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Vipac Engineers & Scientists

Aussi Rossrock Import Pty Ltd

MgO Board Testing

MgO Board Testing to AS NZS 2908

30B-14-0020-TRP-362725-1

01 May 2015

Report Title: MgO Board Testing to AS NZS 2908 **Job Title: MgO Board Testing**	
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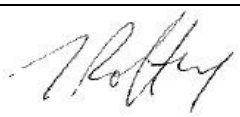
Reviewer:	 Tim Roffey Project Engineer	Date: 01 May 2015

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EXECUTIVE SUMMARY

Vipac Engineers & Scientists Pty Ltd (Vipac) has been commissioned by Aussie Rossrock (the client) to perform testing of their MgO board in accordance with AS/NZS 2908.2:2002

Testing was carried out at Vipac's Port Melbourne laboratory during March and April 2015.

The following are the findings from the tests carried out:

Test	Result
Dimensional Characteristics	Complies with the specification
Apparent Density	Found to be 0.879 g/cm³
Water Permeability	Complies with the specification
Bending Strength	Found to be compliant with Category 3
Soak / Dry Bending Strength	Does not comply with the specification

TABLE OF CONTENTS

1 INTRODUCTION

Vipac Engineers & Scientists Pty Ltd (Vipac) has been commissioned by Aussie Rossrosk (the client) to perform testing of their MgO board in accordance with AS/NZS 2908.2:2002

The following tests were carried out in accordance with AS/NZS 2908.2:2002:

1. Dimensional characteristics
2. Apparent density
3. Bending strength
4. Water permeability
5. Soak/Dry bending strength

The results of these tests are provided in the following sections of this report.

2 TEST SAMPLES

Ten full sheets of the MgO board to be tested were supplied to Vipac by the client. These sheets were of nominal dimensions 2.44m length x 1.22m width x 8mm thick.

The product provided falls under the Type A category according to AS/NZS 2908: *"Type A sheets are intended for external applications where they may be subjected to the direct action of sun, rain and/or snow. They may be supplied coated or uncoated. Type A sheets shall comply with the requirements of the type-tests (listed below)."*

Samples for testing were cut from each of these sheets as specified by AS/NZS 2908. The photos below are a series of close ups of the sheets under test.

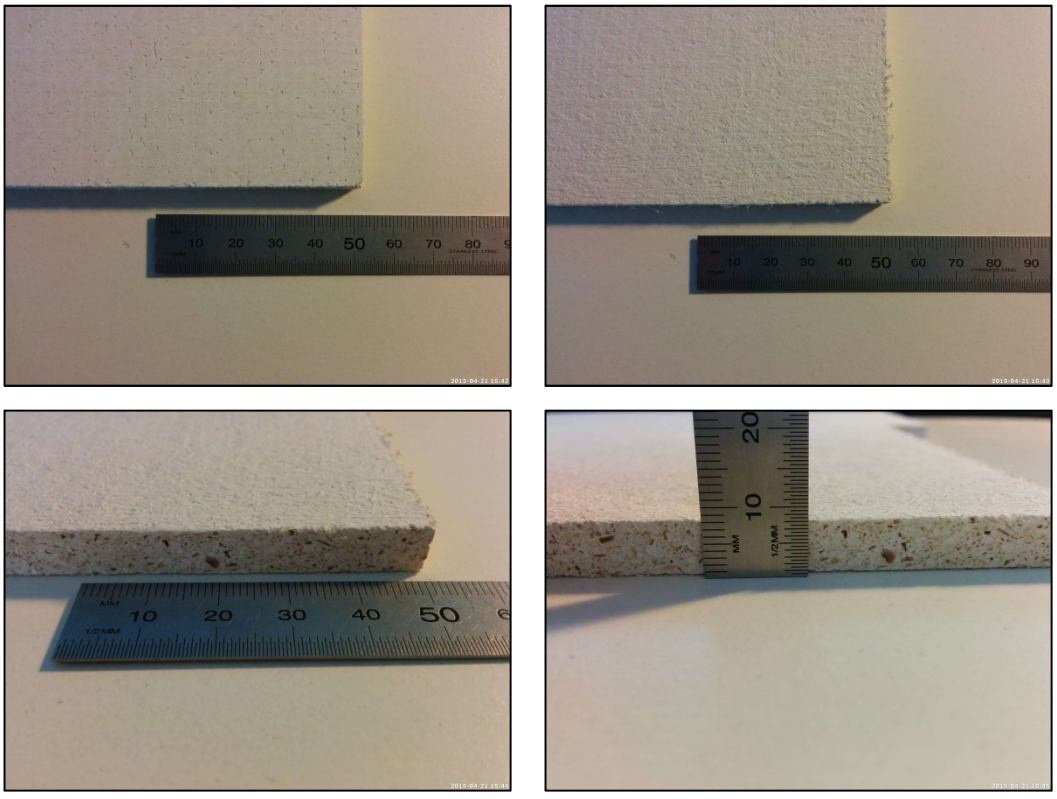

Figure 1: Appearance of the samples under test. Clockwise from top-left: Front face, Rear face, Side view showing thickness, Side view

