

## Prescriptive and Engineered Design Provisions of the Massachusetts One- and Two-Family Dwelling Code

Released July 27, 2009

### Introduction:

Buildings in the United States are designed to withstand the loads that are expected to be applied to the structure over the life of the building. How much snow will settle on a roof structure and impose additional loads to the building? How does a building designer determine the correct design roof load to use? To be more specific, what are the snow load provisions of the Massachusetts One and Two Family Dwelling Code (780 CMR 51.00 through 99.00), which we'll refer to herein as the Massachusetts Residential Code (MRC)?

### Issue:

Recently, SBCA has received a number of inquiries about how to apply snow loads to trusses in Massachusetts. The basic point at issue is whether the ground snow loads shown in the MRC need to be applied to a building directly, or if it's appropriate to apply various design factors to the ground snow load to arrive at the appropriate design roof snow load. And if the ground snow load can be factored to obtain the design roof snow load, what other issues need to be addressed? This *Tech Note* will define the issues and provide the recommended course of action based on the current 7<sup>th</sup> edition of the MRC. This *Tech Note* will not go into a full explanation of how to calculate snow loads, but will rather provide information about the provisions in the MRC that give direction to building designers regarding the methods to use. For a full explanation of how to calculate snow loads, see SBCA's Load Guide at [www.sbcindustry.com/loads.php](http://www.sbcindustry.com/loads.php).

### Recommendation:

Based on the current 7<sup>th</sup> edition of the MRC and the documents on which the MRC is based, there are two methods that are allowed to achieve compliance with the snow load provisions. One is the prescriptive method and the other is the engineering method.

#### ***Prescriptive Method***

MRC Section 5301 gives the prescriptive provisions. First, the goal of building design is to support all applied loads and safely transfer them from the point of origin, through the load resisting elements to the foundation.

**5301.1 Design.** Buildings and structures, and all parts thereof, shall be constructed to safely support all loads, including dead loads, live loads, roof loads, flood loads, snow loads, wind loads as prescribed by 780 CMR 51.00 through 99.00. The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from their point of origin through the load-resisting elements to the foundation.

Information about how much load needs to be applied to the building (and for our discussion, how much snow load) is found in section 5301.2.



Prepared with assistance from the SBCA – Northeast Chapter.  
View all SBCA *Tech Notes* at [www.sbcindustry.com/technotes.php](http://www.sbcindustry.com/technotes.php)

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**5301.2 Climatic and Geographic Design Criteria.** Buildings shall be constructed in accordance with the provisions of 780 CMR 51.00 through 99.00 as limited by the provisions of 780 CMR 5301; *also see 780 CMR Table 5301.2 (1).*

Table 5301.2(1) contains a field for the ground snow load and simply refers to Table 5301.01.2(5). Here is an excerpt from the table. The full table is reproduced in Appendix B.

**TABLE 5301.2(5) MASSACHUSETTS GROUND SNOW LOADS**

25 PSF	35 PSF	40 PSF	40 PSF	50 PSF		
Brewster	Abington	Afford	Nahant	Acton	Goshen	Paxton
Carver	Agawam	Arlington	Natick	Adams	Greenfield	Pepperell
Chatham	Amherst	Ashland	Needham	Amesbury	Groton	Pera

When using the prescriptive method, the ground snow load is used as stated in Table 5301.01.2(5). There is no other direction in the prescriptive requirements of the MRC, so we can only conclude that we must use the full value. It is applied in its entirety to the building as the design roof live load. When using this method, there is no need to run unbalanced load cases for drifting across the ridge of the building. This loading condition has already been considered in the development of the ground snow load value. By its very nature, the prescriptive method is more conservative than the engineered method. This conservatism is necessary to achieve the simplicity of the prescriptive method. Essentially, the logic here is that any building falling within the scope of the MRC can be designed using the full ground snow load value, and the resulting building design will be adequate to transmit the applied loads to the soil without the need to consider such things as the exposure of the building to wind, the thermal efficiency of the building, or the use of the building among others. It is a worst case scenario where one simplified answer covers all building sites within the scope of the MRC for each ground snow load area. However, even though drifting across a ridge is not required to be considered when using this method, the person using the IRC should consider other situations such as drifting at high-low roofs or sliding snow from an upper roof onto a lower one.

