



ICC Evaluation Service, Inc.
www.icc-es.org

Business/Regional Office ■ 5360 Workman Mill Road, Whittier, California 90601 ■ (562) 699-0543
Regional Office ■ 900 Montclair Road, Suite A, Birmingham, Alabama 35213 ■ (205) 599-9800
Regional Office ■ 4051 West Flossmoor Road, Country Club Hills, Illinois 60478 ■ (708) 799-2305

Legacy report on the BOCA® National Building Code/1999

DIVISION: 06—WOOD AND Plastics
Section: 06120—Structural Panels

EVALUATION SUBJECT:

MURUS PANELS

MANUFACTURER:

THE MURUS COMPANY
P.O. BOX 220
MANSFIELD, PA 16933

EVALUATION SCOPE

Compliance with the following code:

BOCA® National Building Code/1999

- Section 1603.1 General
- Section 1708.1 Where required
- Section 1710.3.1 Test procedure
- Section 2305.7 Wind bracing
- Section 1404.2 Durability
- Section 2603.2 Labeling
- Section 2603.3 Surface burning characteristics
- Section 2313.2 Sandwich panels
- Section 1704.3 Labeling

DESCRIPTION

The Murus Panel is a composite panel used for exterior wall and roof applications. The Murus Panel, when used as an exterior wall panel, is used either as a curtain wall panel, which resists transverse loads only, or an exterior wall panel, which resists axial and transverse loads. The composite panel is 4 1/2 inches thick, 4 feet wide and is available in various lengths. See Figure 1 of this report for a diagram of the Murus Panel.

- Table 1 of this report contains allowable transverse loads and spans for the Murus Panel.
- Table 2 of this report contains allowable loads and spans for Murus Panels subjected to uniform transverse and concentric axial loads.
- Table 3 of this report contains allowable loads and spans for Murus Panels subjected to uniform transverse and axial loads with an eccentricity of 3/4 in.

- Table 4 of this report contains the allowable horizontal racking load of the Murus Panel, with and without openings.

■ Panel Components

- **Core:** The foam plastic core consists of one of two available foam plastic systems which are as follows: Flexible Products CIP 1416-HC#2 and Flexible Products PPG 442-22D. The Flexible Products CIP 1416-HC#2 core is made up of a rigid urethane foam which consists of an isocyanurate and polyol catalyst blend. The Flexible Products PPG 442-22D core is made up of a rigid urethane foam which consists of an isocyanurate and a resin component blend. The foam plastic cores have a density of 2.2 pounds per cubic feet.
- **Exterior skins:** Each face of the Murus Panel consists of 7/16-inch exterior grade, Exposure 1, Oriented Strand Board (OSB) complying with the United States Department of Commerce PS 2-95 (DOC PS 2-95).
- **Joinery:** The Murus Panel has a tongue-and-groove edge. The connection between the panels is made with a cam lock system, which consists of two parts, as shown in Figure 2 of this report. The cam lock is located along the vertical edge of the Murus Panel at 2-foot intervals, beginning 1 foot from the top or bottom of the panel. Two Murus panels are secured together by aligning two Murus Panels with cam locks next to each other, with spray foam applied to the tongue (or groove) of one panel, and rotating the cam turning gear in the cam lock with a hex head wrench. After the connection is completed, spray foam is applied in the exterior channel between the two panel skins. The excess foam is removed prior to the application of the exterior wall covering.

CONDITIONS OF USE

This report is limited to the applications and products as stated in this report. The ICC-ES Subcommittee on National Codes intends that the report be used by the code official to determine that the report subject complies with the code requirements specifically addressed, provided that this product is installed in accordance with the following conditions:

- Murus Panels shall be installed in accordance with this report and the manufacturer's instructions. Where the manufacturer's installation instructions differ from this report, this report shall be null and void.
- Murus Panels shall be limited to use as an exterior wall or roof panel in Type 5 construction.
- The use of Murus Panels in fire-resistance rated wall or roof assemblies is beyond the scope of this report.

