

CLIENT:

WILMAPLEX PTY LTD.
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TESTING AUTHORITY:

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DEPARTMENT OF CIVIL ENGINEERING
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JOB NUMBER: **WILMAPLES/14/002**

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This Test Report refers to testing only one sample
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Signature 

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1. Objective

Monash University was commissioned by Wilmaplex Pty. Ltd. to evaluate the Tap-in plate capacity for 90x100, 90x200, 45x100 and 45x200mm sizes assembled with MGP10 radiata pine (JD4) in accordance with AS1649, as shown in Figure 1 which was extracted from AS1649; in both parallel and perpendicular directions, note here that AS1649 categorizes the tap-in plates as Type C fasteners. All specimens were fabricated and supplied by Wilmaplex.

2. Executive summary of test results

Table 1 Tap-in design capacity per nail (N) for JD4 joint group

Load Direction	Design load capacity N_j (N) per nail for timber joint group:	
	Dry timber	
	JD4	
	No factors applied	**Capacity and duration factors applied[1]**
Parallel	**269**	**130**
Perpendicular	**194**	**95**

[1] A capacity factor $\phi = 0.85$ and a duration factor $k_1 = 0.57$ for permanent load was applied.

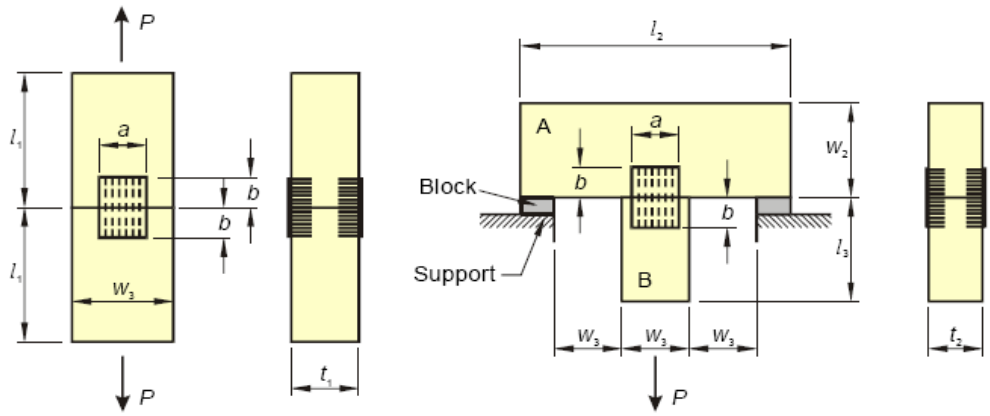
3. Test specimens details

A total of 80 specimens were fabricated and despatched to Monash University Structural Laboratory by Wilmaplex as described in Table 2.

Table 2 Tap-in test specimen details.

Tap-in plate size	Product Code	Load direction	Number of specimens tested
90x100	TIP90100	Parallel	10
		Perpendicular	10
90x200	TIP90200	Parallel	10
		Perpendicular	10
45x100	TIP45100	Parallel	10
		Perpendicular	10
45x200	TIP45200	Parallel	10
		Perpendicular	10

All tap-in plates were manufactured using G300-Z275 steel, see Certificate of Compliance in the Appendix. The product codes were extracted from the wilmaplex 2013 catalogue.



(a) Parallel Type (b) Perpendicular Type

FIGURE 2.4 ASSEMBLIES FOR TESTING CATEGORY C FASTENERS

Figure 1 Tap-in plates test specimens (extracted from AS1649)

4. Testing methodology

All tests procedures undertaken were in accordance with AS 1649-2001, Clause 2.2.6.

5. Test results and analysis

The test data was statistically processed in accordance with AS 1649.

Table 3 Unit lateral load values for tap-in plates

Tap-in plate size (mm)/Code	Direction of testing	ULL_1	ULL_2	R_{bwl} (N)
90x100/TIP90100	Parallel	91	81	**81**
	Perpendicular	56	50	**50**
90x200/TIP90200	Parallel	69	62	**62**
	Perpendicular	49	49	**49**
45x100/TIP45100	Parallel	87	89	**87**
	Perpendicular	71	64	**64**
45x200/TIP45200	Parallel	74	66	**66**
	Perpendicular	53	50	**50**

ULL_1 Unit lateral load based on 5th percentile of maximum loads (AS1649, equation 3.2.5(1))

ULL_2 Unit lateral load based on the average of maximum loads (AS1649, equation 3.2.5(1)

R_{bwl} Basic working load per shear unit

$R_k=3.65\ R_{bwl}$ Characteristic load capacity for limit states design

5.1. 90x100mm tap-in plates results

5.1.1. Parallel direction

Table 4 Statistical analysis for 90x100mm tap-in plates (Parallel).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	11830	4.07	16.59
2	11591	4.06	16.52
3	12070	4.08	16.66
4	11933	4.08	16.62
5	9813	3.99	15.93
6	11004	4.04	16.33
7	12683	4.10	16.84
8	9364	3.97	15.77
9	10912	4.04	16.30
10	12823	4.11	16.88

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.022685\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 4.07

$y_{5\,percent} = \bar{y} - ks$ =4.03 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 91$$

$$ULL2 = \frac{P_1}{3.5xN} = 81$$

N= 42 = the total number of single shear units (teeth) acting on one member of the joint, note that all teeth nails having an edge distance of less than 12mm were ignored.

5.1.2. Perpendicular direction

Table 5 Statistical analysis for 90x100mm tap-in plates (Perpendicular).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	9256	3.97	15.73
2	9261	3.97	15.73
3	10225	4.01	16.08
4	10020	4.00	16.01
5	11169	4.05	16.39
6	10196	4.01	16.07
7	9156	3.96	15.70
8	10519	4.02	16.18
9	9526	3.98	15.83
10	9638	3.98	15.87

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.028038\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 3.99

$y_{5\,percent} = \bar{y} - ks$ =3.94 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 56$$

$$ULL2 = \frac{P_1}{3.5xN} = 50$$

N= 56 = 28 x 2 faces = the total number of single shear units (teeth) acting on one member of the joint.

5.2. 90x200mm tap-in plates results

5.2.1. Parallel direction

Table 6 Statistical analysis for 90x200mm tap-in plates (Parallel).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	20221	4.31	18.54
2	20357	4.31	18.57
3	20670	4.32	18.62
4	22791	4.36	18.99
5	20561	4.31	18.60
6	24159	4.38	19.21
7	22189	4.35	18.89
8	20578	4.31	18.61
9	20054	4.30	18.51
10	20972	4.32	18.68

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.026666\right]}$$

s is the standard deviation of the logarithmic values.

k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 4.33

$y_{5\,percent} = \bar{y} - ks$ =4.28 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 69$$

$$ULL2 = \frac{P_1}{3.5xN} = 62$$

N= 98 = the total number of single shear units (teeth) acting on one member of the joint, note that all teeth nails having an edge distance of less than 12mm were ignored.

5.2.2. Perpendicular direction

Table 7 Statistical analysis for 90x200mm tap-in plates (Perpendicular).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	19433	4.29	18.39
2	16296	4.21	17.74
3	18140	4.26	18.14
4	21870	4.34	18.83
5	22979	4.36	19.02
6	16520	4.22	17.79
7	19737	4.30	18.45
8	20779	4.32	18.64
9	16923	4.23	17.88
10	20407	4.31	18.57

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.0519449\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 4.28

$y_{5\,percent} = \bar{y} - ks$ =4.18 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 49$$

$$ULL2 = \frac{P_1}{3.5xN} = 49$$

N= 112 = 56 x 2 faces = the total number of single shear units (teeth) acting on one member of the joint.

5.3. 45x100mm tap-in plates results

5.3.1. Parallel direction

Table 8 Statistical analysis for 45x100mm tap-in plates (Parallel).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	6792	3.83	14.68
2	5275	3.72	13.85
3	5947	3.77	14.25
4	5205	3.72	13.81
5	7297	3.86	14.92
6	4803	3.68	13.55
7	7052	3.85	14.81
8	5646	3.75	14.08
9	7107	3.85	14.84
10	6792	3.83	14.68

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.055963989\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 3.80

$y_{5\,percent} = \bar{y} - ks$ =3.69 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 87$$

$$ULL2 = \frac{P_1}{3.5xN} = 89$$

N= 20 = the total number of single shear units (teeth) acting on one member of the joint, note that all teeth nails having an edge distance of less than 12mm were ignored.

5.3.2. Perpendicular direction

Table 9 Statistical analysis for 45x100mm tap-in plates (Perpendicular).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	5837	3.77	14.18
2	6423	3.81	14.50
3	5915	3.77	14.23
4	5866	3.77	14.20
5	6535	3.82	14.56
6	6314	3.80	14.44
7	5890	3.77	14.21
8	6735	3.83	14.66
9	6930	3.84	14.75
10	5875	3.77	14.21

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.02675358\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 3.79

$y_{5\,percent} = \bar{y} - ks$ =3.74 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 71$$

$$ULL2 = \frac{P_1}{3.5xN} = 64$$

N= 28 = 14 x 2 faces = the total number of single shear units (teeth) acting on one member of the joint.

5.4. 45x200mm tap-in plates results

5.4.1. Parallel direction

Table 10 Statistical analysis for 45x200mm tap-in plates (Parallel).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	11249	4.05	16.41
2	9357	3.97	15.77
3	9431	3.97	15.80
4	10212	4.01	16.07
5	11895	4.08	16.61
6	9636	3.98	15.87
7	10841	4.04	16.28
8	11692	4.07	16.55
9	10620	4.03	16.21
10	10455	4.02	16.15

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.022179\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 4.04

$y_{5\,percent} = \bar{y} - ks$ =4.00 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 74$$

$$ULL2 = \frac{P_1}{3.5xN} = 66$$

N= 48 = the total number of single shear units (teeth) acting on one member of the joint, note that all teeth nails having an edge distance of less than 12mm were ignored.

5.4.2. Perpendicular direction

Table 11 Statistical analysis for 45x200mm tap-in plates (Perpendicular).

Specimen ID	Maximum load (x_i), N	$\log x_i = y_i$	y_i^2
1	9707	3.99	15.90
2	9853	3.99	15.95
3	10063	4.00	16.02
4	11608	4.06	16.52
5	10550	4.02	16.19
6	9758	3.99	15.91
7	9653	3.98	15.88
8	10621	4.03	16.21
9	9092	3.96	15.67
10	8311	3.92	15.36

$$s = \sqrt{\left[\frac{n\sum y_i^2 - \left(\sum y_i\right)^2}{n(n-1)} = 0.038199\right]}$$

s is the standard deviation of the logarithmic values.
k=1.92 from AS1649, Appendix B

$\bar{y} = \frac{\sum y_i}{n}$, where n=number of specimens tested=10 and $\bar{y}$ is the mean logarithmic value = 3.99

$y_{5\,percent} = \bar{y} - ks$ =3.92 = the logarithmic of the 5th percentile lower probability limit (LPL)

$$ULL_1 = \frac{P_1}{2.8xN} = 53$$

$$ULL2 = \frac{P_1}{3.5xN} = 50$$

N= 56 = 28 x 2 faces = the total number of single shear units (teeth) acting on one member of the joint.

