“SwissCell”:
Moisture Absorption and Load Testing in a Tropically Weathered Condition

By:
Harleigh Doremus
Seth Moody

Portland State University
Arch 510 Final Report
15 March 2011
Introduction/Objective:

SwissCell is a proprietary composite building material consisting honey comb core that is sandwiched (glued) between two layers of magnesium concrete board. SwissCell has been proposed as a semi-permanent building material for post disaster Haiti. During previous testing, to determine thermal properties of the 5cm SwissCell material, the need for structural (bending load) testing was realized. Our task was to make preliminary moisture absorption and bending strength studies of SwissCell in a high temperature and high humidity climate. Our objective is to inform further testing and development of SwissCell in order to obtain a basic level of appropriateness for the Haitian climate. Two SwissCell material types, 5cm & 10cm, were provided by Pacific Green Industries, SwissCell license holders for North America.

- 5cm material is made of what appears to be a high resin content (glossy-brittle) paper honeycomb material, 43mm thick, faced on both sides with a fiber reinforced magcrete board of approximately 3mm thickness for a total dimension of ~5cm.
- 10cm SwissCell is made of standard, resin coated, craft paper (preserved with phenol and formaldehyde, Appendix A) 75mm thick and faced on both sides with 10mm fiber reinforced magcrete board for a total dimension of ~10cm.

Testing Procedure:

The 5cm and 10cm materials were prepared in similar fashion. For each material type 10 samples were cut to 4” x 14” test strips as shown in Figure 1. The 4”x10” dimension was chosen as it is of similar length width ratio as the factory production panels. Half the panels were evaluated for moisture absorption and all panels then underwent load testing to determine the effect of the humidity and heat on their maximum bending load capacity as compared to un-weathered panels.

Moisture Absorption

Each test sample was dried at 150°F for 24 hrs and a dry weight was recorded. 5 samples from each material type were weathered at 90% RH and 90° F for 240 hours in the Thermotron environmental chamber as called for in MIL-STD-810F. After 240 hours weathering the samples were removed and weight was recorded for each weathered sample.

Figure 1: 10cm & 5cm test samples
**Bending load**

The samples were secured onto the testing apparatus as shown Figure 2, allowing a 4” x 10” testing surface which has the same aspect ratio (.40) as the 4’ x 10’ production sized panels. The samples were center loaded from the bottom orthogonally with an approximate 13 square inch loading area. A load cell measured the loading in pounds while a bending load was applied. The samples were all loaded until catastrophic failure. Plots of load were created using the load cell data. Maximum bending load values could then be observed.

**Results:**

![Figure 2: Load testing apparatus.](image)

**Figure 3:** 5cm Dry Panel 1 load vs. displacement curve.
Figure 4: 5cm Dry Panel 6 load vs. displacement curve.

Figure 5: 5cm Weathered Panel 2C load vs. displacement curve.
Figure 6: 5cm Weathered Panel 4C load vs. displacement curve.

Figure 7: 5cm sample comparisons. Weathered (2C, 4C) and Dry Panels (1, 6).
Figure 8: 10cm Weathered Panel 5 load curve

Figure 9: 10cm Weathered Panel 2 load curve
**Figure 10:** 10cm Dry Panel 10 load curve

**Figure 11:** 10cm Dry Panel 7 load curve
Figure 12: Most representative 10cm sample comparisons. Weathered (2, 5) and Dry Panels (7, 10).

Table 1: 5cm SwissCell water absorption results.