ICC-ES legacy reports are not to be construed as representing aesthetics or any other attributes not specifically addressed, nor are they to be construed as an endorsement of the subject of the report or a recommendation for its use. There is no warranty by ICC Evaluation Service, Inc., express or implied, as to any finding or other matter in this report, or as to any product covered by the report.

- The design loads on the system shall not exceed those given in Tables 1, 2, 3 and 4 of this report. Design values are for normal duration under dry use conditions and temperatures less than 160°F.
- Openings in the Murus Panels shall be limited to the sizes given in Figures 6 and 7 of this report. Openings larger than those shown in Figures 6 and 7 are beyond the scope of this report.
- The routing of chaseways into the Murus Panel wall for electrical, plumbing, HVAC or other purposes is beyond the scope of this report.
- A top in-let plate, as shown in Figure 3 of this report, shall be provided along the top edge of all Murus wall panels. The top in-let plate shall be installed in such a manner as to be continuous through the vertical panel joints. The top in-let plate shall consist of 2-inch by 4-inch dimension lumber. The plate shall be located in a 1 1/2-inch-deep routed channel at the top of the panel with spray foam applied between the foam core and the in-let plate. The OSB faces of the Murus Panel shall be secured to the top plate with 8d nails at 4 inches on center. The fasteners on the OSB faces shall be staggered from each other.
- A bottom in-let plate, as shown in Figure 4 of this report, shall be provided along the bottom edge of all Murus wall panels. The bottom in-let plate shall consist of 2-inch by 4-inch dimension lumber. The foam core of the panel shall be routed to completely embed the in-let plate in the panel, so that the OSB faces of the panel will bear completely on the surface which supports the Murus Panels. The in-let plate is to be fastened securely to the supporting structure as required by the approved construction documents. The void in the Murus Panel is sprayed with foam, as described above, prior to placing the panel over the in-let plate. The Murus Panel is then secured to the in-let plate on both faces with 8d nails at 4 inches on center. The fasteners on the OSB faces shall be staggered from each other.
- Openings in the Murus Panels for door and windows shall be rough framed with 2-inch by 4-inch dimension lumber embedded into the foam core of the panel in the same manner as the top and bottom in-let plates. The lumber framing shall be provided on all sides of the opening, as shown in Figure 5 of this report, and shall be secured to the OSB faces of the panel on both sides with 6d nails at 8 inches on center, staggered.
- The manufacturer shall provide the user of this report with instructions for the erection of Murus Panels. These instructions shall include, but not be limited to, details of panel to panel and panel to other building components interfaces.
- This report is subject to periodic re-examination. For information on the current status of this report, contact the ICC-ES.

ITEMS REQUIRING VERIFICATION

The following items are related to the use of the report subject, but are not within the scope of this evaluation. However, these items are related to the determination of code compliance:

- ✓ Product identification consistent with this report.
- ✓ Special inspections in accordance with Section 1705.0 of the BOCA® *National Building Code/1999*, and consistent with the following:

- **SPECIAL INSPECTIONS**

Special inspections are required for the installation of Murus Panels, in that it is work which is of an unusual design wherein installation, fabrication, erection and placement of components requires special expertise to ensure adequacy.

Therefore, the Committee's evaluation of Murus Panels is based upon monitoring and control of the installation of Murus Panels through the use of special inspections in accordance with Section 1705.0 of the BOCA® *National Building Code/1999*. The following items shall be inspected:

- **Bottom in-let plates, top in-let plates and preparation of rough openings for doors and windows**
 - Foam core of panel properly routed (not over routed) to receive 2-in by 4-in nailer
 - Condition of foam core (clean and dry)
- **Application of foam spray**
 - Sufficient quantity of spray applied
 - Ambient temperature/substrate temperature
 - Appropriate mix proportions of foam
 - Label on ingredients
- **Framing of door and window openings**
 - Framing full length on all sides of the opening
 - Framing properly lapped
- **Fastening of panel to in-let plates and opening framing**
 - Size of fasteners
 - Spacing of fasteners
 - Fasteners on both sides of panel
- **Cam locks**
 - Properly secured, as required by the manufacturer's installation instructions
- ✓ Thermal barrier separation, when required, in accordance with Section 2603.4 of the BOCA® *National Building Code/1999*.
- ✓ Where installed in roofing applications, roof covering complies with the applicable provisions of Chapter 15 of the BOCA® *National Building Code/1999*.
- ✓ Where installed in exterior wall applications, exterior wall covering complies with the applicable provisions of Chapter 14 of the BOCA® *National Building Code/1999*.

