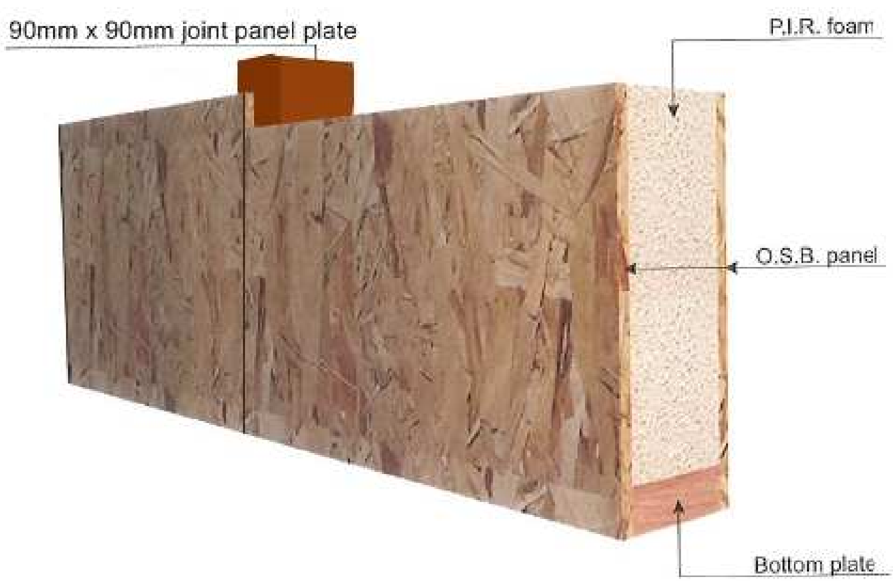
Ozone Panel

120mm Thick Panel Structural Test Report

50mm Fastener Centre Spacing

Racking, Compression and Wind Load



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DOCUMENT CONTROL

120mm Thick Panel Structural Test Report
Racking, Compression and Wind Load

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1. INTRODUCTION

Document Type:	Report of 120 mm Thick Ozone Panel with 50 mm fastener centre spacing, structural tests performed in accordance with AS/NZS 4284:2008, AS 1562.1: 1992, with reference to BRANZ EM3, and Vipac Internal Procedure LI8886-MEL-00.
Manufacturer:	Ozone Panel

Vipac Engineers & Scientists was retained by Ozone Panel (herein referred to as *the Client*) to perform structural wind load testing in accordance with AS/NZS 4284:2008 and with reference to AS 1562.1:1992, racking resistance testing with reference to AS 1684.2:2010, and axial load compression testing according to Vipac Local Instruction LI8886-MEL-00. The objective of this testing was to determine if the structural performance requirements outlined in these standards are met by the product.

1.1. Test Details

Location: Vipac Engineers & Scientists Laboratory
279 Normanby Road, Port Melbourne.

Table 1: Test Personnel

Vipac Engineers & Scientists Ltd	Mr. M. Petrovic
Ozone Panel	Haydn Wright

2. STANDARDS AND VARIATIONS

AS/NZS 1170	Structural design actions
AS 1562.1:1992	Design and Installation of sheet roof and wall cladding
AS 4040.2:1992	Method 2: Resistance to wind pressures for non-cyclonic regions.
AS/NZS 4284:2008	Testing of building facades
AS 1684.2:2010	Residential timber-framed constructions
EM3: Dec 2004	BRANZ Determination of bracing ratings of bracing walls
LI8886-MEL-00	Vipac Procedure for Axial Loading Compression Resistance Testing
NCC	Australian National Construction Code 2012

3. TEST SPECIMEN

3.1. *Specimen Description*

Wall Cladding

The client supplied three 120 mm thick Ozone Panel test specimens with 50 mm fastener centre spacing for testing.

The 120 mm total panel thickness was made up of 2 x 15 mm Oriented Strand Board (OSB) on either side of a Bayer Baymer® PP2484 2-component polyisocyanurate (PIR) rigid foam core

3.2. *Specimen Size & Fixing*

The 120 mm Ozone Panel specimens tested were:

Racking resistance: 2.4 m H x 2.5 m W – 50 mm fastener centre spacing

Axial load compression: 2.5 m H x 2.4 m W – 50 mm fastener centre spacing

Wind pressure resistance: 2.5 m H x 2.4 m W – 50 mm fastener centre spacing

L-H-L cyclonic wind pressure resistance: 1.34 m H x 0.95 m W – 50 mm fastener centre spacing

Table 2: Test Specimen Details

	120 mm Ozone Panel
Fastener Type	Ring Shaft Nail
Fastener Diameter	3 mm
Fastener Length	55 mm
Fastener Centre Spacing	50 mm
Internal Spline	88 mm x 88 mm Timber
Top Plate	88 mm x 88 mm Timber
Bottom Plate	88 mm x 45 mm Timber
Side Plates	45 mm x 45 mm Timber