<table>
<thead>
<tr>
<th>Test Material</th>
<th>Initial Mass (g)</th>
<th>Weathered* Mass (g)</th>
<th>Difference (g)</th>
<th>Percentage Mass Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honeycomb #1</td>
<td>95.4</td>
<td>107.2</td>
<td>7.8</td>
<td>7.85</td>
</tr>
<tr>
<td>Honeycomb #2</td>
<td>94.4</td>
<td>101.6</td>
<td>7.2</td>
<td>7.63</td>
</tr>
<tr>
<td>Swisscell #1</td>
<td>750</td>
<td>906.2</td>
<td>146.2</td>
<td>19.24</td>
</tr>
<tr>
<td>Swisscell #2</td>
<td>792.6</td>
<td>940.8</td>
<td>148.2</td>
<td>18.70</td>
</tr>
</tbody>
</table>

* 240 hours at 90 RH and 90 F
**Table 2**: 10cm SwissCell water absorption results.

<table>
<thead>
<tr>
<th>Test Material</th>
<th>Initial Mass (g)</th>
<th>Weathered* Mass (g)</th>
<th>Difference (g)</th>
<th>Percentage Mass Change (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Panel 1</td>
<td>652.2</td>
<td>819.6</td>
<td>167.4</td>
<td>25.67</td>
</tr>
<tr>
<td>Wet Panel 2</td>
<td>640.2</td>
<td>803</td>
<td>162.8</td>
<td>25.43</td>
</tr>
<tr>
<td>Wet Panel 3</td>
<td>652.2</td>
<td>829.4</td>
<td>177.2</td>
<td>27.17</td>
</tr>
<tr>
<td>Wet Panel 4</td>
<td>668.8</td>
<td>850.4</td>
<td>181.6</td>
<td>27.15</td>
</tr>
<tr>
<td>Wet Panel 5</td>
<td>680.8</td>
<td>872.2</td>
<td>191.4</td>
<td>28.11</td>
</tr>
<tr>
<td>Magcrete Board 1m</td>
<td>287.4</td>
<td>369.8</td>
<td>82.4</td>
<td>28.67</td>
</tr>
<tr>
<td>Magcrete Board 2m</td>
<td>290</td>
<td>373.8</td>
<td>83.8</td>
<td>28.90</td>
</tr>
<tr>
<td>Magcrete Board 3m</td>
<td>285.2</td>
<td>364.6</td>
<td>79.4</td>
<td>27.84</td>
</tr>
<tr>
<td>Magcrete Board 4m</td>
<td>280</td>
<td>360.6</td>
<td>80.6</td>
<td>28.79</td>
</tr>
<tr>
<td>Honeycomb 1h</td>
<td>57</td>
<td>63.6</td>
<td>6.6</td>
<td>11.58</td>
</tr>
<tr>
<td>Honeycomb 2h</td>
<td>53.4</td>
<td>60</td>
<td>6.6</td>
<td>12.36</td>
</tr>
</tbody>
</table>

* 240 hours at 90 RH and 90 F

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**Table 3**: Max loading of 5cm and 10cm “dry” and “weathered” panels

<table>
<thead>
<tr>
<th>Test Panel</th>
<th>Average Max Load (lb)</th>
<th>Weathered Panel: Ave. Reduction of Strength (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5cm Dry</td>
<td>634</td>
<td></td>
</tr>
<tr>
<td>5cm Weathered</td>
<td>230</td>
<td></td>
</tr>
<tr>
<td>10cm Dry</td>
<td>486</td>
<td></td>
</tr>
<tr>
<td>10cm Weathered</td>
<td>291</td>
<td>63.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40.1</td>
</tr>
</tbody>
</table>

**Results Discussion:**

The 5cm and 10cm materials had distinctively different honeycomb materials. The 5cm honeycomb appears glossy, brittle and plastic like (high resin content and compressively strong). The 10cm honeycomb appears dry, flexible and paper like (low resin content).

**5cm material**

The average 90°F and 90% humidity induced a mass change in honeycomb was 7.7% while the composite average % mass change was 18.97%. The difference is
This indicates that the magcrete board (exterior laminations) is absorbing larger amounts of moisture than the honeycomb. A distinct discoloration (yellowing) of the weathered panel, compared to un-weathered panel, was also noticed. Additionally a distinct acrid metallic salt odor is off gassed from the magcrete board when subjected to high temperature and humidity.