INFORMATION SUBMITTED

STRUCTURAL

- "Structural Evaluation of the Murus Stress-Skin Urethane Sandwich Panel," by Harvey B. Manbeck, P.E., Ph.D, of the NAHB/NRC Designated Housing Research Center at Penn State, dated August 1991, containing the following:
 - Results of adhesion testing of the OSB facers and the foam plastic core material when subjected to ASTM Standard C481-62 Aging Cycle A.
 - Results of flatwise tension testing in accordance with ASTM C297.
 - Results of edgewise compression testing in accordance with ASTM C364.
 - Results of flatwise compression testing in accordance with ASTM C365.
 - Results of flexural testing in accordance with ASTM C393.
 - Results of transverse and compression testing in accordance with ASTM E72.

The results of the above test are the basis for Tables 1 through 3 of this report.

- Results of horizontal racking testing in accordance with a modified version of ASTM E72 performed on Murus Panels with and without door and window openings. The modification was that no stud framing was provided, and the panels were 10 feet high rather than 8 feet high. The panels were secured to the base beam and top beam of the test assembly with #6 sheetrock screws at 8 inches on center. The results of the testing are given in Table 4 of this report. The door and window openings tested are shown in Figures 6 and 7 of this report.
- Report No. 30, "Creep Behavior of the Murus Stress-Skin Urethane Composite Sandwich Panel," by Harvey B. Manbeck, P.E., Ph.D, of the NAHB/NRC Designated Housing Research Center at Penn State, dated January 1993, containing results of testing in accordance with Section 1710.3.1 of the BOCA® *National Building Code/1999*.
- Celotex Corporation Testing Services, MTS Job No. 258498, dated June 3, 1998 and June 29, 1998, containing results of tensile, compressive, flexural and shear testing of the CIP 14-8557 (PPG 442-22D) foam plastic in accordance with ASTM D1623, ASTM D1621, ASTM C203 and ASTM C273. The results indicate that the CIP 14-8557 (PPG 442-22D) foam plastic has structural properties at least equivalent to the CIP 1416-HC#2 foam plastic.
- The minimum required design loads for the building for the building system, consistent with the requirements of Chapter 16 of the BOCA® *National Building Code/1999*.
- The allowable design loads of the panels, consistent with this report.
- The ability of all connections between the panel and adjacent building components to transfer all the imposed design loads to the building foundation and footing system.
- Details of panel openings, consistent with this report.
- Statement of Special Inspections

PRODUCT IDENTIFICATION

- Murus Panels or product packaging shall be marked at the plant with the identifying language "See ICC-ES Legacy Report No. 97-36."
- Additionally, each panel shall bear a label containing the manufacturer name, product name, and identification of the inspection agency, PFS Corporation.

This report is subject to re-examination in one year.

FOAM PLASTIC

- Omega Point Laboratories, Report No. 8926-98159, dated March 2, 1995, containing results of testing of the Flexible Products CIP 1416-HC#2 foam plastic in accordance with ASTM E84 at a thickness of 1 in and 5 3/4 in.
- Omega Point Laboratories, Report Nos. 9056-103120 and 9056-103121, dated May 11, 1998, containing results of testing of the Flexible Products CIP 14-8557 (PPG 442-22D) foam plastic in accordance with ASTM E84 at a thickness of 5 3/4 in.

LABELING

- The Murus Company, *Quality Control Manual*, dated March 1999, Revision D, signed by representatives of the Murus Company and PFS Corporation, containing procedures for the manufacture of the Murus Panel, in-house plant inspections, and product labeling.

