MgO Corp 10mm ATSM E455 Compliance

I was asked to ensure compliance of MgO Corp Rescom 10mm panel in wall applications.

The methodology is to use an industry standard Finite Element Analysis package, Autodesk Inventor Professional.

Material properties simulation of the MgO Structural Wall Sheet was conducted in accordance with AS/NZS 2908.2:2000.

The test compares the performance of a timber frame with and without cladding. In the simulation an MgO stud of similar strength was used as the frame. The frame layout was at 600mm centres.

The test frame is an MgO stud frame using 90x45 studs. The diaphragm material is 10mm MgO panel.

Configuration	Force	Displacement	Safety Factor
Timber Frame	1kN	12mm	3
Frame plus Sheet	1kN	<1.0mm	>15
Timber Frame	10kN	112mm	.5
Frame plus Sheet	10kN	1.7mm	6 Typical

The results appear to meet compliance as:

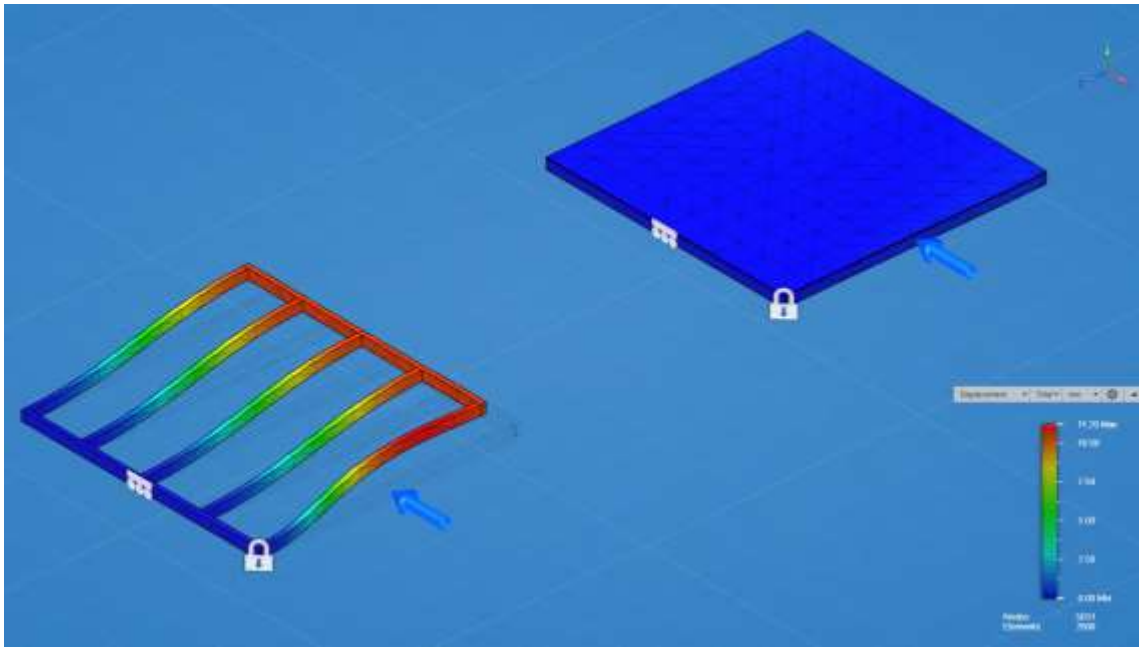
- ASTM E455 Table 1 for simple beam with uniform load: Maximum Deflection
- ASTM E455 Section 10: Calculation