### ***Engineered Method***

The second option is to use the engineering method. This method is more exact in determining the roof design load because it considers a number of different conditions that may occur at a given building site. Consideration is given to such factors as the exposure of the building to wind, the importance of the building in regard to human safety, and the thermal resistance of the ceiling assembly. Consideration is also given to drifting across the ridge as independent load cases to check for localized increases in the stresses of the roof members. Because each of these factors is considered, the building can be designed to more accurately reflect the localized conditions, and snow load can be more precise to reflect those conditions. By eliminating the “one size fits all” approach of the prescriptive method, engineered roof systems can use a more precise design to make more efficient use of materials by putting materials where they are needed most, and reducing the use of materials where they provide no benefit. Section 5301.1 describes these alternate (engineered) provisions:

**5301.1.1 Alternative Provisions.** *As an alternative to the requirements in 780 CMR 5301.1 the following standards are permitted subject to the limitations of 780 CMR 51.00 through 99.00 and the limitations therein. In lieu of prescriptive compliance, where engineered design is used in conjunction with these standards the engineered design shall be performed by a Massachusetts-registered professional engineer or architect, employ an appropriate engineering rationale consistent with the standards below and utilize the wind and snow loads set forth in 780 CMR 51.00 through 99.00.*

1. American Forest & Paper Association (AF&PA) *Wood Frame Construction Manual (WFCM).*
2. American Iron and Steel Institute (AISI), *Standard for Cold-Formed Steel Framing- Prescriptive Method for One- and Two-family Dwellings (COFSIPM).*

The *Wood Frame Construction Manual (WFCM)* listed above is the guide for applying the ground snow loads listed in Table 5301.2(5) to the structure when using an engineering approach. This manual uses the

American Society of Civil Engineers standard, Minimum Design Loads for Buildings and Other Structures (ASCE 7) as the basis for calculating the appropriate snow loads.

Additionally, section 5301.1.3 requires engineered design when “...a building of otherwise conventional construction contains structural elements exceeding the limits of 780 CMR 5301 or otherwise, not conforming to 780 CMR 51.00 through 99.00...”. For instance, Glulam beams, I-joists, trusses and other engineered products are often not entirely addressed by the code. However, they can be used as a substitute for conventional construction and need to be engineered. This engineering needs to show compatibility with the performance of the conventionally framed system.

**5301.1.3 Engineered Design.** *When a building of otherwise conventional construction contains structural elements exceeding the limits of 780 CMR 5301 or otherwise, not conforming to 780 CMR 51.00 through 99.00, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design shall be provided by a Massachusetts registered professional engineer or architect and shall utilize the wind and snow loads set forth in 780 CMR 51.00 through 99.00.*

Further, for wind design exceeding the scope of the MRC, ASCE 7 is specifically listed as a referenced standard in section 5301.2.1.1.

**5301.2.1.1 Design Criteria.** Construction in regions where the basic wind speeds from 780 CMR Table 5301.2(4) **equal or exceed 110 miles per hour** (177.1 km/h) shall be designed in accordance with one of the following:

1. American Forest & Paper Association (AF&PA) *Wood Frame Construction Manual for One- and Two-Family Dwellings* (WFCM); or
  - 1.1 American Forest & Paper Association *Guide to Wood Construction in High Wind Areas for One- and Two-Family Dwellings, 110 mph Exposure B*. A Commonwealth of MA version of the checklist can be used in place of the checklist at the end of the guide. The MA version is found in Appendix 780 CMR 120.P
2. *Southern Building Code Congress International Standard for Hurricane Resistant Residential Construction* (SSTD 10); or
3. *Minimum Design Loads for Buildings and Other Structures* (ASCE-7); or
4. American Iron and Steel Institute (AISI), *Standard for Cold-Formed Steel Framing- Prescriptive Method for One- and Two-family Dwellings* (COFS/PM).
5. Concrete construction shall be designed in accordance with the provisions of 780 CMR 51.00 through 99.00.

### Conclusion:

The prescriptive method is much easier to apply due to the conservative nature of the loading condition defined merely through applying the ground snow load onto the building. The engineered method gives a more accurate analysis of the required loading due to the unique characteristics of each building site with respect to its exposure to the local environment. For the engineered approach, it is clear that ASCE 7 is the appropriate standard to use to determine how the ground snow loads from Table 5301.2(5) are to be applied. When using ASCE 7, *ALL* of the snow load provisions must be followed, not just the balanced load condition. Unbalanced loads for drifting across the ridge, drifting from high to low roofs, sliding snow, rain on snow surcharges, etc., must all be considered. There are also provisions for minimum roof loads which need to be checked as well. The MRC has provisions that cover a range of load application and resistance design options. The approach taken is the building designer’s choice—essentially tending toward a more conservative or a more precise application of loads.

