



AISI S250-21



**American
Iron and Steel
Institute**

AISI STANDARD

North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing

2021 Edition



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DISCLAIMER

The material contained herein has been developed by the American Iron and Steel Institute (AISI) Committee on Framing Standards. The Committee has made a diligent effort to present accurate, reliable and useful information on cold-formed steel framing design and installation. The Committee acknowledges and is grateful for the contributions of the numerous researchers, engineers, and others who have contributed to the body of knowledge on the subject. Specific references are included in the *Commentary*.

With anticipated improvements in understanding of the behavior of cold-formed steel framing and the continuing development of new technology, this material will become dated. It is anticipated that AISI will publish updates of this material as new information becomes available, but this cannot be guaranteed.

The materials set forth herein are for general purposes only. They are not a substitute for competent professional advice. Application of this information to a specific project should be reviewed by a design professional. Indeed, in many jurisdictions, such review is required by law. Anyone making use of the information set forth herein does so at their own risk and assumes any and all liability arising therefrom.

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PREFACE

The American Iron and Steel Institute Committee on Framing Standards has developed AISI S250, *North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing*, to provide calculation tools, methodologies, and testing standards for use in determining the thermal performance of floor, above-grade wall, and roof/ceiling assemblies constructed with *cold-formed steel* framing. This Standard is intended for adoption and use in the United States, Canada, and Mexico.

The equations in this Standard are based on U.S. customary units. When using SI units, the user of this Standard must convert the values to U.S. customary units, execute the equations, and then convert the result(s) to SI units.

The American Iron and Steel Institute also created a spreadsheet that performs mathematical calculations for determining the *thermal transmittance* of wall assemblies and conventional and *truss* roof assemblies based on AISI S250-21. Click **HERE** to download.

The Committee acknowledges and is grateful for the contributions of the numerous engineers, researchers, producers, and others who have contributed to the body of knowledge on the subjects. The Committee wishes to also express its appreciation for the support of the Canadian Sheet Steel Building Institute.

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AISI acknowledges the contributions of Andre Desjarlais, Oak Ridge National Laboratory; Alex McGowan, WSP Group; and Paul Shipp, USG Corporation to this first edition of the Standard.

