~~Red Strikethrough~~ = deleted text
Blue underline = New text

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Review this document in conjunction with the National Building Code – 2023 Alberta Edition

PART 4 – CODE UPDATE INFORMATION

NBC(AE) 2019

4.1.2.1. Loads and Effects
(See Note A-4.1.2.1.)

Table 4.1.2.1.
Importance Categories for Buildings
Forming Part of Sentence 4.1.2.1.(3)

Use and *Occupancy*	Importance Category
Buildings that represent a low direct or indirect hazard to human life in the event of failure, including: • low human-*occupancy buildings*, where it can be shown that collapse is not likely to cause injury or other serious consequences • minor storage *buildings*	Low(1)
All *buildings* except those listed in Importance Categories Low, High and Post-disaster	Normal
Buildings that are likely to be used as post-disaster shelters, including *buildings* whose primary use is: • as an elementary, middle or secondary school • as a community centre Manufacturing and storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released(1)	High

Post-disaster buildings are *buildings* that are essential to the provision of services in the event of a disaster, and include:
• hospitals, emergency treatment facilities and blood banks
• telephone exchanges
• power generating stations and electrical substations
• control centres for air, land and marine transportation
• public water treatment and storage facilities, and pumping stations
• sewage treatment facilities and *buildings* having critical national defence functions
• *buildings* of the following types, unless exempted from this designation by the *authority having jurisdiction*:(2)
  • emergency response facilities
  • fire, rescue and police stations, and housing for vehicles, aircraft or boats used for such purposes
  • communications facilities, including radio and television stations
	Post-disaster

Notes to Table 4.1.2.1.:
(1) See Note A-Table 4.1.2.1.
(2) See Note A-1.4.1.2.(1), Post-disaster Buildings, in Division A.

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4.1.2.1. Loads and Effects
(See Note A-4.1.2.1.)

Table 4.1.2.1.
Importance Categories for Buildings(1)
Forming Part of Sentence 4.1.2.1.(3)

~~Use and *Occupancy*~~Type of *Building*	Importance Category
~~*Buildings* that represent~~ A Low Importance Category *building* is a *building* that represents a low direct or indirect hazard to human life in the event of structural failure.~~, including:~~ ~~• low human-*occupancy buildings*, where it can be shown that collapse is not likely to cause injury or other serious consequences~~ ~~• minor storage *buildings*~~	Low~~(1)~~
~~All *buildings* except those listed in Importance Categories Low, High and Post-disaster~~ A Normal Importance Category *building* is a *building* that does not meet the criteria for a Low Importance Category *building*, High Importance Category *building* or *post-disaster building*.	Normal
~~*Buildings* that are likely to be used as post-disaster shelters, including *buildings* whose primary use is:~~ ~~• as an elementary, middle or secondary school~~ ~~• as a community centre~~ ~~Manufacturing and storage facilities containing toxic, explosive or other hazardous substances in sufficient quantities to be dangerous to the public if released(1)~~ A High Importance Category *building* is a *building* that provides a greater degree of safety to human life than a Normal Importance Category *building*. Community centres and elementary, middle and secondary schools are High Importance Category *buildings*.	High

~~*Post-disaster buildings* are *buildings* that are essential to the provision of services in the event of a disaster, and include:~~
~~• hospitals, emergency treatment facilities and blood banks~~
~~• telephone exchanges~~
~~• power generating stations and electrical substations~~
~~• control centres for air, land and marine transportation~~
~~• public water treatment and storage facilities, and pumping stations~~
~~• sewage treatment facilities and *buildings* having critical national defence functions~~
~~• *buildings* of the following types, unless exempted from this designation by the *authority having jurisdiction*:(2)~~
  ~~• emergency response facilities~~
  ~~• fire, rescue and police stations, and housing for vehicles, aircraft or boats used for such purposes~~
  ~~• communications facilities, including radio and television stations~~
A *post-disaster building*.
	Post-disaster

Notes to Table 4.1.2.1.:
(1) See Note A-Table 4.1.2.1.
~~(2) See Note A-1.4.1.2.(1), Post-disaster Buildings, in Division A.~~

Comments

Unless stated otherwise, changes shown are a result of NBC 2020 changes.

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr>
<td>4.1.3.4. Serviceability</td>
<td>4.1.3.4. Serviceability

2) The effect of service loads on the serviceability limit states shall be determined in accordance with this Article and the load combinations listed in Table 4.1.3.4., the applicable combination being that which results in the most critical effect.

3) Other load combinations that must also be considered are the principal loads acting with the companion loads taken as zero.

4) Deflections calculated for load types P, T and H, if present, with load factors of 1.0 shall be included with the calculated deflections due to principal loads.

5) The determination of the deflection shall consider the following:
a) for materials that result in increased deformations over time under sustained loads, the deflection calculation shall consider the portion of <i>live load</i>, L, that is sustained over time, L_s, and the portion that is transitory, L_t, and
b) the calculated deflection due to <i>dead load</i>, D, and sustained <i>live load</i>, L_s, shall be increased by a creep factor as specified in the standards listed in Section 4.3. to obtain the additional long-term deflection.

6) The determination of the long-term settlement of <i>foundations</i> shall consider the following:
a) for <i>foundation soil</i> types that result in increased settlement over time under sustained loads, the additional long-term settlements shall be determined for the portion of <i>live load</i>, L, that is sustained over time, L_s, and the portion that is transitory, L_t, and
b) the additional long-term settlements due to <i>dead load</i>, D, and sustained <i>live loads</i>, L_s, shall be calculated from the <i>foundation soil</i> properties provided by a qualified professional geotechnical engineer.

Table 4.1.3.4.
Loads and Load Combinations for Serviceability
Forming Part of Sentence 4.1.3.4.(2)

<table>
<tr><th rowspan="2">Limit State</th><th rowspan="2">Structural Parameter</th><th rowspan="2">Load Case</th><th colspan="2">Load Combinations</th></tr>
<tr><th>Principal Loads</th><th>Companion Loads</th></tr>
<tr><td>Deflection for materials not subject to creep</td><td>Deflection of the structure or of components of the structure(1)</td><td>1
2
3</td><td>1.0D + 1.0L
1.0D + 1.0W
1.0D + 1.0S</td><td>0.3W or 0.35S
0.35L(2) or 0.35S
0.3W or 0.35L(2)</td></tr>
<tr><td>Deflection for materials subject to creep</td><td>Total deflection of the structure or of components of the structure(3)</td><td>1
2
3</td><td>1.0D + 1.0L_s(4) + 1.0L_t(5)
1.0D + 1.0W
1.0D + 1.0S</td><td>0.3W or 0.35S
0.35L(2) or 0.35S
0.3W or 0.35L(2)</td></tr>
<tr><td>Vibration serviceability</td><td>Acceleration</td><td colspan="3">(6)</td></tr>
</table>
Notes to Table 4.1.3.4.:
(1) The calculated deflection due to <i>dead load</i>, D, is permitted to be excluded where specified in the standards listed in Section 4.3.
(2) The companion load factor of 0.35 for <i>live load</i>, L, shall be increased to 0.5 for storage areas, equipment areas and <i>service rooms</i>.
(3) The calculated immediate deflection due to <i>dead load</i>, D, is permitted to be excluded where specified in the standards listed in Section 4.3.
(4) L_s = sustained portion of the <i>live load</i>, L.
(5) L_t = transitory portion of the <i>live load</i>, L.
(6) See Note A-Table 4.1.3.4.</td>
<td></td>
</tr>
<tr>
<td>4.1.3.6. Vibration
N/A</td>
<td>4.1.3.6. Vibration

2) Where floor vibrations caused by resonance with operating machinery or equipment are</td>
<td></td>
</tr>
</table>

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td></td><td>anticipated, dynamic analysis of the floor system shall be carried out. (See Note A-4.1.3.6.(2).)</td><td></td></tr>
<tr><td>**4.1.4.1. Dead Loads**
1) The specified *dead load* for a structural member consists of
…
e) the vertical load due to earth, plants and trees.
2) Except as provided in Sentence (5), in areas of a *building* where *partitions*, other than permanent *partitions*, are shown on the drawings, or where *partitions* might be added in the future, allowance shall be made for the weight of such *partitions*.
3) The *partition* weight allowance referred to in Sentence (2) shall be determined from the actual or anticipated weight of the *partitions* placed in any probable position, but shall be not less than 1 kPa over the area of floor being considered.
4) *Partition* loads used in design shall be shown on the drawings as provided in Clause 2.2.4.3.(1)(d) of Division C.
5) In cases where the *dead load* of the *partition* is counteractive, the load allowances referred to in Sentences (2) and (3) shall not be included in the design calculations.
6) Except for structures where the *dead load* of *soil* is part of the load-resisting system, where the *dead load* due to *soil*, superimposed earth, plants and trees is counteractive, it shall not be included in the design calculations. (See Note A-4.1.4.1.(6).)</td><td>**4.1.4.1. Dead Loads**
1) The specified *dead load* for a structural member consists of
…
e) the vertical load due to *soil*, superimposed earth, plants and trees.
2) ~~Except as provided in Sentence (5), in~~ In areas of a *building* ~~where~~ for which *partitions*~~, other than permanent *partitions*,~~ are shown on the drawings, ~~or where~~ the weight of *partitions* ~~might~~ referred to in Clause (1)(c) shall be ~~added in~~ the ~~future, allowance shall be made for~~ taken as the actual weight of such *partitions*. (See Note A-4.1.4.1.(2).)
3) ~~The~~ In areas of a *building* for which *partitions* are not shown on the drawings, the weight of *partitions* referred to in Clause (1)(c) shall be a *partition* weight allowance ~~referred to in Sentence (2) shall be~~ determined from the ~~actual or~~ anticipated weight ~~of the *partitions* placed in any probable~~ and position of the *partitions*, but shall ~~be~~ not be less than 1 kPa over the area of floor being considered. (See Note A-4.1.4.1.(3).)
4) ~~*Partition* loads~~ The weights of *partitions* and *partition* weight allowances used in the design shall be shown on the drawings as provided in Clause 2.2.4.3.(1)(d) of Division C.
5) ~~In cases where the *dead load* of~~ Where the *partition* ~~is counteractive, the load Allowance~~ weight allowance referred to in ~~Sentences (2) and (3)~~ Sentence (3) is counteractive to other loads, it shall not be included in the design calculations.
6) Except for structures where the *dead load* of *soil* is part of the load-resisting system, where the *dead load* due to *soil*, superimposed earth, plants and trees is counteractive to other loads, it shall not be included in the design calculations. (See Note A-4.1.4.1.(6).)</td><td></td></tr>
<tr><td>**4.1.5.3. Full and Partial Loading**
Table 4.1.5.3.
Specified Uniformly Distributed Live Loads on an Area of Floor or Roof
Forming Part of Sentence 4.1.5.3.(1)
<table>
<tr><th>Use of Area of Floor or Roof</th><th>Minimum Specified Load, kPa</th></tr>
<tr><td>Assembly Areas</td><td></td></tr>
<tr><td>a) …</td><td>4.8</td></tr>
<tr><td>b) …</td><td>2.4</td></tr>
<tr><td>c) Portions of assembly areas with fixed seats that have backs for the following uses:</td><td></td></tr>
<tr><td>Arenas</td><td>2.9(1)</td></tr>
<tr><td>Grandstands</td><td></td></tr>
<tr><td>Stadia</td><td></td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Corridors, lobbies and aisles(1)</td><td></td></tr>
<tr><td>Other than those listed below</td><td>4.8</td></tr>
<tr><td>Not more than 1 200 mm in width, and all upper floor corridors of residential areas only of apartments, hotels and motels (that cannot be used by an assembly of people as a viewing area)(1)</td><td>(1)(3)</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Garages for</td><td></td></tr>
<tr><td>Vehicles not exceeding 4 000 kg gross weight</td><td>2.4</td></tr>
<tr><td>Vehicles exceeding 4 000 kg but not exceeding 9 000 kg gross weight</td><td>6.0</td></tr>
<tr><td>Vehicles exceeding 9 000 kg gross weight</td><td>12.0(1)</td></tr>
</table></td><td>**4.1.5.3. Full and Partial Loading**
Table 4.1.5.3.
Specified Uniformly Distributed Live Loads on an Area of Floor or Roof
Forming Part of Sentence 4.1.5.3.(1)
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<tr><td>b) …</td><td>2.4</td></tr>
<tr><td>c) Portions of assembly areas with fixed seats that have backs for the following uses:</td><td></td></tr>
<tr><td>Arenas(1)</td><td>2.9~~(1)~~</td></tr>
<tr><td>Grandstands(1)</td><td></td></tr>
<tr><td>Stadia(1)</td><td></td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Corridors, lobbies and aisles(1)</td><td></td></tr>
<tr><td>Other than those listed below</td><td>4.8</td></tr>
<tr><td>Not more than 1 200 mm in width, and all upper floor corridors of residential areas only of apartments, hotels and motels (that cannot be used by an assembly of people as a viewing area)~~(1)~~</td><td>~~(1)~~(3)</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Garages for</td><td></td></tr>
<tr><td>Vehicles not exceeding 4 000 kg gross weight</td><td>2.4</td></tr>
<tr><td>Vehicles exceeding 4 000 kg but not exceeding 9 000 kg gross weight</td><td>6.0</td></tr>
<tr><td>Vehicles exceeding 9 000 kg gross weight(1)</td><td>12.0~~(1)~~</td></tr>
</table></td><td></td></tr>
</table>

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<tr><td>
<table>
<tr><td>…</td><td>…</td></tr>
<tr><td>Office areas (not including record storage and computer rooms) located in
Basement and the *first storey*
Floors above the *first storey*</td><td>
4.8
2.4</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Residential areas (within the scope of Article 1.3.3.3. of Division A)
Bedrooms
Other areas
Stairs within *dwelling units*</td><td>
1.9
1.9
1.9</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Roofs</td><td>1.0(1)(5)</td></tr>
<tr><td>Sidewalks and driveways over areaways and *basements*</td><td>12.0(1)(5)</td></tr>
<tr><td>…</td><td>…</td></tr>
</table>
…
</td><td>
<table>
<tr><td>…</td><td>…</td></tr>
<tr><td>Office areas(1) (not including record storage and computer rooms) located in
*Basement*s ~~and the *first storey*~~
Floors, including *mezzanines*, with direct access to the exterior at ground level
~~Floors above the *first storey*~~ Other floors</td><td>
4.8
4.8
2.4</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Residential areas (within the scope of Article 1.3.3.3. of Division A)
Bedrooms
Other areas
Stairs within *dwelling units*</td><td>
~~1.9~~
1.9
~~1.9~~</td></tr>
<tr><td>…</td><td>…</td></tr>
<tr><td>Roofs(1)</td><td>1.0~~(1)~~(5)</td></tr>
<tr><td>Sidewalks and driveways over areaways and *basements*(1)</td><td>12.0~~(1)~~(5)</td></tr>
<tr><td>…</td><td>…</td></tr>
</table>
…
</td><td></td></tr>
<tr><td>**4.1.5.5. Loads on Exterior Areas**
(See Note A-4.1.5.5.)

2) Except as provided in Sentences (3) and (4), roofs shall be designed for either the uniform *live loads* specified in Table 4.1.5.3., the concentrated *live loads* listed in Table 4.1.5.9., or the snow and rain loads prescribed in Subsection 4.1.6., whichever produces the most critical effects in the members concerned.

3) …

4) Roof parking decks shall be designed for either the uniformly distributed *live loads* specified in Table 4.1.5.3., the concentrated *live loads* listed in Table 4.1.5.9., or the roof snow load, whichever produces the most critical effect in the members concerned.</td><td>**4.1.5.5. Loads on Exterior Areas**
(See Note A-4.1.5.5.)

2) Except as provided in Sentences (3) and (4), roofs shall be designed for either the uniform *live loads* specified in Table 4.1.5.3., the concentrated *live loads* listed in Table 4.1.5.9., or the snow and rain loads prescribed in Subsection 4.1.6., whichever produces the most critical ~~effects in the members concerned~~ effect.

3) …

4) Roof parking decks and exterior areas accessible to vehicular traffic shall be designed ~~for either the~~
a) for the appropriate load combination listed in Sentence 4.1.3.2.(2) with a *live load*, L, consisting of either a uniformly distributed *live* ~~*loads*~~ *load* as specified in Table 4.1.5.3.~~,~~ ~~the~~ or a concentrated *live* ~~*loads*~~ *load* as listed in Table 4.1.5.9., ~~or the roof snow load,~~ whichever produces the most critical effect ~~in the members concerned~~, and a companion snow load, S, as prescribed in Subsection 4.1.6., but with the companion-load factor reduced to 0.2, and
b) such that the load combination in Clause (a) is not less than the snow and rain loads prescribed in Subsection 4.1.6. with the *live load* taken as zero.

5) Roof parking decks that are used for the long-term storage of vehicles shall be designed for the appropriate load combination listed in Sentence 4.1.3.2.(2) with a *live load*, L, consisting of either a uniformly distributed *live load* as specified in Table 4.1.5.3. or a concentrated *live load* as listed in Table 4.1.5.9., whichever produces the most critical effect, and a snow load, S, as prescribed in Subsection 4.1.6.</td><td></td></tr>
<tr><td>**4.1.5.8. Variation with Tributary Area**
(See Note A-4.1.5.8.)

4) Where the specified *live load* for a floor is reduced in accordance with Sentence (2) or (3), the structural drawings shall indicate that a *live load* reduction factor for tributary area has been applied.</td><td>**4.1.5.8. Variation with Tributary Area**
(See Note A-4.1.5.8.)

1) One- and two-way floor slabs shall have no reduction for tributary area applied to *live load*.

~~4~~5) Where the specified *live load* for a floor is reduced in accordance with Sentence (~~2~~3) or (~~3~~4), the structural drawings shall indicate that a *live load* reduction factor for tributary area has been applied and which structural elements are impacted by this factor.</td><td></td></tr>
<tr><td>**4.1.5.14. Loads on Guards and Handrails**
(See Note A-4.1.5.14. and 4.1.5.15.(1).)

1) The minimum specified horizontal load applied outward at the minimum required height of</td><td>**4.1.5.14. Loads on Guards and Handrails**
(See Note A-4.1.5.14. and 4.1.5.15.(1).)

1) The minimum ~~specified~~ horizontal ~~load~~ specified *live load* applied outward at the minimum</td><td></td></tr>
</table>

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every required *guard* shall be a) 3.0 kN/m for open viewing stands without fixed seats and for *means of egress* in grandstands, stadia, bleachers and arenas, b) a concentrated load of 1.0 kN applied at any point, so as to produce the most critical effect, for access ways to equipment platforms, contiguous stairs and similar areas where the gathering of many people is improbable, and c) 0.75 kN/m or a concentrated load of 1.0 kN applied at any point so as to produce the most critical effect, whichever governs for locations other than those described in Clauses (a) and (b). **2)** The minimum specified horizontal load applied inward at the minimum required height of every required *guard* shall be half that specified in Sentence (1). **3)** Individual elements within the *guard*, including solid panels and pickets, shall be designed for a load of 0.5 kN applied outward over an area of 100 mm by 100 mm located at any point in the element or elements so as to produce the most critical effect. **4)** The size of the opening between any two adjacent vertical elements within a *guard* shall not exceed the limits required by Part 3 when each of these elements is subjected to a specified *live load* of 0.1 kN applied in opposite directions in the in-plane direction of the *guard* so as to produce the most critical effect. **5)** The loads required in Sentence (3) need not be considered to act simultaneously with the loads provided for in Sentences (1), (2) and (6). **6)** The minimum specified load applied vertically at the top of every required *guard* shall be 1.5 kN/m and need not be considered to act simultaneously with the horizontal load provided for in Sentence (1). **7)** Handrails and their supports shall be designed and constructed to withstand the following loads, which need not be considered to act simultaneously: a) a concentrated load not less than 0.9 kN applied at any point and in any direction for all handrails, and b) a uniform load not less than 0.7 kN/m applied in any direction to handrails not located within *dwelling units*.	required height of every required *guard* shall be a) 3.0 kN/m for open viewing stands without fixed seats and for *means of egress* in grandstands, stadia, bleachers and arenas, b) ~~a concentrated load of~~ 1.0 kN applied at any point, so as to produce the most critical effect, for access ways to equipment platforms, contiguous stairs and similar areas where the gathering of many people is improbable, and c) 0.75 kN/m or ~~a concentrated load of~~ 1.0 kN applied at any point so as to produce the most critical effect, whichever governs, for locations other than those described in Clauses (a) and (b). **2)** The minimum ~~specified~~ horizontal ~~load~~ specified *live load* applied inward at the minimum required height of every required *guard* shall be half that specified in Sentence (1). **3)** Individual elements within the *guard*, including solid panels and pickets, shall be designed for a ~~load~~ horizontal specified *live load* of 0.5 kN applied outward over an area of 100 mm by 100 mm located at any point ~~in~~ on the element or elements so as to produce the most critical effect. **4)** The size of the opening between any two adjacent vertical elements within a *guard* shall not exceed the limits required by Part 3 when each of these elements is subjected to a horizontal specified *live load* of 0.1 kN applied in opposite directions in the in-plane direction of the *guard* so as to produce the most critical effect. **5)** The ~~loads~~ specified *live loads* required in Sentence (3) need not be considered to act simultaneously with the loads provided for in Sentences (1), (2), (6) and (~~6~~7). **6)** The minimum specified ~~load~~ *live load* applied vertically at the top of every required *guard* shall be 1.5 kN/m and need not be considered to act simultaneously with the horizontal ~~load~~ specified *live load* provided for in ~~Sentence~~ Sentences (1), (3) and (7). **7)** Handrails and their supports shall be designed and constructed to withstand the following ~~load~~ minimum specified *live loads*, which need not be considered to act simultaneously: a) ~~a concentrated load not less than~~ 0.9 kN applied at any point and in any direction for all handrails, and b) ~~a uniform load not less than~~ 0.7 kN/m applied in any direction ~~to~~ for handrails not located within *dwelling units*.	
4.1.6.2. Specified Snow Load (See Note A-4.1.6.2.) **1)** The specified load, S, due to snow and associated rain accumulation on a roof or any other *building* surface subject to snow accumulation shall be calculated using the formula $S = I_s [S_s (C_bC_wC_sC_a) + S_r]$ where I_s = importance factor for snow load as provided in Table 4.1.6.2.-A, S_s = … C_b = … C_w = wind exposure factor in Sentences (3) and (4), Cs = slope factor in Sentences (5), (6) and (7), C_a = … S_r = … … **2)** The basic roof snow load factor, C_b, shall a) be determined as follows: i) … ii)	**4.1.6.2. Specified Snow Load** (See Note A-4.1.6.2.) **1)** The specified load, S, due to snow and associated rain accumulation on a roof or any other *building* surface subject to snow accumulation shall be calculated using the formula $S = I_s [S_s (C_bC_wC_sC_a) + S_r]$ where I_s = importance factor for snow load, as provided in Table 4.1.6.2.-A, S_s = … C_b = … C_w = wind exposure factor in Sentences (3) and (4), Cs = slope factor in Sentences (5)~~,~~ ~~(6) and~~ to (7), C_a = … S_r = … … **2)** The basic roof snow load factor, C_b, shall a) be determined as follows: i) … ii)	

