

**ITEM 23564.8501 M - FURNISH AND INSTALL PREFABRICATED STEEL SERVICE SUPERSTRUCTURES**

**DESCRIPTION.** The Contractor shall design, furnish and install a prefabricated service superstructure of the type and at the location(s) indicated on the plans and in accordance with the provisions of the contract documents. Service(s) supported by the superstructures shall be defined on the plans and in the contract documents. Maintenance Walks, if specified, shall be shown on the contract plans and shall match the materials option for structural steel. The Contractor's attention is directed to Section 106-01, Source of Supply and Quality Requirements, with regard to advising Departmental Representatives of the sources of the proposed materials.

This specification may require modifications, to accommodate the services carried, to standard designs and configurations available from various manufacturers offering prefabricated superstructures. These manufacturers include, but are not limited to:

Continental Bridge Company  
8301 State Highway 29 North  
Alexandria, Minnesota 56308

Steadfast Bridge Company  
P.O. Box 806  
Fort Payne, Alabama 35967

Wheeler Consolidated  
9330 James Avenue South  
Bloomington, Minnesota 55431

Dopp & Dopp Associates, Inc.  
84 Ferry Street  
Hudson, New Hampshire 03051

Echo Bridge, Inc.  
PO Box 89  
Elmira, New York 14902

U.S. Bridges  
201 Wheeling Avenue  
PO Box 757  
Cambridge, Ohio 43725

Contech  
Round Lake, New York 12151

**MATERIALS.** Materials for this work shall meet the requirements of the following:

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Paint: Section 708, NYSDOT Standard Specifications  
Galvanized Coatings: Section 719-01, NYSDOT Standard Specifications  
Structural Steel (coated): ASTM A709M Gr250 or 345  
Structural Steel (un-coated): ASTM A709M Gr345W  
Hollow Structural Shapes: ASTM A847 or ASTM A500 GrB with the chemical properties of A709 Gr345W or A606 Type 4  
High Strength Bolts, Nuts and Washers: Section 715-14, NYSDOT Standard Specifications  
Safety Rail and Posts: Section 710-23, NYSDOT Standard Specifications  
Maintenance Walkways: ASTM A709M Gr250, Gr345 or Gr345W

Steel which will be exposed to view shall be free of blemishes including pitting, seam marks, roll marks, rolled trade names and roughness. Blemishes may be removed by grinding, or a combination of welding and grinding, so that finished surfaces of members that are exposed in the final structure are free of markings, burrs and other defects.

**CONSTRUCTION DETAILS.** All work, including but not limited to fabrication inspection, transportation, and erection shall be done in accordance with the provisions of the New York State Steel Construction Manual modified as follows:

Welding of tubular steel shall meet the requirements of the current edition of the ANSI/AWS D1.1 Structural Welding Code-Steel.

Copies of certified mill test reports shall be furnished to the Deputy Chief Engineer Structures (DCES) in accordance with the requirements of Subsection 715-01, Structural Steel.

**DESIGN.** A professional engineer licensed to practice in New York State shall be engaged by the Contractor to design and detail the bridge superstructure. These services shall include any required consultation for interpreting plans and resolution of problems which may arise during the performance of the work.

The design shall be in conformance with the current AISC Specifications for Allowable Stress Design.

**LOADS.** The following loads shall be considered in designing the superstructures.

Dead Load (DL) - Shall consist of self weight, loads due to services carried and weight of environmental enclosure (if specified).

Snow Load (SL) - Shall be in accordance with the Building Code of New York State - Section 1608 (Attachment 1). If the superstructure is not enclosed, it shall be considered as having a flat roof for the out-to-out distance.

Ice Load (IL) - Shall be 144 Pa and shall be applied to the superstructure, full width of walkway and services carried, or the exposed surface area of the environmental enclosure (if specified).

Wind Load (W) - Shall be in accordance with NYSDOT Standard Specifications for Highway Bridges, Article 3.15.1.1 except that the minimum force requirements are waived, and a 30%

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reduction in pressure will be allowed. The effective wind area shall be the projected vertical elevation of the superstructure and services, or the environmental enclosure (if specified). Vertical Wind Loads for roofs shall be obtained from the Building Code of New York State - Section 1609 (Attachment 2). If the superstructure is not enclosed, it shall be considered as having a flat roof for the out-to-out distance.

Hammer Load (HL) - Shall be shown on the contract plans, as necessary.

Live Load (LL) - Shall be 2394 Pa for maintenance walkways without vehicle loads. If specified, the vehicle load shall also be applied.

Seismic Load (EQ) - shall consist of a single degree of freedom (SDOF) analysis.

**COMBINATION OF LOADS** - The following load combinations shall apply.

<u>Loads</u>	<u>% Allowable Stress</u>
DL & LL	100
DL & SL & IL	100
DL & SL & IL & W	125
DL & SL & IL & HL	125
DL & EQ	133

Structural tubing section properties used for design shall be per the *Connections Manual for Hollow Structural Sections* Published by the Steel Tube Institute of North America.

Span length and clear width between structural members shall be as indicated on the plans.

Members shall be designed so that both the vertical deflection due to the service pedestrian live load and horizontal deflection due to lateral wind load do not exceed 1/500 of the span length. Final superstructure camber, after all dead loads are applied, shall be limited to 0% minimum, 7-1/2 % maximum, of the span length.

Vibrational characteristics of the bridge shall be checked in design. The fundamental frequency of the bridge without live load should be greater than 3.0 Hz. to avoid the first harmonic. If the fundamental frequency cannot satisfy this limitation, or if the second harmonic is a concern, a dynamic performance evaluation should be made. In lieu of such evaluation the bridge may be proportioned so that the fundamental frequency shall be greater than:

$$f \geq 2.86 \ln (800/w)$$

where  $\ln$  is the natural log and  $W$  is the weight (kilonewtons) of the supported structure, including dead load and an allowance for actual pedestrian live load. Alternatively, the minimum supported structure weight ( $W$ ) shall be greater than:

$$W \geq 800 e^{(-0.35 f)}$$

where  $f$  is the fundamental frequency (Hz).

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Allowable fatigue stress ranges for steel members shall be determined from Article 10.3 of the New York State Department of Transportation Standard Specifications for Highway Bridges, except that the allowable fatigue stress ranges for Redundant Load Path structures may be used, regardless of the actual degree of member redundancy. Fatigue sensitive details should be avoided and out of plane bending details shall be eliminated. Fillet welds should only be used to transfer shear and Complete Penetration Groove Welds (CPGW) or Slip Critical Bolted Connections should be used to transfer moment. All field connections for the truss and floor system shall be through the use of high strength bolts, except the connection of the truss to the bearings which will utilize fillet welds.

The vertical truss members and the floor beams and their connections in half-through truss spans shall be proportioned to resist a lateral force applied at the top of the truss vertical that is not less than  $0.01/K$  times the average design compressive force in the two adjacent top chord members; where  $K$  is the design effective length factor for the individual top chord members supported between the truss vertical. In no case shall the value for  $0.01/K$  be less than 0.003 when determining the minimum lateral force, regardless of the  $K$ -value used to determine the compressive capacity of the top chord. This lateral force shall be applied concurrently with these members' primary forces. End posts shall be designed as a simple cantilever to carry its applied axial load combined with a lateral load of 1.0% of the axial load, applied at the upper end. The top chord shall be considered as a column with elastic lateral supports at the panel points. The critical buckling force of the column, so determined, shall be based on using not less than 2.0 times the maximum design group loading in any panel in the top chord.

Expansion bearings shall be guided and maintenance free. That is, periodic lubrication shall not be required for proper operation.

Drawings and directions for installation shall be provided for anchor bolt templates and bearing plate assemblies to be installed by other trades.

The Contractor's design is subject to approval by the designer of record. The Contractor shall submit three copies of all design computations to the designer of record for approval. The designer of record shall be allowed the minimum of ten working days, or one working day for every four sheets of design calculations, to return the design to the Contractor.

**METHOD OF MEASUREMENT.** Measurement shall be taken as each Prefabricated Steel Service Superstructure installed and accepted by the Engineer.

**BASIS OF PAYMENT.**

**General.** The unit price bid for each Prefabricated Steel Service Superstructure shall include the cost of furnishing all engineering, labor, materials and equipment necessary to complete the work. This includes design, fabrication, transportation and storage of materials, and erection. Each prefabricated steel bridge superstructure shall include all hardware necessary for installation including bearing devices and anchor bolts. The cost of galvanizing, if specified, shall also be included in this item.

Partial payment will be made in accordance with Section 109-04 PARTIAL PAYMENTS.

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**Additional Work.** The provisions of Section 564-5.02 shall apply, modified as follows:

Where the phrase “price bid for structural steel” appears, it shall be replaced by “price bid for Prefabricated Service Superstructure.”

**Other Work.** Work not included in the unit price bid for this item is as follows:

The Services carried, environmental enclosure and paint system, if specified, shall be paid for under their respective bid item(s).