The composite panel submersion test revealed that the honeycomb webs will transport water between cells, allowing water to fill the cells. Due to the nature of the honeycomb geometry, water collected in the individual honeycomb cells does not readily drain out. Water trapped in the honeycomb cells was observed to be dripping from the submerged composite panel for 3 days after removal from submersion.

The maximum load failure (Image 3) of the un-weathered panels was quit abrupt with audible honeycomb cracking preceding panel complete failure. The 5cm weathered panel failures (Image 4) occurred imperceptibly and could only be determined by observation of a load reduction accompanied by honeycomb cracking. There was no obvious tension cracking in the surface of the magcrete board. Close examination of the weathered and load tested panels revealed magcrete board separation at the glue interface.

The average max load failure of the un-weathered was 634lb and the average max load failure of the weathered panels was 230lb. The weathered vs un-weathered reduction in bending load capacity was

\[
100 - \left( \frac{230lb}{633.7lb} \right) \times 100 = 63\% 
\]

10cm material
The average 90°F and 90% humidity induced a mass change in honeycomb was 12% while the magcrete board was absorbing an average 28.6% moisture, as compared to 23% stated by manufacture (Appendix B). The composite panel average % mass change was 26.7%. No discoloration of magcrete panels were noticed in the 10cm test samples. No noticeable acrid metallic salt odor is off gassed from the 10cm magcrete board as compared to the 5cm SwissCell. However the paper honeycomb does off gas a distinct phenol-formaldehyde odor when subjected to
high temperature and humidity. Further investigation of 10cm paper honeycomb MSDS (Appendix A) revealed phenol and formaldehyde as primary preservative agents. The maximum load failure (Image 5) of the un-weathered and weathered panels was slow with no audible honeycomb cracking preceding panel complete failure. Honeycomb failure occurred after magcrete failure and was compressive (crushed). There was no obvious tension cracking in the surface of the magcrete board. Close examination of the un-weathered/weathered and load tested panels revealed magcrete board separation within the fiber of the board.

The average max load failure of the un-weathered was 486lb and the average max load failure of the weathered panels was 291lb. The weathered vs un-weathered reduction in bending load capacity was \(100 - \left(\frac{291lb}{486lb}\right) \times 100\) = \(40\%\).

Further Testing

ASTM Standard E1925-10: Specification For Engineering and Design Criteria For Rigid Wall Relocatable Structures (RWRS) prove applicable for future testing of the SwissCell. This standard has many useful performance requirements which would be helpful in defining new SwissCell tests such as wind velocity, humidity resistance, temperature range, solar loading, heat transfer, roof loads, and floor loads.

Future structural testing of weathered panels that have a waterproofing coating or a reformulated material specifically designed for high humidity environments would provide valuable results of the effectiveness of the reformulated material.

Conclusion

5cm material

There is significant water wicking and trapping within the honeycomb cells when the panels are in direct contact with water. There is a 19% increase in mass and 63% reduction in bending load capacity of panels weathered for 10 days in a 90°F & 90% humidity environment.

Observations during testing indicate that the dry panel load failure occurs across the web connection of the honeycomb which then causes the magcrete board to abruptly fail on the tension surface, as would be expected.
The weathered panel failures occur at magcrete board-glue interface followed by honeycomb failure. This indicates that the weathered composite reduction in load capacity is at the adhesive-magcrete board interface and most likely due to hygroscopic (moisture absorption) nature of the magcrete board.

Optimally there would be little or no honeycomb cell moisture trapping, magcrete board moisture absorption or related reduction in load capacity or difference in load capacity between un-weathered and weathered panel.

Our tests do not recommend using the composite 5cm SwissCell (43mm craft paper honeycomb and 3mm fiber reinforced magcrete board) as a structural component of buildings in high temperature and humidity environments. The conclusion is based on the combination of moisture trapping, moisture absorption, large reduction in load capacity and the 3mm magcrete board acrid off gassing.