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$$C_b = \frac{1}{C_w}\left[1 - (1 - 0.8C_w)\exp\left(-\frac{l_c C_w^2 - 70}{100}\right)\right] \text{ for } l_c > \left(\frac{70}{C_w^2}\right)$$ where l_c = characteristic length of the upper or lower roof, defined as 2w−w²/l, in m, w = … l = larger plan dimension of the roof, in m, or b) conform to Table 4.1.6.2.-B, using linear interpolation for intermediate values of $l_c C_w^2$. (See Note A-4.1.6.2.(2).)	$$C_b = \frac{1}{C_w}\left[1 - (1 - 0.8C_w)\exp\left(-\frac{l_c C_w^2 - 70}{100}\right)\right] \text{ for } l_c > \left(\frac{70}{C_w^2}\right)$$ where l_c = characteristic length of the upper or lower roof, defined as 2w − w²/l, in m, w = … l = larger plan dimension of the roof, in m, ~~or~~ b) conform to Table 4.1.6.2.-B, using linear interpolation for intermediate values of $l_c C_w^2$~~.~~, or c) be taken as equal to 1 for any roof structure with a mean height of less than 1 + S_s/γ, in m, above *grade*, where γ is the specific weight of snow determined in accordance with Article 4.1.6.13. (See Note A-4.1.6.2.(2).)	
4.1.6.4. Specified Rain Load **4)** Where scuppers are provided and where the position, shape and deflection of the loaded surface make an accumulation of rainwater possible, the loads due to rain shall be the lesser of either the one-day rainfall determined in conformance with Subsection 1.1.3. or a depth of rainwater equal to 30 mm above the level of the scuppers, applied over the horizontal projection of the surface and tributary areas.	**4.1.6.4. Specified Rain Load** **4)** Where scuppers are provided as secondary drainage systems and where the position, shape and deflection of the loaded surface make an accumulation of rainwater possible, the loads due to rain shall be the lesser of either the one-day rainfall determined in conformance with Subsection 1.1.3. or a depth of rainwater equal to 30 mm above the ~~level~~ bottom of the scuppers, applied over the horizontal projection of the surface and tributary areas.	
4.1.6.5. Multi-level Roofs **1)** The drifting load of snow on a roof adjacent to a higher roof shall be taken as trapezoidal, as shown in Figure 4.1.6.5.-A, and the accumulation factor, Ca, shall be determined as follows: $$C_a = C_{a0} - (C_{a0} - 1)\left(\frac{x}{x_d}\right) \text{ for } 0 \le x \le x_d$$ or $$C_a = 1.0 \text{ for } x \le x_d$$ where C_{a0} = peak value of C_a at x = 0 determined in accordance with Sentences (3) and (4) and as shown in Figure 4.1.6.5.-B, x = … x_d = … **2)** … **Figure 4.1.6.5.-A** **Snow load factors for lower level roofs** Forming Part of Sentences 4.1.6.5.(1) and (3) and 4.1.6.6.(1)	**4.1.6.5. Multi-level Roofs** **1)** The drifting load of snow on a roof adjacent to a higher roof shall be taken as trapezoidal, as shown in Figure 4.1.6.5.-A, and the accumulation factor, Ca, shall be determined as follows: $$C_a = C_{a0} - (C_{a0} - 1)\left(\frac{x}{x_d}\right) \text{ for } 0 \le x \le x_d$$ or $$C_a = 1.0 \text{ for } x \le x_d$$ where C_{a0} = peak value of C_a at x = 0 determined in accordance with Sentences (3) ~~and~~ to (~~4~~5) and as shown in Figure 4.1.6.5.-B, x = … x_d = … **2)** … **Figure 4.1.6.5.-A** **Snow load factors for lower level roofs** Forming Part of Sentences 4.1.6.5.(1) and (3), Table 4.1.6.5.-A and Sentence 4.1.6.6.(1)	

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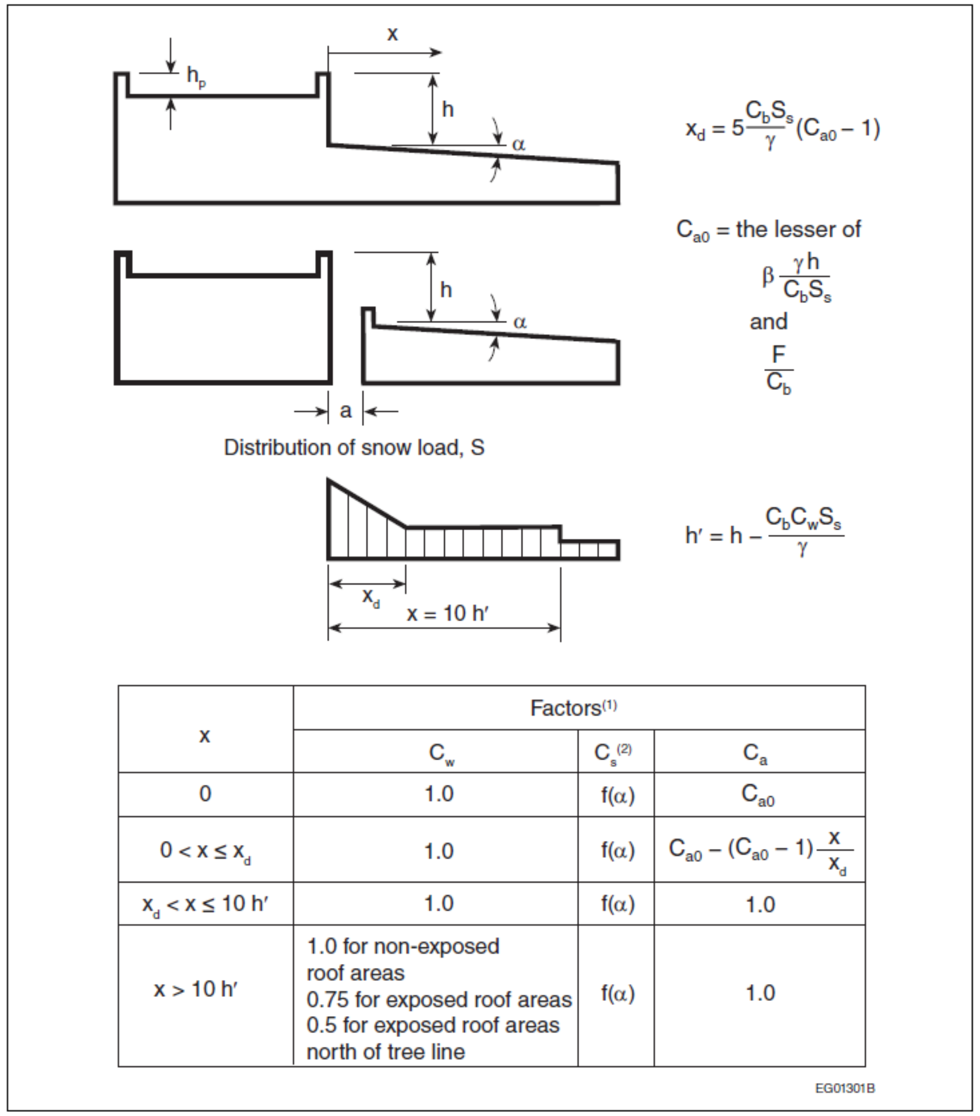

$$x_d = 5\frac{C_bS_s}{\gamma}(C_{a0} - 1)$$

C_{a0} = the lesser of

$$\beta\frac{\gamma h}{C_bS_s}$$

and

$$\frac{F}{C_b}$$

$$h' = h - \frac{C_bC_wS_s}{\gamma}$$

x	Factors[1]		
	C_w	C_s[2]	C_a
0	1.0	f(α)	C_{a0}
$0 < x \le x_d$	1.0	f(α)	$C_{a0} - (C_{a0} - 1)\frac{x}{x_d}$
$x_d < x \le 10\ h'$	1.0	f(α)	1.0
$x > 10\ h'$	1.0 for non-exposed roof areas 0.75 for exposed roof areas 0.5 for exposed roof areas north of tree line	f(α)	1.0

Notes to Figure 4.1.6.5.-A:

(1) If a > 5 m or h ≤ $0.8S_s/\gamma$, drifting from the higher roof need not be considered.

(2) For lower roofs with parapets, C_s = 1.0, otherwise it varies as a function of slope α as defined in Sentences 4.1.6.2.(5) and (6).

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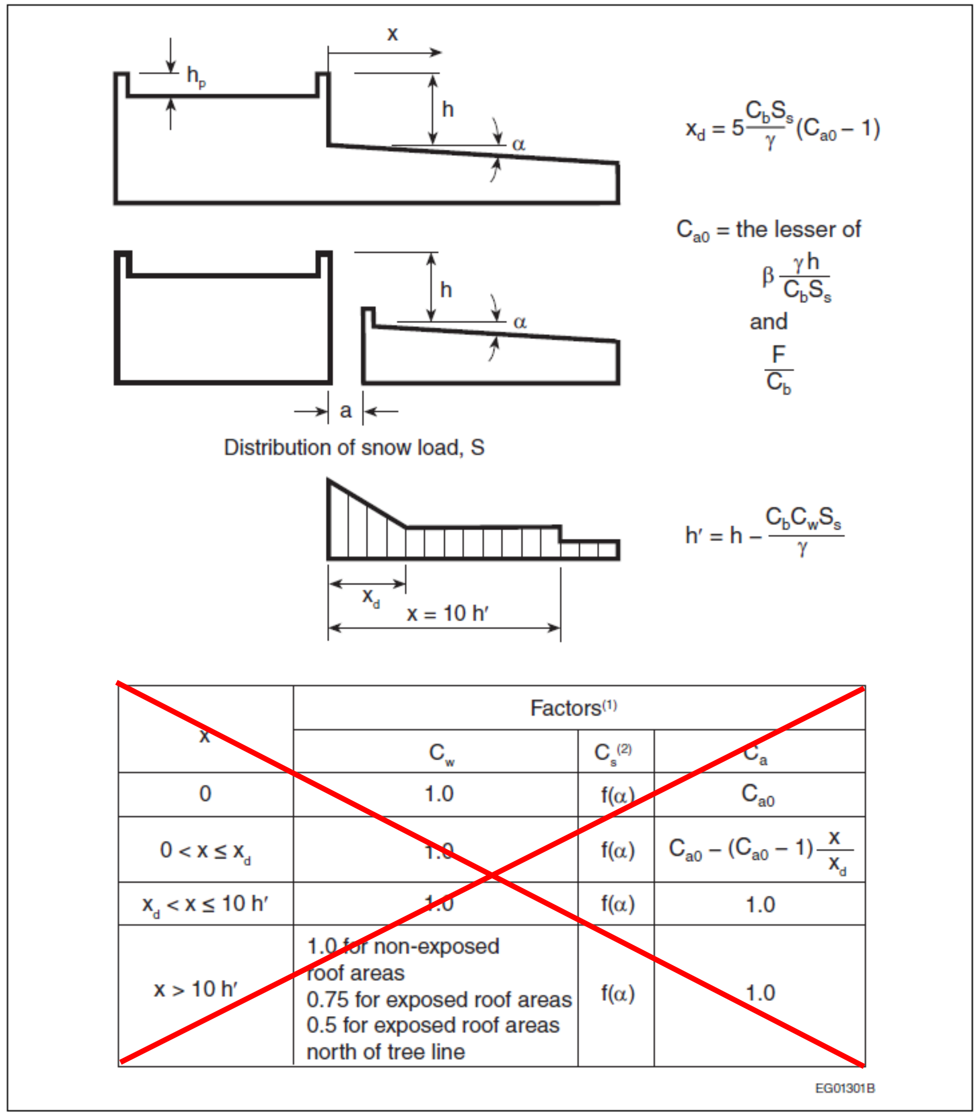

$$x_d = 5\frac{C_bS_s}{\gamma}(C_{a0} - 1)$$

C_{a0} = the lesser of

$$\beta\frac{\gamma h}{C_bS_s}$$

and

$$\frac{F}{C_b}$$

$$h' = h - \frac{C_bC_wS_s}{\gamma}$$

~~x~~	~~Factors[1]~~		
	~~C_w~~	~~C_s[2]~~	~~C_a~~
~~0~~	~~1.0~~	~~f(α)~~	~~C_{a0}~~
~~$0 < x \le x_d$~~	~~1.0~~	~~f(α)~~	~~$C_{a0} - (C_{a0} - 1)\frac{x}{x_d}$~~
~~$x_d < x \le 10\ h'$~~	~~1.0~~	~~f(α)~~	~~1.0~~
~~$x > 10\ h'$~~	~~1.0 for non-exposed roof areas~~ ~~0.75 for exposed roof areas~~ ~~0.5 for exposed roof areas north of tree line~~	~~f(α)~~	~~1.0~~

Notes to Figure 4.1.6.5.-A:

(1) If a > 5 m or h ≤ $0.8S_s/\gamma$, drifting from the higher roof need not be considered.

(2) ~~For lower roofs with parapets, C_s = 1.0, otherwise it varies as a function of slope α as defined in Sentences 4.1.6.2.(5) and (6).~~If h ≥ 5 m, the value of C_{a0} for Case I is permitted to be determined in accordance with Sentence 4.1.6.5.(4).

Table 4.1.6.5.-A

Wind Exposure, Slope and Accumulation Factors in Figure 4.1.6.5.-A

Distance from Roof Step, x	Factors		
	C_w	C_s[(1)]	C_a
0	1.0	f(α)	C_{a0}
$0 < x \le x_d$	1.0	f(α)	$C_{a0} - (C_{a0} - 1)(x/x_d)$
$xd < x \le 10h'$	1.0	f(α)	1.0
$x > 10h'$	1.0 for unexposed roof areas 0.75 for exposed roof areas 0.5 for exposed roof areas north of tree line	f(α)	1.0

Notes to Table 4.1.6.5.-A:

(1) For lower roofs with parapets, C_s = 1.0; otherwise, C_s varies as a function of slope, α, as

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<table>
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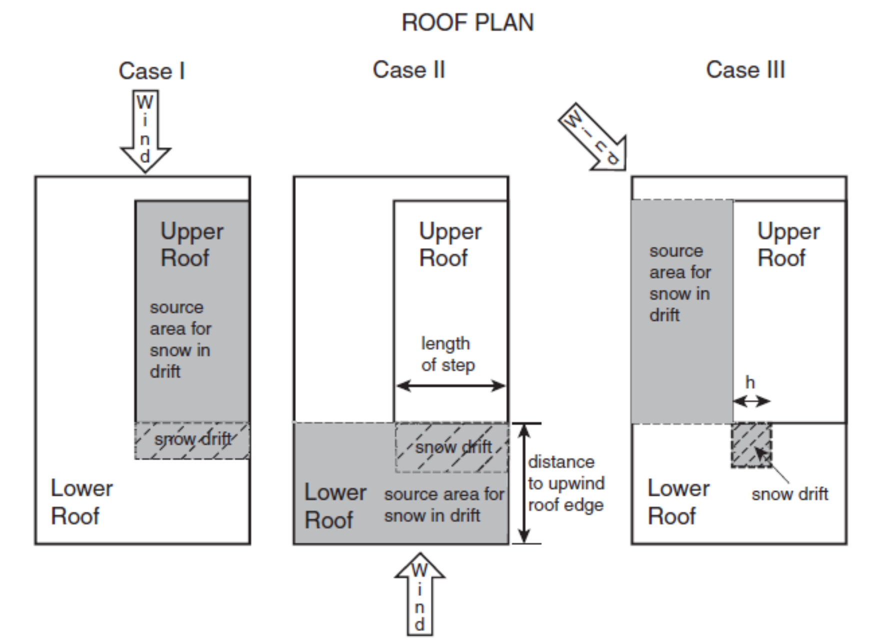
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td></td><td>defined in Sentences 4.1.6.2.(5) and (6).</td><td></td></tr>
<tr><td>3) The value of C_{a0} for each of Cases I, II, and III shall be the lesser of
…</td><td>3) ~~The~~ Except as provided in Sentence (4), the value of C_{a0} for each of Cases I, II~~,~~ and III shall be the lesser of
…
4) Where h ≥ 5 m, the value of Ca0 for Case I is permitted to be taken as
$$C_{a0} = \left(\frac{25-h}{20}\right)\left(\frac{F}{C_b} - 1\right) + 1 \text{ for 5 m} \leq h \leq 25 \text{ m, and}$$
$$C_{a0} = 1 \text{ for } h > 25 \text{ m}$$</td><td></td></tr>
<tr><td>4) The value of C_{a0} shall be the highest of Cases I, II and III, considering the different roof source areas for drifting snow, as specified in Sentence (3) and Figure 4.1.6.5.-B.</td><td>~~4~~5) The value of C_{a0} shall be the highest of Cases I, II and III, considering the different roof source areas for drifting snow, as specified in ~~Sentence~~ Sentences (3) and (4) and Figure 4.1.6.5.-B.</td><td></td></tr>
<tr><td>Figure 4.1.6.5.-B
Snow load cases I, II and III for lower level roofs
Forming Part of Sentences 4.1.6.5.(1), (3) and (4)</td><td>Figure 4.1.6.5.-B
Snow load cases I, II and III for lower level roofs
Forming Part of Sentences 4.1.6.5.(1), (3) and (~~4~~5), and Table 4.1.6.5.-B</td><td></td></tr>
<tr><td>
<table>
<tr><th>Parameter</th><th>Case I</th><th>Case II</th><th>Case III</th></tr>
<tr><td>β</td><td>1.0</td><td>0.67</td><td>0.67</td></tr>
<tr><td>h_p</td><td>parapet height of upper-roof source area</td><td>parapet height of lower-roof source area</td><td>parapet height of lower-roof source area</td></tr>
<tr><td>$l_{cs} = 2w_s - \frac{w_s^2}{l_s}$</td><td>with w_s and l_s being the shorter and longer dimensions of the upper roof</td><td>with w_s and l_s being the shorter and longer dimensions of source area on lower roof for upwind facing step</td><td>with w_s and l_s being the shorter and longer dimensions of the source area on the lower roof for downwind facing step</td></tr>
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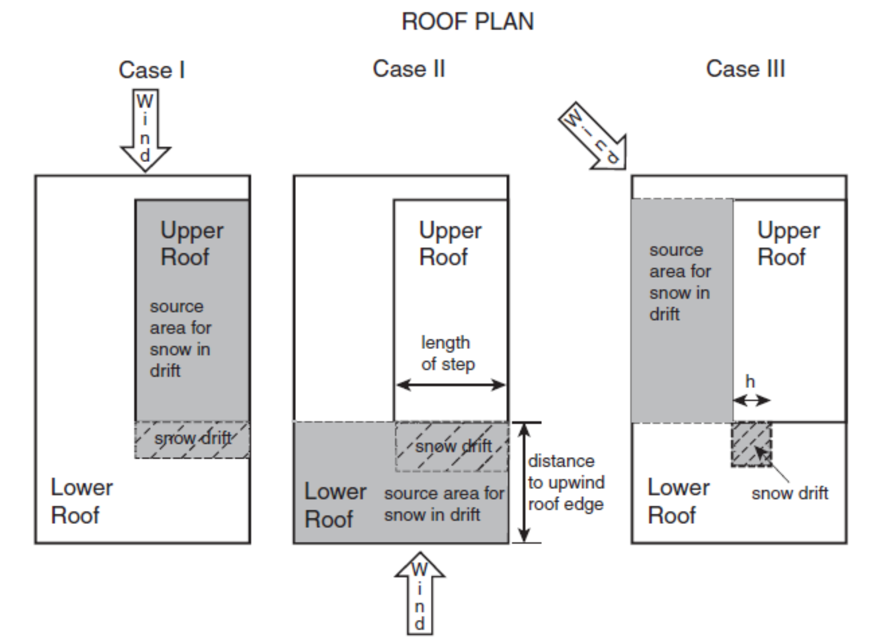
<td>
<table>
<tr><th>~~Parameter~~</th><th>~~Case I~~</th><th>~~Case II~~</th><th>~~Case III~~</th></tr>
<tr><td>~~β~~</td><td>~~1.0~~</td><td>~~0.67~~</td><td>~~0.67~~</td></tr>
<tr><td>~~h_p~~</td><td>~~parapet height of upper-roof source area~~</td><td>~~parapet height of lower-roof source area~~</td><td>~~parapet height of lower-roof source area~~</td></tr>
<tr><td>~~$l_{cs} = 2w_s - \frac{w_s^2}{l_s}$~~</td><td>~~with w_s and l_s being the shorter and longer dimensions of the upper roof~~</td><td>~~with w_s and l_s being the shorter and longer dimensions of source area on lower roof for upwind facing step~~</td><td>~~with w_s and l_s being the shorter and longer dimensions of the source area on the lower roof for downwind facing step~~</td></tr>
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Table 4.1.6.5.-B
Parameters for Snow Load Cases in Figure 4.1.6.5.-B</td><td></td></tr>
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Parameter	Case I	Case II	Case III
β	1.0	0.67	0.67
h_p	parapet height of upper-roof source area	parapet height of lower-roof source area	parapet height of lower-roof source area
$l_{cs} = 2w_s - \frac{w_s^2}{l_s}$	with w_s and l_s being the shorter and longer dimensions of the upper roof	with w_s and l_s being the shorter and longer dimensions of the source area on the lower roof for upwind-facing step	with w_s and l_s being the shorter and longer dimensions of the source area on the lower roof for downwind-facing step

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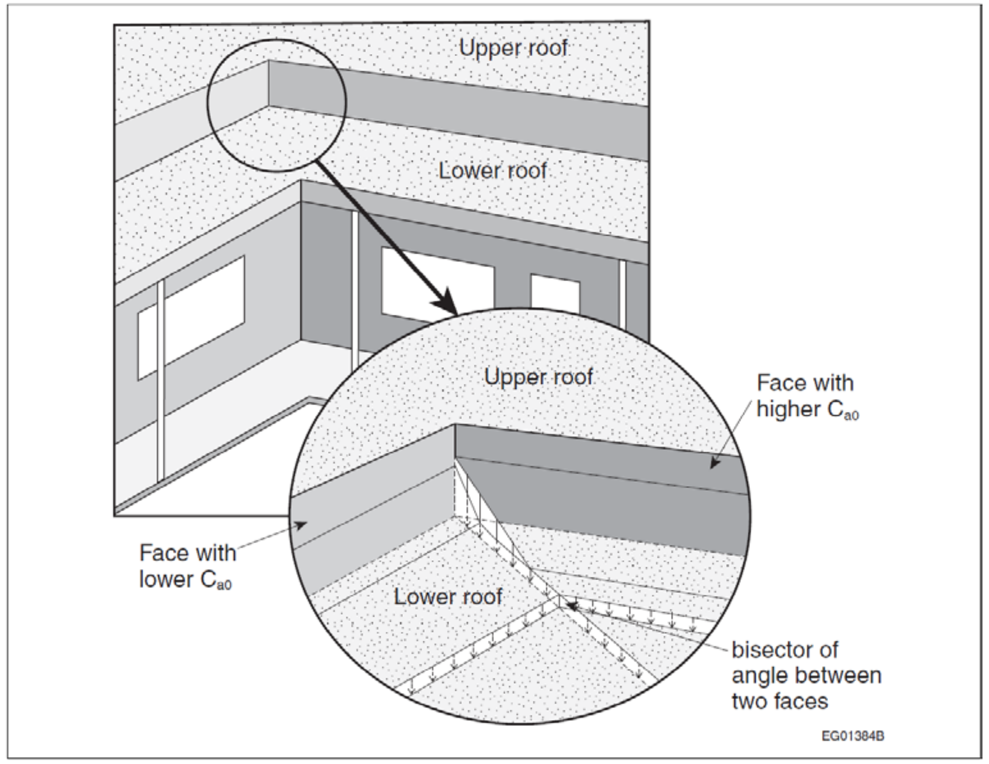
4.1.6.8. Snow Drift at Corners

2) The drift loads on the lower level roof against the two faces of an inside corner of an upper level roof or a parapet shall be calculated for each face and applied as far as the bisector of the corner angle as shown in Figure 4.1.6.8.-B.