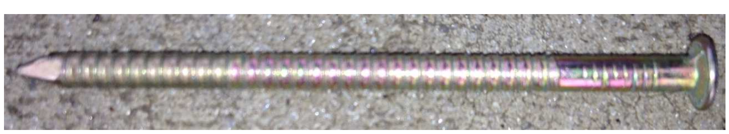

Figure 1: 3 mm x 55 mm Ring Shaft Nail

3.3. Test Specimen Schematic

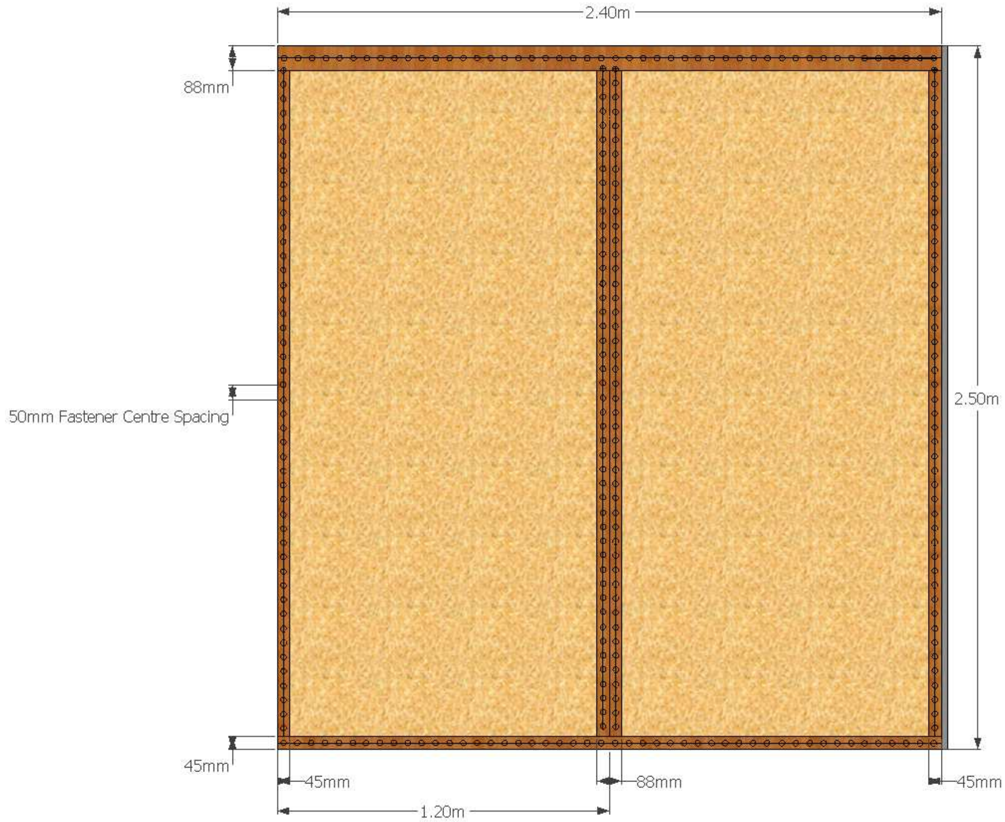

Figure 2: 120mm Thick Panel, 50mm Fastener Centre Spacing

4. APPARATUS

4.1. Racking Resistance and Compression Test

The wall base plate was rigidly fixed along its length to the bottom of the test rig. The wall specimen was then constructed upon this base plate. The wall top plate was fixed along its length to the upper steel member of the test rig. The upper steel member could move in the X and Y-directions; its movement in the Z-direction was restrained with steel guide brackets.

A 50 tonne hydraulic ram was used to apply load to the upper steel member and thus the wall top plate.

A 25 tonne load cell was used to record the racking load applied to the upper steel member and thus the wall top plate.

Displacement transducers were used to measure the specimen deformation during the tests.

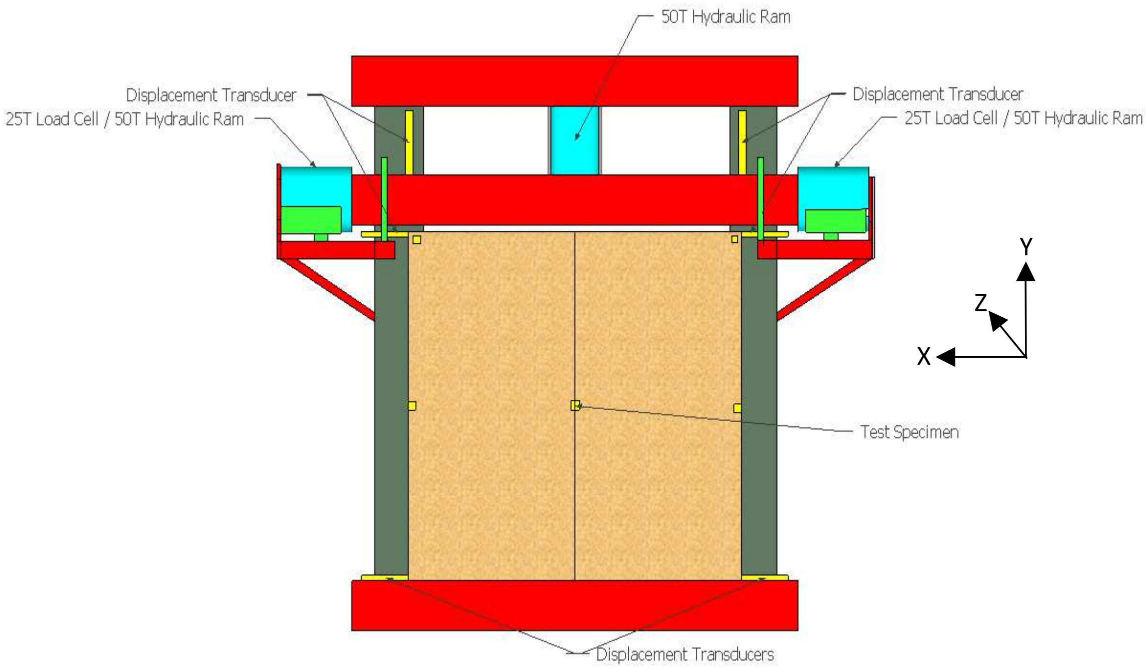

Figure 3: Racking Resistance and Compression Test Rig

4.2. Wind Pressure Resistance Test

The external face of the test specimen was positioned facing into the 5-sided test chamber (Figure 4) to create a complete pressure chamber. A high-pressure fan was ducted into the side of the chamber to generate the required positive and negative test pressures.