SYMBOLS

Symbol	Definition	Section
C_0, C_1, C_2 , etc.	OTZ coefficients	B3.1.1
CFS_{depth}	Web depth of cold-formed steel framing member that is in contact with cavity insulation (inches)	B3.1.3, Appendix 1
CFS_{flange}	Flange width of cold-formed steel framing member (inches)	B3.1.2, Appendix 1
$CFS_{webairspace}$	Depth of air space in cavity (inches)	B3.1.4, Appendix 1
CFS_t	Designation thickness of cold-formed steel framing member (mils)	B3.1.2, Appendix 1
F_c	Correction factor (dimensionless)	B3.2, B3.2.1, B4.1
FF_{cs}	C-shape framing factor (dimensionless)	B3.1.2, B3.1.3, B3.1.4
FF_{otz}	OTZ framing factor (dimensionless)	B3.1.7, B3.1.8
FS	Spacing of cold-formed steel framing members (inches)	B3.1.7, Appendix 1
k	Thermal conductivity (Btu/h·ft ² ·°F)	B3.1.3, B3.1.4, Appendix 1
OTZ	Overall thermal zone (inches)	B3.1.1, B3.1.7
R_1, R_2, R_3	Thermal resistance (R-values) (h·ft ² ·°F/Btu)	B3.1.3, B3.1.4, B3.1.5, B3.1.6
R_{air}	Thermal resistance (R-value) of the cavity air space (h·ft ² ·°F/Btu)	B3.1.1, B3.1.4, B3.1.6
R_{cav}	Total thermal resistance (R-value) of the wall cavity (h·ft ² ·°F/Btu)	B3.1.1
R_{cum}	Cumulative thermal resistance (R-value) (h·ft ² ·°F/Btu)	B3.2.1
R_i	Thermal resistance (R-value) of indoor air film (h·ft ² ·°F/Btu)	B3.1.6, Appendix 1
R_o	Thermal resistance (R-value) of outdoor air film (h·ft ² ·°F/Btu)	B3.1.6, Appendix 1
R_{ins}	Thermal resistance (R-value) of cavity insulation (h·ft ² ·°F/Btu)	B3.1.1, B3.1.3, B3.1.6, B3.2.1, B4.1, B4.2.1, B4.2.2, B4.2.3, Appendix 1
R_{result}	Resulting thermal resistance (R-value) (h·ft ² ·°F/Btu)	B3.2.1
R_{s-roof}	Cumulative thermal resistance (R-value) of roof/ceiling components along a path of heat transfer (h·ft ² ·°F/Btu)	B4.1
R_{s-wall}	Thermal resistance (R-value) of the wall assembly at the web of the cold-formed steel framing member (h·ft ² ·°F/Btu)	B3.1.3
R_{she}	Thermal resistance (R-value) of exterior continuous insulation (h·ft ² ·°F/Btu)	B3.1.1, B3.1.6, Appendix 1
R_{spc}	Thermal resistance (R-value) of all materials in the design assembly in series for the cavity path (h·ft ² ·°F/Btu)	B3.1.6, B3.1.8
R_{sps}	Thermal resistance (R-value) of all materials in the design assembly in series for the C-shape path (h·ft ² ·°F/Btu)	B3.1.6, B3.1.8
R_{tot}	Whole assembly thermal resistance (R-value) (h·ft ² ·°F/Btu)	B3.2.1
$Sheath_{ext}$	Thermal resistance (R-value) of all exterior sheathing(s) (h·ft ² ·°F/Btu)	B3.1.6, Appendix 1
$Sheath_{int}$	Thermal resistance (R-value) of all interior sheathing(s) (h·ft ² ·°F/Btu)	B3.1.6, Appendix 1

R_{ext}	<i>Thermal resistance (R-value) of exterior siding</i> ($\text{h}\cdot\text{ft}^2\cdot^\circ\text{F}/\text{Btu}$)	B3.1.6, Appendix 1
$U_1, U_2, U_o, U_r,$ U_t	<i>Thermal transmittance (U-factors)</i> ($\text{Btu}/\text{h}\cdot\text{ft}^2\cdot^\circ\text{F}$)	B3.1.3, B3.1.4, B3.1.8, B4.1, B4.2, B4.2.1, B4.2.2, B4.2.3



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NORTH AMERICAN STANDARD FOR THERMAL TRANSMITTANCE OF BUILDING ENVELOPES WITH COLD-FORMED STEEL FRAMING

A. GENERAL

A1 Scope and Applicability

A1.1 Scope

This Standard applies to the overall *thermal transmittance (U-factor)* of building envelopes containing *cold-formed steel* framing.

A1.2 Applicability

A1.2.1 This Standard shall be used to determine *thermal transmittance (U-factors)* for assessing the energy code compliance of building envelopes for the following:

- (a) floor assemblies,
- (b) *above-grade wall* assemblies, and
- (c) roof/ceiling assemblies.

A1.2.2 Where conflicts between this Standard and the *applicable code* occur, the requirements of the *applicable code* shall govern. In areas without an *applicable code*, this Standard defines the minimum acceptable standards for elements falling within the scope of this Standard, as defined in Section A1.1.

A1.2.3 This Standard does not preclude the use of other *approved* materials, assemblies, structures or designs of equivalent performance.

A1.2.4 This Standard includes Sections A through B and Appendix 1.

A2 Definitions

In this Standard, “shall” is used to express a mandatory requirement; i.e., a provision that the user is obliged to satisfy in order to comply with the Standard. Provisions described as “permitted” are optional, and the election to use such provisions is at the discretion of the *registered design professional*.

