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R-TECH SERVICES LIMITED

Laboratory Test Report Number: C16034

Date: 14/12/2016

Requested by:

Second Life Products Wales Ltd
Birch,
Abernant Yard,
Pontardawe Road,
Rhydyfro,
Pontardawe,
Swansea,
SA8 4SX
Client order number: SLPW181116RT

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Summary

Introduction

At the request of Second Life Products Wales Ltd testing was carried out on the material below:

Material Reference	Material Type
EKOply	Finished plastic sheet

Test Details

Test Material

Two sheets of the above material measuring 2440 x 1220mm in 19 and 10mm thicknesses were received for testing at R-Tech Services Ltd in November 2016.

Test Procedures

The tests conducted on machined specimens are listed in Table 1. These tests were completed during the period 24/11/2016 to 14/12/2016.

The results given in this report relate only to the materials submitted for test and may not be representative of other samples or batches.

List of test standards and deviations

Test Type	Specification
Water Absorption	ISO 62:2008
Tensile Properties	BS EN ISO 527-2:2012
Flexural Strength	BS EN ISO 178:2010
Temperature of Deflection Under Load	BS EN ISO 75-2:2013 at 1.80MPa and 0.45MPa
Shore Hardness - Cast	ISO 868
Density	ASTM D792-13
Compressive Strength	BS EN ISO 604:2003

Results

Property	Units	Test Method	Results	
			10mm	19mm
Tensile Strength	N/mm^2	BS EN ISO 527-2	4.33	3.47
Tensile Secant Modulus at 0.25% Strain	N/mm^2	BS EN ISO 527-2	283.80	263.70
Tensile Secant Modulus at 0.5% Strain	N/mm^2	BS EN ISO 527-2	246.53	229.69
Elongation at maximum load	%	BS EN ISO 527-2	7.13	4.38
Flexural Strength	N/mm^2	BS EN ISO 178	11.0	8.3
Flexural Modulus	N/mm^2	BS EN ISO 178	361.94	369.02
Compressive Strength	N/mm^2	BS EN ISO 604	2.2	2.4
Temperature of Deflection Under Load 1.8MPa Loading	°C	BS EN ISO 75-2	35.6	N/A
Temperature of Deflection Under Load 0.45MPa Loading	°C	BS EN ISO 75-2	54.2	N/A
Shore Hardness	N/A	ISO 868	56.5	59.8
Water Absorption	mg	ISO 62	490	385
Water Swell	%	N/A	0.05	0.1
Density	g/cm^3	ASTM D792	0.5407	0.492

Laminate Tensile Properties BS EN ISO 527-4

Job Number:	C16034	**Machine:**	Alpha 100kN	**Temperature:**	23.76°C
Vernier:	Digital (M21)	**Extensometer:**	Epsilon 50mm GL	**Humidity:**	50.39%
Material:	EKOply 10mm	**Test speed:**	2mm/min		
Micrometer:	Round Ended Analogue (M25) Flat End Analogue (M6)				

Specimen Dimensions:

Sample ID	Test Date	Operator	Width(mm)	Thickness(mm)	So(mm^2)	Lo(mm)
10TD-1	08/12/2016	CDM	25.09	10.02	251.40	50
10TD-2	08/12/2016	CDM	25.04	10.37	259.66	50
10TD-3	08/12/2016	CDM	25.06	9.87	247.34	50
10TD-4	08/12/2016	CDM	25.03	9.94	248.80	50
10TD-5	08/12/2016	CDM	25.06	9.89	247.84	50