3 TEST RESULTS

3.1 DIMENSIONAL CHARACTERISTICS

3.1.1 NOMINAL LENGTH AND WIDTH

The nominal length and width of the each of the ten test sheets was measured, recorded and assessed against the tolerances specified by the standard. These results are presented in the following tables.

Nominal Length	2440	mm
Allowable Tolerance ±	8	mm

Sheet Number	Measured Values (mm)			Result Pass / Fail
	L1	L2	L3	
1	2440.0	2439.0	2439.0	Pass
2	2439.0	2440.0	2439.0	Pass
3	2440.0	2440.0	2439.0	Pass
4	2440.0	2440.0	2440.0	Pass
5	2440.0	2440.0	2439.0	Pass
6	2440.0	2440.0	2440.0	Pass
7	2440.0	2440.0	2440.0	Pass
8	2440.0	2440.0	2439.0	Pass
9	2440.0	2440.0	2440.0	Pass
10	2439.0	2440.0	2440.0	Pass

Table 1: Nominal length measurement values

Nominal Width	1220	mm
Allowable Tolerance ±	6.1	mm

Sheet Number	Measured Values (mm)			Result Pass / Fail
	W1	W2	W3	
1	1220.0	1220.0	1220.0	Pass
2	1220.0	1220.0	1220.0	Pass
3	1220.0	1220.0	1220.0	Pass
4	1220.0	1220.0	1220.0	Pass
5	1220.0	1220.0	1220.0	Pass
6	1220.0	1220.0	1220.0	Pass
7	1220.0	1220.0	1220.0	Pass
8	1220.0	1220.0	1220.0	Pass
9	1220.0	1220.0	1220.0	Pass
10	1220.0	1220.0	1220.0	Pass

Table 2: Nominal width measurement values

3.1.2 NOMINAL THICKNESS

The nominal thickness of each of the sheets was measured at three locations per sheet. These measurements were recorded and assessed against the specifications of the standard. The results of these measurements are presented in the table below.

Nominal Thickness	8	mm
Allowable Tolerance ±	0.8	mm

Sheet Number	Measured Values (mm)			Average	Max Dev. Allowable	Max Deviation	Result Pass / Fail
	T1	T2	T3				
1	7.47	7.77	7.60	7.61	1.17	0.30	Pass
2	7.64	7.81	7.86	7.77	1.18	0.22	Pass
3	7.56	7.76	7.58	7.63	1.16	0.20	Pass
4	7.54	7.90	7.69	7.71	1.19	0.36	Pass
5	7.40	7.78	7.71	7.63	1.17	0.38	Pass
6	7.56	7.82	7.75	7.71	1.17	0.26	Pass
7	7.56	7.75	7.80	7.70	1.17	0.24	Pass
8	7.48	7.80	7.78	7.69	1.17	0.32	Pass
9	7.38	7.87	7.74	7.66	1.18	0.49	Pass
10	7.58	7.67	7.77	7.67	1.17	0.19	Pass

Table 3: Nominal thickness measurement values

3.2 TOLERANCES ON SHAPE

3.2.1 STRAIGHTNESS OF EDGES

The tolerance on the straightness of edges is 3 mm/m for the relevant dimension (length or width). The table below presents the results of these measurements. A dash (-) indicates that no separation was measured during the inspection.

Dimensions are in mm.

	Edge 1		Edge 2		Edge 3		Edge 4		Result
Sheet	Max Separation	Distance	Max Separation	Distance	Max Separation	Distance	Max Separation	Distance	
1	1.0	0.0	-	-	1.0	700.0	1.0	1500.0	Pass
2	-	-	-	-	1.0	600.0	-	-	Pass
3	0.5	0.0	-	-	-	-	-	-	Pass
4	0.5	0.0	-	-	-	-	-	-	Pass
5	1.5	0.0	-	-	-	-	-	-	Pass
6	0.5	800.0	-	-	-	-	0.5	200.0	Pass
7	-	-	-	-	1.0	1000.0	0.5	1600.0	Pass
8	1.0	1000.0	-	-	1.0	1000.0	-	-	Pass
9	-	-	-	-	-	-	-	-	Pass
10	-	-	-	-	1.0	1000.0	1.0	1600.0	Pass

Table 4: Results of the straightness of edges measurements

3.2.2 SQUARENESS OF EDGES

The tolerance on squareness of sheets is 4 mm/m. The table below presents the results of these measurements. A dash (-) indicates that no separation was measured during the inspection.

