CSI 06 12 16
PRODUCT: Structural Insulated Panels (SIPs)
DIVISION: Wood and Plastics (06)
SECTION: Structural Panels (06 12 16)

Evaluator
Ryan W. Boring, P.E. (FL#72674)
305 North Oakland Avenue
Nappanee, Indiana 46550

Manufacturing Locations

The Murus Company
PO Box 220
3234 Route 549
Mansfield, PA 16933

1. SUBJECT

1.1 ***Murus PUR SIP*** **Roof Panels 4-ft to 24-ft long, 4-1/2-in. to 6-1/2-in. thick.**

2. SCOPE

The Evaluator has evaluated the above product(s) for compliance with the applicable sections of the following codes:

2.1 Florida Building Code Sixth Edition (2017) Building
2.2 State of Florida Product Approval Program Rule 61 G 20-3, FAC
2.3 Compliance Method: Evaluation Report from a Licensed Florida Professional Engineer

The Evaluator has evaluated the following properties of the above product(s):

2.4 Structural performance under transverse loads.

3. USES

3.1 General. *Murus PUR SIPs* are used as structural insulated roof panels capable of resisting transverse loads.

3.2 Construction Types. *Murus PUR SIPs* shall be considered combustible building elements when determining the Type of Construction in accordance with Florida Building Code Sixth Edition (2017) Building Chapter 6.

3.3 Fire Resistive Assemblies. *Murus PUR SIPs* shall not be used as part of a fire-rated assembly unless suitable evidence and details are submitted and approved by the authority having jurisdiction.

3.4 High Velocity Hurricane Zones. The subject of this report has not been evaluated for use in high velocity hurricane zones (HVHZ).

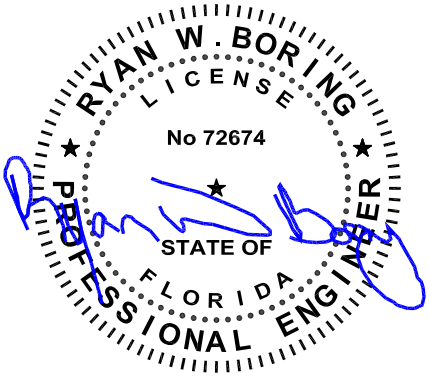
4. DESCRIPTION

4.1 General. *Murus PUR SIPs* are factory-assembled, engineered-wood faced, structural insulated panels (SIPs) with foamed-in-place polyurethane (PUR) foam plastic core. The product is intended for use as load-bearing or non-load bearing roof components. *Murus PUR SIPs* are available in 4-1/2-in. through 6-1/2-in. overall thicknesses and are custom made to the specifications for each use. The maximum product size is 8-ft wide and 24-ft long.

4.2 Materials

4.2.1 Facing. The facing consists of two single-ply oriented strand board (OSB) facings a minimum of 7/16-in. thick conforming to Florida Building Code Sixth Edition (2017) Residential Table 610.3.2 and DOC PS 2-10, Exposure 1, Rated Sheathing with a span index of 24/16. Panels are manufactured with the facing strength axis oriented parallel to the direction of product bending.

4.2.2 Core. The foamed-in-place polyurethane foam core has a minimum 2.2 pcf in-place density and self-adheres to the facing. The foam core has a flame spread index not exceeding 25 and a smoke-developed index not exceeding 450 when tested in accordance with ASTM E84.



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This Engineering Evaluation Report is intended to indicate that the Evaluator has evaluated the product(s) herein based on the information available at the time of report issuance. The Evaluator reserves the right to modify, amend or withdrawal this report at any time based on information that becomes available subsequent to the issuance of this report. The Evaluator makes no warranty, either expressed or implied, regarding the product covered by this report.

4.2.3 Material Sources. The facing and core materials used in the construction of *Murus PUR SIPs* are from approved sources as identified in the in-plant quality system documentation.

