Laboratory Assessment
for
Wonderboard Panel

Wonderboard Panel
Structural Performance Test

Prepared for:

PLYTEC Polymer Sdn Bhd

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TEST 1a: FLEXURAL TEST (ROOM TEMPERATURE)

REF: ASTM D790: Plastic and Composites

Flexural modulus and strength of individual panels. To check the displacement of the panel due to the applied load.

Two Types:

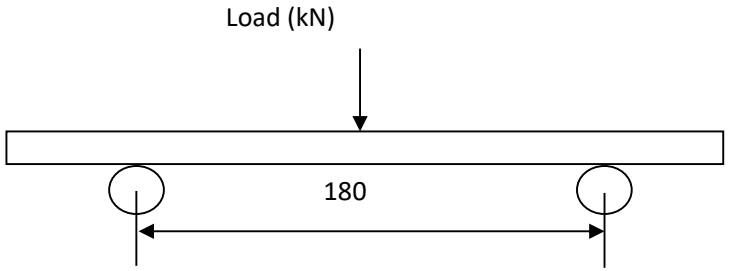
a) Virgin panels

b) Recycled Panels

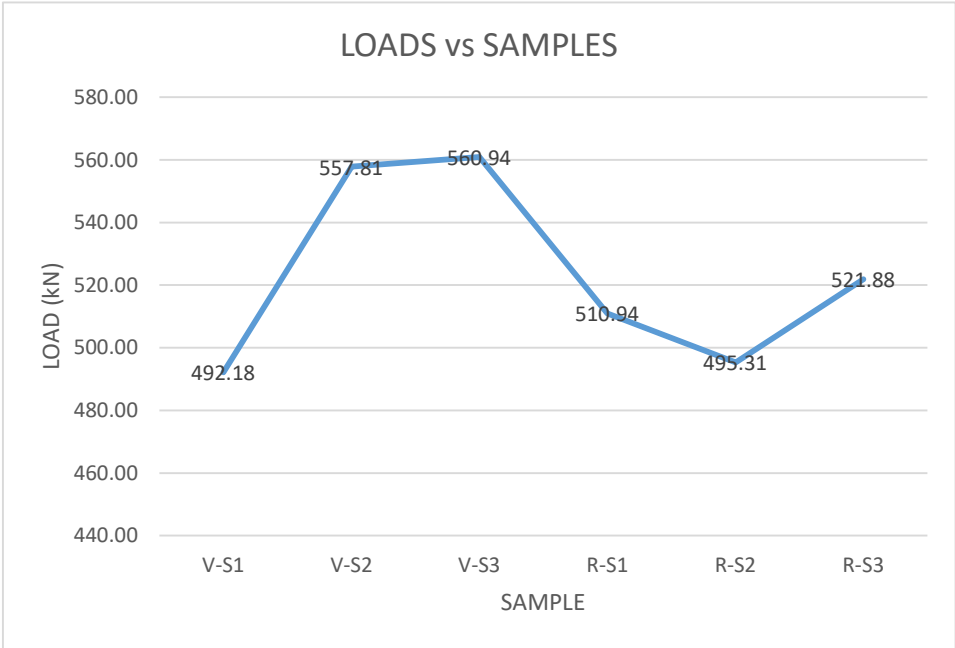
Test Method : Three-point bending test.

Size of Sample : 10mm x 48mm

Allowable deflection : L/270 (A Guide to Good Practice)



NO	SAMPLE	MAXIMUM LOAD (N)	REMARKS
1	V-S1	492.18	Virgin Panel
2	V-S2	557.81	Virgin Panel
3	V-S3	560.94	Virgin Panel
4	R-S1	510.94	Recycled Panel
5	R-S2	495.31	Recycled Panel
6	R-S3	521.88	Recycled Panel
	V (ave)	536.98	
	R (ave)	509.38	



OBSERVATIONS

- Panels of virgin and recycled materials are able to withstand with the max load of 536.98 N (ave) and 509.38 N (ave) respectively.

Dimensions

NO	Sample	Thickness (mm)				Width (mm)			
		1	2	3	Ave.	1	2	3	Ave.
1	V- S1	10.27	10.29	10.22	10.26	48.86	49.04	48.86	48.92
2	V- S2	10.26	10.25	10.26	10.26	48.76	48.86	48.82	48.81
3	V- S3	10.28	10.26	10.24	10.26	48.65	48.68	48.72	48.68
4	R-S1	10.14	10.18	10.15	10.16	48.19	48.19	48.16	48.18
5	R-S2	10.18	10.13	10.08	10.13	48.13	48.02	48.05	48.07
6	R-S3	10.10	10.15	10.11	10.12	48.76	48.54	48.78	48.69
					10.20				48.56

1) Bending Moment:

Section Modulus, Z = $bd^2 / 6$

Z = 17.33 mm^3/mm

Flexural Strength for Plastic formwork = 30 MPa

Note: Flexural Strength of Polypropylene plactic typically ranges from 30 to 40 Mpa.