6. APPENDIX

6.1. Joint load-displacement charts

6.1.1. 100x90mm parallel direction

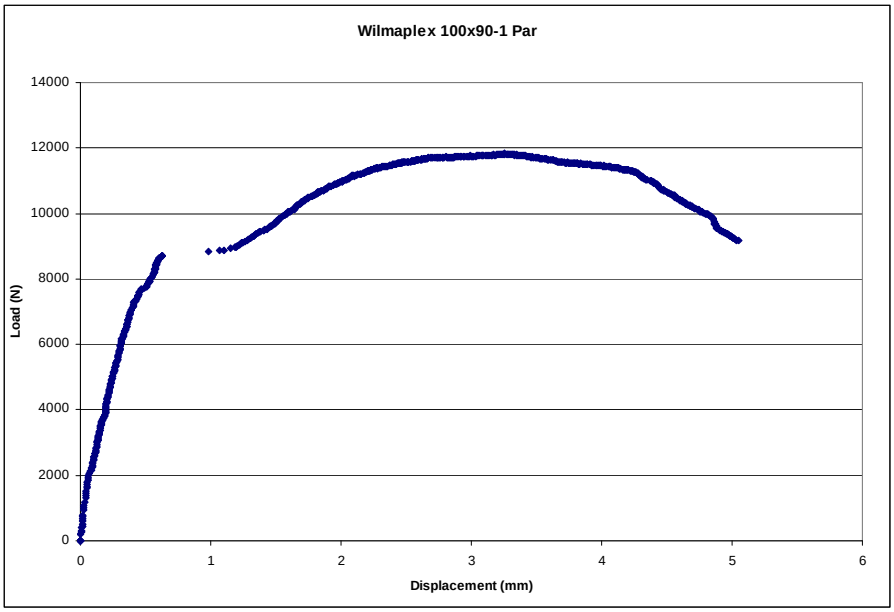


Figure A1 100x90mm parallel direction-1

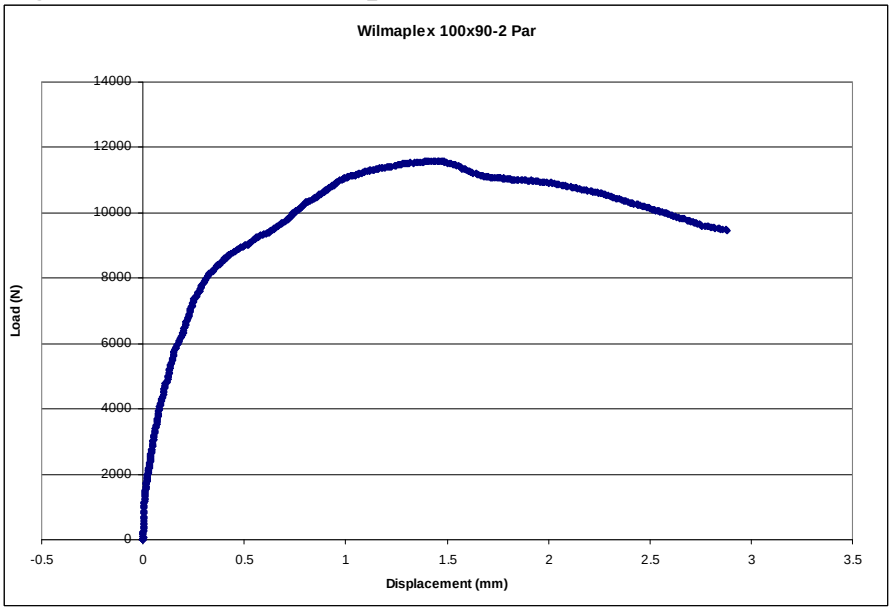


Figure A2 100x90mm parallel direction-2

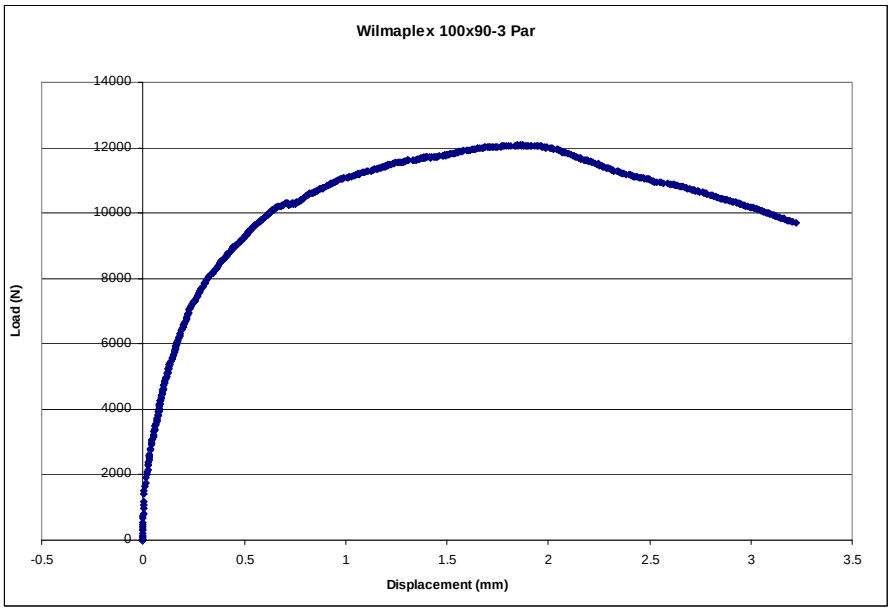


Figure A3 100x90mm parallel direction-3

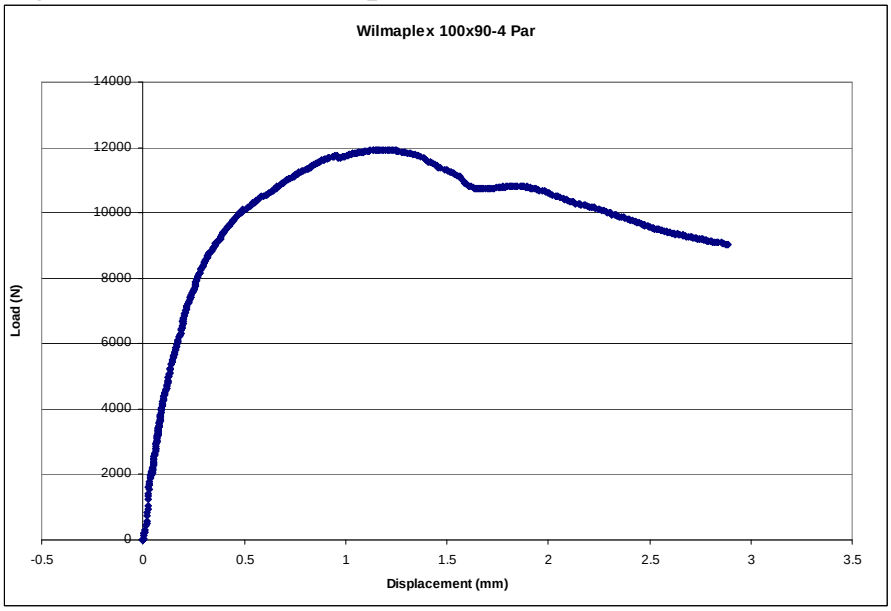


Figure A4 100x90mm parallel direction-4

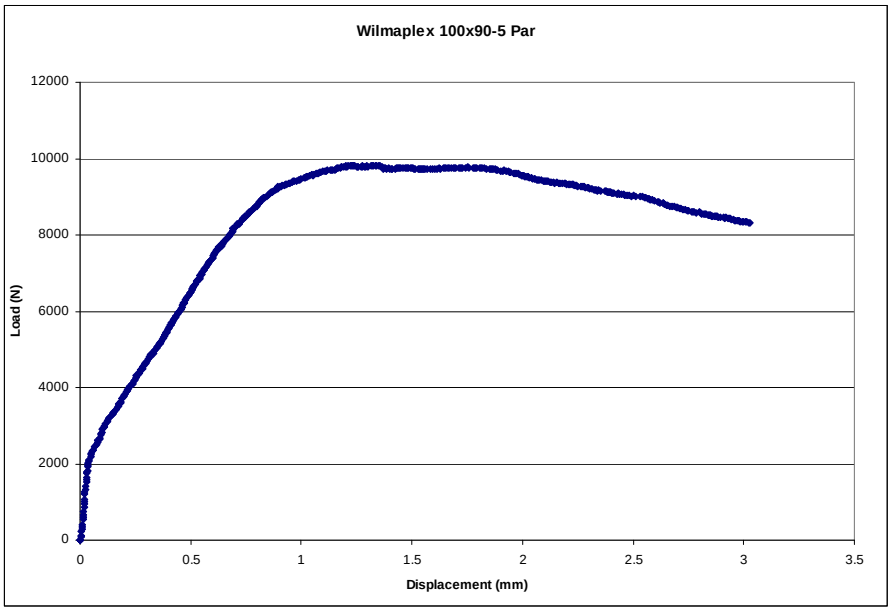


Figure A5 100x90mm parallel direction-5

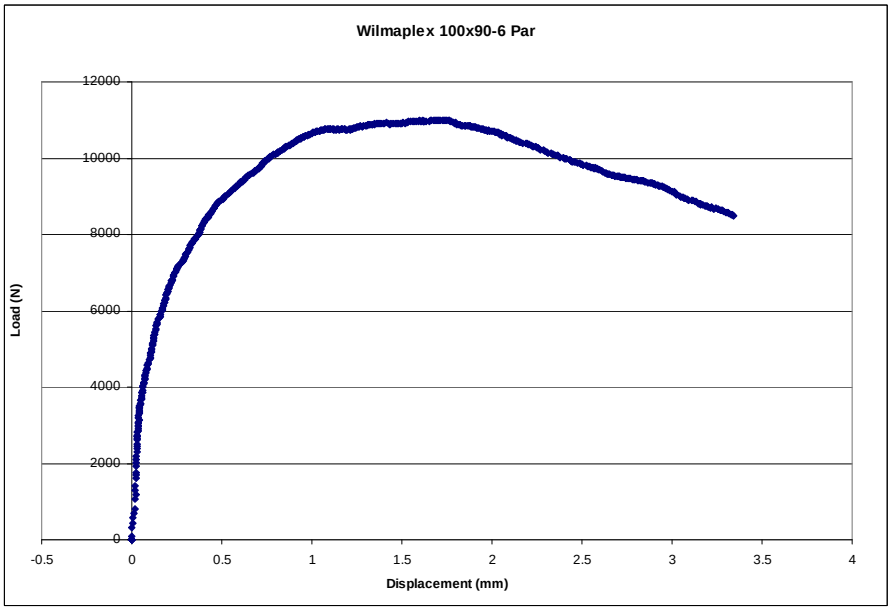


Figure A6 100x90mm parallel direction-6

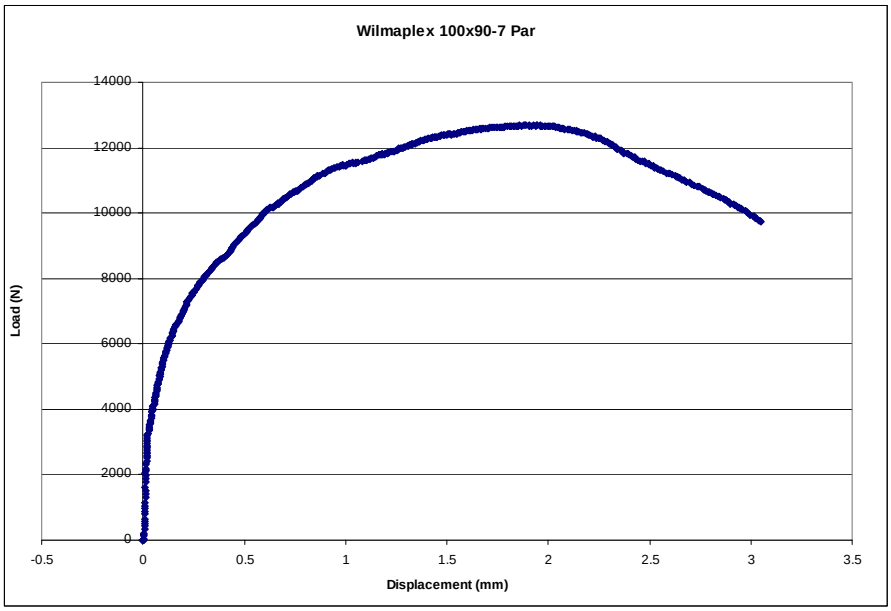


Figure A7 100x90mm parallel direction-7

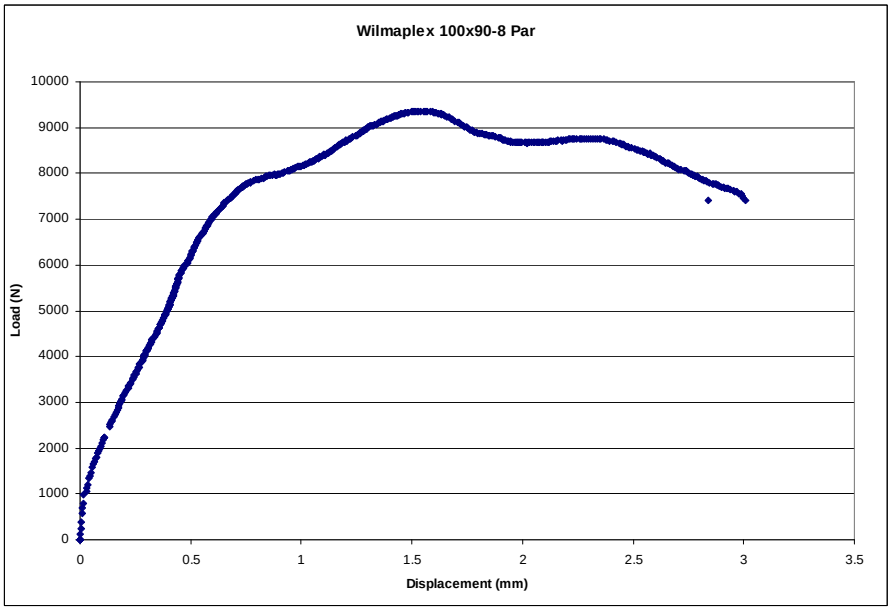


Figure A8 100x90mm parallel direction-8

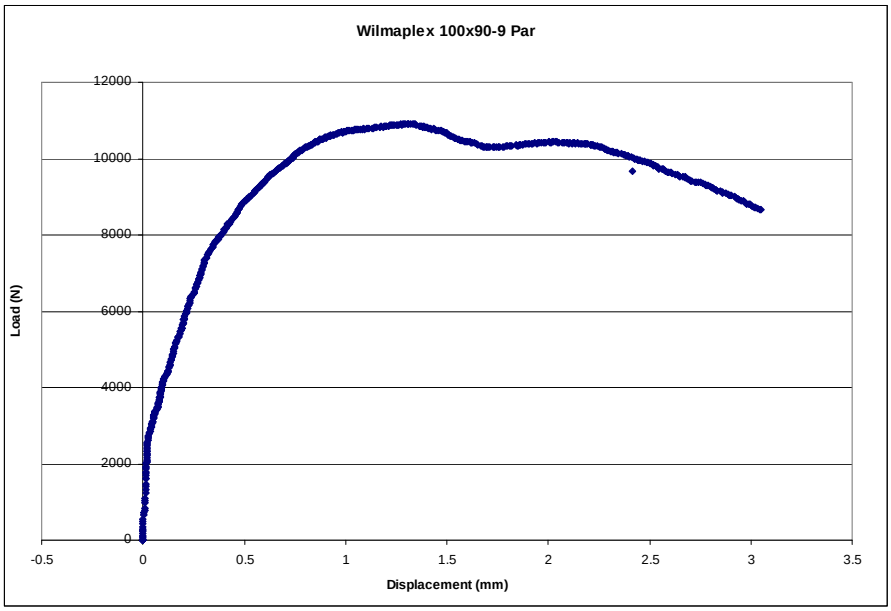


Figure A9 100x90mm parallel direction-9

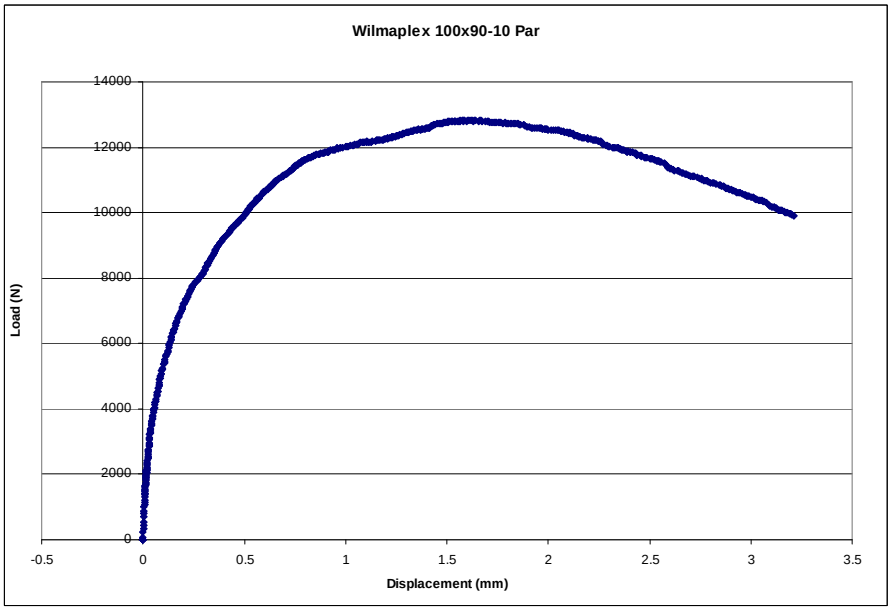


Figure A10 100x90mm parallel direction-10

6.1.2. 100x90mm perpendicular direction

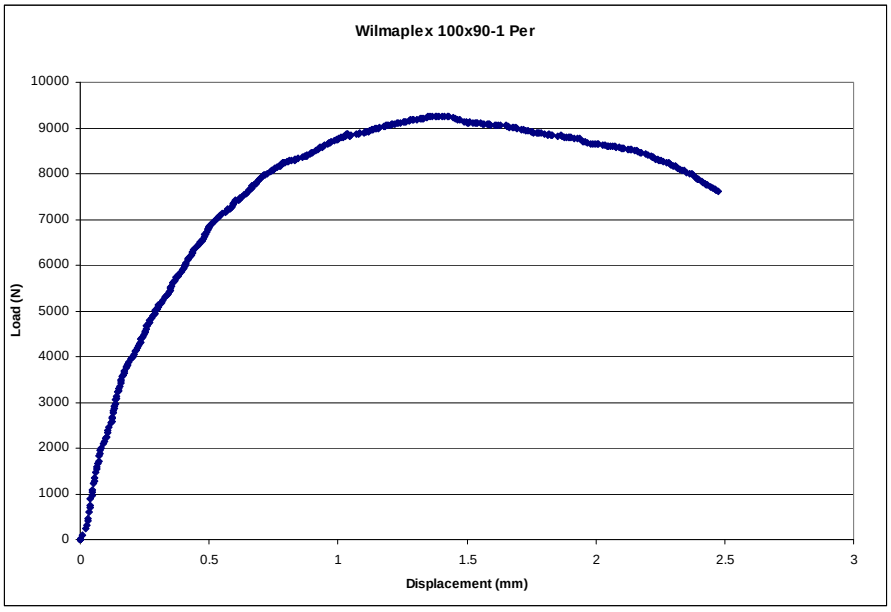


Figure A11 100x90mm perpendicular direction-1

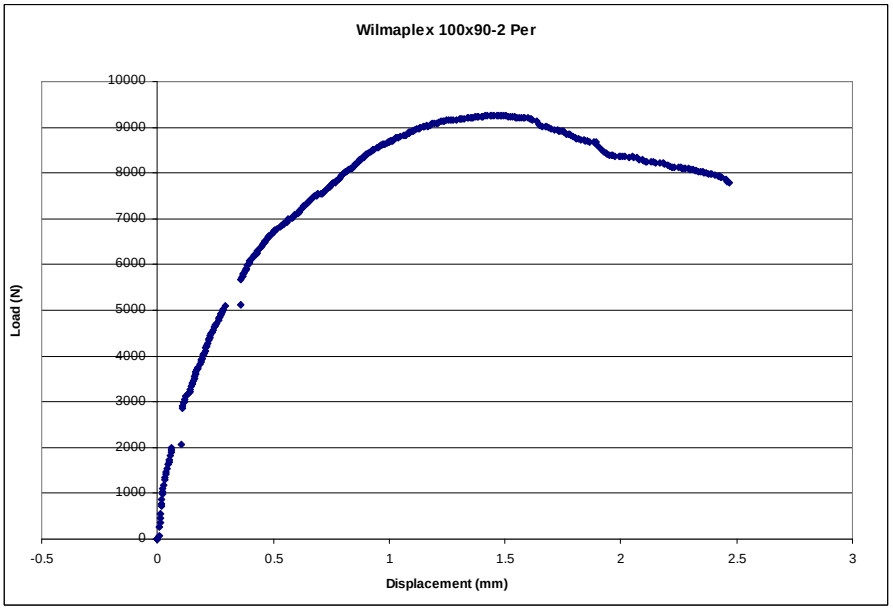


Figure A12 100x90mm perpendicular direction-2

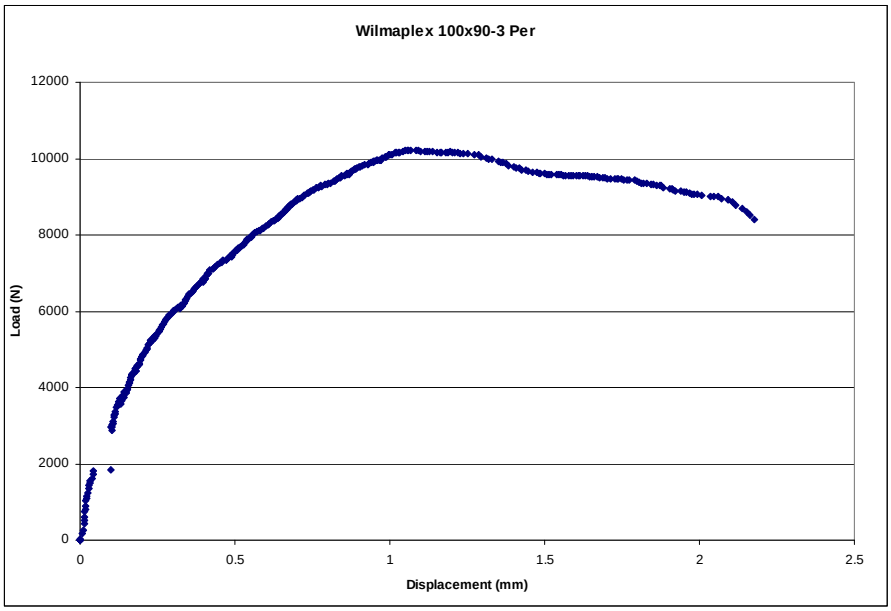


Figure A13 100x90mm perpendicular direction-3

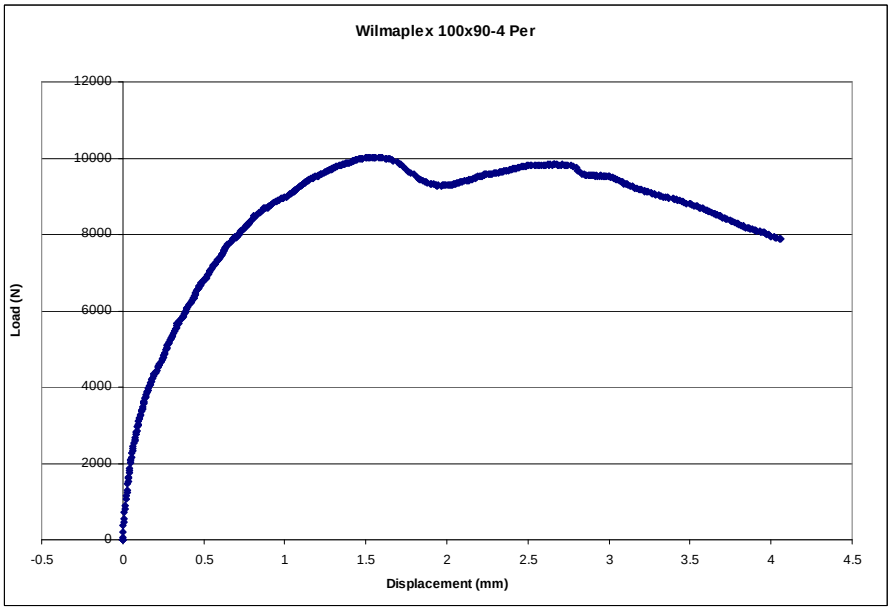


Figure A14 100x90mm perpendicular direction-4

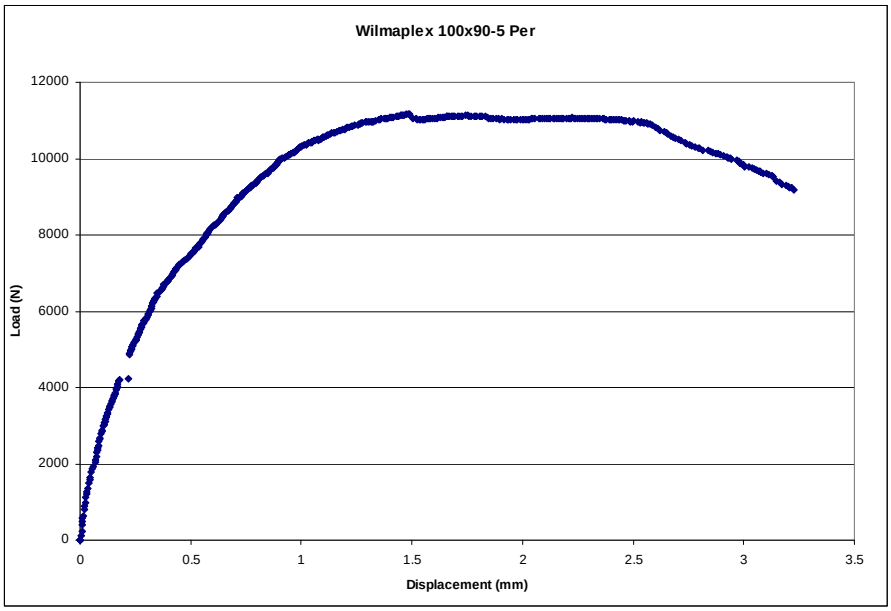