## Appendix A

### Background and Analysis:

The preface to the 7<sup>th</sup> edition, Massachusetts Building Code gives the following statement:

*The Seventh Edition, Massachusetts Building Code (780 CMR), consists of both a basic building code (the Massachusetts Basic Building Code) and a stand-alone one- and two-family dwelling code (the Massachusetts One- and Two-Family Dwelling Code). The technical content of the Massachusetts Basic Building Code is based on the 2003 International Code Council® (ICC®) International Building Code. The technical content of the Massachusetts One- and Two-family Dwelling Code is based on the 2003 ICC International Residential Code....*

It is important to note here the last line of the excerpt above: “The technical content of the *Massachusetts One- and Two-family Dwelling Code* is based on the 2003 ICC *International Residential Code*.” This is important to note because, as we delve into the technical aspects of the MRC, we must understand that the International Residential Code (IRC) is the technical basis for the MRC. As such, the technical basis of the IRC can be applied to the MRC to the extent that it does not contradict the MRC requirements.

Note also that the IRC, section R301.1.3 specifically permits engineered design in accordance with the International Building Code (IBC).

**R301.1.3 Engineered design.** When a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the *International Building Code* is permitted for all buildings and structures, and parts thereof, included in the scope of this code.

Also, the IBC uses ASCE 7 as the referenced standard for determining snow loads:

**1608.1 General.** Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but the design roof load shall not be less than that determined by Section 1607.

Massachusetts has a statewide code, and municipalities are required to enforce this statewide code. Local amendments are not allowed except in a few extenuating circumstances (i.e. external facades of buildings in designated historical districts, state-owned buildings, etc.), and building officials are required to enforce the statewide building code.

**5101.2 Scope and Authority.** 780 CMR 51.00 through 99.00 is promulgated under authority of M.G.L. c. 143, §§ 93 through 100 in accordance with the legislative intent to establish uniform design and construction regulations throughout the Commonwealth. Municipalities may not modify 780 CMR 51.00 through 99.00 or regulate in the subject areas reserved for the Board of Building Regulations and Standards (hereinafter all referred to as the “BBRS”) unless such regulations, ordinances, bylaws or policies are promulgated in accordance with M.G.L. c. 143, §§ 96, 97 and/or 98 as applicable.

#### **Massachusetts General Laws (M.G.L.) Chapter 143: Section 3A. Enforcement of state building code**

Section 3A. Unless otherwise provided by the state building code, the local inspector shall enforce the state building code as to any building or structure within the city or town from which he is appointed, including any building or structure owned by any authority established by the general court but not owned in whole or in part by the commonwealth, and the state building code shall be the code for all buildings and structures within the city or town.

Based on the current 7<sup>th</sup> edition of the MRC and the documents on which the MRC is based, there are two methods that are allowed to achieve compliance with the snow load provisions. One is the prescriptive method and the other is the engineering method.

### Prescriptive Method

MRC Section 5301 gives the prescriptive provisions. First, the goal of building design is to support all applied loads and safely transfer them from the point of origin, through the load-resisting elements to the foundation.

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Information about how much load needs to be applied to the building (and for our discussion, how much snow load) is found in section 5301.2.

**5301.2 Climatic and Geographic Design Criteria.** Buildings shall be constructed in accordance with the provisions of 780 CMR 51.00 through 99.00 as limited by the provisions of 780 CMR 5301; *also see 780 CMR Table 5301.2 (1).*

Table 5301.2(1) contains a field for the ground snow load and simply refers to Table 5301.01.2(5).

**TABLE 5301.2(1)**  
**MASSACHUSETTS CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA**

GROUND SNOW LOAD	WIND SPEED <sup>1</sup> (mph)	SEISMIC DESIGN CATEGORY <sup>2</sup> (One- and Two-Family Dwellings only)	SUBJECT TO DAMAGE FROM				WINTER DESIGN TEMP	ICE SHIELD UNDERLAYMENT REQUIRED <sup>3</sup>	FLOOD HAZARD <sup>4</sup>	AIR FREEZING INDEX <sup>5</sup>	MEAN ANNUAL TEMP <sup>6</sup>
			Weathering <sup>7</sup>	Frost Line Depth <sup>8</sup>	Territory <sup>9</sup>	Drain <sup>10</sup>					
Table 5301.01(5)	Table 5301.01(4)	None	Figure 5301.03(3)	4 ft. shall not be reduced below other limits	Figure 5301.01(4)	Figure 5301.01(7)	Approx. 78F CMR 780.1 Table 120.13.2.1	As required by the exterior roof construction, roof pitch and local climate conditions to be considered	Refer to the applicable Flood Insurance Rate Map (FIRM)	Only utilized in the design and construction of frost-protected shallow foundations	Only utilized in the design and construction of frost-protected shallow foundations

(Footnotes omitted)

Here is an excerpt from Table 5301.2(5). The full table is listed in Appendix B.