Figure 4.1.6.8.-B
Snow load at inside corner
Forming Part of Sentence 4.1.6.8.(2)

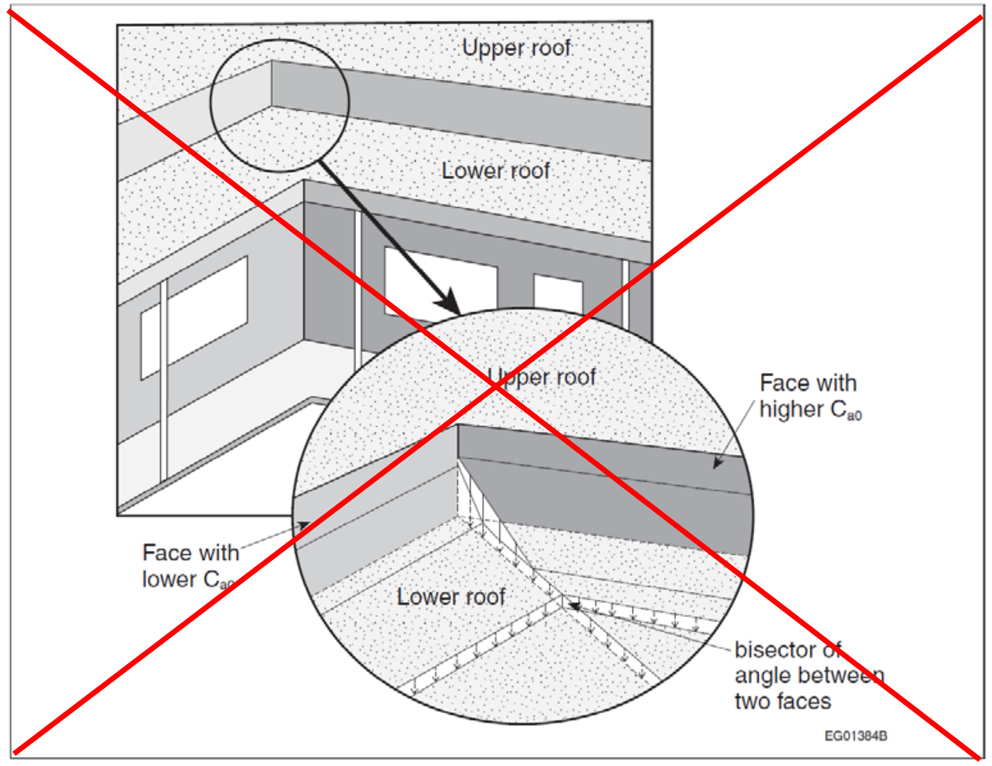


NBC(AE) 2023:

4.1.6.8. Snow Drift at Corners

2) The drift loads on the lower level roof against the two faces of an inside corner of an upper level roof or a parapet shall be calculated for each face and the higher of the two loads shall be applied ~~as far as the bisector of the corner angle~~ where the drifts overlap as shown in Figure 4.1.6.8.-B.

Figure 4.1.6.8.-B
Snow load at inside corner
Forming Part of Sentence 4.1.6.8.(2)



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	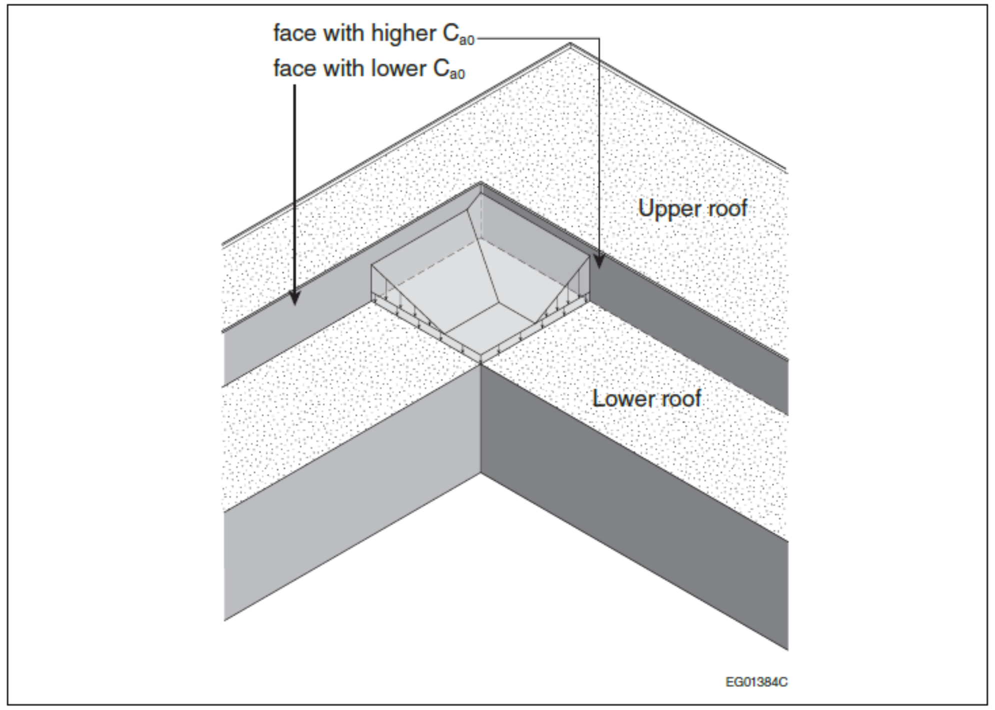	
N/A	**4.1.6.16. Roofs with Solar Panels** (See Note A-4.1.6.16.) **1)** Where solar panels are installed on a roof, the snow loads, S, shall be determined in accordance with Sentences (2) to (6) or with the requirements for roofs without solar panels, whichever produces the most critical effect. **2)** For the purposes of this Article, solar panels shall be classified as a) Parallel Flush, where the panels are installed parallel to the roof surface with their upper surface less than or equal to $C_bC_wS_s/\gamma$ above the roof surface, b) Parallel Raised, where the panels are installed parallel to the roof surface with their upper surface greater than $C_bC_wS_s/\gamma$ above the roof surface, or c) Tilted, where the panels are installed at an angle to the roof surface with their highest edge greater than $C_bC_wS_s/\gamma$ above the roof surface. **3)** For sloped roofs with solar panels, the snow loads, S, shall be determined in accordance with the requirements for roofs without solar panels, except that the slope factor, C_s, shall be a) taken as 1.0 for roof areas extending upslope from the downslope edge of a panel or array of panels at an angle of 45° from each side edge of the panel or array, and b) as specified in Sentences 4.1.6.2.(5) to (7) for all other roof areas. (See Note A-4.1.6.16.(3).) **4)** For sloped roofs with Parallel Flush solar panels, the snow loads, S, shall be determined in accordance with the requirements for roofs without solar panels, except that a) C_s shall be determined in accordance with Sentence (3), b) where the gap width, w_g, between the panels along the roof slope is greater than or equal to the panel width, w_p, along the roof slope, the accumulation factor, C_a, shall be taken as i) 0.0 for the panels, ii) 2.0 for roof areas within a distance of w_p downslope from a downslope panel edge, and iii) 1.0 for all other roof areas (see Note A-4.1.6.16.(4)(b)), and c) where the gap width, w_g, between the panels along the roof slope is less than the	

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	panel width, w_p, along the roof slope, C_a shall be taken as i) 0.0 for panel areas within a distance of w_g downslope from an upslope panel edge, ii) 1.0 for other panel areas, iii) 2.0 for roof areas in gaps between the panels, and iv) 1.0 for all other roof areas (see Note A-4.1.6.16.(4)(c)). **5)** For roofs with Parallel Raised solar panels, the snow loads, S, shall be determined in accordance with the requirements for roofs without solar panels, except that a) where the roof is flat, C_a shall be taken as i) 1.0 for the panels, ii) 1.0 for roof areas not under the panels, iii) 1.0 for roof areas under the panels within a distance of $\min(2h_g,2w_g)$ from a panel edge, where h_g is the gap height between the lower surface of the panels and the roof surface, and w_g is the gap width between the panels, and iv) 0.0 for other roof areas under the panels (see Note A-4.1.6.16.(5)(a)), and b) where the roof is sloped, the snow loads, S, derived from Clause (a) shall be used, except that i) C_s shall be determined in accordance with Sentence (3), ii) S shall be taken as 0.0 on the panels, and iii) S for all roof areas shall be taken as the sum of S on the panels, as derived from Subclause (a)(i) and shifted by a distance of w_p downslope onto the roof, where w_p is the panel width along the roof slope, and S on the roof areas, as derived from Subclauses (a)(ii) to (a)(iv) (see Note A-4.1.6.16.(5)(b)). **6)** For flat roofs with Tilted solar panels, the snow loads, S, shall be determined in accordance with the requirements for roofs without solar panels, except that a) C_a shall be taken as 0.0 for the panels, b) C_a shall be taken as 1.0 for roof areas beyond a distance of $5(h – C_bC_wS_s/γ)$ from the lowest edge of the panels, where h is the height of the highest edge of the panels above the roof surface, c) except as provided in Clauses (d) and (e), for roof areas within a distance of $5(h – C_bC_wS_s/γ)$ from the lowest edge of the panels, C_a shall be taken as i) 1.25 for $(h_g – C_bC_wS_s/γ) ≤ 0.3$ m, where h_g is the gap height between the lowest edge of the panels and the roof surface, ii) $1.294 – 0.1471(h_g – C_bC_wS_s/γ)$ for$0.3 < (h_g – C_bC_wS_s/γ) ≤ 2.0$ m, and iii) 1.0 for $(h_g – C_bC_wS_s/γ) > 2.0$ m (see Note A-4.1.6.16.(6)(c)), d) except as provided in Clause (e), C_a shall be taken as 2.0 for roof areas within a distance of wph beyond the lowest edge of the panels, where w_{ph} is the horizontal projection of the panel width, w_p, along the sloped panel edges, and e) where the panels, panel supports or back plates obstruct snow from sliding under the panels, the load of the increased volume of snow in the gaps between the panels shall be considered to be uniformly distributed. (See Note A-4.1.6.16.(6).)	
4.1.7.2. Classification of Buildings (See Note A-4.1.7.2.) **2)** A *building* shall be classified as dynamically sensitive if a) its lowest natural frequency is less than 1 Hz and greater than 0.25 Hz, b) its height is greater than 60 m, or c) its height is greater than 4 times its minimum effective width, where the effective width, w, of a *building* shall be taken as $$w = \frac{\sum h_i w_i}{\sum h_i}$$	**4.1.7.2. Classification of Buildings** (See Note A-4.1.7.2.) **2)** A *building* shall be classified as dynamically sensitive if a) its lowest natural frequency is less than 1 Hz and greater than 0.25 Hz, b) its height is greater than 60 m, or c) its height is greater than 4 times its minimum effective width, where the effective width, w, of a *building* shall be taken as $$w = \frac{\sum h_i w_i}{\sum h_i}$$	

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where the summations are over the height of the *building* for a given wind direction, h_i is the height above grade to level i, and w_i is the width normal to the wind direction at height h_i; the minimum effective width is the lowest value of the effective width considering all wind directions. **3)** A *building* shall be classified as very dynamically sensitive if a) its lowest natural frequency is less than or equal to 0.25 Hz, or b) its height is more than 6 times its minimum effective width as defined in Clause (2)(c).	where the summations are over the height of the *building* for a given wind direction, h_i is the height above ~~grade~~ *grade* to level i, and w_i is the width normal to the wind direction at height h_i; the minimum effective width is the lowest value of the effective width considering all wind directions. **3)** A *building* shall be classified as very dynamically sensitive if a) its lowest natural frequency is less than or equal to 0.25 Hz, or b) it contains a human occupancy, and its height is more than 6 times its minimum effective width as defined in Clause (2)(c).	
4.1.7.5. External Pressure Coefficients **1)** Applicable values of external pressure coefficients, C_p, are provided in a) Sentences (2) to (5), and b) Article 4.1.7.6. for certain shapes of low *buildings*. **5)** For the design of balcony *guards*, the internal pressure coefficient, C_{pi}, shall be taken as zero and the value of C_p shall be taken as ±0.9, except that within a distance equal to the larger of 0.1W and 0.1D from a *building* corner, C_p shall be taken as ±1.2.	**4.1.7.5. External Pressure Coefficients** **1)** Applicable values of external pressure coefficients, C_p, are provided in a) Sentences (2) to (~~5~~9), and b) Article 4.1.7.6. for certain shapes of low *buildings*. **5)** ~~For~~ Except as provided in Sentence (6), for the design of balcony *guards*, the internal pressure coefficient, C_{pi}, shall be taken as zero and the value of C_p shall be taken as ±0.9, except that, within a distance equal to the larger of 0.1W and 0.1D from a *building* corner, C_p shall be taken as ±1.2. **6)** Where the top of the balcony *guard* is 2.0 m or less below the roof surface, the values of C_p shall be taken as equal to those determined for parapets in Sentences (7) and (8). **7)** To determine the contribution from parapets to the wind loads on the main structural system, the values of C_p shall be taken as a) on the outer faces, equal to those on the walls below, b) on the inner face of the windward parapet, equal to that on the upwind edge of a roof surface at the level of the top of the parapet, and c) on the inner faces of the other parapets, zero. **8)** For the structural design of parapets themselves, the values of C_p shall be taken as equal to those specified in Sentence (7), except that the value of C_p on the inner face of the leeward parapet shall be taken as equal to that on the outer face of the windward parapet. **9)** For the design of cladding on parapets, the values of C_p shall be taken as a) on the outer vertical surfaces, equal to those on the cladding on the walls below, and b) on the inner and top surfaces, equal to those on the cladding of a roof surface at the level of the top of the parapet.	
4.1.7.6. External Pressure Coefficients for Low Buildings **2)** For the design of the main structural system of the *building*, which is affected by wind pressures on more than one surface, the values of C_pC_g are provided in Figure 4.1.7.6.-A. **Figure 4.1.7.6.-A** **External peak values of CpCg for primary structural actions arising from wind load acting simultaneously on all surfaces of low buildings (H ≤ 20 m)** Forming Part of Sentence 4.1.7.6.(2)	**4.1.7.6. External Pressure Coefficients for Low Buildings** **2)** For the design of the main structural system of the *building*, which is affected by wind pressures on more than one surface as shown in Figure 4.1.7.6.-A, the values of ~~C_p~~C_gC_p are provided in ~~Figure~~ Table 4.1.7.6.~~-A.~~ **Figure 4.1.7.6.-A** **~~External peak values of CpCg for primary~~ Primary structural actions arising from wind load acting simultaneously on all surfaces of low buildings (H ≤ 20 m)** Forming Part of Sentence 4.1.7.6.(2) and Table 4.1.7.6.	

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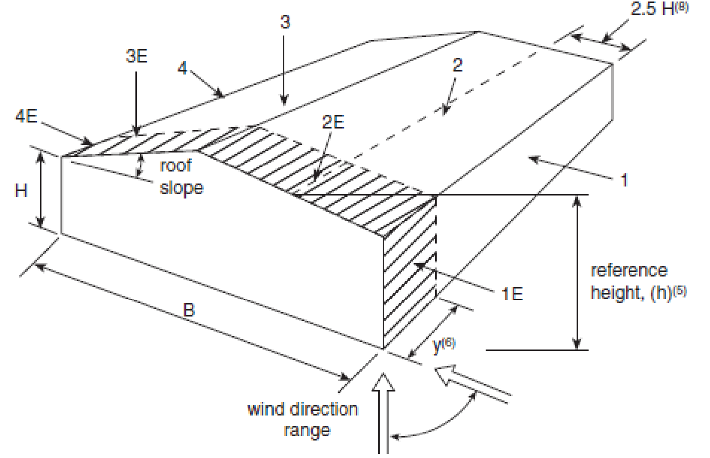
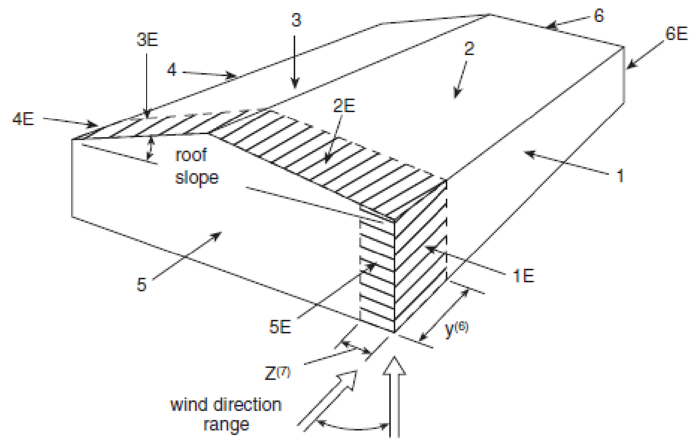
Load Case A: winds generally perpendicular to ridge



Roof Slope	Building Surfaces							
	1	1E	2	2E	3	3E	4	4E
0° to 5°	0.75	1.15	-1.3	-2.0	-0.7	-1.0	-0.55	-0.8
20°	1.0	1.5	-1.3	-2.0	-0.9	-1.3	-0.8	-1.2
30° to 45°	1.05	1.3	0.4	0.5	-0.8	-1.0	-0.7	-0.9
90°	1.05	1.3	1.05	1.3	-0.7	-0.9	-0.7	-0.9

Load Case B: winds generally parallel to ridge



Roof Slope	Building Surfaces											
	1	1E	2	2E	3	3E	4	4E	5	5E	6	6E
0° to 90°	-0.85	-0.9	-1.3	-2.0	-0.7	-1.0	-0.85	-0.9	0.75	1.15	-0.55	-0.8

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Notes to Figure 4.1.7.6.-A:

(1) …
(2) For values of roof slope not shown, the coefficient (C_pC_g) can be interpolated linearly.
(3) Positive coefficients denote forces toward the surface, whereas negative coefficients denote forces away from the surface.
(4) For the design of *foundations*, exclusive of anchorages to the frame, only 70% of the effective load is to be considered.
(5) The reference height, h, for pressures is the mid-height of the roof or 6 m, whichever is greater. The eave height, H, may be substituted for the mid-height of the roof if the roof slope is less than 7°.
(6) End-zone width y should be the greater of 6 m or 2z, where z is the width of the gable-wall end zone defined for Load Case B below. Alternatively, for *buildings* with frames, the end zone y may be the distance between the end and the first interior frame.
(7) End-zone width z is the lesser of 10% of the least horizontal dimension and 40% of height,

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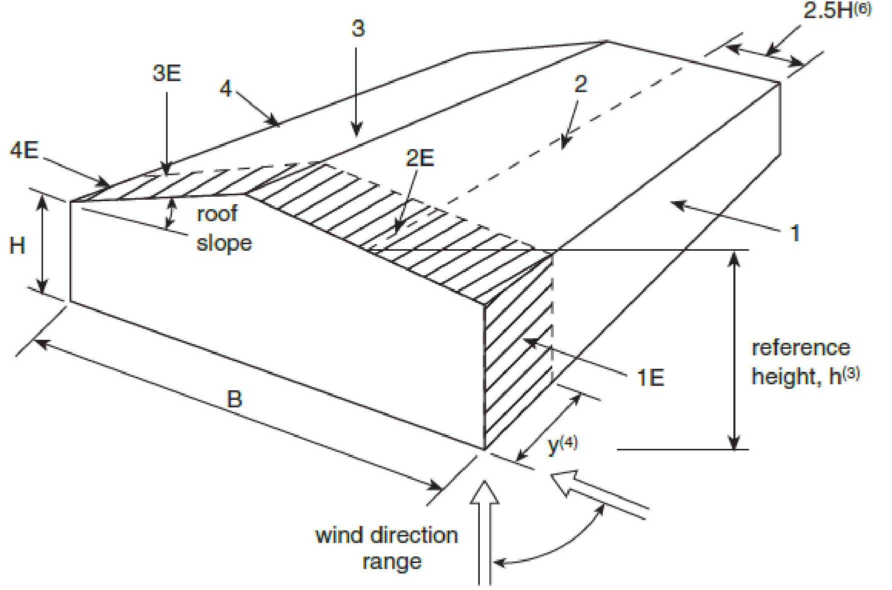
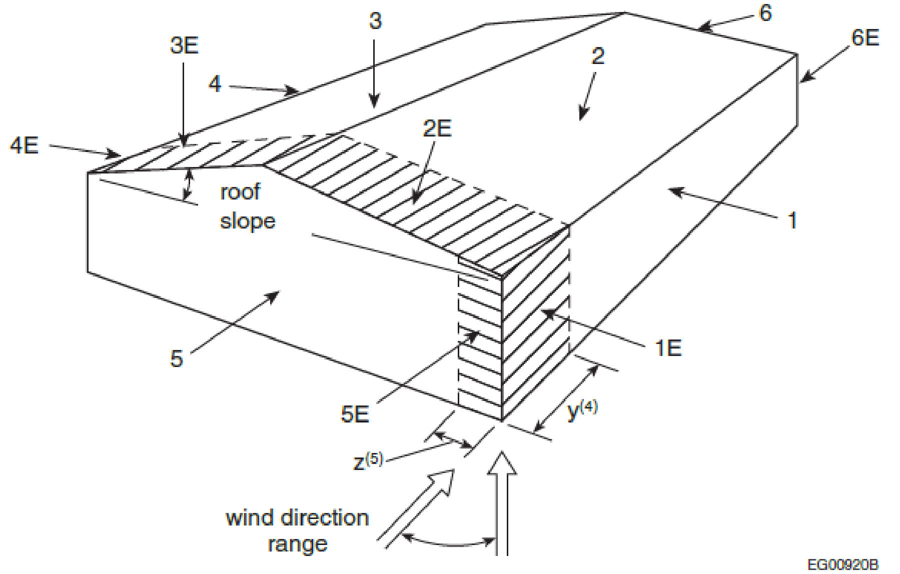
Load Case A: winds generally perpendicular to ridge



Load Case B: winds generally parallel to ridge



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Notes to Figure 4.1.7.6.-A:

(1) …
~~(2) For values of roof slope not shown, the coefficient (C_pC_g) can be interpolated linearly.~~
~~(3) Positive coefficients denote forces toward the surface, whereas negative coefficients denote forces away from the surface.~~
(~~4~~2)For the design of *foundations*, exclusive of anchorages to the frame, only 70% of the effective load is to be considered.
(~~5~~3)The reference height, h, for pressures is the mid-height of the roof or 6 m, whichever is greater. The eave height, H, may be substituted for the mid-height of the roof if the roof slope is less than 7°.
(~~6~~4)End-zone width y should be the greater of 6 m or 2z, where z is the width of the gable-wall end zone defined for Load Case B below. Alternatively, for *buildings* with frames, the end-zone width y may be the distance between the end and the first interior frame.
(~~7~~5)End-zone width z is the lesser of 10% of the least horizontal dimension and 40% of height,

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<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr>
<td>H, but not less than 4% of the least horizontal dimension or 1 m.
(8) For B/H > 5 in Load Case A, the listed negative coefficients on surfaces 2 and 2E should only be applied on an area whose width is 2.5H measured from the windward eave. The pressures on the remainder of the windward roof should be reduced to the pressures for the leeward roof.</td>
<td>H, but not less than 4% of the least horizontal dimension or 1 m.
(~~8~~6)For B/H > 5 in Load Case A, (6) the ~~listed~~ negative coefficients ~~on~~ listed for surfaces 2 and 2E in Table 4.1.7.6. should only be applied on an area whose width is 2.5H measured from the windward eave. The pressures on the remainder of the windward roof should be reduced to the pressures for the leeward roof.