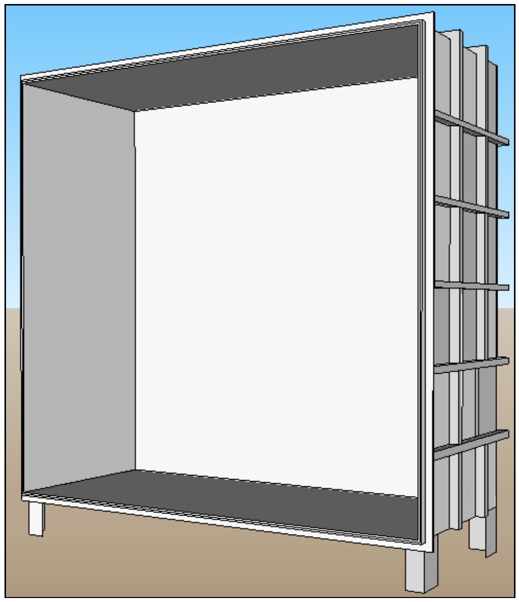

Figure 4: Wind Pressure Resistance Test Rig

5. TEST SEQUENCE

The following tests were performed:

1. Racking Resistance
2. Axial Load Compression Resistance
3. Wind Pressure Resistance - Serviceability Limit State
4. Specimen Temperature Cycled
5. Wind Pressure Resistance - Serviceability Limit State
6. Wind Pressure Resistance - Ultimate Limit State Cyclic Fatigue

6. TEST RESULTS

6.1. Racking Resistance – 50 mm Fastener Centre Spacing

Test Date: 16th April 2012

Test Standard: EM3: Dec 2004 BRANZ Determination of bracing ratings of bracing walls

Cycle Test Loading Protocol:

The specimen was subjected to one cycle to each of ± (5, 10, 15, 20 mm deflection) similar to the illustration in Figure 5.

Target displacements were met within a tolerance of ±2mm

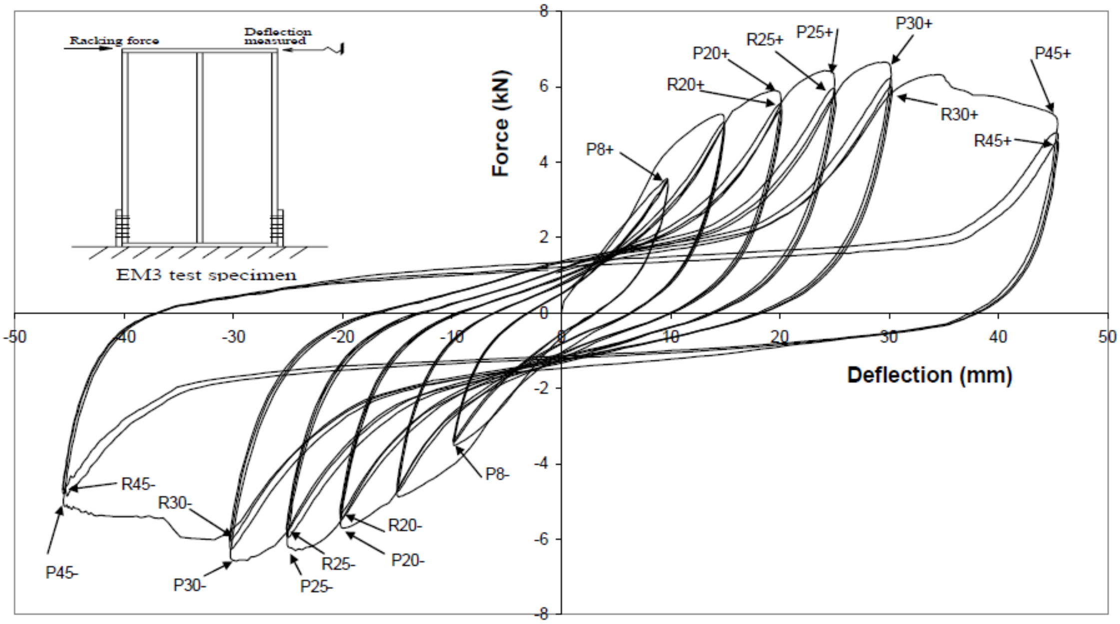

Figure 5: Cycle load protocol

Table 3: Results of cycle test loading protocol

Displacement (mm)	Load (kg/m)
0	0
4.6	412.3
0.5	0
-5.4	-491.5
-0.5	0
9.6	809
1.5	0
-10.5	-638.5
-1.3	0
16.4	686.3
2.8	0
-16.4	-691.3
-3.1	0
20.1	338.8
4.01	0

NOTE: Positive values result from loading in the top left corner; negative values result from loading in the top right corner of the specimen.