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## ATTACHMENT 1

STRUCTURAL DESIGN

1607.12.3 - 1608.9

### SECTION 1608 SNOW LOADS

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

**1608.2 Ground snow loads.** The ground snow loads to be used in determining the design snow loads for roofs are given in Figure 1608.2. Site-specific case studies may be made in lieu of snow loads in Figure 1608.2. Ground snow load determination for site-specific case studies shall be based on an extreme value statistical analysis of data available in the vicinity of the site using a value with a 2-percent annual probability of being exceeded (50-year mean recurrence interval).

**1608.3 Flat roof snow loads.** The flat roof snow load,  $p_f$ , on a roof with a slope equal to or less than 5 degrees (0.09 rad) (1 inch per foot = 4.76 degrees) shall be calculated in accordance with Section 7.3 of ASCE 7.

**1608.3.1 Exposure factor.** The value for the snow exposure factor,  $C_e$ , used in the calculation of  $p_f$  shall be determined from Table 1608.3.1.

**1608.3.2 Thermal factor.** The value for the thermal factor,  $C_t$ , used in the calculation of  $p_f$  shall be determined from Table 1608.3.2.

**1608.3.3 Snow load importance factor.** The value for the snow load importance factor,  $I_s$ , used in the calculation of  $p_f$  shall be determined in accordance with Table 1604.5. Greenhouses that are occupied for growing plants on production or research basis, without public access, shall be included in Importance Category IV.

**1608.3.4 Rain-on-snow surcharge load.** Roofs with a slope less than  $\frac{1}{2}$  inch per foot (2.38 degrees) shall be designed for a rain-on-snow surcharge load determined in accordance with Section 7.10 of ASCE 7.

**1608.3.5 Ponding instability.** For roofs with a slope less than  $\frac{1}{4}$  inch per foot (1.19 degrees), the design calculations shall include verification of the prevention of ponding instability in accordance with Section 7.11 of ASCE 7.

**1608.4 Sloped roof snow loads.** The snow load,  $p_s$ , on a roof with a slope greater than 5 degrees (0.09 rad) (1 inch per foot = 4.76 degrees) shall be calculated in accordance with Section 7.4 of ASCE 7.

**1608.5 Partial loading.** The effect of not having the balanced snow load over the entire loaded roof area shall be analyzed in accordance with Section 7.5 of ASCE 7.

**1608.6 Unbalanced snow loads.** Unbalanced roof snow loads shall be determined in accordance with Section 7.6 of ASCE 7. Winds from all directions shall be accounted for when establishing unbalanced snow loads.

**1608.7 Drifts on lower roofs.** In areas where the ground snow load,  $p_g$ , as determined by Section 1608.2, is equal to or greater than 5 pounds per square foot (0.240 kN/m<sup>2</sup>), roofs shall be designed to sustain localized loads from snow drifts in accordance with Section 7.7 of ASCE 7.

**1608.8 Roof projections.** Drift loads due to mechanical equipment, penthouses, parapets and other projections above the roof shall be determined in accordance with Section 7.8 of ASCE 7.

**1608.9 Sliding snow.** The extra load caused by snow sliding off a sloped roof onto a lower roof shall be determined in accordance with Section 7.9 of ASCE 7.

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**ATTACHMENT 1**

STRUCTURAL DESIGN

TABLE 1608.3.1 - 1609.1.1

**TABLE 1608.3.1  
SNOW EXPOSURE FACTOR,  $C_e$**

TERRAIN CATEGORY <sup>a</sup>	EXPOSURE OF ROOF <sup>a,b</sup>		
	Fully exposed <sup>c</sup>	Partially exposed	Sheltered
A (see Section 1609.4)	N/A	1.1	1.3
B (see Section 1609.4)	0.9	1.0	1.2
C (see Section 1609.4)	0.9	1.0	1.1
D (see Section 1609.4)	0.8	0.9	1.0
Above the treeline in windswept mountainous areas	0.7	0.8	N/A
In Alaska, in areas where trees do not exist within a 2-mile radius of the site	0.7	0.8	N/A

For SI: 1 mile = 1609.344 m.

- a. The terrain category and roof exposure condition chosen shall be representative of the anticipated conditions during the life of the structure. An exposure factor shall be determined for each roof of a structure.
- b. Definitions of roof exposure are as follows:
1. Fully exposed shall mean roofs exposed on all sides with no shelter afforded by terrain, higher structures or trees. Roofs that contain several large pieces of mechanical equipment, parapets which extend above the height of the balanced snow load,  $h_b$ , or other obstructions are not in this category.
  2. Partially exposed shall include all roofs except those designated as "fully exposed" or "sheltered."
  3. Sheltered roofs shall mean those roofs located tight in among conifers that qualify as "obstructions."
- c. Obstructions within a distance of  $10 h_o$  provide "shelter," where  $h_o$  is the height of the obstruction above the roof level. If the only obstructions are a few deciduous trees that are leafless in winter, the "fully exposed" category shall be used except for terrain category "A." Note that these are heights above the roof. Heights used to establish the terrain category in Section 1609.4 are heights above the ground.

**TABLE 1608.3.2  
THERMAL FACTOR,  $C_t$**

THERMAL CONDITION <sup>a</sup>	$C_t$
All structures except as indicated below	1.0
Structures kept just above freezing and others with cold, ventilated roofs in which the thermal resistance ( $R$ -value) between the ventilated space and the heated space exceeds $25 \text{ ft}^2 \cdot \text{hr} \cdot \text{°F/Btu}$	1.0 <sup>c</sup>
Unheated structures	1.2
Continuously heated greenhouses <sup>b</sup> with a roof having a thermal resistance ( $R$ -value) less than $2.0 \text{ ft}^2 \cdot \text{hr} \cdot \text{°F/Btu}$	0.85

For SI:  $^{\circ}\text{C} = [(\text{°F}) - 32] / 1.8$ , 1 British thermal unit per hour = 0.2931 W.

- a. The thermal condition shall be representative of the anticipated conditions during winters for the life of the structure.
- b. A continuously heated greenhouse shall mean a greenhouse with a constantly maintained interior temperature of 50°F or more during winter months. Such greenhouse shall also have a maintenance attendant on duty at all times or a temperature alarm system to provide warning in the event of a heating system failure.
- c. The thermal factor,  $C_t$ , shall be 1.1 if ground snow loads are not taken from Figure 1608.2.

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STRUCTURAL DESIGN

TABLE 1608.3.1 - 1609.1.1

**SECTION 1609  
WIND LOADS**

**1609.1 Applications.** Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures. Wind pressures shall be assumed to come from any horizontal direction and to act normal to the surfaces considered.

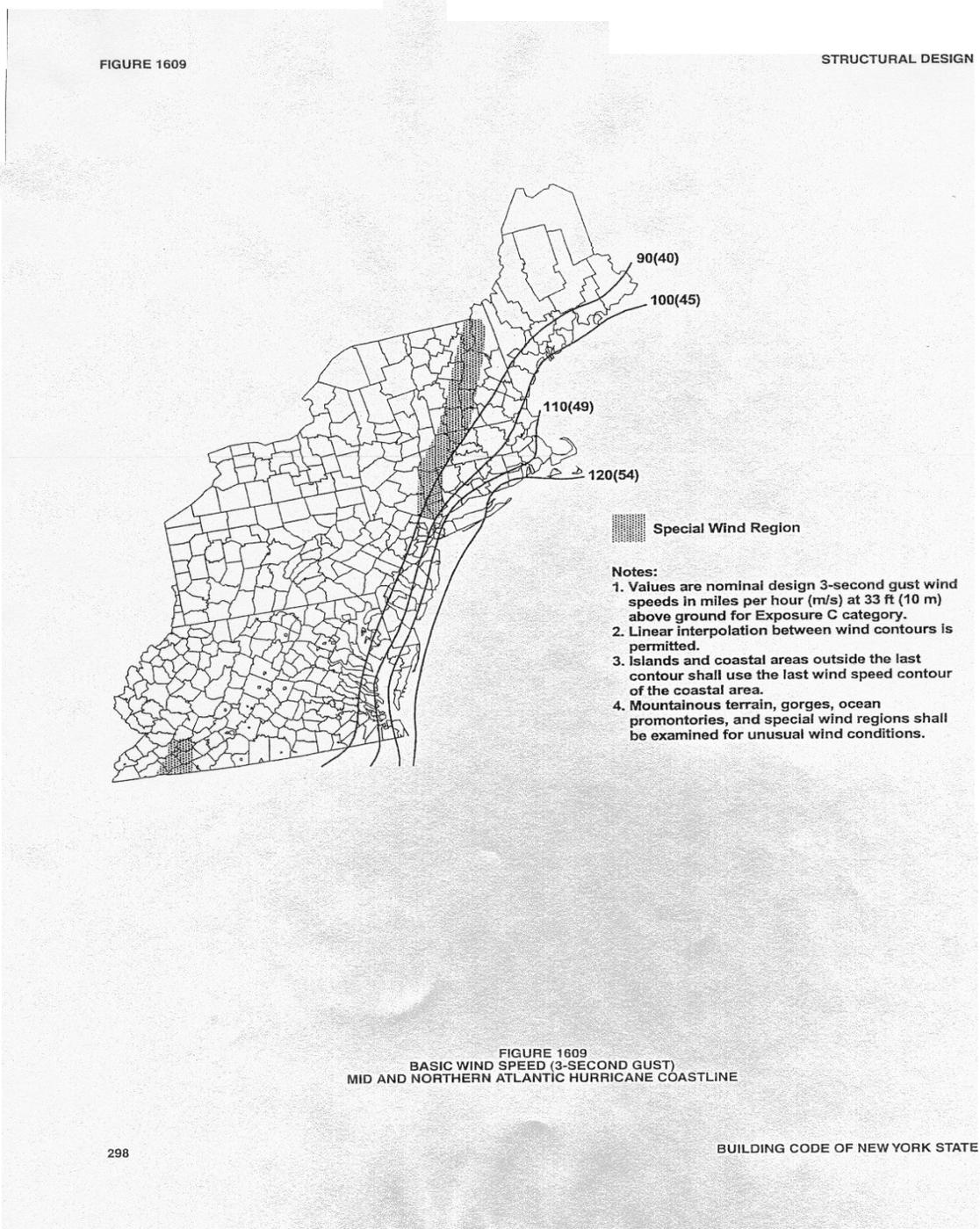
**1609.1.1 Determination of wind loads.** Wind loads on every building or structure shall be determined in accordance with Section 6 of ASCE 7.