Peter Schott

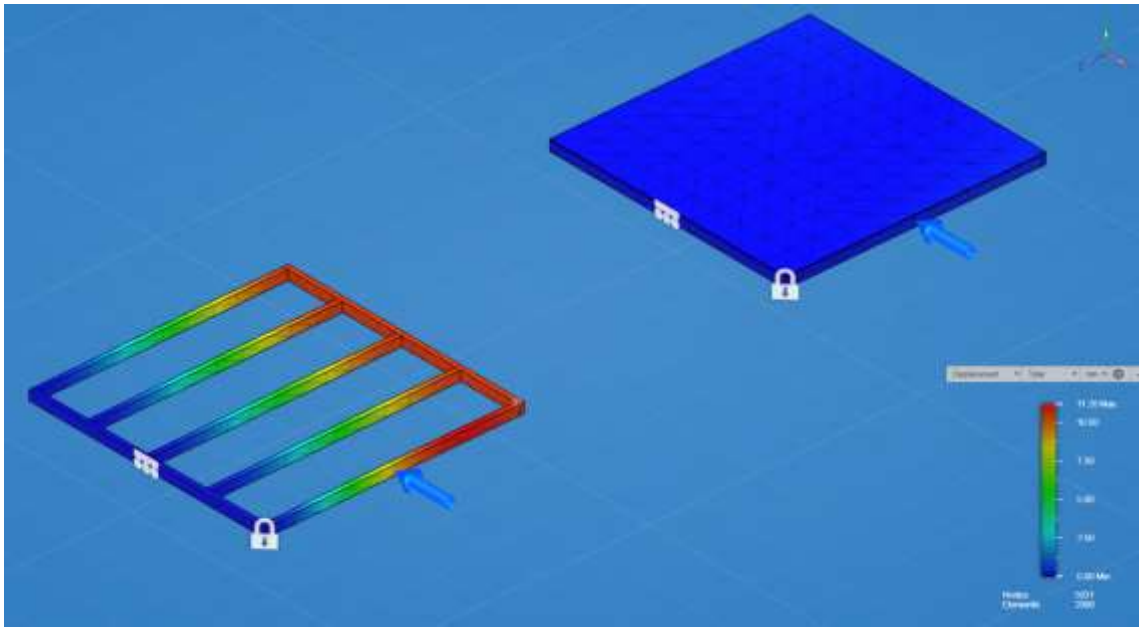
FireAcousticBoard

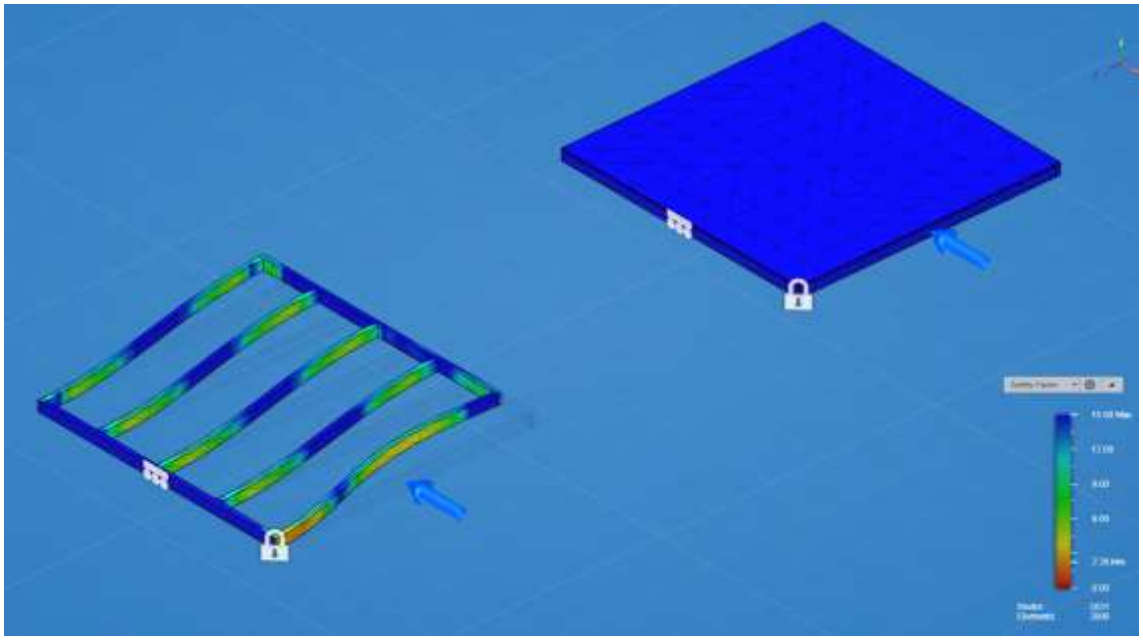
Appendix

1Kn Raking Wall Simulation

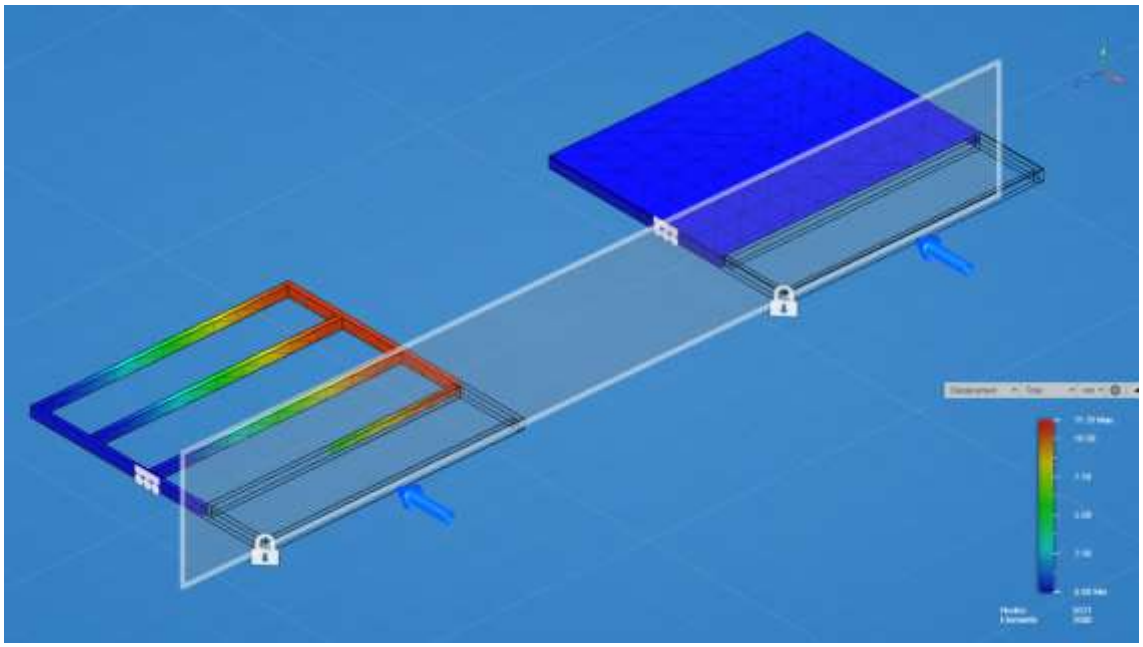


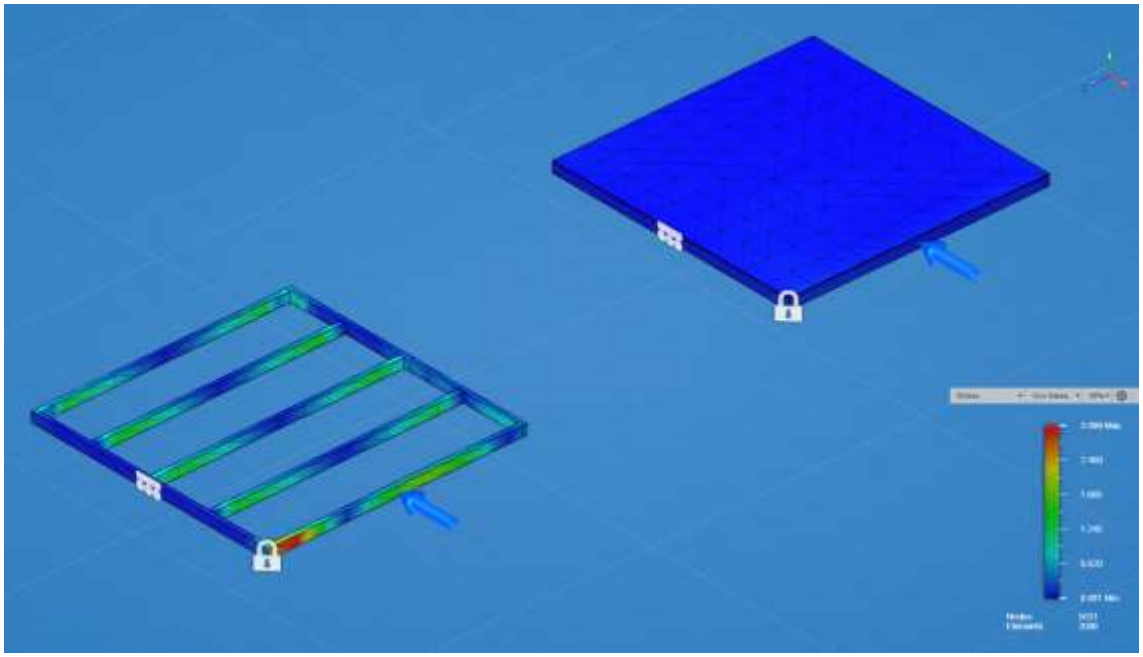
1kN Test. The image above shows factored displacement for clarity. The image below shows actual displacement.





1kN Test. The image above shows Safety Factor. The image below shows inter-member stress





1kN Test. Von Mises Stress

ATSM E455 MgO Corp 10mm Wall Sheet

Analyzed File	Reference and Timber Frame 2400 2400 with diaphram 10mm v2
Analyzed File Path	C:/Users/Pete/AppData/Roaming/Autodesk/PLM360Cache/a360proue29ca72e.autodeskplm360.net/3
Version	Autodesk Sim 360 (1.8.679)
Creation Date	2013-12-17, 12:39:28
Author	Pete Schott FireAcousticBoard

Reference and Timber Frame 2400 2400 with diaphram 10mm

ATSM E455 10mm MgO Corp Wall Panel

Study Properties

Study Type	Static Stress
Last Modification Date	2013-12-17, 12:30:49

Materials

Component	Material	Safety Factor
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2400:3	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2400:4	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:6	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:7	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:8	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:9	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:10	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/MgO Floor Sheet:1	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2400:1	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2400:2	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:1	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:2	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:3	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:4	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:5	MgO 7.0GPa	Yield Strength

MgO 7.0GPa

Density	930 kg / m^3
Young's Modulus	7000 MPa
Poisson's Ratio	0.3
Yield Strength	7 MPa
Ultimate Tensile Strength	8 MPa
Thermal Conductivity	1 W / (m C)
Thermal Expansion Coefficient	1E-07 / C
Specific Heat	1000 J / (kg C)

