
# Chapter 16 – Structural Design

- Chapter 16 of the 2019 Chicago Building Code is aligned with Chapter 16 of the 2018 International Building Code.
- The provisions of Chapter 16 of the CBC are based upon the provisions of the previous building code, a knowledge of the building/structure types in the City, usage of those buildings/structures, typical geotechnical conditions and the structure type and environmental loading conditions relating to the geographic location of the City.

# Chapter 16 – Structural Design

- Scope
- Construction Documents
- General Design Requirements
- Load Combinations
- Dead Loads
- Live Loads
- Snow Loads



# Chapter 16 – Structural Design

- Wind Loads
- Soil Lateral Loads
- Rain Loads
- Flood Loads
- Earthquake Loads
- Structural Integrity

# Scope

- **1601.1 Scope**
  **“**The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code.”



# Construction Documents

- **1601.3 General**
  **“***Construction documents* shall show the size, section and relative locations of structural members with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be indicated on the *construction documents*.”

# Construction Documents, cont'd

- Light Frame Construction
  - Construction documents for buildings constructed using light frame construction in accordance with Section 2803 are excepted from Section 1603.1 but are to have the following information:
    - Floor and roof dead and live loads
    - Ground snow load, $P_g$
    - Basic design wind speed, *V, miles per hour (mph) (km/hr) and allowable stress* design wind speed, $V_{asd}$, as determined in accordance with Section 1609.3.1 andwind exposure.
    - *Seismic design category and site class.*
    - Design load-bearing values of soils.
    - Rain load data.



# Construction Documents, cont'd

- The information to be shown on the construction documents is to include the following load and other information:
  - 1603.1.1 Floor live load
    - Uniform, concentrated & impact
    - Live load reduction
  - 1603.1.2 Roof live load
    - Indicate applicable area
  - 1603.1.3 Roof snow load data
    - Flat roof snow load $P_f$
    - Snow exposure factor $C_e$
    - Snow load importance factor $I_s$
    - Thermal factor $C_t$
    - Slope factor $C_s$
    - Drift surcharge load $P_d$
    - Width of snow drift w

# Construction Documents, cont'd

- The information to be shown on the construction documents cont'd:
  - 1603.1.4 Wind design data
    - Basic wind design speed V
    - Risk category
    - Wind exposure
    - Internal pressure coefficient
    - Design wind pressures for exterior components & cladding
    - Design base shear



# Construction Documents, cont'd

- The information to be shown on the construction documents cont'd:
  - 1603.1.5 Earthquake design data
    - Risk category
    - Seismic importance factor $I_e$
    - Mapped spectral response acceleration factors, $S_s$ & $S_1$
    - Site class
    - Design spectral response acceleration parameters, $S_{DS}$ &$S_{D1}$
    - *Seismic design category*
    - Additional required information for seismic categories B, C or D

# Construction Documents, cont'd

- The information to be shown on the construction documents cont'd:
  - 1603.1.6 Geotechnical information
    - Allowable soil bearing pressure
  - 1603.1.8 Special loads
    - Mechanical equipment
    - Photovoltaic panels



# 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 and referenced standards."

## 1604.2 Strength

"Buildings and other structures must have adequate strength to support the loads"

# General Design Requirements, cont'd

- 1604.3 Serviceability
  - Table 1604.3 Deflection Limits
  - Deflections
  - Reinforced Concrete
  - Steel
  - Masonry
  - Aluminum
  - Limits
  - Framing supporting glass

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

| CONSTRUCTION | $L$ or $L_r$ | $S$ or $W$[f] | $D + L$[d, g] |
|---|---|---|---|
| Roof members:[e] | | | |
| Supporting plaster or stucco 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: | | | |
| With plaster or stucco finishes | — | l/360 | — |
| With other brittle finishes | — | l/240 | — |
| With flexible finishes | — | l/120 | — |
| Interior partitions:[b] | | | |
| With plaster or stucco finishes | l/360 | — | — |
| With other brittle finishes | l/240 | — | — |
| With flexible finishes | l/120 | — | — |
| Farm buildings | — | — | l/180 |
| Greenhouses | — | — | l/120 |



# General Design Requirements, cont'd

- 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."
- 1604.5 Risk Category
  - Table 1604.5

**TABLE 1604.5**
**RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES**

| RISK CATEGORY | NATURE OF OCCUPANCY |
|---|---|
| I | Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to:<br>• Agricultural facilities.<br>• Certain temporary facilities.<br>• Minor storage facilities. |
| II | Buildings and other structures except those listed in 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:<br>• Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300.<br>• Buildings and other structures containing Group E occupancies with an occupant load greater than 250.<br>• Buildings and other structures containing educational occupancies for students above the 12th grade with an occupant load greater than 500.<br>• Group I-2, Condition 1 occupancies with 50 or more care recipients.<br>• Group I-2, Condition 2 occupancies not having emergency surgery or emergency treatment facilities.<br>• Group I-3 occupancies.<br>• Any other occupancy with an occupant load greater than 5,000.[a]<br>• Power-generating stations, water treatment facilities for potable water, wastewater treatment facilities and other public utility facilities not included in Risk Category IV.<br>• Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that:<br>Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and<br>Are sufficient to pose a threat to the public if released.[b] |
| IV | Buildings and other structures designated as essential facilities, including but not limited to:<br>• Group I-2, Condition 2 occupancies having emergency surgery or emergency treatment facilities.<br>• Ambulatory care facilities having emergency surgery or emergency treatment facilities.<br>• Fire, rescue, ambulance and police stations and emergency vehicle garages.<br>• Designated earthquake, hurricane or other emergency shelters.<br>• Designated emergency preparedness, communications and operations centers and other facilities required for emergency response.<br>• Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures.<br>• Buildings and other structures containing quantities of highly toxic materials that:<br>Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code*; and<br>Are sufficient to pose a threat to the public if released.[b]<br>• Aviation control towers, air traffic control centers and emergency aircraft hangars.<br>• Buildings and other structures having critical national defense functions.<br>• Water storage facilities and pump structures required to maintain water pressure for fire suppression. |

# General Design Requirements, cont'd

- 1604.6 & 1604.7 Load Tests
- 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 Structural walls

    "Walls that provide vertical load-bearing resistance or lateral shear resistance for a portion of the structure shall be anchored to the roof and to all floors and members that provide lateral support for the wall or that are supported by the wall."
  - 1604.8.3 Decks, porches exterior balconies and similar structures



# General Design Requirements, cont'd

- 1604.10 Wind & Seismic Detailing

  "Lateral force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7 Chapters 11, 12, 13, 15, 17 and 18 as applicable, even where wind *load effects are greater than seismic load effects."*

# Load Combinations

- 1605.1 General

  "Buildings and other structures shall be designed to resist the load combinations and seismic load effects including the overstrength factor."

- 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."



# Load Combinations

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

  1.4($D$ +$F$)
  1.2($D$ + $F$) + 1.6($L$ + $H$) + 0.5($Lr$ or $S$ or $R$)
  1.2($D$ + $F$)+ 1.6($Lr$ or $S$ or $R$) + 1.6$H$ + ($f$1$L$ or 0.5$W$)
  1.2($D$ + $F$)+ 1.0$W$ + $f$1$L$ + 1.6$H$ + 0.5($Lr$ or $S$ or $R$)
  1.2($D$ + $F$)+ 1.0$E$ + $f$1$L$ + 1.6$H$ + $f$2$S$
  0.9$D$+ 1.0$W$+ 1.6$H$
  0.9($D$ + $F$)+ 1.0$E$+ 1.6$H$
  *(Notations from Section 1602)*

# Load Combinations

- 1605.3 Load combinations using allowable stress design.