**Exceptions:**

1. Wind loads determined by the provisions of Section 1609.6.
2. Subject to the limitations of Section 1609.1.1.1, the provisions of SBCCI SSTD 10 shall be permitted for applicable Group R2 and R3 buildings.
3. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of the *AF & PA Wood Frame Construction Manual for One and Two Family Dwellings, SBC High Wind Edition*.

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**ATTACHMENT 2**



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1609.1.1.1 - 1609.1.5

**1609.1.1.1 Applicability.** The provisions of SSTD 10 and the *AF & PA Wood Frame Construction Manual for One and Two Family Dwellings, SBC High Wind Edition* are applicable only to buildings located within Exposure A, B or C as defined in Section 1609.4. The provisions shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting the following conditions:

1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in exposure B or 30 feet (9144 mm) or higher if located in exposure C;
2. The maximum average slope of the hill exceeds 10 percent; and
3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is greater.

**1609.1.2 Minimum wind loads.** The wind loads used in the design of the main windforce-resisting system shall not be less than 10 pounds per square foot (0.479 kN/m<sup>2</sup>) multiplied by the area of the building or structure projected on a vertical plane normal to the wind direction. In the calculation of design wind loads for components and cladding for buildings, the algebraic sum of the pressures acting on opposite faces shall be taken into account. The design pressure for components and cladding of buildings shall not be less than 10 pounds per square foot (0.479 kN/m<sup>2</sup>) acting in either direction normal to the surface. The design force for open buildings and other structures shall not be less than 10 pounds per square foot (0.479 kN/m<sup>2</sup>) multiplied by the area  $A_f$ .

**1609.1.3 Anchorage against overturning, uplift and sliding.** Structural members and systems, and components and cladding in a building or structure shall be anchored to resist wind-induced overturning, uplift and sliding and to provide continuous load paths for these forces to the foundation. Where a portion of the resistance to these forces is provided by dead load, the dead load shall be taken as the minimum dead load likely to be in place during a design wind event. Where the alternate basic load combinations of Section 1605.3.2 are used, only two-thirds of the minimum dead load likely to be in place during a design wind event shall be used.

**1609.1.4 Protection of openings.** In wind borne debris regions, glazing that receives positive external pressure in the lower 60 feet (18 288 mm) in buildings shall be assumed to be openings unless such glazing is impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact resisting standard or ASTM E 1996 and of ASTM E 1886 referenced therein as follows:

1. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the Large Missile Test of ASTM E 1996.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the Small Missile Test of ASTM E 1996.

**Exceptions:**

1. Wood structural panels with a minimum thickness of  $\frac{7}{16}$  inch (11.1 mm) and maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in one- and two-story buildings. Panels shall be pre-cut to cover the glazed openings with attachment hardware provided. Attachments shall be designed to resist the components and cladding loads determined in accordance with the provisions of Section 1609.6.5. Attachment in accordance with Table 1609.1.4 is permitted for buildings with a mean roof height of 33 feet (10 058 mm) or less where wind speeds do not exceed 130 mph.
2. Buildings in Category IV as defined in Table 1604.5, including production greenhouses as defined in Section 1608.3.3.

**TABLE 1609.1.4**  
WINDBORNE DEBRIS PROTECTION FASTENING  
SCHEDULE FOR WOOD STRUCTURAL PANELS<sup>a,b,c</sup>

FASTENER TYPE	FASTENER SPACING (inches)			
	Panel span ≤ 2 feet	2 feet ≤ Panel span ≤ 4 feet	4 feet < Panel span ≤ 6 feet	6 feet < Panel span ≤ 8 feet
2 <sup>1</sup> / <sub>2</sub> #6 Wood Screws	16	16	12	9
2 <sup>1</sup> / <sub>2</sub> #8 Wood Screws	16	16	16	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 mile per hour = 0.44 m/s.

- This table is based on a maximum wind speed (3-second gust) of 130 mph and mean roof height of 33 feet or less.
- Fasteners shall be installed at opposing ends of the wood structural panel.
- Where screws are attached to masonry or masonry/stucco, they shall be attached utilizing vibration-resistant anchors having a minimum withdrawal capacity of 490 pounds.

**1609.1.4.1 Building with openings.** Where glazing is assumed to be an opening in accordance with Section 1609.1.4, the building shall be evaluated to determine if the openings are of sufficient area to constitute an open or partially enclosed building as defined in Section 1609.2. Open and partially enclosed buildings shall be designed in accordance with the applicable provisions of ASCE 7.

**1609.1.5 Wind and seismic detailing.** Lateral-force-resisting systems shall meet seismic detailing

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## ATTACHMENT 2

1609.2

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requirements and limitations prescribed in this code, even when wind code prescribed load effects are greater than seismic load effects.

**1609.2 Definitions.** The following words and terms shall, for the purposes of Section 1609.6, have the meanings shown herein.

**BUILDINGS AND OTHER STRUCTURES, FLEXIBLE.** Slender buildings and other structures that have a fundamental natural frequency less than 1 Hz.

**BUILDING, ENCLOSED.** A building that does not comply with the requirements for open or partially enclosed buildings.

**BUILDING, LOW-RISE.** Enclosed or partially enclosed buildings that comply with the following conditions:

1. Mean roof height,  $h$ , less than or equal to 60 feet (18 288 mm).
2. Mean roof height,  $h$ , does not exceed least horizontal dimension.

**BUILDING, OPEN.** A building having each wall at least 80 percent open. This condition is expressed for each wall by the equation:

$$A_o \geq 0.8 A_g \quad (\text{Equation 16-11})$$

where:

$A_o$  = Total area of openings in a wall that receives positive external pressure, in square feet ( $m^2$ ).

$A_g$  = The gross area of that wall in which  $A_o$  is identified, in square feet ( $m^2$ ).

**BUILDING, PARTIALLY ENCLOSED.** A building that complies with both of the following conditions:

1. The total area of openings in a wall that receives positive external pressure exceeds the sum of the areas of openings in the balance of the building envelope (walls and roof) by more than 10 percent; and
2. The total area of openings in a wall that receives positive external pressure exceeds 4 square feet (0.37  $m^2$ ) or 1 percent of the area of that wall, whichever is smaller, and the percentage of openings in the balance of the building envelope does not exceed 20 percent.

These conditions are expressed by the following equations:

$$A_o > 1.10A_{oi} \quad (\text{Equation 16-12})$$

$$A_o > 4 \text{ square feet (0.37 } m^2) \text{ or } > 0.01A_g, \text{ whichever is smaller, and } A_{oi}/A_{gi} \leq 0.20 \quad (\text{Equation 16-13})$$

where:

$A_o, A_g$  are as defined for an open building.

$A_{oi}$  = The sum of the areas of openings in the building envelope (walls and roof) not including  $A_o$ , in square feet ( $m^2$ ).

$A_{gi}$  = The sum of the gross surface areas of the building envelope (walls and roof) not including  $A_g$ , in square feet ( $m^2$ ).

**BUILDING, SIMPLE DIAPHRAGM.** A building that complies with all of the following conditions:

1. Enclosed building,
2. Mean roof height  $h$  less than or equal to 60 feet (18 288 mm),
3. Mean roof height  $h$  does not exceed least horizontal dimension,
4. Building has an approximately symmetrical cross section,
5. Building has no expansion joints or structural separations within the building,
6. Wind loads are transmitted through floor and roof diaphragms to the vertical lateral-force-resisting systems,
7. If the building has moment resisting frames, roof slopes do not exceed 30 degrees (0.5235 rad).