Constraints

Fixed:1

Constraint Type	Fixed
Ux	Yes
Uy	Yes
Uz	Yes

Loads

Load Type	Force
Magnitude	1000 N
X Value	-1000 N
Y Value	0 N
Z Value	0 N

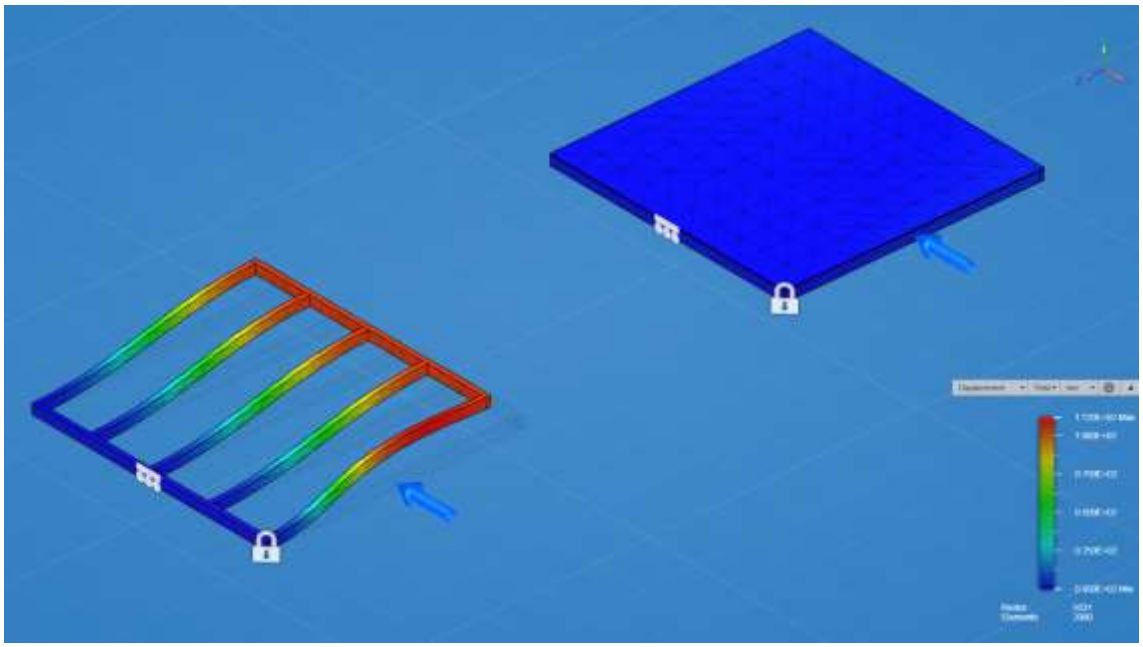
Results

Name	Minimum	Maximum

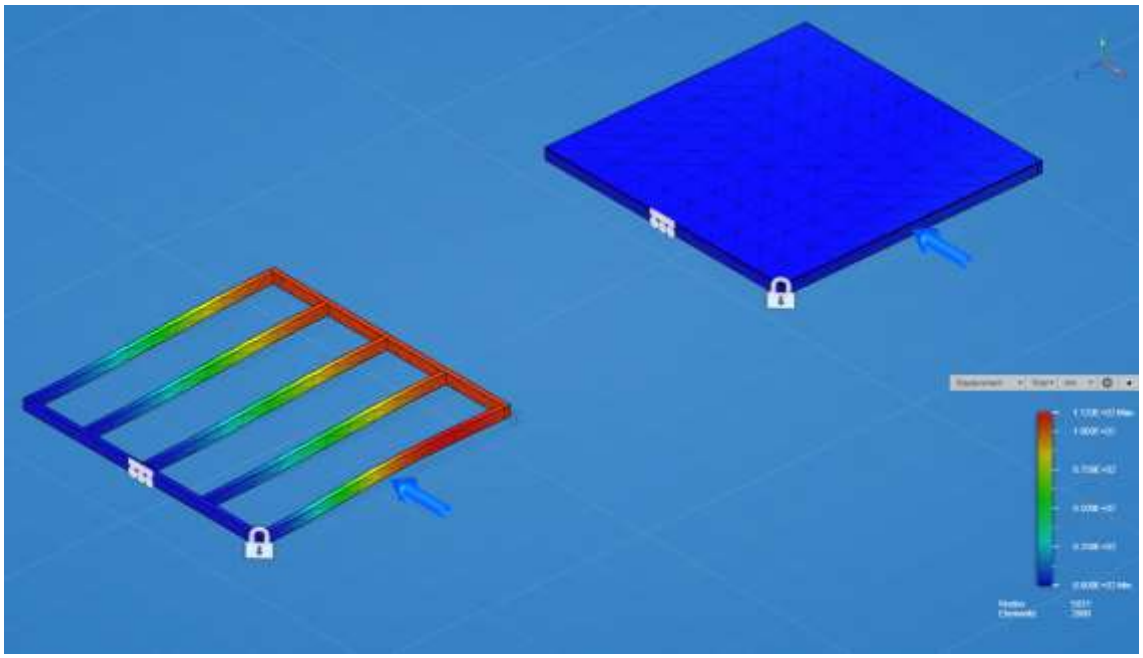
Safety Factor		
Per Body	2.259	15
Stress		
Von Mises	1.359E-03 MPa	3.099 MPa
1st Principal	-0.1733 MPa	3.304 MPa
3rd Principal	-3.098 MPa	0.3883 MPa
Normal XX	-1.039 MPa	0.8797 MPa
Normal YY	-0.2062 MPa	0.459 MPa
Normal ZZ	-3.095 MPa	3.253 MPa
Shear XY	-0.1124 MPa	0.1057 MPa
Shear XZ	-0.4016 MPa	0.2545 MPa
Shear YZ	-0.1796 MPa	0.1407 MPa
Displacement		
Total	0 mm	11.2 mm
X	-11.2 mm	0 mm
Y	-0.3106 mm	0.2998 mm
Z	-0.2308 mm	0.2243 mm
Equivalent	1.733E-07	3.926E-04
1st Principal	1.496E-07	4.389E-04
3rd Principal	-4.422E-04	4.389E-07
Normal XX	-1.399E-04	1.381E-04
Normal YY	-1.331E-04	1.406E-04
Normal ZZ	-4.414E-04	4.339E-04
Shear XY	-2.087E-05	1.964E-05