  *D* + *F*
  *D* + *H* + *F* + *L*
  *D* + *H* + *F* + (*Lr* or *S* or *R*)
  *D* + *H* + *F*+ 0.75(*L*) + 0.75(*Lr* or *S* or *R*
  *D* + *H* + *F* + (0.6*W* or 0.7*E*)
  *D* + *H* + *F* + 0.75(0.6*W*) + 0.75*L* + 0.75(*Lr* or *S* or *R*)
  *D* + *H* + *F* + 0.75 (0.7 *E*) + 0.75 *L* + 0.75 *S*
  0.6*D* + 0.6*W*+*H*
  0.6(*D* + *F)* + 0.7*E*+*H*



# Dead Loads

- 202 Definitions

  "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."*

# Live Loads

- 202 Definitions

  "A *load produced by the use and occupancy* of the building or other structure that does not include construction or environmental *loads such as wind load, snow* load, rain load, earthquake load, flood load or ***dead load.***"

- 1607 Live Load

  Table 1607.1

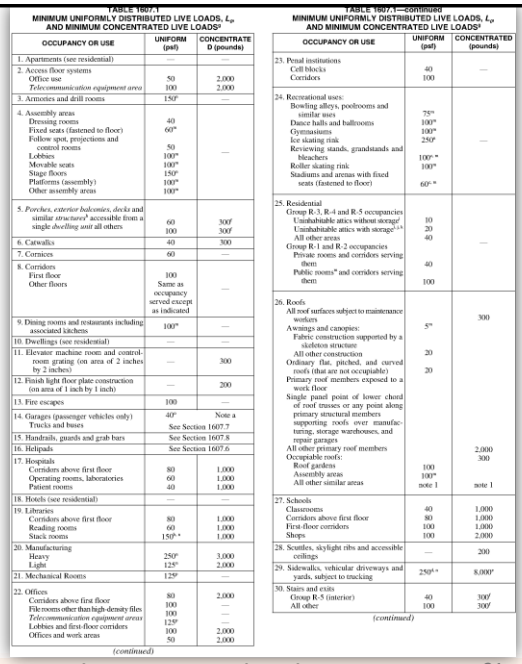


TABLE 1607.1
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, $L_o$, AND MINIMUM CONCENTRATED LIVE LOADS[a]

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (pounds) |
|---|---|---|
| 1. Apartments (see residential) | | |
| 2. Access floor systems | | |
| Office use | 50 | 2,000 |
| *Telecommunication equipment area* | 100 | 2,000 |
| 3. Armories and drill rooms | 150[e] | — |
| 4. Assembly areas | | |
| Dressing rooms | 40 | |
| Fixed seats (fastened to floor) | 60[e] | |
| Follow spot, projections and control rooms | 50 | — |
| Lobbies | 100[e] | |
| Movable seats | 100[e] | |
| Stage floors | 150[e] | |
| Platforms (assembly) | 100[e] | |
| Other assembly areas | 100[e] | |
| 5. *Porches, exterior balconies, decks* and similar *structures*[b] accessible from a single *dwelling unit* all others | 60<br>100 | 300[f]<br>300[f] |
| 6. Catwalks | 40 | 300 |
| 7. Cornices | 60 | — |
| 8. Corridors | | |
| First floor | 100 | |
| Other floors | Same as occupancy served except as indicated | — |
| 9. Dining rooms and restaurants including associated kitchens | 100[e] | — |
| 10. Dwellings (see residential) | — | — |
| 11. Elevator machine room and control-room grating (on area of 2 inches by 2 inches) | — | 300 |
| 12. Finish light floor plate construction (on area of 1 inch by 1 inch) | — | 200 |
| 13. Fire escapes | 100 | — |
| 14. Garages (passenger vehicles only) | 40[e] | Note a |
| Trucks and buses | See Section 1607.7 | |
| 15. Handrails, guards and grab bars | See Section 1607.8 | |
| 16. Helipads | See Section 1607.6 | |
| 17. Hospitals | | |
| Corridors above first floor | 80 | 1,000 |
| Operating rooms, laboratories | 60 | 1,000 |
| Patient rooms | 40 | 1,000 |
| 18. Hotels (see residential) | — | — |
| 19. Libraries | | |
| Corridors above first floor | 80 | 1,000 |
| Reading rooms | 60 | 1,000 |
| Stack rooms | 150[e,s] | 1,000 |
| 20. Manufacturing | | |
| Heavy | 250[e] | 3,000 |
| Light | 125[e] | 2,000 |
| 21. Mechanical Rooms | 125[e] | — |
| 22. Offices | | |
| Corridors above first floor | 80 | 2,000 |
| File rooms other than high-density files | 100 | — |
| *Telecommunication equipment areas* | 100 | — |
| Lobbies and first-floor corridors | 125[e] | — |
| Offices and work areas | 100 | 2,000 |
| | 50 | 2,000 |

*(continued)*

TABLE 1607.1—continued
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS, $L_o$, AND MINIMUM CONCENTRATED LIVE LOADS[a]

| OCCUPANCY OR USE | UNIFORM (psf) | CONCENTRATED (pounds) |
|---|---|---|
| 23. Penal institutions | | |
| Cell blocks | 40 | — |
| Corridors | 100 | |
| 24. Recreational uses: | | |
| Bowling alleys, poolrooms and similar uses | 75[e] | |
| Dance halls and ballrooms | 100[e] | |
| Gymnasiums | 100[e] | |
| Ice skating rink | 250[e] | — |
| Reviewing stands, grandstands and bleachers | 100[e, n] | |
| Roller skating rink | 100[e] | |
| Stadiums and arenas with fixed seats (fastened to floor) | 60[e, n] | |
| 25. Residential | | |
| Group R-3, R-4 and R-5 occupancies | | |
| Uninhabitable attics without storage[i] | 10 | |
| Uninhabitable attics with storage[i,k] | 20 | |
| All other areas | 40 | — |
| Group R-1 and R-2 occupancies | | |
| Private rooms and corridors serving them | 40 | |
| Public rooms[n] and corridors serving them | 100 | |
| 26. Roofs | | |
| All roof surfaces subject to maintenance workers | | 300 |
| Awnings and canopies: | 5[m] | |
| Fabric construction supported by a skeleton structure | | |
| All other construction | 20 | |
| Ordinary flat, pitched, and curved roofs (that are not occupiable) | 20 | |
| 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 over manufacturing, storage warehouses, and repair garages | | |
| All other primary roof members | | 2,000 |
| Occupiable roofs: | | 300 |
| Roof gardens | 100 | |
| Assembly areas | 100[n] | |
| All other similar areas | note 1 | note 1 |
| 27. Schools | | |
| Classrooms | 40 | 1,000 |
| Corridors above first floor | 80 | 1,000 |
| First-floor corridors | 100 | 1,000 |
| Shops | 100 | 2,000 |
| 28. Scuttles, skylight ribs and accessible ceilings | — | 200 |
| 29. Sidewalks, vehicular driveways and yards, subject to trucking | 250[d,s] | 8,000[r] |
| 30. Stairs and exits | | |
| Group R-5 (interior) | 40 | 300[f] |
| All other | 100 | 300[f] |

*(continued)*



# Live Loads,cont'd

- 1607.3 Uniform Live Loads
- 1607.4 Concentrated Live Loads
- 1607.5 Partition Loads (where partitions are subjected to change)
- 1607.6 Helipads
- 1607.7 Heavy vehicle loads
  - 1607.7.5 Posting

    **"**The maximum weight of vehicles allowed into or on a garage or other structure shall be posted by the owner or the owner's authorized agent in accordance with Section 106.1."
- 1607.8 Loads on handrails, guards, grab bars and seats
- 1607.9 Vehicle barriers

