Seismic Design Coefficients for Rmax Thermasheath®-SI Sheathing for Use with the *ASCE 7* & the *International Building Code*

TER No. 1308-08

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DIVISION: 06 00 00 – WOOD, PLASTICS, AND COMPOSITES
Section: 06 12 00 – Structural Panels
Section: 06 12 19 – Shear Wall Panels
Section: 06 16 00 – Sheathing

DIVISION: 07 00 00 – THERMAL AND MOISTURE PROTECTION
Section: 07 21 00 – Thermal Insulation
Section: 07 25 00 – Water-Resistive Barriers/Weather Barriers

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1. Product Evaluated:

1.1. Rmax Thermasheath®-SI

1.2. For the most recent version of this Technical Evaluation Report (TER), visit drjengineering.org. For more detailed state professional engineering and code compliance legal requirements and references, visit drjengineering.org/statelaw. DrJ is fully compliant with all state professional engineering and code compliance laws.

1.3. Requiring an evaluation report from a specific organization (ICC-ES, IAPAMO, CCMC, DrJ, etc.) is a violation of international, federal, state, provincial and local anti-trust and free trade regulations and constitutes restraint of trade. Building code regulations require that evaluation reports are provided by an approved agency meeting specific requirements. Any agency accredited in accordance with ANSI ISO/IEC 17065 meets this requirement within ANSI's scope of accreditation. For a list of accredited agencies, visit ANSI's website. For more information, see drjcertification.org

DrJ is a Professional Engineering Approved Source

Learn more about DrJ's Accreditation

- DrJ is an ISO/IEC 17065 accredited product certification body through ANSI Accreditation Services.
- DrJ provides certified evaluations that are signed and sealed by a P.E.
- DrJ's work is backed up by professional liability insurance.
- DrJ is fully compliant with *IBC* Section 1703.

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1.4. This TER can be used to obtain product approval in any country that is an IAF MLA Signatory (all countries found here) and covered by an IAF MLA Evaluation per the Purpose of the MLA (as an example, see letter to ANSI from the Standards Council of Canada). Manufacturers can go to jurisdictions in the U.S., Canada and other IAF MLA Signatory Countries and have their products readily approved by authorities having jurisdiction using DrJ's ANSI accreditation.

2. Applicable Codes and Standards:[1]

2.1. *2009, 2012* and *2015 International Building Code* (*IBC*)

2.2. *2009, 2012* and *2015 International Residential Code* (*IRC*)

2.3. *2010 and 2014 Florida Building Code* (*FBC*)

2.4. *AWC SDPWS Wind & Seismic – Special Design Provisions for Wind and Seismic (SDPWS)*

2.5. *ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures*

2.6. *ASTM E2126 - Standard Test Methods for Cyclic (Reversed) Load Test for Shear Resistance of Vertical Elements of the Lateral Force Resisting Systems for Buildings*

3. Performance Evaluation:

3.1. The purpose of this TER is to establish seismic design coefficients (SDC) for Rmax Thermasheath®-SI.

3.2. The goal of conducting equivalency testing is to classify Rmax Thermasheath®-SI as one of the seismic force-resisting systems in *ASCE 7* Table 12-2.1, which provides seismic design coefficients for select seismic force-resisting systems.

3.2.1. The basis for equivalency testing is outlined in Section 12.2.1 of *ASCE 7*:

> Seismic force-resisting systems not contained in Table 12.2-1 are permitted provided analytical and test data are submitted to the authority having jurisdiction for approval that establish their dynamic characteristics and demonstrate their lateral force resistance and energy dissipation capacity to be equivalent to the structural systems listed in Table 12.2-1 for equivalent values of response modification coefficient, R, overstrength factor, Ω_o, and deflection amplification factor, C_d.

3.2.2. The analysis undertaken is specifically aimed at verifying the SDCs assigned to Rmax Thermasheath®-SI are equivalent to the system assigned values set forth in Table 2 and given in Table 12.2-1 of *ASCE/SEI 7-10* for Item A.15: Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance.

3.3. The performance comparison procedure described in *ASCE 7* Section 12.2.1 is used to confirm appropriate seismic design coefficients. Specifically:

3.3.1. Cyclic shear wall testing is conducted in accordance with *ASTM E2126.*

3.3.2. Allowable seismic design values are determined.

3.3.3. Comparisons of energy dissipation capacity and ductility are made using the equal energy method.

3.4. The techniques created follow the use of accepted engineering procedures, experience, and technical judgment (see APA Report T2004-59 for a similar analysis of SDCs).