Table 4.1.7.6.
External Peak Values of C_gC_p in Figure 4.1.7.6.-A
Forming Part of Sentence 4.1.7.6.(2)

<table>
<tr><th rowspan="3">Load Case</th><th rowspan="3">Roof Slope</th><th colspan="12">External Peak Values of C_gC_p (1)(2)</th></tr>
<tr><th colspan="12">Building Surfaces</th></tr>
<tr><th>1</th><th>1E</th><th>2</th><th>2E</th><th>3</th><th>3E</th><th>4</th><th>4E</th><th>5</th><th>5E</th><th>6</th><th>6E</th></tr>
<tr><td rowspan="4">A</td><td>0° to 5°</td><td>0.75</td><td>1.15</td><td>-1.3</td><td>-2.0</td><td>-0.7</td><td>-1.0</td><td>-0.55</td><td>-0.8</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>20°</td><td>1.0</td><td>1.5</td><td>-1.3</td><td>-2.0</td><td>-0.9</td><td>-1.3</td><td>-0.8</td><td>-1.2</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>30° to 45°</td><td>1.05</td><td>1.3</td><td>0.4</td><td>0.5</td><td>-0.8</td><td>-1.0</td><td>-0.7</td><td>-0.9</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>90°</td><td>1.05</td><td>1.3</td><td>1.05</td><td>1.3</td><td>-0.7</td><td>-0.9</td><td>-0.7</td><td>-0.9</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>B</td><td>0° to 90°</td><td>-0.85</td><td>-0.9</td><td>-1.3</td><td>-2.0</td><td>-0.7</td><td>-1.0</td><td>-0.85</td><td>-0.9</td><td>0.75</td><td>1.15</td><td>-0.55</td><td>-0.8</td></tr>
</table>

Notes to Table 4.1.7.6.:
(1) For values of roof slope not shown, the coefficient C_gC_p can be interpolated linearly.
(2) Positive coefficients denote forces toward the surface, whereas negative coefficients denote forces away from the surface.

10) The wind loads on balcony *guards* on low *buildings* shall be as specified in Sentences 4.1.7.5.(5) and (6).

11) The wind loads on parapets on low *buildings* shall be as specified in Sentences 4.1.7.5.(7) to (9).</td>
<td></td>
</tr>
<tr>
<td>**4.1.7.7. Internal Pressure Coefficient**

1) The internal pressure coefficient, C_{pi}, shall be as prescribed in Table 4.1.7.7.</td>
<td>**4.1.7.7. Internal Pressure Coefficient**

1) The internal pressure coefficient, C_{pi}, for *buildings* shall be as prescribed in Table 4.1.7.7.

2) The internal pressure coefficient, C_{pi}, for cladding on parapets shall be –0.70 to +0.70. (See Note A-4.1.7.7.(2).)</td>
<td></td>
</tr>
<tr>
<td>**4.1.7.8. Dynamic Procedure**
…
4) For the design of the main structural system, Cg shall be calculated as follows:
…
s = size reduction factor calculated as $\frac{\pi}{3}\left[\frac{1}{1+\frac{8f_nH}{3V_H}}\right]\left[\frac{1}{1+\frac{10f_nW}{V_H}}\right]$,
F = gust energy ratio calculated as $\frac{x_0^2}{(1+x_0^2)^{4/3}}$, where $x_0 = (1\,220\ f_n/V_H)$, and
B = …
where
f_{nD} = …
F_n = lowest natural frequency of the *building*, in Hz, as defined in Sentences 4.1.7.2.(2) and (3),
…
where
$\overline{V}$ = reference wind speed at a height of 10 m, in m/s, calculated as $\sqrt{\frac{2\cdot I_w\cdot q}{\rho}}$,
where</td>
<td>**4.1.7.8. Dynamic Procedure**
…
4) For the design of the main structural system, Cg shall be calculated as follows:
…
s = size reduction factor calculated as $\frac{\pi}{3}\left[\frac{1}{1+\frac{8f_{nD}H}{3V_H}}\right]\left[\frac{1}{1+\frac{10f_{nD}W}{V_H}}\right]$,
F = gust energy ratio calculated as $\frac{x_0^2}{(1+x_0^2)^{4/3}}$, where $x_0 = (1\,220\ f_{nD}/V_H)$, and
B = …
where
f_{nD} = …
~~F_n = lowest natural frequency of the *building*, in Hz, as defined in Sentences 4.1.7.2.(2) and (3),~~
…
where
$\overline{V}$ = reference wind speed at a height of 10 m, in m/s, calculated as $\sqrt{\frac{2\cdot I_w\cdot q}{\rho}}$,
where</td>
<td></td>
</tr>
</table>

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I_W = importance factor, …	I_W = importance factor for wind load, as provided in Table 4.1.7.3., …	
4.1.7.9. Full and Partial Wind Loading **1)** Except where the wind loads are derived from the combined C_pC_g values determined in accordance with Article 4.1.7.6., *buildings* and structural members shall be capable of withstanding the effects of the following loads: a) the full wind loads acting along each of the 2 principal horizontal axes considered separately, b) the wind loads described in Clause (a) but with 100% of the load removed from any one portion of the area, c) the wind loads described in Clause (a) but with both axes considered simultaneously at 75% of their full value, and d) the wind loads described in Clause (c) but with 50% of these loads removed from any portion of the area. (See Note A-4.1.7.9.(1).)	**4.1.7.9. Full and Partial Wind Loading** **1)** Except where the wind loads are derived from the combined ~~C_p~~C_gC_p values determined in accordance with Article 4.1.7.6., *buildings* and structural members shall be capable of withstanding the effects of the following loads: a) the full wind loads acting along each of the 2 principal horizontal axes considered separately, b) 75% of the wind loads described in Clause (a) but ~~with 100% of the load removed from any one portion of the area~~ offset from the central geometric axis of the *building* by 15% of its width normal to the direction of the force to produce the worst load effect, c) 75% of the wind loads described in Clause (a) but with both axes considered simultaneously ~~at 75% of their full value~~, and d) 56% of the wind loads described in Clause (~~c~~a) but with ~~50% of these loads removed from any portion of the area~~ both axes considered simultaneously and offset from the central geometric axis of the *building* by 15% of its width normal to the direction of the force. (See Note A-4.1.7.9.(1).)	
N/A	**4.1.7.12. Attached Canopies on Low Buildings with a Height H ≤ 20 m** (See Note A-4.1.7.12.) **1)** For the purposes of this Article, “attached canopy” shall mean a horizontal canopy with a maximum slope of 2% that is attached to a *building* wall at any height, h_c, above ground level. **2)** The specified external wind pressure, p, and the specified net external wind pressure, p_{net}, for attached canopies on exterior walls of low *buildings* with a height H ≤ 20 m shall be determined as follows: $p = I_W q C_e C_t C_g C_p$, and $p_{net} = I_W q C_e C_t (C_g C_p)_{net}$ where p = specified external wind pressure acting statically and in a direction normal to the upper or lower surface of the canopy, considered positive when acting towards the surface and negative when acting away from the surface, pnet = specified net external wind pressure acting statically on the canopy, considered positive when acting in a downward direction and negative when acting in an upward direction, I_W, q,C_e, C_t = as defined in Sentence 4.1.7.3.(1), C_gC_p = gust pressure coefficient on the upper or lower surface of the canopy, as given in Figure 4.1.7.12.-A, and $(C_gC_p)_{net}$ = net gust pressure coefficient on the canopy, considering simultaneous contributions from the upper and lower surfaces of the canopy, as given in Figure 4.1.7.12.-B. **Figure 4.1.7.12.-A** **Gust pressure coefficients on the upper and lower surfaces of attached canopies with no gap between the canopy and the building** Forming Part of Sentence 4.1.7.12.(2)	

<table>
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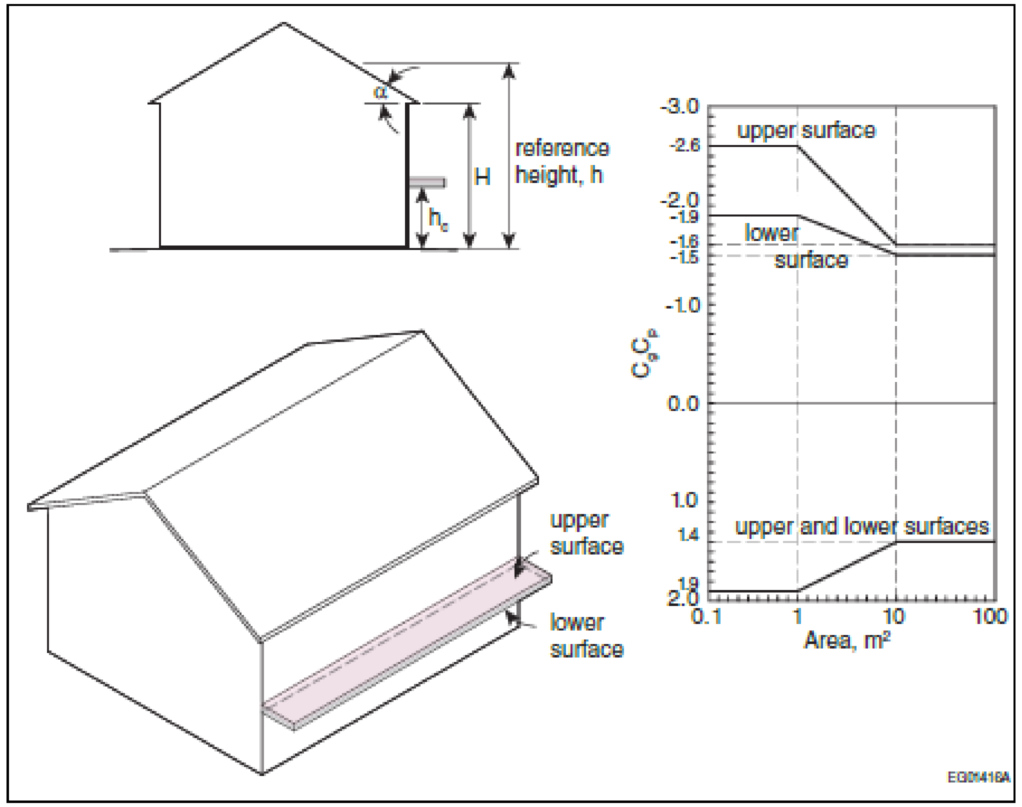
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td></td><td>


Notes to Figure 4.1.7.12.-A:
(1) The coefficients apply for any roof slope, α.
(2) The reference height, h, is the mid-height of the roof or 6 m, whichever is greater.
(3) Positive C_gC_p values denote forces acting towards the upper or lower surface of the canopy, whereas negative C_gC_p values denote forces acting away from the surface. Each structural element must be designed to resist both the positive and negative forces.

Figure 4.1.7.12.-B
Net gust pressure coefficients on attached canopies, considering simultaneous contributions from the upper and lower surfaces of the canopy
Forming Part of Sentence 4.1.7.12.(2)
</td><td></td></tr>
</table>

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	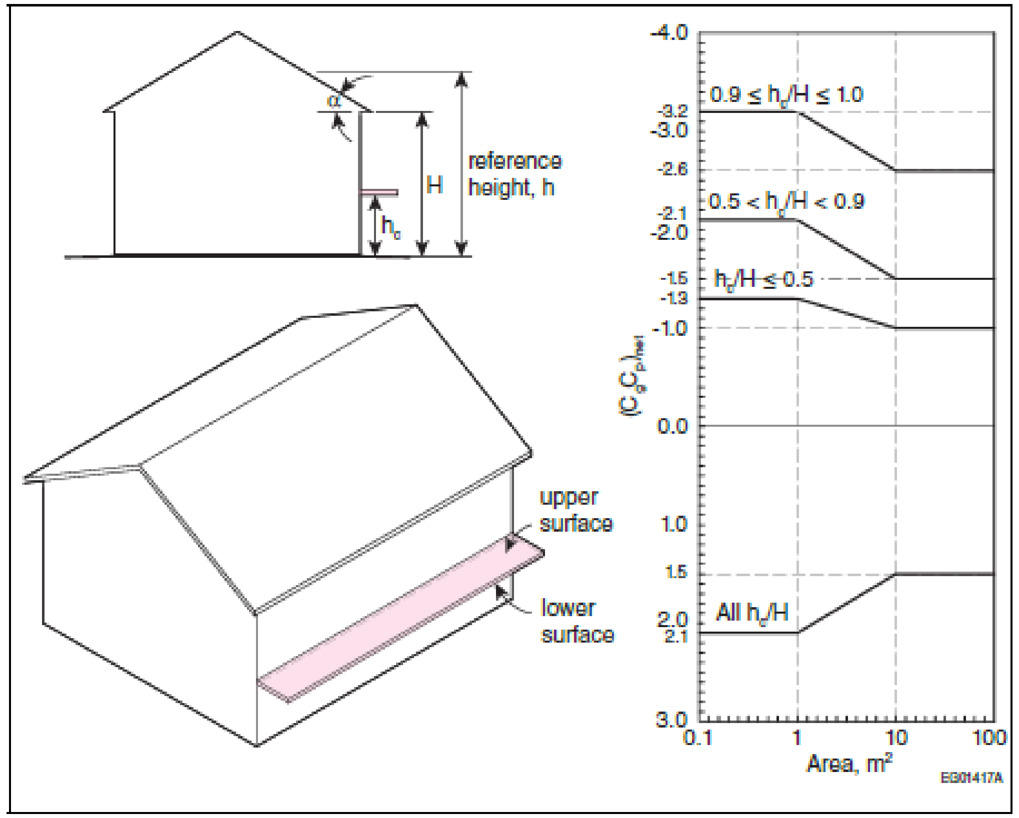 **Notes to Figure 4.1.7.12.-B:** (1) The coefficients apply for any roof slope, α. (2) The reference height, h, is the mid-height of the roof or 6 m, whichever is greater. (3) Positive $(C_gC_p)_{net}$ values denote net forces acting in a downward direction on the canopy, whereas negative $(C_gC_p)_{net}$ values denote net forces acting in an upward direction on the canopy. The canopy must be designed to resist both the positive and negative net forces.	
N/A	**4.1.7.13. Roof-Mounted Solar Panels on Buildings of Any Height** (See Note A-4.1.7.13.) **1)** Where solar panels are installed on a roof, the roof wind loads shall account for the wind loads on the solar panels, as determined in accordance with Sentences (2) to (7), or shall be determined in the same way as for the roof without solar panels, whichever approach results in the most critical effect. **2)** For an array of solar panels where the panels are installed close and parallel to the roof surface with their upper surface not more than 250 mm above the roof surface and with gaps around the panels of not less than 6 mm, the net positive or negative pressure difference between the upper and lower surfaces of a panel or the array shall be calculated as follows: $p = I_w q C_e C_t C_g C_p E \gamma_a$ where I_w, q, C_e, C_t, C_g, C_p = as defined in Sentence 4.1.7.3.(1), determined in the same manner as for the roof cladding, E = edge factor, as provided in Sentence (4), and γ_a = pressure equalization factor, as provided in Sentence (3). **3)** The pressure equalization factor, γ_a, in Sentence (2) shall be a) for a panel or an array where the panel chord length, L_p, is greater than 2 m or for a panel or an array that is within a distance of $2h_2$ from the roof edge or ridge, where h_2	

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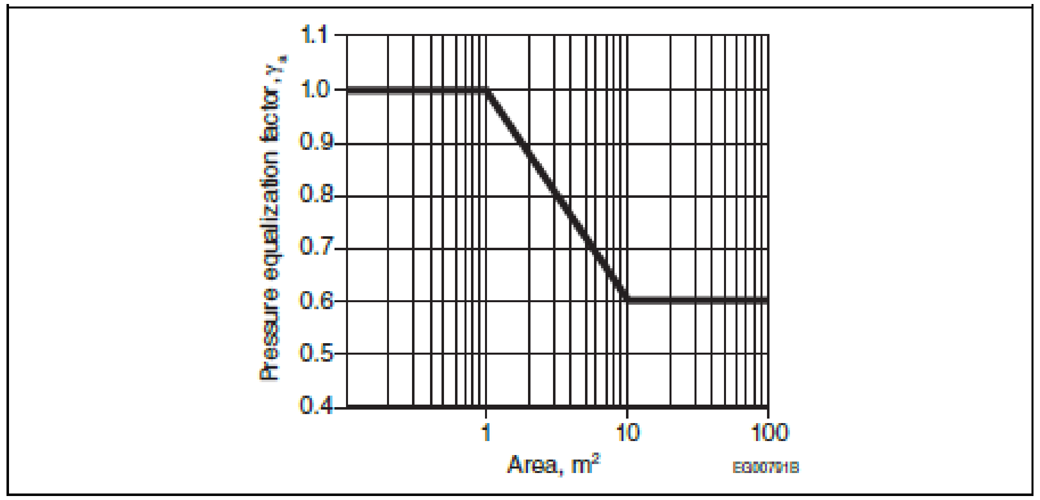
is the height of the panel's highest point above the roof surface, taken as 1.0, and

b) for other panels or arrays, determined from Figure 4.1.7.13.-A based on the area of the panel or array over which the wind load is being calculated.

Figure 4.1.7.13.-A
Pressure equalization factor, γ_a, for solar panels or arrays mounted on roofs of buildings of any height
Forming Part of Clause 4.1.7.13.(3)(b)



4) The edge factor, E, in Sentence (2) shall be taken as

a) 1.5 within a distance of 1.5L_p from an exposed edge of the array of solar panels, as defined in Sentence (5), and

b) 1.0 elsewhere.

5) For the purposes of Clause (4)(a), an exposed edge of the array of solar panels shall be considered to occur

a) where the distance to the next row of panels or the distance across a gap in the same row of panels exceeds 4h_2 or 1.2 m, whichever is greater, or

b) where the distance to the roof edge exceeds 4h_2 or 1.2 m, whichever is greater, and exceeds 0.5h, where h is the reference height of the roof.

6) For an array of solar panels mounted on a roof with a slope, α, less than or equal to 7°, where the panels are tilted relative to the roof surface, have a chord length, L_p, not greater than 2 m, and are installed such that the height of their lowest point above the roof surface, h_1, is not greater than 0.6 m, the height of their highest point above the roof surface, h_2, is not greater than 1.2 m, and their tilt angle relative to the roof surface, ω, is not greater than 35°, or where the panels are installed parallel to the roof surface with their upper surface greater than 250 mm above the roof surface and with gaps not less than 6 mm between the panels, the net positive or negative pressure difference between the upper and the lower surfaces of a panel or the array shall be calculated as follows:

$$p_{net} = I_W q C_e C_t (C_g C_p)_{net}$$

where

I_W, q,C_e, C_t = as defined in Sentence 4.1.7.3.(1), determined in the same manner as for the roof cladding, and

$(C_g C_p)_{net}$ = net gust pressure coefficient, as provided in Sentence (7).

7) The net gust pressure coefficient, $(C_g C_p)_{net}$, in Sentence (6) shall be calculated as follows:

$$(C_g C_p)_{net} = \pm\gamma_p \gamma_c E (C_g C_p)_n$$

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	where γ_p = parapet factor, determined as the lesser of 1.2 and (0.9 + h_{pt}/h), γ_c = chord factor, determined as the greater of (0.6 + 0.2L_p) and 0.8, E = as defined in Sentence (2), and $(C_gC_p)_n$ = normalized gust pressure coefficient, determined from Figure 4.1.7.13.-B based on ω and A_N, where h_{pt} = height of the parapet above the roof surface, in m, h = reference height of the roof, in m, L_p = panel chord length, in m, ω = panel tilt angle relative to the roof surface, and A_N = normalized panel or array area, calculated as $A_N = \frac{1000A}{\max(L_b^2, 25)}$ where A = panel or array area over which the wind load is being calculated, in m^2, and L_b = normalized *building* length, in m, determined as the lesser of $\left(0.4\sqrt{hW_L}\right)$, h and W_S, where W_L = longest horizontal dimension of the *building*, in m, and W_S = smallest horizontal dimension of the *building*, in m. **Figure 4.1.7.13.-B** **Normalized gust pressure coefficient, $(C_gC_p)_n$, for solar panels or arrays mounted on low-sloped roofs of buildings of any height** Forming Part of Sentence 4.1.7.13.(7)	

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	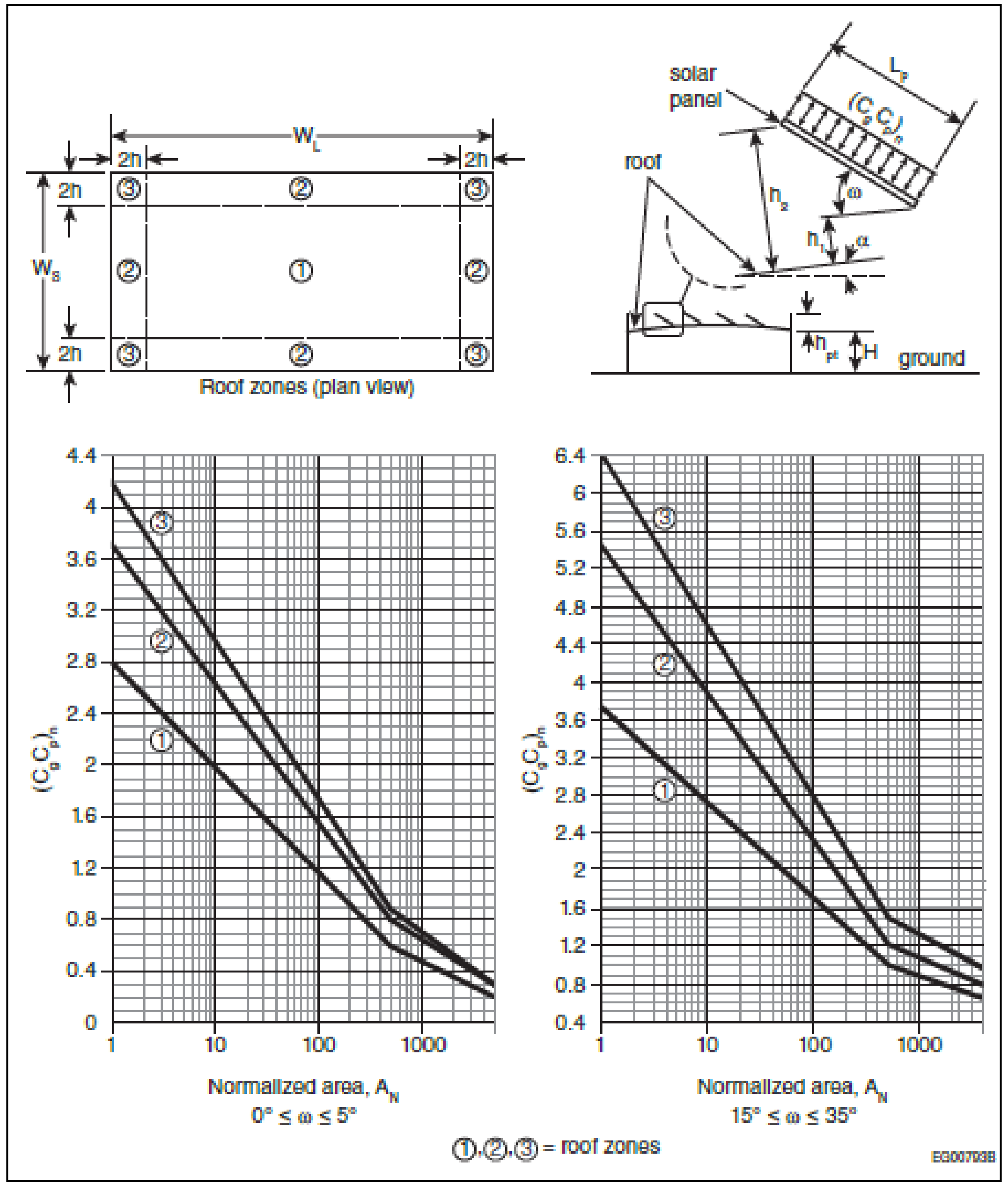 **Notes to Figure 4.1.7.13.-B:** (1) H = height of the *building*. (2) h = reference height of the roof. (3) $(C_gC_p)_n$ values are for both positive and negative values. (4) For panels with 5° < ω < 15°, linear interpolation is permitted.	
4.1.8.1. Analysis **2)** Where $I_EF_sS_a(0.2)$ and $I_EF_sS_a(2.0)$ are less than 0.16 and 0.03 respectively, the deflections and specified loading due to earthquake motions are permitted to be determined in accordance with Sentences (3) to (15), where a) I_E is the earthquake importance factor and has a value of 0.8, 1.0, 1.3 and 1.5 for *buildings* of Low, Normal, High and Post-Disaster importance respectively, b) F_s is the site coefficient based on the average $\bar{N}_{60}$ or $\bar{s}_u$, as defined in. Article 4.1.8.2., for the top 30 m of *soil* below the footings, pile-caps, or mat *foundations* and has a value of i) 1.0 for *rock* sites or when $\bar{N}_{60} > 50$ or s_u > 100 kPa,	**4.1.8.1. Analysis** **2)** Where $I_EF_sS_a(0.2,X_{450})$ and $I_EF_sS_a(2.0,X_{450})$ are less than 0.16 and 0.03 respectively, the deflections and specified loading due to earthquake motions are permitted to be determined in accordance with Sentences (3) to (15), where a) I_E is the earthquake importance factor and has a value of 0.8, 1.0, 1.3 and 1.5 for *buildings* ~~of~~ in the Low, Normal, High and Post-~~D~~disaster ~~i~~Importance Categories respectively, b) F_s is the site coefficient based on the average $\bar{N}_{60}$ or ~~s_u~~ $\bar{s}_u$, as defined in Article 4.1.8.2., for the top 30 m of *soil* below the footings, ~~pile-~~ *pile* caps, or mat *foundations* and has a value of i) 1.0 for *rock* sites or when $\bar{N}_{60} > 50$ or ~~s_u~~ $\bar{s}_u$ > 100 kPa,	