Figure A15 100x90mm perpendicular direction-5

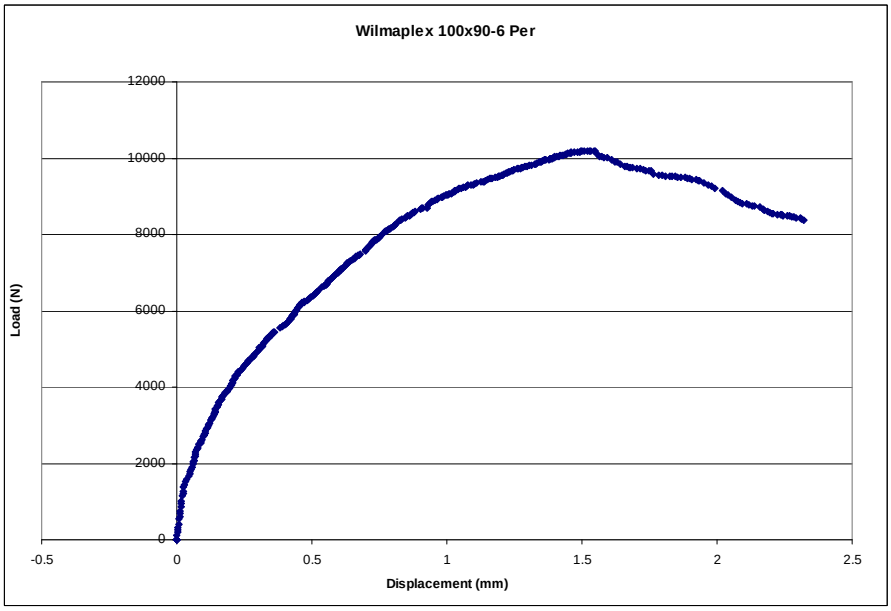


Figure A16 100x90mm perpendicular direction-6

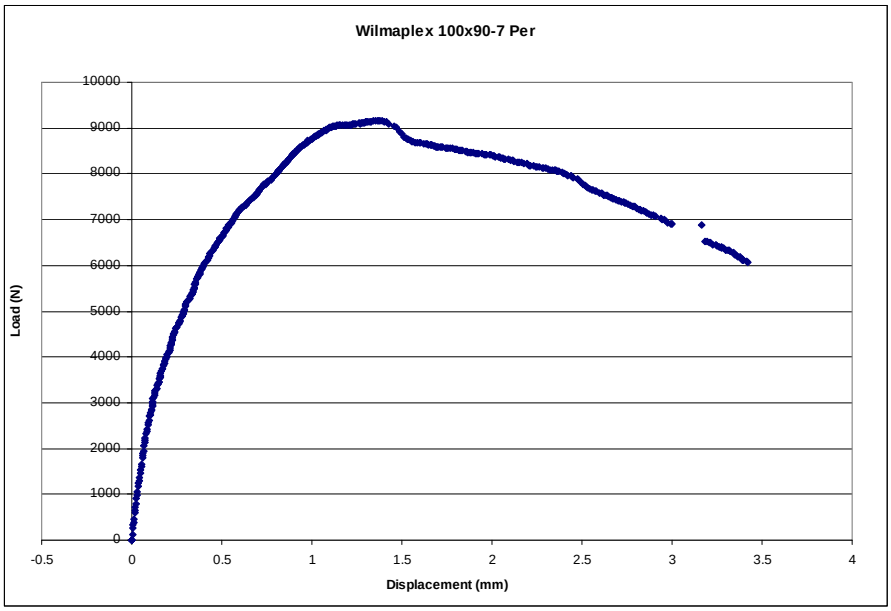


Figure A17 100x90mm perpendicular direction-7

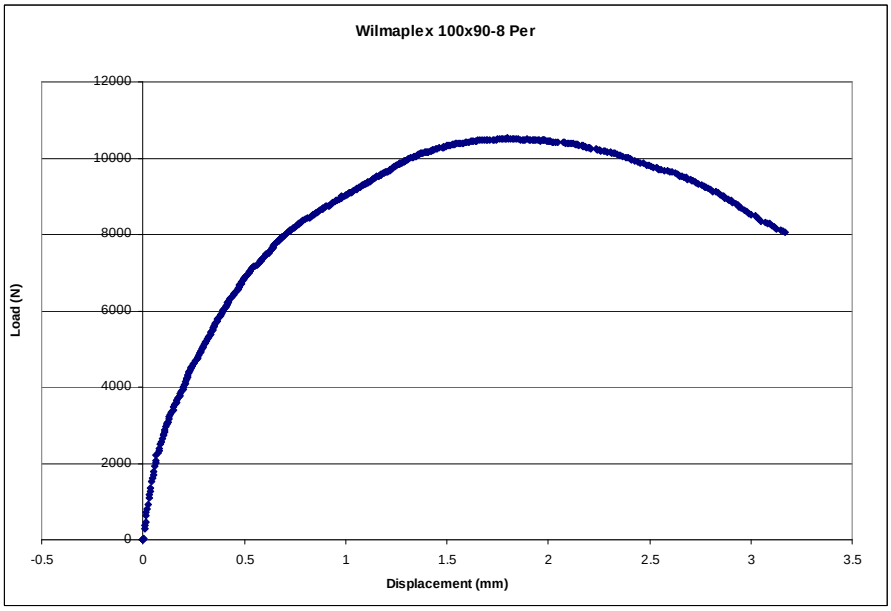


Figure A18 100x90mm perpendicular direction-8

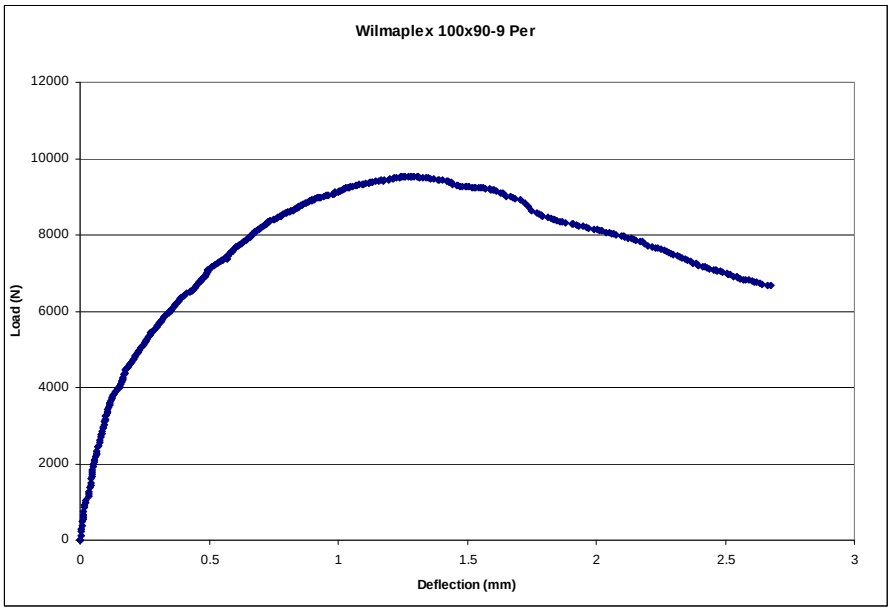


Figure A19 100x90mm perpendicular direction-9

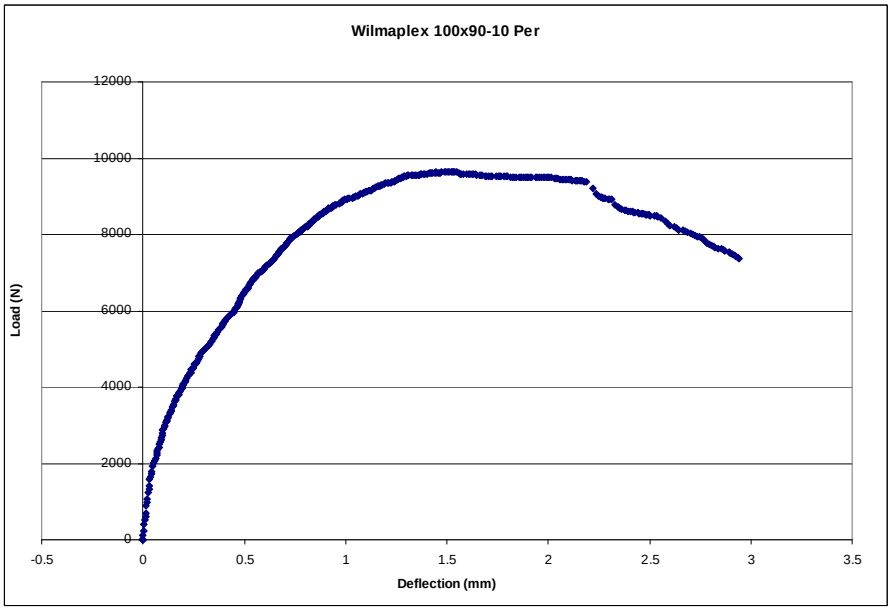


Figure A20 100x90mm perpendicular direction-10

6.1.3. 200x90mm parallel direction

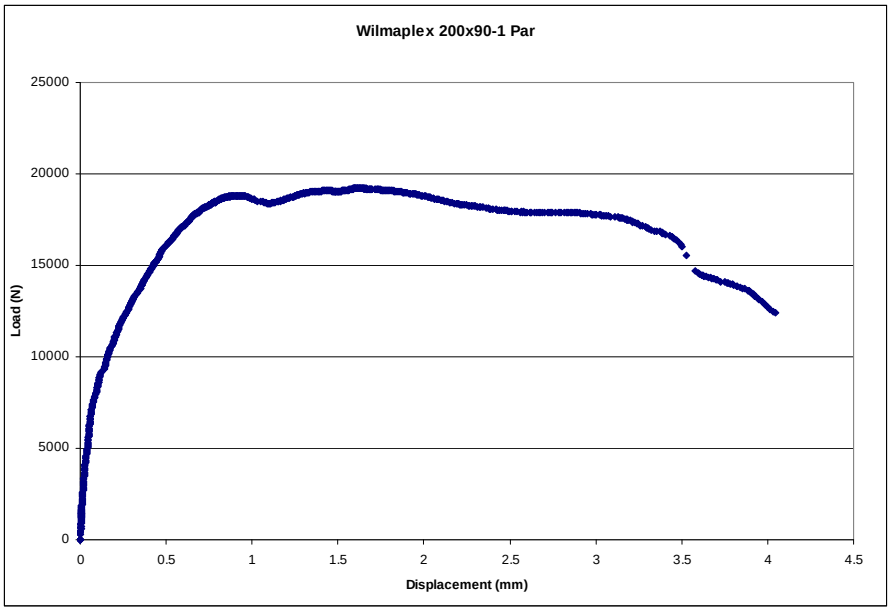


Figure A21 200x90mm parallel direction-1

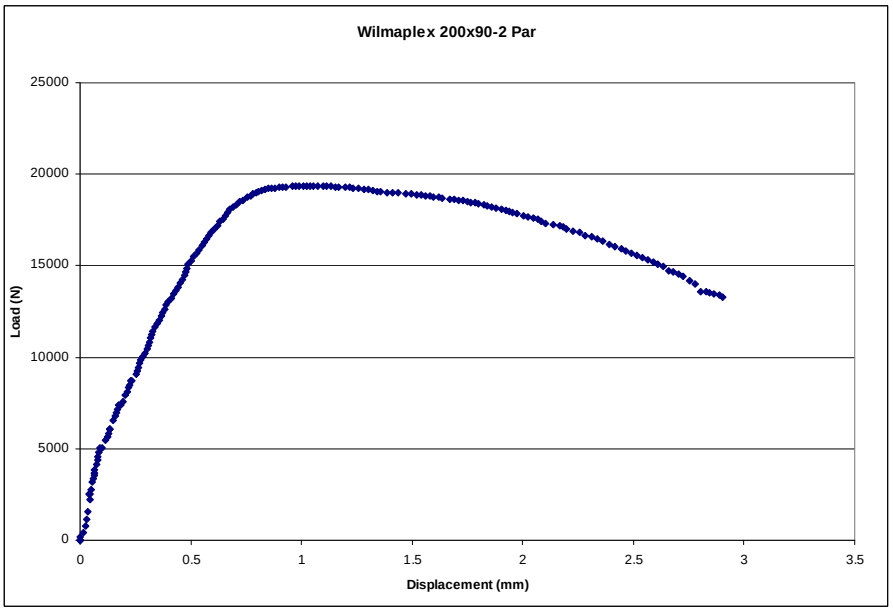


Figure A22 200x90mm parallel direction-2

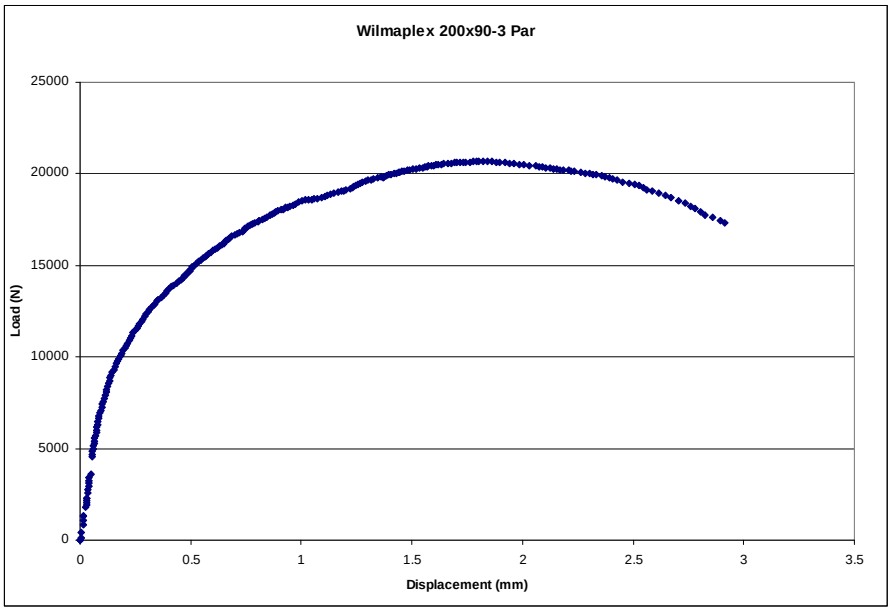


Figure A23 200x90mm parallel direction-3

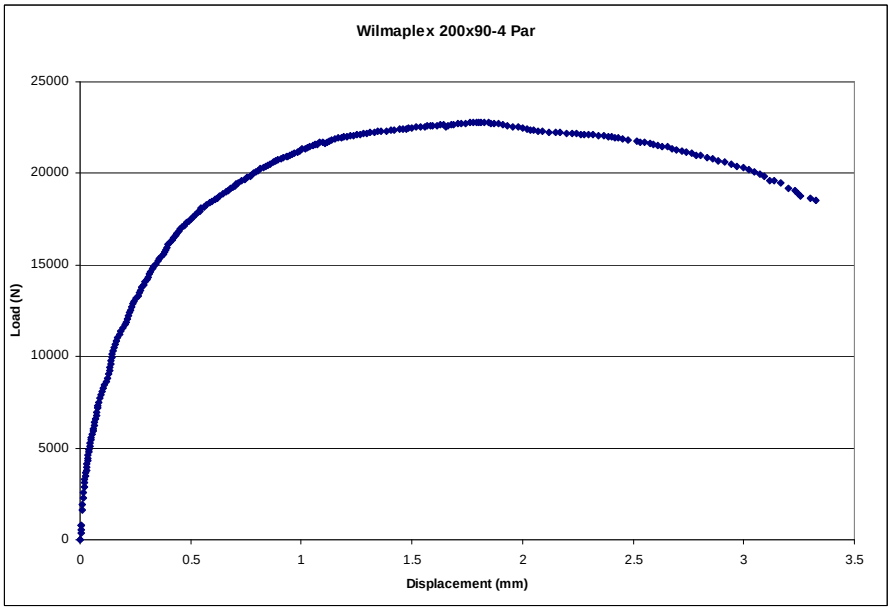


Figure A24 200x90mm parallel direction-4

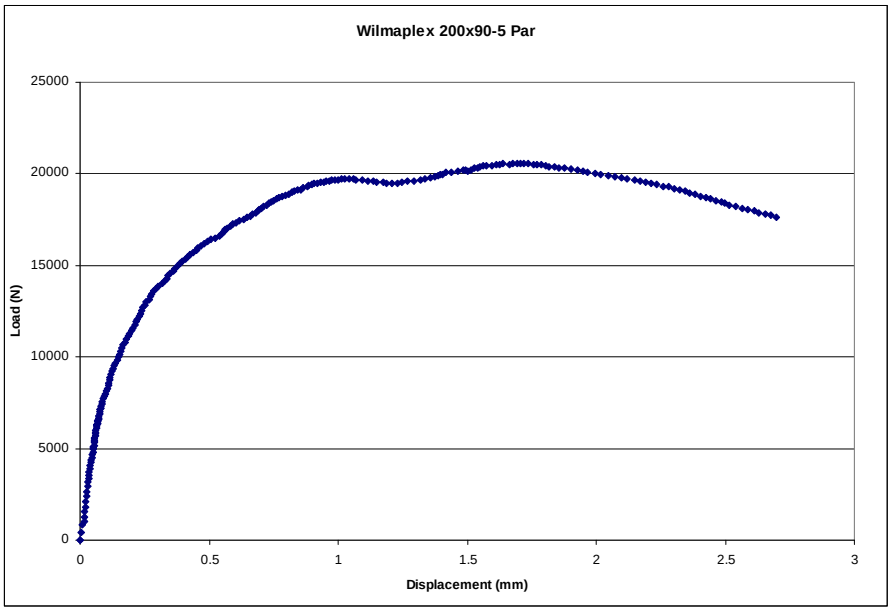


Figure A25 200x90mm parallel direction-5

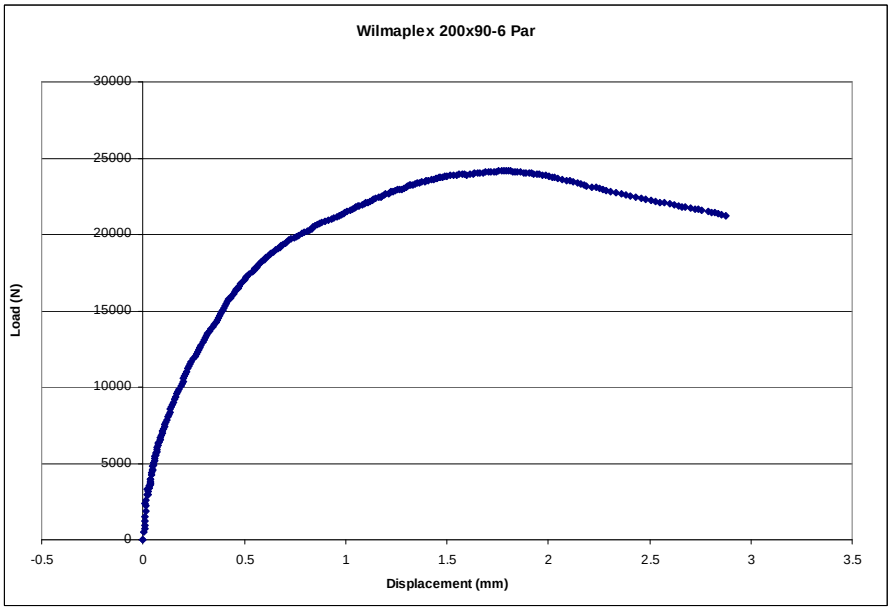


Figure A26 200x90mm parallel direction-6

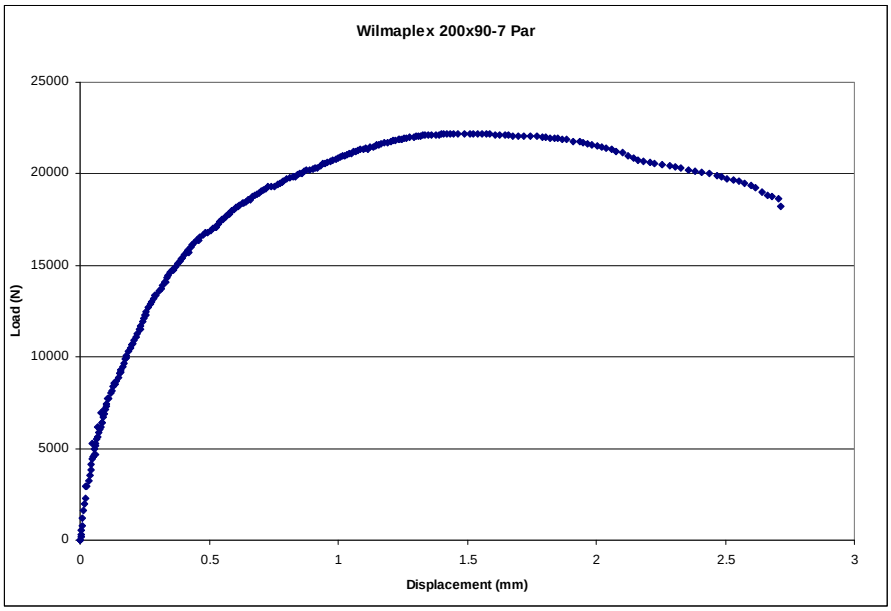


Figure A27 200x90mm parallel direction-7

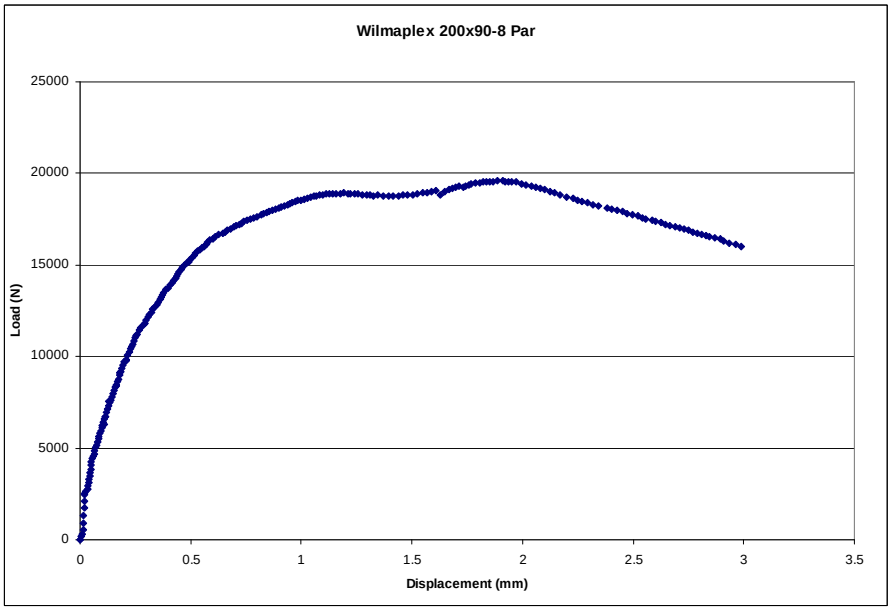


Figure A28 200x90mm parallel direction-8

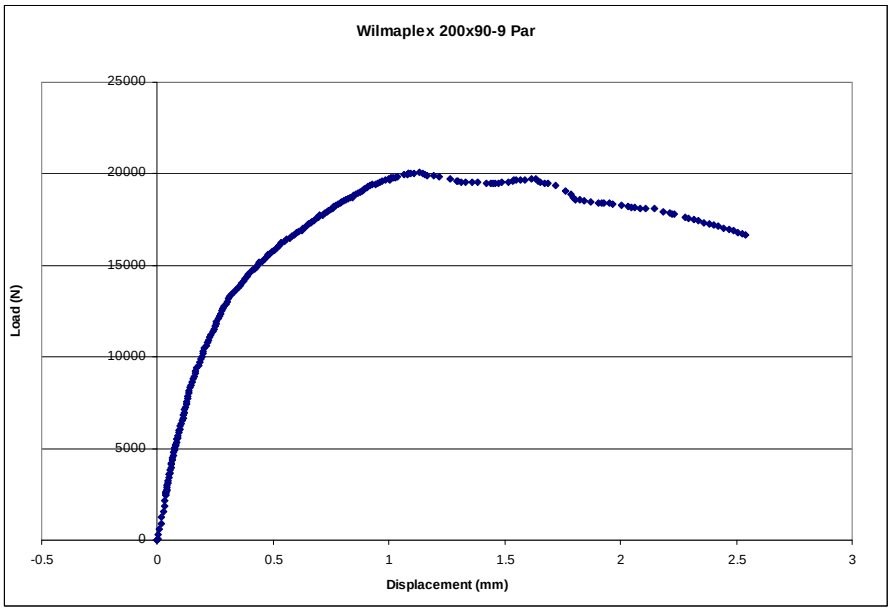


Figure A29 200x90mm parallel direction-9

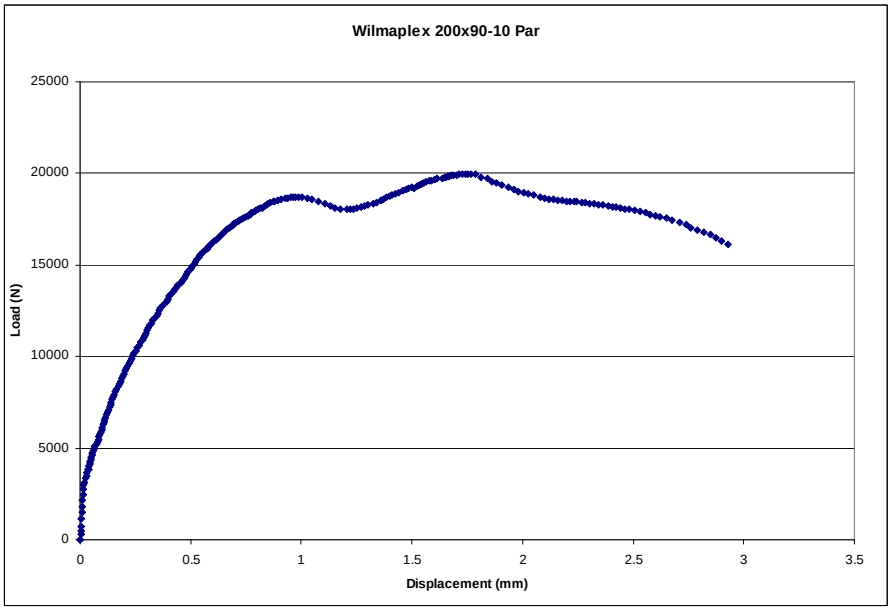


Figure A30 200x90mm parallel direction-10

6.1.4. 200x90mm perpendicular direction

