CHAPTER 16

STRUCTURAL DESIGN

SECTION BC 1601 GENERAL

1601.1 Scope. The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code. ***(Note: Where the text in this Code refers to ASCE 7, the 2005 edition shall be used; and where the text in this Code refers to ASCE 7-10, the 2010 edition shall be used.)***

1601.2 Special provisions for prior code buildings. The provisions of Sections 1601.2.1 through 1601.2.4 shall apply to structural work on prior code buildings.

1601.2.1 Use of this code. Notwithstanding the applicant's election to use the *1968 Building Code* or prior code, the structural calculations shall be permitted to be performed in accordance with this code provided that the structural safety of the prior code building is not reduced. Notwithstanding the provisions of Section 28-101.4.4 of the *Administrative Code*, the use of Load and Resistance Factor Design (LRFD) engineering calculations shall not be deemed to reduce structural safety provided the properties of the existing materials are determined using accepted engineering principles.

1601.2.2 Live loads. Loads indicated in the applicable prior code shall be permitted for structural calculations using engineering formulas from this code provided that the structural safety of the prior code building is not reduced.

1601.2.3 Seismic loads. The determination as to whether seismic requirements apply to an alteration shall be made in accordance with the *1968 Building Code* and interpretations by the department relating to such determinations. Any applicable seismic loads and requirements, including for the bracing of architectural, mechanical, plumbing, fuel gas, fire suppression and electrical systems and equipment, shall be permitted to be determined in accordance with this chapter or the *1968 Building Code* and reference standard RS 9-6 of such code.

1601.2.4 Wind loads. All alterations, minor alterations, and ordinary repairs, to the extent of such work, shall be permitted to be performed in accordance with the wind load requirements set forth in the *1968 Building Code*, or where the *1968 Building Code* so authorizes, the code in effect prior to December 6, 1968.

Exceptions:

1. Equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with Section 1609.
2. Wind loads on glass shall not be permitted to be calculated in accordance with the code in effect prior to December 6, 1968.
3. When the wind surface area of a prior code building or structure is increased by more than 5 percent in any direction or there is a permanent decrease of the lateral force capacity by more than 20 percent in any direction, the entire building or structure shall be designed to resist the design wind load as calculated pursuant to the applicable code, but not less than 5 psf (0.24 kN/m^2).

SECTION BC 1602 DEFINITIONS AND NOTATIONS

1602.1 Definitions. The following words and terms shall, for the purposes of this code, have the meanings shown herein.

ALLOWABLE STRESS DESIGN. A method of proportioning structural members, such that elastically computed stresses produced in the members by nominal loads do not exceed specified allowable stresses (also called "working stress design").

BALCONY, EXTERIOR. See ASCE 7.

DEAD LOADS. The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such as cranes, plumbing stacks and risers, electrical feeders, heating, ventilating and air-conditioning systems and automatic sprinkler systems.

DECK. See ASCE 7.

DESIGN STRENGTH. The product of the nominal strength and a resistance factor (or strength reduction factor).

DIAPHRAGM. A horizontal or sloped system acting to transmit lateral forces to the vertical-resisting elements. When the term "diaphragm" is used, it shall include horizontal bracing systems.

Diaphragm, blocked. In light-frame construction, a diaphragm in which all sheathing edges not occurring on a framing member are supported on and fastened to blocking.

Diaphragm boundary. In light-frame construction, a location where shear is transferred into or out of the diaphragm sheathing. Transfer is either to a boundary element or to another force-resisting element.

Diaphragm chord. A diaphragm boundary element perpendicular to the applied load that is assumed to take axial stresses due to the diaphragm moment.

Diaphragm, flexible. A diaphragm is flexible for the purpose of distribution of story shear and torsional moment where so indicated in Section 12.3.1 of ASCE 7-10.

Diaphragm, rigid. A diaphragm is rigid for the purpose of distribution of story shear and torsional moment when the lateral deformation of the diaphragm is less than or equal to two times the average story drift.

DURATION OF LOAD. The period of continuous application of a given load, or the aggregate of periods of intermittent applications of the same load.

ESSENTIAL FACILITIES. Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from flood, wind, snow or earthquakes.

FABRIC PARTITION. A partition consisting of a finished surface made of fabric, without a continuous rigid backing, that is directly attached to a framing system in which the vertical framing members are spaced greater than 4 feet (1219 mm) on center.

FACTORED LOAD. The product of a nominal load and a load factor.

GUARD. See Section 1002.1.

IMPACT LOAD. The load resulting from moving machinery, elevators, craneways, vehicles and other similar forces and kinetic loads, pressure and possible surcharge from fixed or moving loads.

LIMIT STATE. A condition beyond which a structure or member becomes unfit for service and is judged to be no longer useful for its intended function (serviceability limit state) or to be unsafe (strength limit state).

LIVE LOADS. Those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load or dead load.

LIVE LOADS (ROOF). Those loads produced (1) during maintenance by workers, equipment and materials; and (2) during the life of the structure by movable objects such as planters and by people.

LOAD AND RESISTANCE FACTOR DESIGN (LRFD). A method of proportioning structural members and their connections using load and resistance factors such that no applicable limit state is reached when the structure is subjected to appropriate load combinations. The term "LRFD" is used in the design of steel and wood structures.

LOAD EFFECTS. Forces and deformations produced in structural members by the applied loads.

LOAD FACTOR. A factor that accounts for deviations of the actual load from the nominal load, for uncertainties in the analysis that transforms the load into a load effect, and for the probability that more than one extreme load will occur simultaneously.

LOADS. Forces or other actions that result from the weight of building materials, occupants and their possessions, environmental effects, differential movement and restrained dimensional changes. Permanent loads are those loads in which variations over time are rare or of small magnitude, such as dead loads. All other loads are variable loads (see also "Nominal loads").

NOMINAL LOADS. The magnitudes of the loads specified in this chapter (dead, live, soil, wind, snow, rain, flood and earthquake).

NOTATIONS.

D = Dead load.

E = Combined effect of horizontal and vertical earthquake-induced forces as defined in Section 12.4.2 of ASCE 7-10. NYC

F = Load due to fluids with well-defined pressures and maximum heights.

F_a = Flood load in accordance with Chapter 5 of ASCE 7.

H = Load due to lateral earth pressures, ground water pressure or pressure of bulk materials.

L = Live load, except roof live load, including any permitted live load reduction.

L_r = Roof live load including any permitted live load reduction.

plf = pounds per linear foot. NYC

psig= pounds per square inch gauge. NYC

R = Rain load.

S = Snow load.

T = Self-straining force arising from contraction or expansion resulting from temperature change, shrinkage, moisture change, creep in component materials, movement due to differential settlement or combinations thereof.

W = Load due to wind pressure.

OTHER STRUCTURES. Structures, other than buildings, for which loads are specified in this chapter.

PANEL (PART OF A STRUCTURE). The section of a floor, wall or roof comprised between the supporting frame of two adjacent rows of columns and girders or column bands of floor or roof construction.

RESISTANCE FACTOR. A factor that accounts for deviations of the actual strength from the nominal strength and the manner and consequences of failure (also called "strength reduction factor").

RISK CATEGORY. See definition for "Structural Occupancy Category." NYC NYC

STRENGTH, NOMINAL. The capacity of a structure or member to resist the effects of loads, as determined by computations using specified material strengths and dimensions and equations derived from accepted principles of structural mechanics or by field tests or laboratory tests of scaled models, allowing for modeling effects and differences between laboratory and field conditions.

STRENGTH, REQUIRED. Strength of a member, cross section or connection required to resist factored loads or related internal moments and forces in such combinations as stipulated by these provisions.

STRENGTH DESIGN. A method of proportioning structural members such that the computed forces produced in the members by factored loads do not exceed the member design strength. The term "strength design" is used in the design of concrete and masonry structural elements.

STRUCTURAL OCCUPANCY CATEGORY. A category used to determine structural requirements based on occupancy.

VEHICLE BARRIER SYSTEM. A system of building components near open sides of a garage floor or ramp or building walls that act as restraints for vehicles.

SECTION BC 1603
CONSTRUCTION DOCUMENTS

1603.1 General. Construction documents shall include drawings that show the sizes, sections and relative locations of structural members with floor levels, column centers and offsets fully dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be clearly indicated on the such drawings of parts of the building or structure.

Exception: In lieu of the requirements of Sections‡ 1603.1.1 through 1603.1.10, construction documents for buildings constructed in accordance with the conventional light-frame construction provisions of Section 2308 shall include drawings that indicate the following structural design information:

1. Floor and roof live loads.
2. Ground snow load, P_g.
3. Basic wind speed (3-second gust), miles per hour (mph) (km/hr) and wind exposure.
4. Seismic design category and site class.
5. Flood design data, if located in flood hazard areas established in Section G102.2 of Appendix G.
6. Design load-bearing values of soils or rock under shallow foundations and/or the design load capacity of deep foundations.

1603.1.1 Floor live load. The uniformly distributed, concentrated and impact floor live load used in the design shall be indicated for floor areas. Live load reduction of the uniformly distributed floor live loads, if used in the design, shall be indicated for each type of live load used in the design.

1603.1.2 Partition loads. The equivalent uniform partition loads or, in lieu of these, a statement to the effect that the design was predicated on actual partition loads.

1603.1.3 Roof live load. The roof live load used in the design shall be indicated for roof areas (Section 1607.11).

1603.1.4 Roof snow load. The ground snow load, P_g, shall be indicated. The following additional information shall also be provided, regardless of whether snow loads govern the design of the roof:

1. Flat-roof snow load, P_f.
2. Snow exposure factor, C_e.
3. Snow load importance factor, I_s.
4. Thermal factor, C_t.

1603.1.5 Wind design data. The following information related to wind loads shall be shown, regardless of whether wind loads govern the design of the lateral-force-resisting system of the building:

1. Basic wind speed (3-second gust), miles per hour (km/hr).
2. Wind importance factor, I, and structural occupancy category.
3. Wind exposure. Where more than one wind exposure is utilized, the wind exposure and applicable wind direction shall be indicated.
4. The applicable internal pressure coefficient.
5. Components and cladding. The design wind pressures in terms of psf (kN/m^2) to be used for the design of exterior component and cladding materials not specifically designed by the registered design professional.
6. Design base shear.

1603.1.6 Earthquake design data. The following information related to seismic loads shall be shown, regardless of whether seismic loads govern the design of the lateral-force-resisting system of the building:

1. Seismic importance factor, I, and structural occupancy category.
2. Mapped spectral response accelerations, S_S and S_1.
3. Site class.
4. Spectral response coefficients, S_{DS} and S_{D1}.
5. Seismic design category.
6. Basic seismic-force-resisting system(s).
7. Design base shear.
8. Seismic response coefficient(s), C_S.
9. Response modification factor(s), R.
10. Analysis procedure used.

1603.1.7 Geotechnical information. The design load-bearing values of soils or rock under shallow foundations and/or the design load capacity of deep foundations shall be shown on the construction drawings.

1603.1.8 Flood load. Buildings and other structures located in areas of special flood hazard shall meet the design requirements of Section 5.3 of ASCE 7. The structural design shall be based on the design loads stated in Section 5.4 of ASCE 7.

1603.1.9 Special loads. Special loads that are applicable to the design of the building, structure or portions thereof shall be indicated along with the specified section of this code that addresses the special loading condition.

1603.1.10 Superimposed dead loads. The uniformly distributed superimposed dead loads used in the design shall be indicated for floor and roof areas.

1603.1.11 Other loads. Other loads used in the design, including but not limited to the loads of machinery or equipment, which are of greater magnitude than the loads defined in the specified floor and roof loads shall be indicated by their descriptions and locations.

SECTION BC‡ 1604 GENERAL DESIGN REQUIREMENTS

1604.1 General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

1604.2 Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this code without exceeding the appropriate strength limit states for the materials of construction. Alternatively, buildings and other structures, and parts thereof, shall be designed and constructed to support safely the nominal loads in load combinations defined in this code without exceeding the appropriate specified allowable stresses for the materials of construction. Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the commissioner.

1604.3 Serviceability. Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift. See Section 12.12.1 of ASCE 7-10 for drift limits applicable to earthquake loading.

1604.3.1 Deflections. The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604.3.2 through 1604.3.5 or that permitted by Table 1604.3.

1604.3.2 Reinforced concrete. The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

1604.3.3 Steel. The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI HSS S 100, ASCE 3, ASCE 8 and SJI CJ-1.0, SJI JG-1.1, SJI K-1.1 or SJI LH/DLH-1.1, as applicable.

1604.3.4 Masonry. The deflection of masonry structural members shall not exceed that permitted by TMS 402/ ACI 530/ASCE 5.

1604.3.5 Aluminum. The deflection of aluminum structural members shall not exceed that permitted by AA ADM1.

1604.3.6 Limits. For limits on the deflection of structural members, refer to the relevant material design standards. Should a design standard not provide for deflection limits, deflection of structural members over span, *l*, shall not exceed that permitted by Table 1604.3.

1604.4 Analysis. Load effects on structural members and their connections shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the added eccentricities expected to occur during their

TABLE 1604.3
DEFLECTION LIMITS[a, b, c, h, i]

CONSTRUCTION	*L*	*S* or *W*[f]	*D* + *L*[d, g]
Roof members:[e]			
Supporting plaster ceiling	*l*/360	*l*/360	*l*/240
Supporting nonplaster ceiling	*l*/240	*l*/240	*l*/180
Not supporting ceiling	*l*/180	*l*/180	*l*/120
Floor members	*l*/360	—	*l*/240
Exterior walls and interior partitions:			
With brittle finishes	—	*l*/120	—
With flexible finishes	—	*l*/120	—
Farm buildings	—	—	*l*/180
Greenhouses	—	—	*l*/120

For SI: 1 foot = 304.8 mm.

a. For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed *l*/60. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed *l*/150. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed *l*/90. For roofs, this exception only applies when the metal sheets have no roof covering.

b. Interior partitions not exceeding 6 feet in height and flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.13.

c. See Section 2403 for glass supports.

d. For wood structural members having a moisture content of less than 16 percent at time of installation and used under dry conditions, the deflection resulting from $L + 0.5D$ is permitted to be substituted for the deflection resulting from $L + D$.

e. The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Section 1611 for rain and ponding requirements and Section 1503.4 for roof drainage requirements.

f. The wind load is permitted to be taken as 0.7 times the "component and cladding" loads for the purpose of determining deflection limits herein.

g. For steel structural members, the dead load shall be taken as zero.

h. For aluminum structural members or aluminum panels used in roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed *l*/60. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed *l*/120.

i. For cantilever members, *l* shall be taken as twice the length of the cantilever.

service life. Secondary stresses in trusses shall be considered and, where of significant magnitude, their effects shall be provided for in the design.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

The total lateral force shall be distributed to the various vertical elements of the lateral-force-resisting system in proportion to their rigidities considering the rigidity of the horizontal bracing system or diaphragm. Rigid elements that are assumed not to be a part of the lateral-force-resisting system shall be permitted to be incorporated into buildings provided that their effect on the action of the system is considered and provided for in the design. Except where diaphragms are flexible, or are permitted to be analyzed as flexible, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral-force-resisting system.

Every structure shall be designed to resist the overturning effects caused by the lateral forces specified in this chapter. See Section 1609 for wind loads, Section 1610 for lateral soil loads and Section 1613 for earthquake loads.

1604.5 Structural occupancy category. Each building and structure shall be assigned a structural occupancy category in accordance with Table 1604.5.

1604.5.1 Multiple occupancies. Where a building or structure is occupied by two or more occupancies not included in the same structural occupancy category, it

TABLE 1604.5
STRUCTURAL OCCUPANCY/RISK CATEGORY AND IMPORTANCE FACTORS

STRUCTURAL‡ OCCUPANCY/RISK CATEGORY[a]	NATURE OF OCCUPANCY/RISK
I	Buildings and other structures that represent a low hazard to human life in the event of failure including, but not limited to: 1. Agricultural facilities 2. Certain temporary facilities 3. Minor storage facilities
II	Buildings and other structures except those listed in Structural‡ Occupancy/Risk Categories I, III and IV
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure including, but not limited to: 1. Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. 2. Buildings and other structures containing elementary school, secondary school or day-care facilities with an occupant load greater than 250. 3. Buildings and other structures containing adult education facilities, such as colleges and universities with an occupant load greater than 500. 4. Group I-2 occupancies with an occupant load of 50 or more resident patients but not having surgery or emergency treatment facilities. 5. Group I-3 occupancies. 6. Any other occupancy with an occupant load greater than 5,000. 7. Power-generating stations, water treatment for potable water, waste-water treatment facilities and other public utility facilities not included in Structural‡ Occupancy/Risk Category IV. 8. Buildings and other structures not included in Structural‡ Occupancy/Risk Category IV containing sufficient quantities of toxic or explosive substances to be dangerous to the public if released.
IV	Buildings and other structures designed as essential facilities including, but not limited to: 1. Group I-2 occupancies having surgery or emergency treatment facilities. 2. Fire, rescue, ambulance and police stations and emergency vehicle garages. 3. Designated earthquake, hurricane or other emergency shelters. 4. Designated emergency preparedness, communication, and operation centers and other facilities required for emergency response. 5. Power-generating stations and other public utility facilities required as emergency backup facilities for Structural Occupancy/Risk Category IV structures. 6. Structures containing highly toxic materials as defined by Section 307 where the quantity of the material exceeds the maximum allowable quantities of Table 307.7(2). 7. Aviation control towers, air traffic control centers and emergency aircraft hangars. 8. Buildings and other structures having critical national defense functions. 9. Water storage facilities and pump structures required to maintain water pressure for fire suppression.

a. For purposes of occupant load calculation, occupancies required by Table 1004.1.1 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.‡

shall be assigned the classification of the highest structural occupancy category corresponding to the various occupancies. Where buildings or structures have two or more portions that are structurally separated, each portion shall be separately classified. Where a separated portion of a building or structure provides required access to, required egress from or shares life safety components with another portion having a higher structural occupancy category, both portions shall be assigned to the higher structural occupancy category.

1604.5.2 Importance factors. Importance factors for snow, wind and seismic loads shall be determined in accordance with Table 1604.5.2 based on the Structural Occupancy Category or Risk Category assigned in accordance with Table 1604.5.

TABLE 1604.5.2
IMPORTANCE FACTORS

STRUCTURAL OCCUPANCY/RISK CATEGORY	SNOW IMPORTANCE FACTOR, *I*	WIND IMPORTANCE FACTOR, *I*	SEISMIC IMPORTANCE FACTOR, *I*
I	0.80	0.87	1.00
II	1.00	1.00	1.00
III	1.10	1.15	1.25
IV	1.20	1.15	1.50

1604.6 In-situ load tests. The commissioner is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with Section 1714.

1604.7 Preconstruction load tests. Materials and methods of construction that are not capable of being designed by recognized engineering analysis or that do not comply with the applicable material design standards listed in Chapter 35, or alternative test procedures in accordance with Section 1712, shall be load tested in accordance with Section 1715.

1604.8 Anchorage.

1604.8.1 General. Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed loads.

1604.8.2 Walls. Walls shall be anchored to floors, roofs and other structural elements that provide lateral support for the wall. Such anchorage shall provide a positive direct connection capable of resisting the horizontal forces specified in this chapter but not less than the minimum strength design horizontal force specified in Section 11.7.3 of ASCE 7, substituted for "*E*" in the load combinations of Section 1605.2 or 1605.3. Concrete and masonry walls shall be designed to resist bending between anchors where the anchor spacing exceeds 4 feet (1219 mm). Required anchors in masonry walls of hollow units or cavity walls shall be embedded in a reinforced grouted structural element of the wall. See Section 1609 for wind design requirements and Section 1613 for‡ earthquake design requirements.