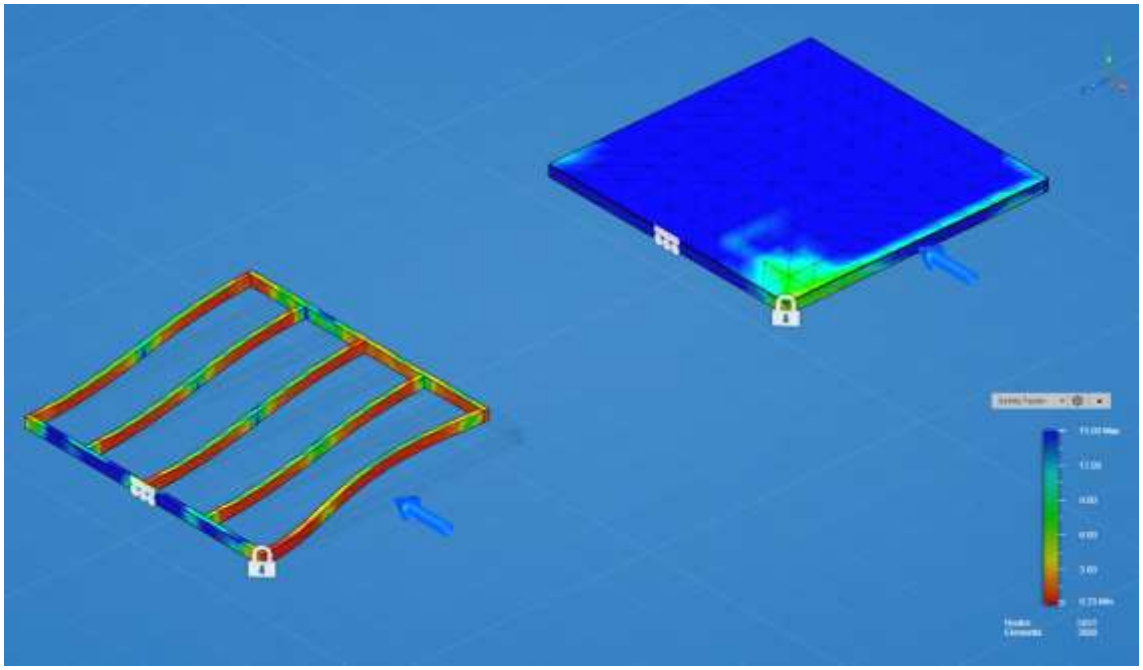
Shear XZ	-7.458E-05	4.727E-05
Shear YZ	-3.335E-05	2.614E-05