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ii) 1.6 when $15 \le \bar{N}_{60} \le 50$ or 50 kPa ≤ s_u ≤ 100 kPa, and iii) 2.8 for all other cases, and c) $S_a(T)$ is the 5% -damped spectral response acceleration value for period T, determined in accordance with Subsection 1.1.3.	ii) 1.6 when $15 \le \bar{N}_{60} \le 50$ or 50 kPa ≤ ~~s_u~~ $\bar{s}_u$ ≤ 100 kPa, and iii) 2.8 for all other cases, and c) $S_a(T, X_{450})$ is the 5% -damped spectral ~~response~~ acceleration value ~~for~~ at period T~~,~~ for site designation X_{450}, as defined in Article 4.1.8.2., determined in accordance with Subsection 1.1.3. and corresponding to a 2% probability of exceedance in 50 years.	
3) The structure shall have a clearly defined a) Seismic Force Resisting System (SFRS) to resist the earthquake loads and their effects, and b) load path (or paths) that will transfer the inertial forces generated by the earthquake to the *foundations* and supporting ground.	**3)** The structure shall have a clearly defined a) ~~S~~seismic ~~F~~force ~~R~~resisting ~~S~~system (SFRS) to resist the earthquake loads and their effects, and b) load path (or paths) that will transfer the inertial forces generated ~~by the~~ in an earthquake to the ~~*foundations* and~~ supporting ground.	
5) The height above *grade* of SFRS designed in accordance with CSA S136, “North American Specification for the Design of Cold-Formed Steel Structural Members (using the Appendix B provisions applicable to Canada),” shall be less than 15m.	**5)** The height above *grade* of an SFRS designed in accordance with CSA S136, “North American Specification for the Design of Cold-Formed Steel Structural Members (using the Appendix B provisions applicable to Canada),” shall be less than 15 m.	
7) The minimum lateral earthquake design force, V_s, at the base of the structure in the direction under consideration shall be calculated as follows: $V_s = F_sS_a(T_s)I_EW_t/R_s$ where $S_a(T_s)$ = value of S_a at T_s determined by linear interpolation between the value of S_a at 0.2 s, 0.5 s, and 1.0 s, and = $S_a(0.2)$ for $T_s \le 0.2$ s, W_t = sum of W_i over the height of the *building*, where W_i is defined in Article 4.1.8.2., and R_s = … where T_s = fundamental lateral period of vibration of the *building*, as defined in Article 4.1.8.2., = $0.085(h_n)^{3/4}$ for steel moment frames, = $0.075(h_n)^{3/4}$ for concrete moment frames, = 0.1 N for other moment frames, = $0.025h_n$ for braced frames, and = $0.05(h_n)^{3/4}$ for shear walls and other structures, where h_n = height above the base, in m, as defined in Article 4.1.8.2., except that V_s shall not be less than $F_sS_a(1.0)I_EW_t/R_s$ and, in cases where R_s =1.5, V_s need not be greater than $F_sS_a(0.5)I_EW_t/R_s$.	**7)** The ~~minimum~~ specified lateral earthquake ~~design~~ force, V_s, at the base of the structure in the direction under consideration shall be calculated as follows: $V_s = F_sS_a(T_s, X_{450})I_EW$~~$_t$~~$/R_s$ where $S_a(T_s,X_{450})$ = value of S_a ~~at~~ (T_s,X_{450}) determined by linear interpolation between the ~~value~~ values of S_a ~~at 0.2 s, 0.5 s, and 1.0 s, and~~ $(0.2,X_{450})$, $S_a(0.5,X_{450})$ and $S_a(1.0,X_{450})$, = $S_a(0.2,X_{450})$ for $T_s \le 0.2$ s, and = $S_a(1.0,X_{450})$ for $T_s \ge 1.0$ s, W~~$_t$~~ = sum of W_i over the height of the *building*, where W_i is defined in Article 4.1.8.2., and R_s = … where T_s = fundamental lateral period of vibration of the *building*, as defined in Article 4.1.8.2., = $0.085(h_n)^{3/4}$ for steel moment frames, = $0.075(h_n)^{3/4}$ for concrete moment frames, = 0.1~~ ~~N for other moment frames, = $0.025h_n$ for braced frames, and = $0.05(h_n)^{3/4}$ for shear walls and other structures, where h_n = height, in m, above the base~~, in m,~~ to level n, as defined in Article 4.1.8.2.~~, except that V_s shall not be less than $F_sS_a(1.0)I_EW_t/R_s$ and, in cases where R_s =1.5, V_s need not be greater than $F_sS_a(0.5)I_EW_t/R_s$.~~ and N = total number of *storeys* above exterior *grade* to level n, as defined in Article 4.1.8.2., except that, in cases where R_s = 1.5, V_s need not be greater than $F_sS_a(0.5,X_{450})I_EW/R_s$.	
8) The total lateral earthquake design force, V_s, shall be distributed over the height of the *building* in accordance with the following formula: $F_x = V_sW_xh_x/\left(\sum_{i=1}^{n} W_ih_i\right)$ where F_x = force applied through the centre of mass at level x, W_x, W_i portion of W that is located at or is assigned to level x or i respectively, and h_x, h_i = height, in m, above the base of level x and level i as per Article 4.1.8.2.	**8)** The ~~total~~ specified lateral earthquake ~~design~~ force, V_s, shall be distributed over the height of the *building* in accordance with the following formula: $F_x = V_sW_xh_x/\left(\sum_{i=1}^{n} W_ih_i\right)$ where F_x = force applied through the centre of mass at level x, W_x, W_i = portion of W that is located at or is assigned to level x or i respectively, and h_x, h_i = height, in m, above the base ~~of~~ to level x ~~and level~~ or i respectively, as ~~per~~ defined in Article 4.1.8.2.	
13) Except as provided in Sentence (14), where cantilever parapet walls, other cantilever walls, exterior ornamentation and appendages, towers, chimneys or penthouses are connected to or form part of a *building*, they shall be designed, along with their connections, for a lateral force,	**13)** Except as provided in Sentence (14), where cantilever parapet walls, other cantilever walls, exterior ornamentation and appendages, towers, chimneys or penthouses are connected to or form part of a *building*, they shall be designed, along with their connections, for a lateral force,	

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Vsp, distributed according to the distribution of mass of the element and acting in the lateral direction that results in the most critical loading for design using the following equation: $V_{sp} = 0.1F_sI_EW_p$ where W_p = weight of a portion of a structure as defined in Article 4.1.8.2.	Vsp, distributed according to the distribution of mass of the element and acting in the lateral direction that results in the most critical loading for design using the following equation: V_{sp} = ~~0.1~~$S_a(0.2, X_{450})F_sI_EW_p$ where W_p = weight of a portion of a structure as defined in Article 4.1.8.2.	
4.1.8.2. Notation **1)** In this Subsection A_r = response amplification factor to account for type of attachment of mechanical/electrical equipment, as defined in Sentence 4.1.8.18.(1), A_x = amplification factor at level x to account for variation of response of mechanical/electrical equipment with elevation within the *building*, as defined in Sentence 4.1.8.18.(1), B_x = … B = … C_p = seismic coefficient for mechanical/electrical equipment, as defined in Sentence 4.1.8.18.(1), D_{nx} = … e_x = … F_a = site coefficient for application in Subsection 4.1.8., as defined in Sentence 4.1.8.4.(7), F(PGA) = site coefficient for PGA, as defined in Sentence 4.1.8.4.(5), F(PGV) = site coefficient for PGV, as defined in Sentence 4.1.8.4.(5), F_s = … F(T) = site coefficient for spectral acceleration, as defined in Sentence 4.1.8.4.(5), F_t = … F_v = site coefficient for application in Subsection 4.1.8., as defined in Sentence 4.1.8.4.(7), F_x = … h_i, h_n, h_x = the height above the base (i = 0) to level i, n, or x respectively, where the base of the structure is the level at which horizontal earthquake motions are considered to be imparted to the structure, h_s = interstorey height (h_i - h_{i-1}), I_E = … M_v = factor to account for higher mode effect on base shear, as defined in Sentence 4.1.8.11.(6), M = … $\bar{N}_{60}$ = Average Standard Penetration Resistance for the top 30 m, corrected to a rod energy efficiency of 60% of the theoretical maximum, PGA = Peak Ground Acceleration, expressed as a ratio to gravitational acceleration, as defined in Sentence 4.1.8.4.(1), PGA_{ref} = reference PGA for determining F(T), F(PGA) and F(PGV), as defined in Sentence 4.1.8.4.(4), PGV = Peak Ground Velocity, in m/s, as defined in Sentence 4.1.8.4.(1), PI = plasticity index for clays, R_d = ductility-related force modification factor reflecting the capability of a structure to dissipate energy through reversed cyclic inelastic behaviour, as given in Article 4.1.8.9., R_o = … R_s = … S_p = …	**4.1.8.2. Notation** **1)** In this Subsection A_r = ~~response~~ element or component force amplification factor to account for type of attachment ~~of mechanical/electrical equipment~~, as defined in Sentence 4.1.8.18.(1), A_x = ~~amplification~~ height factor at level x to account for variation of response of ~~mechanical/electrical equipment~~ an element or component with elevation within the *building*, as defined in Sentence 4.1.8.18.(1), B_x = … B = … C_p = seismic coefficient for ~~mechanical/electrical equipment~~ an element or component, as defined in Sentence 4.1.8.18.(1), D_{nx} = … e_x = … F_a = acceleration-based site coefficient for application in standards referenced in Subsection 4.1.8., as defined in Sentence 4.1.8.4.(7), ~~F(PGA) = site coefficient for PGA, as defined in Sentence 4.1.8.4.(5),~~ ~~F(PGV) = site coefficient for PGV, as defined in Sentence 4.1.8.4.(5),~~ F_s = … ~~F(T) = site coefficient for spectral acceleration, as defined in Sentence 4.1.8.4.(5),~~ F_t = … F_v = velocity-based site coefficient for application in standards referenced in Subsection 4.1.8., as defined in Sentence 4.1.8.4.(7), F_x = … h_i, h_n, h_x = ~~the~~ height, in m, above the base (i = 0) to level i, n, or x respectively, where the base of the structure is the level at which horizontal earthquake motions are considered to be imparted to the structure, h_s = inter~~storey~~*storey* height (h_i - h_{i-1}), I_E = … M_v = factor to account for higher mode ~~effect~~ effects on base shear, as defined in Sentence 4.1.8.11.(6), M = … $\bar{N}_{60}$ = ~~A~~average ~~S~~standard ~~P~~penetration ~~R~~resistance ~~for~~, in blows per 0.3 m, in the top 30 m of *soil*, corrected to a rod energy efficiency of 60% of the theoretical maximum, PGA(X) = ~~P~~peak ~~G~~ground ~~A~~acceleration, expressed as a ratio to gravitational acceleration, for site designation X, as defined in Sentence 4.1.8.4.(1), ~~PGA_{ref} = reference PGA for determining F(T), F(PGA) and F(PGV), as defined in Sentence 4.1.8.4.(4),~~ PGV(X) = ~~P~~peak ~~G~~ground ~~V~~velocity, in m/s, for site designation X, as defined in Sentence 4.1.8.4.(1), PI = plasticity index for ~~clays~~ *soil*, R_d = ductility-related force modification factor reflecting the capability of a structure to dissipate energy through reversed cyclic inelastic behaviour, as ~~given~~ defined in Article 4.1.8.9., R_o = … R_p = element or component response modification factor, as defined in Sentence 4.1.8.18.(1), R_s = … S_a(T,X) = 5%-damped spectral ~~response~~ acceleration, expressed as a ratio to gravitational acceleration, at period T for site designation X, as defined in Sentence 4.1.8.4.(1), SC = Seismic Category assigned to a *building* based on its Importance Category and the	

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S(T) = design spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period of T, as defined in Sentence 4.1.8.4.(9), $S_a(T)$ = 5% damped spectral response acceleration, expressed as a ratio to gravitational acceleration, for a period of T, as defined in Sentence 4.1.8.4.(1), SFRS = Seismic Force Resisting System(s) is that part of the structural system that has been considered in the design to provide the required resistance to the earthquake forces and effects defined in Subsection 4.1.8., s_u = average undrained shear strength in the top 30 m of *soil*, T = period in seconds, T_a = … Ts = fundamental lateral period of vibration of the *building* or structure, in s, in the direction under consideration, as defined in Sentence 4.1.8.1.(7), Tx = floor torque at level x, as defined in Sentence 4.1.8.11.(11), TDD = Total Design Displacement of any point in a seismically isolated structure, within or above the isolation system, obtained by calculating the mean + (I_E × the standard deviation) of the peak horizontal displacements from all sets of ground motion histories analyzed, but not less than $\sqrt{I_E}$ × the mean, where the peak horizontal displacement is based on the vector sum of the two orthogonal horizontal displacements considered for each time step, V = lateral earthquake design force at the base of the structure, as determined by Article 4.1.8.11., V_d = lateral earthquake design force at the base of the structure, as determined by Article 4.1.8.12., V_e = lateral earthquake elastic force at the base of the structure, as determined by Article 4.1.8.12., V_{ed} = lateral earthquake design elastic force at the base of the structure, as determined by Article 4.1.8.12., V_p = lateral force on a part of the structure, as determined by Article 4.1.8.18., V_s = lateral earthquake design force at the base of the structure, as determined by Sentence 4.1.8.1.(7), for application in Article 4.1.8.1., $\bar{V}_{s30}$ = average shear wave velocity in the top 30 m of *soil* or *rock,* W = *dead load*, as defined in Article 4.1.4.1., except that the minimum *partition* load as defined in Sentence 4.1.4.1.(3) need not exceed 0.5 kPa, plus 25% of the design snow load specified in Subsection 4.1.6., plus 60% of the storage load for areas used for storage, except that *storage garages* need not be considered storage areas, and the full contents of any tanks (see Note A-4.1.8.2.(1)), W_i, W_x = … W_p = … W_t = sum of Wi over the height of the *building*, for application in Sentence 4.1.8.1.(7), δ_{ave} = … δ_{max} = …	design spectral acceleration values at periods of 0.2 s and 1.0 s, as defined in Article 4.1.8.5., SFRS = ~~S~~seismic ~~F~~force ~~R~~resisting ~~S~~system~~(s) is~~, that part of the structural system that has been considered in the design to provide the required resistance to the earthquake forces and effects defined in Subsection 4.1.8., S_p = … S(T) = design spectral ~~response~~ acceleration, expressed as a ratio to gravitational acceleration, ~~for a~~ at period ~~of~~ T, as defined in Sentence 4.1.8.4.(~~9~~6), ~~s~~$\bar{s}_u$ = average undrained shear strength, in kPa, in the top 30 m of *soil*, T = period, in ~~seconds~~ s, T_a = … TDD = ~~T~~total ~~D~~design ~~D~~displacement of any point in a seismically isolated structure, within or above the isolation system, obtained by calculating the mean + (I_E × the standard deviation) of the peak horizontal displacements from all sets of ground motion time histories analyzed, but not less than $\sqrt{I_E}$ × the mean, where the peak horizontal displacement is based on the vector sum of the two orthogonal horizontal displacements considered for each time step, Ts = fundamental lateral period of vibration of the *building* or structure, in s, in the direction under consideration, as defined in Sentence 4.1.8.1.(7), Tx = floor torque at level x, as defined in Sentence 4.1.8.11.(11), V = specified lateral earthquake ~~design~~ force at the base of the structure, as determined ~~by~~ in Article 4.1.8.11., V_d = specified lateral earthquake ~~design~~ force at the base of the structure, as determined ~~by~~ in Article 4.1.8.12., V_e = lateral earthquake elastic force at the base of the structure, as determined ~~by~~ in Article 4.1.8.12., V_{ed} = adjusted lateral earthquake ~~design~~ elastic force at the base of the structure, as determined ~~by~~ in Article 4.1.8.12., V_p = specified lateral earthquake force on ~~a part of the structure~~ an element or component, as determined ~~by~~in Article 4.1.8.18., V_s = specified lateral earthquake ~~design~~ force at the base of the structure, as determined ~~by~~ in Sentence 4.1.8.1.(7), for application in Article 4.1.8.1., ~~$\bar{V}$~~V_{s30} = average shear wave velocity, in m/s, in the top 30 m of *soil* or *rock,* W = specified *dead load*, as defined in Article 4.1.4.1., except that the minimum *partition* ~~load~~ weight as defined in Sentence 4.1.4.1.(3) need not exceed 0.5 kPa, plus 25% of the ~~design~~ specified snow load ~~specified~~ as defined in Subsection 4.1.6., plus 60% of the storage load for areas used for storage, except that *storage garages* need not be considered storage areas, and the full contents of any tanks (see Note A-4.1.8.2.(1)), W_i, W_x = … W_p = … ~~W_t = sum of Wi over the height of the *building*, for application in Sentence 4.1.8.1.(7),~~ X = site designation, either X_V or X_S, X_S = site designation in terms of Site Class, where S is the Site Class determined in accordance with Sentence 4.1.8.4.(3), X_V = site designation in terms of V_{s30}, where V is the V_{s30} value calculated from in situ measurements of shear wave velocity, X_{450} = site designation X_V with V_{s30} = 450 m/s, δ_{ave} = … δ_{max} = …	
4.1.8.4. Site Properties **1)** The peak ground acceleration (PGA), peak ground velocity (PGV), and the 5% damped spectral response acceleration values, Sa(T), for the reference ground conditions (Site Class C in Table 4.1.8.4.-A) for periods T of 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s and 10.0 s shall be determined in accordance with Subsection 1.1.3. and are based on a 2% probability of exceedance in 50 years.	**4.1.8.4. Site Properties** **1)** ~~The~~ For site designation X, as determined in accordance with Sentence (2) or (3), the peak ground acceleration, ~~(~~PGA(X), the peak ground velocity, ~~(~~PGV(X), and the 5% -damped spectral ~~response~~ acceleration values, S_a(T,X), ~~for the reference ground conditions (Site Class C in Table 4.1.8.4.-A) for),~~ at periods T of 0.2 s, 0.5 s, 1.0 s, 2.0 s, 5.0 s and 10.0 s shall a) except as provided in Sentence (4), be determined in accordance with Subsection 1.1.3., and ~~are based on~~ b) except as provided in Article 4.1.8.23., correspond to a 2% probability of exceedance	

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	in 50 years.	
Table 4.1.8.4.-A **Site Classification for Seismic Site Response** Forming Part of Sentences 4.1.8.4.(1) to (3)	~~**Table 4.1.8.4.-A**~~ ~~**Site Classification for Seismic Site Response**~~ ~~Forming Part of Sentences 4.1.8.4.(1) to (3)~~	
*** Table A-4.1.8.4.-A not shown ***	*** Table 4.1.8.4.-A Deleted***	
2) Site classifications for ground shall conform to Table 4.1.8.4.-A and shall be determined using $\overline{V}_{s30}$, orwhere $\overline{V}_{s30}$ is not known, using Sentence (3).	~~**2)** Site classifications for ground shall conform to Table 4.1.8.4.-A and shall be determined using $\overline{V}_{s30}$, orwhere $\overline{V}_{s30}$ is not known, using Sentence (3).~~	
3) If average shear wave velocity, $\overline{V}_{s30}$, is not known, Site Class shall be determined from energy-corrected Average Standard Penetration Resistance, $\overline{N}_{60}$, or from *soil* average undrained shear strength, s_u, as noted in Table 4.1.8.4.-A, $\overline{N}_{60}$ and s_u being calculated based on rational analysis. (See Note A-4.1.8.4.(3) and Table 4.1.8.4.-A.)	~~**3)** If average shear wave velocity, $\overline{V}_{s30}$, is not known, Site Class shall be determined from energy-corrected Average Standard Penetration Resistance, $\overline{N}_{60}$, or from *soil* average undrained shear strength, s_u, as noted in Table 4.1.8.4.-A, $\overline{N}_{60}$ and s_u being calculated based on rational analysis. (See Note A-4.1.8.4.(3) and Table 4.1.8.4.-A.)~~	
4) For the purpose of determining the values of F(T) to be used in the calculation of design spectral acceleration, S(T), in Sentence (9), and the values of F(PGA) and F(PGV), the value of PGA_{ref} to be used with Tables 4.1.8.4.-B to 4.1.8.4.-I shall be taken as a) 0.8 PGA, where the ratio Sa(0.2)/PGA < 2.0, and b) PGA, otherwise.	~~**4)** For the purpose of determining the values of F(T) to be used in the calculation of design spectral acceleration, S(T), in Sentence (9), and the values of F(PGA) and F(PGV), the value of PGA_{ref} to be used with Tables 4.1.8.4.-B to 4.1.8.4.-I shall be taken as~~ ~~a) 0.8 PGA, where the ratio Sa(0.2)/PGA < 2.0, and~~ ~~b) PGA, otherwise.~~	
5) The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.-B to 4.1.8.4.-I using linear interpolation for intermediate values of PGAref.	~~**5)** The values of the site coefficient for design spectral acceleration at period T, F(T), and of similar coefficients F(PGA) and F(PGV) shall conform to Tables 4.1.8.4.-B to 4.1.8.4.-I using linear interpolation for intermediate values of PGAref.~~	
6) Site-specific evaluation is required to determine F(T), F(PGA) and F(PGV) for Site Class F. (See Note A-4.1.8.4.(3) and Table 4.1.8.4.-A.)	~~**6)** Site-specific evaluation is required to determine F(T), F(PGA) and F(PGV) for Site Class F. (See Note A-4.1.8.4.(3) and Table 4.1.8.4.-A.)~~	
7) For all applications in Subsection 4.1.8., F_a = F(0.2) and F_v = F(1.0).	~~**7)** For all applications in Subsection 4.1.8., F_a = F(0.2) and F_v = F(1.0).~~	
8) For structures with a fundamental period of vibration equal to or less than 0.5 s that are built on liquefiable *soils*, Site Class and the corresponding values of F(T) may be determined as described in Tables 4.1.8.4.-A, 4.1.8.4.-B, and 4.1.8.4.-C by assuming that the *soils* are not liquefiable. (See Note A-4.1.8.4.(3) and Table 4.1.8.4.-A.)	~~**8)** For structures with a fundamental period of vibration equal to or less than 0.5 s that are built on liquefiable *soils*, Site Class and the corresponding values of F(T) may be determined as described in Tables 4.1.8.4.-A, 4.1.8.4.-B, and 4.1.8.4.-C by assuming that the *soils* are not liquefiable. (See Note A-4.1.8.4.(3) and Table 4.1.8.4.-A.)~~	
9) The design spectral acceleration values of S(T) shall be determined as follows, using linear interpolation for intermediate values of T: S(T) = F(0.2)S_a(0.2) or F(0.5)S_a(0.5), whichever is larger, for T ≤ 0.2 s = F(0.5)S_a(0.5) for T = 0.5 s = F(1.0)S_a(1.0) for T = 1.0 s = F(2.0)S_a(2.0) for T = 2.0 s = F(5.0)S_a(5.0)for T = 5.0 s = F(10.0)S_a(10.0) for T ≥ 10.0 s	~~**9)** The design spectral acceleration values of S(T) shall be determined as follows, using linear interpolation for intermediate values of T:~~ ~~S(T) = F(0.2)S_a(0.2) or F(0.5)S_a(0.5), whichever is larger, for T ≤ 0.2 s~~ ~~= F(0.5)S_a(0.5) for T = 0.5 s~~ ~~= F(1.0)S_a(1.0) for T = 1.0 s~~ ~~= F(2.0)S_a(2.0) for T = 2.0 s~~ ~~= F(5.0)S_a(5.0)for T = 5.0 s~~ ~~= F(10.0)S_a(10.0) for T ≥ 10.0 s~~	
Table 4.1.8.4.-B **Values of F(0.2) as a Function of Site Class and PGA_{ref}** Forming Part of Sentences 4.1.8.4.(4) and (5)	~~**Table 4.1.8.4.-B**~~ ~~**Values of F(0.2) as a Function of Site Class and PGA_{ref}**~~ ~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~	
*** Table 4.1.8.4.-B not shown ***	*** Table 4.1.8.4.-B Deleted ***	
Table 4.1.8.4.-C **Values of F(0.5) as a Function of Site Class and PGA_{ref}** Forming Part of Sentences 4.1.8.4.(4) and (5)	~~**Table 4.1.8.4.-C**~~ ~~**Values of F(0.5) as a Function of Site Class and PGA_{ref}**~~ ~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~	
*** Table 4.1.8.4.-C not shown ***	*** Table 4.1.8.4.-C Deleted ***	
Table 4.1.8.4.-D **Values of F(1.0) as a Function of Site Class and PGA_{ref}**	~~**Table 4.1.8.4.-D**~~ ~~**Values of F(1.0) as a Function of Site Class and PGA_{ref}**~~	