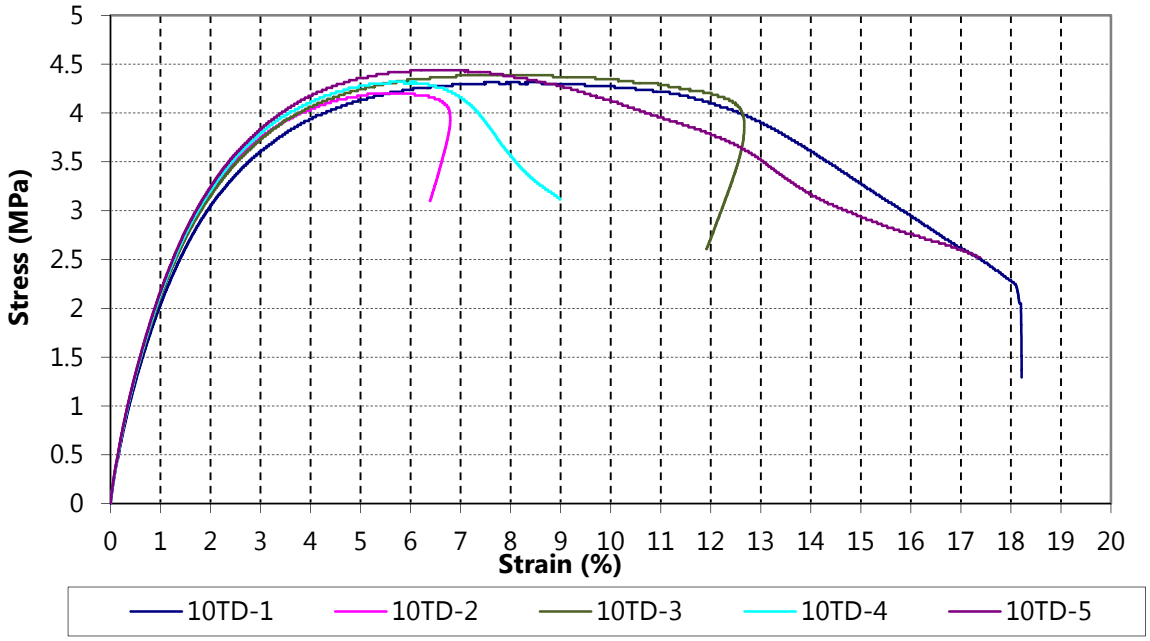
Results:

Sample ID	Fmax (kN)	StressMax (MPa)	Strain at Max Stress (%)	Emodulus 0.25%strain (MPa)	Emodulus 0.5%strain (MPa)
10TD-1	1.09	4.32	7.77	263.5	236.44
10TD-2	1.09	4.20	6.08	288.5	248.00
10TD-3	1.09	4.39	8.85	283.5	247.11
10TD-4	1.08	4.32	5.87	291.5	250.00
10TD-5	1.10	4.44	7.08	292.5	251.11

Statistics:

Sample ID	Fmax (kN)	StressMax (MPa)	Strain at Max Stress (%)	Emodulus 0.25%strain (MPa)	Emodulus 0.5%strain (MPa)
Mean	1.09	4.33	7.13	283.8	246.53
Standard Deviation	0.01	0.09	1.23	11.94	5.86
Max	1.10	4.44	8.85	292.5	251.11
Min	1.08	4.20	5.87	263.5	236.44
Mean + 2SD	1.11	4.51	9.59	307.67	258.25
Mean - 2SD	1.07	4.15	4.67	259.93	234.82

Series Graph:



Compressive Strength BS EN ISO 604/B1:2003

Job Number:	C16034	**Machine:**	Alpha WDW 100kN	**Temperature:**	23.50°C
Vernier:	Digital (M21)	**Extensometer:**	Epsilon 50mm GL	**Humidity:**	50.74%
Material:	EKOply 10mm	**Test Speed:**	1mm/min		
Micrometer:	Round Ended Analogue (M25) Flat End Analogue (M6)				

Specimen Dimensions:

Sample ID	Test Date	Operator	Width(mm)	Thickness(mm)	So(mm^2)
10XCS-1	07/12/2016	CDM	10.15	10.18	103.33
10XCS-2	07/12/2016	CDM	10.00	10.06	100.60
10XCS-3	07/12/2016	CDM	10.16	10.16	103.23
10XCS-4	07/12/2016	CDM	10.05	9.90	99.50
10XCS-5	07/12/2016	CDM	10.19	9.94	101.29