Dimensions are in mm.

	Corner 1		Corner 2		Corner 3		Corner 4		Result
Sheet	Max Separation	Distance of Occurrence	Max Separation	Distance of Occurrence	Max Separation	Distance of Occurrence	Max Separation	Distance of Occurrence	
1	-	-	-	-	1.5	170	1	20	Pass
2	1	290	-	-	1	310	1	20	Pass
3	1	320	-	-	1	320	1.5	20	Pass
4	-	-	-	-	-	-	1.5	0	Pass
5	-	-	-	-	-	-	-	-	Pass
6	-	-	-	-	-	-	-	-	Pass
7	1	320	-	-	1	320	1	10	Pass
8	-	-	-	-	-	-	1	10	Pass
9	-	-	-	-	-	-	-	-	Pass
10	-	-	-	-	-	-	-	-	Pass

Table 5: Results of the squareness of edges measurements

3.3 APPARENT DENSITY

The following is the acceptance criteria for the apparent density of the product under test:

"The manufacturer shall specify in his literature the minimum apparent density of each category of sheet and when testing in accordance with the method specified in 8.1.2.2, the density shall not be less than this value."

Five samples from five different sheets were tested in accordance with the standard. The volume of the samples was determined by immersion in water. The samples were then removed from the water and dried in an oven at 100°C for 24 hours. Upon removal from the oven, the samples were then weighed using calibrated weighing scales. The density of each sample was then determined. The results of this testing are presented in the following table:

Sample	Apparent Density		
	cm^3 Volume	g Mass	g/cm^3 Density
Sheet 1	21.0	18.4	0.876
Sheet 2	21.0	18.6	0.886
Sheet 3	20.0	18.0	0.900
Sheet 4	21.5	18.4	0.856
Sheet 5	21.5	18.9	0.879
Average:	**21.0**	**18.5**	**0.879**

Table 6: Apparent Density test results

3.4 WATER PERMEABILITY

For the water permeability testing three samples were selected from the sheets provided. The samples were cut to the dimensions 600mm x 500mm. An aluminium frame was then sealed to the front face of the samples and water was filled to a depth of 20mm.

The samples were then placed in a conditioning chamber at 23 ±5°C and 50 ±10% relative humidity for a period of 24hours.

At the end of this period the samples were removed from the chamber and inspected for water droplets on the underside of the sheets.

According to AS/NZS 2908, "traces of moisture may appear on the underside of the sheet, but in no instance shall there be any formation of drops of water".

As there was no formation of droplets of water and the end of the conditioning period, the samples are determined to have passed the requirements of the standard.

3.5 BENDING STRENGTH

The bending strength test consists of performing a two point bending test on a number of test samples and determining the Modulus of Rupture of each of the samples. Twenty samples were cut from the ten sheets provided. Samples cut were 250 x 250mm. The twenty samples were then split into two lots. The first ten were subjected to the bending strength testing in the equilibrium condition and the second ten were tested in the wet condition.

The modulus of rupture, $R_{f,}$ in megapascals, is given by the formula:

$$R_f = \frac{3Pl}{2be^2}$$

The tables on the following pages are the results obtained from the testing.

MOR Calculation		Bending Strength - Dry Samples
l	215	Distance between axis (mm)
b	250	Width of test piece (mm)

Sample	Axis A					Axis B					Average
	Width (mm)	Load 1 (N)	Thickness 1 & 2 (mm)		MOR 1 (MPa)	Width (mm)	Load 2 (N)	Thickness 3 & 4 (mm)		MOR 2 (MPa)	Average MOR (MPa)
Sheet 1	249	495	7.98	8.02	10.0	249	525	8.05	8.06	10.5	10.2
Sheet 2	249	530	8.08	8.07	10.5	249	531	8.02	8.01	10.7	10.6
Sheet 3	249	513	7.97	7.95	10.5	249	530	8.05	8.01	10.6	10.6
Sheet 4	250	507	8.03	7.97	10.2	249	492	7.93	7.96	10.1	10.2
Sheet 5	250	514	7.99	8.08	10.3	249	516	8.15	8.14	10.1	10.2
Sheet 6	250	510	8.11	8.12	10.0	249	508	8.12	8.16	9.9	10.0
Sheet 7	249	508	7.96	8.05	10.3	248	536	7.99	8.02	10.9	10.6
Sheet 8	249	507	7.90	7.99	10.4	247	461	7.97	8.08	9.3	9.9
Sheet 9	250	516	8.87	7.96	9.4	247	483	8.01	8.04	9.8	9.6
Sheet 10	247	506	7.90	7.96	10.5	249	478	7.95	7.99	9.7	10.1
Average	10.2					10.2					10.2