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td>Forming Part of Sentences 4.1.8.4.(4) and (5)</td><td>~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~</td><td></td></tr>
<tr><td>*** Table 4.1.8.4.-D not shown ***</td><td>*** Table 4.1.8.4.-D Deleted ***</td><td></td></tr>
<tr><td>**Table 4.1.8.4.-E**
Values of F(2.0) as a Function of Site Class and PGA_{ref}
Forming Part of Sentences 4.1.8.4.(4) and (5)</td><td>~~**Table 4.1.8.4.-E**~~
~~**Values of F(2.0) as a Function of Site Class and PGA_{ref}**~~
~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~</td><td></td></tr>
<tr><td>*** Table 4.1.8.4.-E not shown ***</td><td>*** Table 4.1.8.4.-E Deleted ***</td><td></td></tr>
<tr><td>**Table 4.1.8.4.-F**
Values of F(5.0) as a Function of Site Class and PGA_{ref}
Forming Part of Sentences 4.1.8.4.(4) and (5)</td><td>~~**Table 4.1.8.4.-F**~~
~~**Values of F(5.0) as a Function of Site Class and PGA_{ref}**~~
~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~</td><td></td></tr>
<tr><td>*** Table 4.1.8.4.-F not shown ***</td><td>*** Table 4.1.8.4.-F Deleted ***</td><td></td></tr>
<tr><td>**Table 4.1.8.4.-G**
Values of F(10.0) as a Function of Site Class and PGA_{ref}
Forming Part of Sentences 4.1.8.4.(4) and (5)</td><td>~~**Table 4.1.8.4.-G**~~
~~**Values of F(10.0) as a Function of Site Class and PGA_{ref}**~~
~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~</td><td></td></tr>
<tr><td>*** Table 4.1.8.4.-G not shown ***</td><td>*** Table 4.1.8.4.-G Deleted ***</td><td></td></tr>
<tr><td>**Table 4.1.8.4.-H**
Values of F(PGA) as a Function of Site Class and PGA_{ref}
Forming Part of Sentences 4.1.8.4.(4) and (5)</td><td>~~**Table 4.1.8.4.-H**~~
~~**Values of F(PGA) as a Function of Site Class and PGA_{ref}**~~
~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~</td><td></td></tr>
<tr><td>*** Table 4.1.8.4.-H not shown ***</td><td>*** Table 4.1.8.4.-H Deleted ***</td><td></td></tr>
<tr><td>**Table 4.1.8.4.-I**
Values of F(PGV) as a Function of Site Class and PGA_{ref}
Forming Part of Sentences 4.1.8.4.(4) and (5)</td><td>~~**Table 4.1.8.4.-I**~~
~~**Values of F(PGV) as a Function of Site Class and PGA_{ref}**~~
~~Forming Part of Sentences 4.1.8.4.(4) and (5)~~</td><td></td></tr>
<tr><td>*** Table 4.1.8.4.-I not shown ***</td><td>*** Table 4.1.8.4.-I Deleted ***</td><td></td></tr>
<tr><td></td><td>**2)** Except as provided in Sentence (3), the site designation referred to in Sentence (1) shall be determined using the average shear wave velocity, V_{s30}, calculated from in situ measurements of shear wave velocity, as follows:
a) for the ground profiles described in Table 4.1.8.4.-A, the site designation shall be determined in accordance with the Table, and
b) for all other ground profiles, the site designation shall be X_V, where V is the value of V_{s30}.
(See Note A-4.1.8.4.(2) and (3).)</td><td></td></tr>
<tr><td></td><td>**Table 4.1.8.4.-A**
Exceptions for Site Designation Using V_{s30} Calculated from In Situ Measurements
Forming Part of Sentence 4.1.8.4.(2)
<table>
<tr><th colspan="2">Ground Profile Characteristics</th><th rowspan="2">Site Designation</th></tr>
<tr><th>Average Shear Wave Velocity in Top 30 m, V_{s30}, Calculated from In Situ Measurements, in m/s</th><th>Additional Characteristics</th></tr>
<tr><td>$V_{s30} > 760$</td><td>Ground profile contains more than 3 m of softer materials between *rock* and the underside of footing or mat foundations</td><td>X_{760}</td></tr>
<tr><td>$V_{s30} > 140$</td><td>Ground profile contains more than 3 m of *soil* with all the following characteristics:
• plasticity index, PI > 20,</td><td>X_E</td></tr>
</table>
</td><td></td></tr>
</table>

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	• moisture content, w ≥ 40%, and • undrained shear strength, $s_u < 25$ kPa	
$V_{s30} > 140$	Ground profile contains • liquefiable *soil*, quick and highly sensitive clay, collapsible weakly cemented *soil*, or other *soil* susceptible to failure or collapse under seismic loading, • more than 3 m of peat and/or highly organic clay, • more than 8 m of highly plastic *soil* (with PI > 75), or • more than 30 m of soft to medium-stiff clay	X_F
$V_{s30} \leq 140$	n/a	X_F

3) Where V_{s30} calculated from in situ measurements is not available, the site designation referred to in Sentence (1) shall be X_S, where S is the Site Class determined using the energy-corrected average standard penetration resistance, $\overline{N}_{60}$, or the average undrained shear strength, $\bar{s}_u$, in accordance with Table 4.1.8.4.-B, $\overline{N}_{60}$ and $\bar{s}_u$ being calculated based on rational analysis. (See Notes A-4.1.8.4.(3) and A-4.1.8.4.(2) and (3).)

Table 4.1.8.4.-B
Site Classes, S, for Site Designation X_S
Forming Part of Sentence 4.1.8.4.(3)

Site Class, S	Ground Profile	Ground Profile Characteristics		
		Average Shear Wave Velocity in Top 30 m, V_{s30}, in m/s(1)	Average Standard Penetration Resistance in Top 30 m, $\overline{N}_{60}$, in Blows per 0.3 m	Average Undrained Shear Strength in Top 30 m, $\bar{s}_u$, in kPa
A	Hard *rock*(2)	$V_{s30} > 1\,500$	n/a	n/a
B	*Rock*(2)	$760 < V_{s30} \leq 1\,500$	n/a	n/a
C	Very dense *soil* and soft *rock*	$360 < V_{s30} \leq 760$	$\overline{N}_{60} > 50$	$\bar{s}_u > 100$
D	Stiff *soil*	$180 < V_{s30} \leq 360$	$15 < \overline{N}_{60} \leq 50$	$50 < \bar{s}_u \leq 100$
E	Soft *soil*	$140 < V_{s30} \leq 180$	$10 < \overline{N}_{60} \leq 15$	$40 < \bar{s}_u \leq 50$
		Any ground profile other than Site Class F that contains more than 3 m of *soil* with all the following characteristics: • plasticity index, PI > 20, • moisture content, w ≥ 40%, and • undrained shear strength, $s_u < 25$ kPa		
		$V_{s30} \leq 140$	$\overline{N}_{60} \leq 10$	$\bar{s}_u \leq 40$
F	Other *soils*(3)	Any ground profile that contains • liquefiable *soil*, quick and highly sensitive clay, collapsible weakly cemented *soil*, or other *soil* susceptible to failure or collapse under seismic loading, • more than 3 m of peat and/or highly organic clay, • more than 8 m of highly plastic *soil* (with PI > 75), or • more than 30 m of soft to medium-stiff clay		

Notes to Table 4.1.8.4.-B:

(1) See Note A-4.1.8.4.(2) and (3).

(2) Site designations X_A and X_B, corresponding to Site Classes A and B, are not to be used in cases where the ground profile contains more than 3 m of softer materials between *rock* and the underside of footing or mat *foundations*. The appropriate site designation for such cases is X_{760}.

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td></td><td>(3) Site-specific geotechnical evaluation is required.

4) Site-specific geotechnical evaluation is required to determine the values of $PGA(X_F)$, $PGV(X_F)$ and $S_a(T,X_F)$ for site designation X_F.

5) Where structures on liquefiable <i>soils</i> have a fundamental lateral period, T_a, of 0.5 s or less, the site designation X and the corresponding values of $S_a(T,X)$ and PGA(X) are permitted to be determined in accordance with Sentence (1) by assuming that the <i>soils</i> are not liquefiable.

6) The design spectral acceleration, S(T), shall be determined in accordance with Table 4.1.8.4.-C, using log–log or linear interpolation for intermediate values of T. (See Note A-4.1.8.4.(6).)

Table 4.1.8.4.-C
Design Spectral Acceleration
Forming Part of Sentence 4.1.8.4.(6)

<table>
<tr><th>Period, T, in s</th><th>Design Spectral Acceleration, S(T)</th></tr>
<tr><td>≤ 0.2</td><td>$S_a(0.2,X)$ or $S_a(0.5,X)$, whichever is greater</td></tr>
<tr><td>0.5</td><td>$S_a(0.5,X)$</td></tr>
<tr><td>1.0</td><td>$S_a(1.0,X)$</td></tr>
<tr><td>2.0</td><td>$S_a(2.0,X)$</td></tr>
<tr><td>5.0</td><td>$S_a(5.0,X)$</td></tr>
<tr><td>10.0</td><td>$S_a(10.0,X)$</td></tr>
</table>

7) Where required for the application of a standard referenced in this Subsection, the acceleration-based site coefficient, F_a, for site designation X shall be taken as $S(0.2)/S_a(0.2,X_{450})$ and the velocity-based site coefficient, F_v, for site designation X shall be taken as $S(1.0)/S_a(1.0,X_{450})$.</td><td></td></tr>
<tr><td>4.1.8.5. Importance Factor

1) The earthquake importance factor, I_E, shall be determined according to Table 4.1.8.5.

Table 4.1.8.5. Importance Factor for Earthquake Loads and Effects, I_E
Importance Factor for Earthquake Loads and Effects, I_E
Forming Part of Sentence 4.1.8.5.(1)
…

Notes to Table 4.1.8.5.:
(1) See Article 4.1.8.13.
(2) See Note A-Table 4.1.8.5.</td><td>4.1.8.5. Importance Factor and Seismic Category

1) The earthquake importance factor, I_E, shall be determined according to Table 4.1.8.5.-A

Table 4.1.8.5.-A Importance Factor for Earthquake Loads and Effects, I_E
Importance Factor for Earthquake Loads and Effects, I_E
Forming Part of Sentence 4.1.8.5.(1)
…

Notes to Table 4.1.8.5.-A:
(1) See Article 4.1.8.13.
(2) See Note A-Table 4.1.8.5.-A.

2) <i>Buildings</i> shall be assigned a Seismic Category in accordance with Table 4.1.8.5.-B.

Table 4.1.8.5.-B
Seismic Categories for Buildings
Forming Part of Sentence 4.1.8.5.(2)

<table>
<tr><td>Seismic Category[1]</td><td>$I_ES(0.2)$</td><td>$I_ES(1.0)$</td></tr>
<tr><td>SC1</td><td>$I_ES(0.2) < 0.2$</td><td>$I_ES(1.0) < 0.1$</td></tr>
<tr><td>SC2</td><td>$0.2 \le I_ES(0.2) < 0.35$</td><td>$0.1 \le I_ES(1.0) < 0.2$</td></tr>
<tr><td>SC3</td><td>$0.35 \le I_ES(0.2) \le 0.75$</td><td>$0.2 \le I_ES(1.0) \le 0.3$</td></tr>
<tr><td>SC4</td><td>$I_ES(0.2) > 0.75$</td><td>$I_ES(1.0) > 0.3$</td></tr>
</table></td><td></td></tr>
</table>

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td></td><td>**Notes to Table 4.1.8.5.-B:**
(1) The Seismic Category of a *building* shall be taken as the more severe of the categories determined on the basis of $I_ES(0.2)$ and $I_ES(1.0)$, irrespective of the fundamental lateral period of the *building*, T_a.</td><td></td></tr>
<tr><td>

4.1.8.6. Structural Configuration

3) Except as required by Article 4.1.8.10., in cases where $I_EF_aS_a(0.2)$ is equal to or greater than 0.35, structures designated as irregular must satisfy the provisions referenced in Table 4.1.8.6.

Table 4.1.8.6.
Structural Irregularities(1)(2)
Forming Part of Sentence 4.1.8.6.(1)

<table>
<tr><th>Type</th><th>Irregularity Type and Definition</th><th>Notes</th></tr>
<tr><td>1</td><td>**Vertical Stiffness Irregularity**
Vertical stiffness irregularity shall be considered to exist when the lateral stiffness of the SFRS in a *storey* is less than 70% of the stiffness of any adjacent *storey*, or less than 80% of the average stiffness of the three *storeys* above or below.</td><td>(3)(4)</td></tr>
<tr><td>…</td><td>…</td><td>…</td></tr>
<tr><td>7</td><td>**…**</td><td>(3)(4)(6)</td></tr>
<tr><td>8</td><td>…</td><td>(3)(7)</td></tr>
<tr><td>9</td><td>**Gravity-Induced Lateral Demand Irregularity**
Gravity-induced lateral demand irregularity on the SFRS shall be considered to exist where the ratio, α, calculated in accordance with Sentence 4.1.8.10.(5), exceeds 0.1 for an SFRS with self-centering characteristics and 0.03 for other systems.</td><td>(3)(4)(7)</td></tr>
</table>

Notes to Table 4.1.8.6.:
…

(5) See Article 4.1.8.15.
(6) See Sentences 4.1.8.11.(10), (11) and 4.1.8.12.(4).
(7) See Article 4.1.8.8.

</td><td>

4.1.8.6. Structural Configuration

3) Except as required by Article 4.1.8.10., ~~in cases~~ where ~~$I_EF_aS_a(0.2)$ is equal to or greater than 0.35,~~ the Seismic Category is SC3 or SC4, structures designated as irregular must satisfy the provisions referenced in Table 4.1.8.6.

Table 4.1.8.6.
Structural Irregularities(1)(2)
Forming Part of ~~Sentence~~ Sentences 4.1.8.6.(1) and (3), Clause 4.1.8.7.(1)(c) and Article 4.1.8.10.

<table>
<tr><th>Type</th><th>Irregularity Type and Definition</th><th>Notes</th></tr>
<tr><td>1</td><td>**Vertical Stiffness Irregularity**
~~Vertical~~ For concrete and masonry shear walls, vertical stiffness irregularity shall be considered to exist ~~when~~ where the lateral stiffness of the SFRS in ~~a~~ any *storey* is less than 70% of the stiffness ~~of any~~ in an adjacent *storey*, or less than 80% of the average stiffness ~~of~~ in the three *storeys* above or below. For all other types of SFRS, vertical stiffness irregularity shall be considered to exist where the inter*storey* deflection under lateral earthquake forces divided by the inter*storey* height, hs, of any *storey* is greater than 130% of that of an adjacent *storey*.</td><td>(3)(4)</td></tr>
<tr><td>…</td><td>…</td><td>…</td></tr>
<tr><td>7</td><td>**…**</td><td>(3)(4)(~~6~~7)</td></tr>
<tr><td>8</td><td>…</td><td>(3)(~~7~~8)</td></tr>
<tr><td>9</td><td>**Gravity-Induced Lateral Demand Irregularity**
Gravity-induced lateral demand irregularity on the SFRS shall be considered to exist where the ratio~~,~~ α~~,~~ calculated in accordance with Sentence 4.1.8.10.(~~5~~7), exceeds 0.1 for an SFRS with self-centering characteristics and 0.03 for other systems.</td><td>(3)(4)(~~7~~8)</td></tr>
<tr><td>10</td><td>**Sloped Column Irregularity**
Sloped column irregularity shall be considered to exist where a vertical member that is inclined more than 2° from the vertical supports a portion of the weight of the *building* in axial compression.</td><td>(4)</td></tr>
</table>

Notes to Table 4.1.8.6.:
…
(5) Increased stiffness in *storeys* below *grade* need not be considered in the determination of vertical stiffness irregularity.
(~~5~~6)See Article 4.1.8.15.
(~~6~~7)See Sentences 4.1.8.11.(10)~~,~~ and (11), and 4.1.8.12.(4).
(~~7~~8)See Article 4.1.8.8.

</td><td></td></tr>
<tr><td>

4.1.8.7. Methods of Analysis

1) Analysis for design earthquake actions shall be carried out in accordance with the Dynamic Analysis Procedure described in Article 4.1.8.12. (see Note A-4.1.8.7.(1)), except that the Equivalent Static Force Procedure described in Article 4.1.8.11. may be used for structures that meet any of the following criteria:
a) in cases where $I_EF_aS_a(0.2)$ is less than 0.35,
b) …
c) structures with structural irregularity, of Type 1, 2, 3, 4, 5, 6 or 8 as defined in Table 4.1.8.6., that are less than 20 m in height and have a fundamental lateral period, T_a,

</td><td>

4.1.8.7. Methods of Analysis

1) Analysis for ~~design~~ earthquake actions shall be carried out in accordance with the Dynamic Analysis Procedure described in Article 4.1.8.12. (see Note A-4.1.8.7.(1)), except that the Equivalent Static Force Procedure described in Article 4.1.8.11. may be used for structures that meet any of the following criteria:
a) ~~in cases where $I_EF_aS_a(0.2)$ is less than 0.35~~ where the Seismic Category is SC1 or SC2,
b) …
c) structures with a structural irregularity~~,~~ of Type ~~1,~~ 2, 3, 4, 5, 6 or 8 as defined in Table 4.1.8.6.~~,~~ that are less than 20 m in height and have a fundamental lateral period, T_a,

</td><td></td></tr>
</table>

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
<tr><td>less than 0.5 s in each of two orthogonal directions as defined in Article 4.1.8.8.</td><td>less than 0.5 s in each of two orthogonal directions as defined in Article 4.1.8.8.</td><td></td></tr>
<tr><td>**4.1.8.8. Direction of Loading**

1) Earthquake forces shall be assumed to act in any horizontal direction, except that the following shall be considered to provide adequate design force levels in the structure:
a) …
b) where the components of the SFRS are not oriented along a set of orthogonal axes and $I_EF_aS_a(0.2)$ is less than 0.35, independent analyses about any two orthogonal axes is permitted, or
c) where the components of the SFRS are not oriented along a set of orthogonal axes and $I_EF_aS_a(0.2)$ is equal to or greater than 0.35, analysis of the structure independently in any two orthogonal directions for 100% of the prescribed earthquake loads applied in one direction plus 30% of the prescribed earthquake loads in the perpendicular direction, with the combination requiring the greater element strength being used in the design.</td><td>**4.1.8.8. Direction of Loading**

1) Earthquake forces shall be assumed to act in any horizontal direction, except that the following shall be considered to provide adequate design force levels in the structure:
a) …
b) where the components of the SFRS are not oriented along a set of orthogonal axes and ~~$I_EF_aS_a(0.2)$ is less than 0.35~~ the Seismic Category is SC1 or SC2, independent analyses about any two orthogonal axes is permitted, or
c) where the components of the SFRS are not oriented along a set of orthogonal axes and ~~$I_EF_aS_a(0.2)$ is equal to or greater than 0.35~~ the Seismic Category is SC3 or SC4, analysis of the structure independently in any two orthogonal directions for 100% of the ~~prescribed~~ specified earthquake loads applied in one direction plus 30% of the ~~prescribed~~ specified earthquake loads in the perpendicular direction, with the combination requiring the greater element strength being used in the design.</td><td></td></tr>
<tr><td>**4.1.8.9. SFRS Force Reduction Factors, System Overstrength Factors, and General Restrictions**

1) Except as provided in Sentence 4.1.8.20.(7), the values of R_d and R_o and the corresponding system restrictions shall conform to Table 4.1.8.9. and the requirements of this Subsection.

5) If it can be demonstrated through testing, research and analysis that the seismic performance of a structural system is at least equivalent to one of the types of SFRS mentioned in Table 4.1.8.9., then such a structural system will qualify for values of R_d and R_o corresponding to the equivalent type in that Table. (See Note A-4.1.8.9.(5).)

Table 4.1.8.9.
SFRS Ductility-Related Force Modification Factors, R_d, Overstrength-Related Force Modification Factors, R_o, and General Restrictions(1)
Forming Part of Sentences 4.1.8.9.(1) and (5)

<table>
<tr><th rowspan="3">Type of SFRS</th><th rowspan="3">R_d</th><th rowspan="3">R_o</th><th colspan="5">Restrictions(2)</th></tr>
<tr><th colspan="4">Cases Where $I_EF_aS_a(0.2)$</th><th>Cases Where $I_EF_vS_a(1.0)$</th></tr>
<tr><th>< 0.2</th><th>≥ 0.2 to < 0.35</th><th>≥ 0.35 to ≤ 0.75</th><th>> 0.75</th><th>> 0.3</th></tr>
<tr><td colspan="8">Steel Structures Designed and Detailed According to CSA S16(3)(4)</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Limited ductility plate walls</td><td>2.0</td><td>1.5</td><td>NL</td><td>NL</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td colspan="8">Concrete Structures Designed and Detailed According to CSA A23.3</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>Conventional construction
Moment-resisting frames</td><td>1.5</td><td>1.3</td><td>NL</td><td>NL</td><td>20</td><td>15</td><td>10(5)</td></tr>
</table></td><td>**4.1.8.9. SFRS Force ~~Reduction~~ Modification Factors~~, System Overstrength Factors,~~ and General Restrictions**

1) Except as provided in ~~Sentence~~ Articles 4.1.8.20.~~(7),~~ and 4.1.8.22., the values of R_d and R_o and the corresponding system restrictions shall conform to Table 4.1.8.9. and the requirements of this Subsection.

5) If it can be demonstrated through testing, research and analysis that the seismic performance of a structural system is at least equivalent to one of the types of SFRS ~~mentioned~~ defined in Table 4.1.8.9., then such a structural system will qualify for values of R_d and R_o corresponding to the equivalent type in that Table. (See Note A-4.1.8.9.(5).)