Bending Moment Capacity, M = 0.520 kNm/m

Panel Dimension, 10mm x 48mm (V)

Load, P = 536.98 N

Span, L = 0.18 m

Bending Moment, M = 0.024 kNm

Bending Moment, M = 0.498 kNm/m

> 0.2 kNm/m (for 12 mm thick plywood)

δ = 0.67 mm

Panel Dimension, 10mm x 48mm (R)

Load, P = 509.38 N

Span, L = 0.18 m

Bending Moment, M = 0.023 kNm

Bending Moment, M = 0.488 kNm/m

> 0.2 kNm/m (for 12 mm thick plywood)

δ = 0.67 mm

2) Flexural Rigidity (EI):

$$EI = \frac{PL^3}{48\,\delta}$$

Flexural Rigidity for Plywood

t =	12
E =	5247 *
I =	144
EI =	0.756

** Elastic Modulus of Plywood 12mm*

Panel Dimension, 10mm x 48mm, V

$$EI = \frac{0.0031}{0.0320}$$

EI = 0.098 kNm^2

EI = 2.04 kNm^2/m

> 0.756 kNm^2/m (for 12 mm thick plywood)

Panel Dimension, 10mm x 48mm, R

$$EI = \frac{0.0030}{0.0320}$$

EI = 0.093 kNm^2

EI = 1.93 kNm^2/m

> 0.756 kNm^2/m (for 12 mm thick plywood)

TEST 1b: FLEXURAL TEST (EXTREME TEMPERATURE, 90 DEGREES)

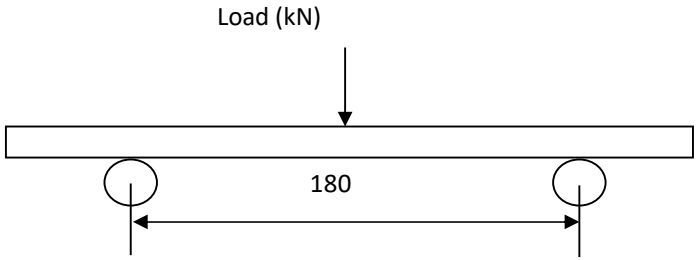
REF: Flexural Test - ASTM D790: Plastic and Composites

Flexural modulus and strength of individual panels. To check the displacement of the panel due to the applied load.

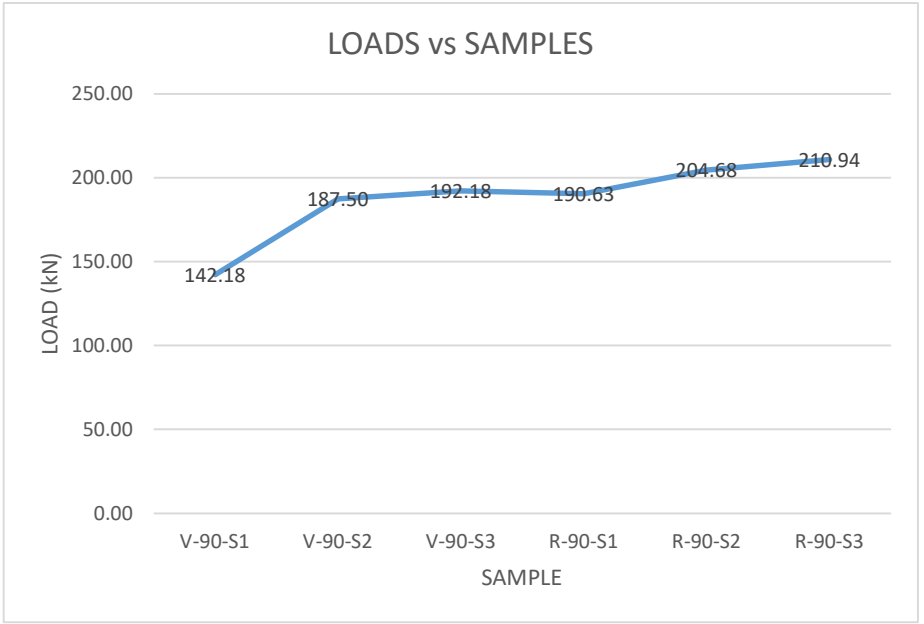
Two Types:

a) Virgin panels
b) Recycled Panels

Test Method : Three-point bending test.
Size of Sample : 10mm x 48mm
Allowable deflection : L/270 (A Guide to Good Practice)