**TABLE 5301.2(5) MASSACHUSETTS GROUND SNOW LOADS**

25 PSF	35 PSF	40 PSF	40 PSF	50 PSF		
Brewster	Abington	Alford	Nahant	Acton	Goshen	Paxton
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When using the prescriptive method, the ground snow load is used as stated in Table 5301.01.2(5). There is no other direction in the prescriptive requirements of the MRC, so we can only conclude that we must use the full value. It is applied in its entirety to the building as the design roof live load. When using this method, there is no need to run unbalanced load cases for drifting across the ridge of the building. This loading condition has already been considered in the development of the ground snow load value. By its very nature, the prescriptive method is more conservative than the engineered method. This conservatism is necessary to achieve the simplicity of the prescriptive method. Essentially, the logic here is that any building falling within the scope of the MRC can be designed using the full ground snow load value, and the resulting building design will be adequate to transmit the applied loads to the soil without the need to consider such things as the exposure of the building to wind, the thermal efficiency of the building, or the use of the building among others. It is a worst case scenario where one simplified answer covers all building sites within the scope of the MRC for each ground snow load area. However, even though drifting across a ridge is not required to be considered when using this method, the person using the IRC

should consider other situations, such as drifting at high-low roofs or sliding snow from an upper roof onto a lower one.

### ***Engineered Method***

The second option is to use the engineering method. This method is more exact in determining the roof design load because it considers a number of different conditions that may occur at a given building site. Consideration is given to such factors as the exposure of the building to wind, the importance of the building in regard to human safety, and the thermal resistance of the ceiling assembly. Consideration is also given to drifting across the ridge as independent load cases to check for localized increases in the stresses of the roof members. Because each of these factors is considered, the building can be designed to more accurately reflect the localized conditions and snow load can be more precise to reflect those conditions. By eliminating the “one size fits all” approach of the prescriptive method, engineered roof systems can use a more precise design to make more efficient use of materials by putting materials where they are needed most and reducing the use of materials where they provide no benefit. Section 5301.1 describes these alternate (engineered) provisions:

***5301.1.1 Alternative Provisions.*** *As an alternative to the requirements in 780 CMR 5301.1 the following standards are permitted subject to the limitations of 780 CMR 51.00 through 99.00 and the limitations therein. In lieu of prescriptive compliance, where engineered design is used in conjunction with these standards the engineered design shall be performed by a Massachusetts-registered professional engineer or architect, employ an appropriate engineering rationale consistent with the standards below and utilize the wind and snow loads set forth in 780 CMR 51.00 through 99.00.*

1. American Forest & Paper Association (AF&PA) *Wood Frame Construction Manual* (WFCM).
2. American Iron and Steel Institute (AISI), *Standard for Cold-Formed Steel Framing- Prescriptive Method for One- and Two-family Dwellings* (COFS/PM).

Note that seismic design requirements are not applicable to one- and two-family detached dwellings.

The *Wood Frame Construction Manual* (WFCM) listed above is the guide for applying the ground snow loads listed in Table 5301.2(5) to the structure when using an engineering approach. This manual uses the American Society of Civil Engineers standard, *Minimum Design Loads for Buildings and Other Structures* (ASCE 7), as the basis for calculating the appropriate snow loads.

For instance, Glulam beams, I-joists, trusses and other engineered products are often not entirely addressed by the code. However, they can be used as a substitute for conventional construction and need to be engineered. This engineering needs to show compatibility with the performance of the conventionally framed system.

***5301.1.3 Engineered Design.*** *When a building of otherwise conventional construction contains structural elements exceeding the limits of 780 CMR 5301 or otherwise, not conforming to 780 CMR 51.00 through 99.00, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design shall be provided by a Massachusetts registered professional engineer or architect and shall utilize the wind and snow loads set forth in 780 CMR 51.00 through 99.00.*

Further, for wind design exceeding the scope of the MRC, ASCE 7 is specifically listed as a referenced standard in section 5301.2.1.1.

**5301.2.1.1 Design Criteria.** Construction in regions where the basic wind speeds from 780 CMR Table 5301.2(4) equal or exceed 110 miles per hour (177.1 km/h) shall be designed in accordance with one of the following:

1. American Forest & Paper Association (AF&PA) *Wood Frame Construction Manual for One- and Two-Family Dwellings* (WFCM); or
  - 1.1 American Forest & Paper Association *Guide to Wood Construction in High Wind Areas for One- and Two-Family Dwellings, 110 mph Exposure B*. A Commonwealth of MA version of the checklist can be used in place of the checklist at the end of the guide. The MA version is found in Appendix 780 CMR 120.P
2. *Southern Building Code Congress International Standard for Hurricane Resistant Residential Construction* (SSTD 10); or
3. *Minimum Design Loads for Buildings and Other Structures* (ASCE-7); or
4. American Iron and Steel Institute (AISI), *Standard for Cold-Formed Steel Framing- Prescriptive Method for One- and Two-family Dwellings* (COFS/PM).
5. Concrete construction shall be designed in accordance with the provisions of 780 CMR 51.00 through 99.00.

