



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

Report Holder
The Murus Company
PO Box 220
Mansfield, PA 16933

Manufacturing Locations

The Murus Company
3234 Route 549
Mansfield, PA 16933

1. SUBJECT

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

2. SCOPE

NTA, Inc. has evaluated the above product(s) for compliance with the applicable sections of the following codes:

2.1 2000, 2003, 2006, 2009, 2012, 2015 International Building Code (IBC)

2.2 2000, 2003, 2006, 2009, 2012, 2015 International Residential Code (IRC)

NTA, Inc. has evaluated the above product(s) in accordance with:

2.3 NTA IM 014 Structural Insulated Panel Evaluation

2.4 NTA IM 036 Quality System Requirements

NTA, Inc. has evaluated the following properties of the above product(s):

2.5 Structural performance under axial, transverse and in-plane shear loads.

To obtain the most current NTA Listing Report, visit www.ntainc.com/report.

3. USES

3.1 General. *Murus PUR SIPs* are used as structural insulated roof and wall panels capable of resisting transverse, axial and in-plane shear loads.

3.2 Construction Types. *Murus PUR SIPs* shall be considered combustible building elements when determining the Type of Construction in accordance with IBC Chapter 6. (IM 014 NACU1)

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. (IM 014 ACU14)

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 wall and 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 2009 IRC Table 613.3.2 and DOC PS 2-04, 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. (IM 014 ACU4)

4.2.2 Core. The foamed-in-place polyurethane foam core has a minimum 2.2 pcf 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.

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. (IM 014 ACU 20)

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5. DESIGN

5.1 Overall Structural System. The scope of this report is limited to the evaluation of the SIP 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. (IM 014 NACU3)

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 where the construction is undertaken. Approved construction documents shall be available at all times on the jobsite during installation. (IM 014 NACU4)

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. (IM 014 NACU5)

5.4 Allowable Loads. Allowable axial, transverse, and in-plane shear loads may be calculated using the panel properties provided in Tables 1 and 2 or selected from Tables 3 through 5. 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 Concentrated Loads. Axial loads shall be applied to the product through continuous members such as structural insulated roof or floor panels or repetitive members such as joists, trusses or rafters spaced at regular intervals of 24-in. on center or less. Such members shall be fastened to a rim board or similar member to distribute the load to the product. For other loading conditions, reinforcement shall be provided. This reinforcement shall be designed in accordance with accepted engineering practice. (IM 014 ACU12)

5.6 Eccentric and Side Loads. Axial loads shall be applied concentrically to the top of the product. Loads shall not be applied eccentrically or through framing attached to one side of the panel (such as balloon framing) except where additional engineering documentation is provided. (IM 014 ACU13)

5.7 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. (IM 014 ACU8)

5.8 In-Plane Shear Design. Shear walls shall be sized to resist all code required wind and seismic loads without exceeding the allowable loads provided herein. Shear wall chords, hold-downs and connections to transfer shear forces between the wall and surrounding structure shall be designed in accordance with accepted engineering practice. (IM 014 ACU17) Allowable strengths for SIP shear walls with structural splines along each panel edge shall be designed in accordance with accepted engineering practice and are subject to the limitations for wood sheathed shear walls.

5.8.1 Seismic Design Categories A, B and C. Use of the shear wall configurations in Table 5 is limited to structures in Seismic Design Categories A, B and C. Where SIPs are used to resist seismic forces the following factors shall be used for design: Response Modification Coefficient, $R = 2.0$; System Overstrength Factor, $\Omega_o = 2.5$; Deflection Amplification Factor, $C_d = 2.0$. (IM 014 ACU16) The maximum panel height-to-width ratio shall be 2:1. (IM 014 ACU17)

5.9 Combined Loads. Panels subjected to any combination of transverse, axial or in-plane shear loads shall be analyzed utilizing a straight line interaction.

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 codes. In the event of a conflict between the manufacturer's published installation instructions and this report, this report shall govern. (IM 014 NACU7)

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.

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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.

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. (IM 014 NACU6)

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. (IM 014 ACU6)

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. (IM 014 ACU7) (IM 014 ACU22)

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. (IM 014 NACU9)

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. (IM 014 ACU11)
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. (IM 014 ACU15)

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.

6.9.2 Exterior Wall Covering. Panels shall be covered on the exterior by a water-resistive barrier as required by the applicable code. The water-resistive barrier shall be attached with flashing in such a manner as to provide a continuous water-resistive barrier behind the exterior wall veneer. (IM 014 ACU9) The exterior facing of the SIP wall shall be covered with weather protection as required by the adopted building code or other approved materials. (IM 014 ACU10)

6.9.3 Interior Finish. The foam plastic core shall be separated from the interior of the building by an approved thermal barrier of 1/2-in. gypsum wallboard or equivalent thermal barrier where required by IBC Section 2603.4.

7. CONDITIONS OF USE

Murus PUR SIPs as described in this report comply with the codes listed in Section 2, 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. (IM 014 ACU3)

7.3 In-use panel heights/spans shall not exceed the values listed herein. Extrapolation beyond the values listed herein is not permitted. (IM 014 ACU2)

7.4 The panels are manufactured in the production facilities listed in this report. (IM 014 NACU8)

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8. EVIDENCE SUBMITTED

NTA, Inc. has examined the following evidence to evaluate this product:

- 8.1** Review of each plant's quality assurance manual in accordance with NTA IM 036.
- 8.2** Plant certification inspection of each manufacturer's production facilities, test procedures, frequency and quality control sampling methods, test equipment and equipment calibration procedures, test records, dates and causes of failures when applicable in accordance with NTA IM 036.
- 8.3** Qualification test data in accordance with NTA IM 014 Standard Evaluation Plan (SEP) 01.
- 8.4** Periodic quality assurance audits of the production facilities.
- 8.5** Periodic verification testing in accordance with NTA IM 014 SEP 01.