10cm material
There is a 27% increase in mass, which matches manufacture specs (Appendix B), and 40% reduction in bending load capacity of panels weathered for 10 days in a 90°F & 90% humidity environment.

Observations during testing indicate that dry and weathered panel bending load failure occur imperceptibly at the magcrete board-glue interface followed by honeycomb compressive failure. This indicates that the weathered composite reduction in load capacity is at the adhesive-magcrete board interface and most likely due to hygroscopic (moisture absorption) nature of the magcrete board.

Optimally there would be little or no honeycomb cell moisture trapping, magcrete board moisture absorption or large difference in load capacity between un-weathered and weathered panel.

Our tests do not recommend using the composite 10cm SwissCell (75mm craft paper honeycomb and 10mm fiber reinforced magcrete board) as a structural component of buildings in high temperature and humidity environments. The conclusion is based on the combination of moisture trapping, moisture absorption, large reduction in load capacity and perception of phenol-formaldehyde off gassing from the 75mm honeycomb paper core material.

Final Recommendations
It is our opinion (based on the composite 5cm and 10cm material types), for SwissCell to be used as a building material in a high temperature and high humidity environment it would be necessary to:
1. **Reformulate the magcrete board** in such way as to make it non-hygroscopic (intrinsically water resistant/proof). Our opinion is that a waterproofing agent mixed as part of the magcrete matrix is necessary.

2. Alternatively **utilize an entirely different waterproof outer face material** as replacement for the magcrete board.

3. **Use the high resin content**, compressively strong, water resistant and relatively inert honeycomb material (43mm high resin content honeycomb material type).

4. **Develop a comprehensive reformulation and structural analysis scheme, before large scale Haitian implementation**, in order to prove the appropriate formula and application for SwissCell material in high humidity and high temperature climate, such as Haiti

**Reference**

- Portland State University : Green Building Research Laboratory
- ASTM Standard E1925-10
- MIL-STD-810E
- Swiss-cell.com; Honeycomb & Applications
- [http://www.museumstuff.com/learn/topics/Paper_honeycomb::sub::History](http://www.museumstuff.com/learn/topics/Paper_honeycomb::sub::History); Museum of Learning. Paper Honeycomb History.
Appendix A

Material Safety Data Sheet Arclin Surfaces, Inc.

HAYWARD, WI OFFICE and PLANT 15859 Dyno Drive, Hayward, WI 54843 Phone (715) 634-5057
Fax (715) 634-2361

TACOMA, WA OFFICE and PLANT 2144 Milwaukee Way, Tacoma, WA 98421 Phone (253) 572-5600 Fax (253) 627-2896

PORTLAND, OR OFFICE and PLANT 2301 No Columbia Blvd, Portland, OR 97217 Phone (503) 289-1111 Fax (503) 978-2607

EMERGENCY NUMBERS CHEMTREC 800-424-9300 Date Issued: December 8, 2010

Outside US: 703-527-3887

Revised:

Section I - Material Identification

Product Name: Spectracore Product Code: Honeycomb Corestock - XP

Product Description: Paper saturated or coated with formaldehyde based resins

Chemical Name: Resin impregnated paper IUPAC: N/A CAS#: N/A UN#: Not Regulated

Section II - Hazardous Ingredients

Ingredients CAS # Weight % * Exposure Limits

Phenol 108-95-2 Below Reportable Threshold 5.0 ppm ACGIH TLV and OSHA PEL

Formaldehyde 50-00-0 Below Reportable Threshold 0.3 ppm ACGIH Ceiling 0.75 ppm OSHA PEL-TWA

Methanol 67-56-1 Below Reportable Threshold 200 ppm ACGIH TLV and OSHA PEL * 29 CFR Part 1910.1200(g)(2)(i)(C)(1), of the Occupational Safety and Health Administration (OSHA)

Hazardous Communication Standard

H.M.I.S. RATINGS HEALTH - 1 FLAMMABILITY - 0 REACTIVITY - 0

Section III - Health Hazards

Effects of Over Exposure:
Contact with skin may cause irritation or rash. Eye contact may cause slight irritation or redness. Heated vapors may cause irritation of the respiratory tract.