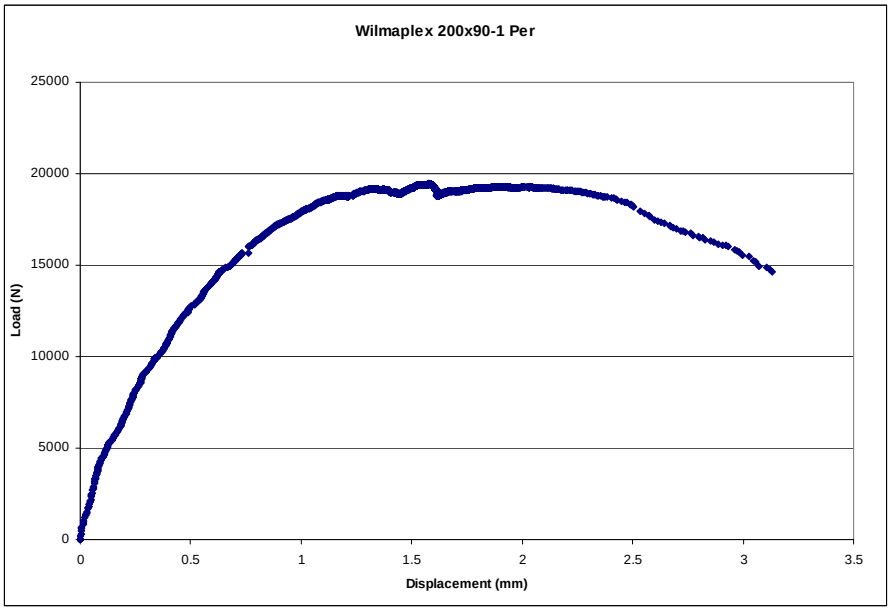


Figure A31 200x90mm perpendicular direction-1

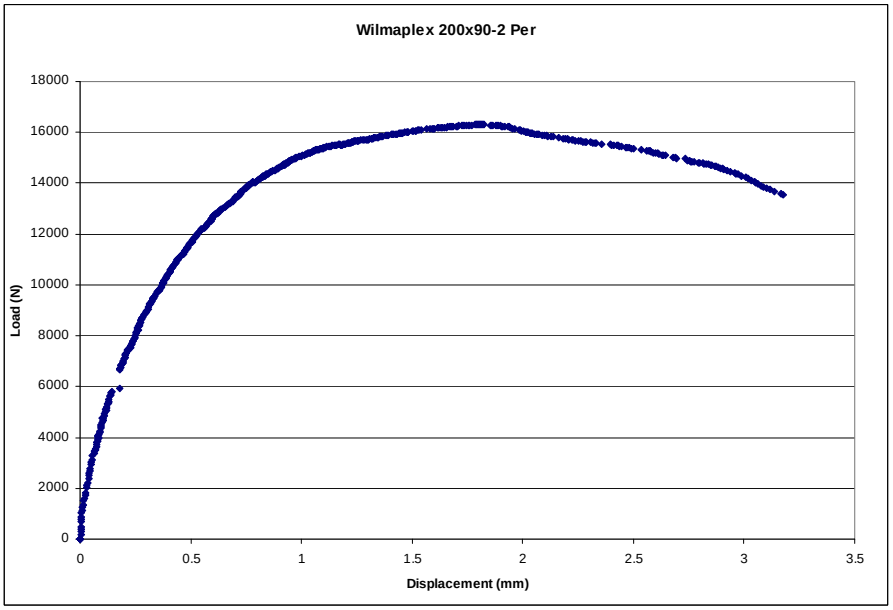


Figure A32 200x90mm perpendicular direction-2

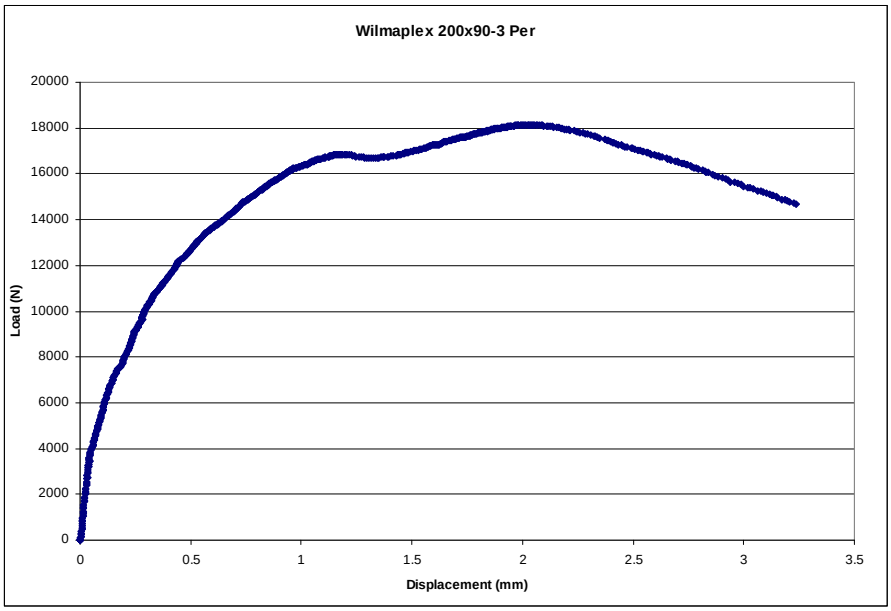


Figure A33 200x90mm perpendicular direction-3

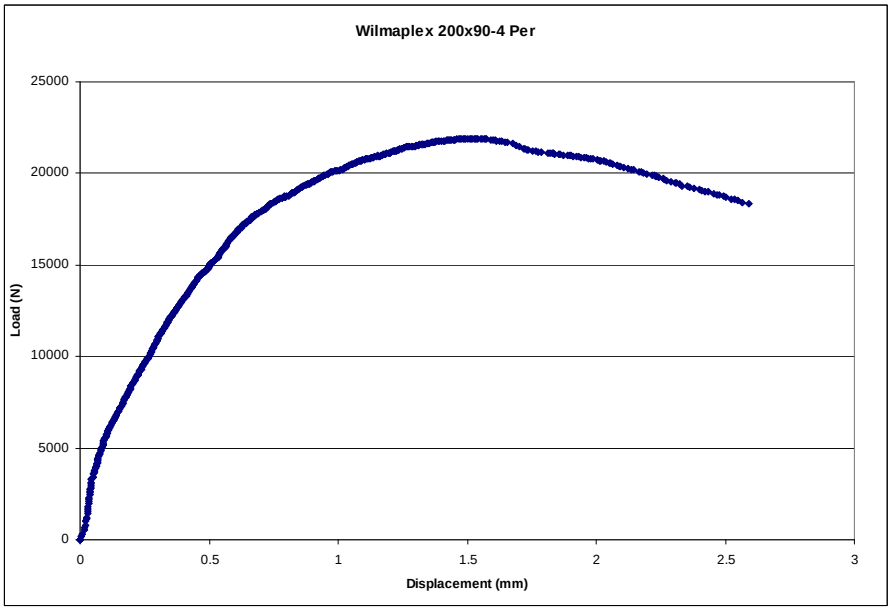


Figure A34 200x90mm perpendicular direction-4

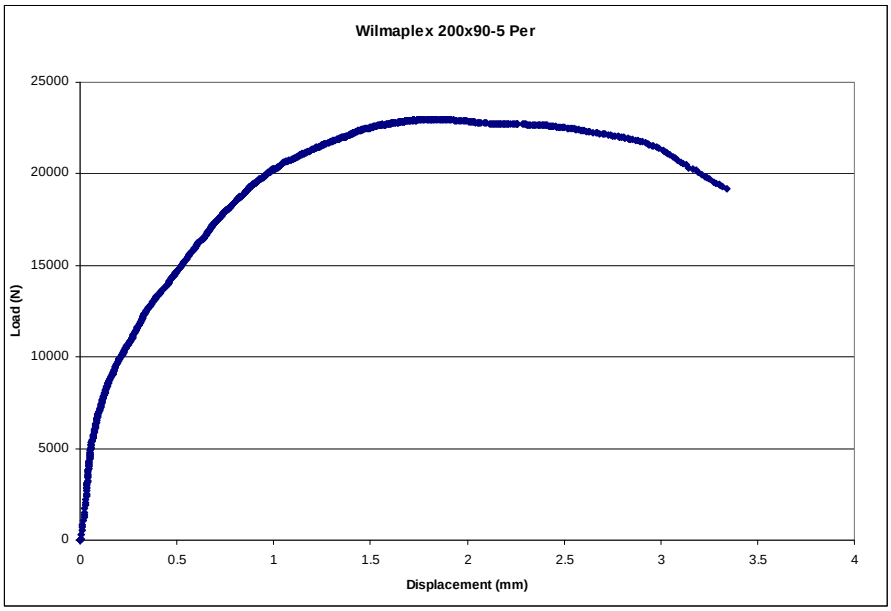


Figure A35 200x90mm perpendicular direction-5

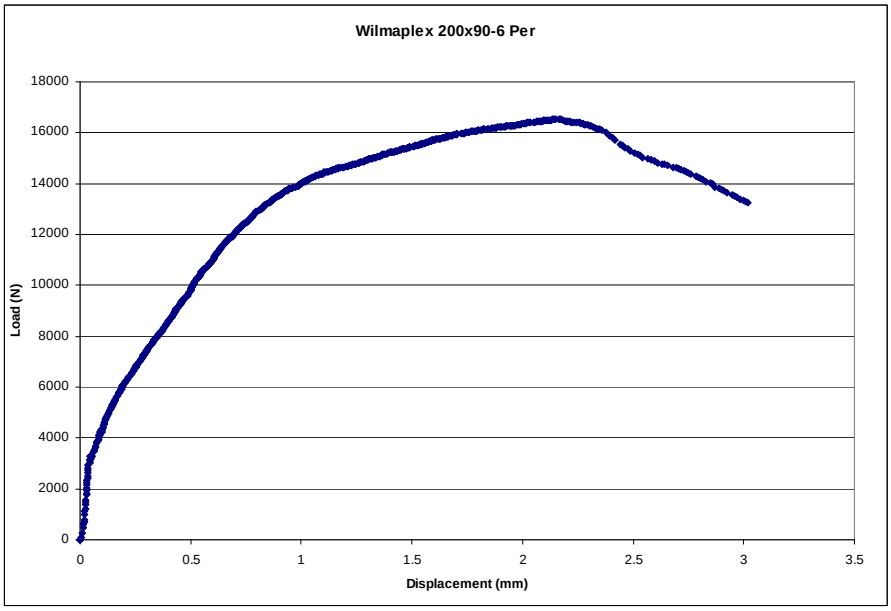


Figure A36 200x90mm perpendicular direction-6

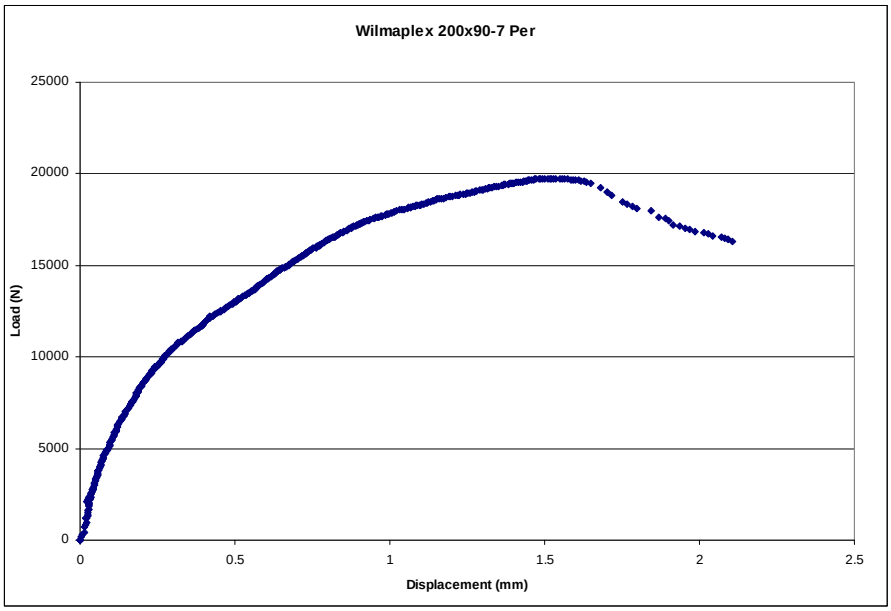


Figure A37 200x90mm perpendicular direction-7

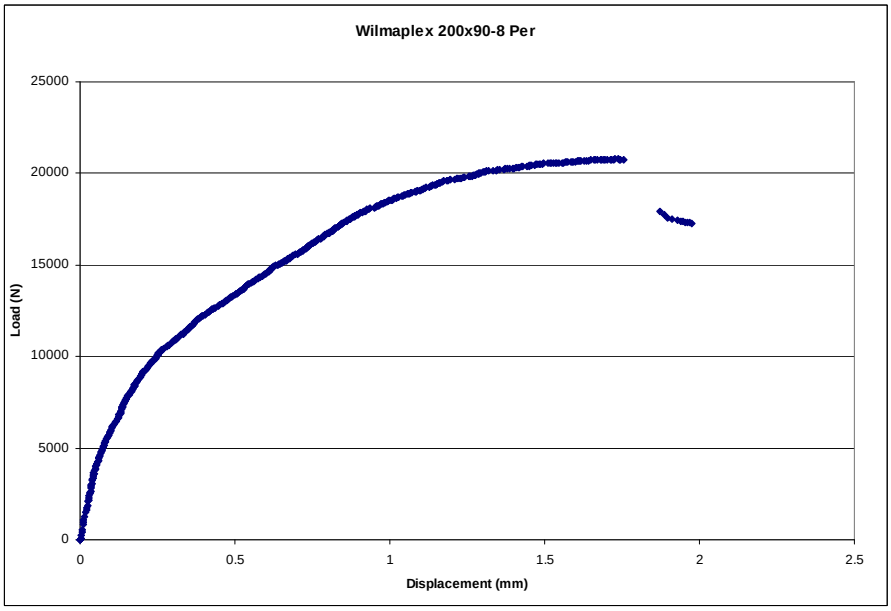


Figure A38 200x90mm perpendicular direction-8

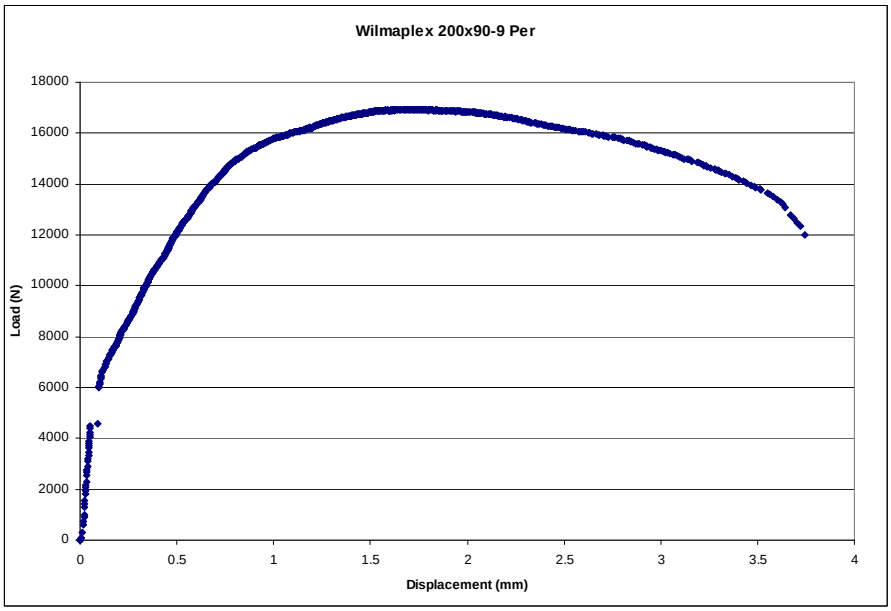


Figure A39 200x90mm perpendicular direction-9

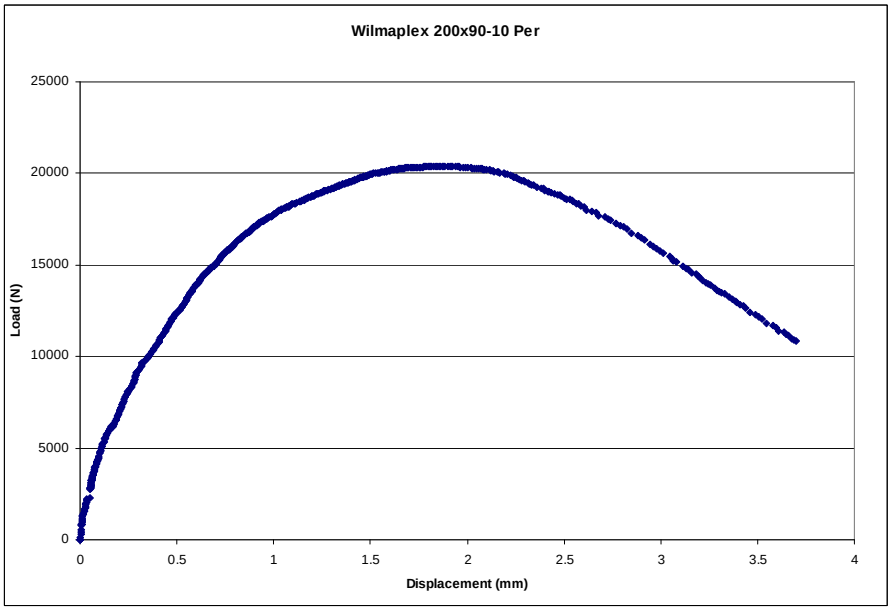


Figure A40 200x90mm perpendicular direction-10

6.1.5. 100x45mm parallel direction

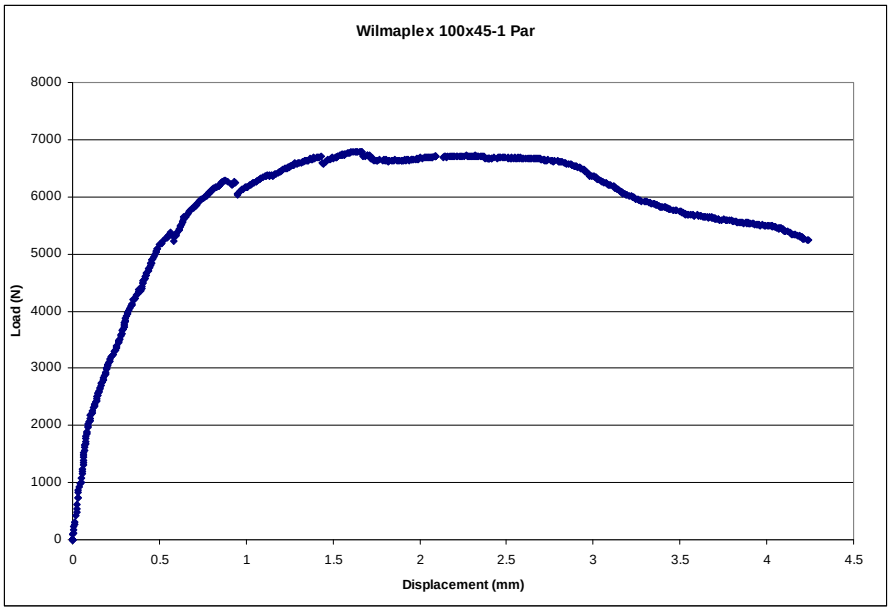


Figure A41 100x45mm parallel direction-1

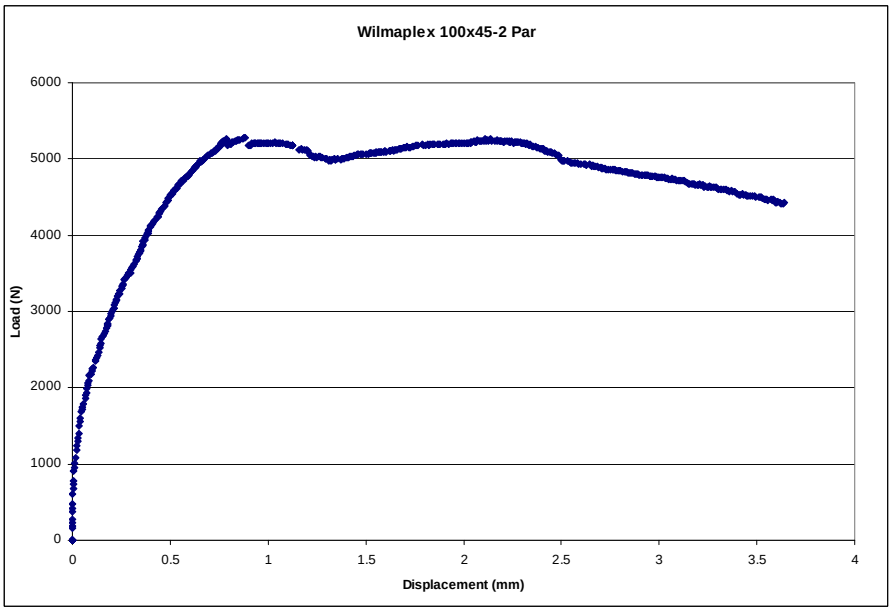


Figure A42 100x45mm parallel direction-2

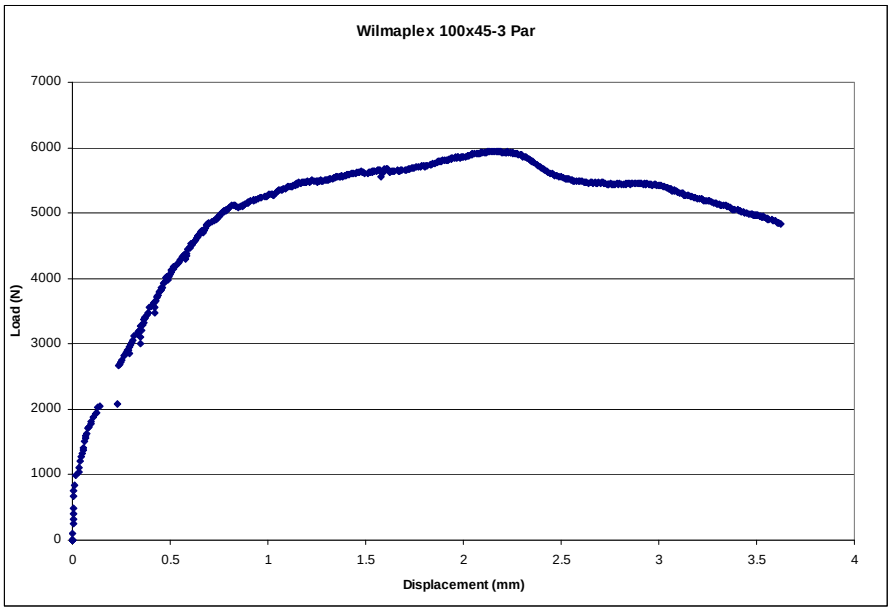


Figure A43 100x45mm parallel direction-3

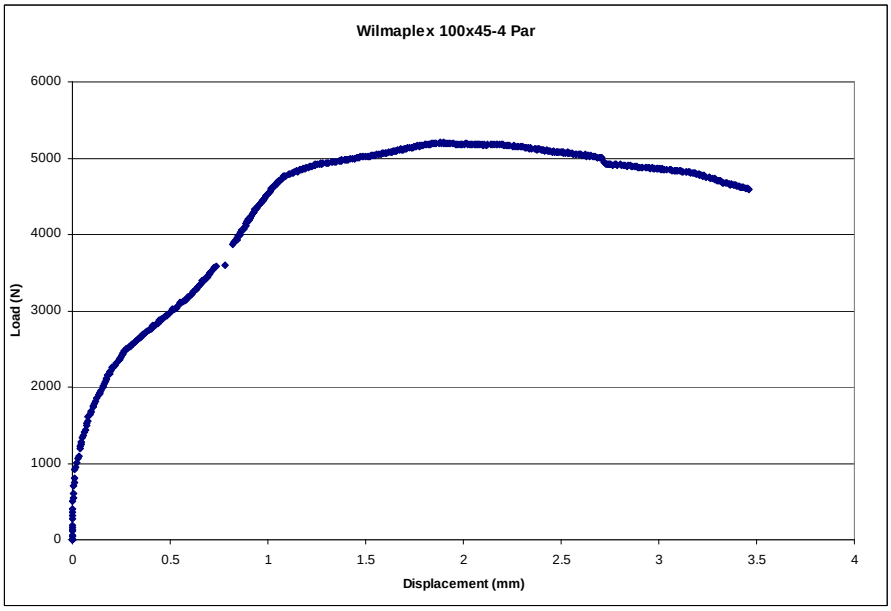


Figure A44 100x45mm parallel direction-4

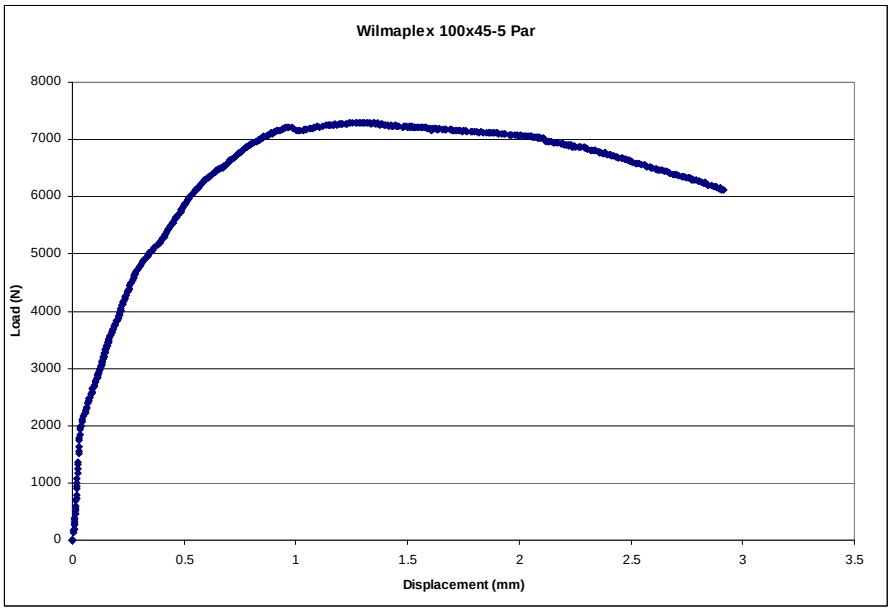


Figure A45 100x45mm parallel direction-5