The prescriptive method is much easier to apply due to the conservative nature of the loading condition defined merely through applying the ground snow load onto the building. The engineered method gives a more accurate analysis of the required loading due to the unique characteristics of each building site with respect to its exposure to the local environment. For the engineered approach, it is clear that ASCE 7 is the appropriate standard to use to determine how the ground snow loads from Table 5301.2(5) are to be applied. When using ASCE 7, *ALL* of the snow load provisions must be followed, not just the balanced load condition. Unbalanced loads for drifting across the ridge, drifting from high to low roofs, sliding snow, rain on snow surcharges, etc., must all be considered. There are also provisions for minimum roof loads, which to be checked as well. The MRC has provisions that cover a range of load application and resistance design options. The approach taken is the building designer's choice—essentially tending toward a more conservative or more precise application of loads.

## Appendix B

### Full text of references sections:

#### Seventh Edition, Massachusetts Building Code (780 CMR)

##### *Preface*

The *Seventh Edition, Massachusetts Building Code (780 CMR)* consists of both a basic building code (the *Massachusetts Basic Building Code*) and a stand-alone one- and two-family dwelling code (the *Massachusetts One- and Two-Family Dwelling Code*). The technical content of the *Massachusetts Basic Building Code* is based on the 2003 International Code Council® (ICC®) *International Building Code*. The technical content of the *Massachusetts One- and Two-family Dwelling Code* is based on the 2003 ICC *International Residential Code*. Extensive technical changes have been made as a result of reviews by the Massachusetts Department of Public Safety (the Department), Board of Building Regulations and Standards (BBRS) and technical advisory committees, and also as required by Massachusetts General Laws and specialized Codes and Regulations.

##### *Scope*

**5101.2 Scope and Authority.** 780 CMR 51.00 through 99.00 is promulgated under authority of M.G.L. c. 143, §§ 93 through 100 in accordance with the legislative intent to establish uniform design and construction regulations throughout the Commonwealth. Municipalities may not modify 780 CMR 51.00 through 99.00 or regulate in the subject areas reserved for the Board of Building Regulations and Standards (hereinafter all referred to as the "BBRS") unless such regulations, ordinances, bylaws or policies are promulgated in accordance with M.G.L. c. 143, §§ 96, 97 and/or 98 as applicable. The provisions of 780 CMR 51.00 through 99.00 shall apply to detached one- and two-family dwellings, not more than three stories in height with separate means of egress, and their accessory structures as follows:

1. The construction, reconstruction, alteration, enlargement, replacement, repair, demolition, removal, or movement and installation of equipment, the inspection of and issuance of and revocation of permits or licenses relative to detached one- and two-family dwellings;
2. The rehabilitation and maintenance of existing buildings;
3. The standards or requirements for materials to be used in connection therewith, including, but not limited to provisions for safety, ingress and egress, energy conservation and sanitary conditions;
4. The establishment of reasonable fees for inspections and the issuance of licenses to individuals engaged as construction supervisors;
5. The certification of inspectors of buildings, building commissioners and local inspectors;
6. The registration of Home Improvement Contractors pursuant to M.G.L. c. 142A, except as such matters are otherwise provided for in the Massachusetts General Laws Annotated, or in the rules and regulations authorized for promulgation under the provisions of 780 CMR 51.00 through 99.00; and
7. Other duties and responsibilities as defined in 780 CMR 110, Special Regulations R1 through R7, as applicable.

**5102.2 Matters Not Provided For.** Any requirements that are essential for the structural, fire or sanitary safety, or interior climate comfort of an existing or proposed detached one- and two-family dwelling, or for the safety of the occupants thereof, which are not specifically provided for by 780 CMR 51.00 through 99.00, shall be determined by the building official. The BBRS shall be notified by the building official in writing within seven working days of any action taken pursuant to 780 CMR 5102.

**5102.3 Zoning Bylaw Restrictions.** When the provisions in 780 CMR 51.00 through 99.00 specified for structural strength, adequate egress facilities, sanitary conditions, equipment, light and ventilation, energy conservation or fire safety conflict with the local zoning bylaws or ordinances, 780 CMR 51.00 through 99.00 shall control the construction or alteration of detached one- and two-family dwellings unless such bylaws or ordinances are promulgated in accordance with the provisions of M.G.L. c. 143, § 98.