Primary Route(s) of Entry:

Inhalation of dust or fumes. Phenol may be absorbed through the skin.

Carcinogenicity:

Formaldehyde, a component of this product, is classified as an IARC (International Agency for Research on Cancer Group I Human carcinogen (nose and pharynx) and a potential human carcinogen by U.S. agencies NTP and OSHA.

Section IV - Emergency and First Aid Procedures

Skin Contact: Wash with soap and water at once.

Eye Contact: Flush with water for 15 minutes and call a physician if irritation persists.

Inhalation: Remove to fresh air.

Ingestion: Not applicable.

In all cases if irritation persists, obtain qualified medical advice.

Date Reviewed: December 8, 2010 Page 1 of 3

Section V - Fire and Explosion Hazard Data

Flashpoint: Not applicable Auto-Ignition Temperature: 410 degrees C. / 770 degrees F.

Extinguishing Media: Water spray, Carbon Dioxide foam or Dry Chemical, as determined by surrounding fire

Special Fire Fighting Procedures: Self-contained breathing apparatus is required.

Hazardous decomposition products may include formaldehyde and oxides of carbon, nitrogen, sodium and potassium.

Unusual Fire and Explosion Hazards: None.

Section VI - Spill or Leak Procedures

Steps to be taken in case material is released or spilled:

Collect material and place in a closed container.

Proper PPE (personal protective equipment) should be worn per Section VIII of this MSDS.
Waste disposal method:

At this time, this material would not be considered a hazardous waste as defined under the federal RCRA regulations (40 CFR 261). However, caution should be taken as these regulations can change and state and local regulations may vary to reclassify this waste. Material should always be disposed of in accordance with federal, state, and local regulations.

For further information, contact your state or local solid waste disposal agency.

Section VII - Handling and Storage

Precautions to be taken in Handling and Storing: Store in a cool, dry and vented space with packaging left intact until use.

Other precautions: Consult the product bulletin prior to using this product.

Section VIII - Special Protection Information

Respiratory Protection: Should be worn to prevent breathing dust or heated fumes.

Ventilation: Local exhaust and general ventilation recommended.

Protective Gloves: Suitable protective gloves should be worn to protect against skin contact and to prevent paper cuts.

Eye Protection: Safety glasses are recommended.

Other Protective Equipment: As required to prevent prolonged or repeated skin contact.

Section IX - Physical Data

Appearance and Odor: Black Medium Weight Paper

Boiling Point: Not Applicable

Percent Moisture Content 2-10% Leachate Analysis (Wt%):

Evaporation Rate: Non-Volatile Leachate Formaldehyde: NA

Vapor Density: Non-Volatile Leachate Phenol: NA

Specific Gravity: Not Applicable Leachate Methanol: NA

Section X - Reactivity Data

Stability: Stable Conditions to Avoid: Warm storage and ignition sources

Incompatibility: None known Hazardous Polymerization: Will not occur
Hazardous Decomposition Products may include formaldehyde, and oxides of carbon, nitrogen, sodium and potassium.

Date Reviewed: December 8, 2010 Page 2 of 3

Section XI - Toxicological Information

When heating the paper, it will give off small amounts of volatile chemicals, primarily formaldehyde and phenol.

Permissible Exposure Levels: The OSHA PEL (Permissible Exposure Limit) and the ACGIH TLV (Threshold Limit Value) for phenol is currently set at 5 ppm for an 8 hour TWA.