Where the following terms appear in this Standard in italics, such terms shall have meaning as defined herein. Terms not defined in Section A2 shall have the ordinary accepted meaning in the context for which they are intended.

Applicable Code. The code under which the building is designed.

Approved. Acceptable to the *authority having jurisdiction*. [AISI S240]

Authority Having Jurisdiction. An organization, political subdivision, office, or individual charged with the responsibility of administering and enforcing the provisions of the *applicable code*.

Base Steel Thickness. The thickness of bare steel exclusive of all coatings. [AISI S240]

Ceiling Joist. A horizontal *structural member* that supports ceiling components and which may be subject to attic loads. [AISI S240]

Chord Member. A *structural member* that forms the top or bottom component of a *truss*. [AISI S240]

Cold-Formed Sheet Steel. Sheet steel or strip steel that is manufactured by (1) press-braking blanks sheared from sheets or cut length of coils or plates, or by (2) continuous roll forming of cold- or hot-rolled coils of sheet steel; both forming operations are performed at ambient room temperature, that is, without any addition of heat such as would be required for hot forming.

[AISI S240]

Cold-Formed Steel. See *Cold-Formed Sheet Steel*. [AISI S240]

Continuous Insulation (c.i.). Insulation that is uncompressed and continuous across all *structural members* without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the building envelope. [ASHRAE 90.1-2019]

C-Shape. A cold-formed steel shape used for *structural members* and *nonstructural members* consisting of a *web*, two (2) *flanges* and two (2) *lips (edge stiffeners)*. [AISI S240]

C-Shape Truss. A truss assembled using *C-shape chord members* and *C-shape web members*.

Designation Thickness. The minimum *base steel thickness* expressed in *mils* and rounded to a whole number. [AISI S240]

Edge Stiffener. See *Lip*. [AISI S240]

Flange. For a *C-shape*, *U-shape* or *track*, that portion of the framing member that is perpendicular to the *web*. For a furring channel, that portion of the framing member that connects the *webs*. [AISI S240]

Framing Factor (FF). The fraction of the total area that is framing.

Framing Factor, C-Shape (FF_{cs}). The *designation thickness* of the *cold-formed steel* framing member (converted from *mils* to *inches*) divided by the width of the *flange*.

Framing Factor, OTZ (FF_{otz}). The *Overall Thermal Zone (OTZ)* divided by the on-center spacing of the framing members.

Joist. A *structural member* primarily used in floor and ceiling framing. [AISI S240]

Light-Frame Construction. Construction where the vertical and horizontal structural elements are primarily formed by a system of repetitive *cold-formed steel* or wood framing members. [AISI S240]

Lip. That part of a *structural* or *nonstructural member* that extends from the *flange* as a stiffening element. [AISI S240]

Load. Force or other action that results from the weight of building materials, occupants and their possessions, environmental effects, differential movement, or restrained dimensional changes. [AISI S240]

Mil. A unit of measurement equal to 1/1000 inch.

Nonstructural Member. A member in a steel-framed system that is not a part of the gravity load-resisting system, lateral force-resisting system or building envelope. [AISI S240]

Overall Thermal Zone (OTZ). The resultant effective area based on an analysis procedure that is designed to account for the thermal impact of *cold-formed steel* framing members in the resultant overall *thermal transmittance (U-factor)* of the wall assembly.

Registered Design Professional. Architect or engineer who is licensed to practice their respective design profession as defined by the legal requirements of the jurisdiction in which the building is to be constructed. [AISI S240]

Roof Rafter. A horizontal or sloped *structural member* that supports roof loads. [AISI S240]

Structural Member. A member that resists design loads [factored loads], as required by the applicable code, except when defined as a *nonstructural member*. [AISI S240]

Stud. A vertical *structural member* or *nonstructural member* in a wall system or assembly. [AISI S240]

Thermal Resistance (R-value). Reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions ($\text{h ft}^2 \text{ }^\circ\text{F/Btu}$). [ASHRAE 90.1-2019]