1604.8.3 Decks. Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads as applicable. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. Connections of decks with cantilevered framing members to exterior walls or other framing members shall be designed for both of the following:‡

1. The reactions resulting from the dead load and live load specified in Table 1607.1, or the snow load specified in Section 1608, in accordance with Section 1605, acting on all portions of the deck.
2. The reactions resulting from the dead load and live load specified in Table 1607.1, or the snow load specified in Section 1608, in accordance with Section 1605, acting on the cantilevered portion of the deck, and no live load or snow load on the remaining portion of the deck.

1604.9 Counteracting structural actions. Structural members, systems, components and cladding shall be designed to resist forces due to earthquake and wind, with consideration of overturning, sliding and uplift. Continuous load paths shall be provided for transmitting these forces to the foundation. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

1604.10 Wind and seismic detailing. Lateral-force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7-10, excluding ASCE 7-10 Chapter 14 and ASCE 7-10 Appendix 11A, even when wind load effects are greater than seismic load effects.‡

SECTION BC 1605
LOAD COMBINATIONS

1605.1 General. Buildings and other structures and portions thereof shall be designed to resist:‡

1. The load combinations specified in Section 1605.2 or 1605.3;
2. The load combinations specified in Chapters 18 through 23; and
3. The load combinations with overstrength factors specified in Section 12.4.3.2 of ASCE 7-10, where required by Section 12.2.5.2, 12.3.3.3 or 12.10.2.1 of ASCE 7-10. With the simplified procedure of ASCE 7-10 Section 12.14, the load combinations with overstrength factors specified in Section 12.14.3.2 of ASCE 7-10 shall be used.

Applicable loads shall be considered, including both earthquake and wind, in accordance with the specified load combinations. Each load combination shall also be investigated with one or more of the variable loads set to zero.

Where the load combinations with overstrength factor in Section 12.4.3.2 of ASCE 7-10 apply, they shall be used as follows:

1. The basic combinations for strength design with overstrength factor in lieu of Equations 16-5 and 16-7 in Section 1605.2.1.
2. The basic combinations for allowable stress design with overstrength factor in lieu of Equations 16-12, 16-13 and 16-15 in Section 1605.3.1.

1605.1.1 Stability. Regardless of which load combinations are used to design for strength, where overall structure stability (such as stability against overturning, sliding, or buoyancy) is being verified, use of the load combinations specified in Section 1605.2 or 1605.3 shall be permitted. Where the load combinations specified in Section 1605.2 are used, strength reduction factors applicable to soil resistance shall be provided by a registered design professional. The stability of retaining walls shall be verified in accordance with Section 1806.2.

1605.2 Load combinations using strength design or load and resistance factor design.

1605.2.1 Basic load combinations. Where strength design or load and resistance factor design is used, structures and portions thereof shall resist the most critical effects from the following combinations of factored loads:

$1.4D + F$ **(Equation 16-1)**

$1.2(D + F + T) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R)$ **(Equation 16-2)**

$1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (f_1L \text{ or } 0.8W)$ **(Equation 16-3)**

$1.2D + 1.6W + f_1L + 0.5(L_r \text{ or } S \text{ or } R)$ **(Equation 16-4)**

$1.2D + 1.0E + f_1L + f_2S$ **(Equation 16-5)**

$0.9D + 1.6W + 1.6H$ **(Equation 16-6)**

$0.9D + 1.0E + 1.6H$ **(Equation 16-7)**

where:

f_1 = 1.0 for floors in places of public assembly, for live loads in excess of 100 pounds per square foot (4.79 kN/m^2), and for parking garage live load, and

= 0.5 for other live loads.

f_2 = 0.7 for roof configurations (such as saw tooth) that do not shed snow off the structure, and

= 0.2 for other roof configurations.

Exception: Where other factored load combinations are specifically required by the provisions of this code, such combinations shall take precedence.

1605.2.2 Other loads. Where a structure is located in a V zone or Coastal A zone and F_a is to be considered in design, in addition to the load combinations of Equations 16-1 through 16-7, the structure and portions thereof shall resist the most critical effects of the load combinations of Equations 16-8 and 16-10.‡ Where a structure is located in an A zone and F_a is to be considered in design, in addition to the load combinations of Equations 16-1 through 16-7, structures and portions thereof shall resist the most critical effects of the load combinations of Equations 16-9 and 16-11. Where ice loads are to be considered in design, the load combinations of Section 2.3.4 of ASCE 7 shall be used. Refer to the following sections for other load combinations:

Flood Load Combinations:

$1.2D + 1.6W + 2.0F_a + f_1L + 0.5(L_r \text{ or } S \text{ or } R)$ **(Equation 16-8)**

$1.2D + 8W + 1.0F_a + f_1L + 0.5(L_r \text{ or } S \text{ or } R)$ **(Equation 16-9)**

$0.9D + 1.6W + 2.0F_a + 1.6H$ **(Equation 16-10)**

$0.9D + 0.8W + 1.0F_a + 1.6H$ **(Equation 16-11)**

1605.3 Load combinations using allowable stress design.

1605.3.1 Basic load combinations. Where allowable stress design (working stress design), as permitted by this code, is used, structures and portions thereof shall resist the most critical effects resulting from the following combinations of loads:

$D + F$ **(Equation 16-12)**

$D + H + F + L + T$ **(Equation 16-13)**

$D + H + F + (L_r \text{ or } S \text{ or } R)$ **(Equation 16-14)**

$D + H + F + 0.75(L + T) + 0.75(L_r \text{ or } S \text{ or } R)$ **(Equation 16-15)**

$D + F + H + (W \text{ or } 0.7E)$ **(Equation 16-16)**

$D + H + F + 0.75(W \text{ or } 0.7E) + 0.75L + 0.75(L_r \text{ or } S \text{ or } R)$ **(Equation 16-17)**

$0.6D + W + H$ **(Equation 16-18)‡**

$0.6D + 0.7E + H$ **(Equation 16-19)‡**

Exceptions:

1. Crane hook loads need not be combined with roof live load or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 30 psf (1.44 kN/m^2) or less need not be combined with seismic loads. Where flat roof snow loads exceed 30 psf (1.44 kN/m^2), 20 percent shall be combined with seismic loads.

1605.3.1.1 Stress increases. Increases in allowable stresses specified in the appropriate material chapter or the referenced standards shall not be used with the load combinations of Section 1605.3.1, except that increases shall be permitted in accordance with Chapter 23.

1605.3.1.2 Other loads. Where a structure is located in a V zone or Coastal A zone and F_a is to be considered in design, in addition to load combinations of Equations 16-12 through 16-19, structures and portions thereof shall resist the most critical effects of load combinations of Equations 16-20, 16-22 and 16-24. Where a structure is located in an A zone and F_a is to be considered in design, in addition to load combinations of Equations 16-12 through 16-19, structures and portions thereof shall resist the most critical effects of load combinations of Equations 16-21, 16-23 and 16-25. Where ice loads are to be considered in design, the load combinations of Section 2.4.3 of ASCE 7 shall be used. Refer to the following sections for other loads:

Flood Load Combinations:

$D + H + F + 1.5F_a + W$ **(Equation 16-20)**

$D + H + F + 0.75F_a + W$ **(Equation 16-21)**

$D + H + F + 0.75W + 0.75L + 0.75(L_r \text{ or } S \text{ or } R) + 1.5F_a$ **(Equation 16-22)**

$D + H + F + 0.75W + 0.75L + 0.75(L_r \text{ or } S \text{ or } R) + 0.75F_a$ **(Equation 16-23)**

$0.6D + W + H + 1.5F_a$ **(Equation 16-24)**

$0.6D + W + H + 0.75F_a$ **(Equation 16-25)**

1605.4 Heliports and helistops. Heliport and helistop landing areas shall be designed for the following loads, combined in accordance with Section 1605:

1. Dead load, D, plus the gross weight of the helicopter, D_h, plus snow load, S.
2. Dead load, D, plus two single concentrated impact loads, L, approximately 8 feet (2438 mm) apart applied anywhere on the touchdown pad (representing each of the helicopter's two main landing gear, whether skid type or wheeled type), having a magnitude of 0.75 times the gross weight of the helicopter. Both loads acting together total 1.5 times the gross weight of the helicopter.
3. Dead load, D, plus a uniform live load, L, of 100 psf (4.79 kN/m^2).

Exception: Landing areas designed for helicopters with gross weights not exceeding 3,000 pounds (13.34 kN) in accordance with Items 1 and 2 shall be permitted to be designed using a 40 psf (1.92 kN/m^2) uniform live load in Item 3, provided the landing area shall be identified with a 3,000-pound (13.34 kN) weight limitation and the 40 psf (1.92 kN/m^2) uniform live load shall not be reduced. The landing area weight limitation shall be indicated by the numeral "3" (kips) located in the bottom right corner of the landing area as viewed from the primary approach path. The indication for the landing area weight limitation shall be a minimum 5 feet (1524 mm) in height.

1605.5 Structural integrity load combinations—alternate load path method. Where specifically required by Sections 1614‡ through 1616, elements and components shall be designed to resist the forces calculated using the following combination of factored loads:

$D + f_1 L + f_2 W$ **(Equation 16-26)**

where:

f_1 = 0.25 for buildings in Structural Occupancy Category II.

f_1 = 0.5 for buildings in Structural Occupancy Category III or IV.

f_2 = 0 for buildings in Structural Occupancy Category II.

f_2 = 0.33 for buildings in Structural Occupancy Category III or IV.

The live load component $f_1 L$ need not be greater than the reduced live load.

1605.6 Structural integrity load combinations—vehicular impact and gas explosions. Where specifically required by Sections 1615.5 and 1615.6, elements and components shall be designed to resist the forces calculated using the following combination of factored loads:

$1.2D + A_k + (0.5L \text{ or } 0.2S)$ **(Equation 16-27)**

$0.9D + A_k + 0.2W$ **(Equation 16-28)**

Where A_k is the load effect of the vehicular impact or gas explosion.

1605.7 Structural integrity load combinations—specific local resistance method. Where the specific local resistance method is used in a key element analysis, the specified local loads shall be used as specified in Section 1616.7.

SECTION BC 1606 DEAD LOADS

1606.1 General. Dead loads are those loads defined in Section 1602.1. Dead loads shall be considered permanent loads.

1606.2 Design dead load. For purposes of design, the actual weights of materials of construction and fixed service equipment shall be used. In the absence of definite information, values used shall be subject to the approval of the commissioner.

SECTION BC 1607 LIVE LOADS

1607.1 General. Live loads are those defined in Section 1602.1

TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS[f, i]

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
1. Apartments (see residential)	—	—
2. Access floor systems Office use Computer use	 50 100	 2,000 2,000
3. Armories and drill rooms	150	—
4. Assembly areas and theaters Fixed seats (fastened to floor) Lobbies Movable seats Private assembly spaces, including conference rooms Stages and platforms Follow spot, projections and control rooms Catwalks Other assembly spaces	 60 100 100 50 125 50 40 Note h	—
5. Balconies (exterior) and Decks[g]‡	1.5 times the live load for the occupancy served. Not required to exceed 100 psf	—
6. Bowling alleys	75	—
7. Cornices	60	—
8. Corridors, except as otherwise indicated	100	—
‡9. Dance halls and ballrooms	100	—
10. Dining rooms and restaurants	100	—
11. Dwellings (see residential)	—	—
12. Elevator machine room grating (on area of 4 in.^{2})	—	300
13. Equipment rooms, including pump rooms, generator rooms, transformer vaults, and areas for switch gear, ventilating, air conditioning, and similar electrical and mechanical equipment	75	—
14. Finish light floor plate construction (on area of 1 in.^{2})	—	200
15. Fire escapes (exterior) On single- and multiple family dwellings	100 40	—
16. Garages (passenger vehicles only) Trucks and buses	40 See Section 1607.6	Note a See Section 1607.6
17. Grandstands (see stadium and arena bleachers)	—	—
18. Gymnasiums, main floors and balconies	100	—
19. Handrails, guards and grab bars	See Section 1607.7	
20. Hospitals Operating rooms, laboratories Private rooms Wards Corridors above first floor	 60 40 40 80	 1,000 1,000 1,000 1,000
21. Hotels (see residential)	—	—
22. Libraries Reading rooms Stack rooms Corridors above first floor	 60 150[b] 80	 1,000 1,000 1,000

(continued)

TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS[f, i]

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
23. Manufacturing		
Light	125	2,000
Heavy	250	3,000
24. Marquees	75	—
25. Office buildings		
File and computer rooms shall be designed for heavier loads based on anticipated occupancy		
Lobbies and first-floor corridors	100	2,000
Offices	50	2,000
Corridors above first floor	80	2,000
26. Penal institutions		
Cell blocks	40	—
Corridors	100	—
27. Residential		
One- and two-family dwellings		
NYC Uninhabitable attics without storage	10	
NYC Uninhabitable attics with storage	20	
Habitable attics and sleeping areas	30	—
NYC All other areas except balconies and decks	40	
Hotels and multifamily dwellings		
Private rooms and corridors serving them	40	
Public rooms and corridors serving them	100	
28. Reviewing stands, grandstands and bleachers	Note c	—
29. Roofs		
All roof surfaces subject to maintenance workers	5	300
Awnings and canopies		
Fabric construction supported by a lightweight rigid skeleton structure	Nonreducible	
All other construction	20	
Ordinary flat, pitched, and curved roofs		
Primary roof members, exposed to a work floor		
Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs;	Note j	2,000
Over manufacturing, storage warehouses, and repair garages	60	300
All other occupancies	100	Note j
Roofs used for other special purposes		
Roofs used for promenade purposes		
Roofs used for roof gardens or assembly purposes		
30. Schools		
Classrooms	40	1,000
Corridors above the first floor	80	1,000
First-floor corridors	100	1,000
31. Scuttles, skylight ribs and accessible ceilings	—	200
NYC 32. Sidewalks, vehicular driveways and yards, subject to trucking	300	8,000[d] or 20,000[d]
NYC 33. Plaza areas (open) accessible to the public (including landscaped portions)	100	—
34. Skating rinks	100	—

(continued)

TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS AND MINIMUM CONCENTRATED LIVE LOADS[f, i]

OCCUPANCY OR USE	UNIFORM (psf)	CONCENTRATED (lbs.)
35. Stadiums and arenas		
Bleachers	100[c]	—
Fixed seats (fastened to floor)	60[c]	
36. Stairs and exits	100	
One- and two-family dwellings	40	Note e
All other	100	
37. Storage warehouses (shall be designed for heavier loads if required for anticipated storage)		
Light	125	—
Heavy	250	—
38. Stores		
Retail		
First floor	100	1,000
Upper floors	75	1,000
Wholesale, all floors	125	1,000
39. Vehicle barriers	See Section 1607.7	
40. Walkways and elevated platforms (other than exitways)	60	—
41. Yards and terraces, pedestrians	100	—

NYC

Notes to Table 1607.1

For SI:
1 inch = 25.4 mm,
1 square inch = 645.16 mm^2,
1 pound per square foot = 0.0479 kN/m^2,
1 pound = 0.004448 kN,
1 pound per cubic foot = 16 kg/m^3. NYC

a. Floors in garages or portions of buildings used for the storage of motor vehicles shall be designed for the uniformly distributed live loads of Table 1607.1 or the following concentrated loads: (1) for garages restricted to vehicles accommodating not more than nine passengers, 3,000 pounds acting on an area of 4.5 inches by 4.5 inches; (2) for mechanical parking structures without slab or deck which are used for storing passenger vehicles only, 2,250 pounds per wheel. NYC

b. The loading applies to stack room floors that support nonmobile, double-faced library bookstacks, subject to the following limitations:
1. The nominal bookstack unit height shall not exceed 90 inches;
2. The nominal shelf depth shall not exceed 12 inches for each face; and
3. Parallel rows of double-faced bookstacks shall be separated by aisles not less than 36 inches wide.

c. Design in accordance with the ICC *Standard on Bleachers, Folding and Telescopic Seating and Grandstands*. NYC

d. The concentrated wheel load shall be applied as follows 8,000 pounds on an area of 20 square inches, 20,000 pounds on an area of 20 inch by 10 inch area. NYC

e. ‡Minimum concentrated load on stair treads (on area of 4 square inches) is 300 pounds.

f. ‡Where snow loads occur that are in excess of the design conditions, the structure shall be designed to support the loads due to the increased loads caused by drift buildup or a greater snow design determined by the commissioner (see Section 1608). For special-purpose roofs, see Section 1607.11.2.2. NYC

g. ‡See Section 1604.8.3 for decks attached to exterior walls.

h. ‡Live loads for assembly spaces other than those described in this table shall be determined from the occupant load requirements as established by Section 1004 of this code using the formula 1,000/(net floor area per occupant) but shall not be less than 50 psf nor more than 100 psf. NYC NYC

i. ‡For establishing live loads for occupancies not specifically listed herein, refer to Referenced Standard ASCE 7 for guidance. NYC NYC

j. Roofs used for other special purposes shall be designed for appropriate loads as approved by the commissioner. NYC

1607.2 Loads not specified. For occupancies or uses not designated in Table 1607.1, the live load shall be determined in accordance with a method approved by the commissioner.

1607.2.1 Stage areas using scenery or scenic elements. Scenery battens and suspension systems shall be designed for a load of 30 pounds per linear foot (437.7 N/m) of batten length. Loft block and head block beams shall be designed to support vertical and horizontal loads corresponding to a 4-inch (102 mm) spacing of battens for the entire depth of the gridiron. Direction and magnitude of total forces shall be determined from the geometry of the rigging system including load concentrations from spot line rigging. Locking rails shall be designed for a uniform uplift of 500 psf (3447 kN/m^2) with a 1,000 pound (454 kg) concentration. Impact factor for batten design shall be 75 percent and for loft and head block beams shall be 25 percent. A plan drawn to a scale not less than $^1/_4$ inch (6.4 mm) equals 1 foot (305 mm) shall be displayed in the stage area indicating the framing plan of the rigging loft and the design loads for all members used to support scenery or rigging. Gridirons over stages shall be designed to support a uniformly distributed live load of 50 psf (2.40 kN/m^2) in addition to the rigging loads indicated.

1607.3 Uniform live loads. The live loads used in the design of buildings and other structures shall be the maximum loads expected by the intended use or occupancy but shall in no case be less than the minimum uniformly distributed unit loads required by Table 1607.1.

1607.4 Concentrated loads. Floors and other similar surfaces shall be designed to support the uniformly distributed live loads prescribed in Section 1607.3 or the concentrated load, in pounds (kilonewtons), given in Table 1607.1, whichever produces the greater load effects. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area 2.5 feet by 2.5 feet (762 mm by 762 mm) and shall be located so as to produce the maximum load effects in the structural members.

1607.5 Partition loads. Weights of all partitions shall be considered, using either actual weights at locations shown on the plans or the equivalent uniform load given in Section 1607.5.2. Partition loads shall be taken as superimposed dead loads.

1607.5.1 Actual loads. Where actual partition weights are used, the uniform design live load may be omitted from the strip of floor area under each partition.