APPLICATION FOR PERMIT

To aid in the determination of compliance with this report, the following represents the minimum level of information to accompany the application for permit:

- The language "See ICC-ES Legacy Report No. 97-36" or a copy of this report;
- Manufacturer's name.
- Product model name and number.
- Design calculations and details for construction utilizing Murus Panels shall be furnished to the code official verifying compliance with this report. The individual preparing such documents shall be competent and qualified in the application of the structural design principals involved, and shall possess the registration or license in accordance with the professional registration laws of the state in which the project is constructed. The calculations shall include, but not be limited to, the following:

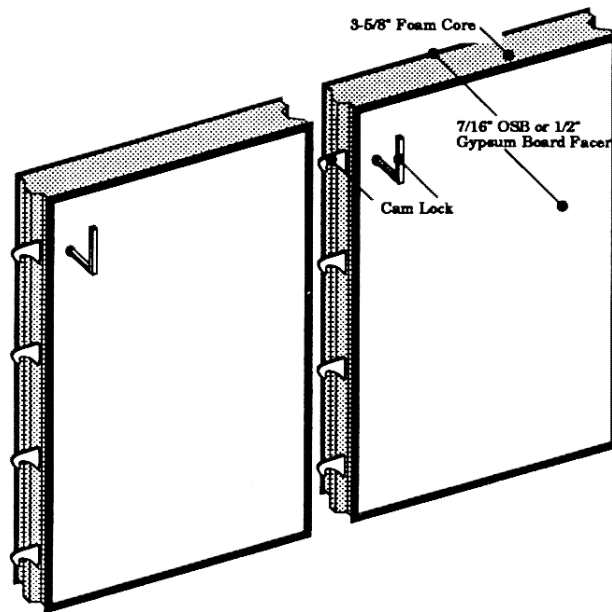


FIGURE 1—*MURUS PANELS

The panels are 48 inches wide. Cam Locks, if provided, are located 1 ft. from the top and bottom and at 2 ft. intervals in between.