Phenol:

OSHA has established a 0.75 ppm PEL for formaldehyde as an 8 hour TWA and a 2 ppm 15-minute STEL (Short Term Exposure Limit). OSHA has also set a 0.5 ppm action level for formaldehyde (see OSHA regulation 21 CFR 1910.1048 for specific information regarding workplace requirements). ACGIH ceiling for formaldehyde is 0.3 ppm.

Formaldehyde:

Formaldehyde, a component of this product, is classified as an IARC (International Agency for Research on Carcinogenicity: Cancer Group I Human carcinogen (nose and pharynx) and a potential human carcinogen by U.S. agencies NTP and OSHA.

Section XII: Ecological Information

No Data Available

Section XIII: Final Disposition

Material should always be disposed of in accordance with federal, state and local regulations. See Section VI for further details.

Section XIV: Transport Information

This product is not regulated.

Section XV: Regulatory Information

This product contains no hazardous ingredients above reportable thresholds as designated in the reporting requirements of "Section 312 and 313 of the Emergency Planning and Community Right to Know Act" of 1986 (40 CFR 370 and 372).

Section XVI: Other Information
DISCLAIMER: The information and recommendations contained herein are offered as a service to our customers but are not intended to relieve the user

from its responsibility to investigate and understand other pertinent sources of information and to comply with all laws and procedures applicable to the safe handling and use of these materials. The information and recommendations provided herein are believed by Arclin Surfaces, Inc. to be accurate or obtained from sources believed to be reliable. However, Arclin Surfaces, Inc. makes no warranty concerning their accuracy and Arclin Surfaces, Inc. will not be liable for claims resulting to any party's use of or reliance on information or recommendations contained herein regardless of whether it is claimed that the information or recommendations are inaccurate, incomplete or otherwise misleading.

Date Reviewed: December 8, 2010
Appendix B

Issue Date: 07-2010 Prepared by: DPA

Issue No.: XIV Checked by: EAG

MAGNUM® BOARD PRODUCTS

Certified Test Summary & Product Specifications

AC386 Criteria-ASTM and UL Methods -with Additional Testing for Specific Products

Structural Performance Tests Conducted by:

RADCO – Long Beach, CA----Test Report No. RAD-4224 & RAD-4451

PRI Construction Materials Technologies, LLC — Tampa, FL

Fire Testing Conducted by:

Southwest Research Institute – San Antonio, CA

01.1443.01.105b (UL263 / E119 Fire Wall)

01.11810.01.165b (E84 Non Flammable)

01.11850.01.431 (E136 Non Combustible)

01.11813.02.046 (U-Pitt Protocol – Non Toxic)

Underwriters Laboratory (UL) Witness Fire Testing

UL Certification File # R26120

International Code Council (ICC) ESR Filing No.: 09-01-01

TEST / STANDARD RESULTS

Flexural Strength – C1185 AS RECEIVED

AVE FLEXURAL MODULUS OF

THICKNESS DIRECTION STRENGTH (PSI) ELASTICITY (PSI)

6mm Machine 2296 PSI 1,158,532
Cross 2054 PSI 1,145,587

12mm Machine 1038 PSI 625,536

Cross 1508 PSI 719,574

SATURATED

6mm Machine 2,023 PSI 608,575

Cross 1,707 PSI 572,930

12mm Machine 1,110 PSI 364,706

Cross 649 PSI 380,366

AC-386 specifies a minimum average flexural strength of 580 psi.

Magnum Board® exceeds this requirement.

In House Laboratory Flexural Testing THICKNESS MPa

6mm 13.245

10mm 13.516

12mm 10.51

15mm 8.88

18mm 7.426

Sample lot consisted of three-(3) of each thickness. Testing was conducted and the reporting results are the average of the three-(3) tests.