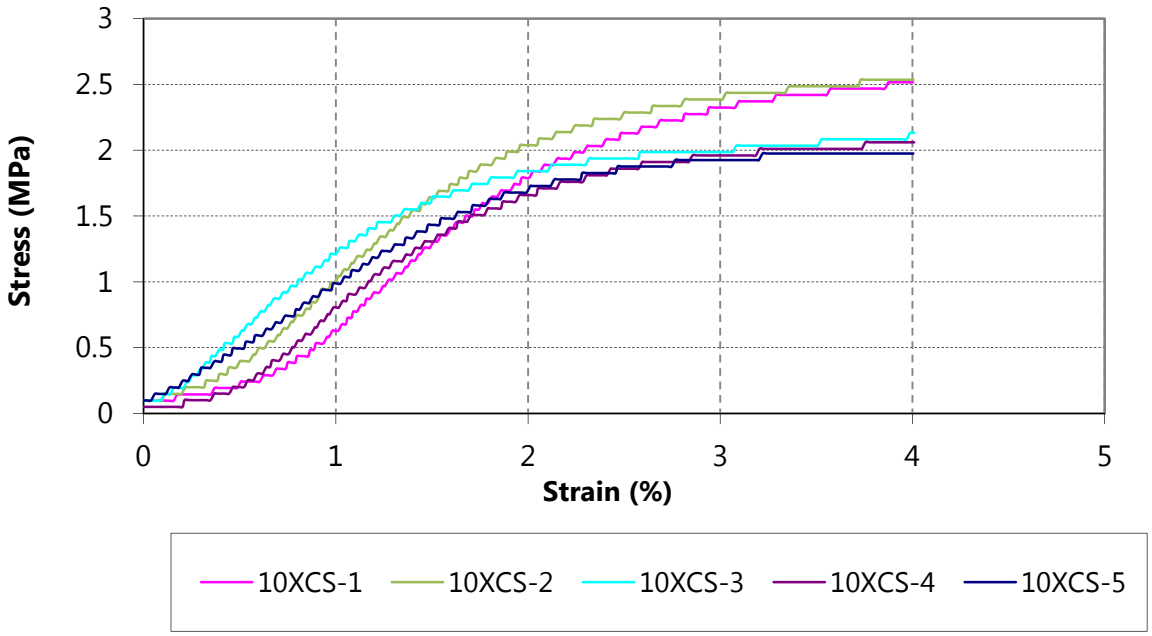
Results:

Sample ID	Compressive Strength (kN)	Compressive Stress (MPa)	Strain at Max Strength (%)
10XCS-1	0.260	2.5	3.9
10XCS-2	0.255	2.5	3.7
10XCS-3	0.220	2.1	4.0
10XCS-4	0.205	2.1	3.8
10XCS-5	0.200	2.0	3.2

Statistics:

Sample ID	Compressive Strength (kN)	Compressive Stress (MPa)	Strain at Max Strength (%)
Mean	0.228	2.2	3.7
Standard Deviation	0.028	0.3	0.3
Max	0.260	2.5	4.0
Min	0.200	2.0	3.2
Mean + 2SD	0.284	2.8	4.3
Mean - 2SD	0.172	1.7	3.1

Series Graph:



Flexural Properties BS EN ISO 170:1998

Job Number :	C16034	**Load cell :**	10kN
Customer :	Second Life Products Wales	**Extensometer :**	Crosshead
Material :	EKOply 10mm	**Specimen grips :**	3 point bend rig
Tester :	CDM	**Test speed :**	2 mm/min
Temperature :	23.68 °C	**Surface in Tension:**	Moulded Surface
Humidity :	50.83 %		

Dimensions:

Sub-Job No.	Sample No.	Width (mm)	Thickness (mm)	S0 (mm^2)	Flex Support (mm)
10XFD	1	15.04	10.34	155.51	82.32
10XFD	2	15.06	10.35	155.87	82.32
10XFD	3	15.07	9.78	147.38	78.32
10XFD	4	15.13	10.12	153.12	82.32
10XFD	5	15.09	9.82	148.18	78.32