10Kn Raking Wall Simulation

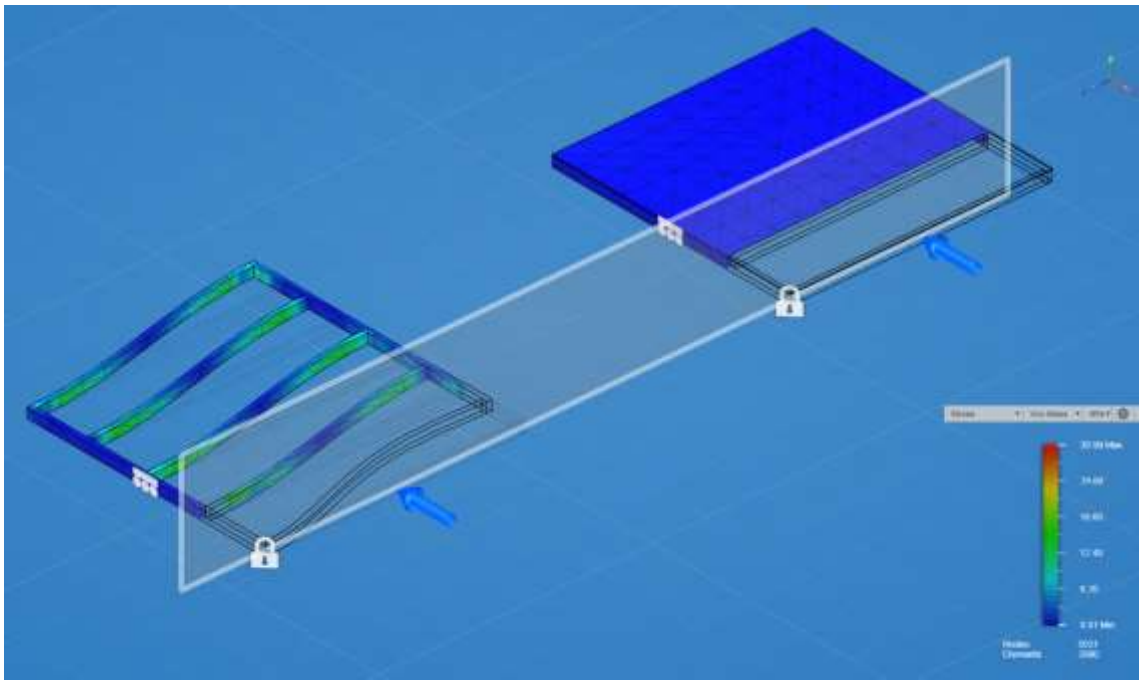


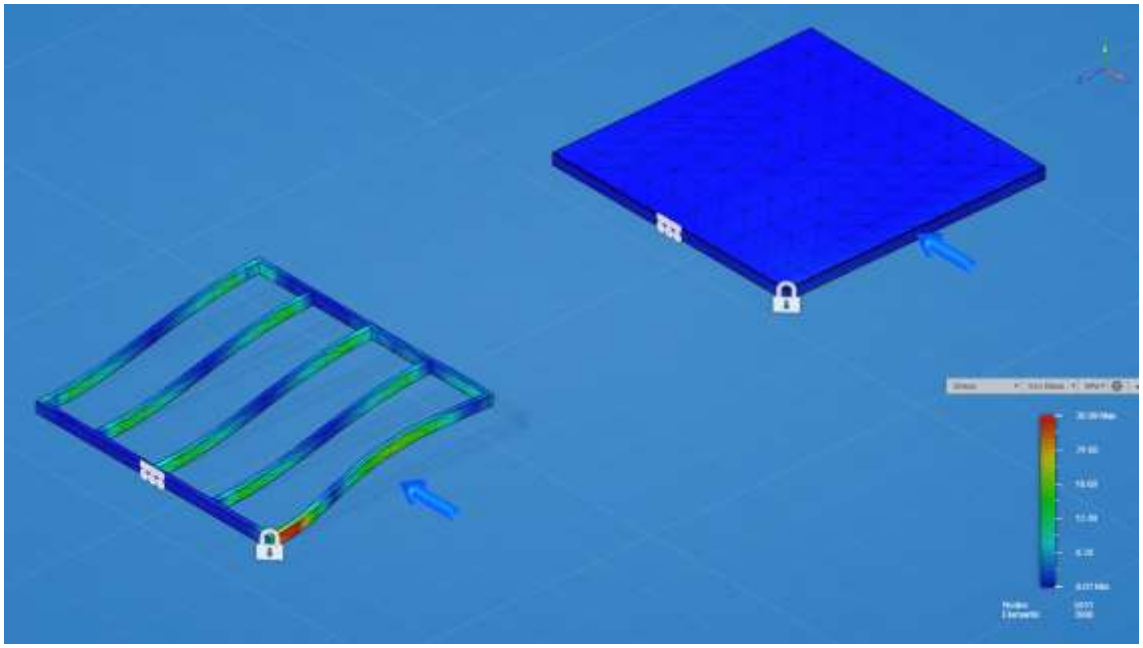
10kN Test. The image above shows factored displacement for clarity. The image below shows actual displacement.





10kN Test. The image above shows Safety Factor. The image below shows inter-member stress





10kN Test. Von Mises Stress

ATSM E455 MgO Corp 10mm Wall Sheet 10kN

Analyzed File	Reference and Timber Frame 2400 2400 with diaphram 10mm v3
Analyzed File Path	C:/Users/Pete/AppData/Roaming/Autodesk/PLM360Cache/a360proue29ca72e.autodeskplm360.net/3
Creation Date	2013-12-17, 12:55:54
Author	Pete Schott FireAcousticBoard

Materials

Component	Material	Safety Factor
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2400:3	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2400:4	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:6	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud	MgO	Yield

2310:7	7.0GPa	Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:8	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:9	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Stud 2310:10	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/MgO Floor Sheet:1	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2400:1	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2400:2	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:1	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:2	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:3	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:4	MgO 7.0GPa	Yield Strength
Reference and Timber Frame 2400 2400 with diaphram 10mm:2/Timber Frame 2400 2400:1/Stud 2310:5	MgO 7.0GPa	Yield Strength

MgO 7.0GPa

Density	930 kg / m^3
Young's Modulus	7000 MPa
Poisson's Ratio	0.3
Yield Strength	7 MPa
Ultimate Tensile Strength	8 MPa

Constraints

Constraint Type	Fixed
Ux	Yes
Uy	Yes
Uz	Yes

Loads

Load Type	Force
Magnitude	10000 N

Results

Name	**Minimum**	**Maximum**
Safety Factor		
Per Body	0.2259	15
Stress		
Von Mises	0.01355 MPa	30.99 MPa
1st Principal	-1.733 MPa	33.04 MPa
Normal YY	-2.062 MPa	4.59 MPa
Normal ZZ	-30.95 MPa	32.53 MPa
Displacement		
Total	0 mm	112 mm
X	-112 mm	0 mm
Y	-3.106 mm	2.998 mm
Z	-2.308 mm	2.243 mm

Material Test MgO Corp 10mm Wall Sheet

Client:	MgO Corp
Attention:	Steve Maskell
Your Reference:	131110
Date:	Nov 2013
REPORT NO: 1305200001	
Mechanical testing of MgO construction materials	

Fire Acoustic Board

Building Infinite Innovation

1 INTRODUCTION

FireAcousticBoard was engaged by Magnesium Oxide Board Corporation to conduct bending tests to determine the material bending strength of five samples designed for building purposes and construction.