**COMPONENTS AND CLADDING.** Elements of the building envelope that do not qualify as part of the main windforce-resisting system.

**EFFECTIVE WIND AREA.** The area used to determine  $GC_p$ . For component and cladding elements, the effective wind area in Tables 1609.6.2.1(2) and 1609.6.2.1(3) is the span length multiplied by an effective width that need not be less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.

**HURRICANE-PRONE REGIONS.** Areas vulnerable to hurricanes defined as:

1. The U.S. Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed is greater than 90 mph and
2. Hawaii, Puerto Rico, Guam, Virgin Islands and American Samoa.

**IMPORTANCE FACTOR,  $I$ .** A factor that accounts for the degree of hazard to human life and damage to property.

**MAIN WINDFORCE-RESISTING SYSTEM.** An assemblage of structural elements assigned to provide support and stability for the overall structure. The system generally receives wind loading from more than one surface.

**MEAN ROOF HEIGHT.** The average of the roof eave height and the height to the highest point on the roof surface, except that eave height shall be used for roof angle of less than or equal to 10 degrees (0.1745 rad).

**WIND-BORNE DEBRIS REGION.** Areas within hurricane-prone regions within 1 mile (1.61 km) of the coastal mean high water line where the basic wind speed is 110 miles (48.4 m/s) per hour or greater; or where the basic wind speed is 120 miles (52.8 m/s) per hour or greater; or Hawaii.



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ATTACHMENT 2

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TABLE 1609.3.1 - 1609.5

TABLE 1609.3.1  
EQUIVALENT BASIC WIND SPEEDS<sup>a,b,c</sup>

$V_{3s}$	85	90	100	105	110	120	125	130	140	145	150	160	170
$V_{fm}$	70	75	80	85	90	100	105	110	120	125	130	140	150

For SI: 1 mile per hour = 0.44 m/s.

a. Linear interpolation is permitted.

b.  $V_{3s}$  is the second gust wind speed (mph).

c.  $V_{fm}$  is the fastest mile wind speed (mph).

**1609.3 Basic wind speed.** The basic wind speed, in miles per hour, for the determination of the wind loads shall be determined by Figure 1609 or by ASCE 7 Figure 6-1 when using the provisions of ASCE 7. Basic wind speed for the special wind regions indicated, near mountainous terrain and near gorges, shall be in accordance with local jurisdiction requirements. Basic wind speeds determined by the local jurisdiction shall be in accordance with Section 6.5.4 of ASCE 7.

In non-hurricane-prone regions, when the basic wind speed is estimated from regional climatic data, the basic wind speed shall be not less than the wind speed associated with an annual probability of 0.02 (50-year mean recurrence interval), and the estimate shall be adjusted for equivalence to a 3-second gust wind speed at 33 feet (10 m) above ground in exposure category C. The data analysis shall be performed in accordance with Section 6.5.4 of ASCE 7.

**1609.3.1 Wind speed conversion.** When required, the 3-second gust wind velocities of Figure 1609 shall be converted to fastest mile wind velocities using Table 1609.3.1.

**1609.4 Exposure category.** For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the transition zone between categories, the category resulting in the largest wind forces shall apply. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features. For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of the following categories:

- 1. Exposure A.** Large city centers with at least 50 percent of the buildings having a height in excess of 70 feet (21 356 mm). Use of this exposure category shall be limited to those areas for which terrain rep-

resentative of Exposure A prevails in the upwind direction for a distance of at least 0.5 mile (0.8 km) or 10 times the height of the building or other structure, whichever is greater. Possible channeling effects or increased velocity pressures due to the building or structure being located in the wake of adjacent buildings shall be taken into account.

- 2. Exposure B.** Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Exposure B shall be assumed unless the site meets the definition of another type exposure.
- 3. Exposure C.** Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet (9144 mm) extending more than 1,500 feet (457.2 m) from the building site in any quadrant. This exposure shall also apply to any building located within Exposure B type terrain where the building is directly adjacent to open areas of Exposure C type terrain in any quadrant for a distance of more than 600 feet (182.9 m). This category includes flat open country, grasslands and shorelines in hurricane-prone regions.
- 4. Exposure D.** Flat, unobstructed areas exposed to wind flowing over open water (excluding shorelines in hurricane-prone regions) for a distance of at least 1 mile (1.61 km). Shorelines in Exposure D include inland waterways, the Great Lakes and coastal areas of California, Oregon, Washington and Alaska. This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the water. Exposure D extends inland from the shoreline a distance of 1,500 feet (460 m) or 10 times the height of the building or structure, whichever is greater.

**1609.5 Importance factor.** Buildings and other structures shall be assigned a wind load importance factor,  $I_w$ , in accordance with Table 1604.5.

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ATTACHMENT 2

TABLE 1609.6.2.1 (1)

STRUCTURAL DESIGN

TABLE 1609.6.2.1(1)  
MAIN WINDFORCE-RESISTING SYSTEM WIND LOADS FOR A BUILDING WITH MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B\*

Wind Velocity	Load Direction	Roof Angle	HORIZONTAL LOADS <sup>b</sup>						VERTICAL LOADS						MAXIMUM HORIZONTAL WALL LOADS <sup>c</sup>			
			End Zone		Interior Zone		Interior Zone		End Zone		Interior Zone		Windward Overhang		1E	4E	1	4
			Wall	Roof <sup>d</sup>	Wall	Roof <sup>d</sup>	Windward roof	Leeward roof	Windward roof	Leeward roof	End zone	Interior zone						
85	Transverse	0 to 5°	11.5	-5.9	7.5	-3.5	-13.8	-7.8	-8.8	-6.1	-20.6	-15.4	-8.7	8.7	-6.7	6.4	-8.2	
		30° < angle ≤ 45°	15.9	-4.2	10.6	-2.3	-13.8	-6.6	-6.6	-7.3	-20.6	-15.4	-8.7	10.8	-9.0	7.8	-6.7	
	Longitudinal	All angles	12.9	8.6	10.2	7.0	5.0	-7.8	4.3	-6.7	-6.6	-6.6	-6.6	9.6	-7.3	8.2	-6.1	
		All angles	11.5	-5.9	7.5	-3.5	-13.8	-7.8	-8.8	-6.1	-20.6	-15.4	-8.7	8.7	-6.7	6.4	-8.2	
90	Transverse	0 to 5°	12.8	-6.7	8.5	-4.0	-15.4	-8.8	-10.7	-8.1	-23.1	-18.4	-9.8	9.8	-7.5	7.2	-6.8	
		30° < angle ≤ 45°	17.8	-4.7	11.9	-2.6	-15.4	-10.7	-10.7	-8.1	-23.1	-18.4	-9.8	12.1	-10.1	8.8	-7.5	
	Longitudinal	All angles	14.4	9.9	11.5	7.9	5.6	-8.8	4.8	-7.5	-8.1	-8.1	-8.1	10.7	-8.1	9.1	-6.8	
		All angles	12.8	-6.7	8.5	-4.0	-15.4	-8.8	-10.7	-8.1	-23.1	-18.4	-9.8	9.8	-7.5	7.2	-6.8	
100	Transverse	0 to 5°	15.9	-8.2	10.5	-4.9	-18.0	-10.8	-13.3	-10.3	-25.7	-20.7	-12.0	12.0	-9.3	8.8	-7.2	
		30° < angle ≤ 45°	22.0	-5.6	14.6	-3.2	-18.1	-13.3	-13.3	-10.3	-25.7	-20.7	-12.0	14.9	-12.5	10.8	-6.3	
	Longitudinal	All angles	17.5	12.2	14.2	9.8	6.9	-10.8	5.9	-9.3	-8.1	-8.1	13.3	-10.1	11.3	-8.4		
		All angles	15.9	-8.2	10.5	-4.9	-18.1	-10.8	-13.3	-10.3	-25.7	-20.7	-12.0	12.0	-9.3	8.8	-7.2	
105	Transverse	0 to 5°	17.5	-9.1	11.6	-5.4	-21.0	-11.9	-14.6	-11.1	-29.4	-23.0	-13.3	13.3	-10.3	9.7	-7.9	
		30° < angle ≤ 45°	24.2	-6.4	16.1	-3.5	-21.0	-14.6	-14.6	-11.1	-29.4	-23.0	-13.3	16.5	-13.8	11.9	-10.3	
	Longitudinal	All angles	18.7	13.4	15.6	10.8	7.6	-11.9	6.6	-10.3	-9.3	-9.3	14.6	-11.1	12.4	-8.2		
		All angles	17.5	-9.1	11.6	-5.4	-21.0	-11.9	-14.6	-11.1	-29.4	-23.0	-13.3	13.3	-10.3	9.7	-7.9	
110	Transverse	0 to 5°	18.2	-10.0	12.7	-6.9	-23.1	-13.1	-16.0	-12.1	-34.5	-27.5	-14.6	14.6	-11.3	10.7	-8.7	
		30° < angle ≤ 45°	26.6	-7.0	17.7	-3.9	-23.1	-16.0	-16.0	-12.2	-34.5	-27.5	-14.6	18.1	-15.1	13.1	-11.3	
	Longitudinal	All angles	21.6	14.8	17.2	11.8	8.3	-13.1	7.2	-11.3	-9.8	-9.8	16.0	-12.2	13.7	-10.1		
		All angles	18.2	-10.0	12.7	-6.9	-23.1	-13.1	-16.0	-12.1	-34.5	-27.5	-14.6	14.6	-11.3	10.7	-8.7	
120	Transverse	0 to 5°	22.8	-11.9	15.1	-7.0	-27.4	-15.6	-18.1	-14.5	-41.1	-32.7	-17.3	17.3	-13.4	12.7	-10.3	
		30° < angle ≤ 45°	31.6	-8.3	21.1	-4.6	-27.4	-18.1	-18.1	-14.5	-41.1	-32.7	-17.3	21.5	-18.0	15.6	-13.4	
	Longitudinal	All angles	25.7	17.6	20.4	14.0	9.9	-15.6	8.6	-13.4	-11.6	-11.6	19.1	-14.5	16.2	-12.1		
		All angles	22.8	-11.9	15.1	-7.0	-27.4	-15.6	-18.1	-14.5	-41.1	-32.7	-17.3	17.3	-13.4	12.7	-10.3	
125	Transverse	0 to 5°	24.8	-12.9	16.4	-7.6	-29.8	-16.9	-19.9	-15.1	-43.7	-33.6	-18.8	18.8	-14.5	13.9	-11.2	
		30° < angle ≤ 45°	34.3	-9.1	22.9	-5.0	-29.8	-20.7	-20.7	-15.7	-43.7	-33.6	-18.8	23.3	-18.5	16.9	-14.5	
	Longitudinal	All angles	27.9	18.1	22.2	15.2	10.7	-16.9	9.3	-14.5	-9.8	-9.8	20.7	-15.7	17.6	-13.1		
		All angles	24.8	-12.9	16.4	-7.6	-29.8	-16.9	-19.9	-15.1	-43.7	-33.6	-18.8	18.8	-14.5	13.9	-11.2	
130	Transverse	0 to 5°	26.8	-13.9	17.8	-8.2	-32.3	-18.3	-22.4	-16.2	-46.2	-36.4	-20.4	20.4	-15.7	14.9	-12.1	
		30° < angle ≤ 45°	37.1	-9.8	24.7	-5.4	-32.4	-22.4	-22.4	-17.0	-46.2	-36.4	-20.4	25.2	-18.2	18.3	-15.7	
	Longitudinal	All angles	30.1	20.6	24.0	16.5	11.6	-18.3	10.0	-16.7	-13.7	-13.7	22.4	-17.0	18.1	-14.2		
		All angles	26.8	-13.9	17.8	-8.2	-32.4	-18.3	-22.4	-16.2	-46.2	-36.4	-20.4	20.4	-15.7	14.9	-12.1	