Evaluation evidence and data are on file with NTA, Inc. NTA, Inc. is accredited by the International Accreditation Service (IAS) as follows:

- ISO 17020 Inspection Agency (AA-682)
- ISO 17025 Testing Laboratory (TL-259)
- ISO 17065 Product Certification Agency (PCA-102)

The scope of accreditation related to testing, inspection or product certification pertain only to the test methods and/or standard referenced therein. Design parameters and the application of building code requirements, such as special inspection, have not been reviewed by IAS and are not covered in the accreditation. Product evaluations are performed under the direct supervision of Professional Engineers licensed in all jurisdictions within the United States as required by the building code and state engineering board rules.

9. FINDINGS

All products referenced herein are manufactured under an in-plant Quality Assurance program to ensure that the production quality meets or exceeds the requirements of the codes noted herein and the criteria as established by NTA, Inc. Furthermore, product must comply with the conditions of this report.

This report is subject to annual review.

10. IDENTIFICATION

Each eligible product shall be permanently marked to provide the following information:

- 10.1** The NTA, Inc. listing mark, shown below.
- 10.2** NTA's Listing No. MUR021615-42
- 10.3** In-plant quality assurance stamp
- 10.4** Identifier for production facility
- 10.5** Project or batch number



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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)	515
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

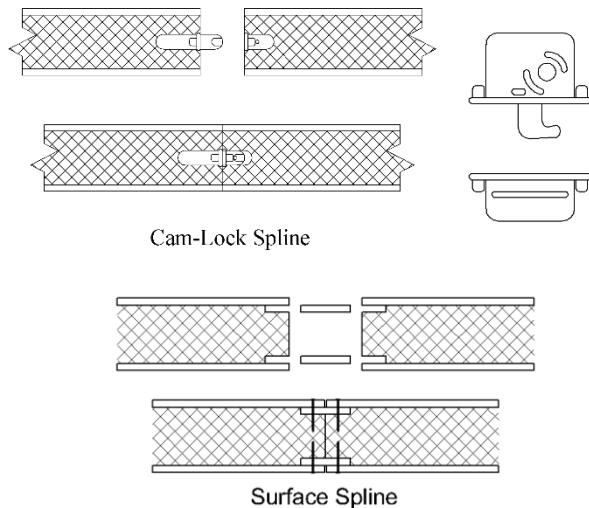


Figure 1: SIP Spline Types

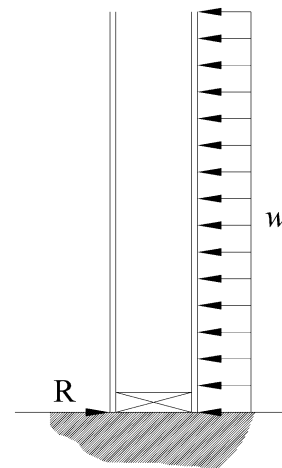


Figure 2: Zero Bearing Support

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Table 3: Allowable Uniform Transverse Loads (psf)^{1,3}

Panel Length (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
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 1.5 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.

Table 4: Allowable Axial Loads (plf)^{1,2,3,4}

Lateral Brace Spacing (ft)	Panel Thickness		
	4-1/2-in.	5-1/2-in.	6-1/2-in.
8	4140	4640	5140
10	3760	4260	4890
12	3380	3880	4640
14	3010	3500	4390
16	--	3120	4140
18	--	--	3900

¹ Permanent loads, such as dead load, shall not exceed 0.50 times the tabulated load.

² All values are for normal duration and may not be increased for other durations.

³ Axial loads shall be applied concentrically to the top of the panel through repetitive members spaced not more than 24 in. on center. Such members shall be fastened to a rim board or similar member to distribute along the top of the SIP.

⁴ The ends of both facings must bear on the supporting foundation or structure to achieve the tabulated axial loads.

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**Table 5: Allowable In-Plane Shear Strength (Pounds per Foot)
 for SIP Shear Walls (Wind and Seismic Loads in Seismic Design Categories A, B and C)^{1, 2}**

Spline Type ⁴	Minimum Nominal SIP Thickness (in.)	Minimum Facing Connections ^{2,4}			Shear Strength (plf)
		Chord ²	Plate ²	Spline ³	
Cam-lock	4-1/2	0.131"x 2-1/2" coated nails, 6" oc	0.131"x 2-1/2" coated nails, 3" oc	Cam-lock 24-in. oc.	150
	4-1/2 ⁵	0.131"x 2-1/2" coated nails, 6" oc	0.131"x 2-1/2" coated nails, 3" oc	Cam-lock 24-in. oc.	225

¹ Maximum shear wall dimensions ratio shall not exceed 2:1 (height: width) for resisting wind or seismic loads.
² Chords, hold downs and connections to other structural elements must be designed by a registered design professional in accordance with accepted engineering practice.
³ Spline type at interior panel-to-panel joints only. Solid chord members are required at each end of each shear wall segment.
⁴ Required connections must be made on each side of the panel. Dimensional or engineered lumber shall have an equivalent specific gravity of 0.42 or greater.
⁵ Assembly includes a second bottom 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, secured using 0.162-in. x 3-1/2-in. nails or an approved equivalent fastener.

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