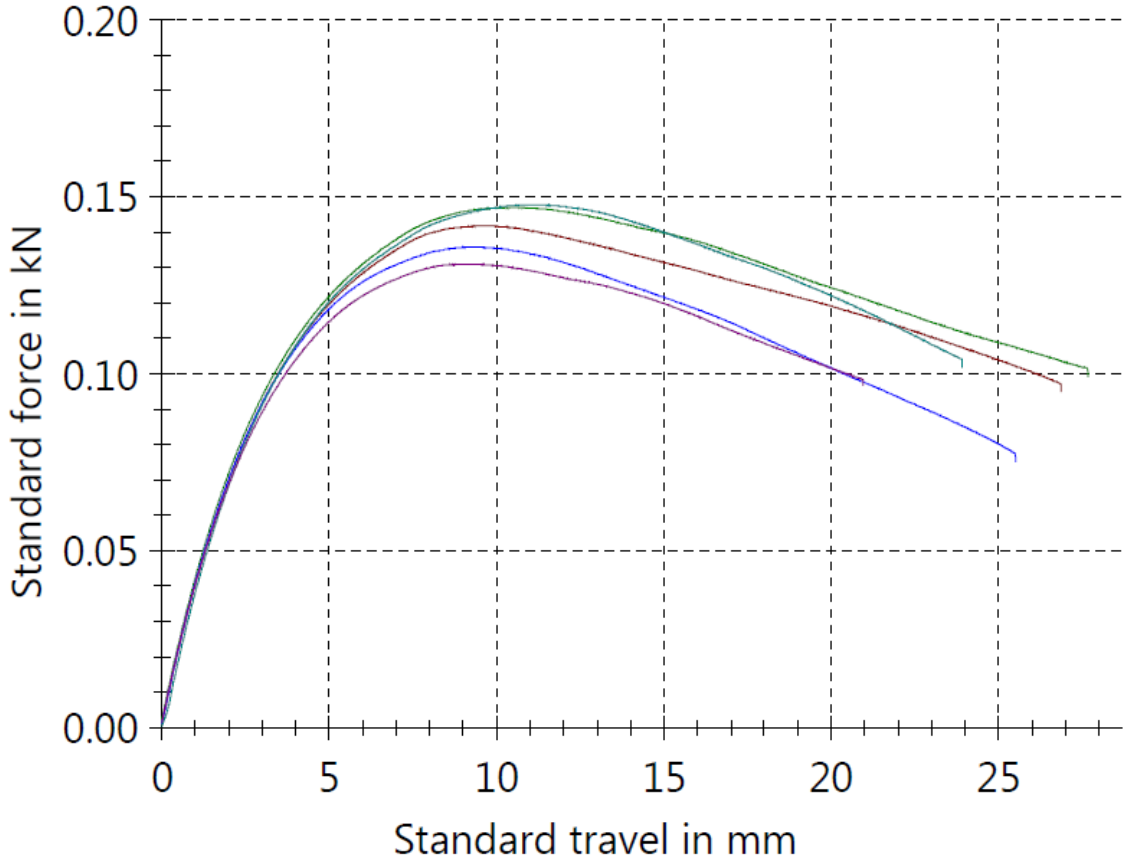
Results:

Sub-Job No.	Sample No.	Max Force (N)	Flexural Stress Max (MPa)	Flexural Modulus (MPa)
10XFD	1	141.8	10.9	376.10
10XFD	2	147.0	11.3	378.08
10XFD	3	135.9	11.1	372.97
10XFD	4	147.7	11.8	314.24
10XFD	5	131.0	10.6	363.86

Statistics:

Sample ID	Max Force (N)	Flexural Stress (MPa)	Flexural Modulus (MPa)
Mean	140.7	11.1	361.94
Standard Deviation	7.2	0.4	27.30
Max	147.7	11.8	378.08
Min	131.0	10.6	314.24
Mean + 2SD	155.1	12.0	416.53
Mean - 2SD	126.3	10.2	307.35

Series Graph:



Shore Hardness ISO 868

Instrument: Checkline Europe AD-300-D

Sample no.	Hardness (Shore D)				
1	51	54	56	58	55
2	59	60	57	57	57
3	59	57	56	57	60
4	55	55	58	58	60
5	54	56	55	56	53
				Mean	**56.5**