(Continued)

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**ATTACHMENT 2**

STRUCTURAL DESIGN

TABLE 1609.6.2.1 (1)

**TABLE 1609.6.2.1(1)(Continued)  
MAIN WINDFORCE-RESISTING SYSTEM WIND LOADS FOR A BUILDING WITH MEAN ROOF HEIGHT OF  
30 FEET LOCATED IN EXPOSURE B<sup>a</sup>**

Wind Velocity	Load Direction	Roof Angle	HORIZONTAL LOADS <sup>b</sup>						VERTICAL LOADS						MAXIMUM HORIZONTAL WALL LOADS <sup>d</sup>					
			End Zone		Interior Zone		End Zone		Interior Zone		End Zone		Interior Zone		End Zone		Interior Zone			
			Wall	Roof <sup>e</sup>	Wall	Roof <sup>e</sup>	Windward roof <sup>f</sup>	Leeward roof	Windward roof	Leeward roof	Windward roof	Leeward roof	Windward roof	Leeward roof	End zone	Interior zone	1E	4E	1	4
140	Transverse	0 to 5°	31.1	-16.1	20.6	-9.6	-37.3	-21.2	-26.0	-16.4	-55.9	-44.5	23.6	-18.2	17.3	-14.0				
		20°	43.0	-11.4	28.7	-6.3	-37.3	-26.0	-26.0	-19.7	-55.9	-44.5	29.3	-24.5	21.2	-18.2				
	Longitudinal	30° < angle ≤ 45°	35.0	23.9	27.6	19.1	13.4	-21.2	11.7	-18.2	-15.8	-19.7	26.0	-19.7	22.1	-16.4				
		All angles	31.1	-16.1	20.6	-9.6	-37.3	-21.2	26.0	-16.4	-55.9	-44.5	23.6	-18.2	17.3	-14.0				
145	Transverse	0 to 5°	33.3	-17.5	22.1	-10.3	-40.1	-22.8	-27.9	-17.6	-56.1	-43.9	25.3	-19.6	18.6	-15.1				
		20°	46.2	-12.2	30.8	-6.7	-40.1	-27.9	-27.9	-21.2	-56.1	-43.9	31.4	-26.3	22.8	-19.6				
	Longitudinal	30° < angle ≤ 45°	37.5	25.6	29.8	20.5	14.4	-22.8	12.5	-19.6	-13.1	-15.1	27.9	-21.2	23.7	-17.6				
		All angles	33.3	-17.3	22.1	-10.3	-40.1	-22.8	-27.9	-17.6	-56.1	-43.9	25.3	-19.6	18.6	-15.1				
150	Transverse	0 to 5°	35.7	-18.5	23.7	-11.0	-42.9	-24.4	-29.8	-18.9	-64.1	-51.1	27.1	-20.9	19.9	-16.1				
		20°	49.4	-13.0	32.9	-7.2	-42.9	-29.8	-29.8	-22.6	-64.1	-51.1	33.6	-28.1	24.4	-20.9				
	Longitudinal	30° < angle ≤ 45°	40.1	27.4	31.9	22.0	15.4	-24.4	13.4	-20.9	-18.2	-20.2	29.8	-22.6	25.4	-18.9				
		All angles	35.7	-18.5	23.7	-11.0	-42.9	-24.4	-29.8	-18.9	-64.1	-51.1	27.1	-20.9	19.9	-16.1				
170	Transverse	0 to 5°	45.8	-23.8	30.4	-14.1	-55.1	-31.3	-38.3	-24.2	-77.1	-60.4	34.8	-26.9	25.6	-20.7				
		20°	63.4	-16.7	42.3	-9.3	-55.1	-38.3	-38.3	-28.1	-77.1	-60.4	43.2	-36.1	31.3	-26.9				
	Longitudinal	30° < angle ≤ 45°	51.5	35.2	41.0	28.2	19.8	-31.3	17.2	-26.9	-18.1	-20.7	38.3	-29.1	32.6	-24.2				
		All angles	45.8	-23.8	30.4	-14.1	-55.1	-31.3	-38.3	-24.2	-77.1	-60.4	34.8	-26.9	25.6	-20.7				

For SI: 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

a. Pressures for roof angles between 5° and 20° and between 20° and 30° shall be interpolated from the table.

b. Pressures are the sum of the windward and leeward pressures and shall be applied to the windward elevation of the building in accordance with Figure 1609.6(1).

c. If pressure is less than 0, use 0.

d. "Max. Horizontal Wall Loads" are only for the design of wall elements which also support roof framing. As part of the MWFRS, these elements shall be designed for the interaction of vertical and horizontal loads or have independent mechanisms for each load. For interaction design of walls as MWFRS, the vertical roof loads shall be the "Vertical Loads" from Table 1609.6.2.1(1), and the horizontal loads shall be the "Max. Horizontal Wall Loads." The zone loads shall be applied as shown in Figure 1609.6(1) and as follows: 1E to the Windward Wall End Zone, 4E to the Leeward Wall End Zone, 1 to the Windward Wall Interior Zone, and 4 to the Leeward Wall Interior Zone.

e. Note that there are two load conditions between 20° and 30°. Negative pressure from 20° to 30° shall be interpolated using a pressure value of 0 for 30°. Positive pressures between 25° and 30° shall be interpolated using pressure value of 0 for 25°.