1607.5.2 Equivalent uniform load. The equivalent uniform partition loads in Table 1607.5 may be used in lieu of actual partition weights except for bearing partitions or partitions in toilet room areas (other than in one- and two-family dwellings), at stairs and elevators, and similar areas where partitions are concentrated. In such cases, actual partition weights shall be used in design. Except as otherwise exempted, equivalent uniform partition loads shall be used in areas where partitions are not definitely located on the plans, or in areas where partitions are subject to rearrangement or relocation.

TABLE 1607.5
EQUIVALENT UNIFORM PARTITION LOADS

PARTITION WEIGHT (plf)	EQUIVALENT UNIFORM LOAD (psf) (to be added to floor dead and live loads)
50 or less	0
51 to 100	6
101 to 200	12
201 to 350	20
Greater than 350	20 plus a concentrated live load of the weight in excess of 350 plf.

For SI: 1 pound per linear foot = 0.01459 kN/m^2,
1 pound per square foot = 0.0479 kN/m^2.

1607.6 Garages.

1607.6.1 Passenger vehicle garages. Areas used for, and restricted by physical limitations of clearance to, the transit or parking of passenger vehicles shall be designed for the uniformly distributed and concentrated loads for parking areas for such vehicles as provided in Table 1607.1 applied without impact. An exception is made for members or constructions which, because of physical limitations, cannot be subjected to direct load from the vehicle or from a jack or hoist used to raise or suspend the vehicle. Such members or constructions shall be designed for the loads corresponding to the actual usage.

TABLE 1607.6
UNIFORM AND CONCENTRATED LOADS

LOADING CLASS[a]	UNIFORM LOAD (pounds/linear foot of lane)	CONCENTRATED LOAD (pounds)[b]	
		For moment design	For shear design
H20-44 and HS20-44	640	18,000	26,000
H15-44 and HS15-44	480	13,500	19,500

For SI: 1 pound per linear foot = 0.0 1459 kN/m, 1 pound = 0.004448 kN,
1 ton = 8.90 kN.

a. An H loading class designates a two-axle truck with a semitrailer. An HS loading class designates a tractor truck with a semitrailer. The numbers following the letter classification indicate the gross weight in tons of the standard truck and the year the loadings were instituted.

b. See Section 1607.6.1 for the loading of multiple spans.

1607.6.2 Truck and bus garages. Minimum live loads for garages having trucks or buses shall be as specified in Table 1607.6, but shall not be less than 50 psf (2.40 kN/m^2), unless other loads are specifically justified and approved by the commissioner. Actual loads shall be used where they are greater than the loads specified in the table.

1607.6.2.1 Truck and bus garage live load application. The concentrated load and uniform load shall be uniformly distributed over a 10-foot (3048 mm) width on a line normal to the centerline of the lane placed within a 12-foot-wide (3658 mm) lane. The loads shall be placed within their individual lanes so as to produce the maximum stress in each structural member. Vertical impact shall be taken as 10 percent of the vertical load. Single spans shall be designed for the uniform load in Table 1607.6 and one simultaneous concentrated load positioned to produce the maximum effect. Multiple spans shall be designed for the uniform load in Table 1607.6 on the spans and two simultaneous concentrated loads in two spans positioned to produce the maximum negative moment effect. Multiple span design loads, for other effects, shall be the same as for single spans.

1607.7 Loads on handrails, guards, grab bars, seats and vehicle barrier systems. Handrails, guards, grab bars, accessible seats, accessible benches and vehicle barrier systems shall be designed and constructed to the structural loading conditions set forth in this section.

1607.7.1 Handrail assemblies and guards. Handrail assemblies and guards shall be designed to resist a load of 50 plf (0.73 kN/m) applied in any direction at the top and to transfer this load through the supports to the structure. Glass handrail assemblies and guards shall also comply with Section 2407.

Exceptions:

1. For one- and two-family dwellings, only the single, concentrated load required by Section 1607.7.1.1 shall be applied.
2. In Group I-3, F, H, and S occupancies, for areas that are not accessible to the general public and that have an occupant load no greater than 50, the minimum load shall be 20 pounds per foot (0.29 kN/m).

1607.7.1.1 Concentrated load. Handrails‡ and guards shall be able to resist a single concentrated load of 200 pounds (0.89 kN), applied in any direction at any point, and have attachment devices and supporting structure to transfer this loading to appropriate structural elements of the building. This load need not be assumed to act concurrently with the loads specified in the preceding paragraph.

1607.7.1.2 Components. Intermediate rails (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds (0.22 kN) on an area equal to 1 square foot (0.093 m^2), including openings and space between rails, a vertically downward load of 50 pounds per foot (0.73 kN/m), and a concentrated upward load of 50 pounds (0.22 kN) applied at the most critical location. Reactions due to this loading are not required to be applied simultaneously with one another, and are not required to be superimposed with those of Section 1607.7.1 or 1607.7.1.1. The railings, balusters and components shall be designed separately for the effect of wind when the total wind load on the panel or component exceeds 50 pounds (0.22 kN). The wind load need not be combined with any other live load.

1607.7.2 Grab bars, shower seats and dressing room bench seats. Grab bars, shower seats and dressing room bench seat systems shall be designed to resist a single concentrated load of 250 pounds (1.11 kN) applied in any direction at any point.

1607.7.3 Vehicle barrier systems. Vehicle barrier systems for passenger vehicles shall be designed to resist a single load of 6,000 pounds (26.70 kN) applied horizontally in any direction to the barrier system and shall have anchorage or attachment capable of transmitting this load to the structure. For design of the system, two loading conditions shall be analyzed. The first condition shall apply the load at a height of 1 foot, 6 inches (457 mm) above the floor or ramp surface.‡ The second loading condition shall apply the load at 2 feet, 3 inches (686 mm) above the floor or ramp surface. The more severe load condition shall govern the design of the barrier restraint system. The load shall be assumed to act on an area not to exceed 1 square foot (0.0929 m^2), and is not required to be assumed to act concurrently with any handrail or guard loadings specified in Section 1607.7.1. Garages accommodating trucks and buses shall be designed in accordance with a recognized method acceptable to the commissioner that contains provision for traffic railings.

1607.7.3.1 Columns in parking areas. Unless specially protected, columns in parking areas subject to impact of moving vehicles shall be designed to resist the lateral load due to impact and this load shall be considered a variable load. For passenger vehicles, this lateral load shall be taken as a minimum of 6,000 pounds (26.70 kN) applied at least 1 foot 6 inches (457 mm); above the roadway, and acting simultaneously with other design loads. In addition, columns in parking areas shall meet the requirements of Section 1615 for structural integrity.

1607.8 Impact loads. The live loads specified in Section 1607.3 include allowance for impact conditions. Provisions shall be made in the structural design for uses and loads that involve unusual vibration and impact forces.

1607.8.1 Elevators. Elevator loads shall be increased by 100 percent for impact and the structural supports shall be designed within the limits of stress and deflection prescribed by ASME A17.1.

1607.8.2 Machinery. For the purpose of design, the weight of machinery and moving loads shall be increased as follows to allow for impact: (1) elevator machinery, 100 percent; (2) light machinery, shaft- or motor-driven, 20 percent; (3) reciprocating machinery or power-driven units, 50 percent; (4) hangers for floors or balconies, 33 percent. Percentages shall be increased where specified by the manufacturer.

1607.8.3 Railroad equipment. Minimum loads (including vertical, lateral, longitudinal, and impact) and the distribution thereof shall meet the applicable requirements of Chapter 15 of the *AREMA Manual for Railway Engineering*.

1607.8.4 Assembly structures. Seating areas in grandstands, stadiums, and similar assembly structures shall be designed to resist the simultaneous application of a horizontal swaying load of at least 24 plf (36 kg/m) of seats applied in a direction parallel to the row of the seats, and of at least 10 plf (15 kg/m) of seats in a direction perpendicular to the row of the seats. When this load is used in combination with wind for outdoor structures, the wind load shall be one-half of the design wind load.

1607.9 Reduction in live loads. Except for uniform live loads at roofs, all other minimum uniformly distributed live loads, L_o, in Table 1607.1 are permitted to be reduced in accordance with Section 1607.9.1 or 1607.9.2. Roof uniform live loads, other than special purpose roofs of Section 1607.11.2.2, are permitted to be reduced in accordance with Section 1607.11.2. Roof uniform live loads of special purpose roofs are permitted to be reduced in accordance with Section 1607.9.1 or 1607.9.2.

1607.9.1 General. Subject to the limitations of Sections 1607.9.1.1 through 1607.9.1.4, members for which a value of $K_{LL}A_T$ is 400 square feet (37.16 m^2) or more are permitted to be designed for a reduced live load in accordance with the following equation:

$$L = L_o\left(0.25 + \frac{15}{\sqrt{K_{LL}A_T}}\right)$$ **(Equation 16-29‡)**

For SI: $$L = L_o\left(0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}}\right)$$

where:

L = Reduced design live load per square foot (square meter) of area supported by the member.

L_o = Unreduced design live load per square foot (square meter) of area supported by the member (see Table 1607.1).

K_{LL} = Live load element factor (see Table 1607.9.1).

A_T = Tributary area, in square feet (square meters). L shall not be less than $0.50L_o$ for members supporting one floor and L shall not be less than $0.40L_o$ for members supporting two or more floors.

TABLE 1607.9.1
LIVE LOAD ELEMENT FACTOR, K_{LL}

ELEMENT	K_{LL}
Interior columns Exterior columns without cantilever slabs	4 4
Edge columns with cantilever slabs	3
Corner columns with cantilever slabs Edge beams without cantilever slabs Interior beams	2 2 2
All other members not identified above including: Edge beams with cantilever slabs Cantilever beams One-way slabs Two-way slabs Members without provisions for continuous shear transfer normal to their span	1

1607.9.1.1 One-way slabs. The tributary area, A_T, for use in Equation 16-22 for one-way slabs shall not exceed an area defined by the slab span times a width normal to the span of 1.5 times the slab span.

1607.9.1.2 Heavy live loads. Live loads that exceed 100 psf (4.79 kN/m^2) shall not be reduced.

Exceptions:

1. The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607.9.1.
2. For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

1607.9.1.3 Passenger vehicle garages. The live loads shall not be reduced in passenger vehicle garages.

Exception: The live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent, but the live load shall not be less than L as calculated in Section 1607.9.1.

1607.9.1.4 Special occupancies. Live loads of 100 psf (4.79 kN/m^2) or less at areas where fixed seats are located shall not be reduced in public assembly occupancies or in areas used for retail or wholesale sales.

1607.9.1.5 Special structural elements. Live loads shall not be reduced for one-way slabs except as permitted in Section 1607.9.1.1. Live loads shall not be reduced for calculating shear stresses at the heads of columns in flat slab or flat plate construction.

1607.9.1.6 Roof members. Live loads of 100 psf (4.79 kN/m^2) or less shall not be reduced for roof members except as specified in Section 1607.11.2.

1607.9.2 Alternate floor live load reduction. As an alternative to Section 1607.9.1, floor live loads are permitted to be reduced in accordance with the following provisions. Such reductions shall apply to slab systems, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted in Group A occupancies.
2. A reduction shall not be permitted where the live load exceeds 100 psf (4.79 kN/m^2) except that the design live load for members supporting two or more floors is permitted to be reduced by 20 percent.

   Exception: For uses other than storage, where approved, additional live load reductions shall be permitted where shown by the registered design professional that a rational approach has been used and that such reductions are warranted.

3. A reduction shall not be permitted in passenger vehicle parking garages except that the live loads for members supporting two or more floors are permitted to be reduced by a maximum of 20 percent.

4. For live loads not exceeding 100 psf (4.79 kN/m^2), the design live load for any structural member supporting 150 square feet (13.94 m^2) or more is permitted to be reduced in accordance with Equation 16-27.

5. For one-way slabs, the area, A, for use in Equation 16-27 shall not exceed the product of the slab span and a width normal to the span of 0.5 times the slab span.

$R = 0.08\ (A - 150)$ **(Equation 16-30)**

For SI: $R = 0.861(A - 13.94)$

Such reduction shall not exceed the smallest of:

1. 40 percent for horizontal members;
2. 60 percent for vertical members; or
3. R as determined by the following equation:

$R = 23.1\ (1 + D/L_o)$ **(Equation 16-31)**

where:

A = Area of floor or roof supported by the member, square feet (m^2).

D = Dead load per square foot (m^2) of area supported.

L_o = Unreduced live load per square foot (m^2) of area supported.

R = Reduction in percent.

1607.10 Distribution of floor loads. Where uniform floor live loads are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full dead loads on all spans in combination with the floor live loads on spans selected to produce the greatest effect at each location under consideration. It shall be permitted to reduce floor live loads in accordance with Section 1607.9.

1607.11 Roof loads. The structural supports of roofs and marquees shall be designed to resist wind and, where applicable, snow and earthquake loads, in addition to the dead load of construction and the appropriate live loads as prescribed in this section, or as set forth in Table 1607.1. The live loads acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

1607.11.1 Distribution of roof loads. Where uniform roof live loads are reduced to less than 20 psf (0.96 kN/m^2) in accordance with Section 1607.11.2.1 and are applied to the design of structural members arranged so as to create continuity, the reduced roof live loads shall be applied to adjacent spans or to alternate spans, whichever produces the most unfavorable load effect. See Section 1607.11.2 for reductions in minimum roof live loads and Section 7.5 of ASCE 7 for partial snow loading.

1607.11.1.1 Arches and gabled frames. The following simplification is permissible:

1. Live load placed on one-half of the span adjacent to one support.
2. Live load placed on the center one-fourth of the span.
3. Live load placed on $^3/_8$ of the span adjacent to each support.

1607.11.2 Reduction in roof live loads. The minimum uniformly distributed live loads of roofs and marquees, L_o, in Table 1607.1 are permitted to be reduced in accordance with Section 1607.11.2.1 or 1607.11.2.2.

1607.11.2.1 Flat, pitched and curved roofs. Ordinary flat, pitched and curved roofs,‡ and awnings and canopies other than of fabric construction supported by light-weight rigid skeleton structures, are permitted to be designed for a reduced roof live load as specified in the following equations or other controlling combinations of loads in Section 1605, whichever produces the greater load. In structures such as greenhouses, where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof load than specified in the following equations shall not be used unless approved by the commissioner. Such structures ‡shall be designed for a minimum roof live load of 12 psf (0.58 kN/m^2).

$L_r = L_o R_1 R_2$ **(Equation 16-32)**

where: $12 \le L_r \le 20$

For SI: $L_r = L_o R_1 R_2$

where: $0.58 \le L_r \le 0.96$

L_r = Reduced live load per square foot (m^2) of horizontal projection in pounds per square foot (kN/m^2).

The reduction factors R_1 and R_2 shall be determined as follows:

$R_1 = 1$ for $A_t \le 200$ square feet (18.58 m^2) **(Equation 16-33)**

$R_1 = 1.2 - 0.001A_t$ for 200 square feet $< A_t <$ 600 square feet **(Equation 16-34)**

For SI: $1.2 - 0.011A_t$ for 18.58 square meters $< A_t <$ 55.74 square meters

$R_1 = 0.6$ for $A_t \ge 600$ square feet (55.74 m^2) **(Equation 16-35)**

where:

A_t = Tributary area (span length multiplied by effective width) in square feet (m^2) supported by any structural member, and

$R_2 = 1$ for $F \le 4$ **(Equation 16-36)**

$R_2 = 1.2 - 0.05\ F$ for $4 < F < 12$ **(Equation 16-37)**

$R_2 = 0.6$ for $F \ge 12$ **(Equation 16-38)**

F = For a sloped roof, the number of inches of rise per foot (for SI: $F = 0.12 \times$ slope, with slope expressed as a ‡percentage for an arch or dome, the rise-to-span ratio multiplied by 32

1607.11.2.2 Special-purpose roofs. Roof‡ gardens, marquees, and roofs used for‡ promenade, assembly or other special purposes shall be designed for a minimum live load, L_o, as specified in Table 1607.1. Such live loads are permitted to be reduced in accordance with Section 1607.9. Live loads of 100 psf (4.79 kN/ m^2) or more at areas or roofs classified as Group A occupancies shall not be reduced.

1607.11.3 Green roofs. Where roofs utilize a green roof system and are not intended for human occupancy, the uniform design live load in the area covered by the green roof shall be 20 psf (0.958 kN/m^2). The weight of the landscaping materials shall be considered as dead load and shall be computed on the basis of saturation of the soil. Where roofs utilize a green roof system and are used for human occupancy, the minimum live load shall be as specified in Table 1607.1 or Section 1607.11.2.2, whichever is greater.

1607.11.4 Awnings,‡ canopies, and sun control devices. Awnings, canopies, and sun control devices shall be designed for uniform live loads as required in Table 1607.1 as well as for snow loads and wind loads as specified in Sections 1608 and 1609.

1607.11.5 Hanging loads. Girders and roof trusses (other than joists) over garage areas regularly utilized for the repair of vehicles and over manufacturing floors or storage floors used for commercial purposes shall be capable of supporting, in addition to the specified live and wind loads, a concentrated live load of 2,000 pounds (908 kg) applied at any lower chord panel point for trusses, and at any point of the lower flange for girders.

1607.12 Crane loads. The crane live load shall be the rated capacity of the crane. Design loads for the runway beams, including connections and support brackets, of moving bridge cranes and monorail cranes shall include the maximum wheel loads of the crane and the vertical impact, lateral and longitudinal forces induced by the moving crane.

1607.12.1 Maximum wheel load. The maximum wheel loads shall be the wheel loads produced by the weight of the bridge, as applicable, plus the sum of the rated capacity and the weight of the trolley with the trolley positioned on its runway at the location where the resulting load effect is maximum.

1607.12.2 Vertical impact force. The maximum wheel loads of the crane shall be increased by the percentages shown below to determine the induced vertical impact or vibration force:

Monorail cranes (powered) . . . . 25 percent

Cab-operated or remotely operated bridge cranes (powered) . . . . 25 percent

Pendant-operated bridge cranes (powered). . . . . 10 percent

Bridge cranes or monorail cranes with hand-geared bridge, trolley and hoist . . . . 0 percent

1607.12.3 Lateral force. The lateral force on crane runway beams with electrically powered trolleys shall be calculated as 20 percent of the sum of the rated capacity of the crane and the weight of the hoist and trolley. The lateral force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction perpendicular to the beam, and shall be distributed according to the lateral stiffness of the runway beam and supporting structure. F = For a sloped roof, the number of inches of rise per foot (for SI: $F = 0.12 \times$ slope, with slope expressed as a ‡percentage for an arch or dome, the rise-to-span ratio multiplied by 32

1607.12.4 Longitudinal force. The longitudinal force on crane runway beams, except for bridge cranes with hand geared bridges, shall be calculated as 10 percent of the maximum wheel loads of the crane. The longitudinal force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction parallel to the beam.

1607.13 Interior walls and partitions. Interior walls and partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the loads to which they are subjected but not less than a horizontal load of 5 psf (0.240 kN/ m^2).

Exception: Fabric partitions complying with Section 1607.13.1 shall not be required to resist the minimum horizontal load of 5 psf (0.24 kN/m^2).

1607.13.1 Fabric partitions. Fabric partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength to resist the following load conditions:

1. A horizontal distributed load of 5 psf (0.24 kN/m^2) applied to the partition framing. The total area used to determine the distributed load shall be the area of the fabric face between the framing members to which the fabric is attached. The total distributed load shall be uniformly applied to such framing members in proportion to the length of each member.
2. A concentrated load of 40 pounds (0.176 kN) applied to an 8-inch diameter (203 mm) area of the fabric face at a height of 54 inches [50.3 square inches (32 452 mm^2)] above the floor.