4.2.4 Splines. *Murus PUR SIPs* are interconnected with surface splines or a cam-lock system (Figure 1). Connections using dimensional lumber splines or engineered structural splines are not specifically addressed in this report and must be designed in accordance with accepted engineering practice to meet applicable code requirements.

5. DESIGN

5.1 Overall Structural System. The scope of this report is limited to the evaluation of the SIP Roof component. Panel connections and other details related to incorporation of the product into the overall structural system of a building are beyond the scope of this report.

5.2 Design Approval. Where required by the authority having jurisdiction, structures using *Murus PUR SIPs* shall be designed by a registered design professional. Construction documents, including engineering calculations and drawings providing floor plans, window details, door details and connector details, shall be submitted to the code official when application is made for a permit. The individual preparing such documents shall possess the necessary qualifications as required by the applicable code and the professional registration laws of the state of Florida. Approved construction documents shall be available at all times on the jobsite during installation.

5.3 Design Loads. Design loads to be resisted by the product shall be as required under the applicable code. Loads on the panels shall not exceed the loads noted in this report. Where loading conditions result in superimposed stresses, the sum of the ratio of actual loads over allowable loads shall not exceed one. Calculations demonstrating that the loads applied are less than the allowable loads described in this report shall be submitted to the code official for approval.

5.4 Allowable Loads. Allowable transverse loads may be calculated using the panel properties provided in Tables 1 and 2 or selected from Table 3. For loading conditions not specifically addressed herein, structural members designed in accordance with accepted engineering practice shall be provided to meet applicable code requirements.

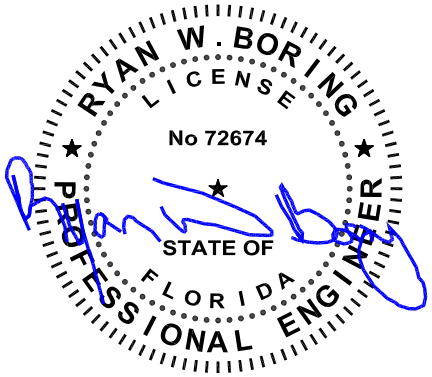
5.5 Openings. Openings in panels shall be reinforced with wood or steel designed in accordance with accepted engineering practice to resist all loads applied to the opening as required by the adopted code. Details for door and window openings shall be provided to clarify the manner of supporting axial, transverse and/or in-plane shear loads at openings. Such details shall be subject to approval by the local authority having jurisdiction.

6. INSTALLATION

6.1 General. *Murus PUR SIPs* shall be fabricated, identified and erected in accordance with this report, the approved construction documents and the applicable code. In the event of a conflict between the manufacturer's published installation instructions and this report, this report shall govern. Approved construction documents shall be available at all times on the jobsite during installation.

6.2 Splines. *Murus PUR SIPs* are interconnected at the panel edges through the use of a surface spline or cam-lock system, as shown in Figure 1. When cam-locks are used to connect panels, the cam-locks are spaced no less than 24-in. oc. All joints shall be sealed in accordance with the SIP manufacturer's installation instructions.

6.3 Plates. The top and bottom plates of the panels shall be dimensional or engineered lumber sized to match the core thickness of the panel. The plates shall be secured using not less than 0.131-in. x 2-1/2-in. nails, spaced 6-in. on center on both sides of the panel or an approved equivalent fastener. A second top plate of 1-1/8 in. minimum thickness dimensional or engineered lumber with a specific gravity of 0.42 that is cut to the full thickness of the panel shall be secured to the first top plate using 0.162-in. x 3-1/2-in. nails or an approved equivalent fastener.



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6.4 Cutting and Notching. No field cutting or routing of the panels shall be permitted except as shown on approved construction documents from a registered design professional.

6.5 Protection from Decay. SIPs that rest on exterior foundation walls shall not be located within 8 in. of exposed earth. SIPs supported by concrete or masonry that is in direct contact with earth shall be protected from the concrete or masonry by a moisture barrier.