Dimensions and Tolerances per C1325-04 C1325-04

Length: Meets requirements of section 7.4 of ASTM C1186

Width: Meets requirements of section 7.4 of ASTM C1186

Thickness: Meets requirements of section 7.5 of ASTM C1186

Squareness: Meets requirements of section 7.6 of ASTM C1186

Edge Straightness: Meets requirements of section 7.7 of ASTM C1186

Surface Finish: See attached pictures depicting our Premium (sanded) back product and our Class A (rolled process) back product.
Moisture Movement – C1186 Thickness – Direction - Aver Dim Chg

<table>
<thead>
<tr>
<th></th>
<th>Machine</th>
<th>Cross</th>
</tr>
</thead>
<tbody>
<tr>
<td>6MM</td>
<td>0.01%</td>
<td>0.03%</td>
</tr>
<tr>
<td>12MM</td>
<td>0.04%</td>
<td>0.03%</td>
</tr>
</tbody>
</table>

Water Absorption – C1186 12MM = 23%


Magnum Board® is ranked 10 of 10 and exceeds the requirements of test method ASTM D-3273. Magnum Board® Products are not a nutrient for mold and mildew.

Compression Indentation – C1325 No residual deformation was noted following loading and the rest period. Exceeds requirements of C1325.

Nail Head Pull-Through – C1325 12MM = 174.8 lb.

Magnum Board® exceeds the requirements of C1325.

Falling Ball Impact – C1325 All Magnum Board® specimens exceed the 12” requirements per C1325

Shear Bond Strength – C1325 Mortar Avg. Shear Strength (PSI)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland</td>
<td>168.82</td>
</tr>
<tr>
<td>Latex</td>
<td>234.32</td>
</tr>
</tbody>
</table>

Magnum Board® exceeds the requirements of C-1325

NOTE: Refer to endorsement by Mapei

Humidified Deflection – C1396-06A Magnum Board® exceeds requirements of ASTM C1396 and AC386.

Surface Burning Characteristics – E8405

<p>| |</p>
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6MM</td>
</tr>
<tr>
<td>12MM</td>
</tr>
</tbody>
</table>

Magnum Board® exceeds the test criteria presented in ASTM E84 and is classified non-flammable.
Non-Combustible Construction – ASTM E136

Magnum Board® exceeds the test criteria presented in ASTM E136 and is classified as non-combustible.

Underwriters Laboratory Fire Rating

UL263 and ASTM E119

Exceeds requirements for single 12MM (15/32”) layer one (1) hour wall fire rating. File No. R26120

NOTE: Two hour single layer wall rating has been conducted, but is not yet UL approved. These tests were conducted on single layer walls.

Magnum Board® did not require retesting at one-half the time to pass hose stream as do gypsum products. These are true one and two hour wall tests.

Xenon Arc Accelerated Weathering – ASTM G155

All five specimens were examined under 5x magnification following 2,000 hours of exposure. No signs of surface cracking, checking, crazing, erosion, or chalking were observed.

Magnum Board® exceeds the requirements of ASTM G155.

Freeze / Thaw – ASTM C1185 Magnum Board® exceeds the requirements of ASTM C1185 and AC386.

Toxicity Testing – U-Pitt Protocol Magnum Board® exceeds the combustion toxicity protocol developed at the University of Pittsburgh, and the requirements for interior finish
material as defined by Title 27, Chapter 1, Subchapter 5, Article 5, of the Building Code of the City of New York.

Magnum Board® is classified as non-toxic and is carcinogen and silica free. r 5, Article 5, of the Building Code of the City of New York.

Magnum Board® is classified as non-toxic and is carcinogen and silica free. Structural Performance Magnum Board® exceeds the structural requirements of ASTM E330 and AC386.

Density Depending on application, Magnum Board® densities may range from 0.85 to 1.15 g/cm³.

Surface Texture Magnum Board® sanded back product is smooth one side – uniform machine textured on the back side.

Magnum Board® rolled product is smooth one side -rolled on the back side.

Color White to off white.