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**ATTACHMENT 2**

**TABLE 1609.6.2.1(2)**

**STRUCTURAL DESIGN**

**TABLE 1609.6.2.1(2)  
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B<sup>a</sup>**

ZONE PER FIGURE 1609.6(2)	BASIC WIND SPEED V (mph—3-second gust)																								
	85	90	100	105	110	120	126	130	140	145	150	170													
1	10	10.0	-13.0	10.0	-14.6	10.0	-18.0	10.0	-19.8	10.0	-21.8	10.0	-25.9	11.4	-28.1	12.4	-30.4	14.3	-35.3	15.4	-37.8	16.5	-40.5	21.1	-52.0
2	100	10.0	-12.7	10.0	-14.2	10.0	-17.5	10.0	-19.3	10.0	-21.2	10.0	-25.2	10.7	-27.4	11.6	-29.6	13.4	-34.4	14.4	-36.9	15.4	-39.4	19.8	-50.7
1	50	10.0	-12.2	10.0	-13.7	10.0	-16.9	10.0	-18.7	10.0	-20.5	10.0	-24.4	10.0	-26.4	10.6	-28.6	12.3	-33.2	13.1	-35.6	14.1	-38.1	18.1	-48.9
1	100	10.0	-11.9	10.0	-13.3	10.0	-16.5	10.0	-18.2	10.0	-19.9	10.0	-23.7	10.0	-25.7	10.0	-27.8	11.4	-32.2	12.2	-34.6	13.0	-37.0	16.7	-47.6
2	10	10.0	-21.8	10.0	-24.4	10.0	-30.2	10.0	-33.3	10.0	-36.5	10.0	-43.5	11.4	-47.2	12.4	-51.0	14.3	-59.2	15.4	-63.5	16.5	-67.9	21.1	-87.2
2	50	10.0	-16.4	10.0	-18.4	10.0	-22.7	10.0	-25.1	10.0	-27.5	10.0	-32.7	10.0	-35.5	10.6	-38.4	12.3	-44.5	13.1	-47.8	14.1	-51.1	18.1	-65.7
2	100	10.0	-14.1	10.0	-15.8	10.0	-19.5	10.0	-21.5	10.0	-23.6	10.0	-28.1	10.0	-30.5	10.0	-33.0	11.4	-38.2	12.2	-41.0	13.0	-43.9	16.7	-56.4
3	10	10.0	-32.8	10.0	-36.8	10.0	-45.4	10.0	-50.1	10.0	-55.0	10.0	-65.4	11.4	-71.0	12.4	-76.8	14.3	-89.0	15.4	-95.5	16.5	-102.2	21.1	-131.3
3	50	10.0	-27.2	10.0	-30.5	10.0	-37.6	10.0	-41.5	10.0	-45.5	10.0	-54.2	10.7	-58.8	11.6	-63.6	13.4	-73.8	14.4	-79.1	15.4	-84.7	19.8	-108.7
3	100	10.0	-14.1	10.0	-15.8	10.0	-19.5	10.0	-21.5	10.0	-23.6	10.0	-28.1	10.0	-30.5	10.0	-33.0	11.4	-38.2	12.2	-41.0	13.0	-43.9	16.7	-56.4
1	10	10.0	-11.9	10.0	-13.3	10.0	-16.5	10.0	-18.2	10.0	-19.9	10.0	-23.7	10.0	-25.7	10.0	-27.8	11.4	-32.2	12.2	-34.6	13.0	-37.0	30.0	-47.6
1	50	10.0	-11.1	10.0	-12.5	10.0	-15.4	10.0	-17.0	10.0	-18.6	10.0	-22.2	12.9	-24.1	13.9	-26.0	16.1	-30.2	17.3	-32.4	18.5	-34.6	23.8	-44.5
1	100	10.0	-10.8	10.0	-12.1	10.0	-14.9	10.0	-16.5	10.0	-18.1	10.0	-21.5	11.4	-23.3	12.4	-25.2	14.3	-29.3	15.4	-31.4	16.5	-33.6	21.1	-43.2
2	10	10.0	-25.1	10.0	-28.2	10.0	-34.8	10.0	-38.3	10.0	-42.1	10.0	-50.1	16.2	-54.3	17.5	-58.7	20.3	-68.1	21.8	-73.1	23.3	-78.2	30.0	-100.5
2	50	10.0	-19.7	10.0	-22.1	10.0	-27.3	10.0	-30.1	10.0	-33.0	10.0	-39.3	12.9	-42.7	13.9	-46.1	16.1	-53.5	17.3	-57.4	18.5	-61.4	23.8	-78.9
3	10	10.0	-22.8	10.0	-25.6	10.0	-31.5	10.0	-34.8	10.0	-38.2	10.0	-45.4	14.8	-49.3	16.0	-53.3	18.5	-61.8	19.9	-66.3	21.3	-71.0	27.3	-91.2
3	50	10.0	-17.4	10.0	-19.5	10.0	-24.1	10.0	-26.6	10.0	-29.1	10.0	-34.7	11.4	-37.6	12.4	-40.7	14.3	-47.2	15.4	-50.6	16.5	-54.2	21.1	-69.6
3	100	10.0	-17.4	10.0	-19.5	10.0	-24.1	10.0	-26.6	10.0	-29.1	10.0	-34.7	11.4	-37.6	12.4	-40.7	14.3	-47.2	15.4	-50.6	16.5	-54.2	21.1	-69.6
1	10	11.6	-12.3	13.0	-13.8	16.0	-17.1	17.6	-18.8	19.4	-20.7	23.0	-24.6	25.0	-26.7	27.0	-28.9	31.4	-33.5	33.7	-35.9	36.0	-38.4	46.3	-49.3
1	50	11.1	-11.5	12.5	-12.8	15.4	-15.9	17.0	-17.5	18.6	-19.2	22.2	-22.8	24.1	-24.8	26.0	-26.8	30.2	-31.1	32.4	-33.3	34.6	-35.7	44.5	-45.8
1	100	10.8	-10.8	12.1	-12.1	14.9	-14.9	16.5	-16.5	18.1	-18.1	21.5	-21.5	23.3	-23.3	25.2	-25.2	29.3	-29.3	31.4	-31.4	34.6	-34.6	43.2	-43.2
2	10	11.6	-14.5	13.0	-16.3	16.0	-20.1	17.6	-22.2	19.4	-24.3	23.0	-29.0	25.0	-31.4	27.0	-34.0	31.4	-39.4	33.7	-42.3	36.0	-45.3	46.3	-58.1
2	50	11.1	-13.7	12.5	-15.3	15.4	-18.9	17.0	-20.8	18.6	-22.9	22.2	-27.2	24.1	-29.5	26.0	-32.0	30.2	-37.1	32.4	-39.8	34.6	-42.5	44.5	-54.6
2	100	10.8	-13.0	12.1	-14.6	14.9	-18.0	16.5	-19.8	18.1	-21.8	21.5	-25.9	23.3	-28.1	25.2	-30.4	29.3	-35.3	31.4	-37.8	33.6	-40.5	43.2	-52.0
3	10	11.9	-15.2	13.3	-17.0	16.5	-21.0	18.2	-23.2	19.9	-25.5	23.7	-30.3	25.7	-32.9	27.8	-35.6	32.3	-41.2	34.6	-44.2	37.0	-47.3	47.6	-60.8
3	50	11.1	-13.7	12.5	-15.3	15.4	-18.9	17.0	-20.8	18.6	-22.9	22.2	-27.2	24.1	-29.5	26.0	-32.0	30.2	-37.1	32.4	-39.8	34.6	-42.5	44.5	-54.6
3	100	10.8	-13.0	12.1	-14.6	14.9	-18.0	16.5	-19.8	18.1	-21.8	21.5	-25.9	23.3	-28.1	25.2	-30.4	29.3	-35.3	31.4	-37.8	33.6	-40.5	43.2	-52.0
4	10	13.0	-14.1	14.6	-15.8	18.0	-19.5	19.8	-21.5	21.8	-23.6	25.9	-28.1	28.1	-30.5	30.4	-33.0	35.3	-38.2	37.8	-41.0	40.5	-43.9	52.0	-56.4
4	50	12.4	-13.5	13.9	-15.1	17.2	-18.7	18.9	-20.6	20.8	-22.6	24.7	-26.9	26.8	-29.2	29.0	-31.6	33.7	-36.7	36.1	-39.3	38.7	-42.1	49.6	-54.1
4	100	11.6	-12.7	13.0	-14.3	16.1	-17.6	17.8	-19.4	19.5	-21.3	23.2	-25.4	25.2	-27.2	29.8	-31.6	-34.6	33.9	-37.1	36.2	-39.7	46.6	51.0	
4	100	11.1	-12.2	12.4	-13.6	15.3	-16.8	16.9	-18.5	18.5	-20.4	22.0	-24.2	23.9	-26.3	25.9	-28.4	30.0	-33.0	32.2	-35.4	34.4	-37.8	44.2	-48.6
5	10	13.0	-17.4	14.6	-19.5	18.0	-24.1	19.8	-26.6	21.8	-29.1	25.9	-34.7	28.1	-37.6	30.4	-40.7	35.3	-47.2	37.8	-50.6	40.5	-54.2	52.0	-69.6
5	50	12.4	-16.2	13.9	-18.2	17.2	-22.5	18.9	-24.8	20.8	-27.2	24.7	-32.4	26.8	-35.1	29.0	-38.0	33.7	-44.0	36.1	-47.2	38.7	-50.5	49.6	-64.9
5	100	11.6	-14.7	13.0	-16.5	16.1	-20.3	17.8	-22.4	19.5	-24.6	23.2	-29.3	25.2	-31.8	27.2	-34.3	31.6	-39.8	33.9	-42.7	36.2	-45.7	46.6	-58.7
5	100	11.1	-13.5	12.4	-15.1	15.3	-18.7	16.9	-20.6	18.5	-22.6	22.0	-26.9	23.9	-29.2	25.9	-31.6	30.0	-36.7	32.2	-39.3	34.4	-42.1	44.2	-54.1

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 degree = 0.01745 rad.

a. For effective areas between those given above, the load is permitted to be interpolated; otherwise, use the load associated with the lower effective area.