3.5. The objective of the *ASTM E2126* testing is to provide a means to verify:

3.5.1. The SDCs assigned to Rmax Thermasheath®-SI when used as vertical components of seismic force-resisting code-specified systems. This evaluation is needed since the codes do not provide guidance regarding requirements for these product types.

3.5.2. Recognition of SDCs under the *2015, 2012*, *2009* and *2006 IBC*.

3.5.2.1. The basis of recognition is *IBC* Section 104.11.

[1] Unless otherwise noted, all references in this code compliant research report (TER) are from the 2015 version of the codes and the standards referenced therein, including, but not limited to, *ASCE 7*, *SDPWS* and *WFCM*. This product also complies with the 2000-2012 versions of the *IBC* and *IRC* and the standards referenced therein. As required by law, where this research report is not approved, the building official shall respond in writing, stating the reasons this research report was not approved. For variations in state and local codes, if any, see Section 8.

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3.5.3. The SDCs for Rmax Thermasheath®-SI apply to load-bearing or non-load-bearing wood wall assemblies used to resist in-plane lateral loads in conjunction with light-frame wood wall construction.

3.6. The SDCs assigned to Rmax Thermasheath®-SI are equivalent to wood light-frame walls sheathed using wood structural panels rated for shear resistance.

3.7. Use of Rmax Thermasheath®-SI as a water-resistive barrier (WRB) is outside the scope of this evaluation. For this application see TER No. 1207-01.

3.8. Use of Rmax Thermasheath®-SI in a portal frame is outside the scope of this evaluation. For this application see TER No. 1207-01.

3.9. Evaluation as part of a fire resistance rated assembly is outside the scope of this TER.

3.10. Any code compliance issues not specifically addressed in this section are outside the scope of this evaluation.

4. Product Description and Materials:

4.1. Thermasheath®-SI is a proprietary wall sheathing consisting of a fibrous paperboard layer adhered to a proprietary foam plastic insulated sheathing (FPIS).

4.1.1. The proprietary fibrous sheathing board is a laminated board made of fibered, specially treated plies that are pressure-laminated with a water-resistant adhesive. The surface finish consists of a facer on one or both sides.

4.1.2. The FPIS layer consists of a proprietary polyisocyanurate insulation board. This layer also contains a facer material on both sides.

4.2. Material Availability:

4.2.1. Thickness: 1/2" (12 mm) through 1" (25 mm)

4.2.2. Standard product width: 48" (1,219 mm)

4.2.3. Standard lengths: 96", 108" and 120" (2,438 mm, 2,743 mm and 3,048 mm)

5. Applications:

5.1. Structural Seismic Resistance Applications

5.1.1. General Provisions

5.1.1.1. Except as otherwise described in this TER, Thermasheath®-SI shall be designed and installed in accordance with the codes and standards listed in Section 2 using the provisions set forth therein for the design and installation of wood structural panels (WSP).

5.1.1.1.1. Thermasheath®-SI is permitted to be designed in accordance with *SDPWS* for the design of shear walls using the methods set forth therein, including the perforated shear wall methodology, and subject to the *SDPWS* boundary conditions, except as specifically allowed in this TER.

5.1.1.1.2. Anchorage for in-plane shear shall be provided to transfer the induced shear force into and out of each shear wall.

5.1.1.1.2.1. For seismic design, anchor bolt spacing shall not exceed 4' o.c.

5.1.1.2. The maximum aspect ratio for Rmax Thermasheath®-SI shall be 4:1.

5.1.1.3. The minimum full height panel width shall be 24".

5.1.1.4. All panel edges shall be blocked with a minimum 2" nominal lumber.

5.1.1.5. Where Thermasheath®-SI is installed with ½" gypsum wallboard on the interior side of the wall, the gypsum sheathing shall be applied to the interior side of the wall assembly and fastened with a minimum 5d cooler nails or 1 1/4" #6 types W or S screws spaced 8" o.c. at panel edges and 8" o.c. in the field of the panels.

5.1.1.6. Where the application exceeds the limitations set forth herein, design shall be permitted in accordance with accepted engineering procedures, experience, and technical judgment.

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5.1.2. Performance-Based Wood-Framed Construction

5.1.2.1. Rmax Thermasheath®-SI panels used in wall assemblies designed as shear walls are permitted to be designed in accordance with the methodology used in *SDPWS* for wood structural panels.