SECTION BC 1608 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.

1608.2 Ground snow loads. The ground snow load, P_g, to be used in determining the design snow loads for roofs is 25 psf (1.2 kN/m^2).

1608.3 Flat roof snow loads. The flat roof snow load, ρ_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 ρ_f shall be determined from Table 1608.3.1.

TABLE 1608.3.1
SNOW EXPOSURE FACTOR, C_e

TERRAIN CATEGORY[a]	EXPOSURE OF ROOF[a,b]		
	Fully exposed[c]	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

For SI: 1 mile = 1609 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.

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

TABLE 1608.3.2
THERMAL FACTOR, C_t

THERMAL CONDITION[a]	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 25h · ft^2 · °F/Btu	1.1
Unheated structures	1.2
Continuously heated greenhouses[b] with a roof having a thermal resistance (*R*-value) less than 2.0h · ft^2 ·°F/Btu	0.85

For SI: 1 h·ft^2· °F/Btu = 0.176m^2·K/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.

1608.3.3 Snow load importance factor. The value for the snow load importance factor, I_s, used in the calculation of ρ_f shall be determined in accordance with Table 1604.5.2 based on the Structural Occupancy Category 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 Structural Occupancy Category I.

1608.3.4 Reserved.

1608.3.5 Ponding instability. For roofs with a slope less than $^1/_4$ 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.

1608.3.6 Ice. For ice loads to be used in the design of ice sensitive structures, such as open framed or guyed towers, refer to Chapter 10 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 psf (0.240 kN/ m^2), roofs shall be designed to sustain localized loads from snowdrifts 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 ASCE7.

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.

SECTION BC 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.

1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapter 6 of ASCE 7,‡ with the basic wind speed and the exposure category determined in accordance with Sections 1609.3 through 1609.4. Wind loads may also be determined using provisions of the alternate methods described in Section 1609.6.‡ Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Exceptions:

1. Reserved.
2. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of the AF&PA WFCM.
3. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AISI S230.

4. Designs using *NAAMM FP 1001 Guide Specification for Design of Metal Flagpoles.*
5. Designs using TIA/EIA-222 for antenna-supporting structures and antennas.
6. Wind tunnel tests in accordance with Section 6.6 of ASCE 7, subject to the limitations in Section 1609.1.1.2.

1609.1.1.1 Applicability. The provisions of ICC 600, AF&PA WFCM and AISI S230 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.

1609.1.1.2 Wind tunnel test limitations. The lower limit on pressures for main wind-force-resisting systems and components and cladding shall be in accordance with Sections 1609.1.1.2.1 and 1609.1.1.2.2.

1609.1.1.2.1 Lower limits on main wind-force-resisting system. Base overturning moments determined from wind tunnel testing shall be limited to not less than 80 percent of the design base overturning moments determined in accordance with Section 6.5 of ASCE 7, unless specific testing is performed that demonstrates that lower vaults result from the aerodynamic coefficient of the building, rather than shielding from other structures. The 80-percent limit shall be permitted to be adjusted by the ratio of the frame load at critical wind directions as determined from wind tunnel testing without specific adjacent buildings, but including appropriate upwind roughness, to that determined in Section 6.5 of ASCE 7. In no case shall the limiting value be less than 50 percent of the design base overturning moments determined in accordance with Section 6.5 of ASCE 7.

1609.1.1.2.2 Lower limits on components and cladding. The design pressures for components and cladding on walls or roofs shall be selected as the greater of: (i) the wind tunnel test results; or (ii) 80 percent of the pressure obtained for Zone 4 for walls and Zone 1 for roofs, as determined in Section 6.5 of ASCE 7, unless specific testing is performed that demonstrates that lower values result from the aerodynamic coefficient of the building rather than shielding from nearby structures. Alternatively, limited tests at a few wind directions without specific adjacent buildings, but in the presence of an appropriate upwind roughness, shall be permitted to be used to demonstrate that the lower pressures are due to the shape of the building and not to shielding. In no case shall the limiting value be less than 65 percent of the pressure obtained for Zone 4 for walls and Zone 1 for roofs, as determined in Section 6.5 of ASCE 7.

1609.1.2 Protection from wind borne debris. The following buildings shall be protected with an impact-resistant covering or glazing in accordance with the Missile Levels and Wind Zones specified in ASTM E 1886 and ASTM E 1996 or other approved test methods and performance criteria:

1. Buildings in Structural Occupancy Category IV, as defined in Table 1604.5, located in Exposure C or D, as defined in Section 1609.4;
2. Buildings in Structural Occupancy Category III, as defined in Table 1604.5, located in Exposure D, as defined in Section 1609.4, where the glazing of such building encloses places of assembly for 300 or more persons or areas of in-place shelter.

Exception: Glazing protection in accordance with Section 1609.1.2 shall not be required if the glazing is located more than 60 feet (18 288 mm) above the ground and more than 30 feet (9144 mm) above aggregate-surfaced roofs, including roofs with gravel or stone ballast located within 1,500 feet (457.2 m) of the building.

1609.1.2.1 Louvers. Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of an approved impact-resisting standard or the large missile test of ASTM E 1996.

1609.1.2.2 Garage doors. Garage door glazed opening protection for wind-borne debris shall meet the requirements of an approved impact-resisting standard or ANSI/DASMA 115.

1609.1.3 Minimum wind loads. The wind loads used in the design of the main wind-force-resisting system shall not be less than 10 psf (0.479 kN/m^2) 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 20 psf (0.958 kN/m^2) acting in either direction normal to the surface. The design force for open buildings and other structures shall not be less than 10 psf (0.479 kN/m^2) multiplied by the area A_f.

1609.1.4 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, including the weight of soils and foundations, shall be taken as the minimum dead load likely to be in place during a design wind event.

1609.1.5 Wind and seismic detailing. Lateral-force-resisting systems shall meet seismic detailing 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, have the meanings shown herein.

BUILDINGS AND OTHER STRUCTURES, FLEXIBLE. 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:

$A_o \geq 0.8A_g$ **(Equation 16-39)**

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:

   $A_o > 1.10A_{oi}$ **(Equation 16-40)**

   A_o > 4 square feet (0.37 m^2) or > $0.01A_g$, whichever is smaller, and $A_{oi}/A_{gi} \leq 0.20$ **(Equation 16-41)**

   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 in which wind loads are transmitted through floor and roof diaphragms to the vertical lateral-force-resisting systems.

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

EAVE HEIGHT, *h*. The distance from the ground surface adjacent to the building to the roof eave line at the particular wall. If the distance of the eave varies along the wall, the average distance shall be used.

EFFECTIVE WIND AREA. The area used to determine *GCp*. 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. New York City is within the hurricane-prone region.

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

MAIN WIND FORCE-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. New York City is not in the wind-borne debris region.

1609.3 Basic wind speed. The basic wind speed for New York City is 98 mph (43.8 m/s). The basic wind speed is measured at 33 feet (10 058 mm) above ground in Exposure C as a 3-second gust speed. This wind speed is based on local wind climate with a nominal annual probability of 0.02 [nominal 50-year mean recurrence interval which is obtained by dividing the 700 year mean recurrence wind speed by $\sqrt{1.6}$].‡

1609.3.1 Wind speed conversion. When required, the 3-second gust wind speed, V_{3S} can be converted to a fastest-mile wind speed, V_{fm} using Equation 16-42 below.

$V_{fm} = (V_{3S} - 10.5) / 1.05$ **(Equation 16-42)**

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. When applying the simplified wind load method of Section 1609.6, a single exposure category shall be used based upon the most restrictive for any given wind direction.

1609.4.1 Wind directions and sectors. For each selected wind direction at which the wind loads are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind loads shall be used to represent winds from that direction.

1609.4.2 Surface roughness categories. A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1609.4.3 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1609.4.3.

Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, grasslands, and limited water surfaces per Figure 1609.4.3.

Surface Roughness D. Flat, unobstructed areas and water surfaces, including areas in hurricane-prone regions. This category includes smooth mud flats, salt flats and unbroken ice.

1609.4.3 Exposure categories. An exposure category shall be determined in accordance with the following:

Figure 1609.4.3 provides the exposure categories at the shore lines for wind directions approaching over the water within the city boundaries.

Exposure B. Exposure B shall apply where the ground surface roughness condition, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.

Exception: For buildings whose mean roof height is less than or equal to 30 feet (9144 mm), the upwind distance is permitted to be reduced to 1,500 feet (457 m).

Exposure C. Exposure C shall apply where it is shown in Figure 1609.4.3 or for all cases where Exposures B or D does not apply.

Exposure D. Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of at least 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall extend inland from the shoreline for a distance of 600 feet (183 m) or 20 times the height of the building, whichever is greater.

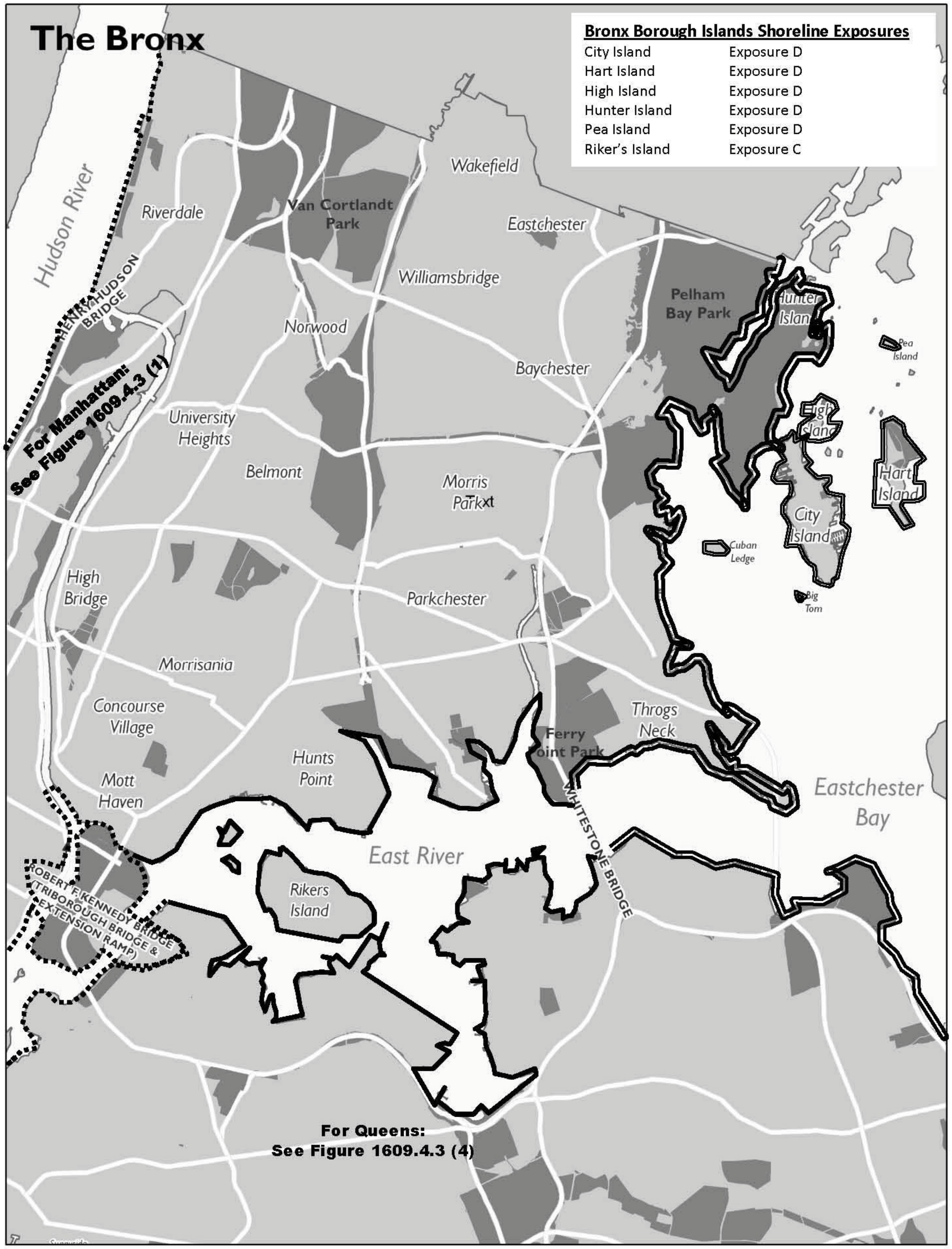
Notes:

Exposure C: Buildings within a distance of 2,600 feet from shoreline.

Exposure C: Buildings within a distance of 2,600 feet or 20 times building height from the shoreline, whichever is greater.

Exposure D: Coastal zone, see Section 1609.4.

Figure 1609.4.3(1)
NEW YORK CITY WIND EXPOSURE: MANHATTAN SHORELINE

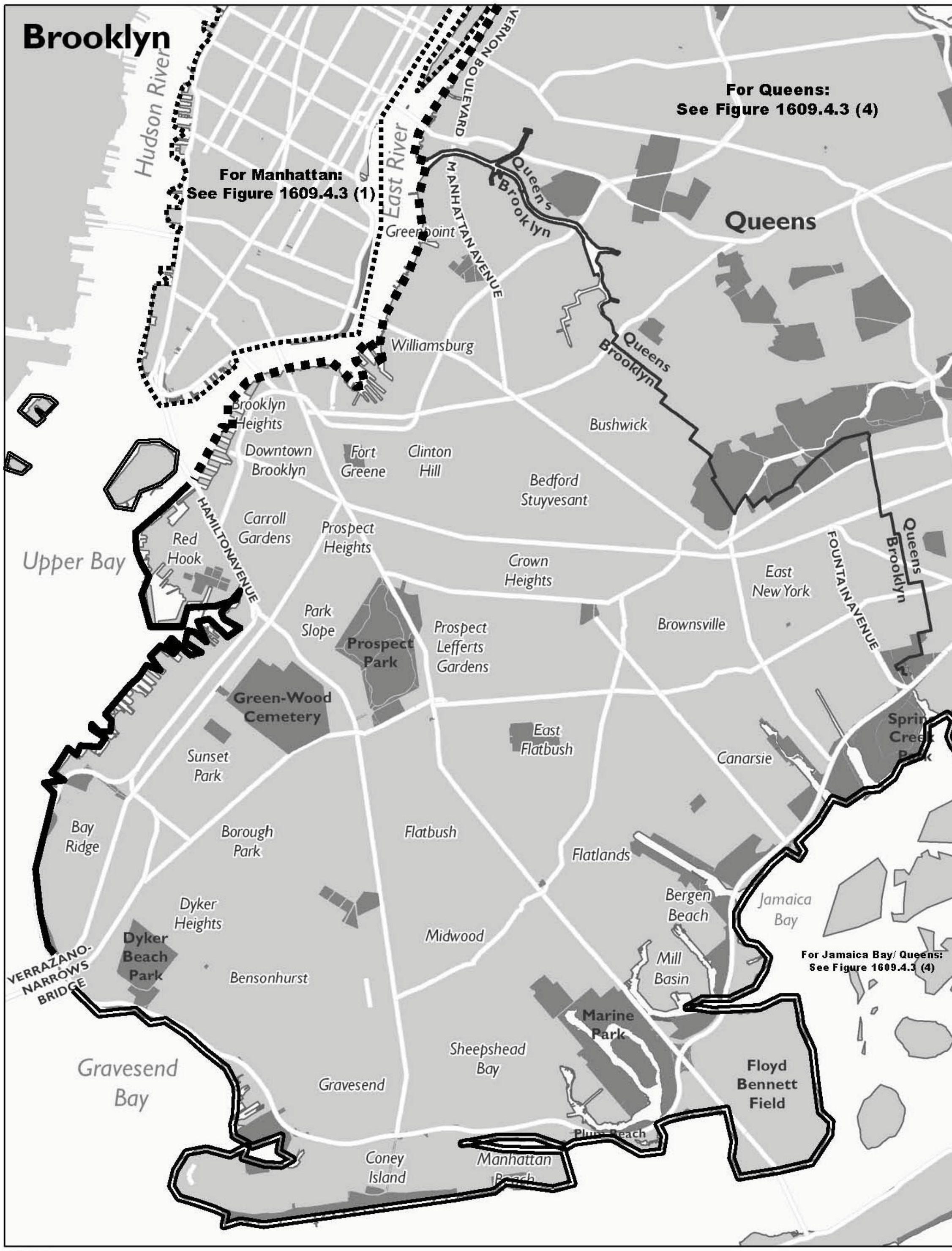


Notes:

- Exposure C: Buildings within a distance of 2,600 feet from shoreline.
- Exposure C: Buildings within a distance of 2,600 feet or 20 times building height from the shoreline, whichever is greater.
- Exposure D: Coastal zone, see Section 1609.4.

1. All islands northeast of Whitestone Bridge are Exposure Category D.

FIGURE 1609.4.3(2)
NEW YORK CITY WIND EXPOSURE: BRONX SHORELINE



Notes:

- ▪▪▪▪▪ Exposure C: Buildings within a distance of 2,600 feet from shoreline.
- ━━━ Exposure C: Buildings within a distance of 2,600 feet or 20 times building height from the shoreline, whichever is greater.
- ═══ Exposure D: Coastal zone, see Section 1609.4.

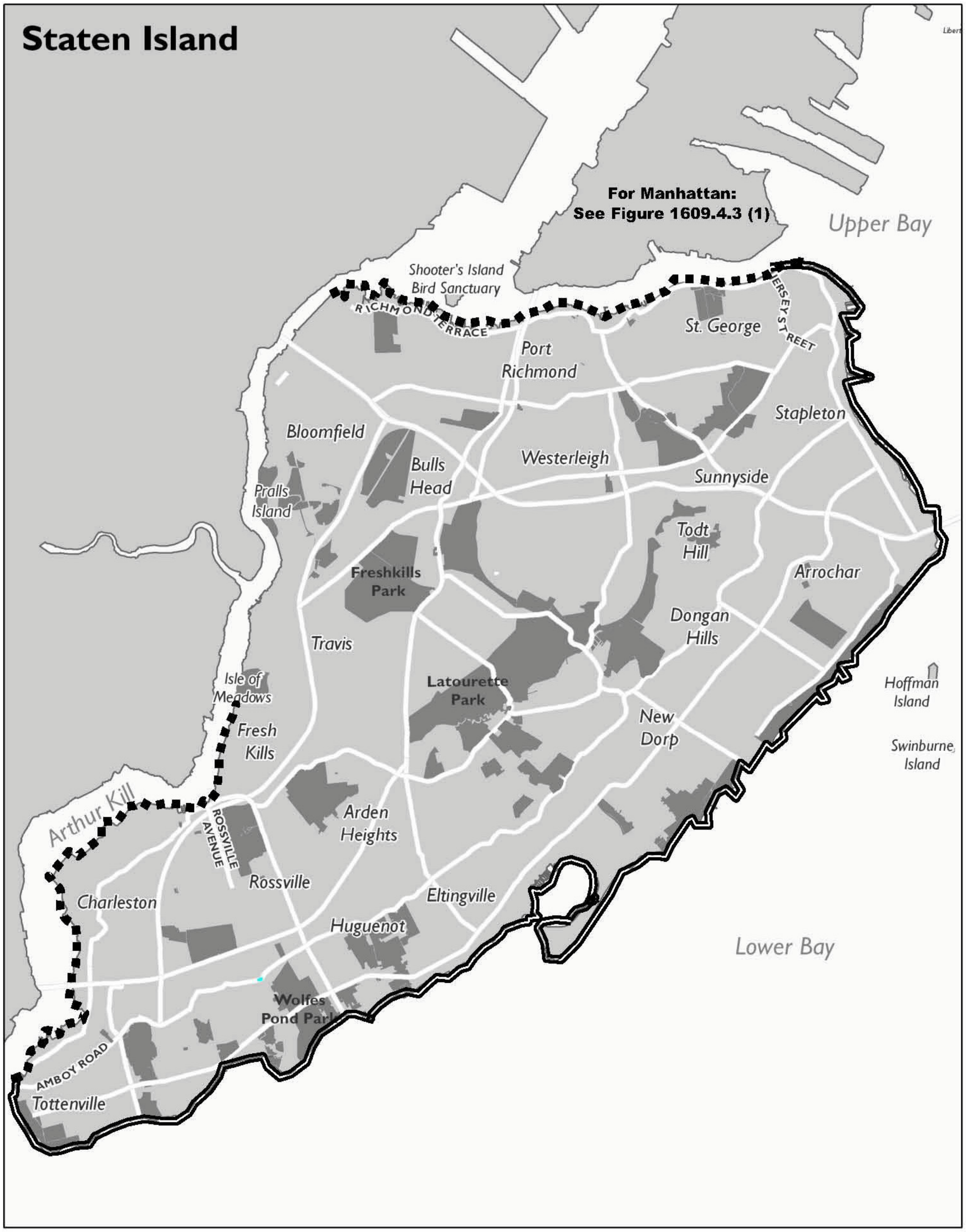
FIGURE 1609.4.3(3)
NEW YORK CITY WIND EXPOSURE: BROOKLYN SHORELINE

Notes:

- Exposure C: Buildings within a distance of 2,600 feet from shoreline.
- Exposure C: Buildings within a distance of 2,600 feet or 20 times building height from the shoreline, whichever is greater.
- Exposure D: Coastal zone, see Section 1609.4.