NO	SAMPLE	MAXIMUM LOAD (N)	REMARKS
1	V-90-S1	142.18	Virgin Panel
2	V-90-S2	187.50	Virgin Panel
3	V-90-S3	192.18	Virgin Panel
4	R-90-S1	190.63	Recycled Panel
5	R-90-S2	204.68	Recycled Panel
6	R-90-S3	210.94	Recycled Panel
	V (ave)	173.95	
	R (ave)	202.08	



OBSERVATIONS

- Panels of virgin and recycled materials are able to withstand with the max load of 536.98 N (ave) and 509.38 N (ave) respectively.

Dimensions

NO	Sample	Thickness (mm)				Width (mm)			
		1	2	3	Ave.	1	2	3	Ave.
1	V-90-S1	10.27	10.29	10.22	10.26	48.86	49.04	48.86	48.92
2	V-90-S2	10.26	10.25	10.26	10.26	48.76	48.86	48.82	48.81
3	V-90-S3	10.28	10.26	10.24	10.26	48.65	48.68	48.72	48.68
4	R-90-S1	10.14	10.18	10.15	10.16	48.19	48.19	48.16	48.18
5	R-90-S2	10.18	10.13	10.08	10.13	48.13	48.02	48.05	48.07
6	R-90-S3	10.10	10.15	10.11	10.12	48.76	48.54	48.78	48.69
					10.20				48.56

1) Bending Moment:

Section Modulus, Z = $bd^2 / 6$

Z = 17.33 mm^3/mm

Flexural Strength for Plastic formwork = 30 MPa

Note: Flexural Strength of Polypropylene plactic typically ranges from 30 to 40 Mpa.

Bending Moment Capacity, M = 0.520 kNm/m

Panel Dimension, 10mm x 48mm (V)

Load, P = 173.95 N

Span, L = 0.18 m

Bending Moment, M = 0.008 kNm

Bending Moment, M = 0.161 kNm/m (Extreme Temperature 90 degrees)

δ = 0.67 mm

Panel Dimension, 10mm x 48mm (R)

Load, P = 202.08 N

Span, L = 0.18 m

Bending Moment, M = 0.009 kNm

Bending Moment, M = 0.193 kNm/m (Extreme Temperature 90 degrees)

δ = 0.67 mm

2) Flexural Rigidity (EI):

$$EI = \frac{PL^3}{48\,\delta}$$

Flexural Rigidity for Plywood (Normal Temperature)

t =	12
E =	5247
I =	144
EI =	0.756

** Elastic Modulus of Plywood 12mm*

Panel Dimension, 10mm x 48mm, V

$$EI = \frac{0.0010}{0.0320}$$

EI = 0.032 kNm^2

EI = 0.66 kNm^2/m (Extreme Temperature, 90 degrees)

> 0.756 kNm^2/m (for 12 mm thick plywood)

Panel Dimension, 10mm x 48mm, R

$$EI = \frac{0.0012}{0.0320}$$

EI = 0.037 kNm^2

EI = 0.77 kNm^2/m (Extreme Temperature, 90 degrees)

> 0.756 kNm^2/m (for 12 mm thick plywood)

TEST 2 : SHEAR STRENGTH

Shear Test – ASTM D732 – Shear Strength of Plastics

Shear strength.

NO	Sample	Thickness (mm)				Width (mm)				Area	Maximum Load (N)	Shear Stress (N/mm^2)	Shear Stress (kN/m)
		1	2	3	Ave.	1	2	3	Ave.	mm^2			
1	V- S1	10.35	10.35	10.30	10.33	48.06	48.05	48.04	48.05	496.52	1029.68	2.074	21.43
2	V- S2	10.32	10.31	10.30	10.31	48.10	47.80	48.19	48.03	495.19	1109.37	2.240	23.10
3	V- S3	10.21	10.26	10.25	10.24	48.06	48.11	48.17	48.11	492.68	1103.13	2.239	22.93
4	R-S1	10.08	10.12	10.12	10.11	47.92	47.80	47.95	47.89	484.01	1090.63	2.253	22.77
5	R-S2	10.18	10.10	10.10	10.13	47.95	47.08	48.13	47.72	483.24	1007.81	2.086	21.12
6	R-S3	10.08	10.10	10.21	10.13	48.87	48.84	48.83	48.85	494.82	1028.13	2.078	21.05

Shear Stress

Virgin Samples 22.48 kN/m

Recycled Samples 21.65 kN/m

Notes:

1) The shear strength of 22.48 kN/m is considerably higher than shear strength of 19mm plywood having treshold value of 9.75 kN/m.