Heat Deflection Temperature ISO 75-2:2013

Method A: (1.80MPa Loading) Instrument: CEAST VICAT HDT 3

Sample No.	Thickness (mm)				Width (mm)				Length (mm)	Span (mm)	HDT (°C)
	1	2	3	Mean	1	2	3	Mean			
1	11.24	11.11	10.77	11.04	9.90	10.00	9.85	9.92	80.26	64	36.3
2	10.80	11.12	11.33	11.08	10.00	9.95	10.04	10.00	80.33	64	35.5
3	10.81	11.15	11.32	11.09	10.06	9.99	10.01	10.02	80.29	64	35.0
										Mean	**35.6**

Method B: (0.45MPa Loading) Instrument: CEAST VICAT HDT 3

Sample No.	Thickness (mm)				Width (mm)				Length (mm)	Span (mm)	HDT (°C)
	1	2	3	Mean	1	2	3	Mean			
1	10.73	10.61	10.72	10.69	10.12	10.12	10.00	10.08	80.20	64	55.3
2	10.82	11.08	11.20	11.03	9.96	10.15	10.00	10.04	80.07	64	53.3
3	10.69	10.91	11.04	10.88	9.93	10.13	10.20	10.09	80.53	64	54.0
										Mean	**54.2**

Water Absorption ISO 62:2008

Sample No.	Weight before immersion (g)	Weight after 168 hour immersion (g)	Water absorption (mg)	Swell (%)
1	14.6047	15.0512	446.5	0.01
2	14.3653	14.8027	437.4	0.09
3	14.1982	14.7843	586.1	0.04
		Mean	**490**	**0.05**

Density ASTM D792-13

Specimen ID	Mass in air (g)	Mass in distilled water (g)	Temperature of water (°C)	Density of distilled water (g/cm^3)	Density of specimen (g/cm^3)
1	2.8619	-3.0228	22.0	0.998203	0.4585
2	2.4910	-2.1059	22.0	0.998203	0.5409
3	2.8982	-1.7495	22.0	0.998203	0.6226
				Mean	**0.5407**

Laminate Tensile Properties BS EN ISO 527-4

Job Number:	C16034	**Machine:**	Alpha 100kN	**Temperature:**	23.50°C
Vernier:	Digital (M21)	**Extensometer:**	Epsilon 50mm GL	**Humidity:**	47.02%
Material:	EKOply 19mm	**Test speed:**	2mm/min		
Micrometer:	Round Ended Analogue (M25) Flat End Analogue (M6)				

Specimen Dimensions:

Sample ID	Test Date	Operator	Width(mm)	Thickness(mm)	So(mm^2)	Lo(mm)
19TD-1	24/11/2016	CDM	25.07	19.98	500.90	50
19TD-2	24/11/2016	CDM	25.04	20.03	501.55	50
19TD-3	24/11/2016	CDM	25.00	20.05	501.25	50
19TD-4	24/11/2016	CDM	25.02	20.06	501.90	50
19TD-5	24/11/2016	CDM	25.04	20.07	502.55	50

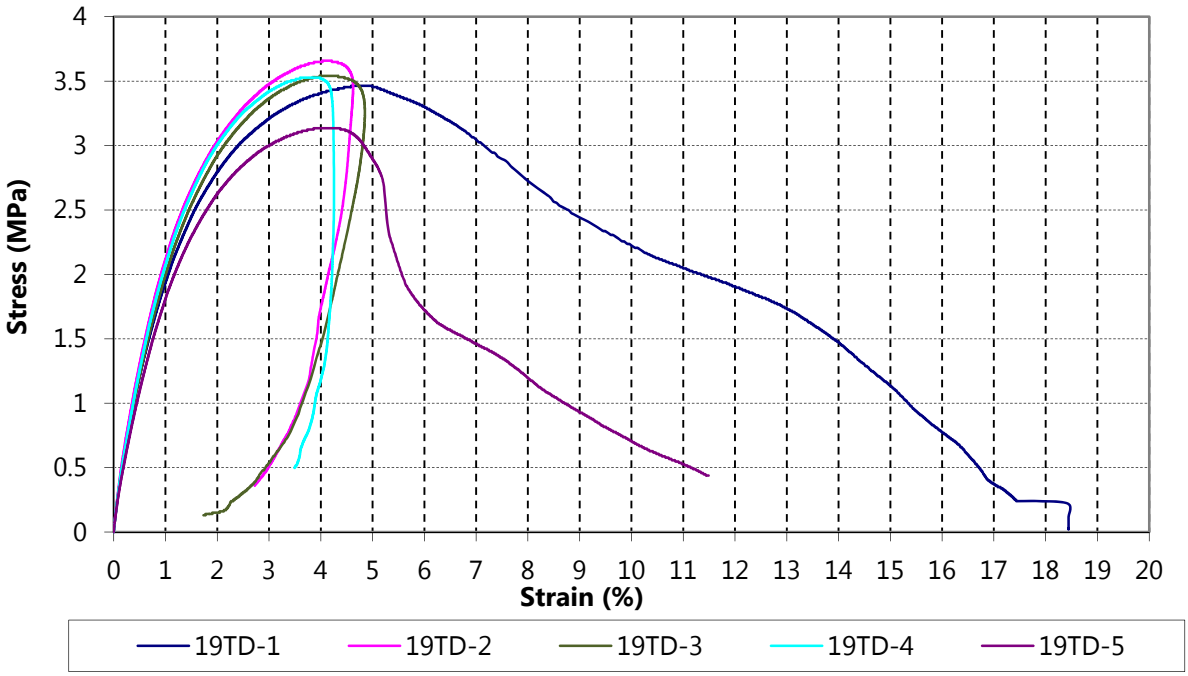
Results:

Sample ID	Fmax (kN)	StressMax (MPa)	Strain at Max Stress (%)	Emodulus 0.25%strain (MPa)	Emodulus 0.5%strain (MPa)
19TD-1	1.74	3.46	4.99	272.0	229.56
19TD-2	1.84	3.66	4.21	289.5	248.22
19TD-3	1.78	3.54	4.34	264.0	228.22
19TD-4	1.77	3.53	3.99	264.0	236.89
19TD-5	1.58	3.13	4.38	229.0	205.56

Statistics:

Sample ID	Fmax (kN)	StressMax (MPa)	Strain at Max Stress (%)	Emodulus 0.25%strain (MPa)	Emodulus 0.5%strain (MPa)
Mean	1.74	3.47	4.38	263.7	229.69
Standard Deviation	0.10	0.20	0.37	22.02	15.65
Max	1.84	3.66	4.99	289.50	248.22
Min	1.58	3.13	3.99	229.00	205.56
Mean + 2SD	1.93	3.86	5.13	307.73	260.99
Mean - 2SD	1.54	3.07	3.64	219.67	198.39

Series Graph:



Compressive Strength BS EN ISO 604/B1:2003

Job Number:	C16022	**Machine:**	Alpha WDW 100kN	**Temperature:**	23.32°C
Vernier:	Digital (M21)	**Extensometer:**	Epsilon 50mm GL	**Humidity:**	50.97%
Material:	EKOply 19mm	**Test Speed:**	1mm/min		
Cure:	24 hours @ ambient		**Post Cure:**	16 hours at 40°C	
Micrometer:	Round Ended Analogue (M25) Flat End Analogue (M6)				

Specimen Dimensions:

Sample ID	Test Date	Operator	Width(mm)	Thickness(mm)	So(mm^2)
19CS-1	02/12/2016	CDM	9.97	10.15	101.20
19CS-2	02/12/2016	CDM	10.13	10.09	102.21
19CS-3	02/12/2016	CDM	10.07	10.11	101.81
19CS-4	02/12/2016	CDM	10.17	10.13	103.02
19CS-5	02/12/2016	CDM	10.08	10.16	102.41