1. All islands located in the Jamaica Bay area are Exposure Category D.

FIGURE 1609.4.3(4)
NEW YORK CITY WIND EXPOSURE: QUEENS SHORELINE



Notes:

- Exposure C: Buildings within a distance of 2,600 feet from shoreline.
- Exposure C: Buildings within a distance of 2,600 feet or 20 times building height from the shoreline, whichever is greater.
- Exposure D: Coastal zone, see Section 1609.4.

FIGURE 1609.4.3(5)
NEW YORK CITY WIND EXPOSURE: STATEN ISLAND SHORELINE

NYC

1609.5 Importance factor. Buildings and other structures shall be assigned a wind load importance factor, *I*, in accordance with Table 1604.5.2 based on the Structural Occupancy Category determined by Table 1604.5.

1609.6 Simplified wind load methods.

1609.6.1 Scope. The procedures in Section 1609.6 shall be permitted to be used for determining and applying wind pressures in the design of enclosed buildings as listed below:

1. For buildings with flat, gabled or hipped roofs having a mean roof height not exceeding the least horizontal dimension or 60 feet (18 288 mm), whichever is less, the use of Section 1609.6.2, Simplified Procedure I, is permitted.
2. For buildings located within any Borough with a mean roof height of not more than 200 feet (60 960 mm) not located in Exposure C or D in accordance with Section 1609.4, the use of Section 1609.6.3, Simplified Procedure II, is permitted.
3. For buildings located within the Borough of Manhattan with a mean roof height of not more than 300 feet (91 440 mm) and not located in Exposure C or D in accordance with Section 1609.4, the use of Section 1609.6.3, Simplified Procedure II, is permitted.

1609.6.2 Simplified Design Procedure I (for low-rise buildings).

1. The wind shall be assumed to come from any horizontal direction.
2. An importance factor *I* shall be determined in accordance with Section 1609.5.
3. An exposure category shall be determined in accordance with Section 1609.4.
4. A height and exposure adjustment coefficient, λ, shall be determined from Table 1609.6.2.1(4).

1609.6.2.1 Main wind force-resisting system. Simplified design wind pressures, p_s, for the main wind force-resisting systems represent the net pressures (sum of internal and external) to be applied to the horizontal and vertical projections of building surfaces as shown in Figure 1609.6.2.1. For the horizontal pressures (Zones A, B, C, D), p_s is the combination of the windward and leeward net pressures. p_s shall be determined from Equation 16-43).

$$p_s = \lambda I P_{s30} \qquad \textbf{(Equation 16-43)}$$

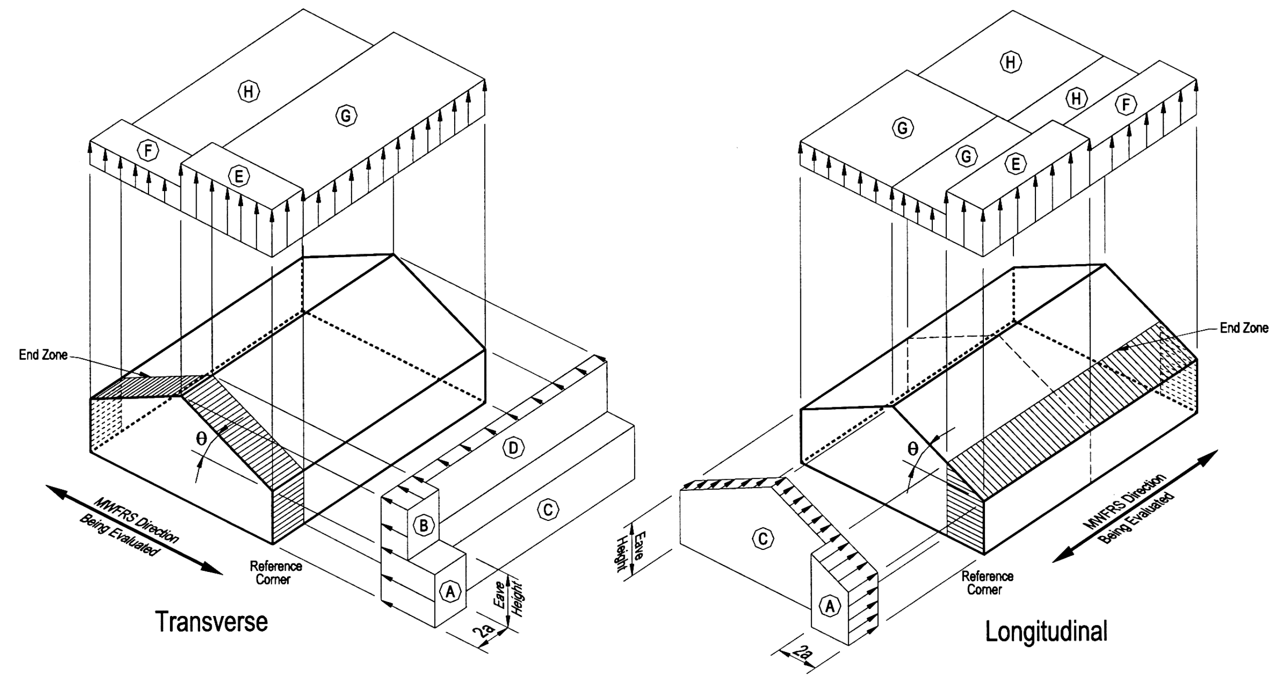
where:

λ = Adjustments factor for building height and exposure from Table 1609.6.2.1(4).

I = Importance factor as defined in Section 1609.5.

P_{s30} = Simplified design wind pressure for Exposure B, at h = 30 feet (9144 mm), and for I =1.0, from Table 1609.6.2.1(1).

1609.6.2.1.1 Minimum pressures. The load effects of the design wind pressures from Section 1609.6.2.1 shall not be less than assuming the pressures, p_s, for Zones A, B, C and D all equal to + 20 psf (0.96 kN/m^2), while assuming Zones E, F, G, and H all equal to 0 psf.



For SI: 1 foot = 304.8 mm, 1 degree = 0.0 174 rad.

FIGURE 1609.6.2.1
MAIN WINDFORCE LOADING DIAGRAM

Notes:

1. Pressures are applied to the horizontal and vertical projections for Exposure B, at h = 30 feet, for I = 1.0. Adjust to other exposures and heights with adjustment factor λ.
2. The load patterns shown shall be applied to each corner of the building in turn as the reference corner.
3. For the design of the longitudinal MWFRS, use θ = 0°, and locate the Zone E/F, G/H boundary at the mid-length of the building.
4. Load Cases 1 and 2 must be checked for 25° < θ ≤ 45°. Load Case 2 at 25° is provided only for interpolation between 25° to 30°.
5. Plus and minus signs signify pressures acting toward and away from the projected surfaces, respectively.
6. For roof slopes other than those shown, linear interpolation is permitted.
7. The total horizontal load shall not be less than that determined by assuming $P_S = 0$ in Zones B and D.
8. The zone pressures represent the following:
   Horizontal pressure zones — Sum of the windward and leeward net (sum of internal and external) pressures on vertical projection of:

A – End zone of wall	E – End zone of windward roof
B – End zone of roof	F – End zone of leeward roof
C – Interior zone of wall	G – Interior zone of windward roof
D – Interior zone of roof	H – Interior zone of leeward roof

   Vertical pressure zones — Net (sum of internal and external) pressures on horizontal projection of:
9. Where Zone E or G falls on a roof overhang on the windward side of the building, use E_{OH} and G_{OH} for the pressure on the horizontal projection of the overhang.
   Overhangs on the leeward and side edges shall have the basic zone pressure applied.
10. Notation:
    a: 10 percent of least horizontal dimension or 0.4*h*, whichever is smaller, but not less than either 4 percent of least horizontal dimension or 3 feet.
    h: Mean roof height, in feet (meters), except that eave height shall be used for roof angles <10°.
    θ: Angle of plane of roof from horizontal, in degrees.

TABLE 1609.6.2.1(1)
SIMPLIFIED DESIGN WIND PRESSURE (MAIN WINDFORCE-RESISTING SYSTEM), p_{s30} (Exposure B at h = 30 feet with I = 1.0) (psf)

ROOF ANGLE (degrees)	ROOF RISE IN 12	LOAD CASE	ZONES									
			Horizontal Pressures				Vertical Pressures				Overhangs	
			A	B	C	D	E	F	G	H	E_{OH}	G_{OH}
0 to 5°	Flat	1	12.0	-6.0	8.0	-4.0	-14.0	-8.0	-10.0	-6.0	-20.0	-15.0
10°	2	1	22.0	-9.0	15.0	-5.0	-23.0	-14.0	-16.0	-11.0	-33.0	-26.0
15°	3	1	24.0	-8.0	16.0	-5.0	-23.0	-15.0	16.0	-12.0	-33.0	-26.0
20°	4	1	27.0	-7.0	18.0	-4.0	-23.0	-16.0	16.0	-12.0	-33.0	-26.0
25°	6	1	24.0	4.0	18.0	4.0	-11.0	-15.0	-8.0	-12.0	-20.0	-17.0
		2	—	—	—	—	-4.0	-8.0	-1.0	-5.0	—	—
30° to 45°	7 to 12	1	22.0	15.0	17.0	12.0	2.0	-13.0	1.0	-12.0	-8.0	-9.0
		2	22.0	15.0	17.0	12.0	9.0	-7.0	7.0	-5.0	-4.0	-9.0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0174 rad, 1 mile per hour = 0.44 m/s, 1 pound per square foot = 47.9 N/m².

TABLE 1609.6.2.1(2)
NET DESIGN WIND PRESSURE (COMPONENT AND CLADDING), p_{net30}
(Exposure B at h = 30 feet with I = 1.0 and kzt = 1 and 98 mph 3 sec. gust basic wind speed) (psf)

	ZONE	EFFECTIVE WIND AREA	PRESSURE/ SUCTION	
Roof 0 to 7 degrees	1	10	7.0	-17.0
	1	20	7.0	-16.0
	1	50	6.0	-16.0
	1	100	6.0	-15.0
	2	10	7.0	-28.0
	2	20	7.0	-25.0
	2	50	6.0	-21.0
	2	100	6.0	-18.0
	3	10	7.0	-42.0
	3	20	7.0	-35.0
	3	50	6.0	-26.0
	3	100	6.0	-18.0
Roof > 7 to 27 degrees	1	10	10.0	-15.0
	1	20	9.0	-15.0
	1	50	8.0	-14.0
	1	100	7.0	-14.0
	2	10	10.0	-27.0
	2	20	9.0	-25.0
	2	50	8.0	-22.0
	2	100	7.0	-20.0
	3	10	10.0	-39.0
	3	20	9.0	-37.0
	3	50	8.0	-33.0
	3	100	7.0	-31.0
Roof > 27 to 45 degrees	1	10	15.0	-17.0
	1	20	15.0	-16.0
	1	50	14.0	-15.0
	1	100	14.0	-14.0
	2	10	15.0	-20.0
	2	20	15.0	-19.0
	2	50	14.0	-18.0
	2	100	14.0	-17.0
	3	10	15.0	-20.0
	3	20	15.0	-19.0
	3	50	14.0	-18.0
	3	100	14.0	-17.0
	ZONE	EFFECTIVE WIND AREA	PRESSURE/ SUCTION	
Wall	4	10	17.0	-18.0
	4	20	16.0	-18.0
	4	50	15.0	-17.0
	4	100	14.0	-16.0
	4	500	13.0	-14.0
	5	10	17.0	-22.0
	5	20	16.0	-21.0
	5	50	15.0	-19.0
	5	100	14.0	-18.0
	5	500	13.0	-14.0

For SI: 1 foot = 304.8 mm, 1 degree = 0.0 174 rad,
1 mile per hour = 0.44 m/s, 1 pound per square foot = 47.9 N/m².

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

TABLE 1609.6.2.1(3)
ROOF OVERHANG NET DESIGN WIND PRESSURE (COMPONENT AND CLADDING), p_{net30}
(Exposure B at h = 30 feet with I_w = 1.0 and 98 mph 3 sec. gust basic wind speed) (psf)

	ZONE	EFFECTIVE WIND AREA (sq. ft.)	PRESSURE/ SUCTION
Roof 0 to 7 degrees	2	10	-24.0
	2	20	-24.0
	2	50	-23.0
	2	100	-23.0
	3	10	-40.0
	3	20	-31.0
	3	50	-20.0
	3	100	-12.0
Roof > 7 to 27 degrees	2	10	-31.0
	2	20	-31.0
	2	50	-31.0
	2	100	-31.0
	3	10	-52.0
	3	20	-47.0
	3	50	-41.0
	3	100	-35.0
Roof > 27 to 45 degrees	2	10	-28.0
	2	20	-28.0
	2	50	-26.0
	2	100	-26.0
	3	10	-28.0
	3	20	-28.0
	3	50	-26.0
	3	100	-26.0

For SI: 1 foot = 304.8 mm, 1 degree = 0.0174 rad, 1 mile per hour = 0.45 m/s, 1 pound per square foot = 47.9 N/m^2.

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

TABLE 1609.6.2.1(4)
ADJUSTMENT FACTOR FOR BUILDING HEIGHT AND EXPOSURE, (λ)

MEAN ROOF HEIGHT	EXPOSURE		
(feet)	B	C/C1	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.

1609.6.2.2 Components and cladding‡. Net‡ design wind pressures, p_{net}, for the components and cladding of buildings represent the net pressures (sum of internal and external) to be applied normal to each building surface as shown in Figure 1609.6.2.2. The net design wind pressure, p_{net}, shall be determined from Equation 16-44:

$$p_{net} = \lambda I p_{net30}$$ **(Equation 16-44)**

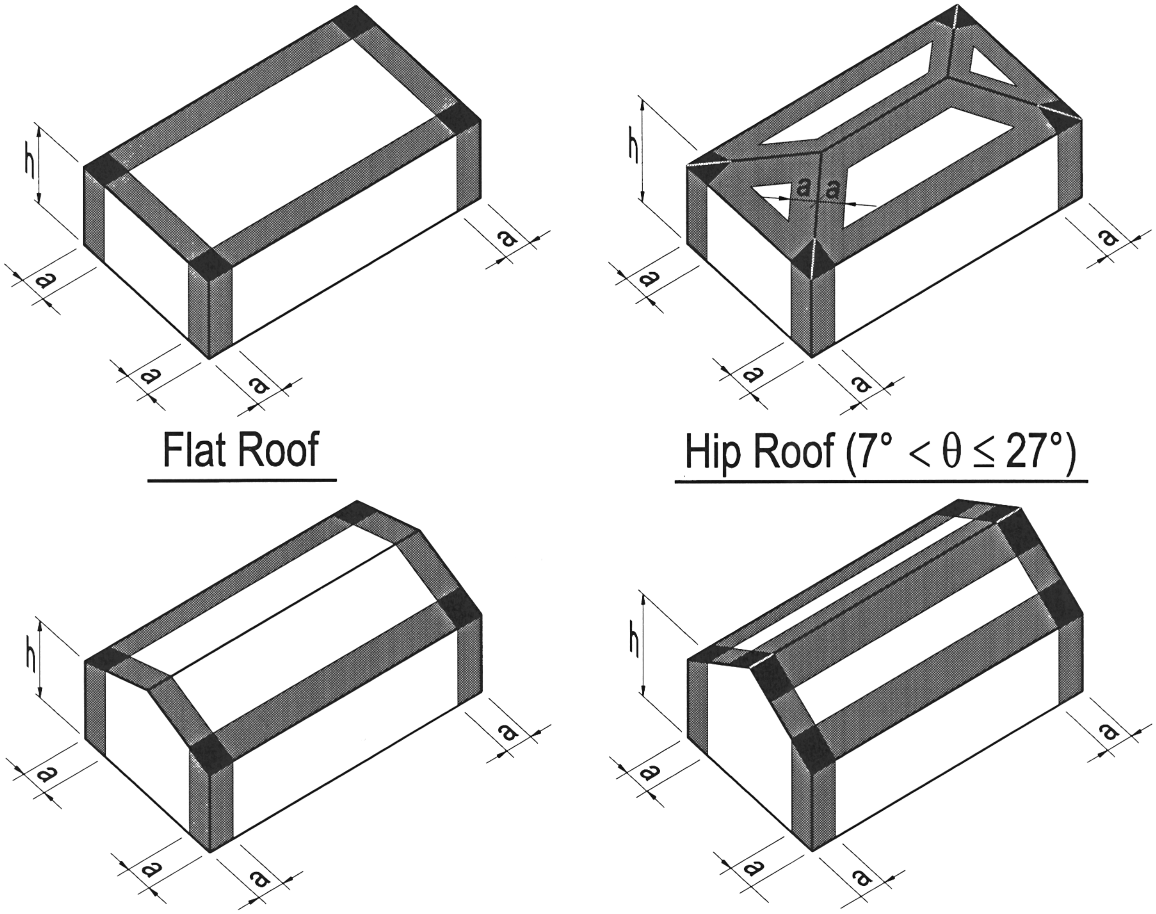
where:

λ = Adjustments factor for building height and exposure from Table 1609.6.2.1(4).

I = Importance factor as defined in Section 1609.5.

P_{net30} = Net design wind pressure for Exposure B, at h = 30 feet (9144 mm), and for I‡ =1.0, from Tables 1609.6.2.1(2) and 1609.6.2.1(3).

1609.6.2.2.1 Minimum pressures. The positive design wind pressures, p_{net}, from Section 1609.6.2.2 shall not be less than + 20 psf (1.44 kN/m^2), and the negative design wind pressures, p_{net}, from Section 1609.6.2.2 shall not be less than – 20 psf (-1.44 kN/m^2).