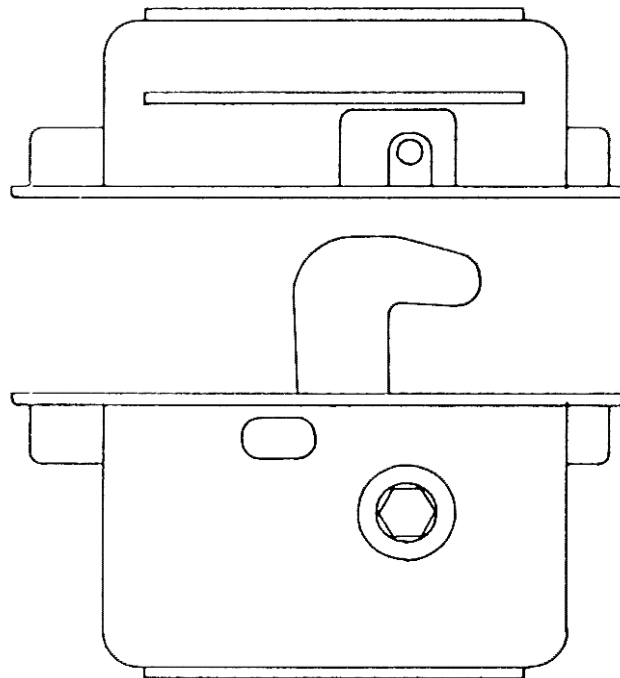


FIGURE 2*—CAM LOCK

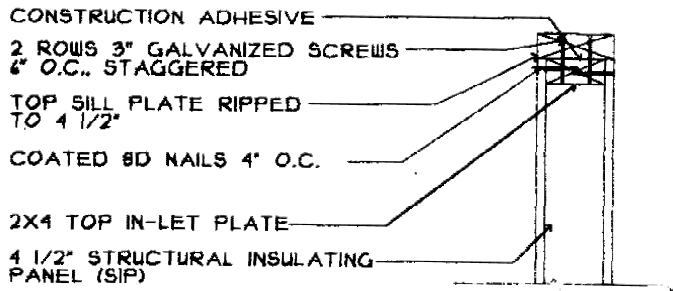


FIGURE 3*—TOP IN-LET PLATE

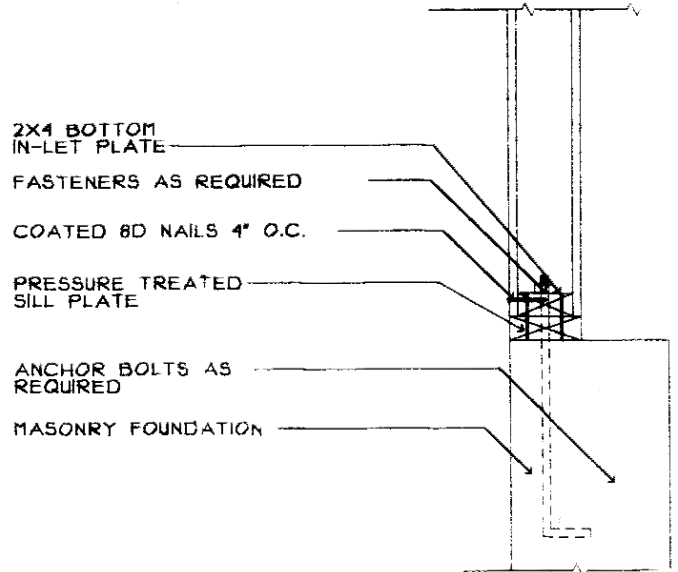


FIGURE 4*—BOTTOM IN-LET PLATE

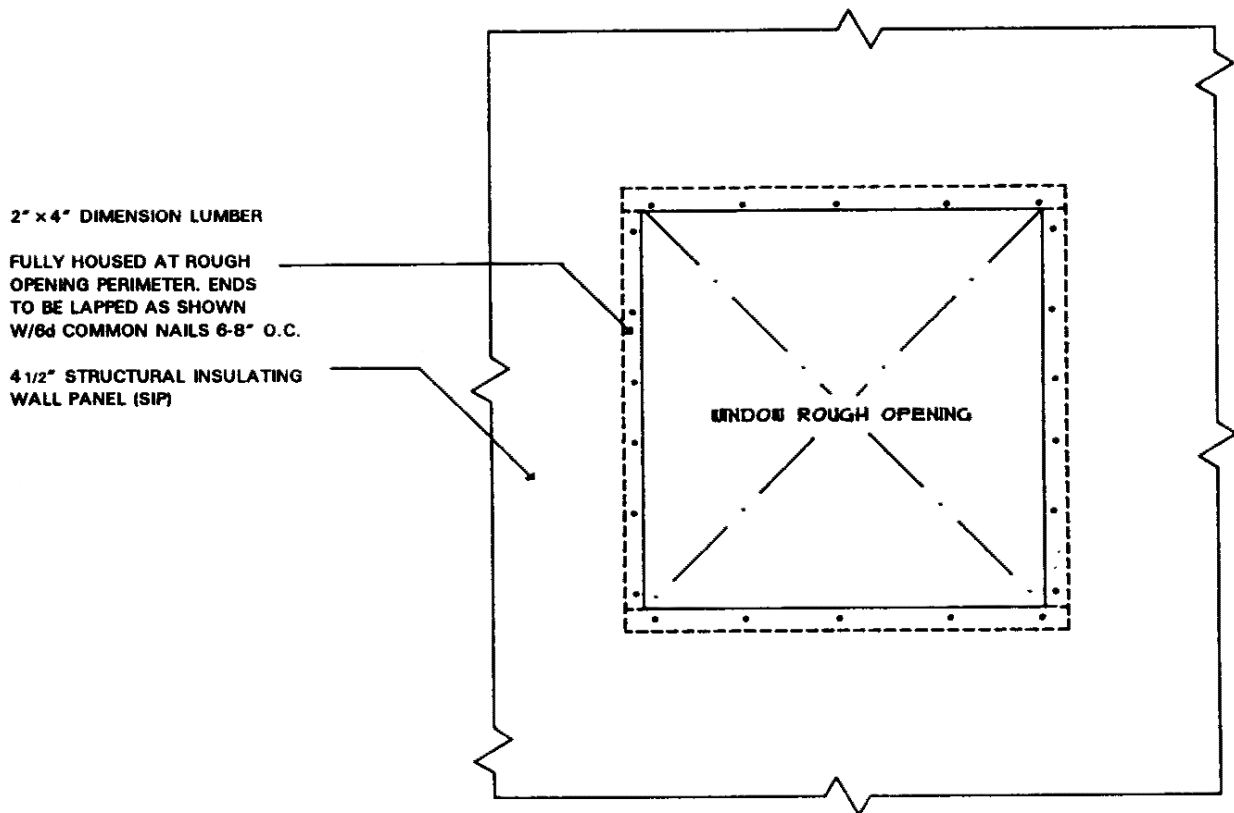


FIGURE 5*—FRAMING AT ROUGH OPENINGS FOR WINDOWS AND DOORS

TABLE 1
TRANSVERSE LOAD-SPAN TABLE FOR THE MURUS PANEL
(Customary Units)

UNIFORM TRANSVERSE LOAD ¹ (psf)	ALLOWABLE PANEL SPAN ^{2,3,4} (ft - in)			
	DEFLECTION LIMITS			
	L/180	L/240	L/360	L/480
5	20'-8"	18'-9"	16'-4"	14'-9"
10	16'-4"	14'-9"	13'-0"	11'-9"
15	14'-3"	13'-0"	11'-4"	10'-3"
20	13'-0"	11'-9"	10'-3"	9'-4"
25	12'-1"	11'-0"	9'-7"	8'-8"
30	11'-4"	10'-3"	9'-0"	8'-2"
35	10'-9"	9'-9"	8'-7"	7'-9"
40	10'-3"	9'-4"	8'-2"	7'-6"
45	9'-11"	9'-0"	7'-10"	7'-2"
50	9'-7"	8'-8"	7'-7"	6'-11"
55	9'-3"	8'-4"	7'-4"	6'-8"
60	9'-0"	8'-2"	7'-2"	6'-6"
65	8'-9"	8'-0"	7'-0"	6'-3"
70	8'-7"	7'-9"	6'-9"	6'-2"
75	8'-4"	7'-7"	6'-8"	6'-0"
80	8'-2"	7'-5"	6'-9"	5'-11"

1. Uniform load for normal load durations only.
2. Values given are for full (four foot) panel widths with facing strands oriented parallel to the panel span assuming proper end support and connections. The transverse load-carrying capacity of panels that contain openings is beyond the scope of this report.