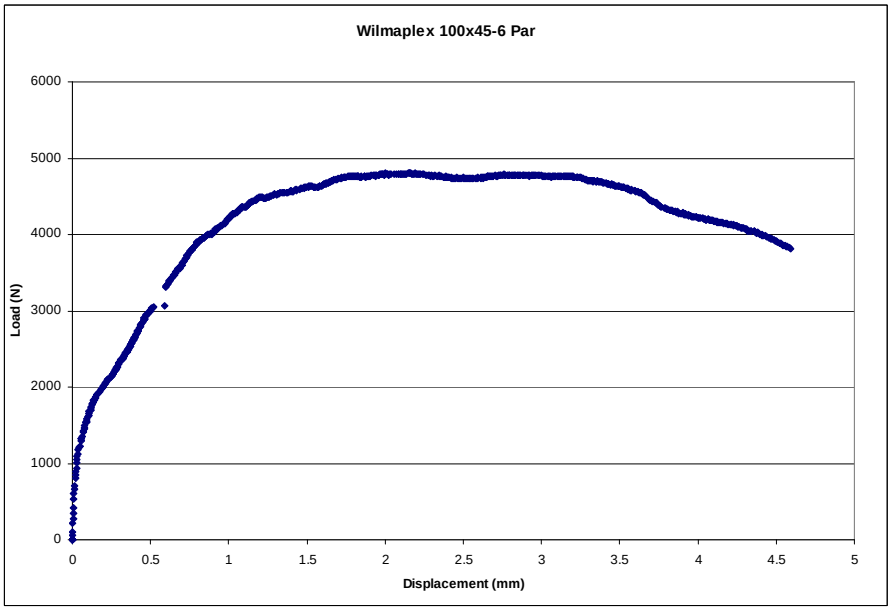


Figure A46 100x45mm parallel direction-6

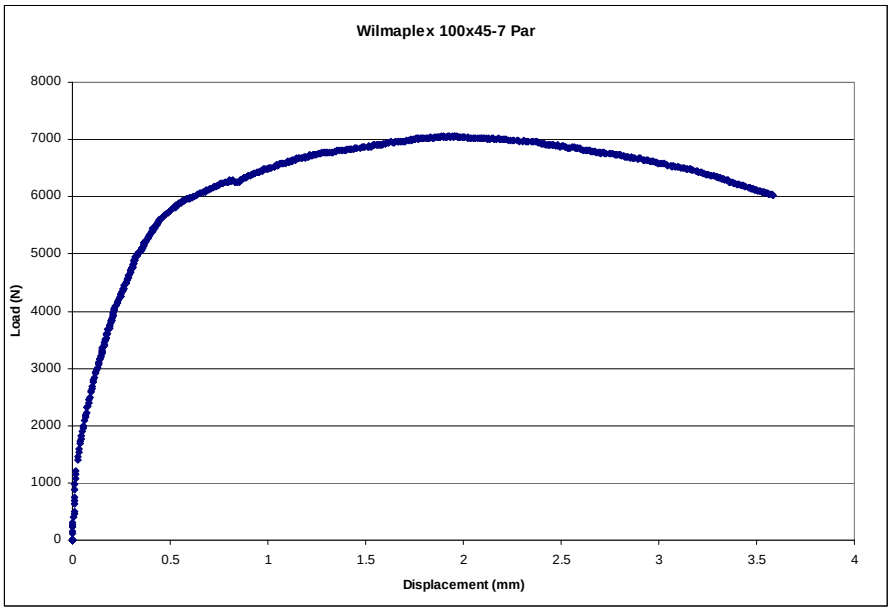


Figure A47 100x45mm parallel direction-7

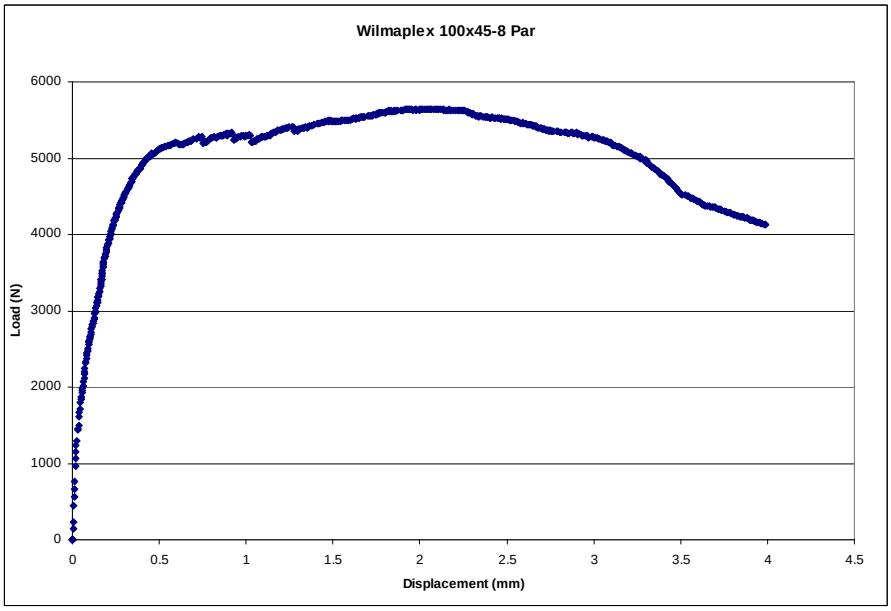


Figure A48 100x45mm parallel direction-8

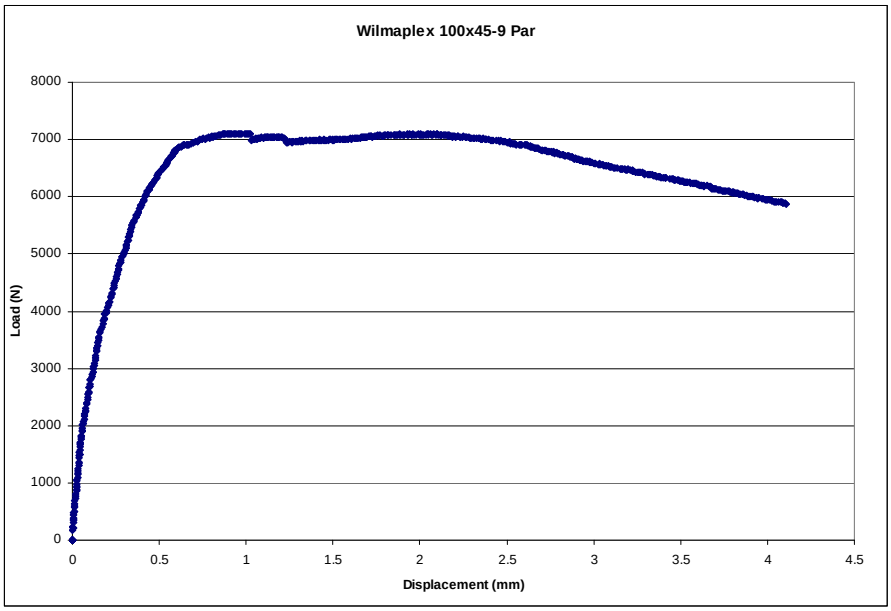


Figure A49 100x45mm parallel direction-9

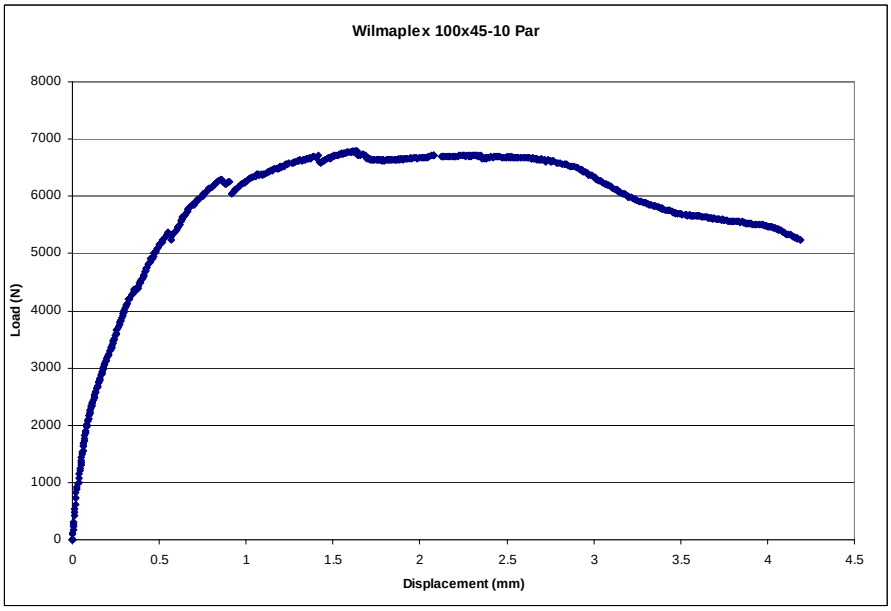


Figure A50 100x45mm parallel direction-10

6.1.6. 100x45mm perpendicular direction

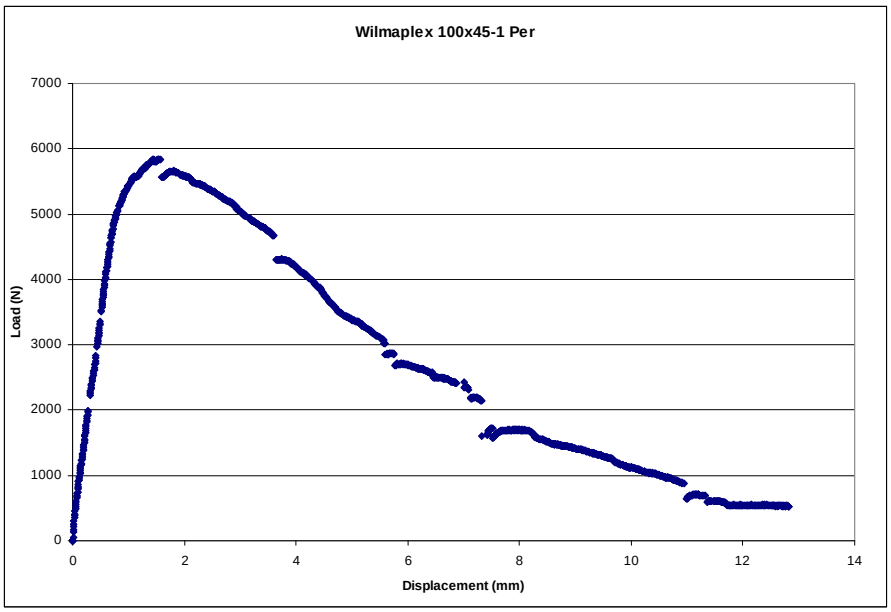


Figure A51 100x45mm perpendicular direction-1

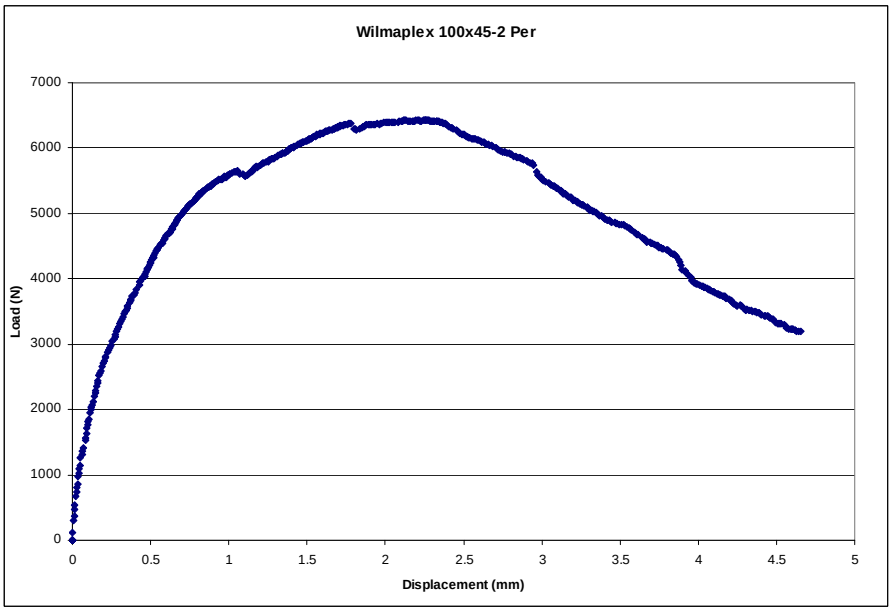


Figure A52 100x45mm perpendicular direction-2

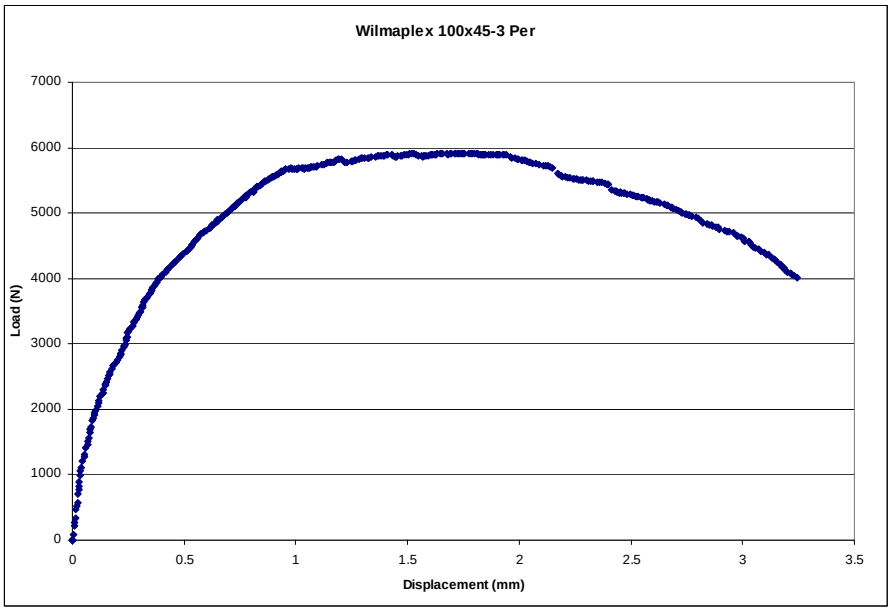


Figure A53 100x45mm perpendicular direction-3

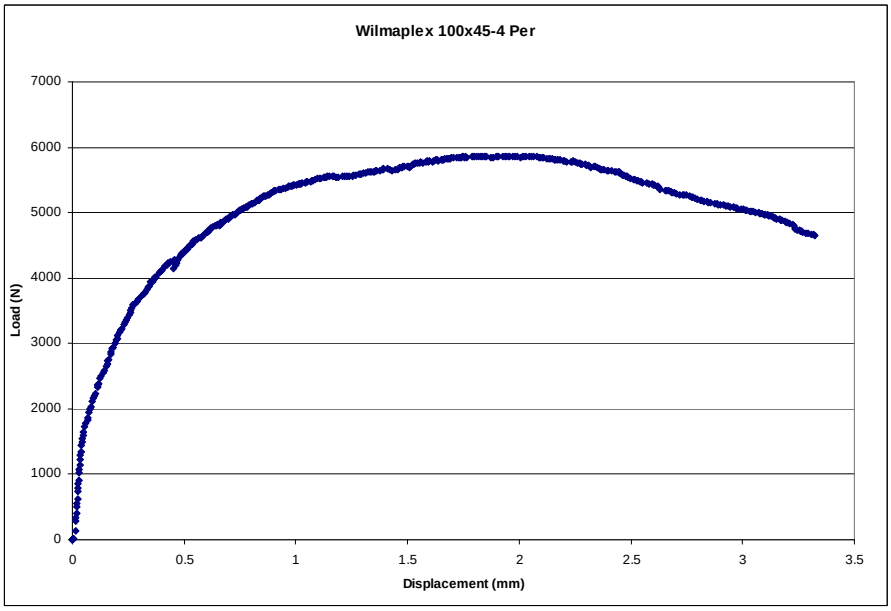


Figure A54 100x45mm perpendicular direction-4

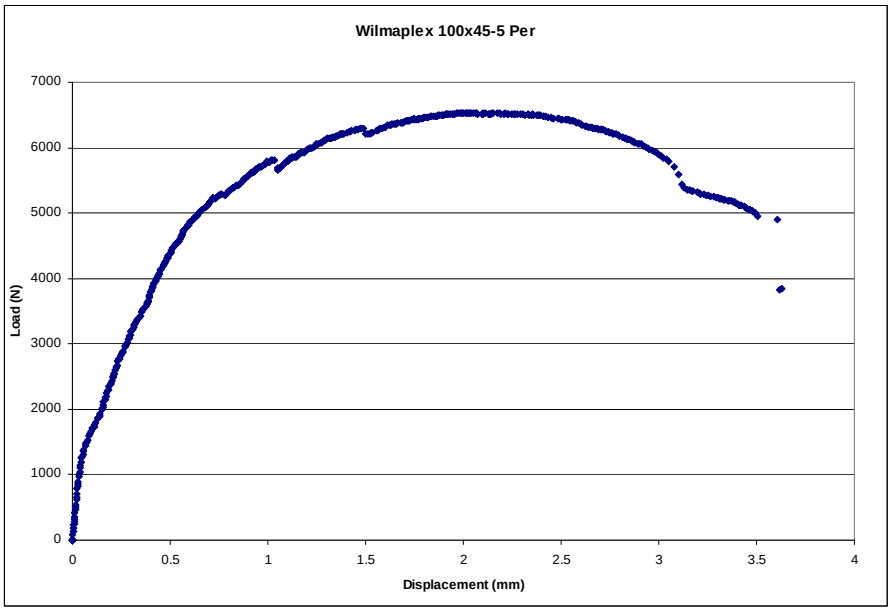


Figure A55 100x45mm perpendicular direction-5

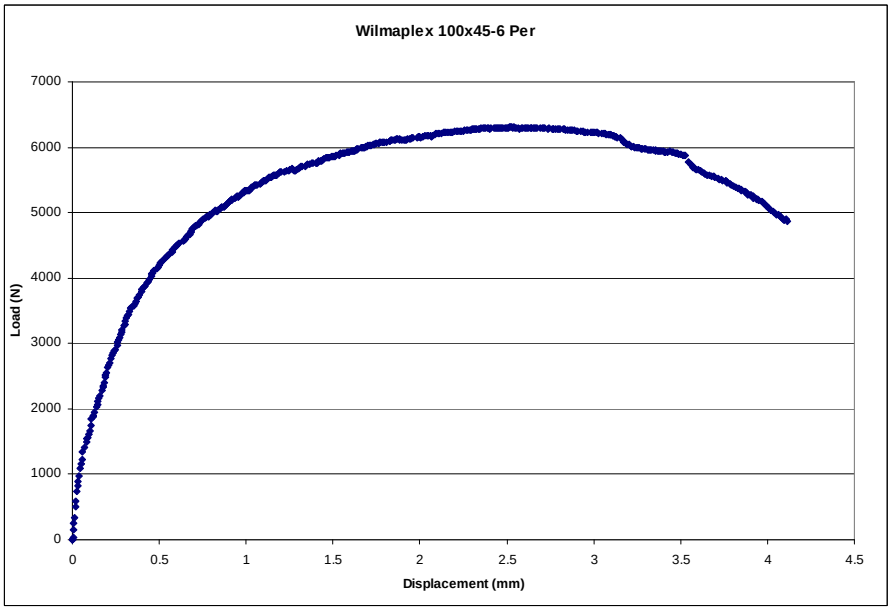


Figure A56 100x45mm perpendicular direction-6

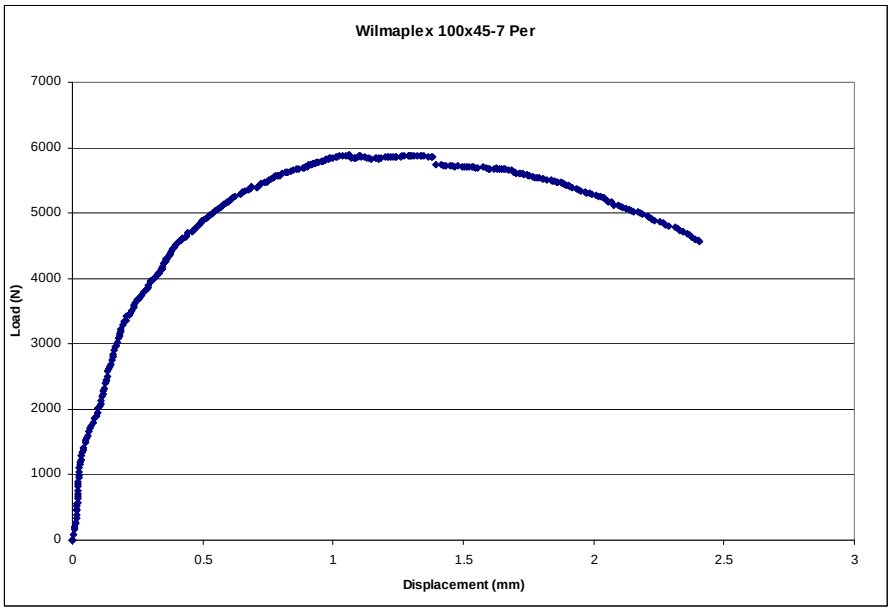


Figure A57 100x45mm perpendicular direction-7

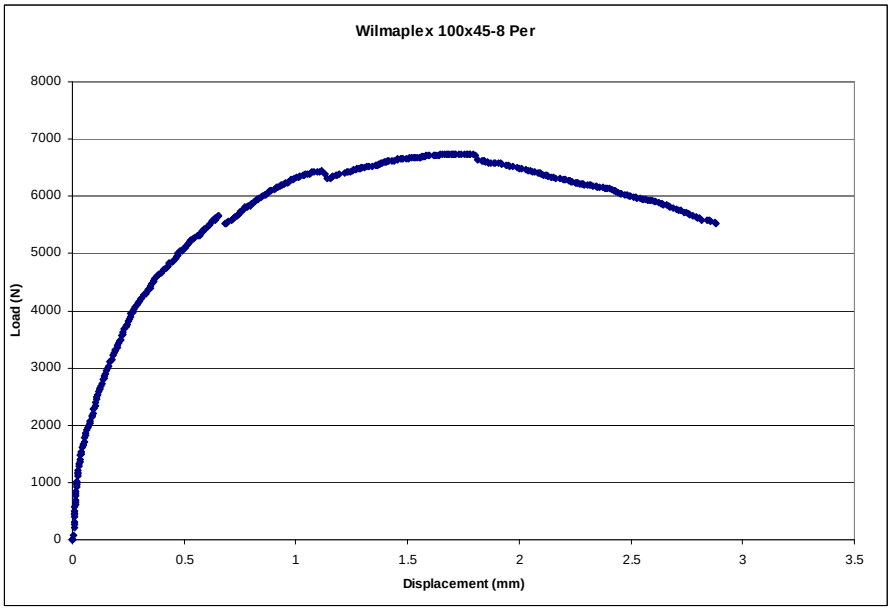


Figure A58 100x45mm perpendicular direction-8

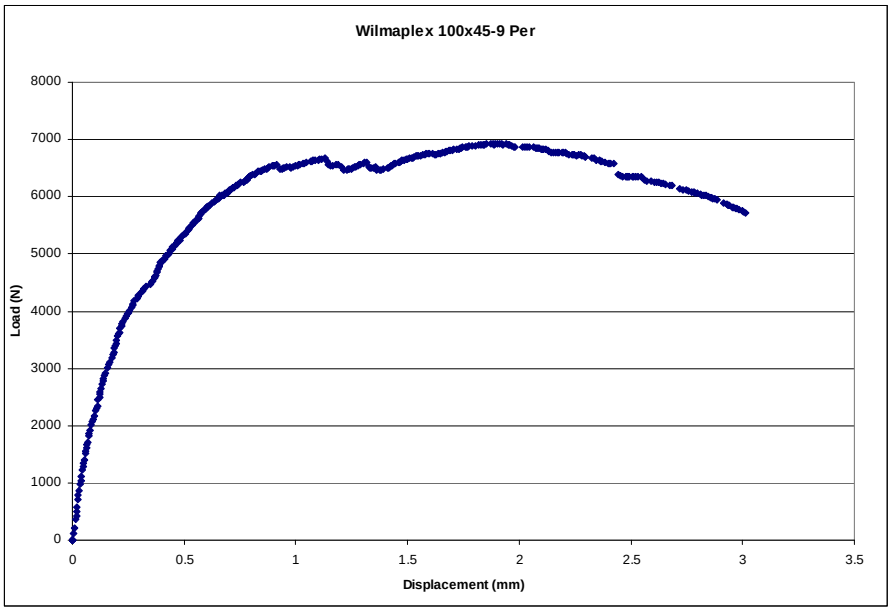


Figure A59 100x45mm perpendicular direction-9

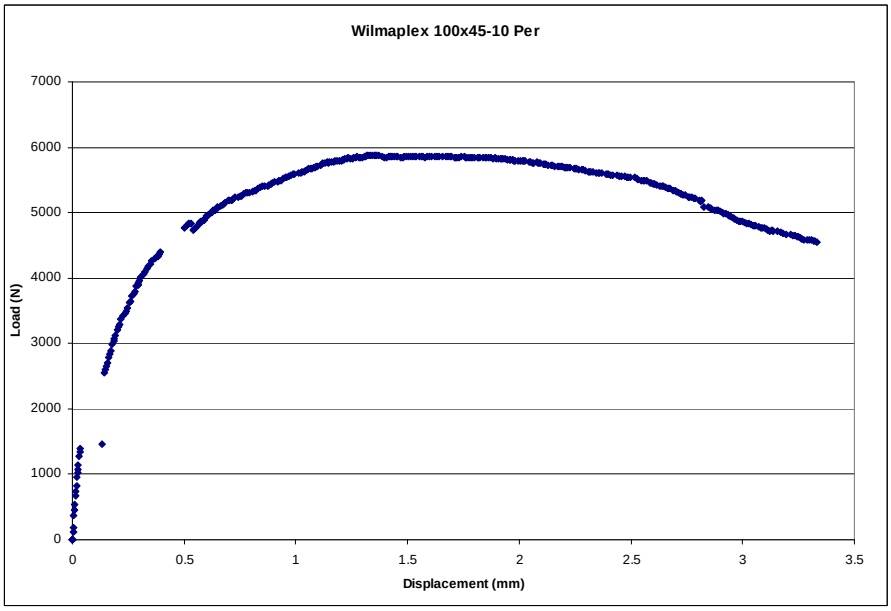


Figure A60 100x45mm perpendicular direction-10

6.1.7. 200x45mm parallel direction