# Live Loads, cont'd

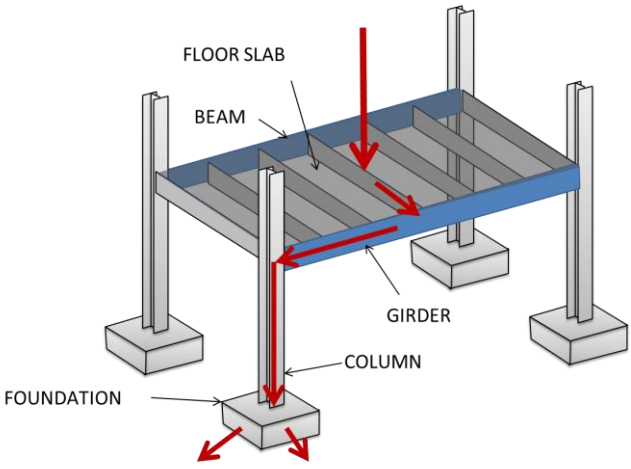
- 1607.10 Impact loads
- 1607.11 Live Load Reduction
- 1607.12 Distribution of Live Loads

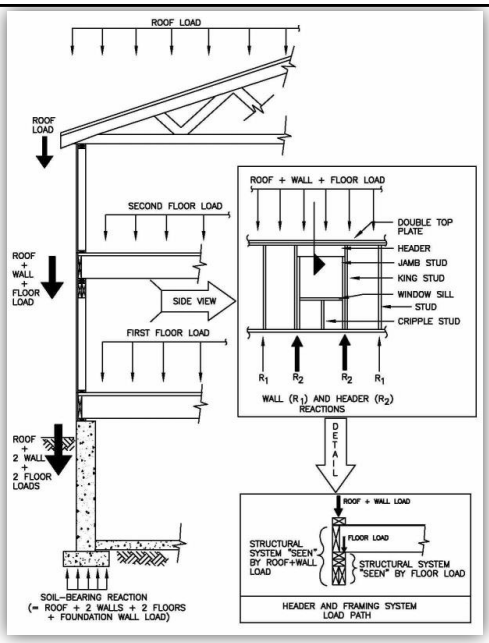
  Live loads are to be distributed to produce the greatest load effect (i.e.skip live load).
- 1607.13 Roof Loads

  Roof structures are to be designed to support wind, snow and seismic loads.
  - 1607.13.3 Occupiable rooftop live loads are permitted to be reduced
  - 1607.13.5 Photovoltaic panel system loads are to be considered



# Gravity Load Path



# 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 be not less than that determined by Section 1607."
- 1608.2 Ground snow load $p_g$
  - The ground snow load is 25 psf
- 1603.3 Ponding instability

  Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Chapters 7 and 8 of ASCE 7



# Snow Loads, cont'd

- Roof snow load
  - Flat roof snow load $p_f$
    - ASCE 7 Section 7.3
    - $p_f = (0.7)(C_e)(C_t)(I_s)(p_g)$
  - Exposure factor Ce
    - ASCE 7 Section 7.3.1
    - Table 7.3-1
  - Snow Thermal Factor ($C_t$)
    - ASCE 7 Section 7.3.2
    - Table 7.3-2
  - Snow importance factor $I_s$
    - ASCE 7 Table 1.5-2

**Table 7.3-1 Exposure Factor, $C_e$**

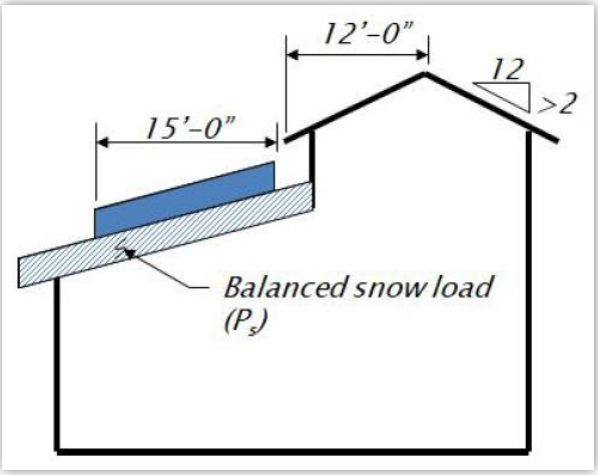
| Surface Roughness Category | Exposure of Roof[a] | | |
|---|---|---|---|
| | Fully Exposed | Partially Exposed | Sheltered |
| B (see Section 26.7) | 0.9 | 1.0 | 1.2 |
| C (see Section 26.7) | 0.9 | 1.0 | 1.1 |
| D (see Section 26.7) | 0.8 | 0.9 | 1.0 |
| Above the tree line in windswept mountainous areas | 0.7 | 0.8 | NA |
| In Alaska, in areas where trees do not exist within a 2-mi (3-km) radius of the site | 0.7 | 0.8 | NA |

**Table 7.3-2 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 $25°F \times h \times ft^2/Btu$ $(4.4\ K \times m^2/W)$ | 1.1 |
| Unheated and open air structures | 1.2 |
| Freezer building | 1.3 |
| Continuously heated greenhouses[b] with a roof having a thermal resistance (R-value) less than $2.0°F \times h \times ft^2/Btu$ $(0.4\ K \times m^2/W)$ | 0.85 |

# Snow Loads, cont'd

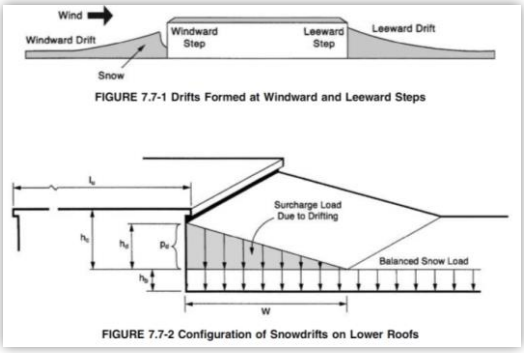
- Minimum snow load $p_m$
  - ASCE 7 Section 7.3.4
  - For slope < 15° $p_m = 20\ I_S$
- Sloped roof snow loads
  - ASCE 7 Section 7.4
- Partial loading
  - ASCE 7 Section 7.5
- Unbalanced snow loads
  - ASCE 7 Section 7.6

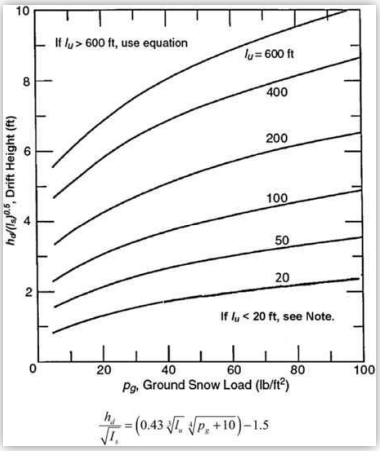





# Snow Loads, cont'd

- Snow drifts
  - ASCE 7 Section 7.7



# Wind Loads

- 1609.1.1 Determination

  "Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7."

- 1609.1.2 Special Investigations

  "Special investigations shall be required to determine wind loads for *buildings* and other *structures* with a *mean roof height* exceeding 400 feet (122 m). Special investigations shall be required to determine wind loads for *buildings* and other *structures* with a *mean roof height* of 400 feet (122 m) or less and having irregular shapes, response characteristics or site locations with shielding or channeling effects that warrant special consideration."



# Wind Loads, cont'd

- 1609.3 Basic design wind speed

  Risk category I – 101 mph

  Risk category II – 107 mph

  Risk Category III – 114 mph

  Risk Category IV – 119 mph

# Wind Loads, cont'd

- 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."

  – 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."



# Wind Loads, cont'd

- 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 following categories, 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.