5.1.2.2. Rmax Thermasheath®-SI shear walls that require seismic design in accordance with *IBC* Section 1613 shall use the seismic allowable unit shear capacities set forth in Table 1.

5.1.2.2.1. The response modification coefficient, R, system overstrength factor, Ω_0, and the deflection amplification factor, C_d, indicated in Table 1 shall be used to determine the base shear, element design forces, and design story drift in accordance with *ASCE 7* Chapter 12 and Section 14.5.

5.1.2.2.2. Allowable transverse loads due to wind are as shown in Table 2 with the corresponding allowable wind speeds.

Allowable Strength Design (ASD) Capacity and Seismic Design Coefficients (Seismic)[1]													
Seismic Force-Resisting System	Maximum Stud Spacing (in)	Gypsum Wallboard (GWB)	Seismic Allowable Unit Shear Capacity (plf)	Apparent Shear Stiffness, G_a (kips/in)	Response Modification Factor, R[2]	System Overstrength Factor, Ω_0[3]	Deflection Amplification Coefficient, C_d[4]	Structural System Limitations & Building Height (ft.) Limit[5]				
								Seismic Design Category				
								B	C	D	E	F
Light-Frame (Wood) Walls Sheathed with Thermasheath®-SI	16" o.c.	½" GWB	320	12.5	6.5	3	4	NL	NL	65	65	65
	16" o.c.	No GWB	225	6.5	6.5	3	4	NL	NL	65	65	65

1. All seismic design coefficients follow the equivalency procedures as defined in Section 3 of this TER.
2. Response modification coefficient, R, for use throughout *ASCE 7*. Note R reduces forces to a strength level, not an allowable stress level.
3. The tabulated value of the overstrength factor, Ω_0, is permitted to be reduced by subtracting one-half (0.5) for structures with flexible diaphragms.
4. Deflection amplification factor, C_d, for use with *ASCE 7* Section 12.8.6, 12.8.7 and 12.9.2.
5. NL = Not Limited. Heights are measured from the base of the structure as defined in *ASCE 7* Section 11.2.
6. Gypsum wallboard attached with minimum #6 type W or S screws 1¼" long spaced 8" o.c. at panel edges and in the field. Maximum stud spacing is 16" o.c.

Table 1: Seismic Performance of Rmax Thermasheath®-SI

5.1.2.3. Rmax Thermasheath®-SI panels are permitted to resist transvers loads using the allowable resistance (in pounds per square foot) set forth in Table 2.

Nominal Uniform Load Capacities (psf) for Resisting Transverse Wind Loads									
Sheathing Panel	Transverse Wind Load Resistance								
	Sheathing Thickness (in.)	Maximum Stud Spacing (in.)	Negative		Positive		Fastener Schedule	Basic Wind Speed V_{asd} per *ASCE 7-05* (mph)	Basic Wind Speed V_{ult} per *ASCE 7-10* (mph)
			Ultimate Average Pressure (psf)	Allowable Design Value (psf)	Ultimate Average Pressure (psf)	Allowable Design Value (psf)			
Rmax Thermasheath®-SI	1/2"	16" o.c.	170	105	180	115	1" crown, 1¼" leg 16 gage galvanized staples, 3" o.c. at the perimeter, 6" o.c. in the field	170	215

1. The ASD allowable uniform load capacities to be used for wind design are determined by dividing the nominal uniform load capacities by an ASD reduction factor of 1.6, per *SDPWS* Section 3.2.1.
2. Design wind load capacity shall be in accordance with *IBC* Section 1609.1.1.
3. Staple crowns shall be installed parallel to grain.
4. Allowable wind speeds are based on the following: Mean roof height 30', Exposure B, 10 sq ft effective wind area. See the applicable building code for any adjustment need for specific building location and configuration.

Table 2: Transverse Load Performance of Rmax Thermasheath®-SI

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5.2. Table 2 Derivation:

5.2.1. The seismic design coefficients for the Rmax Thermasheath®-SI panels were determined using the Equal Energy Method.

5.2.2. Using the Equal Energy Method, the R factor was determined for each test using the following formula:

$$R = 0.7 \times \sqrt{\frac{2 * A}{K_e * {\Delta_e}^2}}$$

Where:

R = Response modification factor

A = the area under envelope curve from zero to ultimate displacement (Δ_u) of the specimen, lb-in

P_{peak} = maximum absolute load resisted by the specimen in the given envelope, lbf

Δ_e = displacement of the top edge of the specimen at $0.4P_{peak}$, in

K_e = elastic shear stiffness of the shear wall = $0.4P_{peak}/\Delta_e$.