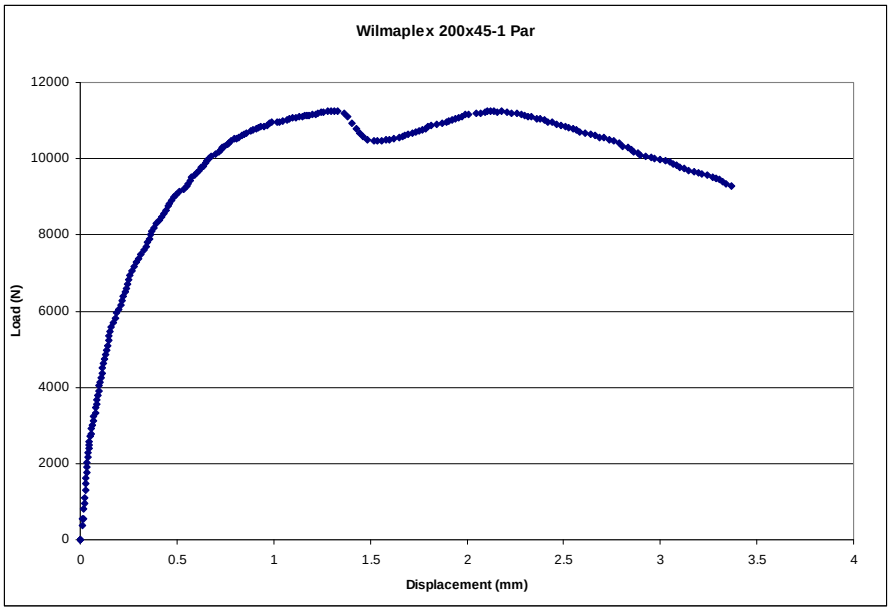


Figure A61 200x45mm parallel direction-1

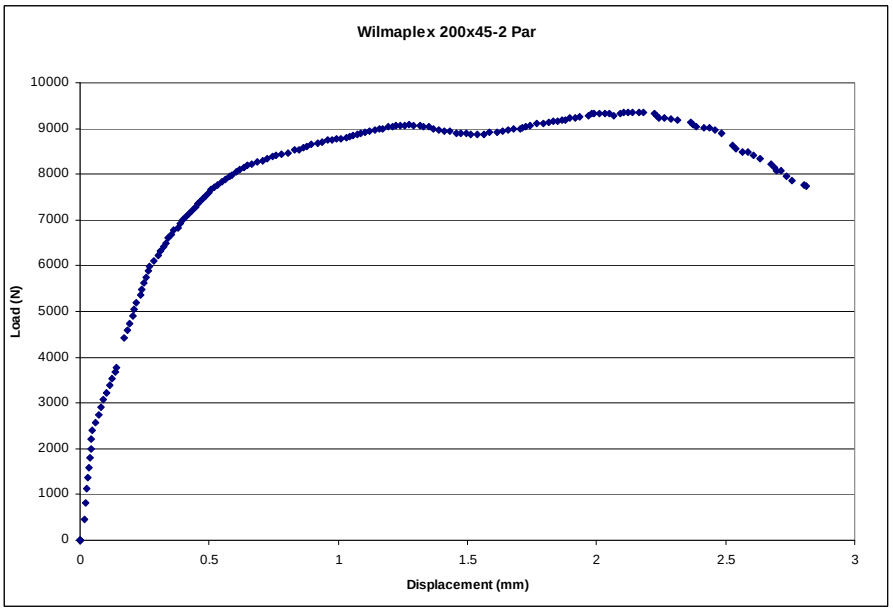


Figure A62 200x45mm parallel direction-2

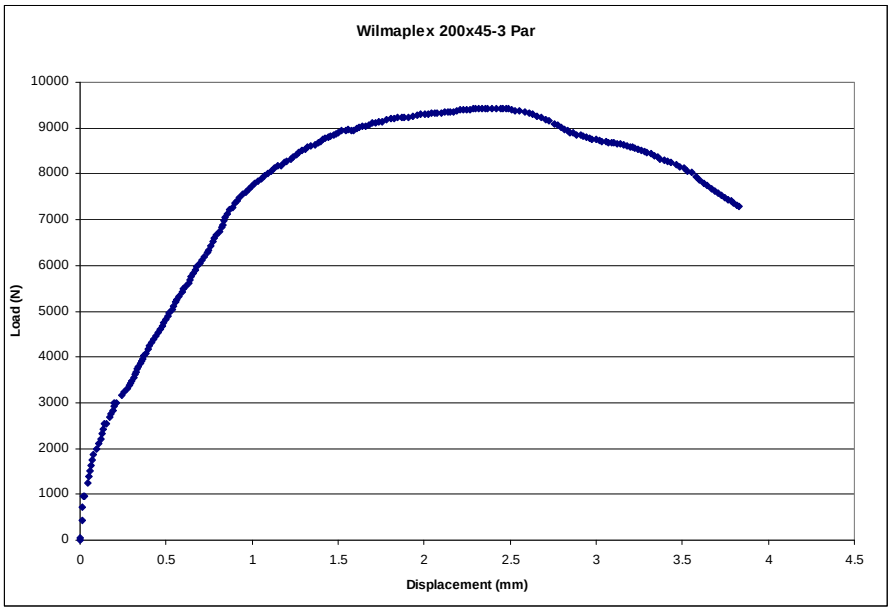


Figure A63 200x45mm parallel direction-3

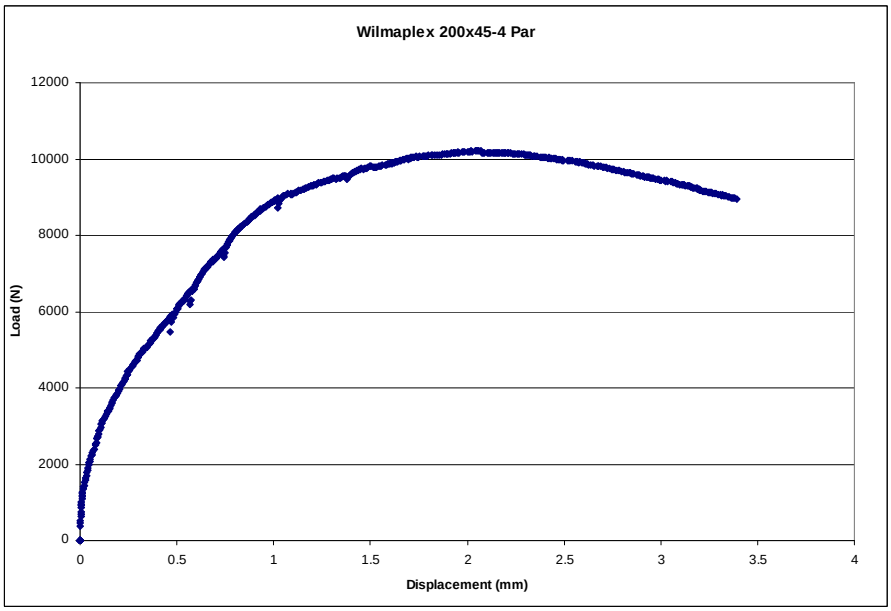


Figure A64 200x45mm parallel direction-4

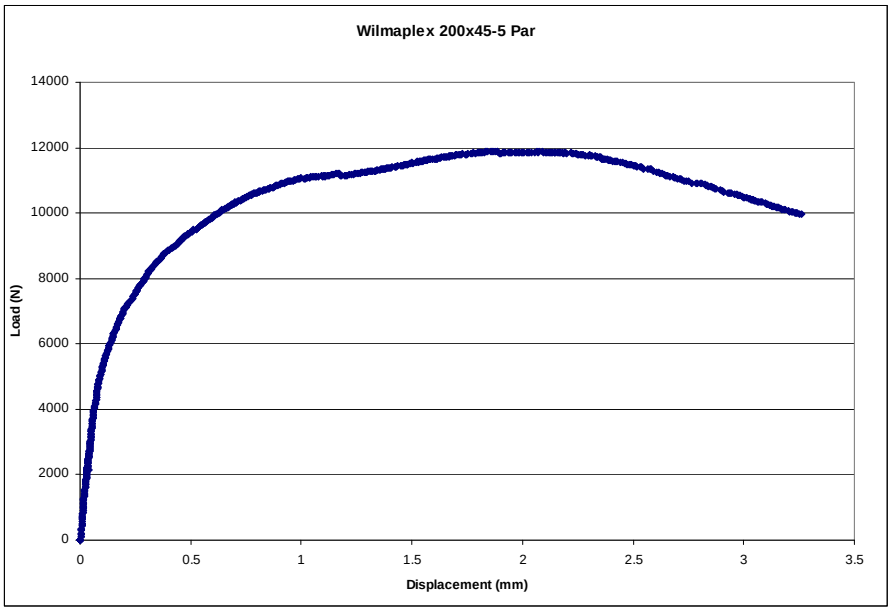


Figure A65 200x45mm parallel direction-5

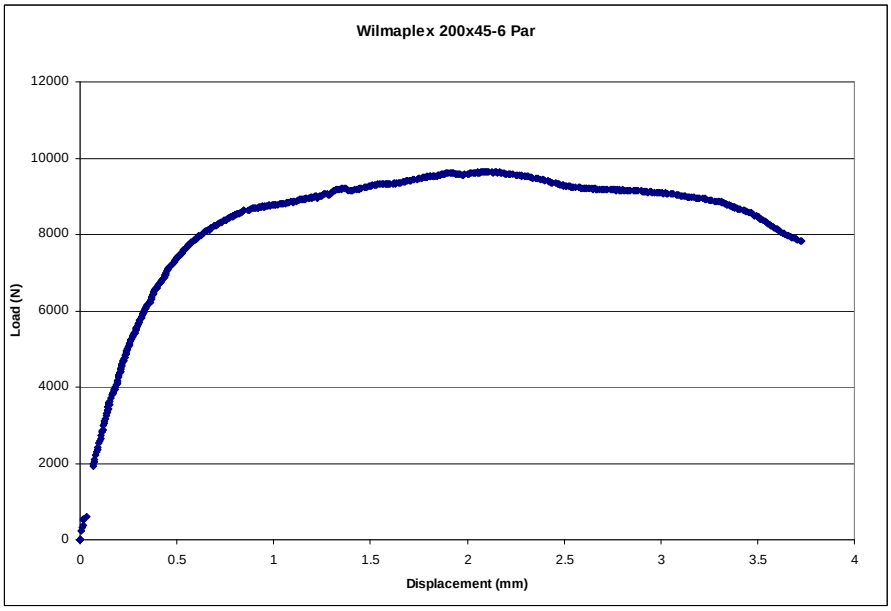


Figure A66 200x45mm parallel direction-6

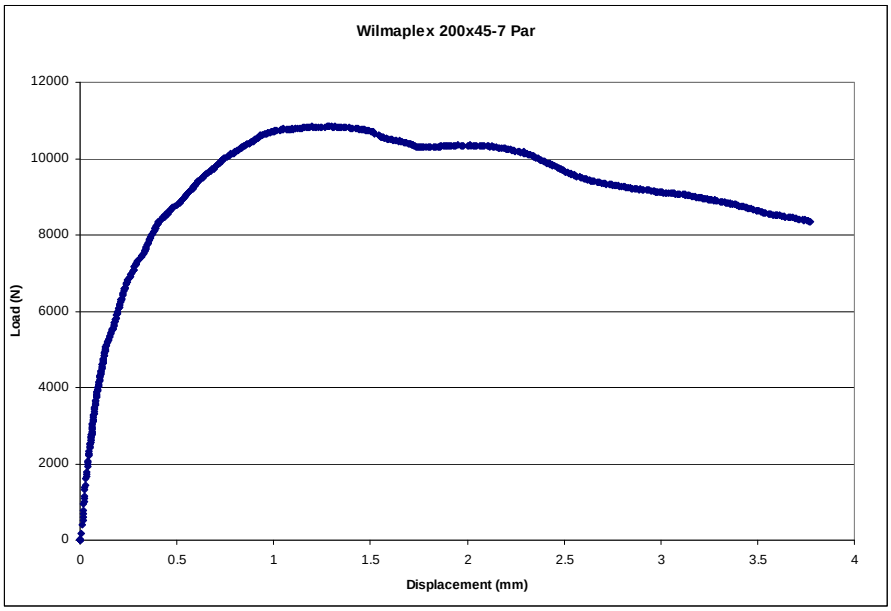


Figure A67 200x45mm parallel direction-7

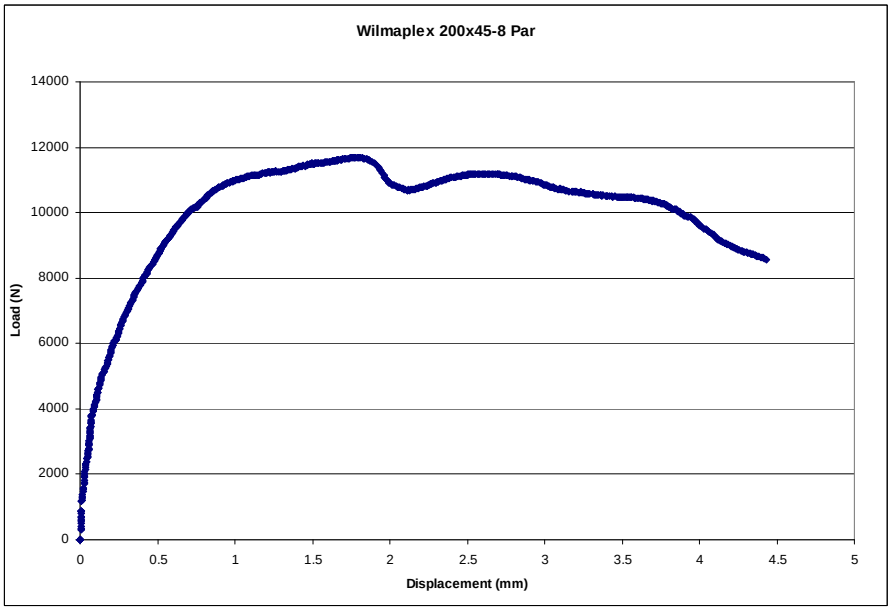


Figure A68 200x45mm parallel direction-8

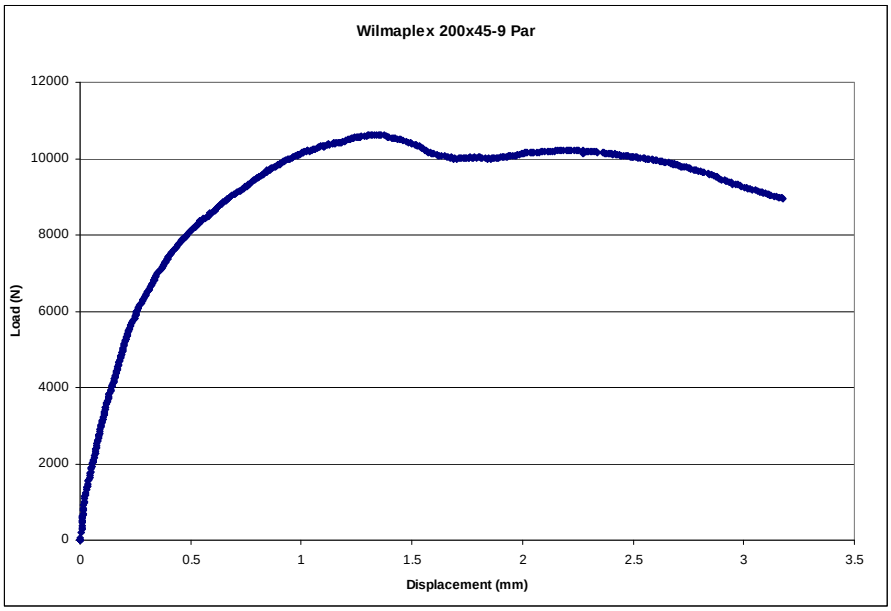


Figure A69 200x45mm parallel direction-9

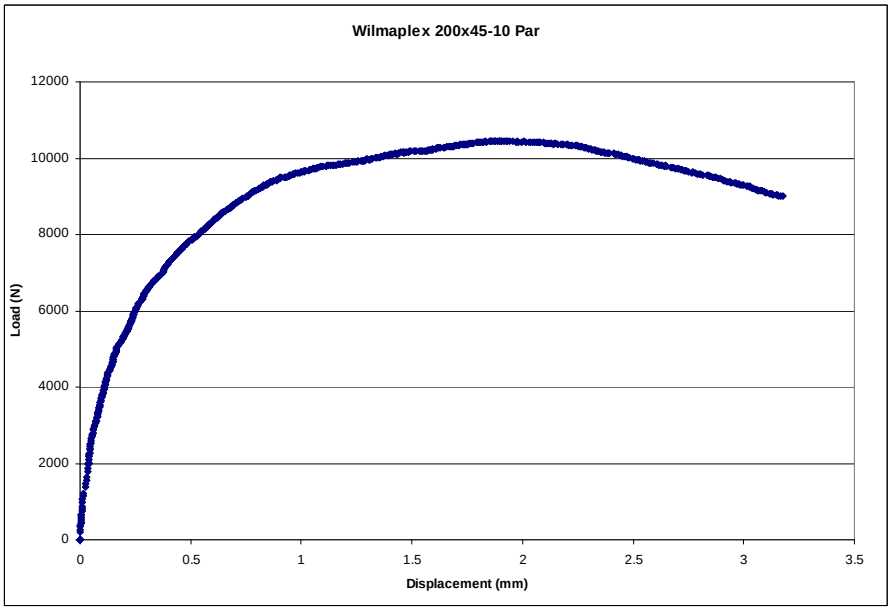


Figure A70 200x45mm parallel direction-10

6.1.8. 200x45mm perpendicular direction

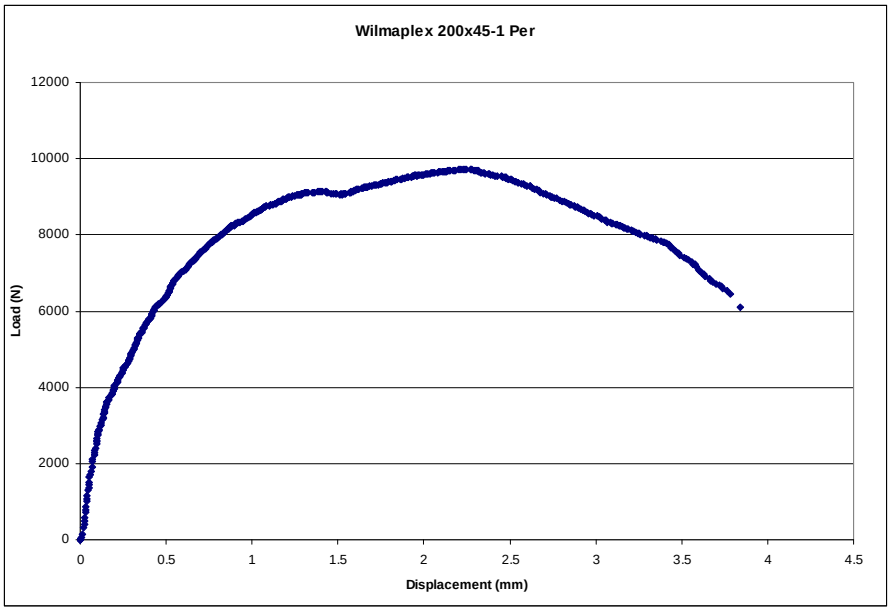


Figure A71 200x45mm perpendicular direction-1

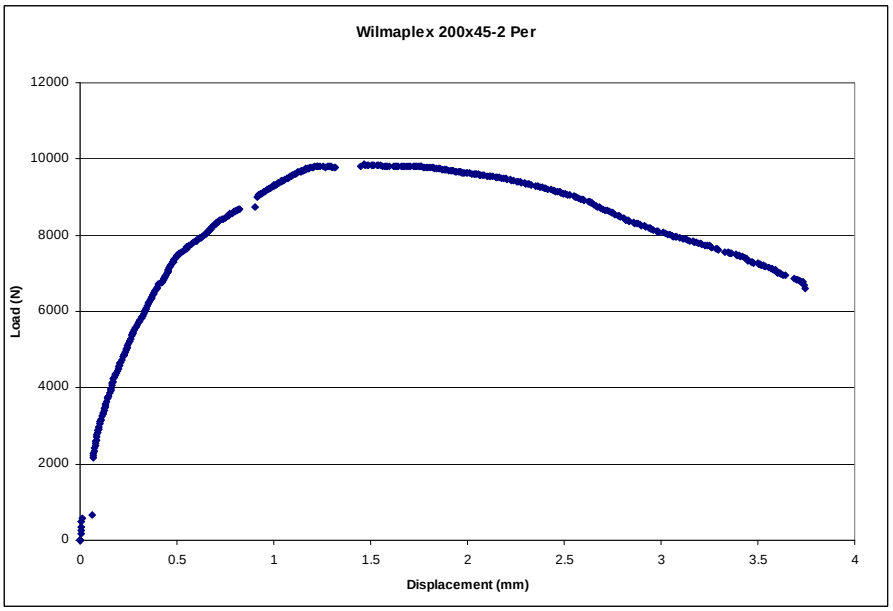


Figure A72 200x45mm perpendicular direction-2

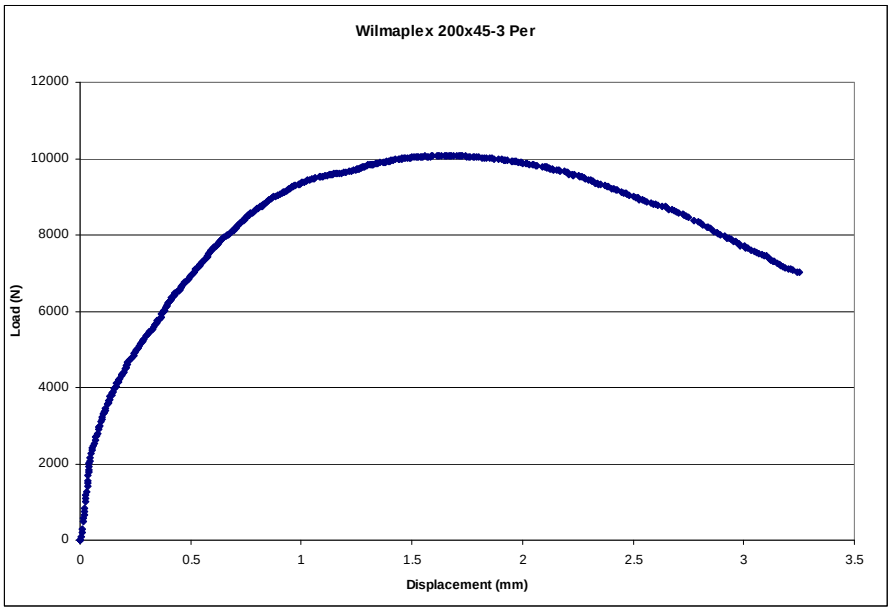


Figure A73 200x45mm perpendicular direction-3

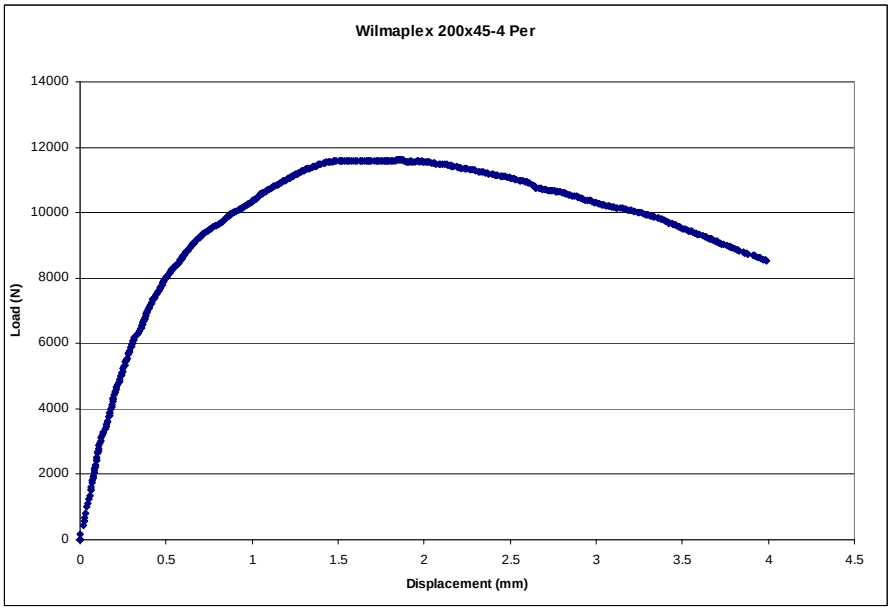


Figure A74 200x45mm perpendicular direction-4

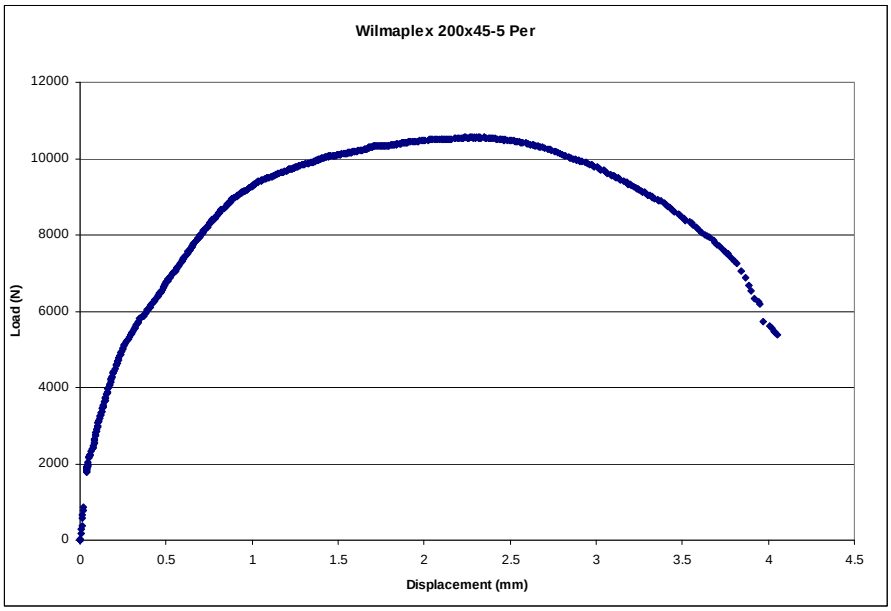


Figure A75 200x45mm perpendicular direction-5

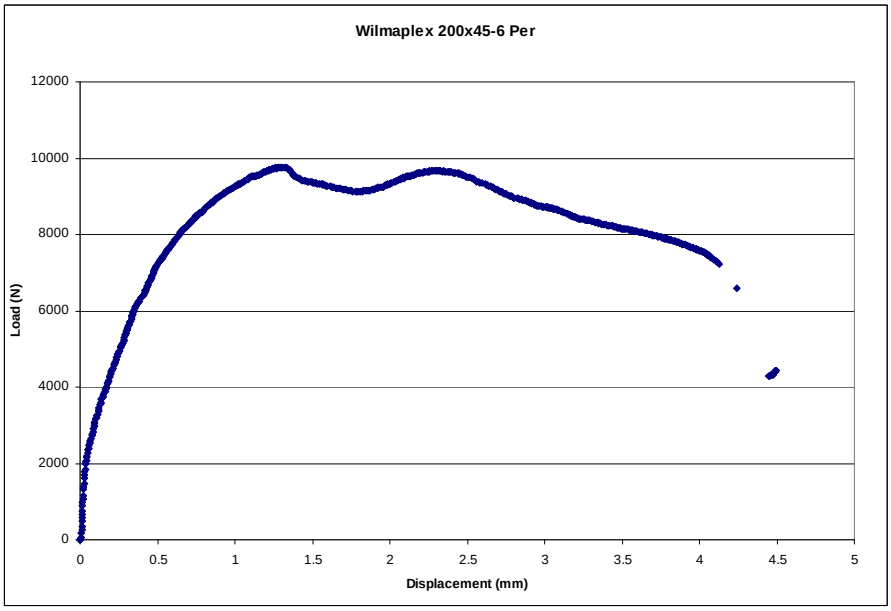