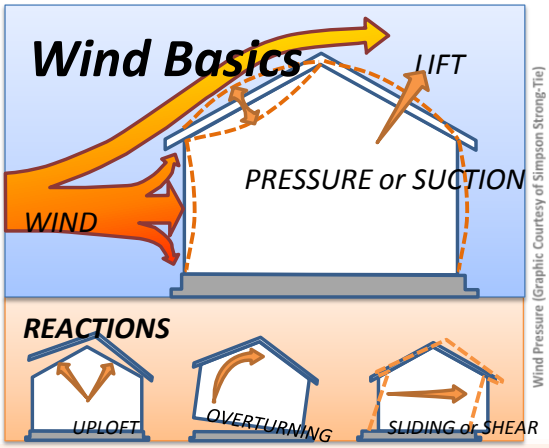
  "Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, and grasslands."

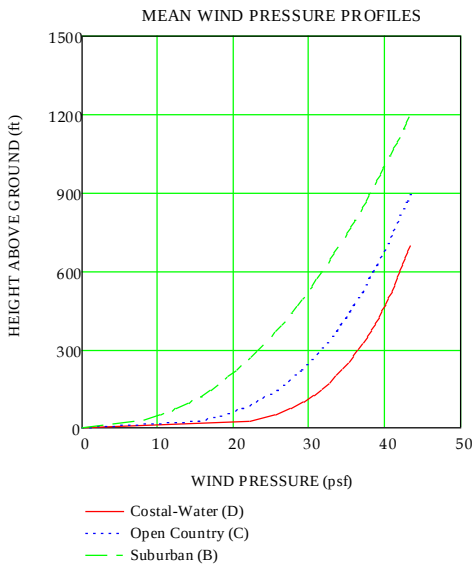
  – Surface Roughness D.

  "Flat, unobstructed areas and water surfaces."

# Wind Loads, cont'd

- Wind Pressure






# Wind Loads, cont'd

- 1609.4.3 Exposure categories
  - Exposure B

    "For buildings with a mean roof height of less than or equal to 30 feet (9144 mm),Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance of not less than 1,500 feet (457 m). For buildings with a mean roof height greater than 30 feet (9144 mm), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance of not less than 2,600 feet (792 m) or 20 times the height of the building, whichever is greater."
  - Exposure C

    "Exposure C shall apply for all cases where Exposure 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 not less than 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 feet (183 m) or 20 times the building height, whichever is greater, from an Exposure D condition as defined in the previous sentence."
- 1609.5 Roof systems

# Wind Loads, cont'd

- 1609.6 Alternative wind loads for enclosed structures with a mean roof height of 60 feet or less.

  "Where the *mean roof height of a structure is 60 feet (18.3 m) or less, wind loads on the main windforce-resisting system and on components and cladding shall be permitted to be* determined in accordance with Section 1609.6, provided the following conditions are met:"

  – 1. The *structure is classified as "enclosed" in accordance with Chapter 26 of ASCE 7.*
  – 2. Both the windward and leeward wind loads are transmitted by roof and vertically spanning wall assemblies, through continuous floor and roof diaphragms, to the *main windforce-resisting system.*
  – 3. Thelongest horizontal dimension of the *structureis no more than five times the* shortest horizontal dimension of the *structure.*
  – 4. The *structurehas no unusual geometrical irregularity in spatial form.*
  – 5. The *structure does not have response characteristics that make it subject to acrosswind* loading, vortex shedding, or instability caused by galloping or flutter.
  – 6. The *structuredoes not have a site location for which channeling effects or buffeting in* the wake of upwind obstructions warrant special consideration.1609.4.3 Exposure categories



# Wind Loads, cont'd

- 1609.6.1 Main windforce-resisting system

  "The load due to wind pressure, *W, on the main windforce-resisting system shall be* based on exposure category and *risk categoryas indicated in Table 1609.6.1."*

- Table 1609.6.1 Load Due to Wind Pressure on Main Windforce-Resisting System

| EXPOSURE CATEGORY | LOAD DUE TO WIND PRESSURE (pounds per square foot) Risk Category | | |
|---|---|---|---|
| | I or II | III | IV |
| B | 25 | 28 | 31 |
| C | 32 | 37 | 40 |
| D | 38 | 43 | 46 |

# Wind Loads, cont'd

- 1609.6.2 Components and cladding

  "The load due to wind pressure, *W, on components and cladding shall be the values in* Table 1609.6.1 multiplied by the multiplier provided in Table 1609.6.2."

  – Table 1609.6.2 Multipliers to Determine Components and Cladding Wind Pressure

| CONDITION | MULTIPLIER[k] | |
|---|---|---|
| | Flat Roof (less than 7° slope) | Sloped Gable Roof[j] |
| Wall (field)[a] | 1.2 | 1.2 |
| Wall (corner)[a, c] | 1.4 | 1.4 |
| Roof (field)[b] | 1.0[h] | 2.0 |
| Roof (edge)[b] | 2.3[d, h] | 3.0[f, i] |
| Roof (corner)[b] | 3.2[e, h] | 3.6[g, i] |



# Soil Lateral Loads

- 1610.1 General

  "Foundation walls and retaining walls shall be designed to resist lateral soil loads. Soil loads specified in Table 1610.1 shall be used as the minimum design lateral soil loads unless determined otherwise by a geotechnical investigation in accordance with Section 1803. 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 shall be permitted to be designed for active pressure. Design lateral pressure from surcharge loads shall be added to the lateral earth pressure load. Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1805.4.2 and 1805.4.3.Where a portion or the whole of the adjacent soil is below a free-water surface, computations shall be based on the weight of the soil diminished by buoyancy, plus full hydrostatic pressure."

# Soil Lateral Loads, cont'd

- 1610.1 General, cont'd

  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.

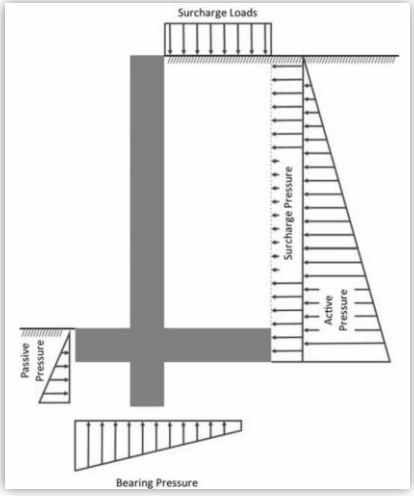
- TABLE 1610.1 Lateral Soil Load Design

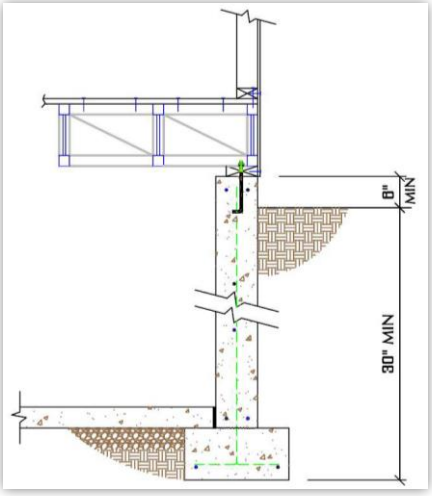
| | DESIGN LATERAL SOIL LOAD[a] (pounds per square foot per foot of depth) |
|---|---|
| Active pressure | 45 |
| At rest pressure | 60 |



# Soil Lateral Loads, cont'd

- Lateral Soil Loads
  - At-rest
  - Active
  - Passive
  - Hydrostatic
  - Surcharge



# Soil Bearing Capacity

- Table 1806.2(1) Maximum Soil Bearing Capacity

**TABLE 1806.2(1)**
**PRESUMPTIVE LOAD-BEARING VALUES WITHOUT FULL GEOTECHNICAL INVESTIGATION**

| CLASS OF MATERIALS | VERTICAL FOUNDATION PRESSURE (psf) | LATERAL BEARING PRESSURE (psf/ft below natural grade) | LATERAL SLIDING RESISTANCE | |
|---|---|---|---|---|
| | | | Coefficient of friction[a] | Cohesion (psf)[b] |
| Sandy gravel and gravel (GW and GP) | 3,000 | 200 | 0.35 | — |
| Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC) | 2,000 | 150 | 0.25 | — |
| Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH) | 1,500 | 100 | — | 130 |
| Non-engineered fill | 500 | 50 | 0.1 | — |

For SI: 1 pound per square foot = 0.0479 kPa, 1 pound per square foot per foot = 0.157 kPa/m.
a. Coefficient to be multiplied by the dead load.
b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.