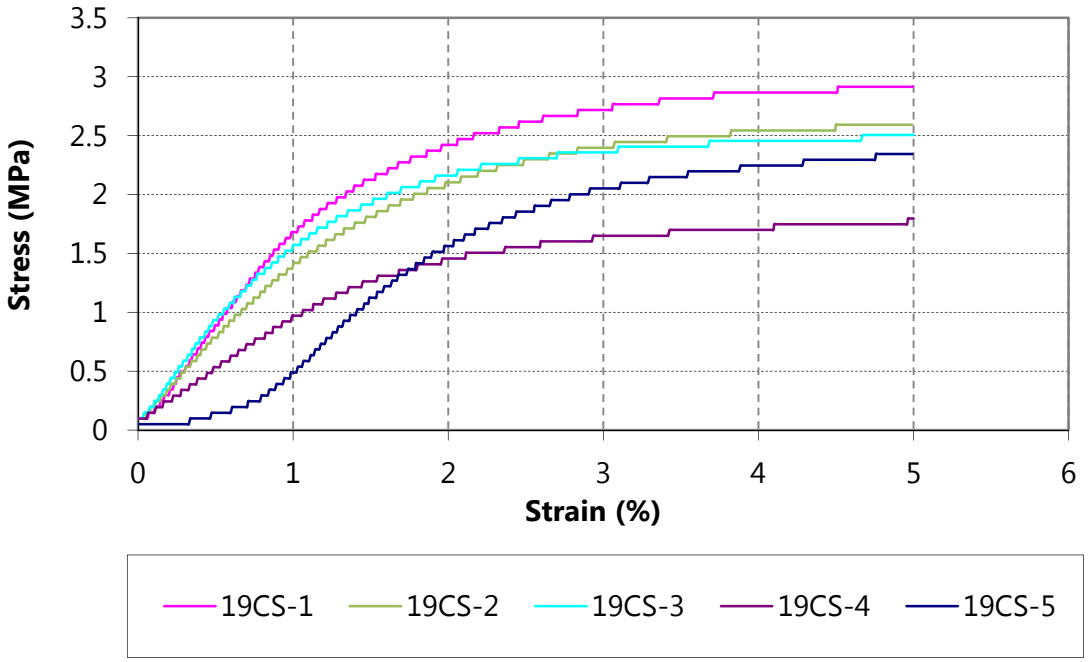
Results:

Sample ID	Compressive Strength (kN)	Compressive Stress (MPa)	Strain at Max Strength (%)
19CS-1	0.295	2.9	4.5
19CS-2	0.265	2.6	4.5
19CS-3	0.255	2.5	4.7
19CS-4	0.185	1.8	5.0
19CS-5	0.240	2.3	4.8

Statistics:

Sample ID	Compressive Strength (kN)	Compressive Stress (MPa)	Strain at Max Strength (%)
Mean	0.248	2.4	4.7
Standard Deviation	0.041	0.4	0.2
Max	0.295	2.9	5.0
Min	0.185	1.8	4.5
Mean + 2SD	0.329	3.3	5.1
Mean - 2SD	0.167	1.6	4.3

Series Graph:



Flexural Properties BS EN ISO 170:1998

Job Number :	C16034	**Load cell :**	10kN
Customer :	Second Life Products Wales	**Extensometer :**	Crosshead
Material :	EKOply 19mm	**Specimen grips :**	3 point bend rig
Tester :	CDM	**Test speed :**	2 mm/min
Temperature :	23.92 °C	**Surface in Tension:**	Moulded Surface
Humidity :	49.59 %		

Dimensions:

Sub-Job No.	Sample No.	Width (mm)	Thickness (mm)	S0 (mm^2)	Flex Support (mm)
19XFD	1	15.02	19.50	292.89	154.9
19XFD	2	15.00	19.25	288.75	154.9
19XFD	3	15.11	19.23	290.57	154.9
19XFD	4	15.07	19.51	294.02	154.9
19XFD	5	14.94	19.51	291.48	154.9