The Bending Strength, also called Modulus of Rupture, was performed in accordance with AS/NZS 2908.2-2000 Cellulose-Cement Products - Part 2 Flat sheets with the following test restrictions:

- No large sheet measurement was conducted
- All samples where dry
- Acceptable Characteristics (Section 5) was limited to Modulus of Rupture (Section 5.2.1)
- Type Characteristics (Section 6) was limited to Bending Strength (Modulus of Rupture). Refer Section 5.2.1 and Section 6.1 of the standard
- All test specimens are rectangular as described in Figure 2 of the standard

AS/NZS 2908.2-2000 Cellulose-Cement Products does not specify requirements for testing of Young's Modulus however the general principals where applied to the tests. The Young's Modulus of the samples was approximated using the same parameters of the three point bend test with the additional measurement of deflection at the breaking load.

Testing was carried out at the FireAcousticBoard site, located at 18B Wirraway Drive, Redcliffe Airport QLD.

The test samples meet the requirements of Type A, Category 3 standard.

Sample	Bending Strength	Modulus of Rupture
MgO Wall 10mm MA	7.37 GPa	8.10 MPa

2 SCOPE

Testing as per the following clause of AS/NZS 2908.2-2000 was carried out:

- Bending Strength – Section 8.1.2

- Modulus of Rupture

3 SAMPLES

The tests involved four samples of each specimen. The size and shape of these samples complied with Figure 2 of the standard.

- Sample 1: MgO Wall 10mm thickness MA
- Sample 2: MgO Corporation 20mm Floor GT
- Sample 3: MgO Corporation 20mm Floor MA

Testing apparatus. Typical failure: a crack develops under the sample

5 PROCEDURE

The following procedure is followed:

1. The sample is cut as per figure 2 of the standard
2. The sample is measured at 3 locations for thickness and width
3. The rectangular sample is place perpendicular to two supports located at 1000mm centres.
4. The press is lowered to contact the sample and the vertical micrometre is zeroed
5. The press is lowered until the displacement is approximately 2mm.
6. Note the initial load (L_1)
7. The sample is allowed to relax for 3 minutes. Note the final load (L_2)
8. The press is lowered by a future 2mm and step 5 to 7 repeat until the displacement is 10mm
9. Continue to lower the 2mm until the sample ruptures. Note the load prior to failure and the displacement.

Modulus of Rupture (R_f, in MPa) was determined using the following equation:

$$Rf = \frac{3Pl}{2wt^2}$$

Where:
P = the load at breaking (N)
l = length between support (mm)
w = width of sample (mm)
t = thickness of sample (mm)

The sample is measured in 3 locations. The width and thickness of the sample is the average of the 3 measurements. The Modulus of Rupture is the average of the four samples.

Young's Modulus (E_b, in GPa) was determined using the following equation:

$$E_b = \frac{Pl^3}{4wt^3\, y}$$

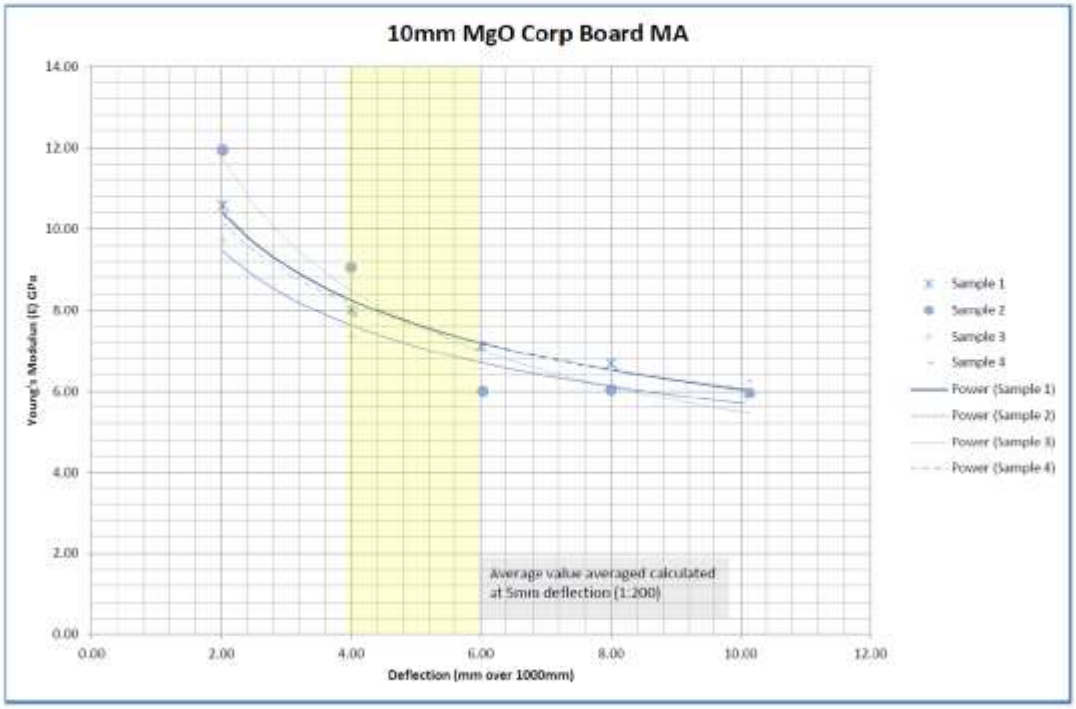
Where:
P = the load at breaking (N)
l = Length between support (mm)
w = width of sample (mm)
t = Thickness of sample (mm)
y =Deflection at breaking