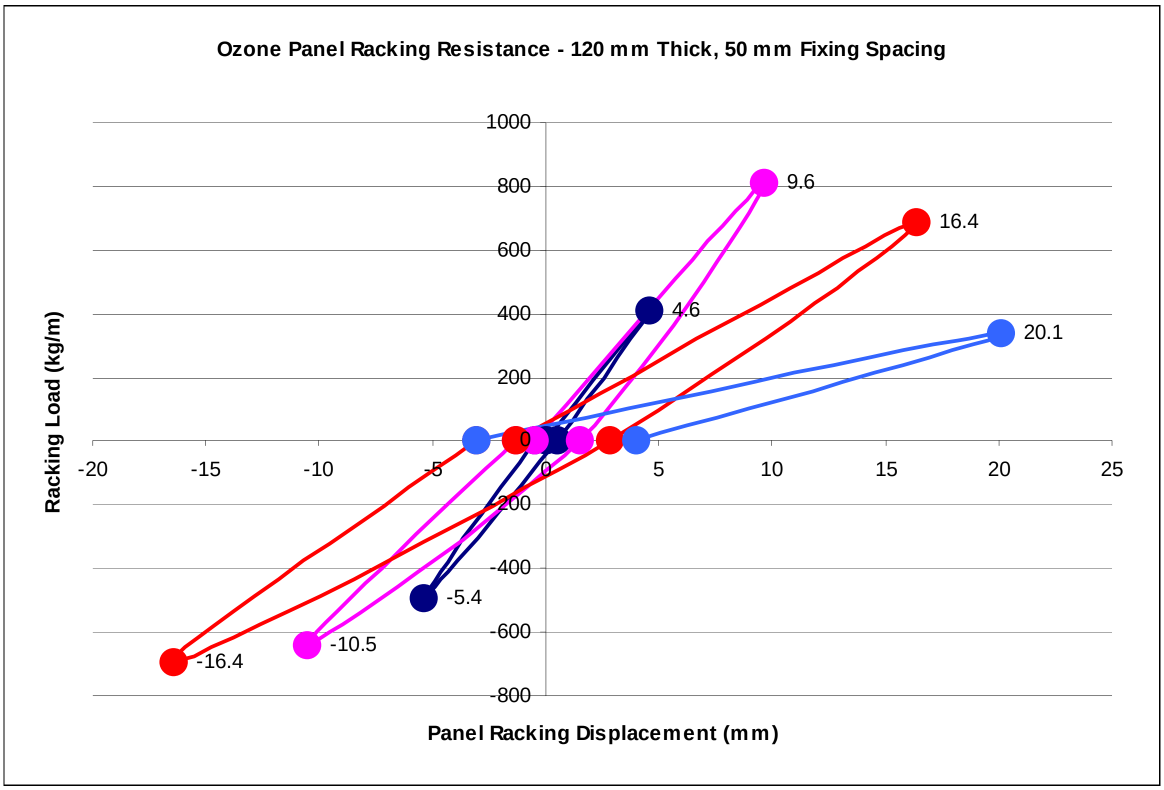

Figure 6: Ozone panel racking resistance - 120mm thick, 50mm fastener centre spacing

The final test point at –20 mm racking could not be achieved because the fixings holding the wall base plate to the test rig pulled through the timber base plate (Figure 13.)

6.1.1. Calculation of Bracing Rating Value

According to the BRANZ EM3 standard, the bracing rating – wind (BR_W) is computed as the lesser of the two values:

- Maximum value of P20
- P8/0.563

In this case the lesser value is P20 = 338.8 kg/m

The 120 mm thick Ozone Panel with 50 mm fastener centre spacing was found to have a wind bracing rating of 338.8 kg per meter length of wall at an average wall height of 2.5 m.

6.2. Axial Load Compression Resistance – 50 mm Fastener Centre Spacing

Test Date: 16th April 2012

Test Standard: Vipac Local Instruction LI8886-MEL-00

Target Serviceability Test Load: 2916 kg/m

Results:

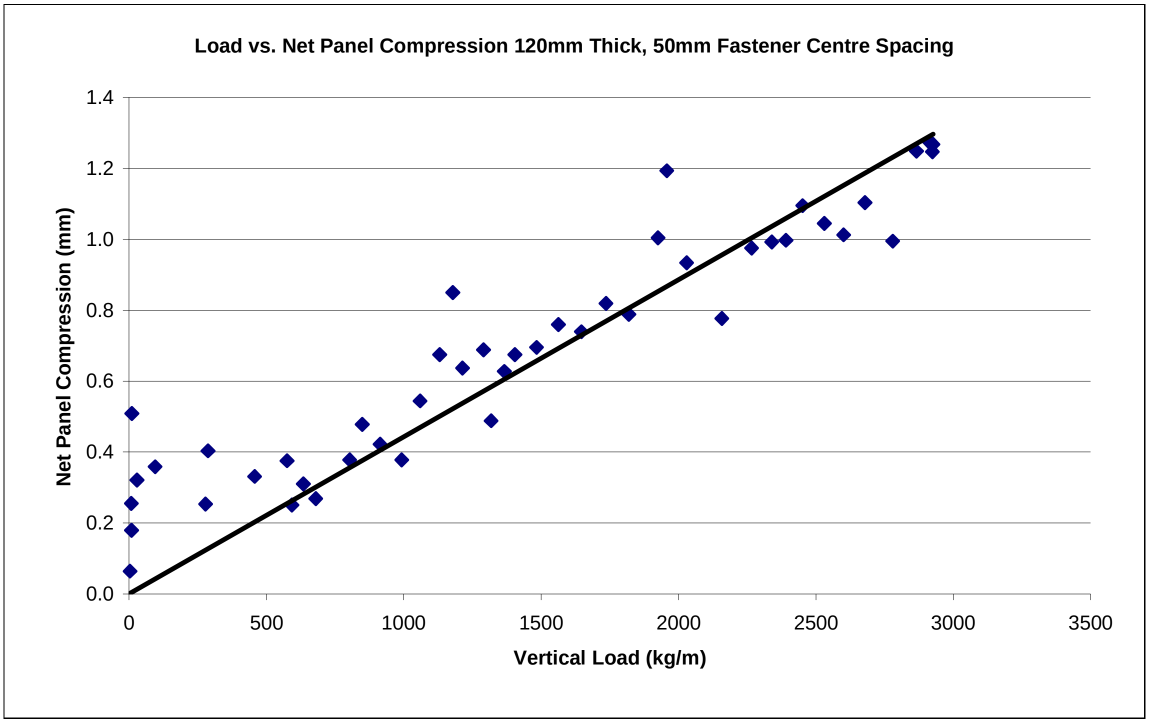

Figure 7: Load vs. Net Panel Compression 120 mm thick, 50 mm Fastener Centre Spacing

Data points due to hysteresis are excluded from the trend line shown in Figure 7.

At an average load of 2946.6 kg/m, the average net panel compression was 1.2 mm.

Upon removal of this load, the net panel deformation returned to within 5% of its initial position.

Target Ultimate Strength Test Load: 10,000 kg/m

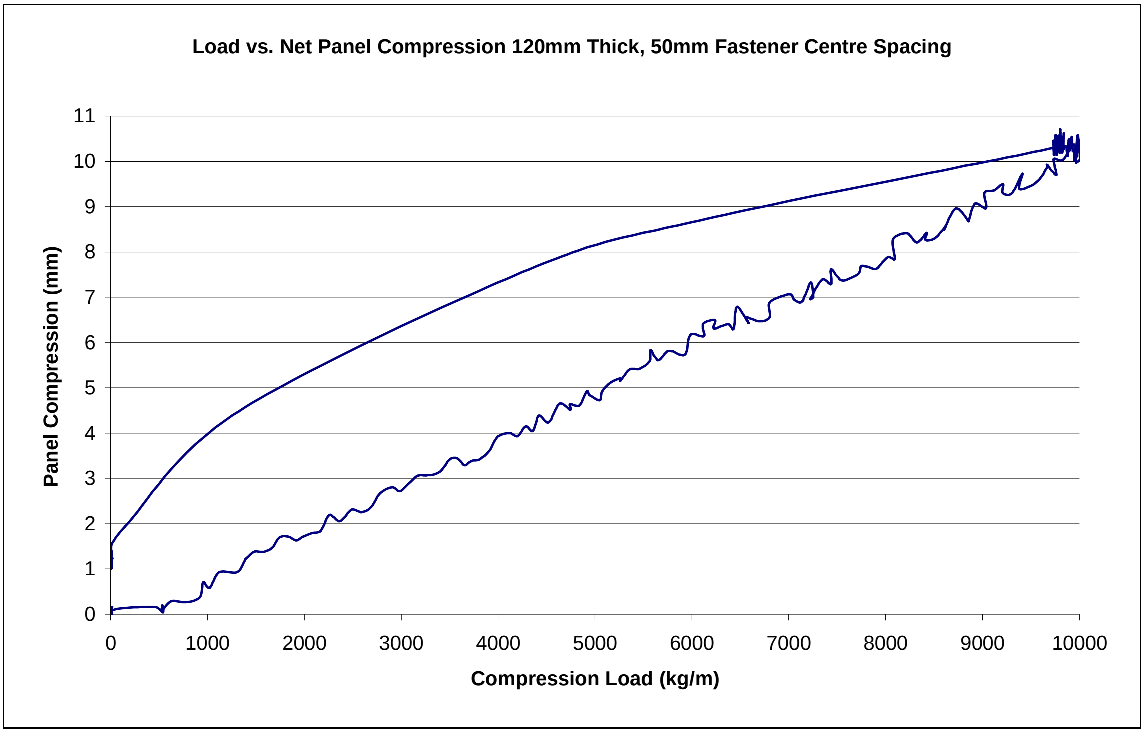

Figure 8: Load vs. Net Panel Compression 120mm thick, 50mm Fastener Centre Spacing

At an average axial compression load of 9810.0 kg/m, the average net panel compression was 10.1 mm. Figure 8 shows the load vs. compression as linear up to the maximum compression. Upon removal of the load, the residual panel deformation was an average of 1.2 mm.

Conclusion: For the 120 mm thick specimen with 50 mm fastener centre spacing tested, the panel showed **no permanent deformation** under the average axial compression load of 2946.6 kg/m. Upon removal of the load, the panel returned to within 5% of its maximum deformation and therefore the system in the configuration tested **is suitable** for applications where the **serviceability load is exclusively** axial compression and **does not exceed 2946.6 kg/m**.

Under an average axial compression load of 9810 kg/m, **no ultimate failure** of the panel system or any of its components were noted. In the configuration as tested, the system **is suitable** for applications where the **ultimate load is exclusively** axial compression and **does not exceed 9810.0 kg/m**.