6.6 Protection from Termites. In areas subject to damage from termites, SIPs shall be protected from termites using an approved method. Panels shall not be installed below grade or in contact with earth.

6.7 Heat-Producing Fixtures. Heat-producing fixtures shall not be installed in the panels unless protected by a method approved by the code official or documented in test reports. This limitation shall not be interpreted to prohibit heat-producing elements with suitable protection.

6.8 Voids and Holes

6.8.1 Voids in Core. In lieu of openings designed in accordance with section 5.7, the following voids are permitted. Voids may be provided in the panel core during fabrication at predetermined locations only. Voids parallel to the panel span shall be limited to a single 1 in. maximum diameter hole. Such voids shall be spaced a minimum of 4 ft on center measured perpendicular to the panel span. Two 1/2 in. diameter holes may be substituted for the single 1 in. hole provided they are maintained parallel and within 2 in. of each other. Voids perpendicular to the panel span shall be limited to a single 1 in. maximum diameter hole placed not closer than 18-in. from the support. Additional voids in the same direction shall be spaced not less than 24-in. on center.

6.8.2 Holes in Panels. Holes may be placed in panels during fabrication at predetermined locations only. Holes shall be limited to 4 in. by 4 in. square. The minimum distance between holes shall not be less than 4 ft on center measured perpendicular to the panel span and 24 in. on center measured parallel to the panel span. Not more than three holes shall be permitted in a single line parallel to the panel span. The holes may intersect voids permitted elsewhere in this report.

6.9 Panel Cladding

6.9.1 Roof Covering. The roof covering, underlayment and flashing shall comply with the applicable codes. All roofing materials must be installed in accordance with the manufacturer's installation instructions. The use of roof coverings requiring the application of heat during installation shall be reviewed and approved by a registered design professional.

6.10 Interior Finish. The foam plastic core shall be separated from the interior of the building by an approved thermal barrier of ½-in. gypsum wallboard or equivalent thermal barrier where required by Florida Building Code Sixth Edition (2017) Building, Section 2603.4.

7. CONDITIONS OF USE

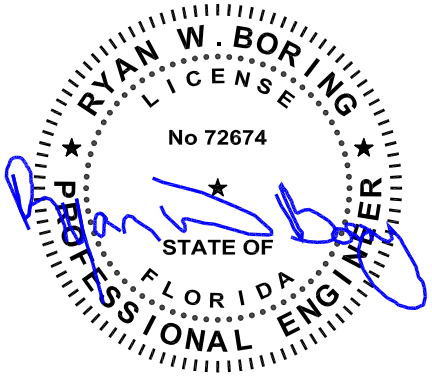
Murus PUR SIPs as described in this report comply with the codes listed in Section 2 above, subject to the following conditions:

7.1 Installation complies with this report and the approved construction documents.

7.2 This report applies only to the panel thicknesses specifically listed herein.

7.3 In-use panel heights/spans shall not exceed the values listed herein. Extrapolation beyond the values listed herein is not permitted.

7.4 The panels are manufactured in the production facilities listed in this report.



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8. EVIDENCE SUBMITTED

The Evaluator has examined the following evidence to evaluate this product:

8.1 Test reports:

8.1.1 ASTM E72-15 Section 11, Transverse Load, NTA, Inc. IAS Lab Certification No. TL-259, , 6/17/16, Test Report Numbers:

- 8.1.1.1 MUR(660)092815-20, 48-in. x 96-in. x 4.5-in.
- 8.1.1.2 MUR(660)092815-21, 48-in. x 96-in. x 6.5-in.
- 8.1.1.3 MUR(660)092815-22, 48-in. x 288-in. x 4.5-in. MUR(660)092815-23, 48-in. x 288-in. x 5.5-in. , 6/17/16
- 8.1.1.4 MUR(660)092815-24, 48-in. x 288-in. x 6.5-in. MUR(660)092815-25, 48-in. x 96-in. x 4.5-in. (zero bearing)
- 8.1.1.5 MUR(660)092815-26, 48-in. x 96-in. x 6.5-in. (zero bearing)
- 8.1.1.6 MUR(660)122115-15, 48-in. x 96-in. x 6.5-in.