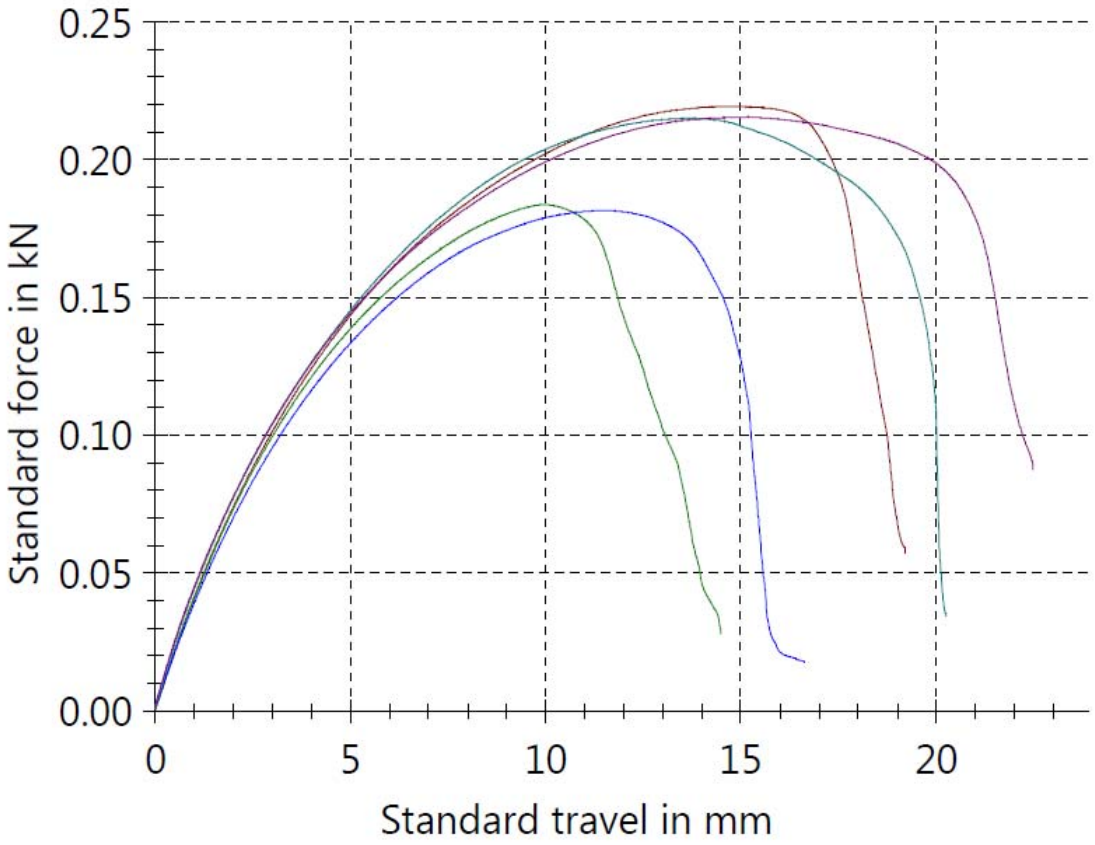
Results:

Sub-Job No.	Sample No.	Max Force (N)	Flexural Stress Max (MPa)	Flexural Modulus (MPa)
19XFD	1	219.3	8.9	359.26
19XFD	2	183.8	7.7	376.43
19XFD	3	181.6	7.6	346.04
19XFD	4	215.1	8.7	375.84
19XFD	5	215.6	8.8	387.54

Statistics:

Sample ID	Max Force (N)	Flexural Stress (MPa)	Flexural Modulus (MPa)
Mean	203.1	8.3	369.02
Standard Deviation	18.7	0.7	16.34
Max	219.3	8.9	387.54
Min	181.6	7.6	346.04
Mean + 2SD	240.5	9.7	401.17
Mean - 2SD	165.7	7.0	336.43

Series Graph:



Shore Hardness ISO 868

Instrument: Checkline Europe AD-300-D

Sample no.	Hardness (Shore D)				
1	60	60	60	59	61
2	61	60	61	59	61
3	60	59	59	61	58
4	59	60	59	58	58
5	59	60	61	60	61
				Mean	**59.8**

Water Absorption ISO 62:2008

Sample No.	Weight before immersion (g)	Weight after 168 hour immersion (g)	Water absorption (mg)	Swell (%)
1	22.9324	23.234	301.0	0.09
2	23.8849	24.3269	492.0	0.12
3	25.6002	25.9617	361.5	0.08
		Mean	**385**	**0.10**

Density ASTM D792-13

Specimen ID	Mass in air (g)	Mass in distilled water (g)	Temperature of water (°C)	Density of distilled water (g/cm^3)	Density of specimen (g/cm^3)
1	4.3247	-4.4390	22.0	0.998203	0.492592
2	4.1279	-4.1909	22.0	0.998203	0.495322
3	4.2172	-4.4200	22.0	0.998203	0.487383
				Mean	**0.491765**

Authorisation

Reported by:

Dr Geraint Havard
ProfGradIMMM AMIMechE
Composites Manager

End of report