3. Values given are computed from the continuous span uniform deflection equation using the flexural stiffness parameter $(EI)_g$ developed from the full scale transverse panel assembly test of the Murus Panel (ASTM E72-80).
4. Design values are for normal load duration under dry use conditions and temperatures less than 160°F.

TABLE 2
ALLOWABLE AXIAL LOAD/UNIT WIDTH FOR THE MURUS PANEL WITH NO ECCENTRICITY
(Customary Units)

TRANSVERSE LOAD ¹ psf	ALLOWABLE AXIAL LOAD* ^{1, 2, 3, 4} lb/ft										
	PANEL LENGTHS ft										
	4	5	6	7	8	9	10	11	12	13	14
0	9025	8720	8165	7250	5870	4640	3755	3105	2610	2220	1915
2	8975	8630	8030	7075	5690	4470	3600	2955	2460	2080	1775
4	8920	8540	7900	6905	5510	4310	3445	2805	2315	1940	1635
6	8865	8455	7765	6740	5340	4150	3295	2660	2175	1800	1500
8	8815	8365	7640	6575	5170	3990	3145	2515	2035	1660	1365
10	8760	8275	7510	6415	5005	3840	3000	2375	1900	1530	900*
12	8710	8190	7380	6255	4840	3690	2855	2235	1765	1240*	35*
14	8655	8100	7255	6100	4685	3540	2715	2100	1630	435*	NP
16	8600	8015	7130	5950	4530	3395	2575	1965	1180*	NP	NP
18	8550	7925	7010	5800	4375	3250	2440	1835	440*	NP	NP
20	8495	7840	6885	5650	4230	3110	2305	1665*	NP	NP	NP
22	8445	7755	6765	5505	4080	2975	2170	990*	NP	NP	NP
24	8390	7670	6645	5365	3940	2835	2040	310*	NP	NP	NP
26	8340	7585	6525	5220	3795	2705	1910	NP	NP	NP	NP
28	8285	7500	6410	5085	3655	2570	1590*	NP	NP	NP	NP
30	8235	7415	6295	4945	3520	2440	975*	NP	NP	NP	NP