5.2.3. The calculated R factor is directly related to the area under the load deflection curve, which is a measure of the energy dissipation.

5.2.4. The ductility, μ, of the wall was calculated as follows:

$$\mu = \frac{\Delta_u}{\Delta_e}$$

Where:

Δ_u = displacement corresponding to the last data point with the absolute load equal or greater than $\left|0.8P_{peak}\right|$, in; and

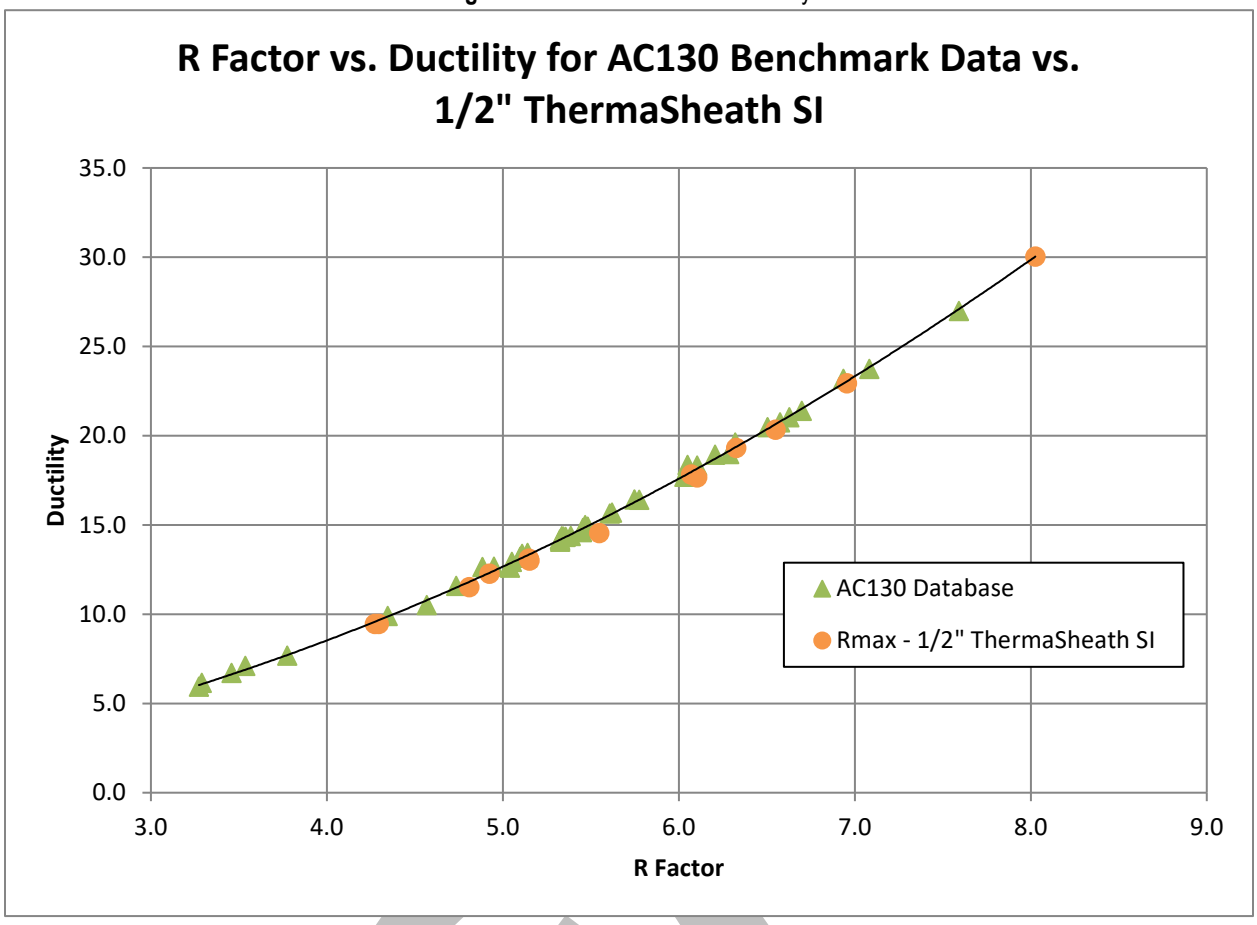
Δ_e = displacement of the top edge of the specimen at $0.4P_{peak}$, in

5.2.1. A plot of the calculated R factor vs. the ductility of the wall is displayed in Figure 1.

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Figure 1: Plot of R Factor vs. Ductility



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5.2.2. Rmax Thermasheath®-SI performed within the range of WSP shear walls in the AC130 database as shown by the comparisons presented in this report.