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**ATTACHMENT 2**

STRUCTURAL DESIGN

TABLE 1609.6.2.1(3)

**TABLE 1609.6.2.1(3)  
ROOF OVERHANG COMPONENT AND CLADDING DESIGN WIND PRESSURES  
FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B<sup>a</sup>**

ZONE PER FIGURE 1609.6(2)	EFFECTIVE WIND AREA <sup>a</sup> (ft <sup>2</sup> )	80	100	110	120	126	130	140	146	150	170
		Roof > 0 to 10 Degrees	10	-21.0	-25.9	-28.6	-31.4	-37.3	-40.5	-43.8	-50.8
	20	-20.6	-25.5	-28.1	-30.8	-36.7	-39.8	-43.0	-49.9	-53.5	-73.6
	50	-20.1	-24.9	-27.4	-30.1	-35.8	-38.8	-42.0	-48.7	-52.2	-71.8
	100	-19.8	-24.4	-26.9	-29.5	-35.1	-38.1	-41.2	-47.8	-51.3	-70.5
	3	-34.6	-42.7	-47.1	-51.6	-61.5	-66.7	-72.1	-83.7	-89.7	-123.4
	3	-27.1	-33.5	-36.9	-40.5	-48.3	-52.4	-56.6	-65.7	-70.4	-96.8
	3	-17.3	-21.4	-23.6	-25.9	-30.8	-33.4	-36.1	-41.9	-44.9	-61.8
	3	-10.0	-12.2	-13.4	-14.8	-17.6	-19.1	-20.6	-23.9	-25.6	-35.2
	2	-27.2	-33.5	-37.0	-40.6	-48.3	-52.4	-56.7	-65.7	-70.5	-96.9
	2	-27.2	-33.5	-37.0	-40.6	-48.3	-52.4	-56.7	-65.7	-70.5	-96.9
	2	-27.2	-33.5	-37.0	-40.6	-48.3	-52.4	-56.7	-65.7	-70.5	-96.9
	2	-27.2	-33.5	-37.0	-40.6	-48.3	-52.4	-56.7	-65.7	-70.5	-96.9
	3	-45.7	-56.4	-62.2	-68.3	-81.2	-88.1	-95.3	-110.6	-118.6	-163.0
	3	-40.5	-50.0	-55.1	-60.5	-72.0	-78.1	-84.5	-98.0	-105.1	-144.4
	3	-33.6	-41.5	-45.7	-50.2	-59.7	-64.8	-70.1	-81.3	-87.2	-119.9
	3	-28.4	-35.1	-38.7	-42.4	-50.5	-54.8	-59.3	-68.7	-73.7	-101.3
	2	-24.7	-30.5	-33.6	-36.9	-43.9	-47.6	-51.5	-59.8	-64.1	-88.1
	2	-24.0	-29.6	-32.6	-35.8	-42.6	-46.2	-50.0	-58.0	-62.2	-85.5
	2	-23.0	-28.4	-31.3	-34.3	-40.8	-44.3	-47.9	-55.6	-59.6	-82.0
	2	-22.2	-27.4	-30.3	-33.2	-39.5	-42.9	-46.4	-53.8	-57.7	-79.3
	3	-24.7	-30.5	-33.6	-36.9	-43.9	-47.6	-51.5	-59.8	-64.1	-88.1
	3	-24.0	-29.6	-32.6	-35.8	-42.6	-46.2	-50.0	-58.0	-62.2	-85.5
	3	-23.0	-28.4	-31.3	-34.3	-40.8	-44.3	-47.9	-55.6	-59.6	-82.0
	3	-22.2	-27.4	-30.3	-33.2	-39.5	-42.9	-46.4	-53.8	-57.7	-79.3
	3	-24.7	-30.5	-33.6	-36.9	-43.9	-47.6	-51.5	-59.8	-64.1	-88.1
	3	-24.0	-29.6	-32.6	-35.8	-42.6	-46.2	-50.0	-58.0	-62.2	-85.5
	3	-23.0	-28.4	-31.3	-34.3	-40.8	-44.3	-47.9	-55.6	-59.6	-82.0
	3	-22.2	-27.4	-30.3	-33.2	-39.5	-42.9	-46.4	-53.8	-57.7	-79.3

For 6L: 1 foot = 304.8 mm, 1 degree = 0.01745 rad, 1 mile per hour = 0.44 m/s.

a. For effective areas between those given above, the load is permitted to be interpolated; otherwise, use the load associated with the lower effective area.

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ATTACHMENT 2

TABLE 1609.6.2.1(4) - 1609.6.4.1

STRUCTURAL DESIGN

TABLE 1609.6.2.1(4)  
HEIGHT AND EXPOSURE  
ADJUSTMENT COEFFICIENTS<sup>a</sup>

MEAN ROOF (feet)	EXPOSURE		
	B	C	D
15	1.00	1.21	1.47
20	1.00	1.29	1.55
25	1.00	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

For SI: 1 foot = 304.8 mm.

a. All table values shall be adjusted for other exposures and heights by multiplying by the above coefficients.

**1609.6 Simplified provisions for low-rise buildings.**

**1609.6.1 Scope.** The procedures in Section 1609.6 shall be used for determining and applying wind pressures in the design of simple diaphragm buildings with flat, gabled and hipped roofs and having a mean roof height not exceeding the least horizontal dimension or 60 feet (18 288 mm), whichever is less, subject to the following limitations:

The provisions of Section 1609.6 shall not apply to buildings, sited on the upper half of an isolated hill or escarpment meeting all the following conditions:

1. The hill or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C.
2. The maximum average slope of the hill exceeds 10 percent.
3. The hill or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 1 mile (1.61 km), whichever is less.

**1609.6.2 Wind pressures.**

**1609.6.2.1 Load determination.** Structural members, cladding, fasteners and systems providing for the structural integrity of the building shall be designed for the loads from Tables 1609.6.2.1(1), 1609.6.2.1(2) and 1609.6.2.1(3) using Figure 1609, multiplied by the appropriate height and exposure coefficient from Table 1609.6.2.1(4) and importance factor from Table 1604.5.

**1609.6.2.2 Load case.** Members that act as both part of the main windforce-resisting system and as components and cladding shall be designed for each separate load case.

**1609.6.3 Edge strips and end zones.** The width of edge strips (a) shall be 10 percent of the least horizontal dimension or 40 percent of the eave height, whichever is less but not less than either 4 percent of the least horizontal dimension or 3 feet (914 mm). End zones as shown in Figure 1609.6.(1) shall be twice the width of the edge strip (a).

**1609.6.4 Main windforce-resisting system (MWFRS).** All elements and connections of the MWFRS shall be designed for vertical and horizontal loads based on the combined leeward and windward wall pressures and roof pressures determined from Table 1609.6.2.1(1). Pressures shall be applied in accordance with the loading diagrams shown in Figure 1609.6(3) to the end zone and interior zone as shown in Figure 1609.6(1). The building shall be designed for all wind directions. For buildings having flat roofs a ridge line normal to the wind direction shall be assumed at the mid-length dimension of the roof for all directions considered. Each corner shall be considered in turn as the windward corner.

**1609.6.4.1 Overhang loads.** The pressures to be used for the effects of roof overhangs on MWFRS shall be taken from Table 1609.6.2.1(1) and includes the effect of the wind on both the bottom and top surfaces.