# 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. The design rainfall shall be based on a 100-year hourly rainfall rate of 3.1 inches (83 mm)."
- 1611.2 Ponding instability
  "Susceptible bays of roofs shall be evaluated for ponding instability 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."

# 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 chapters 11, 12, 13, 15, 17 and 18 of ASCE 7, as applicable. The *seismic design category for a structure is permitted to be* determined in accordance with Section 1613 or ASCE 7.



# Earthquake Loads, cont'd

- 1613.1 Scope
  - Exceptions:

    1. Buildings and structures assigned to *Seismic Design Category A shall comply with* Section 1613.4.

    2. Group R-3 and R-5 occupancies.

    3. The *seismic force-resisting system of wood-frame buildings of light-frame construction* that conform to the provisions of Section 2308 are not required to be analyzed as specified in this section.

    4. Agricultural and industrial storage structures intended only for incidental human occupancy.

    5. Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7 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.

    6. References within ASCE 7 to Chapter 14 shall not apply, except as specifically required herein.

# Earthquake Loads, cont'd

- 1613.2 Seismic ground motion values
  - 1613.2.1 Acceleration parameters

    "The acceleration parameters shall be: mapped 0.2 sec. spectral response acceleration (5% of critical damping, Site Class B) $S_S$ = 0.125 g and mapped 1.0 sec. spectral response acceleration (5% of critical damping, Site Class B) $S_1$ = 0.066."



# Earthquake Loads, cont'd

- 1613.2 Seismic ground motion values

FIGURE 1613.2.1(1)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ($MCE_R$) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)

FIGURE 1613.2.1(2)—continued
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ($MCE_R$) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)

# Earthquake Loads, cont'd

- 1613.2 Seismic ground motion values
  - 1613.2.2 Site class definitions
    - Based on the site soil properties, the site shall be classified as *Site Class A, B, C, D, E or F* in accordance with Chapter 20 of ASCE 7.The site class shall reflect the soil conditions that affect the ground motion input to the *structure.*
    - Where the soil properties are not known in sufficient detail to determine the site class, Site Class D, subjected to the requirements of Section 1613.2.3, shall be used unless the *building official or a registered geotechnical engineer determines that Site Class E or F soils* are present at the site.
    - Where site investigations that are performed in accordance with Chapter 20 of ASCE 7 reveal rock conditions consistent with Site Class B, but site-specific velocity measurements are not made, the site coefficients $F_a$ and $F_v$ shall be taken at unity (1.0).



# Earthquake Loads, cont'd

- 1613.2 Seismic ground motion values
  - 1613.2.2 Site class definitions

| Site Class | $\bar{v}_s$ | $\bar{N}$ or $\bar{N}_{ch}$ | $\bar{s}_u$ |
|---|---|---|---|
| A. Hard rock | > 5,000 ft/s | NA | NA |
| B. Rock | 2,500 to 5,000 ft/s | NA | NA |
| C. Very dense soil and soft rock | 1,200 to 2,500 ft/s | > 50 | > 2,000 psf |
| D. Stiff soil | 600 to 1,200 ft/s | 15 to 50 | 1,000 to 2,000 psf |
| E. Soft clay soil | < 600 ft/s | < 15 | < 1,000 psf |
| | Any profile with more than 10 ft of soil having the following characteristics:<br>• Plasticity index PI > 20,<br>• Moisture content $w \geq 40\%$, and<br>• Undrained shear strength $\bar{s}_u < 500$ psf | | |
| F. Soils requiring site response analysis in accordance with Section 21.1 | See Section 20.3.1 | | |

**Figure 17: Soil Site Classification,**
**Courtesy of American Society of Professional Engineers (ASCE), ASCE 7-16 ®, Table 20.3-1**

# Earthquake Loads, cont'd

- 1613.2 Seismic ground motion values
  - 1613.2.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters.

The maximum considered earthquake spectral response acceleration for short periods, $S_{MS}$, *and at 1-second period,* $S_{M1}$, *adjusted for site class effects and five-percent damped design spectral response acceleration at short periods,* $S_{DS}$, *and at 1-second period,* $S_{D1}$ *shall be as provided in Table 1613.2.3.*



# Earthquake Loads, cont'd

- 1613.2 Seismic ground motion values
  - 1613.2.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters.

Table 1613.2.3 Seismic Design Parameters.

-

| Site Class | Maximum Spectral Response Accelerations | | Design Spectral Response Accelerations | | Seismic Design Category Risk Category | |
|---|---|---|---|---|---|---|
| | $S_{MS}$ | $S_{M1}$ | $S_{DS}$ | $S_{D1}$ | I, II or III | IV |
| A | 0.100 | 0.053 | 0.067 | 0.035 | A | A |
| B | 0.113 | 0.053 | 0.075 | 0.035 | A | A |
| C | 0.163 | 0.099 | 0.108 | 0.066 | A | A |
| D | 0.200 | 0.155 | 0.133 | 0.103 | B[a] | C |
| E | 0.300 | 0.277 | 0.200 | 0.185 | C | D |
| F | note b | note b | note b | note b | note c | |

a. The structure shall be assigned to *Seismic Design Category* A where the mean roof height does not exceed 60 feet (18.3 m) and the horizontal distance between vertical elements of the *seismic force-resisting system* does not exceed 40 feet (12.2 m).

b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.

# Earthquake Loads, cont'd

- 1613.4 Seismic design requirements for buildings assigned to Seismic Design Category A.

  *"Buildings and other structures assigned to Seismic Design Category A need only comply with* the requirements of this section. Nonstructural components of buildings and structures in *Seismic Design Category A are exempt from seismic design requirements."*



# Earthquake Loads, cont'd

- 1613.4 Requirements for Design Category A, cont'd
  - 1613.4.1General

    "All *structures shall be provided with a continuous load path in accordance with the* requirements of Section 1613.4.2 and shall have a complete lateral force-resisting system with adequate strength to resist the forces indicated in Section 1613.4.3. All members of the structural system shall be connected to their supporting members in accordance with Section 1613.4.4. Structural walls shall be anchored to diaphragms and supports in accordance with Section 1613.4.5. The effects on the *structure and its* components caused by the forces stipulated in this section shall be taken as the notional load,*N, and combined with the effects of other loads in accordance with the load* combinations of Section 1605. Where material resistance depends on load duration, notional loads are permitted to be taken as having a duration of 10 minutes."

# Earthquake Loads, cont'd

- 1613.4 Requirements for Design Category A, cont'd
  - 1613.4.2 Load path connections

    All parts of the structure between separation joints shall be interconnected to form a continuous path to the lateral force-resisting system, and the connections shall be capable of transmitting the lateral forces induced by the parts being connected. Any smaller portion of the structure shall be tied to the remainder of the structure with elements having the strength to resist a force of not less than 5% of the portion's weight.