6.3. Wind Pressure Resistance - Serviceability Limit State - 50 mm Fastener Centre Spacing

Test Date: 16th April 2012

Test Standard: AS 1562.1: 1992

Test Pressure: Region C4 cyclonic Positive 3000 Pa & Negative 3000 Pa

The pressure steps in the serviceability limit state test were in accordance with AS/NZS 4284:2008

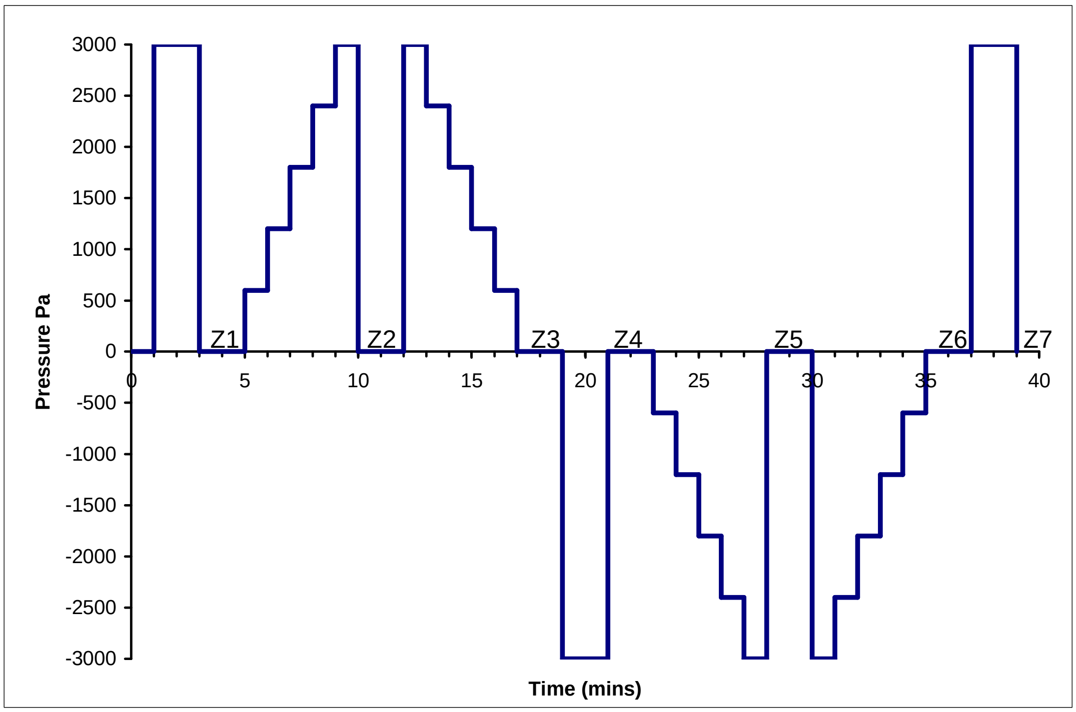

Figure 9: Serviceability limit pressure steps

6.3.1. Net Deflection Results – 50 mm Fastener Centre Spacing

Formulae: The mid-span deflection (d) of each member is given by the following:

$d = D_m - D_e$

where

D_m = Net mid span displacement

D_e = Average of net end displacements.

Requirement: The maximum net cladding deflection shall not exceed Span/120 + p/30 (where span is the stud centre spacing, and p is the fastener spacing)

Table 4: Member No. and Displacement

Member No	Member	Description
1	Internal Spline	Centre vertical specimen deflection
2	Left Panel Span	Deflection of span between internal splines
3	Right Panel Span	Deflection of span between internal splines

Table 5: Net Displacement

Member No.	Transducer Nodes (Figure 9)	Span (mm)	Avg. Fastener Spacing (mm)	Pressure (Pa)	Max. Element Deflection (mm)	Deflection Criteria = span/150	Element Span/Deflection Ratio
1	6, 3, 7	2350	50	3000	4.6	15.7	516
				-3000	4.6	15.7	510
2	1, 2, 3	1175	50	3000	1.1	7.8	1051
				-3000	1.3	7.8	877
3	3, 4, 5	1175	50	3000	1.4	7.8	818
				-3000	1.6	7.8	714

Conclusion: For the 120 mm thick specimen with 50 mm fastener centre spacing tested, the system displayed **no permanent deformation**, fracture or pull through of the fasteners. The maximum specimen element deflection **complies** with AS 1562.1:1992 and AS/NZS1170.0:2002 **Maximum Displacement criterion of span/150** for up to and including wind region C4 cyclonic**.**

6.3.2. Successive Member Displacement – 50 mm Fastener Centre Spacing

Requirement: The residual deflection of any part of the cladding or of the fixings at 1 minute after removal of the pressure (Z7 as shown in Figure 8) shall not exceed Span/1000.

Table 6: Successive Member Displacement Results

Nodes (Figure 9)	Pressure Loading Sequence Zeros	
	Z1 (mm)	Z7 (mm)
1	0.0	-0.3
2	0.0	-0.8
3	0.0	-1.5
4	0.0	-1.3
5	0.0	-1.2
6	0.0	-0.7
7	0.0	-1.1

Span/1000 = 2.35 mm

Conclusion: The residual displacements **do not** exceed **Span/1000** for any of the members and therefore the system as tested **complies** with the requirements of AS 1562.1:1992 up to wind region C4 cyclonic.