**5102.4 General Bylaw Restrictions.** When the provisions herein specified for structural strength, adequate egress facilities, sanitary conditions, equipment, light and ventilation, energy conservation or fire safety conflict with the local general bylaws or ordinances, 780 CMR 51.00 through 99.00 shall control the construction or alteration of detached one- and two-family dwellings unless such bylaws or ordinances are promulgated in accordance with the provisions of M.G.L. c. 143, § 98.

## **780 CMR 5301 DESIGN CRITERIA**

**5301.1 Design.** Buildings and structures, and all parts thereof, shall be constructed to safely support all loads, including dead loads, live loads, roof loads, flood loads, snow loads, wind loads as prescribed by 780 CMR 51.00 through 99.00. The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from their point of origin through the load-resisting elements to the foundation.

**5301.1.1 Alternative Provisions.** *As an alternative to the requirements in 780 CMR 5301.1 the following standards are permitted subject to the limitations of 780 CMR 51.00 through 99.00 and the limitations therein. In lieu of prescriptive compliance, where engineered design is used in conjunction with these standards the engineered design shall be performed by a Massachusetts-registered professional engineer or architect, employ an appropriate engineering rationale consistent with the standards below and utilize the wind and snow loads set forth in 780 CMR 51.00 through 99.00.*

1. American Forest & Paper Association (AF&PA) *Wood Frame Construction Manual* (WFCM).
2. American Iron and Steel Institute (AISI), *Standard for Cold-Formed Steel Framing- Prescriptive Method for One- and Two-family Dwellings* (COFS/PM). *Note that seismic design requirements are not applicable to one- and two-family detached dwellings.*

**5301.1.3 Engineered Design.** *When a building of otherwise conventional construction contains structural elements exceeding the limits of 780 CMR 5301 or otherwise, not conforming to 780 CMR 51.00 through 99.00, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design shall be provided by a Massachusetts registered professional engineer or architect and shall utilize the wind and snow loads set forth in 780 CMR 51.00 through 99.00.*

## **5301.2 Climatic and Geographic Design Criteria.**

Buildings shall be constructed in accordance with the provisions of 780 CMR 51.00 through 99.00 as limited by the provisions of 780 CMR 5301; **also see 780 CMR Table 5301.2 (1).**

**5301.2.1.1 Design Criteria.** Construction in regions where the basic wind speeds from 780 CMR Table 5301.2(4) equal or exceed 110 miles per hour (177.1 km/h) shall be designed in accordance with one of the following:

1. American Forest & Paper Association (AF&PA) *Wood Frame Construction Manual for One- and Two-Family Dwellings* (WFCM); or
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2. *Southern Building Code Congress International Standard for Hurricane Resistant Residential Construction* (SSTD 10); or
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4. American Iron and Steel Institute (AISI), *Standard for Cold-Formed Steel Framing- Prescriptive Method for One- and Two-family Dwellings* (COFS/PM).
5. Concrete construction shall be designed in accordance with the provisions of 780 CMR 51.00 through 99.00.

**5301.2.3 Snow Loads.** Wood framed construction, cold-formed steel framed construction and masonry and concrete construction in regions with ground snow loads 70 psf (3.35 kN/m<sup>2</sup>) or less, shall be in accordance with Chapters 55,

56 and 58. Buildings in regions with ground snow loads greater than 70 psf (3.35 kN/m<sup>2</sup>) shall be designed in accordance with accepted engineering practice.

5301.6 Roof Load. Roof shall be designed for the live load indicated in 780 CMR Table 5301.6 or the snow load based on the Massachusetts Ground Snow Load 780 CMR Table 5301.2(5), whichever is greater.

**780 CMR TABLE 5301.6  
MINIMUM ROOF LIVE LOADS IN  
POUNDS-FORCE PER SQUARE FOOT OF  
HORIZONTAL PROJECTION**

ROOF SLOPE	TRIBUTARY LOADED AREA IN SQUARE FEET FOR ANY STRUCTURAL MEMBER		
	0 to 200	201 to 600	Over 600
Flat or rise less than 4 inches per foot (1:3)	20	16	12
Rise 4 inches per foot (1:3) to less than 12 inches per foot (1:1)	16	14	12
Rise 12 inches per foot (1:1) and greater	12	12	12

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>, 1 inch per foot = 0.0833 mm/m.

5802.10.2 Design. Wood trusses shall be designed in accordance with accepted engineering practice. The design and manufacture of metal plate connected wood trusses shall comply with ANSI/TPI 1. The truss design drawings shall be prepared by a *Massachusetts-registered architect or registered professional engineer*.