Figure A76 200x45mm perpendicular direction-6

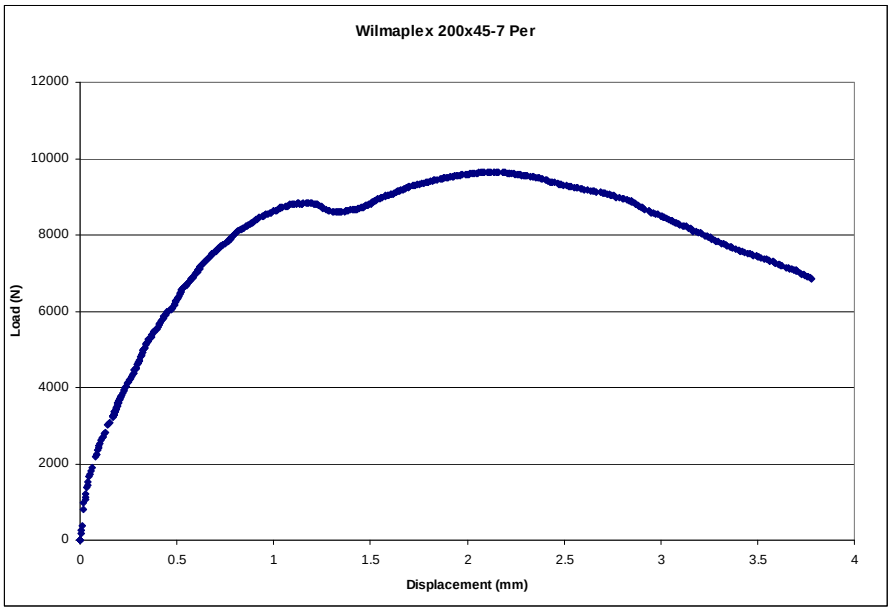


Figure A77 200x45mm perpendicular direction-7

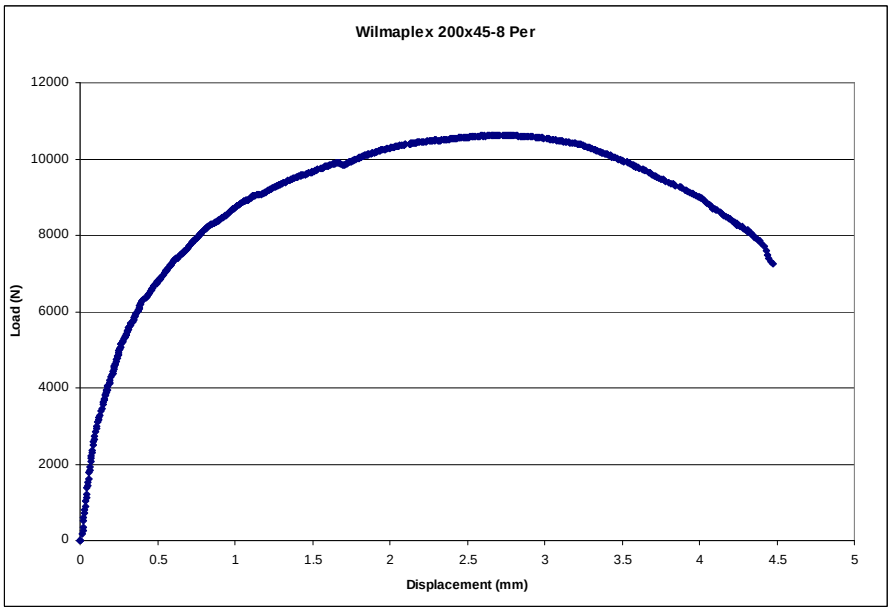


Figure A78 200x45mm perpendicular direction-8

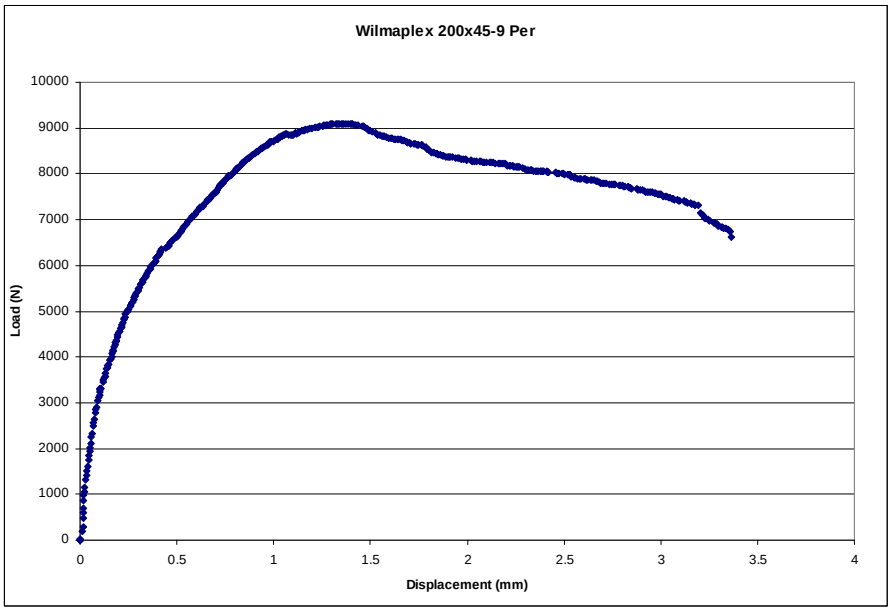


Figure A79 200x45mm perpendicular direction-9

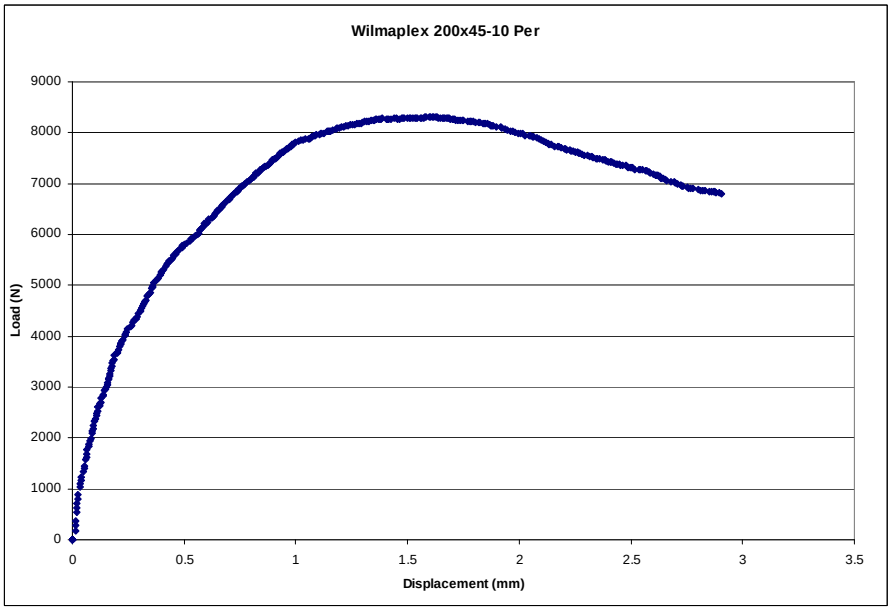


Figure A80 200x45mm perpendicular direction-10

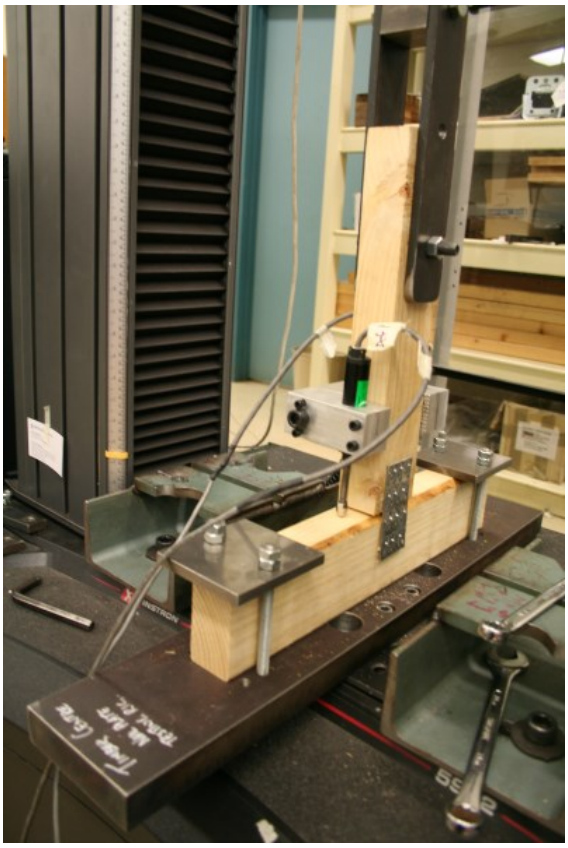


Figure A81 Typical test set-up for perpendicular type testing.

Figure A82 Typical test set-up for parallel type testing

Figure A83 Typical mode of failure, pull-out of teeth from timber for perpendicular direction tests.

Figure A84 Typical mode of failure, pull-out of teeth from timber for parallel direction tests.

TEST CERTIFICATE — **BLUESCOPE STEEL**

Page 1 of 2
Certificate No. : 21803WPD/14
Transmission Date: 09/05/14

Customer:	SELECTION STEEL SALES PTY. LTD 64-66 VENTURA PLACE DANDENONG SOUTH VIC 3175	Supplier:	BlueScope Steel Limited WESTERN PORT, VIC, AUSTRALIA A.B.N. 16 000 011 058
Cust Order No:	201244	MOI No: Printed At: on:	955399 Supplier MWS 12/11/2014

NATA — Accredited for compliance with ISO/IEC 17025.

I certify that the original records of the company show that the item(s) referred to on this certificate conform to the specification as stated and that the product test results on this certificate supercede product test results on any other certificate.