Table 7: Bending strength test results for samples tested in the equilibrium (dry) condition

MOR Calculation		Bending Strength - Wet Samples
l	215	Distance between axis (mm)
b	250	Width of test piece (mm)

Sample	Axis A					Axis B					Average
	Width (mm)	Load 1 (N)	Thickness 1 & 2 (mm)		MOR 1 (MPa)	Width (mm)	Load 2 (N)	Thickness 3 & 4 (mm)		MOR 2 (MPa)	Average MOR (MPa)
Sheet 1	249	409	8.08	8.03	8.2	251	448	8.05	7.98	9.0	8.6
Sheet 2	248	411	8.00	8.14	8.2	250	432	8.05	8.13	8.5	8.4
Sheet 3	248	417	7.92	7.90	8.7	250	408	7.88	7.96	8.4	8.5
Sheet 4	249	403	7.81	7.85	8.5	248	412	7.92	8.02	8.4	8.5
Sheet 5	249	397	8.06	8.15	7.8	248	429	8.08	8.15	8.5	8.1
Sheet 6	249	409	8.08	8.07	8.1	249	424	8.05	8.12	8.4	8.3
Sheet 7	249	418	7.96	7.95	8.6	249	464	7.93	7.93	9.6	9.1
Sheet 8	250	423	7.96	7.96	8.6	249	380	7.97	7.97	7.7	8.2
Sheet 9	249	418	7.95	8.03	8.5	249	401	7.91	7.98	8.2	8.4
Sheet 10	248	422	7.97	8.02	8.6	249	403	7.94	8.02	8.2	8.4
Average	8.4					8.5					8.4

Table 8: Bending strength test results for samples tested in the wet condition

Category	Minimum MOR	
	Type A Sheets	Type B Sheets
1	~	4
2	~	7
3	7	10
4	13	16
5	18	22

Table 9: Minimum MOR Values as specified in Table 1 of AS/NZS 2908

Bending Strength Test Results Summary		
	MOR	Resulting Category
Equilibrium Condition	10.2	3
Wet Condition	8.4	3

Table 10: MOR Results obtained from testing

As can be seen from the above tables the average modulus of rupture for the sheets in the equilibrium and wet conditions are 10.2 Mpa and 8.4 Mpa respectively. This places the sheets in a category 3 in accordance with AS/NZS 2908.

3.6 SOAK / DRY BENDING STRENGTH

The Soak / Dry Bending Strength test consists of performing a two point bending test on a number of test samples, determining the Modulus of Rupture of each of the samples and then calculating the ratio of these values.

Twenty samples were cut from the ten sheets provided. Samples cut were 250 x 250mm. The twenty samples were then split into two lots. The first ten were subjected to the bending strength testing in the equilibrium (dry) condition.

The second lot of ten samples are subjected to 25 cycle conditioning period consisting of the following:

- Immersion in water at ambient temperature (greater than 5°C) for 18 hours.
- Drying in a ventilated oven of 60 ±5°C and relative humidity of less than 20% for 6 hours.

Once the 25 cycles are complete the samples are conditioned in a laboratory atmosphere for 7 days. At the end of this period the bending strength test is carried out on these samples.

The modulus of rupture, $R_{f,}$ in megapascals, is given by the formula:

$$R_f = \frac{3Pl}{2be^2}$$

The tables below are the results obtained from the testing.