The sample is measured in 3 locations. The width and thickness of the sample is the average of the 3 measurements. The Young's Modulus varies with deflection. To increase the acccuracy of the reading the gradient of the curve is used to calculated for each sample at 5.00mm. The Young's Modulus is the average of the four samples.

6 RESULTS

The experimental readings are shown at Appendix A1.

Sample	Bending Strength	Modulus of Rupture
MgO Wall 10mm MA	7.37 GPa	8.10 MPa



Appendix

A1 10mm MgO Board MA Report

Title 10mm MgO Corp Board MA

Test Date 10.11.2013

Method Young's Modulus Experiment

Standard AS/NZS 2908.2-2000

Sample 1

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	222.0	10.18	1000.0
1	222	10.3	
2	222.5	10.2	
3	221.5	10.03	

Experimental Data (Raw)			Calculations	
L1 kN	L2 kN	D mm	Youngs (MPa)	Young (Gpa)
0.02	0.02	2.02	10579.11	10.58
0.03	0.03	4.01	7993.69	7.99
0.04	0.04	6.01	7111.41	7.11
0.05	0.05	8.00	6678.06	6.68
0.06	0.06	10.06		

Result: Plot gradient at 5mm **7.56**

Sample 2

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	203.0	10.07	1000.0
1	211.5	9.91	
2	212.0	9.89	
3	209.5	10.41	

Experimental Data (Raw)			Calculations	
L1 kN	L2 kN	D mm	Youngs (MPa)	Young (Gpa)
0.02	0.02	2.02	11940.82	11.94
0.03	0.03	4.00	9045.17	9.05
0.03	0.03	6.03	6000.11	6.00
0.04	0.04	8.00	6030.11	6.03
0.05	0.05	10.14	5946.86	5.95

Result: Plot gradient at 5mm **7.55**

Sample 3

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	211.0	10.64	1000.0
1	209.5	10.61	
2	212	10.79	
3	211.5	10.53	

Experimental Data (Raw)			Calculations	
L1 kN	L2 kN	D mm	Youngs (MPa)	Young (Gpa)
0.02	0.02	2.02	9729.78	9.73
0.03	0.03	4.01	7351.93	7.35
0.04	0.04	6.00	6551.39	6.55
0.05	0.05	8.02	6126.61	6.13
0.06	0.06	10.06	5861.08	5.86

Result: Plot gradient at 5mm **6.95**

Sample 4

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	202.5	10.55	1000.0
1	203.0	10.43	
2	202.0	10.73	
3	202.5	10.49	

Experimental Data (Raw)			Calculations	
L1 kN	L2 kN	D mm	Youngs (MPa)	Young (Gpa)
0.02	0.02	2.02	10409.65	10.41
0.03	0.03	4.02	7846.08	7.85
0.04	0.04	5.99	7020.87	7.02
0.05	0.05	8.03	6546.54	6.55
0.06	0.06	10.10	6245.79	6.25

Result: Plot gradient at 5mm **7.44**

Average Bending Modulus (average of four results)

7.37 Gpa

Method Modulus of Rupture Experiment

Standard AS/NZS 2908.2-2000

Sample 1

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	222.0	10.18	1000.0
1	222	10.3	
2	222.5	10.2	
3	221.5	10.03	

Experimental Data (Raw)			Calculations
L1 kN	L2 kN	D mm	Modulus of Rupture (Mpa)
0.12		30.14	7.83

Sample 2

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	211.0	10.07	1000.0
1	211.5	9.91	
2	212.0	9.89	
3	209.5	10.41	

Experimental Data (Raw)			Calculations
L1 kN	L2 kN	D mm	Modulus of Rupture (Mpa)
0.12		30.31	8.41

Sample 3

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	211.0	10.64	1000.0
1	209.5	10.61	
2	212	10.79	
3	211.5	10.53	

Experimental Data (Raw)			Calculations
L1 kN	L2 kN	D mm	Modulus of Rupture (Mpa)
0.13		31.15	8.18

Sample 4

Physical Measurements

	Width mm	Thickness mm	Centres mm
Average	202.5	10.55	1000.0
1	203.0	10.43	
2	202.0	10.73	
3	202.5	10.49	

Experimental Data (Raw)			Calculations
L1 kN	L2 kN	D mm	Modulus of Rupture (Mpa)
0.12		12.01	7.99

Average Modulus of Rupture (average of four results)

8.10 MPa