Table 4.1.8.9.
SFRS Ductility-Related Force Modification Factors, R_d, Overstrength-Related Force Modification Factors, R_o, and General Restrictions(1)
Forming Part of Sentences 4.1.8.9.(1) and (5), 4.1.8.10.(5) and (6), 4.1.8.11.(12), 4.1.8.15.(9) and 4.1.8.20.(8)

<table>
<tr><th rowspan="3">Type of SFRS</th><th rowspan="3">R_d</th><th rowspan="3">R_o</th><th colspan="5">Restrictions(2)</th></tr>
<tr><th colspan="4">~~Cases Where $I_EF_aS_a(0.2)$~~ Seismic Category</th><th>~~Cases Where $I_EF_vS_a(1.0)$~~</th></tr>
<tr><th>~~< 0.2~~ SC1</th><th>~~≥ 0.2 to < 0.35~~ SC2</th><th>~~≥ 0.35 to ≤ 0.75~~ SC3</th><th>~~> 0.75~~ SC4</th><th>~~> 0.3~~</th></tr>
<tr><td colspan="8">Steel Structures Designed and Detailed According to CSA S16(3)(4)</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td rowspan="9">*** entire column deleted ***</td></tr>
<tr><td>Moderately ductile truss moment-resisting frames</td><td>3.5</td><td>1.6</td><td>NL</td><td>NL</td><td>50</td><td>30</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>Moderately ductile plate walls</td><td>3.5</td><td>1.3</td><td>NL</td><td>NL</td><td>40</td><td>40</td></tr>
<tr><td>Limited ductility plate walls</td><td>2.0</td><td>~~1.5~~
1.3</td><td>NL</td><td>NL</td><td>60</td><td>60</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td colspan="7">Concrete Structures Designed and Detailed According to CSA A23.3</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>Conventional construction
Moment-resisting frames</td><td>1.5</td><td>1.3</td><td>NL</td><td>NL</td><td>20</td><td>~~15~~
10(5)(6)</td></tr>
</table></td><td></td></tr>
</table>

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Shear walls Two-way slabs without beams	1.5 1.3	1.3 1.3	NL 20	NL 15	40 NP	30 NP	30 NP
Tilt-up construction Moderately ductile walls and frames Limited ductility walls and frames Conventional walls and frames	 2.0 1.5 1.3	 1.3 1.3 1.3	 30 30 25	 25 25 20	 25 20 NP	 25 20 NP	 25 20(6) NP
Other concrete SFRS(s) not listed above	1.0	1.0	15	15	NP	NP	NP
Timber Structures Designed and Detailed According to CSA O86							
…	…	…	…	…	…	…	…
Other wood- or gypsum-based SFRS(s) not listed above	1.0	1.0	15	15	NP	NP	NP
…	…	…	…	…	…	…	…
Cold-Formed Steel Structures Designed and Detailed According to CSA S136							
…	…	…	…	…	…	…	…
Other cold-formed SFRS(s) not defined above	1.0	1.0	15	15	NP	NP	NP

Notes to Table 4.1.8.9.:

…

(5) Frames limited to a maximum of 2 *storeys*.

(6) Frames limited to a maximum of 3 *storeys*.

4.1.8.10. Additional System Restrictions

1) Except as required by Clause (2)(b), structures with a Type 6 irregularity, Discontinuity in Capacity - Weak Storey, as described in Table 4.1.8.6., are not permitted unless $I_E F_a S_a(0.2)$ is less than 0.2 and the forces used for design of the SFRS are multiplied by $R_d R_o$.

2) *Post-disaster buildings* shall
- a) not have any irregularities conforming to Types 1, 3, 4, 5, 7 and 9 as described in Table 4.1.8.6., in cases where $I_E F_a S_a(0.2)$ is equal to or greater than 0.35,
- b) not have a Type 6 irregularity as described in Table 4.1.8.6.,
- c) have an SFRS with an R_d of 2.0 or greater, and
- d) have no *storey* with a lateral stiffness that is less than that of the *storey* above it

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Shear walls Two-way slabs without beams	1.5 1.3	1.3 1.3	NL 20	NL 15	40 NP	30 NP	
Tilt-up construction Moderately ductile walls and frames Limited ductility walls and frames Conventional walls and frames	 2.0 1.5 1.3	 1.3 1.3 1.3	 30 30 25	 25 25 20	 25 20 NP	 25 20(7) NP	
Other concrete SFRS~~(~~s~~)~~ not listed above	1.0	1.0	15	15	NP	NP	
Timber Structures Designed and Detailed According to CSA O86							
…	…	…	…	…	…	…	
Moderately ductile cross-laminated timber shear walls: platform-type construction	2.0	1.5	30	30	30	20	
Limited ductility cross-laminated timber shear walls: platform-type construction	1.0	1.3	30	30	30	20	
…	…	…	…	…	…	…	
Other wood- or gypsum-based SFRS~~(~~s~~)~~ not listed above	1.0	1.0	15	15	NP	NP	
…	…	…	…	…	…	…	
Cold-Formed Steel Structures Designed and Detailed According to CSA S136							
…	…	…	…	…	…	…	
Other cold-formed SFRS~~(~~s~~)~~ not defined above	1.0	1.0	15	15	NP	NP	

Notes to Table 4.1.8.9.:

…

(5) Frames are limited to a maximum of 2 *storeys*.

(6) The maximum height limit is permitted to be increased to 15 m where $I_E S(1.0) \le 0.3$.

(~~6~~7)Frames are limited to a maximum of 3 *storeys*.

4.1.8.10. Additional System Restrictions

1) Except as required by Clause (2)(b), structures with a Type 6 irregularity, Discontinuity in Capacity - Weak Storey, as described in Table 4.1.8.6., are not permitted unless ~~$I_E F_a S_a(0.2)$ is less than 0.2~~ the Seismic Category is SC1 and the forces used for design of the SFRS are multiplied by $R_d R_o$.

2) *Post-disaster buildings* shall
- a) not have ~~any irregularities~~ ~~conforming to Types~~ Type 1, 3, 4, 5, 7 ~~and~~ 9, or 10 irregularities as described in Table 4.1.8.6., ~~in cases~~ where ~~$I_E F_a S_a(0.2)$ is equal to or greater than 0.35~~ The Seismic Category is SC3 or SC4,
- b) not have a Type 6 irregularity as described in Table 4.1.8.6.,
- c) have an SFRS with an R_d of 2.0 or greater, ~~and~~
- d) where they are constructed with concrete or masonry shear walls, have no *storey* with a lateral stiffness that is less than that of the *storey* above it, and
- e) where they are constructed with other types of SFRS, have no *storey* for which the inter*storey* deflection under lateral earthquake forces divided by the inter*storey* height, h_s, is greater than that of the *storey* above it.

3) High Importance Category *buildings* shall
- a) not have Type 1, 3, 4, 5, 7, 9 or 10 irregularities as described in Table 4.1.8.6., where the Seismic Category is SC4,
- b) not have a Type 6 irregularity as described in Table 4.1.8.6.,
- c) have an SFRS with an R_d of at least
  - i) 2.0 where the Seismic Category is SC4, and
  - ii) 1.5 otherwise,
- d) where they are constructed with concrete or masonry shear walls, have no *storey* with a lateral stiffness that is less than that of the *storey* above it, and

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	e) where they are constructed with other types of SFRS, have no *storey* for which the inter*storey* deflection under lateral earthquake forces divided by the inter*storey* height, h_s, is greater than that of the *storey* above it.	
3) For *buildings* having fundamental lateral periods, T_a, of 1.0 s or greater, and where $I_EF_vS_a(1.0)$ is greater than 0.25, shear walls that are other than wood-based and form part of the SFRS shall be continuous from their top to the *foundation* and shall not have irregularities of Type 4 or 5 as described in Table 4.1.8.6.	**~~3~~4)** ~~For *buildings* having~~ Where the fundamental lateral period~~s~~, T_a, ~~of 1.0 s or~~ is greater~~,~~ than or equal to 1.0 s and ~~where $I_EF_vS_a$~~I_ES(1.0) is greater than 0.25, shear walls that are other than wood-based and form part of the SFRS shall be continuous from their top to the *foundation* and shall not have Type 4 or 5 irregularities ~~of Type 4 or 5~~ as described in Table 4.1.8.6.	
4) For *buildings* constructed with more than 4 *storeys* of continuous wood construction and where IEFaSa(0.2) is equal to or greater than 0.35, timber SFRS consisting of shear walls with wood-based panels or of braced or moment-resisting frames as defined in Table 4.1.8.9. within the continuous wood construction shall not have Type 4 or Type 5 irregularities as described in Table 4.1.8.6. (See Note A-4.1.8.10.(4).)	**~~4~~5)** For *buildings* in Seismic Category SC3 or SC4 that are constructed with more than 4 *storeys* of continuous wood construction ~~and where IEFaSa(0.2) is equal to or greater than 0.35~~, timber SFRSs consisting of shear walls with wood-based panels or of braced or moment-resisting frames as defined in Table 4.1.8.9. within the continuous wood construction shall not have Type 4 or ~~Type~~ 5 irregularities as described in Table 4.1.8.6. (See Note A-4.1.8.10.(~~4~~5) and (6).)	
	6) For *buildings* in Seismic Category SC3 or SC4 that are constructed with more than 4 *storeys* of continuous wood construction, timber SFRSs consisting of moderately ductile or limited ductility cross-laminated timber shear walls, platform-type construction, as defined in Table 4.1.8.9. within the continuous wood construction shall not have Type 4, 5, 6, 8, 9 or 10 irregularities as described in Table 4.1.8.6. (See Note A-4.1.8.10.(5) and (6).)	
5) The ratio~~,~~ α~~,~~ for a Type 9 irregularity as described in Table 4.1.8.6. shall be determined independently for each orthogonal direction using the following equation: $\alpha = Q_g/Q_y$ where Q_G = … Q_y = the resistance of the yielding mechanism required to resist the minimum earthquake loads, which need not be taken as less than R_o multiplied by the minimum lateral earthquake force as determined in Article 4.1.8.11. or 4.1.8.12., as appropriate. (See Note A-4.1.8.10.(5).)	**~~5~~7)** The ratio~~,~~ α~~,~~ for a Type 9 irregularity as described in Table 4.1.8.6. shall be determined independently for each orthogonal direction using the following equation: $\alpha = Q_g/Q_y$ where Q_G = … Q_y = the resistance of the yielding mechanism required to resist the ~~minimum~~ earthquake loads, which need not be taken as less than R_o multiplied by the ~~minimum~~ specified lateral earthquake force as determined in Article 4.1.8.11. or 4.1.8.12., as appropriate. (See Note A-4.1.8.10.(~~5~~7).)	
6) For *buildings* with a Type 9 irregularity as described in Table 4.1.8.6. and where $I_EF_aS_a(0.2)$ is equal to or greater than 0.5, deflections determined in accordance with Article 4.1.8.13. shall be multiplied by 1.2.	**~~6~~8)** For *buildings* with a Type 9 irregularity as described in Table 4.1.8.6. and where ~~$I_EF_aS_a$~~I_ES(0.2) is equal to or greater than 0.5, deflections determined in accordance with Article 4.1.8.13. shall be multiplied by 1.2.	
7) Structures where the value of α, as determined in accordance with Sentence (5), exceeds twice the limits specified in Table 4.1.8.6. for a Type 9 irregularity, and where $I_EF_aS_a(0.2)$ is equal to or greater than 0.5, are not permitted unless determined to be acceptable based on non-linear dynamic Analysis studies. (See Note A-4.1.8.10.(7).)	**~~7~~9)** ~~Structures~~ For *buildings* where the value of α, as determined in accordance with Sentence (~~5~~7), exceeds twice the appropriate limit~~s~~ specified in Table 4.1.8.6. for a Type 9 irregularity~~,~~ and where ~~$I_EF_aS_a$~~I_ES(0.2) is equal to or greater than 0.5, ~~are not permitted unless determined to be acceptable based on~~ a ~~n~~Non-linear ~~d~~Dynamic ~~A~~analysis ~~studies.~~ of the structure shall be carried out in accordance with Article 4.1.8.12. and the following criteria: a) the analysis shall account for the effects of the vertical response of the *building* mass, b) the analysis shall account for the effects of the vertical response of *building* components that undergo a vertical displacement when displaced laterally, c) the analysis shall use vertical ground motion time histories that are compatible with horizontal ground motion time histories scaled to the target response spectrum and that are applied concurrently with the horizontal ground motion time histories, d) the largest inter*storey* deflection at any level of the *building* as determined from the analysis shall not be greater than 60% of the appropriate limit stated in Sentence 4.1.8.13.(3), and e) the results of an analysis using the ground motion time histories in Clause (c) multiplied by 1.5 shall satisfy the non-linear acceptance criteria. (See Note A-4.1.8.10.(~~7~~9).)	
	10) The design of *buildings* in Seismic Category SC3 or SC4 with a Type 10 irregularity as described in Table 4.1.8.6. shall satisfy the following requirements: a) the structure shall be designed to resist the additional earthquake forces due to the	

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	vertical accelerations of the mass supported by inclined vertical members (see Note A-4.1.8.10.(10)(a)), and b) the effects of the horizontal and vertical movements of inclined vertical members, while undergoing earthquake-induced deformations, on the floor systems they support shall be considered in the design of the *building* and accounted for in the application of Sentence 4.1.8.3.(5).	
4.1.8.11. Equivalent Static Force Procedure for Structures Satisfying the Conditions of Article 4.1.8.7. **2)** Except as provided in Sentence (12), the minimum lateral earthquake force, V, shall be calculated using the following formula: $V = S(T_a)M_vI_EW/(R_dR_o)$ except a) … b) for moment-resisting frames, braced frames, and other systems, V shall not be less than $S(2.0)M_vI_EW/(R_dR_o)$ c) for *buildings* located on a site other than Class F and having an SFRS with an R_d equal to or greater than 1.5, V need not be greater than the larger of $\frac{2}{3}S(0.2)I_EW/(R_dR_o)$ and $S(0.5)\ I_EW/(R_dR_o)$ **3)** Except as provided in Sentence (4), the fundamental lateral period, T_a, in the direction under consideration in Sentence (2), shall be determined as: a) for moment-resisting frames that resist 100% of the required lateral forces and where the frame is not enclosed by or adjoined by more rigid elements that would tend to prevent the frame from resisting lateral forces, and where h_n is in metres: i) $0.085\ (h_n)^{3/4}$ for steel moment frames, ii) $0.075\ (h_n)^{3/4}$ for concrete moment frames, or iii) 0.1 N for other moment frames, b) $0.025h_n$ for braced frames where h_n is in metres, c) $0.05\ (h_n)^{3/4}$ for shear wall and other structures where h_n is in metres, or d) other established methods of mechanics using a structural model that complies with the requirements of Sentence 4.1.8.3.(8), except that i) for moment-resisting frames, T_a shall not be taken greater than 1.5 times that determined in Clause (a), ii) for braced frames, T_a shall not be taken greater than 2.0 times that determined in Clause (b), iii) for shear wall structures, T_a shall not be taken greater than 2.0 times that determined in Clause (c), iv) for other structures, T_a shall not be taken greater than that determined in Clause (c), and v) … **7)** The total lateral seismic force, V, shall be distributed such thata portion, F_t, shall be assumed to be concentrated at the top of the *building*, where F_t is equal to $0.07\ T_aV$ but need not exceed 0.25 V and may be considered as zero where the fundamental lateral period, T_a, does not exceed 0.7 s; the remainder, $V - F_t$, shall be distributed along the height of the *building*, including the top level, in accordance with the following formula: …	**4.1.8.11. Equivalent Static Force Procedure for Structures Satisfying the Conditions of Article 4.1.8.7.** **2)** Except as provided in Sentence (12), the ~~minimum~~ specified lateral earthquake force, V, shall be calculated using the following formula: $V = S(T_a)M_vI_EW/(R_dR_o)$ except a) … b) for moment-resisting frames, braced frames, and other systems, V shall not be less than $S(2.0)M_vI_EW/(R_dR_o)$, and c) for *buildings* located on a site designated as other than ~~Class F~~ X_F and having an SFRS with an R_d equal to or greater than 1.5, V need not be greater than the larger of ~~$\frac{2}{3}$~~(2/3)$S(0.2)I_EW/(R_dR_o)$ and $S(0.5)\ I_EW/(R_dR_o)$ **3)** Except as provided in Sentence (4), the fundamental lateral period, T_a, in the direction under consideration in Sentence (2), shall be determined as: a) for moment-resisting frames that resist 100% of the ~~required~~ lateral earthquake forces and where the frame is not enclosed by or adjoined by more rigid elements that would tend to prevent the frame from resisting lateral forces~~, and where h_n is in metres~~: i) $0.085(h_n)^{3/4}$ for steel moment frames, ii) $0.075(h_n)^{3/4}$ for concrete moment frames, or iii) 0.1N for other moment frames, b) $0.025h_n$ for braced frames ~~where h_n is in metres~~, c) $0.05(h_n)^{3/4}$ for shear wall and other structures ~~where h_n is in metres~~, or d) other established methods of mechanics using a structural model that complies with the requirements of Sentence 4.1.8.3.(8), except that i) for moment-resisting frames, T_a shall not be taken as greater than 1.5 times that determined in Clause (a), ii) for braced frames, T_a shall not be taken as greater than 2.0 times that determined in Clause (b), iii) for shear wall structures, T_a shall not be taken as greater than 2.0 times that determined in Clause (c), iv) for other structures, T_a shall not be taken as greater than that determined in Clause (c), and v) … **7)** The ~~total~~ specified lateral ~~seismic~~ earthquake force, V, shall be distributed such that a) a portion, F_t, ~~shall be assumed to be~~ is concentrated at the top of the *building*, where F_t is equal to $0.07T_aV$ but need not exceed 0.25V and may be considered as zero where the fundamental lateral period, T_a, does not exceed 0.7 s~~;~~, and b) the remainder, $V - F_t$, ~~shall be~~ is distributed along the height of the *building*, including the top level, in accordance with the following formula: …	

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Table 4.1.8.11.
Higher Mode Factor, Mv, and Base Overturning Moment Reduction Factor, J(1)(2)(3)(4)
Forming Part of Sentence 4.1.8.11.(6)

S(0.2)/ S(5.0)	M_v for $T_a \le 0.5$	M_v for $T_a = 1.0$	M_v for $T_a = 2.0$	M_v for $T_a \ge 5.0$	J for $T_a \le 0.5$	J for $T_a = 1.0$	J for $T_a = 2.0$	J for $T_a \ge 5.0$
Moment-Resisting Frames								
5	1	1	1	(5)	1	0.97	0.92	(5)
20	1	1	1	(5)	1	0.93	0.85	(5)
40	1	1	1	(5)	1	0.87	0.78	(5)
65	1	1	1.03	(5)	1	0.80	0.70	(5)
Coupled Walls(6)								
5	1	1	1	1(7)	1	0.97	0.92	0.80(8)
20	1	1	1	1.08(7)	1	0.93	0.85	0.65(8)
40	1	1	1	1.30(7)	1	0.87	0.78	0.53(8)
65	1	1	1.03	1.49(7)	1	0.80	0.70	0.46(8)
Braced Frames								
5	1	1	1	(5)	1	0.95	0.89	(5)
20	1	1	1	(5)	1	0.85	0.78	(5)
40	1	1	1	(5)	1	0.79	0.70	(5)
65	1	1.04	1.07	(5)	1	0.71	0.66	(5)
Walls, Wall-Frame Systems								
5	1	1	1	1.25(7)	1	0.97	0.85	0.55(8)
20	1	1	1.18	2.30(7)	1	0.80	0.60	0.35(8)
40	1	1.19	1.75	3.70(7)	1	0.63	0.46	0.28(8)
65	1	1.55	2.25	4.65(7)	1	0.51	0.39	0.23(8)
Other Systems								
5	1	1	1	(5)	1	0.97	0.85	(5)
20	1	1	1.18	(5)	1	0.80	0.60	(5)
40	1	1.19	1.75	(5)	1	0.63	0.46	(5)
65	1	1.55	2.25	(5)	1	0.51	0.39	(5)

Notes to Table 4.1.8.11.:

(1) For intermediate values of the spectral ratio S(0.2)/S(5.0), M_v and J shall be obtained by linear interpolation.

(2) For intermediate values of the fundamental lateral period, T_a, $S(T_a)M_v$ shall be obtained by linear interpolation using the values of M_v obtained in accordance with Note (1).

(3) …

(4) For a combination of different seismic force resisting systems (SFRS) not given in Table 4.1.8.11. that are in the same direction under consideration, use the highest M_v factor of all the SFRS and the corresponding value of J.

(5) …

9) Torsional effects that are concurrent with the effects of the forces mentioned in Sentence (7) and are caused by the simultaneous actions of the following torsional moments shall be considered in the design of the structure according to Sentence (11):

a) …

10) Torsional sensitivity shall be determined by calculating the ratio B_x for each level x according to the following equation for each orthogonal direction determined independently:

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Table 4.1.8.11.
Higher Mode Factor, Mv, and Base Overturning Moment Reduction Factor, J(1)(2)(3)(4)
Forming Part of Sentence 4.1.8.11.(6)

S(0.2)/ S(5.0)	M_v for $T_a \le 0.5$	M_v for $T_a = 1.0$	M_v for $T_a = 2.0$	M_v for $T_a \ge 5.0$	J for $T_a \le 0.5$	J for $T_a = 1.0$	J for $T_a = 2.0$	J for $T_a \ge 5.0$
Moment-Resisting Frames								
5	1	1	1	(5)	1	~~0.97~~1	~~0.92~~0.95	(5)
20	1	1	1	(5)	1	~~0.93~~0.97	~~0.85~~0.88	(5)
40	1	1	1	(5)	1	~~0.87~~0.90	~~0.78~~0.79	(5)
~~65~~70	1	1	~~1.03~~1	(5)	~~1~~0.98	~~0.80~~0.88	0.70	(5)
Coupled Walls(6)								
5	1	1	1	1(7)	1	~~0.97~~1	~~0.92~~0.95	0.80(8)
20	1	1	1	~~1.08~~1.09(7)	1	~~0.93~~0.97	~~0.85~~0.88	~~0.65~~0.66(8)
40	1	1	1	~~1.30~~1.33(7)	1	~~0.87~~0.90	~~0.78~~0.79	~~0.53~~0.52(8)
~~65~~70	1	1	~~1.03~~1	~~1.49~~1.90(7)	~~1~~0.98	~~0.80~~0.88	0.70	~~0.46~~0.40(8)
Braced Frames								
5	1	1	1	(5)	1	~~0.95~~0.98	~~0.89~~0.93	(5)
20	1	1	1	(5)	1	~~0.85~~0.91	~~0.78~~0.80	(5)
40	1	1	1	(5)	~~1~~0.91	~~0.79~~0.82	~~0.70~~0.72	(5)
~~65~~70	1	~~1.04~~1	~~1.07~~1.19	(5)	~~1~~0.91	~~0.71~~0.77	~~0.66~~0.61	(5)
Walls, Wall-Frame Systems								
5	1	1	1	~~1.25~~1.30(7)	1	~~0.97~~1	0.85	~~0.55~~0.59(8)
20	1	1	1.18	~~2.30~~2.50(7)	1	0.80	0.60	0.35(8)
40	1	~~1.19~~1.25	~~1.75~~1.85	~~3.70~~4.10(7)	~~1~~0.80	~~0.63~~0.59	~~0.46~~0.42	~~0.28~~0.23(8)
~~65~~70	1	~~1.55~~1.25	~~2.25~~2.30	~~4.65~~6.40(7)	~~1~~0.80	~~0.51~~0.56	~~0.39~~0.30	~~0.23~~0.18(8)
Other Systems								
5	1	1	1	(5)	1	~~0.97~~1	0.85	(5)
20	1	1	1.18	(5)	1	0.80	0.60	(5)
40	1	~~1.19~~1.25	~~1.75~~1.85	(5)	~~1~~0.80	~~0.63~~0.59	~~0.46~~0.44	(5)
~~65~~70	1	~~1.55~~1.37	~~2.25~~2.30	(5)	~~1~~0.80	~~0.51~~0.56	~~0.39~~0.30	(5)

Notes to Table 4.1.8.11.:

(1) For intermediate values of the spectral ratio S(0.2)/S(5.0), M_v and J shall be obtained by linear interpolation. For spectral ratios less than 5, M_v and J shall be obtained by linear interpolation with their values at a spectral ratio of 0 taken as equal to 1. For spectral ratios greater than 70, M_v and J shall be taken as equal to their values at a spectral ratio of 70.