For SI: 1 foot = 304.8 mm, 1 degree = 0.0174 rad.

Notes:

1. Pressures are applied normal to the surface for Exposure B, at h = 30 feet, for I_w = 1.0. Adjust to other exposures and heights with adjustment factor λ.
2. Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
3. For hip roofs with θ ≤ 25°, Zone 3 shall be treated as Zone 2.
4. For effective areas between those given, the value is permitted to be interpolated, otherwise use the value associated with the lower effective area.
5. Notation:
   a: 10 percent of least horizontal dimension or 0.4*h*, whichever is smaller, but not less than either 4 percent of least horizontal dimension or 3 feet.
   h: Mean roof height, in feet (meters), except that eave height shall be used for roof angles < 10°.
   θ: Angle of plane of roof from horizontal, in degrees.

FIGURE 1609.6.2.2
COMPONENT AND CLADDING PRESSURE

1609.6.2.3 Load case. Members that act as both part of the main wind force-resisting system and as components and cladding shall be designed for each separate load case.

1609.6.3 Simplified Design Procedure II.

1609.6.3.1 Main wind-force-resisting system. Main wind force-resisting systems shall comply with the following:

1. The building shall be designed for the following net lateral wind pressure to be applied to the horizontal projection of the building surfaces:
   1.1. From 0 to 100 feet (0 to 30 480 mm) elevation 20 psf (0.96 kN/m^2).
   1.2. From 100 to 300 feet (30 480 to 91 440 mm) elevation 25 psf (1.2 kN/m^2).
2. An importance factor, *I,* shall be determined in accordance with Section 1609.5 and shall be applied to the pressures indicated above.

1609.6.3.2 Design wind load cases. The main wind-force-resisting system of buildings, whose wind loads have been determined pursuant to Section 1609.6.3, shall be designed for wind load cases as defined below:

Case 1. Full design wind pressure acting on the projected area perpendicular to each principal axis of the structure, considered separately along each principal axis.

Case 2. Seventy-five percent of the design wind pressure acting on the projected area perpendicular to each principal axis of the structure to be applied eccentric to the center of the exposure with eccentricity equal to 15 percent of the exposure width, considered separately for each principal direction.

Case 3. Wind loading as defined in Case 1 for each orthogonal direction, but considered to act simultaneously at 75 percent of the specified value.

1609.6.3.3 Components and cladding‡. Net‡ design wind positive and negative pressures (pressure and suction) for the components and cladding of buildings represent the net pressures (sum of internal and external) to be applied normal to each building surface. The net design wind positive and negative pressures‡ shall not be less than 30 psf (1.44 kN/m^2), except at the corners of the building with a width equivalent to 10 percent of the building's width at its side, the net design wind negative pressure for the components and cladding shall not be less than: (i) 45 psf (2.16 kN/m^2) for the portion of the building between 200 feet (60.76 meters) to 300 feet (91.14 meters) height above ground and (ii) 40 psf (1.92 kN/m^2) for the portion of the building between 100 feet (30.38 meters) to 199 feet (60.66 meters) in height above ground.‡

1609.6.3.4 Roof. The design pressure and suction acting over the entire roof including purlins, roofing, and other roof elements (including their fastenings) shall not be less than 30 psf (1.44 kN/m^2).

1609.6.3.5 Other building elements. The following building elements of buildings whose wind loads have been determined under the provisions of Section 1609.6.3 shall be designed for wind pressures shown in Section 1609.6.3.1 multiplied by the following shape factors given in Table 1609.6.3.5.

TABLE 1609.6.3.5
OTHER BUILDING ELEMENTS

CONSTRUCTION SHAPE FACTOR	
Signs (and their supports), or portions thereof, having 70 percent or more of solid surface	1.5
Signs (and their supports), or portions thereof, having less than 70 percent of solid surface	2.0
Tanks, cooling towers, and similar constructions	1.5
Square and rectangular chimneys	1.5

1609.6.3.5.1 Eaves and cornices. Eaves, cornices, and overhanging elements of the buildings shall be designed for upward pressures twice the values given in Section 1609.6.3.1.

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 satisfying the height and other requirements of the simplified methods or Section 1609.1.1 for buildings of any height.

1609.7.2 Roof coverings. Roof coverings shall comply with the requirements for roof decks pursuant to Section 1609.7.1.

Exceptions:

1. 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.
2. Asphalt shingles installed over a roof deck complying with Section 1609.7.1 shall comply with the wind-resistance requirements of Section 1507.2.7.1.

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

$$M_a = q_h C_L b L L_a (1.0 - GC_p)$$ **(Equation 16-45)‡**

For SI: $M_a = q_h C_L b L L_a (1.0 - GC_p) / 1{,}000$‡

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 1716.2.‡

GC_p = Roof pressure coefficient for each applicable roof zone determined from Chapter 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^2) 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 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.‡

1609.8 Wind on temporary structures. Wind on temporary structures shall be permitted to be designed for reduced wind loading in accordance with the requirements of Section 1618.

SECTION BC 1610
SOIL LATERAL LOAD

1610.1 General. Foundation walls and retaining walls shall be designed to resist lateral soil and hydrostatic loads. The soil loads specified in Table 1610.1 shall be used as the minimum design lateral soil loads unless specified otherwise in a geotechnical investigation report prepared in accordance with Section 1802. Foundation walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top are permitted to be designed for active pressure. Design lateral pressure from hydrostatic, dynamic, or surcharge loads shall be added to the lateral earth pressure load, as applicable. For hydrostatic lateral pressure, see Section 1806.2. Design lateral pressure shall be increased if soils at the site are expansive.

Exception: Foundation walls extending not more than 8 feet (2438 mm) below grade and laterally supported at the top by flexible diaphragms shall be permitted to be designed for active pressure.

TABLE 1610.1
SOIL LATERAL LOAD

DESCRIPTION OF BACKFILL MATERIAL[c]	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD[a] (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45	60
Well-graded, clean sands; gravelly sand mixes	SW	30	60
Poorly graded clean sands; sand-gravel mixes	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

For SI: 1 pound per square foot per foot of depth = 0.157 kPa/m, 1 foot = 304.8 mm.

a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.

b. Unsuitable as backfill material.

c. The definition and classification of soil materials shall be in accordance with ASTM D 2487.

SECTION BC 1611
RAIN LOADS

1611.1 Design rain loads. Each portion of a roof shall be designed to sustain the load of rainwater that will accumulate on it if the primary drainage system for that portion is blocked plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow.

$R = 5.2\ (d_s + d_h)$ **(Equation 16-46)**

For SI: $R = 0.0098\ (d_s = d_h)$

where:

d_h = Additional depth of water on the undeflected roof above the inlet of secondary drainage system at its design flow (i.e., the hydraulic head), in inches (mm).

d_s = Depth of water on the undeflected roof up to the inlet of‡ secondary drainage system when the primary drainage system is blocked (i.e., the static head), in inches (mm).

R = Rain load on the undeflected roof, in psf (kN/m^2). When the phrase "undeflected roof" is used, deflections from loads (including dead loads) shall not be considered when determining the amount of rain on the roof.

1611.2 Ponding instability. For roofs with a slope less than $^1/_4$ inch per foot [1.19 degrees (0.0208 rad)], the design calculations shall include verification of adequate stiffness to preclude progressive deflection in accordance with Section 8.4 of ASCE 7.

1611.3 Controlled drainage. Roofs equipped with hardware to control the rate of drainage shall be equipped with a secondary drainage system at a higher elevation that limits accumulation of water on the roof above that elevation. Such roofs shall be designed to sustain the load of rainwater that will accumulate on them to the elevation of the secondary drainage system plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow determined from Section 1611.1. Such roofs shall also be checked for ponding instability in accordance with Section 1611.2.

SECTION BC 1612
FLOOD LOADS

1612.1 General. The requirements for flood loads shall be as specified in Appendix G of this code.

1612.2 Reserved.

1612.3 Reserved.

1612.4 Reserved.

1612.5 Reserved.

SECTION BC 1613
EARTHQUAKE LOADS

1613.1 Scope. Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with ASCE 7-10, excluding Chapter 14 and Appendix 11A. The seismic design category for a structure shall be determined in accordance with either Section 1613 or ASCE 7-10.

Exceptions:

1. One- and two-family dwellings three stories or less in height.
2. The seismic-force-resisting system of wood-frame buildings that conform to the provisions of Section 2308.
3. Agricultural storage structures intended only for incidental human occupancy.
4. Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7-10 and for which other regulations provide seismic criteria, such as vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenances and nuclear reactors.

1613.1.1 Seismic importance factor. The value for the seismic load importance factor, *I*, used in the calculation of *E* shall be determined in accordance with Table 1604.5.2 based on the Risk Category determined in accordance with Table 1604.5.

1613.2‡ Definitions. The following words and terms shall, for the purposes of this section, have the meanings shown herein.

DESIGN EARTHQUAKE GROUND MOTION.‡ The earthquake ground motion that buildings and structures are specifically proportioned to resist in Section 1613.

MAXIMUM CONSIDERED EARTHQUAKE (MCE) GROUND MOTION‡. The most severe earthquake effects considered by this standard more specifically defined in the following two terms.

MAXIMUM CONSIDERED EARTHQUAKE GEOMETRIC MEAN (MCE_G) PEAK GROUND ACCELERATIONS. The most severe earthquake effects considered by this standard determined for geometric mean peak ground acceleration and without adjustment for targeted risk. The MCE_G peak ground acceleration adjusted for site effects (PGA_M) is used in this standard for evaluation of liquefaction, lateral spreading, seismic settlements, and other soil-related issues. The PGA_M values adjusted for site effects are provided in Table 1813.2.1 or can be derived from the site-specific procedures provided in Section 21.5 of ASCE 7-10.

RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) GROUND MOTION RESPONSE ACCELERATIONS. The most severe earthquake effects considered by this standard determined for the orientation that results in the largest maximum response for horizontal ground motions and with adjustment for targeted risk. The MCE_R Ground Motion values can be determined from general procedure in Section 1613.5.3 or can be derived from the site specific procedures provided in Sections 21.1 and 21.2 of ASCE 7-10.

MECHANICAL SYSTEMS. For the purposes of determining seismic loads in ASCE 7-10, mechanical systems shall also include fire protection, plumbing and fuel gas systems as specified therein.

ORTHOGONAL. To be in two horizontal directions, at 90 degrees (1.57 rad) to each other.

SEISMIC DESIGN CATEGORY. A classification assigned to a structure based on its risk category and the severity of the design earthquake ground motion at the site.

SEISMIC-FORCE-RESISTING SYSTEM. The part of the structural system that has been considered in the design to provide the required resistance to the prescribed seismic forces.

SITE CLASS. A classification assigned to a site based on the types of soils present and their engineering properties as defined in Section 1613.5.2.

SITE COEFFICIENTS. The values of, F_a, and, F_v, indicated in Tables 1613.5.3(1) and 1613.5.3(2), respectively.

1613.3 Reserved.

1613.4 Reserved.

1613.5 Seismic ground motion values. Seismic ground motion values shall be determined in accordance with this section.

1613.5.1 Mapped acceleration parameters. The mapped maximum considered earthquake spectral response acceleration at short periods (S_S) shall be 0.281 g and at 1-second period (S_1) shall be 0.073 g. The mapped long-period transition period (T_L) shall l be 6 seconds.

1613.5.2 Site class definitions. Based on the site soil properties, the site shall be classified as either Site Class A, B, C, D, E or F in accordance with Table 1613.5.2. Where the soil properties are not known in sufficient detail to determine the site class, Site Class D shall be used unless the commissioner or geotechnical data determines that Site Class E or F soil is present at the site.

1613.5.3 Site coefficients and risk-targeted maximum considered earthquake (MCE$_R$) spectral response acceleration parameters. The MCE$_R$ spectral response acceleration parameters for short periods, S_{MS}, and at 1-second period, S_{M1}, adjusted for site class effects shall be determined by Equations 16-47 and 16-48, respectively:‡

$S_{MS} = F_a S_S$ **(Equation 16-47)‡**

$S_{M1} = F_v S_1$ **(Equation 16-48)‡**

where:‡

F_a = Site coefficient defined in Table 1613.5.3(1).‡

F_v = Site coefficient defined in Table 1613.5.3(2).‡

S_S = The mapped MCE$_R$ spectral accelerations for short periods as determined in Section 1613.5.1.‡

S_1 = The mapped MCE$_R$ spectral accelerations for a 1-second period as determined in Section 1613.5.1.‡

TABLE 1613.5.2
SITE CLASS DEFINITIONS

SITE CLASS	SOIL PROFILE NAME	AVERAGE PROPERTIES IN TOP 100 feet, AS PER SECTION 1615.1.5		
		Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \bar{v}_s \le 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_s \le 2{,}500$	$\bar{N} > 50$	$\bar{s}_u \ge 2{,}000$
D	Stiff soil profile	$600 \le \bar{v}_s \le 1{,}200$	$15 \le \bar{N} \le 50$	$1{,}000 \le \bar{s}_u \le 2{,}000$
E	Stiff soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	$\bar{s}_u < 1{,}000$
E	—	Any profile with more than 10 feet of soil having the following characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content w ≥ 40%, and 3. Undrained shear strength < 500 psf.		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays (H > 10 feet of peat and/or highly organic clay where H = thickness of soil). 3. Very high plasticity clays (H > 25 feet with plasticity index PI >75). 4. Very thick soft/medium stiff clays (H > 120 feet).		

For SI:1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kPa. N/A = Not applicable.

TABLE 1613.5.3(1)
VALUES OF SITE COEFFICIENT, F_a, AS A FUNCTION OF SITE CLASS AND MAPPED SPECTRAL RESPONSE ACCELERATION AT SHORT PERIODS (S_S)[a]

SITE CLASS	F_a
A	0.80
B	1.00
C	1.20
D	1.57
E	2.37
F	Note a

a. Site-specific geotechnical investigation and dynamic site response analyses shall be performed to determine appropriate values, except that for structures with periods of vibration equal or less than 0.5 second, values of F_a for liquefiable soils are permitted to be taken equal to the values for the site class determined without regard to liquefaction in Section 1613.5.5.

TABLE 1613.5.3(2)
VALUES OF SITE COEFFICIENT, F_v, AS A FUNCTION OF SITE CLASS AND MAPPED SPECTRAL RESPONSE ACCELERATION AT 1-SECOND PERIOD (S_1)[a]

SITE CLASS	F_v
A	0.80
B	1.00
C	1.70
D	2.40
E	3.50
F	Note a

a. Site-specific geotechnical investigation and dynamic site response analyses shall be performed to determine appropriate values, except that for structures with periods of vibration equal or less than 0.5 second, values of F_v for liquefiable soils are permitted to be taken equal to the values for the site class determined without regard to liquefaction in Section 1613.5.5.

1613.5.4 Design spectral response acceleration parameters. Five-percent damped design spectral response acceleration at short periods, S_{DS}, and at 1-second period, S_{D1}, shall be determined from Equations‡ 16-49 and 16-50, respectively:‡

$$S_{DS} = 2/3 S_{MS} \qquad \textbf{(Equation 16-49)‡}$$

$$S_{D1} = 2/3 S_{M1} \qquad \textbf{(Equation 16-50)‡}$$

where:‡

S_{MS} = The MCE$_R$ spectral response accelerations for short period as determined in Section 1613.5.3.‡

S_{M1} = The MCE$_R$ spectral response accelerations for 1-second period as determined in Section 1613.5.3.‡

1613.5.5 Site classification for seismic design. Site classification for Site Class C, D or E shall be determined from Table 1613.5.5. The notations presented below apply to only materials encountered above rock meeting Class 1a, 1b, or 1c as defined in Section 1804 or rock with shear wave velocity greater than 2,500‡ feet per second (762 m/s) to a maximum depth of 100 feet (30 480 mm). Profiles containing distinctly different soil and rock layers shall be subdivided into those layers designated by a number that ranges from 1 to n at the bottom where there is a total of n distinct layers in the upper 100 feet (30 480 mm). The symbol i then refers to any one of the layers between 1 and n.‡

where:‡

v_{si} = The shear wave velocity in feet per second (m/s).‡

d_i = The thickness of any layer between 0 and 100 feet (30 480 mm).‡

$$\bar{v}_s = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{v_{si}}} \qquad \textbf{(Equation 16-51)‡}$$

$$\sum_{i=1}^{n} d_i = 100 \text{ feet } (30\,480 \text{ mm})$$

where:‡

N_i is the Standard Penetration Resistance (ASTM D1586) not to exceed 100 blows/foot (328 blows/m) as directly measured in the field without corrections. When refusal is met for a rock layer of Class 1d, N_i shall be less than or equal to 100 blows/foot (328 blows/m) provided that the extent of the Class 1d material is confirmed by a boring to a depth where Class 1c or better rock is determined, not to exceed 100 feet. Alternatively, if this boring is not performed, site classification should be based on all soil material that is above the Class 1d layer.‡

$$\bar{N} = \frac{\sum_{i=1}^{n} d_i}{\sum_{i=1}^{n} \frac{d_i}{N_i}} \qquad \textbf{(Equation 16-52)‡}$$

$$\bar{N}_{ch} = \frac{d_s}{\sum_{i=1}^{m} \frac{d_i}{N_i}} \qquad \textbf{(Equation 16-53)‡}$$

where:‡

$$\sum_{i=1}^{m} d_i = d_s$$

Use d_i and N_i for cohesionless soil layers only in Equation 16-42. ‡

d_s = The total thickness of cohesionless soil layers in the top 100 feet (30 480 mm).‡

m = The number of cohesionless soil layers in the top 100 feet (30 480 mm).‡

S_{ui} = The undrained shear strength in psf (kPa), not to exceed 5,000 psf (240 kPa), ASTM D 2166 or D 2850.‡

$$\overline{S_u} = \frac{d_c}{\Sigma_{i=1}^{k} \frac{d_i}{S_{ui}}}$$

where:‡

$$\sum_{i=1}^{k} d_i = d_c$$

d_c = The total thickness (100 - d_s) (For SI: 30480 - d_s) of cohesive soil layers in the top 100 feet (30 480 mm).‡

k = The number of cohesive soil layers in the top 100 feet (30 480 mm).‡

PI = The plasticity index, ASTM D 4318.‡

w = The moisture content in percent, ASTM D 2216.‡

Where a site does not qualify under the criteria for Site Class F and there is a total thickness of soft clay greater than 10 feet (3048 mm) where a soft clay layer is defined by $\bar{s}_u$ < 500 psf (24 kPa), w > 40 percent, and PI > 20, it shall be classified as Site Class E. The shear wave velocity for rock, Site Class B, shall be either measured on site or estimated by a geotechnical engineer or engineering geologist/seismologist for competent rock with moderate fracturing and weathering. Softer and more highly fractured and weathered rock shall either be measured on site for shear wave velocity or classified as Site Class C. The hard rock category, Site Class A, shall be supported by shear wave velocity measurements either on site or on profiles of the same rock type in the same formation with an equal or greater degree of weathering and fracturing. Where hard rock conditions are known to be continuous to a depth of 100 feet (30 480 mm), surficial shear wave velocity measurements are permitted to be extrapolated to assess $\bar{v}_s$. The rock categories, Site Classes A and B, shall not be used if there is more than 10 feet (3048 mm) of soil between the rock surface and the bottom of the spread footing or mat foundation.‡

1613.5.5.1 Steps for classifying a site.

1. Check for the four categories of Site Class F requiring site-specific evaluation. If the site corresponds to any of these categories, classify the site as Site Class F and conduct a site-specific evaluation according to ASCE 7-10 and the requirements of Section 1813. NYC NYC NYC NYC NYC
2. Check for the existence of a total thickness of soft clay > 10 feet (3048 mm) where a soft clay layer is defined by: $\bar{s}_u$ < 500 psf (24 kPa), $w \geq$ 40 percent and PI > 20. If these criteria are satisfied, classify the site as Site Class E.
3. Categorize the site using one of the following three methods with $\bar{v}_s$, $\bar{N}$, and $\bar{s}_u$ and computed in all cases as specified.
   - 3.1. $\bar{v}_s$ for the top 100 feet (30 480 mm) ($\bar{v}_s$ method).
   - 3.2. $\bar{N}$ for the top 100 feet (30 480 mm) ($\bar{N}$ method).
   - 3.3. $\bar{N}_{ch}$ for cohesionless soil layers (PI < 20) in the top 100 feet (30 480 mm) and average, $\bar{s}_u$, for cohesive soil layers (PI > 20) in the top 100 feet (30 480 mm) ($\bar{s}_u$ method).