6.3.3. Displacement Transducer Layout

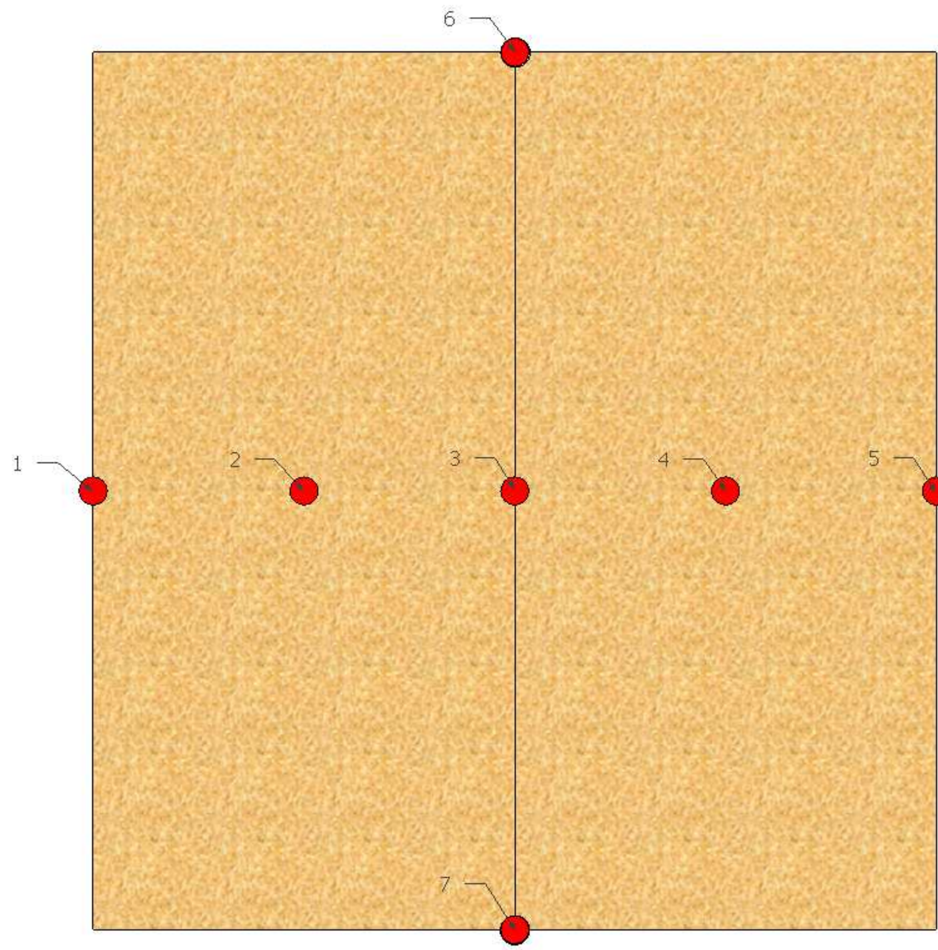

Figure 10: Displacement Transducer Layout

6.4. Structural - Ultimate Limit State

Date: 24th August 2012

Test Standard: NCC Low-High-Low Fatigue Cycling Sequence

Criteria: When subjected to the Low-High-Low fatigue cycling sequence as outlined in the Australian NCC, with a target pressure of 10 kPa, all parts of the system shall remain substantially in position, notwithstanding any permanent distortion that might occur in the sheeting and/or fastenings.

Test Pressure: Region C4 cyclonic 10 kPa for the pressure cycles listed below:

Sequence	No. Cycles	Min Load (kPa)		Max Load (kPa)
A	4500	0	to	4.5
B	600	0	to	6
C	80	0	to	8
D	1	0	to	10
E	80	0	to	8
F	600	0	to	6
G	4500	0	to	4.5

Conclusion: Ultimate limit state results **comply** with the requirements of the NCC Low-High-Low fatigue cycling sequence up to and including region C4 cyclonic.

6.5. Resistance to Temperature Cycling

In order to determine the ability of the polyisocyanurate rigid foam to resist temperature variations in the Australian climate, the panel used for resistance to wind loads was conditioned in a temperature cycling chamber and subjected to 7 days (10 cycles) from –20 °C to +45 °C as shown in Figure 11.