TEST 3 : COMPRESSION TEST

Direct compressive strength measured over 100 mm x 100 mm of individual panels

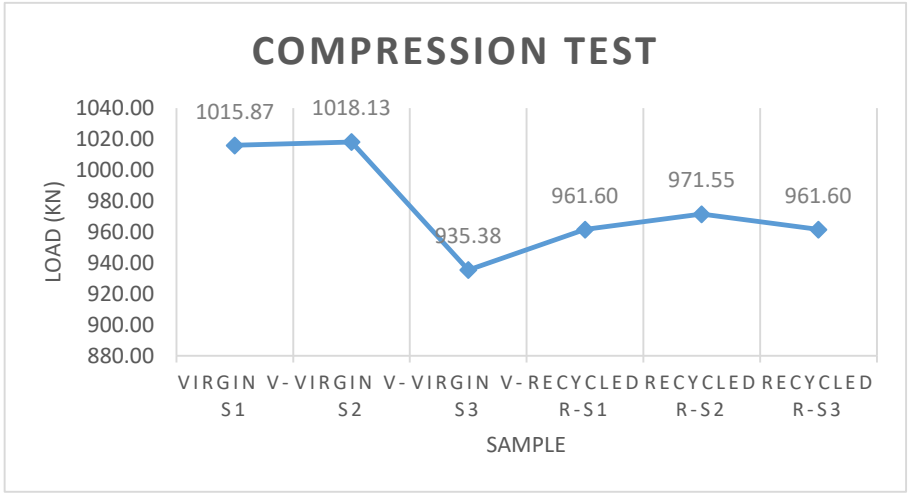
Compression Test – ISO 604 – Determination of Compressive Properties

Test Method : Compression test.

Size of Sample : 100mm x 100mm

FoS = 2.5

NO	SAMPLE	MAXIMUM LOAD (kN)	Compressive Strength (N/mm2)	Safe Compressive Strength (N/mm2)(Average)
1	Virgin V-S1	1015.87	101.59	39.59
2	Virgin V-S2	1018.13	101.81	
3	Virgin V-S3	935.38	93.54	
4	Recycled R-S1	961.60	96.16	38.60
5	Recycled R-S2	971.55	97.16	
6	Recycled R-S3	961.60	96.16	



Notes:

1) Direct Compressive strength of Plastic Formwork materials:

a) Ultimate Stength, 40 - 60 MPa for reinforced or high-quality engineered plastics.

b) Ultimate Strength, 15 - 30 MPa for plastic formwork without reinforcement.

2) No sign of distress or permanent deformation at the service load and ultimate load of 7 and 14 kN respectively.

2) Compressive strength of samples - the direct safe compressive strengths, measured over an area of 100 x 100 mm^2, based on the average value of three (3) samples each of two properties namely virgin materials and recycled materials, are 39.59 N/mm^2 and 38.6 N/mm^2 respectively.

3) Load-bearing capacity - Safe working load 50 - 80 KPa

The sample of virgin materials and recycled materials are able to resist the safe maximum load of 395.9 kN/m^2 and 386.0 kN/m^2 respectively. Ultimare load is more than 500 kN/m^2

TEST 4 : TENSILE TEST UNDER AMBIENT AND EXTREME TEMPERATURES

Tensile Test – ISO 527-1 – Determination of Tensile Properties

Conduct the necessary testing and characterisation required to assess the performance of the materials proposed including but not limited to tensile test under ambient and extreme temperatures.

Room Temperature

SAMPLE	Thickness (mm)				Width (mm)				Area	Force (N)	Displacement (mm)	Tensile Strength (N/mm^2)	
	1	2	3	Ave	1	2	3	Ave	mm^2				Ave
V-S1	10.80	10.25	10.80	10.62	12.78	12.75	12.75	12.76	135.47	2412.50	12.35	17.81	18.14
V-S2	10.80	10.30	10.60	10.57	12.77	12.78	12.77	12.77	134.97	2504.68	12.60	18.56	
V-S3	10.79	10.30	10.80	10.63	12.75	12.74	12.75	12.75	135.50	2445.31	9.72	18.05	
R-S1	10.14	10.21	10.12	10.16	12.75	12.76	12.75	12.75	129.53	2000.00	4.18	15.44	16.15
R-S2	10.21	10.21	10.22	10.21	12.78	12.78	12.78	12.78	130.53	2220.31	6.44	17.01	
R-S3	10.81	10.16	10.12	10.36	12.76	12.77	12.75	12.76	132.24	2115.63	5.17	16.00	