TABLE 1613.5.5
SITE CLASSIFICATION[a]

SITE CLASS	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
E	< 600 ft/s	< 15	< 1,000 psf
D	600 to 1,200 ft/s	15 to 50	1,000 to 2,000 psf
C	1,200 to 2,500 ft/s	> 50	> 2,000

For SI: 1 foot per second = 304.8 mm per second, 1 pound per square foot = 0.0479 kN/m^2.

a. If the method is used and the and criteria differ, select the category with the softer soils (for example, use Site Class E instead of D).

1613.5.6 Determination of seismic design category. All structures shall be assigned to a seismic design category based on their risk category determined in accordance with Table 1604.5 and the design spectral response acceleration parameters S_{DS} and S_{D1}, determined in accordance with Section 1613.5.4 or the site-specific procedures of ASCE 7-10. Each building and structure shall be assigned to the more severe seismic design category in accordance with Table 1613.5.6(1) or 1613.5.6(2), irrespective of the fundamental period of vibration of the structure, T. NYC NYC NYC NYC NYC NYC

TABLE 1613.5.6(1)
SEISMIC DESIGN CATEGORY BASED ON
SHORT-PERIOD (0.2 SECOND) RESPONSE ACCELERATIONS NYC

VALUE OF S_{DS}	RISK CATEGORY[a]		
	I & II	III	IV
S_{DS} < 0.167g	A	A	A
0.167g < S_{DS} < 0.33g	B	B	C
0.33g < S_{DS} < 0.50g	C	C	D
0.50g < S_{DS}	D[a]	D[a]	D[a]

NYC NYC NYC

a. Requirements for Seismic Design Categories E and F have been eliminated from the *New York City Building Code* as such categories do not apply in New York City. References to these Seismic Design Categories can be found in ASCE 7-10. NYC NYC NYC NYC

TABLE 1613.5.6(2)
SEISMIC DESIGN CATEGORY BASED ON
1-SECOND PERIOD RESPONSE ACCELERATION

VALUE OF S_{D1}	RISK CATEGORY[a]		
	I & II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g < S_{D1} < 0.133g$	B	B	C
$0.133g < S_{D1} < 0.20g$	C	C	D
$0.20g \le S_{D1}$	D[a]	D[a]	D[a]

a. Requirements for Seismic Design Categories E and F have been eliminated from the *New York City Building Code* as such categories do not apply in New York City. References to these Seismic Design Categories can be found in ASCE 7-10.

1613.5.6.1 Alternative seismic design category determination. The seismic design category is permitted to be determined from Table 1613.5.6(1) alone when all of the following apply:

1. In each of the two orthogonal directions, the approximate fundamental period of the structure, T_a, as determined in accordance with Section 12.8.2.1 of ASCE 7-10, is less than 0.8 T_s, as determined in accordance with Section 11.4.5 of ASCE 7-10.
2. In each of the two orthogonal directions, the fundamental period of the structure used to calculate the story drift is less than T_s.
3. Equation 12.8-2 of ASCE 7-10 is used to determine the seismic response coefficient, C_s.
4. The diaphragms are rigid, as defined in Section 12.3.1 of ASCE 7-10 or, for diaphragms that are flexible, the distances between the vertical elements of the seismic-force-resisting system do not exceed 40 feet (12 192 mm).

1613.5.6.2 Simplified design procedure. Where the alternate simplified design procedure of ASCE 7-10 is used, the seismic design category shall be determined in accordance with ASCE 7-10.

1613.6 Alternatives to ASCE 7-10. The provisions of Section 1613.6 shall be permitted as alternatives to the relevant provisions of ASCE 7-10.

1613.6.1 Additional seismic-force-resisting systems for seismically isolated structures. Add the following exception to the end of Section 17.5.4.2 of ASCE 7-10:

Exception: For isolated structures designed in accordance with this standard, the Structural System Limitations and the Structural Height Limits in Table 1613.8 for ordinary steel concentrically braced frames (OCBFs) as defined in Chapter 11 of ASCE 7-10 and ordinary moment frames (OMFs) as defined in Chapter 11 of ASCE 7-10 are permitted to be taken as 160 feet (48 768 mm) for structures assigned to Seismic Design Category D, provided that the following conditions are satisfied:

1. The value of R_I as defined in Chapter 17 of ASCE 7-10 is taken as 1.
2. For OMFs and OCBFs, design is in accordance with AISC 341.

1613.7 Structural separations. All structures shall be separated from adjacent structures. When a structure adjoins a property line not common to a public way (typically side or rear lot lines), that structure shall also be set back from the property line by at least 1 inch (25 mm) for each 50 feet (15 240 mm) of height and a minimum of 1 inch (25 mm) for structures with heights less than 50 feet (15 240 mm). For structures in Seismic Design Category D, refer to ASCE 7-10 for additional requirements.

Exception: Smaller separations or property line setbacks shall be permitted when justified by rational analysis based on maximum expected ground motions with a minimum separation of 1 inch (25 mm) along the full height of the structure.

1613.7.1 Masonry structures. For structures adjacent to existing unreinforced masonry bearing wall structures, the structural separation shall be filed with a material with a minimum compressive strength of 25 psi (172.37 kPa) and a maximum compressive strength of 100 psi (689.74 kPa). Additionally, when the adjacent wall is a party wall, the party wall shall be made secure by the party responsible for the new construction as per Chapter 33.

1613.7.2 Covers. The infill material shall be covered on all sides and shall meet the appropriate provisions of Chapter 26. The covering must be of adequate strength to resist the wind loads for cladding as specified in Chapter 16 and shall conform to all applicable provisions in Chapter 14.

1613.7.3 Covers wider than 5 inches (127 mm). When a building separation wider than 5 inches (127 mm) is created pursuant to Section 1613.7, such separation, at the roof level of the proposed new building, or at the roof level of an existing adjoining building where if that building is lower than the proposed new building, shall have a horizontal cover/closure that conforms with the following:

1. The cover/closure material shall be noncombustible; and

   Exception: The cover/closure material used shall be permitted to be combustible material in accordance with Section 1509.9 if all the material on the appropriate roof conforms to the limitations therein, there are no masonry openings in either wall abutting the building separation, and both buildings are noncombustible.

2. The cover/closure shall be capable of withstanding the roof live load of 30 psf (1.43 kPa), securely fastened to the new building, and be of a type that would be capable of preventing unauthorized or accidental access to the space.

1613.8 ASCE 7-10, Table 12.2-1. Modify ASCE 7-10, Table 12.2-1 as follows:

TABLE 1613.8
DESIGN COEFFICIENT AND FACTORS FOR BASIC SEISMIC C-FORCE-RESISTING SYSTEMS

Seismic Force-Resisting System	ASCE 7-10 Section Where Detailing Requirements Are Specified	Response Modification Coefficient	Overstrength Factor	Deflection Amplification Factor	STRUCTURAL SYSTEM LIMITATIONS INCLUDING STRUCTURAL HEIGHT, H_n (FT), LIMITS[c] Seismic Design Category		
A. BEARING WALL SYSTEMS		R[a]	Ω_0[g]	C_d[b]	B	C	D[d]
1. Special reinforced concrete shear walls [l,m]	14.2	5	2.5	5	NL	NL	NL
2. Ordinary reinforced concrete shear walls [l]	14.2	4	2.5	4	NL	NL	NP
3. Detailed plain concrete shear walls [l]	14.2	2	2.5	2	NL	NP	NP
4. Ordinary plain concrete shear walls [l]	14.2	1.5	2.5	1.5	NL	NP	NP
5. Intermediate precast shear walls [l]	14.2	4	2.5	4	NL	NL	40[k]
6. Ordinary precast shear walls [l]	14.2	3	2.5	3	NL	NP	NP
7. Special reinforced masonry shear walls	14.4	5	2.5	3.5	NL	NL	NL
8. Intermediate reinforced masonry shear walls	14.4	3.5	2.5	2.25	NL	NL	NP
9. Ordinary reinforced masonry shear walls	14.4	2	2.5	1.75	NL	NL	NP
10. Detailed plain masonry shear walls	14.4	2	2.5	1.75	NL	NP	NP
11. Ordinary plain masonry shear walls	14.4	1.5	2.5	1.25	NL	NP	NP
12. Prestressed masonry shear walls	14.4	1.5	2.5	1.75	NL	NP	NP
13. Ordinary reinforced Autoclaved Aerated Concrete (AAC) masonry shear walls	14.4	2	2.5	2	NL	35	NP
14. Ordinary plain (unreinforced) Autoclaved Aerated Concrete (AAC) masonry shear walls	14.4	1.5	2.5	1.5	NL	NP	NP
15. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance or steel sheets	14.1 and 14.5	6.5	3	4	NL	NL	65
16. Light-frame (cold-formed steel) walls sheathed with wood structural panels rated for shear resistance or steel sheets	14.1	6.5	3	4	NL	NL	65
17. Light-frame walls with shear panels of all other materials	14.1 and 14.5	2	2.5	2	NL	NL	35
18. Light-frame (cold-formed steel) wall systems using flat strap bracing	14.1	4	2	3.5	NL	NL	65
B. BUILDING FRAME SYSTEMS		R[a]	Ω_0[g]	C_d[b]	B	C	D[d]
1. Steel eccentrically braced frames	14.1	8	2	4	NL	NL	NL
2. Steel special concentrically braced frames	14.1	6	2	5	NL	NL	NL
3. Steel ordinary concentrically braced frames	14.1	3.25	2	3.25	NL	NL	35[j]
4. Special reinforced concrete shear walls [l,m]	14.2	6	2.5	5	NL	NL	NL
5. Ordinary reinforced concrete shear walls [l]	14.2	5	2.5	4.5	NL	NL	NP
6. Detailed plain concrete shear walls [l]	14.2 and 14.2.2.8	2	2.5	2	NL	NP	NP
7. Ordinary plain concrete shear walls [l]	14.2	1.5	2.5	1.5	NL	NP	NP
8. Intermediate precast shear walls [l]	14.2	5	2.5	4.5	NL	NL	40[k]
9. Ordinary precast shear walls [l]	14.2	4	2.5	4	NL	NP	NP
10. Steel and concrete composite eccentrically braced frames	14.3	8	2	4	NL	NL	NL
11. Steel and concrete composite special concentrically braced frames	14.3	5	2	4.5	NL	NL	NL
12. Steel and concrete composite ordinary braced frames	14.3	3	2	3	NL	NL	NP
13. Steel and concrete composite plate shear walls	14.3	6.5	2.5	5.5	NL	NL	NL
14. Steel and concrete composite special shear walls	14.3	6	2.5	5	NL	NL	NL
15. Steel and concrete composite ordinary shear walls	14.3	5	2.5	4.5	NL	NL	NP

(continued)

TABLE 1613.8 —continued
DESIGN COEFFICIENT AND FACTORS FOR BASIC SEISMIC C-FORCE-RESISTING SYSTEMS

					STRUCTURAL SYSTEM LIMITATIONS INCLUDING STRUCTURAL HEIGHT, H_n (FT), LIMITS[c]		
Seismic Force-Resisting System	ASCE 7-10 Section Where Detailing Requirements Are Specified	Response Modification Coefficient	Overstrength Factor	Deflection Amplification Factor	Seismic Design Category		
16. Special reinforced masonry shear walls	14.4	5.5	2.5	4	NL	NL	NL
17. Intermediate reinforced masonry shear walls	14.4	4	2.5	4	NL	NL	NP
18. Ordinary reinforced masonry shear walls	14.4	2	2.5	2	NL	NL	NP
19. Detailed plain masonry shear walls	14.4	2	2.5	2	NL	NP	NP
20. Ordinary plain masonry shear walls	14.4	1.5	2.5	1.25	NL	NP	NP
21. Prestressed masonry shear walls	14.4	1.5	2.5	1.75	NL	NP	NP
22. Light-frame (wood) walls sheathed with wood structural panels rated for shear resistance	14.5	7	2.5	4.5	NL	NL	65
23. Light-frame (cold-formed steel) walls sheathed with wood structural panels rated for shear resistance or steel sheets	14.1	7	2.5	4.5	NL	NL	65
24. Light-frame walls with shear panels of all other materials	14.1 and 14.5	2.5	2.5	2.5	NL	NL	35
25. Steel buckling-restrained braced frames	14.1	8	2.5	5	NL	NL	NL
26. Steel special plate shear walls	14.1	7	2	6	NL	NL	NL
C. MOMENT-RESISTING FRAME SYSTEMS		**R[a]**	**Ω_0[g]**	**C_d[b]**	**B**	**C**	**D[d]**
1. Steel special moment frames	14.1 and 12.2.5.5	8	3	5.5	NL	NL	NL
2. Steel special truss moment frames	14.1	7	3	5.5	NL	NL	NL
3. Steel intermediate moment frames	14.1 and 12.2.5.7	4.5	3	4	NL	NL	35[h]
4. Steel ordinary steel moment frames	14.1 and 12.2.5.6	3.5	3	3	NL	NL	NP[i]
5. Special reinforced concrete moment frames [n]	14.2 and 12.2.5.5	8	3	5.5	NL	NL	NL
6. Intermediate reinforced concrete moment frames	14.2	5	3	4.5	NL	NL	NP
7. Ordinary reinforced concrete moment frames	14.2	3	3	2.5	NL	NP	NP
8. Steel and concrete composite special moment frames	14.3 and 12.2.5.5	8	3	5.5	NL	NL	NL
9. Steel and concrete composite intermediate moment frames	14.3	5	3	4.5	NL	NL	NP
10. Steel and concrete composite partially restrained moment frames	14.3	6	3	5.5	NL	NL	100
11. Steel and concrete composite ordinary moment frames	14.3	3	3	2.5	NL	NP	NP
12. Cold-formed steel—special bolted moment frame [p]	14.1	3.5	3[o]	3.5	35	35	35
D. DUAL SYSTEMS WITH SPECIAL MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES	**12.2.5.1**	**R[a]**	**Ω_0[g]**	**C_d[b]**	**B**	**C**	**D[d]**
1. Steel eccentrically braced frames	14.1	8	2.5	4	NL	NL	NL
2. Steel special concentrically braced frames	14.1	7	2.5	5.5	NL	NL	NL
3. Special reinforced concrete shear walls [l]	14.2	7	2.5	5.5	NL	NL	NL
4. Ordinary reinforced concrete shear walls [l]	14.2	6	2.5	5	NL	NL	NP
5. Steel and concrete composite eccentrically braced frames	14.3	8	2.5	4	NL	NL	NL
6. Steel and concrete composite special concentrically braced frames	14.3	6	2.5	5	NL	NL	NL
7. Steel and concrete composite plate shear walls	14.3	7.5	2.5	6	NL	NL	NL
8. Steel and concrete composite special shear walls	14.3	7	2.5	6	NL	NL	NL

(continued)

TABLE 1613.8—continued
DESIGN COEFFICIENT AND FACTORS FOR BASIC SEISMIC C-FORCE-RESISTING SYSTEMS

					STRUCTURAL SYSTEM LIMITATIONS INCLUDING STRUCTURAL HEIGHT, H_n (FT), LIMITS[C]		
Seismic Force-Resisting System	ASCE 7-10 Section Where Detailing Requirements Are Specified	Response Modification Coefficient	Overstrength Factor	Deflection Amplification Factor	Seismic Design Category		
9. Steel and concrete composite ordinary shear walls	14.3	6	2.5	5	NL	NL	NP
10. Special reinforced masonry shear walls	14.4	5.5	3	5	NL	NL	NL
11. Intermediate reinforced masonry shear walls	14.4	4	3	3.5	NL	NL	NP
12. Steel buckling-restrained braced frames	14.1	8	2.5	5	NL	NL	NL
13. Steel special plate shear walls	14.1	8	2.5	6.5	NL	NL	NL
E. DUAL SYSTEMS WITH INTERMEDIATE MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES	**12.2.5.1**	**R**[a]	**Ω_0**[g]	**C_d**[b]	**B**	**C**	**D**[d]
1. Steel special concentrically braced frames[f]	14.1	6	2.5	5	NL	NL	35
2. Special reinforced concrete shear walls [l]	14.2	6.5	2.5	5	NL	NL	NL
3. Ordinary reinforced masonry shear walls	14.4	3	3	2.5	NL	NL	NP
4. Intermediate reinforced masonry shear walls	14.4	3.5	3	3	NL	NL	NP
5. Steel and concrete composite special concentrically braced frames	14.3	5.5	2.5	4.5	NL	NL	NL
6. Steel and concrete composite ordinary braced frames	14.3	3.5	2.5	3	NL	NL	NP
7. Steel and concrete composite ordinary shear walls	14.3	5	3	4.5	NL	NL	NP
8. Ordinary reinforced concrete shear walls [l]	14.2	5.5	2.5	4.5	NL	NL	NP
F. SHEAR WALL-FRAME INTERACTIVE SYSTEM WITH ORDINARY REINFORCED CONCRETE MOMENT FRAMES AND ORDINARY REINFORCED CONCRETE SHEAR WALLS[l]	**14.2 and 12.2.5.8**	**4.5**	**2.5**	**4**	**NL**	**NP**	**NP**
G. CANTILEVERED COLUMN SYSTEMS DETAILED TO CONFORM TO THE REQUIREMENTS FOR:	**12.2.5.2**	**R**[a]	**Ω_0**[g]	**C_d**[b]	**B**	**C**	**D**[d]
1. Steel special cantilever column systems	14.1	2.5	1.25	2.5	35	35	35
2. Steel ordinary cantilever column systems	14.1	1.25	1.25	1.25	35	35	NP[i]
3. Special reinforced concrete moment frames [n]	14.2 and 12.2.5.5	2.5	1.25	2.5	35	35	35
4. Intermediate reinforced concrete moment frames	14.2	1.5	1.25	1.5	35	35	NP
5. Ordinary reinforced concrete moment frames	14.2	1	1.25	1	35	NP	NP
6. Timber frames	14.5	1.5	1.5	1.5	35	35	35
H. STEEL SYSTEMS NOT SPECIFICALLY DETAILED FOR SEISMIC RESISTANCE, EXCLUDING CANTILEVER COLUMN SYSTEMS	**14.1**	**3**	**3**	**3**	**NL**	**NL**	**NP**

a. Response modification coefficient, *R*, for use throughout the standard. Note *R* reduces forces to a strength level, not an allowable stress level.
b. Deflection amplification factor, C_d, for use in Sections 12.8.6, 12.8.7, and 12.9.2 of ASCE 7-10.
c. NL = Not Limited and NP = Not Permitted. For metric units use 30.5 m for 100 ft and use 48.8 m for 160 ft.
d. See Section 12.2.5.4 of ASCE 7-10 for a description of seismic force-resisting systems limited to buildings with a structural height, h_n, of 240 ft (73.2 m) or less.
e. See Section 12.2.5.4 of ASCE 7-10 for seismic force-resisting systems limited to buildings with a structural height, h_n, of 160 ft (48.8 m) or less.
f. Ordinary moment frame is permitted to be used in lieu of intermediate moment frame for Seismic Design Categories B or C.
g. Where the tabulated value of the overstrength factor, Ω_0, is greater than or equal to $2^1/_2$, Ω_0 is permitted to be reduced by subtracting the value of $^1/_2$ for structures with flexible diaphragms.
h. See Section 12.2.5.7 of ASCE 7-10 for limitations in structures assigned to Seismic Design Category D.
i. See Section 12.2.5.6 of ASCE 7-10 for limitations in structures assigned to Seismic Design Category D.