5.2.3. Based on the comparisons presented in the report and in accordance with *ASCE 7* Section 12.2.1, the WSP shear wall design coefficients and factors are appropriate for Rmax Thermasheath®-SI.

5.2.4. The seismic ASD resistance was obtained by dividing the tested shear capacity by a factor of safety of 2.5.

6. Installation:

6.1. Thermasheath®-SI shall be installed in accordance with the manufacturer's published installation instructions and this TER. In the event of a conflict between the manufacturer's installation instructions and this TER, the more restrictive shall govern.

6.2. Refer to TER No. 1207-01, the manufacturer's installation instructions in addition to this TER for complete details and requirements.

7. Test and Engineering Substantiating Data:

7.1. *International Building Code (IBC)*, International Code Council.

7.2. "A Brief Guide to Seismic Design Factors"; SEAOC Seismology Committee; *Structure Magazine*, September 2008.

7.3. AWC, *Special Design Provisions for Wind and Seismic (SDPWS)*.

7.4. APA, 2004. Confirmation of Seismic Design Coefficients for the APA Portal Frame. Research Report T2004-59. September, 2004. APA-The Engineered Wood Association. Tacoma, WA.

7.5. *Design of Multistory Reinforced Concrete Buildings for Earthquake Motions*; John Blume, Nathan Newmark, and Leo Corning, Portland Cement Association, Skokie, Illinois; 1961.

7.6. *Establishing seismic equivalency to code-listed light-frame wood wall systems*; Ned Waltz, Tom Skaggs, Philip Line, and David Gromala; Proceeding of World Conference on Timber Engineering (WCTE), WCTE, Miyazaki, Japan; 2008.

7.7. *Minimum Design Loads for Buildings and other Structures* (ASCE 7); American Society of Civil Engineers.

7.8. *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures*, 2003 Edition, Part 2: Commentary (FEMA 450-2); Building Seismic Safety Council, Washington, D.C.

7.9. *Reinforced Concrete Structures*; Robert Park and T. Paulay; John Wiley and Sons; 1975.

7.10. "Seismic Force-Resisting Systems Part 1: Seismic Design Factors"; SEAOC Seismology Committee; *Structure Magazine*, January 2009.

7.11. "Seismic Force-Resisting Systems Part 2: Codified Systems"; SEAOC Seismology Committee; *Structure Magazine*, February 2009.

7.12. Seismic test reports and data for determining comparative equivalency for use as an alternative material conducted by an ISO/IEC 17025 accredited testing laboratory under contract with Qualtim, Inc., based on *ASTM E2126*.

7.13. The product(s) evaluated by this TER falls within the scope of one or more of the model, state or local building codes for building construction. The testing and/or substantiating data used in this TER is limited to buildings, structures, building elements, construction materials and civil engineering related specifically to buildings.

7.14. The provisions of model, state or local building codes for building construction do not intend to prevent the installation of any material or to prohibit any design or method of construction. Alternatives shall use consensus standards, performance-based design methods or other engineered alternative means of compliance. This TER assesses compliance with defined standards, generally accepted engineering analysis, performance-based design methods, etc. in the context of the pertinent building code requirements.

7.15. Some information contained herein is the result of testing and/or data analysis by other sources, which DrJ relies on to be accurate as it undertakes its engineering analysis.

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7.16. DrJ has reviewed and found the data provided by other professional sources credible. This information has been approved in accordance with DrJ's procedure for acceptance of data from approved sources.

7.17. DrJ's responsibility for data provided by approved sources is in accordance with professional engineering law.

7.18. Where appropriate, DrJ relies on the derivation of design values, which have been codified into law through codes and standards (e.g., *IRC*, *WFCM*, *IBC*, *SDPWS*, etc.). This includes review of code provisions and any related test data that helps with comparative analysis or provides support for equivalency to an intended end-use application.

8. Findings:

8.1. When installed and fastened in accordance with this report, Rmax Thermasheath®-SI has the SDCs as defined in Table 1.

8.2. *IBC* Section 104.11 and *IRC* Section R104.11 (*IFC* Section 104.9 is similar) state:

> **104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code. … Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons the alternative was not *approved*.[2]

8.3. This product has been evaluated with the codes listed in Section 2, and is compliant with all known state and local building codes. Where there are known variations in state or local codes that are applicable to this evaluation, they are listed here:

8.3.1. No known variations

8.4. This TER uses professional engineering law, the building code, ANSI/ASTM consensus standards and generally accepted engineering practice as its criteria for all testing and engineering analysis. DrJ's professional engineering work falls under the jurisdiction of each state Board of Professional Engineers, when signed and sealed.