# Earthquake Loads, cont'd

- 1613.4 Requirements for Design Category A, cont'd
  - 1613.4.3 Lateral forces

    "Each structure shall be analyzed for the effects of static lateral forces applied independently in each of two orthogonal directions. In each direction, the static lateral forces at all levels shall be applied simultaneously. For purposes of analysis, the force at each level shall be determined using Equation 16-36a."

    $F_x = 0.01W_x$ *(Equation 16-36a)* where:

    $F_x$ = *The design lateral force applied at story x.*

    $W_x$ = *the portion of the total dead load of the* structure, *D, located or assigned to level x.*

# Earthquake Loads, cont'd

- 1613.4 Requirements for Design Category A, cont'd
  - 1614.4.4 Connection to supports

    "A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder, or truss either directly to its supporting elements or to slabs designed to act as diaphragms. Where the connection is through a diaphragm, the member's supporting element shall also be connected to the diaphragm. The connection shall have the strength to resist a force of 5% of the unfactored dead load plus live load reaction imposed by the supported member on the supporting member."

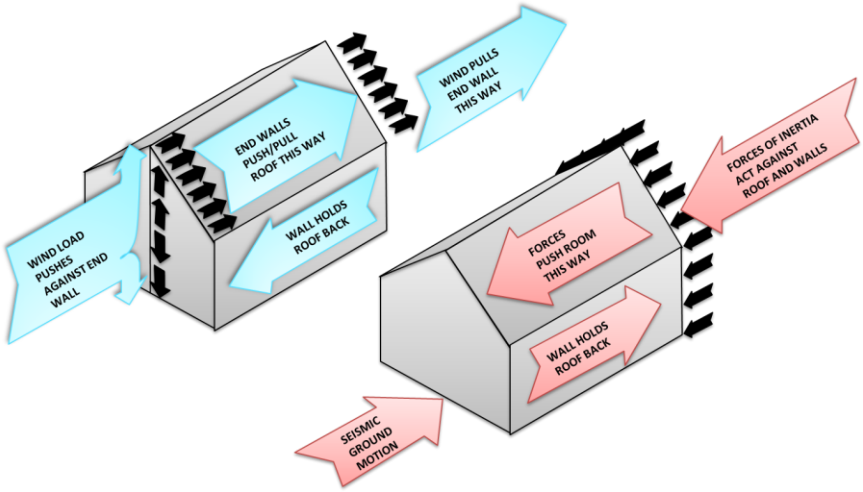


# Earthquake Loads, cont'd

- 1613.4 Requirements for Design Category A, cont'd
  - 1614.4.5 Anchorage of structural walls

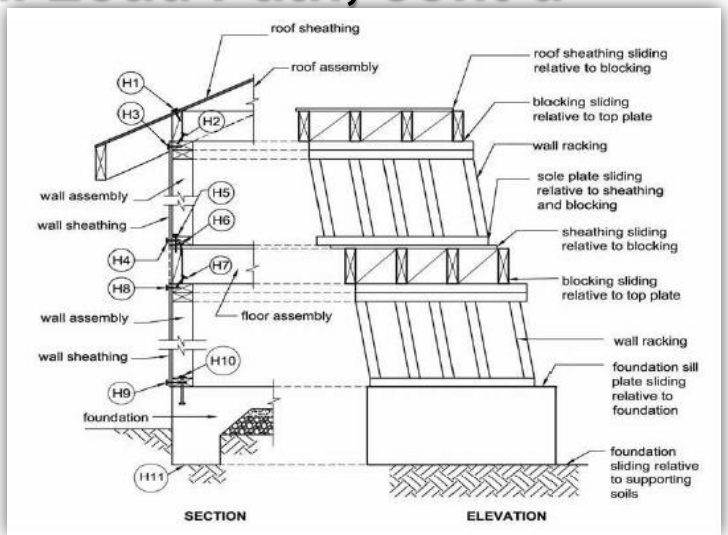
    "Walls that provide vertical load bearing or lateral shear resistance for a portion of the structure shall be anchored to the roof and all floors and members that provide lateral support for the wall or that are supported by the wall. The anchorage shall provide a direct connection between the walls and the roof or floor construction. The connections shall be capable of resisting a strength level horizontal force perpendicular to the plane of the wall equal to 0.2 times the weight of the wall tributary to the connection, but not less than 5 psf (0.24 kN/m2)."

# Lateral Load Path






# Lateral Load Path, cont'd



# Earthquake Loads -Summary

- Acceleration coefficients
  - 1613.2.1 Acceleration parameters
- Site class
  - CBC Section 1613.2.2 Site class definitions
- Maximum spectral response acceleration $S_{MS}$ & $S_{M1}$
  - CBC Section 1613.2.3
- Design spectral response acceleration $S_{DS}$ & $S_{D1}$
  - CBC Table 1613.2.3 Seismic Design Parameters
- Importance factor $I_e$
  - ASCE 7 Table 1.5-2

**Table 1.5-2 Importance Factors by Risk Category of Buildings and Other Structures for Snow, Ice, and Earthquake Loads**

| Risk Category from Table 1.5-1 | Snow Importance Factor, $I_s$ | Ice Importance Factor—Thickness, $I_i$ | Ice Importance Factor—Wind, $I_w$ | Seismic Importance Factor, $I_e$ |
|---|---|---|---|---|
| I | 0.80 | 0.80 | 1.00 | 1.00 |
| II | 1.00 | 1.00 | 1.00 | 1.00 |
| III | 1.10 | 1.15 | 1.00 | 1.25 |
| IV | 1.20 | 1.25 | 1.00 | 1.50 |

Note: The component importance factor, $I_p$, applicable to earthquake loads, is not included in this table because it depends on the importance of the individual component rather than that of the building as a whole, or its occupancy. Refer to Section 13.1.3.



# Earthquake Loads –Summary, cont'd

- Seismic design category
  - CBC Table 1613.2.3 Seismic Design Parameters
- Structural system selection
- Response and deflection modification
  - R, $\Omega_o$, $C_d$
  - ASCE 7 Table 12.2.1
- Allowable story drift
  - ASCE 7 Section 12.12.1
  - $\Delta_x = 0.025\ h_{sx}$

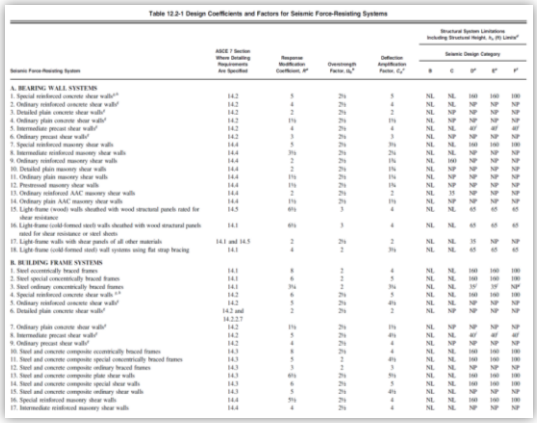


Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

# Earthquake Loads – Summary, cont'd

- Continuous load path
  - ASCE 7 Section 12.1.3
- Building configuration
  - ASCE 7 Section 12.3.2.1, 12.3.3.4 and Table 12.3-1
  - Vertical structural irregularities
  - Horizontal structural irregularities
- Redundancy coefficient $\rho$
  - ASCE 7 Section 12.3.4.2
- Analysis procedure
  - ASCE 7 Section 12.6 and Table 12.6-1



# Earthquake Loads – Summary, cont'd

- Equivalent lateral force procedure
  - Seismic Base shear
    - ASCE 7 Section 12.8.1
    - $V = C_s W$
  - Gravity loads
    - Dead load and applicable live load
  - Seismic response coefficient
    - ASCE 7 Section 12.8.1.1
    - $C_s = S_{DS} /(R/I_E)$
  - Vertical force distribution
    - ASCE 7 Section 12.8.3
    - $F_x = C_{vx} V$