**TABLE 5301.2(1)  
MASSACHUSETTS CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA**

GROUND SNOW LOAD	WIND SPEED* (mph)	SEISMIC DESIGN CATEGORY* (One- and Two-Family Detached Dwellings-only)	SUBJECT TO DAMAGE FROM				WINTER DESIGN TEMP*	ICE SHIELD UNDERLAYMENT REQUIRED <sup>1</sup>	FLOOD HAZARD <sup>5</sup>	AIR FREEZING INDEX <sup>1</sup>	MEAN ANNUAL TEMP <sup>6</sup>
			Weathering <sup>a</sup>	Frost Line Depth <sup>b</sup>	Termite <sup>c</sup>	Decay <sup>d</sup>					
Table 5301.2(5)	Table 5301.2(4)	N/A	Figure 5301.2(3)	4 ft. Minimum unless engineered data shows otherwise	Figure 5301.2(6)	Figure 5301.2(7)	Appendix 780 CMR 120.J Table 120.J3.2.1	As required by the exterior roof covering manufacturer; roof pitch and local climate must also be considered	Refer to the applicable Flood Insurance Rate Map (FIRM)	Only utilized in the design and construction of frost-protected shallow foundations	Only utilized in the design and construction of frost-protected shallow foundations

For SI: 1 foot = 304.8 mm.

- a. Weathering may require a higher strength concrete or grade of masonry than necessary to satisfy the structural requirements of this code. The weathering index ("negligible," "moderate" or "severe") shall be determined from the Weathering Probability Map [Figure 5301.2(3)]. The grade of masonry units shall be determined from ASTM C 34, C 55, C 62, C 73, C 90, C 129, C 145, C 216 or C 652, as applicable.
- b. The frost line depth shall be a minimum of 4 feet in Massachusetts unless engineering data demonstrates that the frost line depth is less than or greater than 4 feet. Under no circumstances will permanent foundation systems, required to be protected from frost be allowed set at less than 4 feet without engineering design ensuring foundation frost protection.
- c. Site-specific termite conditions should be determined when possible, otherwise Figure 5301.2(6) shall be utilized.
- d. Typically "slight" to "moderate."
- e. The basic wind speed shall be determined from Table 5301.2(4) for the specific city or town where construction is intended.
- f. See Appendix 780 CMR 120.J3.2.1.
- g. Seismic design is not required for one- and two-family detached dwellings.
- h. The community Flood Insurance Rate Map (FIRM) shall be utilized to establish the flood hazard.
- i. The requirements of the manufacturer of the exterior roof covering shall be followed with regard to ice shield underlayment; likewise roof pitch and local climate must be considered.
- j. Only utilized when one is designing a frost-protected shallow foundation. When applicable, refer to the "100-year return period air freezing index" from Figure 5403.3(2) and for further clarification view the National Climatic Data Center data table "Air Freezing Index-USA Method (Base 32°Fahrenheit)" at [www.ncdc.noaa.gov/jpsf.html](http://www.ncdc.noaa.gov/jpsf.html).
- k. Only utilized when one is designing a frost-protected shallow foundation. When applicable, refer to the "100-year return period air freezing index" from Figure 5403.3(2) and for further clarification view the National Climatic Data Center data table "Air Freezing Index-USA Method (Base 32°Fahrenheit)" at [www.ncdc.noaa.gov/bsf.html](http://www.ncdc.noaa.gov/bsf.html).