Basic Compounds Refer to MSDS posted on website: www.magnumbp.com

Transverse Load iaw AC376 – E72

<table>
<thead>
<tr>
<th>Test Sample</th>
<th>Psf</th>
<th>Kpa</th>
<th>psf</th>
<th>Kpa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>133.12</td>
<td>6.37</td>
<td>111.80</td>
<td>5.35</td>
</tr>
<tr>
<td>2</td>
<td>142.48</td>
<td>6.82</td>
<td>140.82</td>
<td>6.74</td>
</tr>
<tr>
<td>3</td>
<td>161.30</td>
<td>7.72</td>
<td>139.36</td>
<td>6.67</td>
</tr>
</tbody>
</table>

Average 145.63 6.97 130.66 6.26

Standard Deviation 14.35 0.69 16.35 0.78

Results of transverse loads exceed the requirements of AC376

Wet Racking Shear IAW AC376 – E72 Section 15.05

Test Number Ultimate Load (lb) Lbf / lineal ft.
1 3600 450
2 3600 450
3 2900 363

Average 3367.421

Standard Deviation 404.51

ASTM D696 – 08 Standard Test Method for

Coefficient of Linear Thermal Expansion

Property Result

Thermal Coefficient of Lineal Expansion, 3.97 x 10^-6 [in/in-°F] 38-90°F

Asbestos Magnum Board® has no asbestos.

Carcinogens There are no carcinogens in Magnum Board® whatsoever. Refer to our U-Pitt toxicity test above.

Formaldehyde Magnum Board® Products do not contain formaldehyde.

Off Gassing the emission of especially noxious gases

Magnum Board® Products do not produce off-gassing

STC Values:

NOTE: The following results are in house test lab results and are not certified by an approved ICC testing laboratory . STC Value standard wall system, 12MM both sides, wood or metal stud construction and batts: ~STC48

R Values:

NOTE: The following results are either in-house test lab results or published results from SIPA and are not certified by an approved ICC testing laboratory.

Structural Insulated Panel (SIP) R Values using 10MM

Magnum Board®:

Magnum Board® thermal insulation R value per inch = 1.2

Compared to:

Cement Board: .8
Plywood: 1.2
Gypsum Wallboard: .9
Gypsum Sheathing: 1.1
O.S.B. 1.

SIP R-Values (Calculated R-Values)

SIP Panel
Thickness 4 1/2" 6 1/2" 8 1/4" 10 1/4"
EPS 14.4 21.6 27.9 35.1
XPS 19.5 29.5 38.3 48.3
Polyurethane 21.7 32.9 N/A N/A

Consult the panel manufacturer to verify R-values. R-value can vary between SIP manufacturers.

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Consult the panel manufacturer to verify R-values. R-value can vary between SIP manufacturers.

International Code Council Approved Test Laboratories Used For This Testing Include:

1. RADCO – Long Beach, CA for all strength and performance testing.

2. Southwest Research Institute – San Antonio, TX for all fire testing.

3. Underwriters Laboratory – for all witness fire testing. See certifications on their web site.

Sanded back finish & Rolled back finish:

1. Sanded back product is tested and certified to all above testing requirements = ~2.3 LBS/SF (12MM thickness).

2. Rolled back product is in house tested only = ~2.3 LBS/SF (12MM thickness).

3. UL rated fire wall is tested and certified to all above testing requirements = ~2.9 LBS/SF (12MM (15/32”) thickness).

Magnum Building Products Product Line includes:

1. Interior Applications
   a. Wall Board
   b. Ceiling Board
   c. Backer Board
   d. Underlayment
   e. Trim Materials

2. Exterior Applications
   a. Sheathing
   b. Soffit – Ventilated and Non Ventilated
   c. Fascia
   d. Trim Materials
   e. Siding

NOTE: Magnum Board sheathing alone is not tested for roofing or flooring substrate and our warranty does not cover use in these applications.
10150 Highland Manor Drive – Suite 200 –Tampa, FL 33610
Ph. 813-314-2202 –Fax: 813-314-2203
Website: www.magnumbp.com – Sales@magnumbp.com – Info@magnumbp.com