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STRUCTURAL DESIGN

FIGURE 1609.6(1)

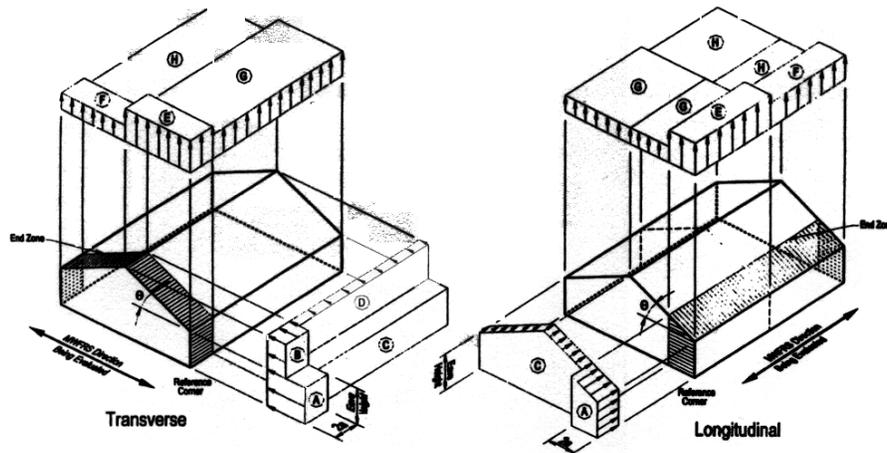


FIGURE 1609.6(1)  
MAIN WINDFORCE-RESISTING SYSTEM LOADING DIAGRAM

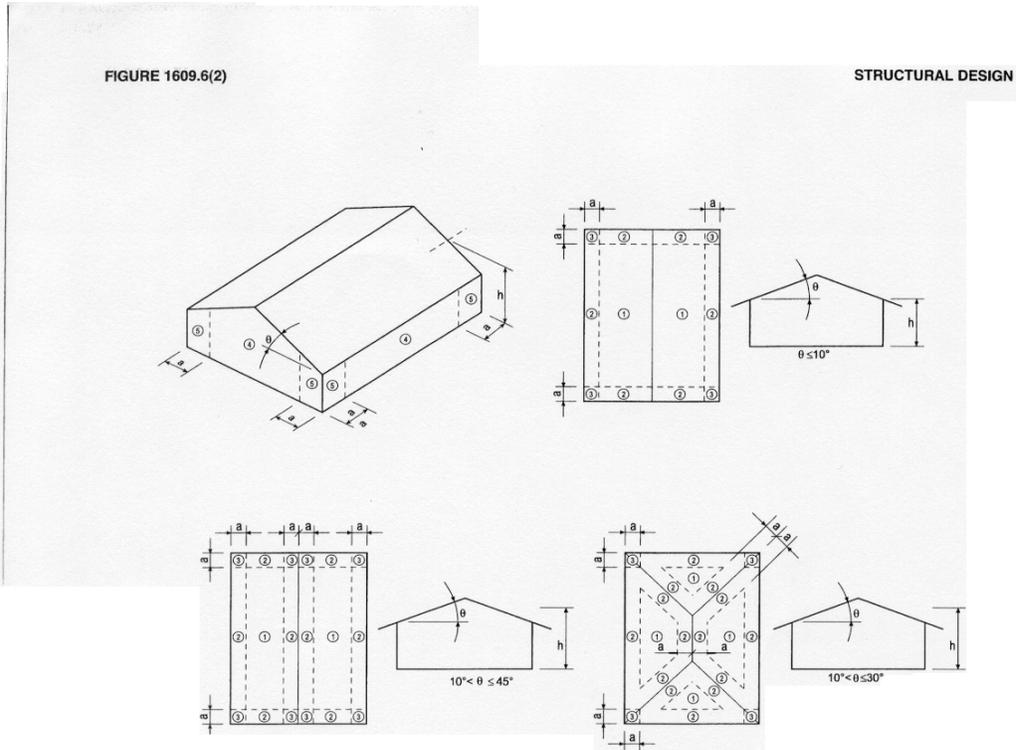
Notes:

1. Pressures shown are for exposure B, at  $h=30$  ft., for  $I=1.0$ . Adjust to other exposures and heights with the adjustment factor from Table 1609.6.2.1(4).
2. The load patterns shown shall be applied to each corner of the building in turn as the reference corner.
3. For flat roofs and for design of the MWFRS parallel to the ridge, locate the zone E/F, G/H boundary at the mid-length of the building.
4. Plus and minus signs signify pressures acting toward and away from the projected surfaces, respectively.
5. The total horizontal shear shall not be less than that determined by values from 1609.2.1 neglecting wind forces in zones B & D.
6. The zone pressures correspond to the following values in Table 1609.6.2.1(1):
 

Horizontal Loads – Combined windward and leeward net pressures on:	
A - End zone of wall projection	C - Interior zone of wall projection
B - End zone of roof projection	D - Interior zone of roof projection
Vertical Loads – Net pressures on:	
E - End zone of windward roof	G - Interior zone of windward roof
F - End zone of leeward roof	H - Interior zone of leeward roof
7. Where zone E or G falls on a roof overhang on the windward side of the building, use the Windward Overhang Loads from Table 1609.6.2.1(1). The value of the load on the vertical projection of the portion of zone E on the overhang shall be taken as the End Zone Windward Overhang Load. The value of the load on the vertical projection of the portion of zone G on the overhang shall be taken as the Interior Zone Windward Overhang Load.
8. Notation:
  - $\alpha$ : End zone width, in feet (meters) = 10 percent of least horizontal dimension or  $0.4h$ , whichever is smaller, but not less than either 4 percent of least horizontal dimension or 3 ft. (1 m).
  - $h$ : Mean roof height, in feet (meters), except that eave height shall be used for roof angles  $<10^\circ$ .
  - $\theta$ : Angle of plane of roof from horizontal, in degrees.
9. Main windforce-resisting roof members within end zones, except for members spanning at least from eave to ridge, or supporting members spanning at least from eave to ridge, shall be designed for end zone loads.

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For SI: 1 degree = 0.01745

**FIGURE 1609.6(2)  
COMPONENT AND CLADDING LOADING DIAGRAMS**

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FIGURE 1609.6(3)

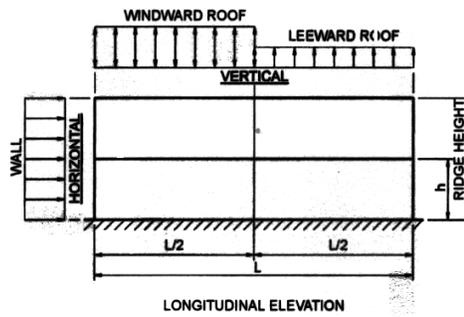
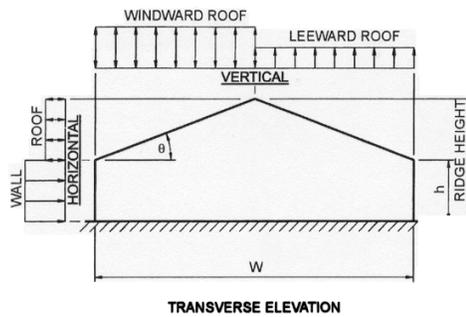


FIGURE 1609.6(3)  
APPLICATION OF MAIN WINDFORCE-RESISTING SYSTEM (MWFRS)  
LOADS FOR SIMPLE DIAPHRAGM BUILDINGS

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**1609.6.5 Components and cladding.** Pressure for wind-loading actions on components and cladding shall be determined from Table 1609.6.2.1(2) for enclosed portions of the building and Table 1609.6.2.1(3) for overhangs, based on the effective area for the element under consideration. The pressures in Table 1609.6.2.1(3) include internal pressure. The pressure shall be applied in accordance with the loading diagrams in Figure 1609.6(2).

**1609.7 Roof systems.**

**1609.7.1 Roof deck.** The roof deck shall be designed to withstand the wind pressures determined under either the provisions of Section 1609.6 for buildings with a mean roof height not exceeding 60 feet (18 288 mm) or Section 1609.1.1 for buildings of any height.

**1609.7.2 Roof coverings.** Roof coverings shall comply with Section 1609.7.1.

**Exception:** Rigid tile roof coverings that are air-permeable and installed over a roof deck complying with Section 1609.7.1 are permitted to be designed in accordance with Section 1609.7.3.

**1609.7.3 Rigid tile.** Wind loads on rigid tile roof coverings shall be determined in accordance with the following equation:

$$M_a = q_h C_L b L L_a [1.0 - G C_p] \quad \text{(Equation 16-14)}$$

For SI: 
$$M_a = \frac{q_h C_L b L L_a [1.0 - G C_p]}{1000}$$

where:

- $b$  = Exposed width feet (mm) of the roof tile.
- $C_L$  = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1715.2.
- $G C_p$  = Roof pressure coefficient for each applicable roof zone determined from Section 6 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.
- $L$  = Length feet (mm) of the roof tile.
- $L_a$  = Moment arm feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at  $0.76L$  from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by

testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

$M_a$  = Aerodynamic uplift moment feet-pounds (N-mm) acting to raise the tail of the tile.

$q_h$  = Wind velocity pressure psf (kN/m<sup>2</sup>) determined from Section 6.5.10 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be either loose laid on battens, mechanically fastened, mortar set or adhesive set.
2. The roof tiles shall be installed on solid sheathing which has been designed as components and cladding.
3. An underlayment shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).
7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).
8. Roof tiles using mortar set or adhesive set systems shall have at least two-thirds of the tile's area free of mortar or adhesive contact.