K. ANNETT - BLUESCOPE STEEL APPROVED SIGNATORY
Chemical LAB 0632

PRODUCT: *GALV G300 Z275* SPECIFICATION: *NO SPEC.*

CHEMICAL ANALYSIS (Chemical Analysis supplied by the Steelmaker. Basic Oxygen Steelmaking process.)

Item No	Dimensions (mm)	PACK No	NATA Lab	CHEMICAL COMPOSITION PERCENT														
				HEAT No	C	P	Mn	Si	S	Ni	Cr	Mo	Cu	Al	Ti	Nb	V	Sn
01	0.70 x 915	N39739	0632	6388819	.093	.022	.42	<.005	.019	.017	.026	.005	.040	.026	<.002	.001	<.003	.002
01	0.70 x 915	N39740	0632	6388819	.093	.022	.42	<.005	.019	.017	.026	.005	.040	.026	<.002	.001	<.003	.002
01	0.70 x 915	N39741	0632	6388819	.093	.022	.42	<.005	.019	.017	.026	.005	.040	.026	<.002	.001	<.003	.002
01	0.70 x 915	N39743	0632	6388819	.093	.022	.42	<.005	.019	.017	.026	.005	.040	.026	<.002	.001	<.003	.002
01	0.70 x 915	N39734	0632	6388829	.083	.020	.42	<.005	.018	.017	.026	.005	.042	.034	<.002	.001	<.003	.005
01	0.70 x 915	N39736	0632	6388829	.083	.020	.42	<.005	.018	.017	.026	.005	.042	.034	<.002	.001	<.003	.005

Item No	Dimensions (mm)	PACK No	NATA Lab	CHEMICAL COMPOSITION PERCENT	
				HEAT No	N
01	0.70 x 915	N39739	0632	6388819	.0037
01	0.70 x 915	N39740	0632	6388819	.0037
01	0.70 x 915	N39741	0632	6388819	.0037
01	0.70 x 915	N39743	0632	6388819	.0037
01	0.70 x 915	N39734	0632	6388829	.0035
01	0.70 x 915	N39736	0632	6388829	.0035

Figure A85 Steel test certificate