8.1.2 ASTM E72-15 Section 11, Transverse Load, NTA, Inc. IAS Lab Certification No. TL-259, , 11/22/16, Test Report Numbers:

- 8.1.2.1 MUR(660)091516-24, 48-in. x 48-in. x 4.5-in.
- 8.1.2.2 MUR(660)091516-24, 48-in. x 48-in. x 6.5-in.

8.1.3 MUR(660)092815-21, ASTM E 661-03(2015), Concentrated Load, 06/17/2016, NTA, Inc. IAS Lab Certification No. TL-259

8.1.4 MUR(660)092815-34 Various Tests evaluating properties of polyurethane core material 06/17/2016, NTA, Inc. IAS Lab Certification No. TL-259 Including:

- 8.1.4.1 ASTM C272-12 Water Absorption
- 8.1.4.2 ASTM D1622-14 Density
- 8.1.4.3 ASTM D1621-10 Compressive Strength
- 8.1.4.4 ASTM C203-05a(2012) Flexural Strength
- 8.1.4.5 ASTM D1623-09 Tensile Strength
- 8.1.4.6 ASTM C273-11 Shear Strength
- 8.1.4.7 ASTM D1623-09 Adhesion
- 8.1.4.8 ASTM E96-14 Water Vapor Permeance
- 8.1.4.9 ASTM D2126-09 Dimensional Stability

8.1.5 MUR(660)092815-35, ASTM C480-08 Creep Resistance. 06/17/2016, NTA, Inc. IAS Lab Certification No. TL-259

8.1.6 F3569.01-121-24, NFPA 286-15 Contribution of wall and Ceiling Interior Finish to Room Fire Growth. 01/29/2016. Intertek-ATI, IAS Lab Certification No. TL-144

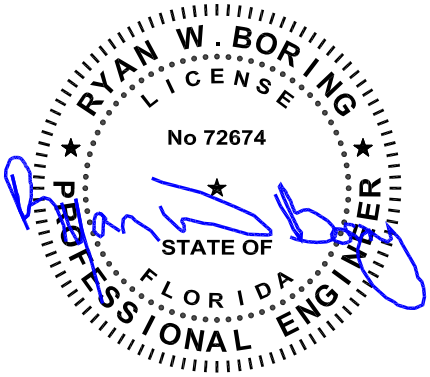

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Table 1: Basic Properties[1, 2]

Property	Strong-Axis Bending
Allowable Tensile Stress, F_t (psi)	495
Allowable Compressive Stress, F_c (psi)	619
Elastic Modulus (Bending), E_b (psi)	1,002,768
Shear Modulus, G (psi)	355
Allowable Core Shear Stress, F_v (psi)	6.5
Core Compressive Modulus, E_c (psi)	340
Reference Depth, h_o (in.)	4.500
Shear Depth Factor Exponent, m	0.977

[1] All properties are based on a minimum panel width of 24-in.
[2] Refer to *NTA IM14 TIP 01 SIP Design Guide* for details on engineered design using basic panel properties.

Table 2: Section Properties

Panel Thickness, h (in.)	Core Thickness, c (in.)	Dead Weight, w_d (psf)	Facing Area, A_f (in.^{2}/ft)	Shear Area, A_v (in.^{2}/ft)	Moment of Inertia, I (in.^{4}/ft)	Section Modulus, S (in.^{3}/ft)	Radius of Gyration, r (in.)	Centroid-to-Facing Dist., y_c (in.)
4.5	3.63	3.95	10.5	48.8	43.3	19.3	2.03	2.25
5.5	4.63	4.15	10.5	60.8	67.3	24.5	2.53	2.75
6.5	5.63	4.35	10.5	72.8	96.5	29.7	3.03	3.25