* Load limited by L/240 deflection criterion

NP = Not Permitted

1. Uniform transverse and axial loads are for normal load durations only.
2. Values given are for full (four foot) panel widths with facing strands oriented parallel to the panel span assuming proper end support and connections. The load-carrying capacity of panels that contain openings is beyond the scope of this report.
3. Values given are computed from the combined load case and limiting deflection criterion using the flexural stiffness parameter $(EI)_g$ developed from the full-scale transverse panel assembly test of the Murus Panel (ASTM E72-80), F_c developed from the compression edgewise test of the Murus Panel (ASTM C364-61), F_b from published data for Oriented Strand Board.
4. Design values are for dry end use conditions and temperatures less than 160°F.

TABLE 3
ALLOWABLE AXIAL LOAD/UNIT WIDTH FOR THE MURUS PANEL WITH A 0.75-IN. ECCENTRICITY

TRANSVERSE LOAD ¹ psf	ALLOWABLE AXIAL LOAD ^{*1, 2, 3, 4} lb/ft										
	PANEL LENGTHS ft										
	4	5	6	7	8	9	10	11	12	13	14
0	4925	4605	4245	3835	3340	2930	2570	2260	1990	1765	1565
2	4895	4560	4190	3765	3260	2840	2475	2155	1885	1655	1455
4	4870	4520	4135	3695	3180	2755	2380	2055	1780	1545	1345
6	4845	4482	4080	3625	3100	2665	2285	1955	1680	1440	1130*
8	4815	4440	4025	3555	3020	2575	2190	1860	1575	1170*	760*
10	4790	4400	3970	3490	2945	2490	2095	1760	1335*	840*	385*
12	4760	4355	3915	3420	2865	2405	2005	1630*	1045*	510*	NP
14	4735	4315	3860	3350	2785	2320	1915	1380*	755*	180*	NP
16	4705	4275	3805	3280	2710	2235	1820	1128*	460*	NP	NP
18	4680	4235	3750	3215	2630	2150	1640*	875*	170*	NP	NP
20	4650	4195	3695	3145	2555	2065	1420*	620*	NP	NP	NP
22	4625	4155	3640	3080	2480	1980	1205*	365*	NP	NP	NP
24	4595	4115	3585	3010	2400	1895	990*	115*	NP	NP	NP
26	4570	4070	3530	2945	2325	1770*	775*	NP	NP	NP	NP
28	4540	4030	3475	2880	2250	1585*	555*	NP	NP	NP	NP
30	4515	3990	3420	2810	2175	1405*	340*	NP	NP	NP	NP

* Load limited by L/240 deflection criterion

NP = Not Permitted

- Uniform transverse and axial loads are for normal load durations only.
- Values given are for full (four foot) panel widths with facing strands oriented parallel to the panel span assuming proper end support and connections. The load-carrying capacity of panels that contain openings is beyond the scope of this report.
- Values given are computed from the combined load case and limiting deflection criterion using the flexural stiffness parameter $(EI)_g$ developed from the full-scale transverse panel assembly test of the Murus Panel (ASTM E72-80), F_c developed from the compression edgewise test of the Murus Panel (ASTM C364-61), F_b from published data for Oriented Strand Board, and an eccentricity of 0.75 inch, the same as required in the compression test of the Murus Panel (ASTM E72-80).
- Design values are for dry end use conditions and temperatures less than 160°F.