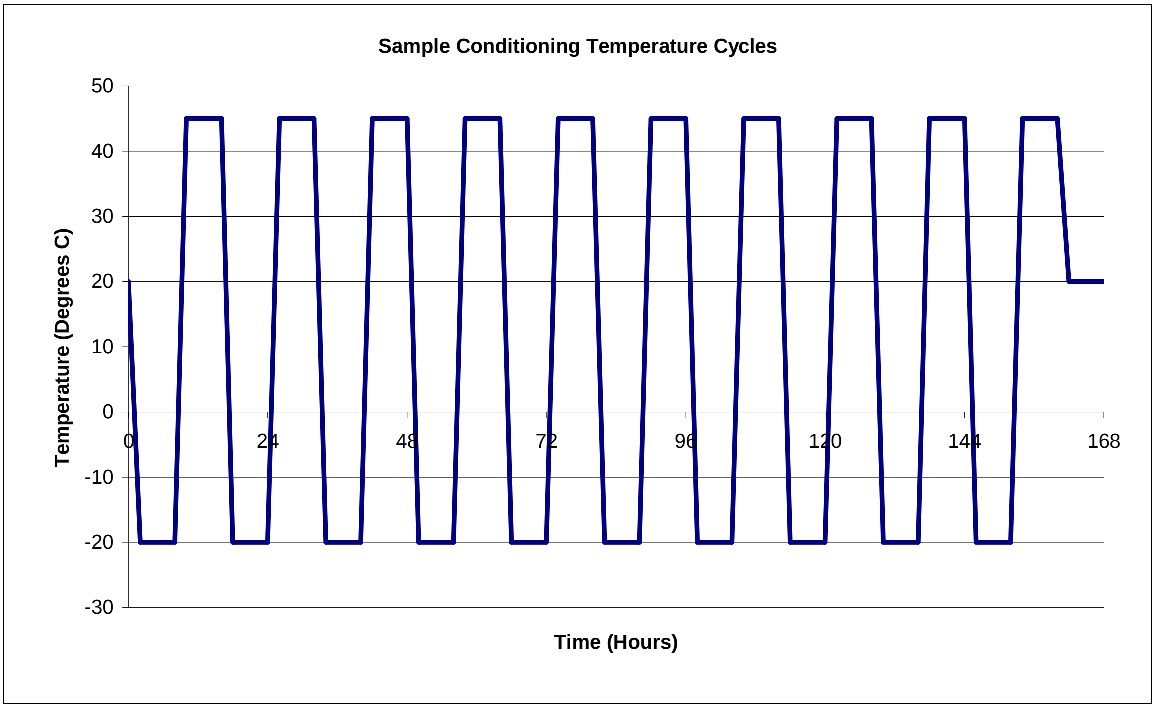

Figure 11: Sample Conditioning Temperature Cycles

Test Date: 30th April 2012

Test Standard: AS 1562.1: 1992

Test Pressure: Region C4 cyclonic Positive 3000 Pa & Negative 3000 Pa

The pressure steps in the test were in accordance with AS/NZS 4284: 2008

6.5.1. Net Deflection Results – 50 mm Fastener Centre Spacing – Post Temperature Cycling

Formulae: The mid-span deflection (*d*) of each member is given by the following:

$d = D_m - D_e$

where

D_m = Net mid span displacement

D_e = Average of net end displacements.

Requirement: The maximum net cladding deflection shall not exceed Span/120 + p/30 (where span is the stud centre spacing, and p is the fastener spacing)

Table 7: Member No. and Displacement

Member No	Member	Description
1	Internal Spline	Centre specimen deflection
2	Left Panel Span	Deflection of span between internal splines
3	Right Panel Span	Deflection of span between internal splines

Table 8: Net Displacement

Member No.	Transducer Nodes (Figure 9)	Span (mm)	Avg. Fastener Spacing (mm)	Pressure (Pa)	Max. Element Deflection (mm)	Deflection Criteria = span/150	Element Span/Deflection Ratio
1	1, 2, 3	1175	50	3000	1.6	7.8	726
				-3000	1.2	7.8	950
2	3, 4, 5	1175	50	3000	1.8	7.8	656
				-3000	1.7	7.8	709

Conclusion: For the 120 mm thick specimen with 50 mm fastener centre spacing tested, the system displayed **no permanent deformation**, fracture or pull through of the fasteners. The maximum specimen element deflection **complies** with AS 1562.1:1992 and AS/NZS1170.0:2002 **Maximum Displacement criterion of span/150** for up to and including wind region C4 cyclonic**.**

6.5.2. Successive Member Displacement – 50 mm Fastener Centre Spacing - Post Temperature Cycling

Requirement: The residual deflection of any part of the cladding or of the fixings 1 minute after removal of the pressure (Z7) shall not exceed Span/1000.

Table 9: Successive Member Displacement Results

Nodes (Figure 9)	Pressure Loading Sequence Zeros	
	Z1 (mm)	Z7 (mm)
1	0.0	-0.3
2	0.0	-0.8
3	0.0	-1.5
4	0.0	-1.3
5	0.0	-1.2
6	0.0	-0.7
7	0.0	-1.1

Span/1000 = 2.35 mm

Conclusion: The residual displacements **do not** exceed **Span/1000** for any of the members and therefore **comply** with the requirements of AS 1562.1:1992 up to wind region C4 cyclonic.

6.5.3. Resistance to Temperature Cycling Summary

The sample passed deflection and residual displacement tests both before and after temperature cycling.

7. SUMMARY OF RESULTS

The Ozone Panel systems specified in Section 3 **passed** the nominated criteria to the maximum wind region/loading listed in

Table 10 below:

Table 10: Specimen Compliance Summary

Minimum Panel Thickness	Maximum Fastener Centre Spacing	Test Type	Maximum Wind Region/Loading
120 mm	50 mm	Racking Resistance	**Bracing Rating – Wind = 338.8 kg/m**
120 mm	50 mm	Axial Load (Compression)	**Serviceability: 2946.6 kg/m** **Ultimate Limit: 9810.0 kg/m**
120 mm	50 mm	Wind Pressure Resistance	**Up to and including C4**
120 mm	50 mm	Resistance to Temperature Cycling	**10 Cycles from –20 °C to +45 °C**
120 mm	50 mm	Ultimate Limit State Fatigue Resistance	**Up to and including C4**

APPENDIX

Racking Resistance Test Images

Figure 12: Test specimen installed in racking resistance and axial loading rig

Figure 13: Specimen lifting off the test rig during racking test because of fixings pulling through the timber base plate

Figure 14: Racking test specimen showing where 8mm coach bolt has sheared in wall base plate after 20mm racking deflection

Axial Load (Compression) Test Images

Figure 15: Axial load test setup

Wind Load Resistance Test Images

Figure 16: Wind load resistance test setup in pressure rig, transducers mounted along horizontal

Figure 17: Test specimen during Low-High-Low fatigue testing