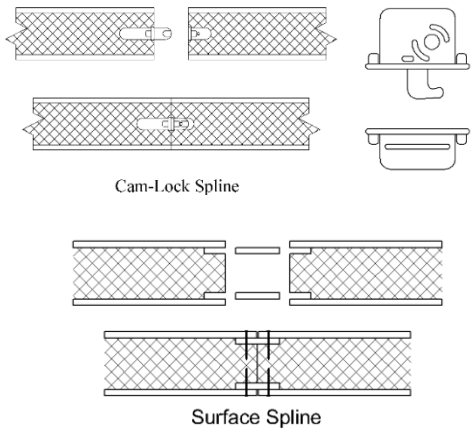


Figure 1: SIP Spline Types

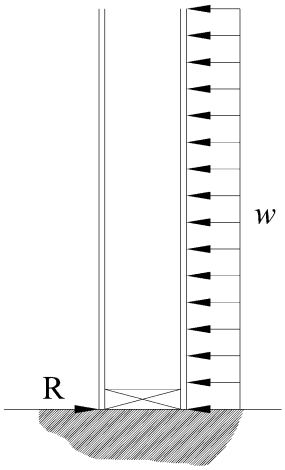


Figure 2: Zero Bearing Support

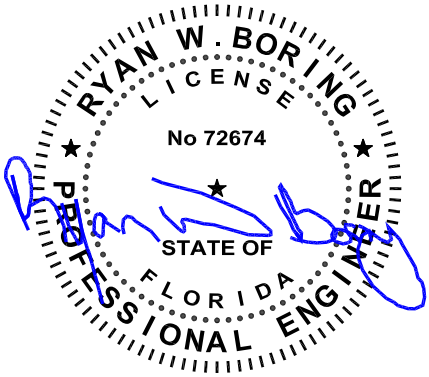
Table 3: Allowable Uniform Transverse Loads (psf) [1, 3]

Span (ft)	4-1/2-in. thick SIP			5-1/2-in. thick SIP			6-1/2-in. thick SIP		
	Deflection Limit[2]			Deflection Limit[2]			Deflection Limit[2]		
	L/180	L/240	L/360	L/180	L/240	L/360	L/180	L/240	L/360
4	175.5	131.6	87.8	222.6	166.9	111.3	247.6	202.3	134.8
6	105.5	79.1	52.7	134.3	102.2	68.1	141.5	125.4	83.6
8	69.5	52.2	34.8	91.7	68.8	45.8	99.0	85.7	57.1
10	48.1	36.1	24.1	64.8	48.6	32.4	76.2	61.5	41.0
12	34.5	25.8	17.2	47.2	35.4	23.6	60.7	45.5	30.3
14	25.3	19.0	12.7	35.3	26.5	17.6	45.9	34.5	23.0
16	19.0	14.3	9.5	26.9	20.2	13.4	35.4	26.6	17.7
18	14.6	10.9	7.3	20.9	15.6	10.4	27.8	20.8	13.9
20	11.3	8.5	5.7	16.4	12.3	8.2	22.1	16.5	11.0
22	9.0	6.7	4.5	13.1	9.8	6.6	17.8	13.3	8.9
24	7.2	5.4	3.6	10.6	8.0	5.3	14.5	10.8	7.2

[1] Table values assume a simply supported panel with 1.1/2-in. of continuous bearing on facing at supports (C_v = 1.0) with solid wood plates at bearing locations. Values do not include the dead weight of the panel. For wall panel capacities utilizing a zero bearing configuration (Figure 2), the allowable load shall be determined using C_v = 0.8.

[2] Deflection limit shall be selected by building designer based on the serviceability requirements of the structure and the requirements of adopted building code. Values are based on loads of short duration only and do not consider the effects of creep.

[3] Permanent loads, such as dead load, shall not exceed 0.50 times the tabulated load.



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