780 CMR: STATE BOARD OF BUILDING REGULATIONS AND STANDARDS

THE MASSACHUSETTS STATE BUILDING CODE

TABLE 5301.2(5) MASSACHUSETTS GROUND SNOW LOADS

25 PSF	35 PSF	40 PSF	40 PSF	50 PSF
Brewster	Abington	Alford	Nahant	Acton
Carver	Agawam	Arlington	Natick	Goshen
Chatham	Amherst	Ashland	Needham	Greenfield
Eastham	Avon	Belmont	New Braintree	Pepperell
Harwich	Belchertown	Bellingham	New Marlborough	Penn
Martha's Vineyard	Braintree	Beverly	New Salem	Petersham
Nantucket	Brockton	Blackstone	Newton	Phillipston
Orleans	Chicopee	Blandford	Norfolk	Pittsfield
Plymouth	Cohasset	Boston	North Brookfield	Plainfield
Provincetown	East Longmeadow	Brimfield	Northampton	Princeton
Truro	Easton	Brookfield	Northbridge	Reading
Wareham	Foxborough	Brookline	Norwood	Richmond
Wellfleet	Granby	Brookline	Peabody	Rockport
	Hadley	Canton	Pelham	Rolyalston
	Hampden	Charlton	Quincy	Rowe
	Hingham	Chelsea	Revere	Hudson
	Holbrook	Dedham	Russell	Huntington
	Holyoke	Douglas	Salem	Ipswich
	Hull	Dover	Saugus	Lancaster
	Longmeadow	Dudley	Sheffield	Lanesborough
	Ludlow	East Brookfield	Sherborn	Lawrence
	Mansfield	Easthampton	Shutesbury	Lee
	Monson	Egremont	Somerville	Leicester
	North Attleborough	Everett	Southampton	Lenox
	Norwell	Framingham	Southborough	Carlisle
	Palmer	Franklin	Southbridge	Leominster
	Plainville	Grafton	Stoncham	Leyden
	Randolph	Granville	Sturbridge	Littleton
	Rockland	Great Barrington	Sudbury	Lowell
	Scituate	Hardwick	Sunderland	Lunenburg
	Sharon	Hatfield	Sutton	Maynard
	South Hadley	Holland	Swampscott	Merrimac
	Southwick	Holliston	Tolland	Methuen
	Gosnold	Hopedale	Upton	Middlefield
	Halifax	Hopkington	Uxbridge	Millbury
	Hanover	Leverett	Wakefield	Concord
	Hanson	Lexington	Wales	Conway
	Kingston	Lincoln	Walpole	Cummington
	Lakeville	Lynn	Waltham	Dalton
	Marion	Lynnfield	Ware	Monroe
	Marshfield	Malden	Warren	Montague
	Mashpee	Manchester	Washington	Monterey
	Mattapoisett	Marblehead	Watertown	New Ashford
	Middleborough	Marlborough	Wayland	Newbury
	New Bedford	Medfield	Webster	Newburyport
	Norton	Medford	Wellesley	North Adams
	Pembroke	Medway	West Brookfield	North Andover
	Plympton	Melrose	Westborough	North Reading
	Reynham	Mendon	Westhampton	Northborough
	Rehoboth	Middleton	Weston	Northfield
	Rochester	Milford	Westwood	Northampton
	Sandwich	Millis	Whately	Northborough
	Seekonk	Millville	Winchester	Northfield
	Somerset	Milton	Winthrop	Oakham
	Swansea	Montgomery	Woburn	Orange
	Taunton	Mount Washington	Worcester	Otis
	West Bridgewater		Wrentham	Oxford
	Westport			
	Whitman			

## *Massachusetts General Laws*

### INSPECTION OF BUILDINGS

#### Chapter 143: Section 3A. Enforcement of state building code

**Section 3A.** Unless otherwise provided by the state building code, the local inspector shall enforce the state building code as to any building or structure within the city or town from which he is appointed, including any building or structure owned by any authority established by the general court but not owned in whole or in part by the commonwealth, and the state building code shall be the code for all buildings and structures within the city or town. In the event of a conflict between the code and a statute, ordinance or bylaw regulating an historic district, regional historic district or architecturally controlled district, the statute, ordinance or bylaw regulating exterior architectural features within that district shall prevail. The inspector shall enforce the state building code as to any building or structure within any city or town that is owned in whole or in part by the commonwealth or any departments, commissions, agencies or authorities of the commonwealth. The inspector shall have all the powers of a local inspector under this chapter and under the state building code as to buildings or structures that are owned in whole or in part by the commonwealth or any of its departments, agencies, commissions or authorities.

The inspector may review any order or decision of a local inspector. The inspector shall supervise the enforcement of the state building code, make periodic reviews of all local building inspection practices and make recommendations for improvement of such practices. Reports of such reviews shall be filed with the commission.

The provisions of this section shall not apply to bridges and their appurtenant supporting structures which have been or are to be constructed by or are under the custody and control of the department of highways or the Massachusetts Turnpike Authority or for which said department or authority has maintenance responsibility.

### *International Residential Code*

**R301.1.3 Engineered design.** When a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the *International Building Code* is permitted for all buildings and structures, and parts thereof, included in the scope of this code.

**International Building Code**

1608.1 General. Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but the design roof load shall not be less than that determined by Section 1607.

**Excerpt from TABLE 1607.1  
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, L<sub>o</sub>, AND  
MINIMUM CONCENTRATED LIVE LOADS**

29. Roofs		
All roof surfaces subject to maintenance workers		300
Awnings and canopies		
Fabric construction supported by a lightweight rigid skeleton structure	5	
All other construction	nonreducible	
Ordinary flat, pitched, and curved roofs	20	
Primary roof members, exposed to a work floor	20	
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs:		
Over manufacturing, storage warehouses, and repair garages		2,000
All other occupancies		300
Roofs used for other special purposes	Note 1	Note 1
Roofs used for promenade purposes	60	
Roofs used for roof gardens or assembly purposes	100	



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