# Earthquake Loads – Summary, cont'd

- Equivalent lateral force procedure, cont'd
  - Horizontal distribution of force (inherent torsion)
    - ASCE 7 Section 12.8.4.1
  - Accidental torsion
    - Assumed displacement of the center of mass
  - Dynamic amplification of torsion
    - If irregularities exist
    - ASCE 7 Section 12.8.4.3
  - Center of rigidity
  - Center of mass
  - Torsional moment
  - Frame/shear wall force



# Structural Integrity

- 1616.1 General
  "*High-rise buildings* that are assigned to *Risk Category* III or IV shall comply with the requirements of Section 1616.2 if they are frame structures, or Section 1616.3 if they are bearing wall structures."
- 1616.2 Frame structures
- 1616.2.1 Concrete structures

  Conform to the requirements of Section 4.10 of ACI 318 and other specific requirements
- 1616.2.2 Structural steel and composite steel and concrete structures

  Minimum column and beam connection strength

# Structural Integrity, cont'd

- 1616.3 Bearing wall structures
  - 1616.3.1 Concrete wall structures

    Precast bearing wall structures to conform to the requirements of Sections 16.2.4 and 16.2.5 of ACI 318
  - 1616.3.2 Other bearing wall structures
    - 1616.3.2.1 Longitudinal ties
    - 1616.3.2.2 Transverse ties
    - 1616.3.2.3 Perimeter ties
    - 1616.3.2.4 Vertical ties



# CBC Chapters 17 - 23

- Chapter 17 Special Inspections and Tests
- Chapter 18 Soils and Foundations (Geotechnical Information)
- Chapter 19 Concrete
- Chapter 20 Aluminum
- Chapter 21 Masonry
- Chapter 22 Steel
- Chapter 23 Wood

# Chapter 17 Special Inspections and Tests

- 1701.1 Scope

  "The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Construction materials and test procedures shall conform to the applicable standards listed in this code and the other *Chicago Construction Codes."*
- 1703 Products, Materials and Assemblies
  - Test reports by an approved agency
  - Confirm that a product, material or assembly complies with applicable code requirements



# Chapter 17 Special Inspections and Tests

- 1704 *Special Inspections and Tests, Contractor Responsibility* and Structural Observation
- 1705 Required Special Inspections and Tests
  - Test reports by an approved agency
  - Confirm that a product, material or assembly complies with applicable code requirements
  - Materials and systems required to be installed in accordance with additional manufacturer's instructions

# Chapter 17 Special Inspections and Tests

- 1706 Design Strength of Materials
- 1707 Alternative Test Procedure
- 1708 In-Situ Load Tests
- 1709 Preconstruction Load Tests



# Chapter 18 Soils and Foundations

- Section 1802 Design Basis
  - 1802.1 General.

    "Allowable bearing pressures, allowable stresses and design formulas provided in this chapter shall be used with the *allowable stress design load combinations* specified in Section 1605.3. The quality and design of materials used structurally in excavations and foundations shall comply with the requirements specified in Chapters 16, 19, 21, 22 and 23. Excavations and fills shall comply with Chapter 33."

# Geotechnical Information

- 1. Excavation notice/letter
- 2. Geotechnical report
- 3. Geotechnical review
- 4. Soil site classification
- 5. Allowable bearing pressure
- 6. Lateral soil pressure
- 7. Required information in geotechnical report



# Geotechnical Information, cont'd

- Excavation Notice/Letter
  - A written notice must be sent to owners of adjacent properties where excavation work will be either:
    - More than 5 feet vertically below existing grade and within 5 feet of an existing building on a different lot or the public way.
    - More than 10 feet vertically below existing grade at any location on the property.
  - Where excavation will reduce support from any existing foundation, a registered design professional must prepare an assessment of the existing structure.

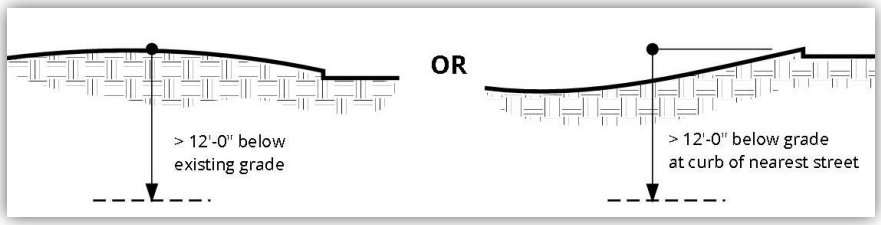
# Geotechnical Information, cont'd

- Geotechnical Report
  - None required
    - Single-story storage structures without basements and detached private garages not exceeding 2,000 square feet.
    - Alterations and additions that do not require new foundations and do not result in an increase in loads exceeding 5% of the existing foundation design capacity.
  - Limited or deferred report acceptable
    - Where excavation more than 8 feet below existing grade is not required, a test pit is used for soil classification and to locate the ground-water table, and the values used as the basis for design do not exceed presumptive values in Table 1806.2(1).
    - For construction not exceeding four stories above grade plane, not requiring excavation more than 8 feet below existing grade, and not covering more than 16,000 square feet of ground area.
  - Report required before permit issuance
    - Construction exceeding 4 stories in height (including additions that result in an increase in loads exceeding 5 percent of existing foundation design capacity).
    - Excavation or soil penetration work more than 8 feet below existing grade.
    - Construction covering more than 16,000 ft² of ground area.
    - Structural design based upon a net bearing pressure exceeding the applicable value specified in Table 1806.2(2).



# Geotechnical Information, cont'd

- Geotechnical Review
  - An in-house geotechnical review, and Office of Underground Coordination (OUC) utility clearance is required where a permit involves foundation, excavation, or soil penetration work.



# Geotechnical Information, cont'd

- Soil site classification

| Site Class | $\bar{v}_s$ | $\bar{N}$ or $\bar{N}_{ch}$ | $\bar{s}_u$ |
|---|---|---|---|
| A. Hard rock | > 5,000 ft/s | NA | NA |
| B. Rock | 2,500 to 5,000 ft/s | NA | NA |
| C. Very dense soil and soft rock | 1,200 to 2,500 ft/s | > 50 | > 2,000 psf |
| D. Stiff soil | 600 to 1,200 ft/s | 15 to 50 | 1,000 to 2,000 psf |
| E. Soft clay soil | < 600 ft/s | < 15 | < 1,000 psf |
| | Any profile with more than 10 ft of soil having the following characteristics:<br>• Plasticity index PI > 20,<br>• Moisture content $w \geq 40\%$, and<br>• Undrained shear strength $\bar{s}_u < 500$ psf | | |
| F. Soils requiring site response analysis in accordance with Section 21.1 | See Section 20.3.1 | | |

**Figure 17: Soil Site Classification,**
**Courtesy of American Society of Professional Engineers (ASCE), ASCE 7-16 ©, Table 20.3-1**



# Geotechnical Information, cont'd

- Allowable bearing pressure
  - If a geotechnical report is not required, or not required at the time of permitting, the "presumptive load bearing values" in Table 1806.2(1) or 1806.2(2) may be used.
  - If a design is based on a higher bearing pressure than listed in Table 1806.2(2) based on soil type,
    a geotechnical report explicitly recommending
    a higher value must be submitted with the permit application.

# Geotechnical Information, cont'd

- Lateral soil pressure
  - If scope of work includes retaining or foundation walls that will retain soil, construction documents must identify passive and active earth pressures used in design.
    - Values may be based on a geotechnical report.
    - Where geotechnical report is not required or not required at the time of permitting, lateral pressures specified in Table 1610.1 must be used for design.