TABLE 4
HORIZONTAL RACKING RESISTANCE OF MURUS PANELS

Panel Assembly	Allowable Racking Resistance ¹	
	lbs	plf
Full Panel Assemblies	430	53.75
Panel with Door Opening ²	400	50
Panel with Window Opening ²	430	53.75

1. The connection at the head and sill of the panel shall conform to Figures 3 and 4 of this report.
2. The size of the door and window openings shall not exceed those shown in Figures 6 and 7 of this report, and the opening shall be rough framing with 2x4 dimension lumber, as shown in Figure 5 of this report.
3. The values in this table were obtained from panels attached with sheet rock screws at 8 inch on center.

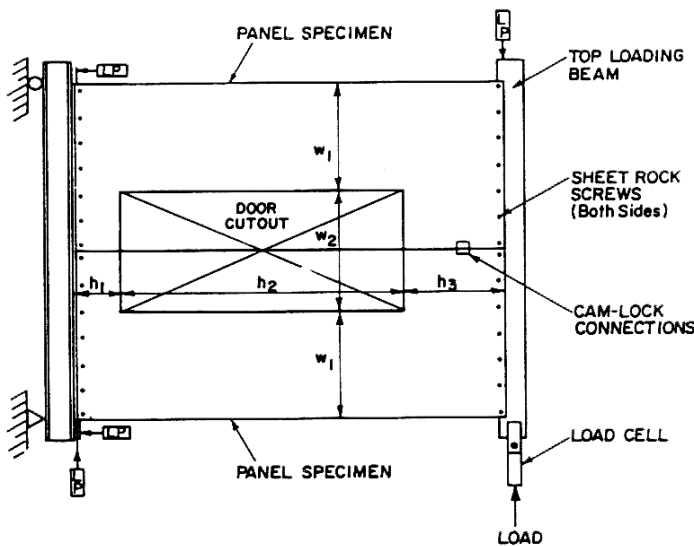


FIGURE 6*
PANEL TESTED WITH DOOR OPENING

- $h_1 = 12$ inches (30 cm)
- $h_2 = 84$ inches (210 cm)
- $h_3 = 24$ inches (60 cm)
- $w_1 = 29 \frac{1}{4}$ inches (74 cm)
- $w_2 = 37 \frac{1}{2}$ inches (95 cm)

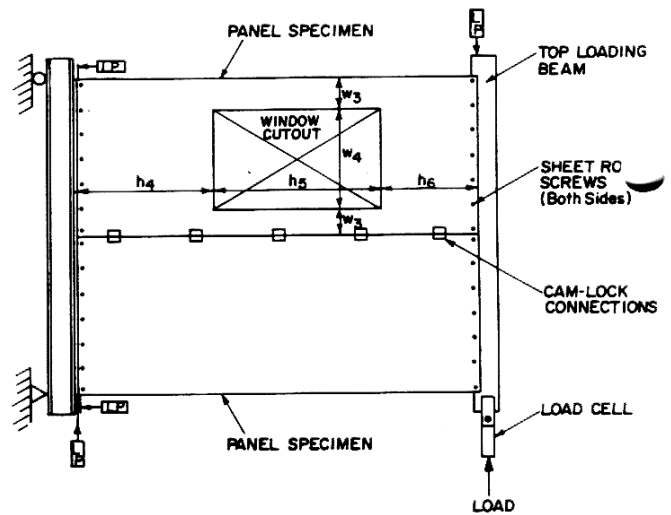


FIGURE 7*
PANEL TESTED WITH WINDOW OPENING

- $h_4 = 42$ inches (107 cm)
- $h_5 = 54$ inches (137 cm)
- $h_6 = 24$ inches (60 cm)
- $w_3 = 8$ inches (20 cm)
- $w_4 = 32$ inches (81 cm)

*THESE DRAWINGS ARE FOR ILLUSTRATION PURPOSES ONLY. THEY ARE NOT INTENDED FOR USE AS CONSTRUCTION DOCUMENTS FOR THE PURPOSE OF DESIGN, FABRICATION OR ERECTION.