Extreme Temperature (90 degree)

SAMPLE	Thickness (mm)				Width (mm)				Area	Force (N)	Displacement (mm)	Tensile Strength (N/mm^2)		
	1	2	3	Ave	1	2	3	Ave	mm^2					
V-S1	10.80	10.25	10.80	10.62	12.78	12.75	12.75	12.76	135.47	487.50	18.01	3.60	3.51	80.63%
V-S2	10.80	10.30	10.60	10.57	12.77	12.78	12.77	12.77	134.97	426.56	32.12	3.16		
V-S3	10.79	10.30	10.80	10.63	12.75	12.74	12.75	12.75	135.50	512.50	25.30	3.78		
R-S1	10.14	10.21	10.12	10.16	12.75	12.76	12.75	12.75	129.53	625.00	19.59	4.83	4.62	71.42%
R-S2	10.21	10.21	10.22	10.21	12.78	12.78	12.78	12.78	130.53	537.50	19.67	4.12		
R-S3	10.81	10.16	10.12	10.36	12.76	12.77	12.75	12.76	132.24	648.34	19.78	4.90		

Room Temperature

SAMPLE	Yield Stress N/mm^2	Strain (0.2%)	Elastic Modulus GPa	Ave (E) GPa
V-S1	13.64	0.014	0.974	1.074
V-S2	15.04	0.013	1.157	
V-S3	15.27	0.014	1.091	
R-S1	7.30	0.003	2.433	2.066
R-S2	9.59	0.005	1.918	
R-S3	9.23	0.005	1.846	

Observations:

1) Virgin materials have higher yield strength but lesser elastic modulus, while recycled materials exhibit the opposite trend.

2) Virgin materials have longer and uniform polymer chains and minimal contamination. Its can align and resist applied forces more effectively, resulting in higher yield strength.

3) Virgin materials tend to be more flexible due to uniform and unbroken polymer structure allowing more elastic deformation under stress.

Extreme Temperature (90 degree)

SAMPLE	Yield Stress	Strain (0.2%)	Elastic Modulus	Ave (E)
	N/mm^2		GPa	GPa
V-S1	2.74	0.032	0.086	0.143
V-S2	2.43	0.021	0.116	
V-S3	2.97	0.013	0.228	
R-S1	4.05	0.021	0.193	0.167
R-S2	3.26	0.021	0.155	
R-S3	4.10	0.027	0.152	

4) Recycled materials exhibit higher elastic modulus due to degraded or shortened polymer chains make the material more brittle.

Notes:

1) Tensile strengths for virgin materials and recycled materials captured at room temperature (27 ^{o}C) are 18.13 N/mm^2 and 16.15 N/mm2 respectively.

2) Effect of temperature on tensile strength - Values of tensile strengths of virgin materials and recycled materials, having readings of 3.51 N/mm^2 and 4.61 N/mm^2, are reduced to approximately 80.6% and 71.4% at 90 ^{o}C respectively.

3) Elastic Modulus for virgin materials and recycled materials are 1.074 GPa and 2.066 Gpa respectively.

4) Results showed that as the temperature increases the tensile strength reduces but the ductility increases.

Test 5 : SKIDDING TEST

Ref: ASTM E303, BS 7976-2, EN 13036-4

The test evaluates the frictional properties of plastic formwork, particularly when it is subjected to loads or wet conditions, ensuring stability during construction activities.

Slip Resistance Classifications (Pendulum Test Value)

PTV	Slip Potential
0 - 24	High Slip Potential
25 - 35	Moderate Slip Potential
36+	Low Slip Potential (Safe)

(EN 13036-4)

PTV	Dry Conditions					Wet Conditions				
	PTV1	PTV2	PTV3	Ave	Remarks	PTV1	PTV2	PTV3	Ave	Remarks
Virgin	58	65	65	62.67	Low Slip	30	31	29	30.00	Moderate
Recycled	85	100	110	98.33	Low Slip	43	40	43	42.00	Low Slip

Notes:

1) The values of PTV of more than 36, dry conditions for both virgin and recycled materials, are generally considered safe (low slip potential).

2) For wet conditions, PTV values for recycled materials are positoned under low slip potential category. Virgin materials situated under moderate category.