MOR Calculation		Soak / Dry - Dry Samples
l	215	Distance between axis (mm)
b	250	Width of test piece (mm)

Sample	Axis A					Axis B					Average
	Width (mm)	Load 1 (N)	Thickness 1 & 2 (mm)		MOR 1 (MPa)	Width (mm)	Load 2 (N)	Thickness 3 & 4 (mm)		MOR 2 (MPa)	Average MOR (MPa)
Sheet 1	249	495	7.98	8.02	10.0	249	525	8.05	8.06	10.5	10.2
Sheet 2	249	530	8.08	8.07	10.5	249	531	8.02	8.01	10.7	10.6
Sheet 3	249	513	7.97	7.95	10.5	249	530	8.05	8.01	10.6	10.6
Sheet 4	250	507	8.03	7.97	10.2	249	492	7.93	7.96	10.1	10.2
Sheet 5	250	514	7.99	8.08	10.3	249	516	8.15	8.14	10.1	10.2
Sheet 6	250	510	8.11	8.12	10.0	249	508	8.12	8.16	9.9	10.0
Sheet 7	249	508	7.96	8.05	10.3	248	536	7.99	8.02	10.9	10.6
Sheet 8	249	507	7.90	7.99	10.4	247	461	7.97	8.08	9.3	9.9
Sheet 9	250	516	8.87	7.96	9.4	247	483	8.01	8.04	9.8	9.6
Sheet 10	247	506	7.90	7.96	10.5	249	478	7.95	7.99	9.7	10.1
Average	10.2					10.2					10.2

Table 11: Soak / Dry bending strength test results for samples tested in the equilibrium (dry) condition

MOR Calculation		Soak / Dry - Soaked Samples
l	215	Distance between axis (mm)
b	250	Width of test piece (mm)

Sample	Axis A					Axis B					Average
	Width (mm)	Load 1 (N)	Thickness 1 & 2 (mm)		MOR 1 (MPa)	Width (mm)	Load 2 (N)	Thickness 3 & 4 (mm)		MOR 2 (MPa)	Average MOR (MPa)
Sheet 1	249	280	7.96	7.93	5.7	247	225	7.86	7.92	4.7	5.2
Sheet 2	249	269	7.91	7.95	5.5	247	282	8.06	7.93	5.8	5.6
Sheet 3	249	256	7.93	7.90	5.3	247	282	8.07	7.86	5.8	5.5
Sheet 4	249	260	7.82	7.87	5.5	249	273	7.87	7.87	5.7	5.6
Sheet 5	248	254	7.97	7.99	5.2	249	280	7.99	8.01	5.7	5.4
Sheet 6	248	240	8.06	8.02	4.8	250	277	8.01	8.12	5.5	5.2
Sheet 7	247	263	7.94	7.98	5.4	249	317	7.96	7.96	6.5	6.0
Sheet 8	247	244	7.86	8.02	5.1	250	243	7.98	7.86	5.0	5.0
Sheet 9	247	272	7.95	7.96	5.6	250	252	7.92	7.95	5.2	5.4
Sheet 10	248	300	7.96	7.92	6.2	248	298	7.99	7.91	6.1	6.2
Average	5.4					5.6					5.5

Table 12: Soak / Dry bending strength test results for samples tested in the wet condition

The modulus of rupture ratio is given by:

$$r_i = \frac{R_{fi}}{R_{fci}}$$

Where: R_{fi} is the MOR of the i^{th} test specimen after the soak dry cycling

R_{fci} is the MOR of the i^{th} reference test specimen (from the first lot)

The average, r, and standard deviation, *s,* of the individual ratios, r_i, are then calculated and used to determine the 95% lower confidence limit, L_i, given by the equation:

$$L_i = r - 0.58s$$

The results of this testing are given in the following table:

Soak Dry Bending Strength Test Results					
Sheet	**Equilibrium MOR**	**Cycled MOR**	**MOR Ratio**	**Average MOR**	**MOR Standard Deviation**
1	10.2	5.2	0.510	0.541	0.0305
2	10.6	5.6	0.532		
3	10.6	5.5	0.525		
4	10.2	5.6	0.551		
5	10.2	5.4	0.533		
6	10.0	5.2	0.519		
7	10.6	6.0	0.563		
8	9.9	5.0	0.509		
9	9.6	5.4	0.562		
10	10.1	6.2	0.608		

Table 13: Soak / Dry Bending Strength Test Results

Lower 95% confidence limit:

$$0.541 - 0.58 \cdot (0.0305) = \ 0.521$$

The lower 95% confidence limit according to AS/NZS 2908 shall be greater than 0.75 therefore this sheet does not meet the requirements of the standard.

4 CONCLUSIONS

The testing carried out on the sample sheets provided by the client has resulted in the findings as presented in the table below:

Test	Result
Dimensional Characteristics	Complies with the specification
Apparent Density	Found to be 0.879 g/cm³
Water Permeability	Complies with the specification
Bending Strength	Found to be compliant with Category 3
Soak / Dry Bending Strength	Does not comply with the specification

Table 14: Summary table of results