(continued)

TABLE 1613.8—continued
DESIGN COEFFICIENT AND FACTORS FOR BASIC SEISMIC C-FORCE-RESISTING SYSTEMS

j. Steel ordinary concentrically braced frames are permitted in single-story buildings up to a structural height, h_n, of 60 ft (18.3 m) where the dead load of the roof does not exceed 20 psf (0.96 kN/m^2) and in penthouse structures.
k. An increase in structural height, h_n, to 45 ft (13.7 m) is permitted for single story storage warehouse facilities.
l. In Section 2.2 of ACI 318. A shear wall is defined as a structural wall.
m. In Section 2.2 of ACI 318. The definition of "special structural wall" includes precast and cast-in-place construction.
n. In Section 2.2 of ACI 318. The definition of "special moment frame" includes precast and cast-in-place construction.
o. Alternately, the seismic load effect with overstrength, E_{mh}, is permitted to be based on the expected strength determined in accordance with AISI S110.
p. Cold-formed steel – special bolted moment frames shall be limited to one-story in height in accordance with AISI S110.

SECTION BC 1614 STRUCTURAL INTEGRITY DEFINITIONS

1614.1 Definitions. The following words and terms shall, for the purposes of this section, have the meanings shown herein.

ALTERNATE LOAD PATH. A secondary or redundant load path capable of transferring the load from one structural element to other structural elements.

ALTERNATE LOAD PATH METHOD. A design approach that accounts for an extreme event by providing alternate load paths for elements that are no longer able to carry load. In an alternate load path design, key elements are considered notionally removed, one at a time, and the structure is designed to transfer the loads from the removed element to other structural elements, as required by Section 1616.

ASPECT RATIO. The height of any portion of a building divided by its least dimension at the elevation from which the height is being measured.

COLLAPSE. Failure of a structural element to the extent that it can no longer support any load.

ELEMENT. A structural member or structural assembly.

KEY ELEMENT. An element of the structural system, including its connections, that meets one or more of the following criteria:

1. An element which when lost, results in more than local collapse.
2. An element that braces a key element, the failure of which results in failure of the key element (further secondary elements need not be considered key elements).
3. An element whose tributary area exceeds 3,000 square feet (279 m^2)‡ on a single level.

LOCAL COLLAPSE. Failure of a structural element that results in the collapse of areas being directly supported by that element and not extending vertically more than three stories.

RESPONSE RATIO. The ratio of an ultimate response quantity (e.g., deflection) to its value at yield.

ROTATION. The angle, measured at the ends of a member, whose tangent is equal to the deflection of the member at midspan divided by half the length of the member.

SPECIFIC LOCAL LOAD. A load applied to a structural element or structural system as specified in Section 1616.7.

SPECIFIC LOCAL RESISTANCE METHOD. A design approach that accounts for extreme event loads by providing sufficient strength for elements that may fail. In a specific local resistance design, key elements are designed for specific local loads as required by Section 1616.

SECTION BC 1615 STRUCTURAL INTEGRITY—PRESCRIPTIVE REQUIREMENTS

1615.1 Scope. The intent of these provisions is to enhance structural performance under extreme event scenarios by providing additional overall system redundancy and local robustness. All structures shall be designed to satisfy the prescriptive requirements of this section.

Exception: Structures in Structural Occupancy Category I of Table 1604.5 and structures in Occupancy Group R-3 are exempt from the requirements of Sections 1614 through 1616.

1615.2 Continuity and ties. All structural elements shall have a minimum degree of continuity and shall be tied together horizontally and vertically as specified in Chapters 19, 21, and 22 for concrete, masonry and steel, respectively.

1615.3 Lateral bracing. Floor and roof diaphragms or other horizontal elements shall be tied to the lateral load-resisting system.

1615.4 Reserved.

1615.5 Vehicular impact. Structural columns that are directly exposed to vehicular traffic shall be designed for vehicular impact. Structural columns that are adequately protected by bollards, guard walls, vehicle arrest devices or other elements do not need to be designed for vehicular impact. The load combinations for vehicular impact shall be as specified in Section 1605.6.

Specific loads for vehicular impact shall be as follows:

1. Exterior corner columns shall be designed for a concentrated load of 40 kips applied horizontally in any direction from which a vehicle can approach at a height of either 18 inches (457 mm) or 36 inches (914 mm) above the finished driving surface, whichever creates the worst effect.
2. All other exterior columns exposed to vehicular traffic, and columns within loading docks, and columns in parking garages along the driving lane shall be designed for a concentrated load of 20 kips applied horizontally in any direction from which a vehicle can

approach at a height of either 18 inches (457 mm) or 36 inches (914 mm) above the finished driving surface, whichever creates the worst effect.

1615.6 Gas explosions. In buildings with gas piping operating at pressures in excess of 15 psig (103 kPa gauge), all key elements and their connections within 15 feet (4572 mm) of such piping shall be designed to resist a potential gas explosion. The structure shall be designed to account for the potential loss of the affected key elements one at a time by the alternate load path‡ method. Load combinations for the alternate load path‡ shall be as specified in Section 1605.5. In lieu of the alternate load path method‡, the affected key elements shall be designed to withstand a load of 430 psf (20.6 kPa) applied using the load combinations specified in Section 1605.6. The load shall be applied along the entire length of the element, and shall be applied in the manner and direction that produces the most damaging effect.

Exceptions:

1. If a structural enclosure designed to resist the specified pressure is provided around the high-pressure gas piping, only the key elements within the structural enclosure need to comply with this section.
2. A reduced pressure for gas explosions can be used based on an engineering analysis approved by the commissioner.

1615.6.1 Explosion prevention and deflagration venting. The structural design and installation of explosion prevention systems and deflagration venting shall be in accordance with the requirements of Appendices E and G of the *New York City Fuel Gas Code*, as well as the *New York City Fire Code*, and the rules and regulations of the department.

SECTION BC 1616 STRUCTURAL INTEGRITY—KEY ELEMENT ANALYSIS

1616.1 Scope. A key element analysis shall be performed for the following buildings:

1. Buildings included in Structural Occupancy Category IV as defined in this chapter.
2. Buildings with the aspect ratios of seven or greater.
3. Buildings greater than 600 feet (183 m) in height or more than 1,000,000 square feet (92 903 m^2) in gross floor area.
4. Buildings taller than seven stories where any element, except for walls greater than 10 feet (3.048 m) in length, supports in aggregate more than 15 percent of the building area.
5. Buildings designed for areas with 3,000 or more occupants in one area in close proximity, including fixed seating and grandstand areas.
6. When specifically ordered by the commissioner.

1616.2 Load combinations. Where specifically required by Section 1616.1, elements and components shall be designed to resist the forces calculated using the combination specified in Section 1605.5 or 1605.7 as applicable.

1616.3 Reserved.

1616.4 Seismic and wind. When the code-prescribed seismic or wind design produces greater effects, the seismic or wind design shall govern, but the detailing requirements and limitations prescribed in this and referenced sections shall also be followed.

1616.5 Joints. Where a structure is divided by joints that allow for movement, each portion of the structure between joints shall be considered as a separate structure.

1616.6 Key element analysis. Where key elements are present in a structure, the structure shall be designed to account for their potential loss one at a time by the alternate load path method or by the specific local resistance method as specified in Section 1616.7.

1616.7 The specific local resistance method. Where the specific local resistance method is used key elements shall be designed using specific local loads as follows:

1. Each compression element shall be designed for a concentrated load equal to 2 percent of its axial load but not less than 15 kips, applied at midspan in any direction, perpendicular to its longitudinal axis. This load shall be applied in combination with the full dead load and 50 percent of the live load in the compression element.
2. Each bending element shall be designed for the combination of the principal acting moments plus an additional moment, equal to 10 percent of the principal acting moment applied in the perpendicular plane.
3. Connections of each tension element shall be designed to develop the smaller of the ultimate tension capacity of the member or three times the force in the member.
4. All structural elements shall be designed for a reversal of load. The reversed load shall be equal to 10 percent of the design load used in sizing the member.

1616.8 Design criteria. Alternate load path method and/or specific local resistance method for key elements shall conform to the appropriate design criteria as determined from Sections 1616.9, 1616.10 and 1616.11. Load combinations for the alternate load path method shall be as specified in Section 1605.5.

1616.9 Analysis procedures. All structural analysis for specific local loads or alternate load paths shall be made by one of the following methods:

1616.9.1 Static elastic analysis. For analysis of this type, dynamic effects of member loss or dynamic effects of specific local loads need not be considered. The structural demand is obtained from linear static analysis. However, structural member capacity is based on ultimate capacity of the entire cross section. The demand/capacity ratio of structural elements shall not exceed one.

1616.9.2 Dynamic inelastic analysis. For analysis of this type, dynamic effects of member loss or specific local loads shall be considered. The structure does not need to remain elastic; however, the response ratio and rotation limits obtained from Table 1616.9.3 shall not be exceeded.

1616.9.3‡ Energy methods. Static inelastic analysis using energy equilibrium may also be used. The structure does not need to remain elastic; however, the response ratio and rotation limits obtained from Table 1616.9.3 shall not be exceeded.

TABLE 1616.9.3
RESPONSE RATIO AND ROTATION LIMITS

ELEMENT	RESPONSE RATIO	ROTATION
Concrete slabs	$\mu < 10$	$\theta < 4°$
Post-tensioned beams	$\mu < 2$	$\theta < 1.5°$
Concrete beams Concrete columns	$\mu < 20$	$\theta < 6°$
	$\mu < 2$	$\theta < 6°$
Long span acoustical deck	$\mu < 2$	$\theta < 3°$
Open web steel joists	$\mu < 2$	$\theta < 6°$
Steel beams	$\mu < 20$	$\theta < 10°$
Steel columns	$\mu < 5$	$\theta < 6°$

For SI: 1 degree = 0.01745 rad.

Note: Table 1616.9.3 is intended for SDOF and simplified MDOF response calculations and a low level of protection. Table 1616.9.3 does not apply for explicit finite element methods that calculate the performance of the structural elements in response to the specified loading intensity. Steel joists: downward loading 6 degrees, upward loading ductility of 2.

1616.10 Minimum response. Structural response of elements determined using a dynamic inelastic analysis shall not be less than 80 percent of the structural response determined using a static elastic analysis.

1616.11 Strength reduction factors. For structural design for specific local loads or alternate load paths, all strength reduction factors may be taken as one.

SECTION BC 1617
STRUCTURAL PEER REVIEW

1617.1 General. The provisions of this section specify where structural peer review is required, how and by whom it is to be performed.

1617.2 Where required. A structural peer review of the primary structure shall be performed a report provided for the following buildings:

1. Buildings included in Structural Occupancy Category IV as defined in this chapter and more than 50,000 square feet (4645 m^2) of framed area.
2. Buildings with aspect ratios of seven or greater.
3. Buildings greater than 600 feet (183 m) in height or more than 1,000,000 square feet (92 903 m^2) in gross floor area.
4. Buildings taller than seven stories where any element, except for walls greater than 10 feet (3.048 meters) in length, supports in aggregate more than 15 percent of the building area.
5. Buildings designed using nonlinear time history analysis or with special seismic energy dissipation systems.
6. ‡Buildings designed for areas with 3,000 or more occupants in one area in close proximity, including fixed seating and grandstand areas.
7. ‡Buildings where a structural peer review is requested by the commissioner.

1617.3 Structural peer review. It shall be verified that the structural design is in general conformance with the requirements of this code.

1617.4 Structural peer reviewer. The structural peer review shall be performed by a qualified independent structural engineer who has been retained by or on behalf of the owner. A structural peer reviewer shall meet the requirements of the rules of the department.

1617.5 Extent of the structural peer review.

1617.5.1 Scope. The structural peer reviewer shall review the plans and specifications submitted with the permit application for general compliance with the structural and foundation design provisions of this code. The reviewing engineer shall perform the following tasks at a minimum:

1. Confirm that the design loads conform to this code.
2. Confirm that other structural design criteria and design assumptions conform to this code and are in accordance with generally accepted engineering practice.
3. Review geotechnical and other engineering investigations that are related to the foundation and structural design and confirm that the design properly incorporates the results and recommendations of the investigations.
4. Review the structural frame and the load supporting parts of floors, roofs, walls and foundations. Cladding, cladding framing, stairs, equipment supports, ceiling supports, non-loadbearing partitions, railings and guards, and other secondary structural items shall be excluded.
5. ‡Confirm that the structure has a complete load path.
6. ‡Perform independent calculations for a representative fraction of systems, members, and details to check their adequacy. The number of representative systems, members, and details verified shall be sufficient to form a basis for the reviewer's conclusions.
7. ‡Verify that performance-specified structural components (such as certain precast concrete elements) have been appropriately specified and coordinated with the primary building structure.
8. ‡Verify that the design engineer of record complied with the structural integrity provisions of the code.
9. Review the structural and architectural plans for the building. Confirm that the structural plans are in general conformance with the architectural

plans regarding loads and other conditions that may affect the structural design.

10. Confirm that major mechanical items are accommodated in the structural plans.
11. Attest to the general completeness of the structural plans and specifications.

1617.5.2 Structural design criteria. If the design criteria and design assumptions are not shown on the drawings or in the computations, the structural engineer of record shall provide a statement of these criteria and assumptions for the reviewer. In addition, the design engineer shall provide information and/or calculations, if requested by the peer reviewer.

1617.6 Structural peer review report.

1617.6.1 General. The reviewing engineer shall submit a report to the department stating whether or not the structural design shown on the plans and specifications generally conforms to the structural and foundation requirements of this code.

1617.6.2 Contents. The report shall demonstrate, at a minimum, compliance with Items 1 through 11 of Section 1617.5.1. In addition, the report shall also include the following:

1. The codes and standards used in the structural design of the project.
2. The structural design criteria, including loads and performance requirements.
3. The basis for design criteria that are not specified directly in applicable codes and standards. This should include reports by specialty consultants such as wind tunnel study reports and geotechnical reports. Generally, the report should confirm that existing conditions at the site have been investigated as appropriate and that the design of the proposed structure is in general conformance with these conditions.

1617.6.3 Phased submission. If an application is submitted for a permit for the construction of foundations or any other part of a building before the construction documents for the whole building have been submitted, then the structural peer review and report shall be phased. The structural peer reviewer shall be provided with sufficient information on which to make a structural peer review of the phased submission.

1617.7 Responsibility.

1617.7.1 Structural engineer of record. The structural engineer of record shall retain sole responsibility for the structural design. The activities and reports of the structural peer reviewer shall not relieve the structural engineer of record of this responsibility.

1617.7.2 Structural peer reviewer. The structural peer reviewer's report states his or her opinion regarding the design by the engineer of record. The standard of care to which the structural peer reviewer shall be held in the performance of the structural peer review and report is that the level of skill and care are consistent with structural peer.

SECTION 1618
LOADS ON TEMPORARY INSTALLATIONS

1618.1 General. Installations governed by this code shall be defined as temporary when such installations are intended to be taken apart or removed after a limited period following their installation, including, but not limited to, tents, scaffolds, sidewalk sheds, cranes, and run back structures. Temporary installations shall comply with all the provisions of this code, except as described in Sections 1618.1.1 through 1618.3.2.

1618.1.1 Duration. Such limited period shall not exceed one year for temporary installations used in construction operations covered by Chapter 33. For temporary installations covered by Section 3103, the limited period shall not exceed ninety days. The limited period shall be counted from the date the temporary installation is substantially installed.

1618.1.1.1 Extension of time. Subject to the approval of the commissioner, a request to extend the time for a temporary installation, subject to the limits in Section 1618.1.1, shall be accompanied by the submission of a report from a registered design professional that certifies the following:

1. Such registered design professional performed an inspection within the last 30 days to confirm that the installation complies with the requirements of the approved construction documents for the temporary installation; and
2. The action plan required by Section 1618.3:
   2.1. Is still in effect;
   2.2. Has been revised to reflect the current conditions of the installation; or
   2.3. Is no longer required, as the installation has been retrofitted to comply with the loads for new construction without any reduction, pursuant to Section 1618.2.

1618.1.2 Construction documents. Any temporary installation utilizing the exemptions and load reductions in the structural design shall be prominently indicated on drawings as temporary, and all reduced loads shall be indicated on the drawings. The environmental load mitigations shall be indicated on the construction documents. The construction documents shall be maintained at the site of the temporary installation and be available to the department upon request.

1618.2 Loads. Temporary installations shall be designed and constructed to resist the loads required by Chapter 16 of this code for new construction.

Exception: Temporary installations that are accompanied by an action plan in accordance with Section 1618.3 shall be permitted to reduce the design environmental loads required by Chapter 16 of this code as follows:

1. Seismic. Temporary installations shall be permitted to use 2 percent of the design dead and live load in lieu of the seismic forces required by Section 1614 in load combinations including seismic forces. This

load shall be distributed in proportion to the design loads, shall be applied in any horizontal direction and need not be combined with other environmental loads.

2. Wind. The wind design for temporary installations shall be computed as required by Section 1609. The basic wind speed used to design the structure shall be permitted to be reduced by applying a factor of 0.8.

3. Other environmental forces. Other environmental forces, including, but not limited to, snow, ice, and temperature differential effects, shall be permitted to be reduced as appropriate for the limited exposure of the installation.

1618.3 Action plan. All temporary installations reducing the design environmental loads in accordance with Section 1618.2 shall include environmental load mitigation measures as part of an action plan. The action plan measures shall be indicated on the drawings.

1618.3.1 Implementation. The action plan shall be such that it may be reliably implemented in one day's notice or less as appropriate for the actions.

1618.3.2 Components. The action plan shall, at a minimum, include the following:

1. Threshold of predicted environmental loads;
2. Method of monitoring environmental loads;
3. Party responsible for monitoring loads and determining implementation of action plan;
4. Party responsible for effectuating the action plan;
5. Evacuation procedures;
6. Safety zone, standoff distance or standoff perimeter as appropriate. Safety zone, standoff distance or standoff perimeter shall not extend beyond the property line;
7. Any other activities, such as the addition or removal of structural and/or nonstructural elements, removal of loads or creating sacrificial elements so that the structure may resist unreduced forces as required for permanent structures;
8. Plan to prevent wind-born debris; and
9. Verification that the design and procedures shall not adversely impact other structures.