# Geotechnical Information, cont'd

- Geotechnical report - required information
  - A plot showing locations of soil investigations
  - A record of soil boring and penetration test logs and soil samples
  - A record of the soil profile
  - Elevation of the water table
  - Recommendations for foundation type and design criteria
  - Expected total and differential settlement
  - Deep foundation information
  - Special design and construction provisions for foundations of structures founded on expansive soils
  - Compacted fill material properties and testing
  - Controlled low-strength material properties and testing
  - Construction considerations
  - Site class and horizontal seismic forces in slope stability analysis

# Chapter 19 Concrete

- 1901.1 Scope

  "The provisions of this chapter shall govern the materials, quality control, design and construction of concrete used in structures."

- 1901.2 Plain and reinforced concrete

  "Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905 of this code."



# Chapter 19 Concrete, cont'd

- 1901.5 Construction documents
- The construction documents for structural concrete construction shall include:
  - 1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
  - 2. The specified strength or grade of reinforcement.
  - 3. The size and location of structural elements, reinforcement and anchors.
  - 4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
  - 5. The magnitude and location of prestressing forces.
  - 6. Anchorage length of reinforcement and location and length of lap splices.
  - 7. Type and location of mechanical and welded splices of reinforcement.
  - 8. Details and location of contraction or isolation joints specified for plain concrete.
  - 9. Minimum concrete compressive strength at time of posttensioning.
  - 10. Stressing sequence for posttensioning tendons.
  - 11. For structures assigned to *Seismic Design Category* D, a statement if slab on grade is designed as a structural diaphragm.

# Chapter 20 Aluminum

- 2002.1 General

  "Aluminum used for structural purposes in buildings and structures shall comply with AA ASM 35 and AA ADM. The *nominal loads shall be the minimum design* loads required by Chapter 16."



# Chapter 21 Masonry

- 2101.1 Scope.

  "This chapter shall govern the materials, design, construction and quality of masonry."

- 2101.2 Design methods.

  "Masonry shall comply with the provisions of TMS 402, TMS 403 or TMS 404 as well as applicable requirements of this chapter."

# Chapter 22 Steel

- 2201.1 Scope

  "The provisions of this chapter govern the quality, design, fabrication and erection of steel construction."

- 2205.1 General

  "The design, fabrication and erection of *structural steel elements in buildings, structures and portions* thereof shall be in accordance with AISC 360."

- 2205.2 Seismic design

  "Where required, the seismic design, fabrication and erection of buildings, structures and portions thereof shall be in accordance with Section 2205.2.1 or 2205.2.2, as applicable."



# Chapter 22 Steel, cont'd

- 2205.2 Seismic design.

  "Where required, the seismic design, fabrication and erection of buildings, structures and portions thereof shall be in accordance with Section 2205.2.1 or 2205.2.2, as applicable."

- 2205.2.1 Structural steel seismic force-resisting systems.

  "The design, detailing, fabrication and erection of structural steel *seismic force-resisting systems shall be in* accordance with the provisions of Section 2205.2.1.1 or 2205.2.1.2, as applicable."

- 2205.2.1.1 Seismic Design Category B or C.

  "Structures assigned to *Seismic Design Category B or C shall* be of any construction permitted in Section 2205. Where a response modification coefficient, *R, in accordance* with ASCE 7, Table 12.2-1, is used for the design of structures assigned to *Seismic Design Category* B or C, the structures shall be designed and detailed in accordance with the requirements of AISC 341."

# Chapter 22 Steel, cont'd

- Section 2206 Composite Structural Steel and Concrete Structures
  - 2206.1 General.

    "Systems of *structural steel elements acting* compositely with reinforced concrete shall be designed in accordance with AISC 360 and ACI 318, excluding ACI 318 Chapter 14."
- Section 2207 Steel Joists
  - 2207.1 General.

    "The design, manufacture and use of openweb *steel joists and joist girders shall be in accordance with* either SJI 100 or SJI 200, as applicable."



# Chapter 22 Steel, cont'd

- Section 2210 Cold-Formed Steel
  - 2210.1 General

    "The design of cold-formed carbon and low-alloy steel structural members shall be in accordance with AISI S100. The design of cold-formed stainless-steel structural members shall be in accordance with ASCE 8."

# Chapter 22 Steel, cont'd

- Section 2211 Cold-Formed Steel Light-Frame Construction
- 2211.1 Structural framing.

  "For cold-formed steel *light-frame construction, the design and installation of the following* structural framing systems, including their members and connections, shall be in accordance with AISI S240, and Sections 2211.1.1 through 2211.1.3, as applicable:
  - 1. Floor and roof systems.
  - 2. Structural walls.
  - 3. Shear walls, strap-braced walls and diaphragms that resist in-plane lateral loads.
  - 4. Trusses."



# Chapter 23 Wood

- 2301.1 Scope

  "The provisions of this chapter shall govern the materials, design, construction and quality of wood members and their fasteners."
- 2302.1 General

  "The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:
  - 1. *Allowable stress design in accordance with Sections* 2304, 2305 and 2306.
  - 2. *Load and resistance factor design in accordance with* Sections 2304, 2305 and 2307.
  - 3. *Conventional light-frame construction in accordance* with Sections 2304 and 2308.
  - 4. AWC WFCM in accordance with Section 2309.5. The design and construction of log structures in accordance with the provisions of ICC 400."
- Section 2303 Minimum Standards and Quality
  - Allowable and prescriptive requirements for wood framing: Tables 2304.6.1 to 2304.11

# Chapter 23 Wood cont'd

- Section 2305 General Design Requirements for Lateral Force-Resisting Systems
  - 2305.1 General.

    "Structures using wood-frame shear walls or wood-frame *diaphragms to resist wind, seismic or other lateral* loads shall be designed and constructed in accordance with AWC SDPWS and the applicable provisions of Sections 2305, 2306 and 2307."
  - 2305.1.1 Openings in shear panels

    "Openings in shear panels that materially affect their strength shall be detailed on the plans and shall have their edges adequately reinforced to transfer all shearing stresses.
  - 2305.2 Diaphragm deflection
  - 2305.3 Shear wall deflection



# Chapter 23 Wood cont'd

- Section 2306 Allowable Stress Design
  - 2306.1 Allowable stress design.
  - "The design and construction of wood elements in structures using *allowable stress design* shall be in accordance with the following applicable standards…"
  - Allowable shear values Tables 2306.2(1) to 2306.3(3)
- Section 2307 Load and Resistance Factor Design
  - 2307.1 Load and resistance factor design. The design and construction of wood elements and structures using *load and resistance factor design shall be in accordance with ANSI*/AWC NDS and AWC SDPWS.

# Chapter 23 Wood cont'd

- Section 2308 Conventional Light-Frame Construction
  - 2308.1 General.
  - "The requirements of this section are intended for *conventional light-frame construction. Other* construction methods are permitted to be used, provided that a satisfactory design is submitted showing compliance with other provisions of this code. Interior nonload-bearing partitions, ceilings and curtain walls of *conventional light-frame construction are not subject to the limitations of Section* 2308.2."
  - Framing details: Tables 2308.6.5.1 to 2308.6.8.3
  - Span tables for wood framing: Tables 2308.7.1 to 2308.7.12



# Chapter 23 Wood cont'd

- Section 2309 Wood Frame Construction Manual
  - 2309.1 Wood Frame Construction Manual.
  - "Structural design in accordance with the AWC WFCM shall be permitted for buildings assigned to *Risk Category I* or II subject to the limitations of Section 1.1.3 of the AWC WFCM and the load assumptions contained therein. Structural elements beyond these limitations shall be designed in accordance with accepted engineering practice."

# Department Contacts

Dixit Patel
Structural Examiner
312.744.7620

Jamaica McCarthy
Structural Examiner
312.744.6145

Man Leung
Structural Examiner
312.744.8081