9. Conditions of Use:

9.1. Where required by the authority having jurisdiction (AHJ) in which the project is to be constructed, this report and the installation instructions shall be submitted at the time of permit application.

9.2. Any generally accepted engineering calculations needed to show compliance with this TER shall be submitted to the code official for review and approval.

9.3. Design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed.

9.4. Rmax Thermasheath®-SI shall not be used as a nailing base.

9.5. Walls sheathed with Rmax Thermasheath®-SI shall not be used to resist horizontal loads from concrete and masonry walls.

9.6. When Rmax Thermasheath®-SI is not installed as shear wall bracing, other means of bracing the walls are required.

9.7. When used in accordance with the *IBC* in Seismic Design Categories C, D, E or F, special inspections shall comply with *IBC* Section 1705.12[3].

9.8. Design loads shall be determined in accordance with the building code adopted by the jurisdiction in which the project is to be constructed.

9.9. Loads applied shall not exceed those recommended by the manufacturer as follows:

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[2] The last sentence is adopted language in the 2015 codes.
[3] 2009 *IBC* Section 1705.3; 2012 *IBC* Section 1705.11.

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9.9.1. Allowable shear loads do not exceed values in Table 1 for seismic loads.

9.9.2. Transverse design loads shall not exceed those described in Table 2, unless an approved exterior wall covering capable of separately resisting loads perpendicular to the face of the walls is installed over the sheathing.

9.10. The manufacturer's installation instructions shall be shipped to the jobsite with the materials or otherwise be available on the jobsite for inspection.

9.11. Solid blocking shall be installed behind all horizontal joints.

9.12. The sheathing materials are manufactured in Dallas, TX, Fernley, NV, and Greer, SC, under a quality control program with quality control inspections in accordance with *IBC* Section 110.4, 110.3.8 or 110.3.9.

9.13. Design

9.13.1. Building Designer Responsibility

9.13.1.1. Unless the AHJ allows otherwise, the Construction Documents shall be prepared by a Building Designer (e.g., Owner, Registered Design Professional, etc.) for the Building and shall be in accordance with *IRC* Section R106 and *IBC* Section 107.

9.13.1.2. The Construction Documents shall be accurate and reliable and shall provide the location, direction and magnitude of all applied loads and shall be in accordance with *IRC* Section R301 and *IBC* Section 1603.

9.13.2. Construction Documents

9.13.2.1. Construction Documents shall be submitted to the Building Official for approval and shall contain the plans, specifications and details needed for the Building Official to approve such documents.

9.14. Responsibilities

9.14.1. The information contained herein is a product, engineering or building code compliance technical evaluation report performed in accordance with the referenced building codes, testing and/or analysis through the use of accepted engineering procedures, experience and technical judgment.

9.14.2. DrJ technical evaluation reports provide an assessment of only those attributes specifically addressed in the Products Evaluated or Code Compliance Process Evaluated section.

9.14.3. The engineering evaluation was performed on the dates provided in this TER, within DrJ's professional scope of work.

9.14.4. This product is manufactured under a third-party quality control program in accordance with *IRC* Section R104.4 and R109.2 and *IBC* Section 104.4 and 110.4.

9.14.5. The actual design, suitability and use of this TER for any particular building is the responsibility of the Owner or the Owner's authorized agent, and the TER shall be reviewed for code compliance by the Building Official.

9.14.6. The use of this TER is dependent on the manufacturer's in-plant QC, the ISO/IEC 17020 third-party inspection process, proper installation per the manufacturer's instructions, the Building Official's inspection and any other code requirements that may apply to assure accurate compliance with the applicable building code.

10. Identification:

10.1. Each Rmax Thermasheath®-SI panel described in this TER is identified by a label on the board or packaging material bearing the manufacturer's name, product name, TER number, and other information to confirm code compliance

10.2. Additional technical information can be found at Rmax.com.

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11. Review Schedule:

11.1. This TER is subject to periodic review and revision. For the most recent version of this TER, visit drjengineering.org.

11.2. For information on the current status of this TER, contact DrJ Engineering.

- Mission and Professional Responsibilities
- Product Evaluation Policies
- Product Approval – Building Code, Administrative Law and P.E. Law

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