(2) For intermediate values of the fundamental lateral period, T_a, in cases where $S(T_a)$ is obtained by log–log interpolation, M_v shall be obtained by linear interpolation using the values of M_v obtained in accordance with Note (1). In cases where $S(T_a)$ is obtained by linear interpolation, the product $S(T_a)M_v$ shall be obtained by linear interpolation using the values of M_v obtained in accordance with Note (1).

(3) …

(4) For a combination of different ~~seismic force resisting systems (~~SFRSs~~)~~ not given in Table 4.1.8.11. that are in the same direction under consideration, use the highest M_v factor of all the SFRSs and the corresponding value of J.

(5) …

9) Torsional effects that are concurrent with the effects of the forces ~~mentioned~~ determined in Sentence (7) and are caused by the simultaneous actions of the following torsional moments shall be considered in the design of the structure according to Sentence (11):

a) …

10) Torsional sensitivity shall be determined by calculating the ratio B_x for each level x according to the following equation for each orthogonal direction determined independently:

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$B_x = \delta_{max}/\delta_{ave}$ where B = … δ_{max} = maximum *storey* displacement at the extreme points of the structure, at level x in the direction of the earthquake induced by the equivalent static forces acting at distances ± 0.10 D_{nx} from the centres of mass at each floor, and δ_{ave} = average of the displacements at the extreme points of the structure at level x produced by the above-mentioned forces. **11)** Torsional effects shall be accounted for as follows: a) for a *building* with B ≤ 1.7 or where $I_EF_aS_a(0.2)$ is less than 0.35, by applying torsional moments about a vertical axis at each level throughout the *building*, derived for each of the following load cases considered separately: i) $T_x = F_x(e_x + 0.10\ D_{nx})$, and ii) $T_x = F_x(e_x - 0.10\ D_{nx})$ where F_x is the lateral force at each level determined according to Sentence (7) and where each element of the *building* is designed for the most severe effect of the above load cases, or b) for a *building* with B > 1.7, in cases where $I_EF_aS_a(0.2)$ is equal to or greater than 0.35, by a Dynamic Analysis Procedure as specified in Article 4.1.8.12. **12)** Where the fundamental lateral period, T_a, is determined in accordance with Clause (3)(d) and the *building* is constructed with more than 4 *storeys* of continuous wood construction and has a timber SFRS consisting of shear walls with wood-based panels or of braced or moment-resisting frames as defined in Table 4.1.8.9., the lateral earthquake force, V, as determined in accordance with Sentence (2) shall be multiplied by 1.2 but need not exceed the value determined by using Clause (2)(c). (See Note A-4.1.8.10.(4).)	$B_x = \delta_{max}/\delta_{ave}$ where B = … δ_{max} = maximum *storey* displacement at the extreme points of the structure~~,~~ at level x in the direction of the earthquake induced by the ~~equivalent static~~ forces determined in Sentence (7) acting at distances ± 0.10 D_{nx} from the centres of mass at each floor, and δ_{ave} = average of the displacements at the extreme points of the structure at level x produced by the ~~above-mentioned~~ forces determined in Sentence (7). **11)** Torsional effects shall be accounted for as follows: a) for a *building* with B ≤ 1.7 or ~~where $I_EF_aS_a(0.2)$ is less than 0.35~~ in Seismic Category SC1 or SC2, by applying torsional moments about a vertical axis at each level throughout the *building*, derived for each of the following load cases considered separately: i) $T_x = F_x(e_x + 0.10$~~-~~$D_{nx})$, and ii) $T_x = F_x(e_x - 0.10$~~-~~$D_{nx})$ where F_x is ~~the lateral force at each level~~ determined ~~according to~~ in accordance with Sentence (7) and where each element of the *building* is designed for the most severe effect of the above load cases, or b) for a *building* with B > ~~1.7, in cases where $I_EF_aS_a(0.2)$ is equal to or greater than 0.35~~ 1.7 in Seismic Category SC3 or SC4, by a Dynamic Analysis Procedure as specified in Article 4.1.8.12. **12)** Where the fundamental lateral period, T_a, is determined in accordance with Clause (3)(d) and the *building* is constructed with more than 4 *storeys* of continuous wood construction and has a timber SFRS consisting of shear walls with wood-based panels or of braced or moment-resisting frames as defined in Table 4.1.8.9., the specified lateral earthquake force, V, as determined in ~~accordance with~~ Sentence (2) shall be multiplied by 1.2 but need not exceed the value determined by using Clause (2)(c). (See Note A-4.1.8.10.(~~4~~5) and (6).)	
4.1.8.12. Dynamic Analysis Procedure **3)** The ground motion histories used in the Numerical Integration Linear Time History Method shall be compatible with a response spectrum constructed from the design spectral acceleration values, S(T), defined in Sentence 4.1.8.4.(9). (See Note A-4.1.8.12.(3).) … **5)** Except as provided in Sentence (6), the design elastic base shear, V_{ed}, shall be equal to the elastic base shear, V_e, obtained from a Linear Dynamic Analysis. **6)** For structures located on sites other than Class F that have an SFRS with R_d equal to or greater than 1.5, the elastic base shear obtained from a Linear Dynamic Analysis may be multiplied by the larger of the following factors to obtain the design elastic base shear, V_{ed}: $\frac{2S\,(0.2)}{3S\,(T_a)} \le 1.0$ and $S\,(0.5)\,/S(T_a) \le 1.0$ **7)** The design elastic base shear, V_{ed}, shall be multiplied by the importance factor, I_E, as determined in Article 4.1.8.5., and shall be divided by R_dR_o, as determined in Article 4.1.8.9., to obtain the design base shear, V_d. **8)** Except as required by Sentence (9) or (12), if the base shear, V_d, obtained in Sentence (7), is less than 80% of the lateral earthquake design force, V, of Article 4.1.8.11., V_d shall be taken as 0.8 V.	**4.1.8.12. Dynamic Analysis Procedure** **3)** The ground motion time histories used in the Numerical Integration Linear Time History Method shall be compatible with a response spectrum constructed from the design spectral acceleration values, S(T), defined in Sentence 4.1.8.4.(~~9~~6). (See Note A-4.1.8.12.(3).) … **5)** Except as provided in Sentence (6), the ~~design~~ adjusted elastic base shear, V_{ed}, shall be equal to the elastic base shear, V_e, obtained from a Linear Dynamic Analysis. **6)** For ~~structures~~ *buildings* located on ~~sites~~ a site designated as other than ~~Class F~~ X_F that have an SFRS with R_d equal to or greater than 1.5, the elastic base shear, V_e, obtained from a Linear Dynamic Analysis may be multiplied by the larger of the following factors to obtain ~~the design elastic base shear,~~ V_{ed}: ~~$\frac{2S\,(0.2)}{3S\,(T_a)} \le 1.0$~~ (2/3)S(0.2) /S ($T_a$) ≤ 1.0 and $S\,(0.5)\,/S(T_a) \le 1.0$ **7)** ~~The design elastic base shear,~~ V_{ed}~~,~~ shall be multiplied by the earthquake importance factor, I_E, as determined in Article 4.1.8.5., and shall be divided by R_dR_o, as determined in Article 4.1.8.9., to obtain the ~~design base shear~~ specified lateral earthquake force, V_d. **8)** Except as required by Sentence (9) or (12), if ~~the base shear,~~ V_d, ~~obtained~~ as determined in Sentence (7), is less than 80% of ~~the lateral earthquake design force,~~ V, ~~of~~ as determined in Article 4.1.8.11., V_d shall be taken as 0.8 V.	

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9) For irregular structures requiring dynamic analysis in accordance with Article 4.1.8.7., V_d shall be taken as the larger of the V_d determined in Sentence (7), and 100% of V. **10)** Except as required by Sentence (11), the values of elastic *storey* shears, *storey* forces, member forces, and deflections obtained from the Linear Dynamic Analysis, including the effect of accidental torsion determined in Sentence (4), shall be multiplied by V_d/V_e to determine their design values, where V_d is the base shear. **11)** For the purpose of calculating deflections, it is permitted to use a value for V based on the value for T_a determined in Clause 4.1.8.11.(3)(d) to obtain V_d in Sentences (8) and (9). **12)** For *buildings* constructed with more than 4 *storeys* of continuous wood construction, having a timber SFRS consisting of shear walls with wood-based panels or braced or moment-resisting frames as defined in Table 4.1.8.9., and whose fundamental lateral period, T_a, is determined in accordance with Clause 4.1.8.11.(3)(d), the design base shear, V_d, shall be taken as the larger value of V_d determined in accordance with Sentence (7) and 100% of V. (See Note A-4.1.8.10.(4).)	**9)** For irregular structures requiring dynamic analysis in accordance with Article 4.1.8.7., V_d shall be taken as the larger of ~~the~~ V_d, as determined in Sentence (7), and 100% of V, as determined in Article 4.1.8.11. **10)** Except as required by Sentence (11), the values of elastic *storey* shears, *storey* forces, member forces, and deflections obtained from the Linear Dynamic Analysis, including the effect of accidental torsion determined in Sentence (4), shall be multiplied by V_d/V_e to determine their design values~~, where V_d is the base shear~~. **11)** For the purpose of calculating deflections, it is permitted to use a value ~~for~~ of V based on the value ~~for~~ of T_a determined in Clause 4.1.8.11.(3)(d) to obtain V_d in Sentences (8) and (9). **12)** For *buildings* constructed with more than 4 *storeys* of continuous wood construction, having a timber SFRS consisting of shear walls with wood-based panels or braced or moment-resisting frames as defined in Table 4.1.8.9., and whose fundamental lateral period, T_a, is determined in accordance with Clause 4.1.8.11.(3)(d), ~~the design base shear,~~ V_d~~,~~ shall be taken as the larger ~~value~~ of V_d, as determined in ~~accordance with~~ Sentence (7), and 100% of V, as determined in Article 4.1.8.11. (See Note A-4.1.8.10.(~~4~~5) and (6).)	
4.1.8.15. Design Provisions **1)** Except as provided in Sentences (2) and (3), diaphragms, collectors, chords, struts and connections shall be designed so as not to yield, and the design shall account for the shape of the diaphragm, including openings, and for the forces generated in the diaphragm due to the following cases, whichever one governs (see Note A-4.1.8.15.(1)): a) forces due to loads determined in Article 4.1.8.11. or 4.1.8.12. applied to the diaphragm are increased to reflect the lateral load capacity of the SFRS, plus forces in the diaphragm due to the transfer of forces between elements of the SFRS associated with the lateral load capacity of such elements and accounting for discontinuities and changes in stiffness in these elements, or b) a minimum force corresponding to the design-based shear divided by N for the diaphragm at level x. **2)** Steel deck roof diaphragms in *buildings* of less than 4 *storeys* or wood diaphragms that are designed and detailed according to the applicable referenced design standards to exhibit ductile behaviour shall meet the requirements of Sentence (1), except that they may yield and the forces shall be a) for wood diaphragms acting in combination with vertical wood shear walls, equal to the lateral earthquake design force, b) for wood diaphragms acting in combination with other SFRS, not less than the force corresponding to R_dR_o = 2.0, and c) … **5)** In cases where $I_EF_aS_a(0.2)$ is equal to or greater than 0.35, the elements supporting any discontinuous wall, column or braced frame shall be designed for the lateral load capacity of the components of the SFRS they support. (See Note A-4.1.8.15.(5).)	**4.1.8.15. Design Provisions** **1)** Except as provided in Sentences (2) and (3), diaphragms, collectors, chords, struts and connections shall be designed so as not to yield, and the design shall account for the shape of the diaphragm, including openings, and for the forces generated in the diaphragm due to the following cases, whichever one governs ~~(see Note A-4.1.8.15.(1))~~: a) forces ~~due to loads~~ determined in Article 4.1.8.11. or 4.1.8.12. applied to the diaphragm are increased to reflect the lateral load capacity of the SFRS, plus forces in the diaphragm due to the transfer of forces between elements of the SFRS associated with the lateral load capacity of such elements and accounting for discontinuities and changes in stiffness in these elements, or b) a minimum force corresponding to the ~~design-based shear~~ specified lateral earthquake force, V, divided by N for the diaphragm at level x. (See Note A-4.1.8.15.(1).) **2)** Steel deck roof diaphragms in *buildings* of less than 4 *storeys* or wood diaphragms that are designed and detailed according to the applicable referenced design standards to exhibit ductile behaviour shall meet the requirements of Sentence (1), except that they may yield and the forces shall be a) for wood diaphragms acting in combination with vertical wood shear walls, equal to the specified lateral earthquake ~~design~~ force, V, b) for wood diaphragms acting in combination with other SFRSs, not less than the force corresponding to R_dR_o = 2.0, and c) … **5)** ~~In cases where $I_EF_aS_a(0.2)$~~ Where the Seismic Category is ~~equal to~~ SC3 or ~~greater than 0.35~~ SC4, the elements supporting any discontinuous wall, column or braced frame shall be designed for the lateral load capacity of the components of the SFRS they support. (See Note A-4.1.8.15.(5).)	
4.1.8.16. Foundation Provisions … **3)** The shear and overturning resistances of the *foundation* determined using a bearing stress equal to 1.5 times the factored bearing strength of the *soil* or *rock* and all other resistances equal to 1.3 times the factored resistances need not exceed the design forces determined in Sentence 4.1.8.7.(1) using R_dR_o = 1.0, except that the factor of 1.3 shall not apply to the portion of the resistance to uplift or overturning resulting from gravity loads. … **6)** In cases where $I_EF_aS_a(0.2)$ is equal to or greater than 0.35, the following requirements shall	**4.1.8.16. Foundation Provisions** … **3)** The shear and overturning resistances of the *foundation* determined using a bearing stress equal to 1.5 times the factored bearing strength of the *soil* or *rock* and all other resistances equal to 1.3 times the factored resistances need not exceed the ~~design~~ forces determined in Sentence 4.1.8.7.(1) using R_dR_o = 1.0, except that the factor of 1.3 shall not apply to the portion of the resistance to uplift or overturning resulting from gravity loads. … **6)** ~~In cases where $I_EF_aS_a(0.2)$~~ Where the Seismic Category is ~~equal to~~ SC3 or ~~greater than 0.35~~	

<table>
<tr><th colspan="3">PART 4 – CODE UPDATE INFORMATION</th></tr>
<tr><th>NBC(AE) 2019</th><th>NBC(AE) 2023</th><th>Comments</th></tr>
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<td>
be satisfied:
a) …

7) At sites where $I_EF_aS_a(0.2)$ is equal to or greater than 0.35, <i>basement</i> walls shall be designed to resist earthquake lateral pressures from backfill or natural ground. (See Note A-4.1.8.16.(7).)

8) At sites where $I_EF_aS_a(0.2)$ is greater than 0.75, the following requirements shall be satisfied:
a) …
b) spread footings founded on <i>soil</i> defined as Site Class E or F shall be interconnected by continuous ties in not less than two directions.

9) Each segment of a tie between elements that is required by Clauses (6)(a) or (8)(b) shall be designed to carry by tension or compression a horizontal force at least equal to the greatest factored <i>pile</i> cap or column vertical load in the elements it connects, multiplied by a factor of 0.10 $I_EF_aS_a$ (0.2), unless it can be demonstrated that equivalent restraints can be provided by other means. (See Note A-4.1.8.16.(9).)
</td>
<td>
SC4, the following requirements shall be satisfied:
a) …

7) ~~At sites where $I_EF_aS_a(0.2)$~~ Where the Seismic Category is ~~equal to~~ SC3 or ~~greater than 0.35~~ SC4, <i>basement</i> walls shall be designed to resist earthquake lateral pressures from backfill or natural ground. (See Note A-4.1.8.16.(7).)

8) ~~At sites where $I_EF_aS_a(0.2)$ is greater than 0.75~~ Where the Seismic Category is SC4, the following requirements shall be satisfied:
a) …
b) spread footings founded on <i>soil</i> ~~defined as Site Class E or F~~ designated as X_V, where V_{s30} is less than or equal to 180 m/s, X_E or X_F shall be interconnected by continuous ties in not less than two directions.

9) Each segment of a tie between elements that is required by ~~Clauses~~ Clause (6)(a) or (8)(b) shall be designed to carry by tension or compression a horizontal force at least equal to the greatest factored <i>pile</i> cap or column vertical load in the elements it connects, multiplied by a factor of ~~0.10 $I_EF_aS_a$~~ $0.1I_ES$(0.2), unless it can be demonstrated that equivalent restraints can be provided by other means. (See Note A-4.1.8.16.(9).)
</td>
<td></td>
</tr>
<tr>
<td>
4.1.8.18. Elements of Structures, Non-structural Components and Equipment
(See Note A-4.1.8.18.)

1) Except as provided in Sentences (2), (7) and (16), elements and components of <i>buildings</i> described in Table 4.1.8.18. and their connections to the structure shall be designed to accommodate the <i>building</i> deflections calculated in accordance with Article 4.1.8.13. and the element or component deflections calculated in accordance with Sentence (9), and shall be designed for a lateral force, V_p, distributed according to the distribution of mass:

$V_p = 0.3F_aS_a(0.2)I_ES_pW_p$

where
F_a = as defined in Sentence 4.1.8.4.(7),
$S_a(0.2)$ =spectral response acceleration value at 0.2 s, as defined in Sentence 4.1.8.4.(1),

I_E = importance factor for the <i>building</i>, as defined in Article 4.1.8.5.,
S_p = …

Table 4.1.8.18.
Elements of Structures and Non-structural Components and Equipment(1)
Forming Part of Sentences 4.1.8.18.(1), (2), (3), (6) and (7)

<table>
<tr><th>Category</th><th>Part or Portion of Building</th><th>C_p</th><th>A_r</th><th>R_p</th></tr>
<tr><td colspan="5"></td></tr>
<tr><td>1</td><td>All exterior and interior walls except those in Category 2 or 3</td><td>1.00</td><td>1.00</td><td>2.50</td></tr>
<tr><td>2</td><td>Cantilever parapet and other cantilever walls except retaining walls</td><td>1.00</td><td>2.50</td><td>2.50</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>`</td><td>Masonry or concrete fences more than 1.8 m tall</td><td>1.00</td><td>1.00</td><td>2.50</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>17</td><td>Electrical cable trays, bus ducts, conduits</td><td>1.00</td><td>2.50</td><td>2.50</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
</table>
</td>
<td>
4.1.8.18. Elements of Structures, Non-structural Components and Equipment
(See Note A-4.1.8.18.)

1) Except as provided in Sentences (2), (7) and (16), elements and components of <i>buildings</i> described in Table 4.1.8.18. and their connections to the structure shall be designed to accommodate the <i>building</i> deflections calculated in accordance with Article 4.1.8.13. and the element or component deflections calculated in accordance with Sentence (9), and shall be designed for a specified lateral earthquake force, V_p, distributed according to the distribution of mass:

$V_p = 0.3\cancel{F_aS_a}S(0.2)I_ES_pW_p$

where
~~F_a = as defined in Sentence 4.1.8.4.(7),~~
$S_{\cancel{a}}(0.2)$ =design spectral ~~response~~ acceleration value at a period of 0.2 s, as defined in Sentence 4.1.8.4.(~~1~~6),
I_E = earthquake importance factor for the <i>building</i>, as defined in Article 4.1.8.5.,
S_p = …

Table 4.1.8.18.
Elements of Structures and Non-structural Components and Equipment(1)
Forming Part of Sentences 4.1.8.18.(1)~~, (2),~~ to (3), (6), ~~and~~ (7) and (16), and Clauses 4.1.8.23.(2)(c) and (3)(c)

<table>
<tr><th>Category</th><th>Part or Portion of Building</th><th>C_p</th><th>A_r</th><th>R_p</th></tr>
<tr><td colspan="5">Architectural and Structural Components</td></tr>
<tr><td>1</td><td>All exterior and interior walls, and cladding panels, except those in Category 2 or 3</td><td>1.00</td><td>1.00</td><td>2.50</td></tr>
<tr><td>2</td><td>Cantilever parapet and other cantilever walls, including cantilever cladding panels, except retaining walls</td><td>1.00</td><td>2.50</td><td>2.50</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>10</td><td>Masonry or concrete fences more than 1.8 m tall</td><td>1.00</td><td>1.00</td><td>2.50</td></tr>
<tr><td colspan="5">Mechanical and Electrical Components</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
<tr><td>17</td><td>Electrical cable trays, bus ducts, conduits</td><td>1.00</td><td>2.50</td><td>2.50</td></tr>
<tr><td colspan="5">Other System Components</td></tr>
<tr><td>…</td><td>…</td><td>…</td><td>…</td><td>…</td></tr>
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2) For *buildings* other than *post-disaster buildings*, seismically isolated *buildings*, and *buildings* with supplemental energy dissipation systems, where $I_EF_aS_a(0.2)$ is less than 0.35, the requirements of Sentence (1) need not apply to Categories 6 through 22 of Table 4.1.8.18.	**2)** For *buildings* in Seismic Category SC1 or SC2, other than *post-disaster buildings*, seismically isolated *buildings*, and *buildings* with supplemental energy dissipation systems, ~~where $I_EF_aS_a(0.2)$ is less than 0.35,~~ the requirements of Sentence (1) need not apply to Categories 6 through 22 of Table 4.1.8.18.	
3) For the purpose of applying Sentence (1) for Categories 11 and 12 of Table 4.1.8.18., elements or components shall be assumed to be flexible or flexibly connected unless it can be shown that the fundamental period of the element or component and its connection is less than or equal to 0.06 s, in which case the element or component is classified as being rigid or rigidly connected.	**3)** For the purpose of applying Sentence (1) for Categories 11 and 12 of Table 4.1.8.18., elements or components shall be assumed to be flexible or flexibly connected unless it can be shown that the fundamental period of the element or component and its connection is less than or equal to 0.06 s, in which case the element or component is classified as being rigid ~~or~~ and rigidly connected.	
7) Connections to the structure of elements and components listed in Table 4.1.8.18. shall be designed to support the component or element for gravity loads, shall conform to the requirements of Sentence (1), and shall also satisfy these additional requirements: a) friction due to gravity loads shall not be considered to provide resistance to seismic forces, b) … c) R_p for anchorage using shallow expansion, chemical, epoxy or cast-in-place anchors shall be 1.5, where shallow anchors are those with a ratio of embedment length to diameter of less than 8, d) power-actuated fasteners and drop-in anchors shall not be used for tension loads, e) …	**7)** Connections to the structure of elements and components listed in Table 4.1.8.18. shall be designed to support the component or element for gravity loads, shall conform to the requirements of Sentence (1), and shall also satisfy these additional requirements: a) except as provided in Sentence (17), friction due to gravity loads shall not be considered to provide resistance to ~~seismic~~ earthquake forces, b) … c) R_p for ~~anchorage using~~ shallow ~~expansion, chemical, epoxy or~~ post-installed mechanical, post-installed adhesive, and cast-in-place anchors in concrete shall be 1.5, where shallow anchors are those with a ratio of embedment length to diameter of less than 8, d) post-installed mechanical, drop-in and adhesive anchors in concrete shall be pre-qualified for seismic applications by cyclic load testing in accordance with i) CSA A23.3, “Design of concrete structures,” and ii) ACI 355.2, “Qualification of Post-Installed Mechanical Anchors in Concrete (ACI 355.2-19) and Commentary,” or ACI 355.4, “Qualification of Post-Installed Adhesive Anchors in Concrete (ACI 355.4-19) and Commentary,” as applicable, e) post-installed mechanical and adhesive anchors in masonry and post-installed mechanical anchors in structural steel shall be pre-qualified for seismic applications by cyclic tension load testing (see Note A-4.1.8.18.(7)(e)), ~~d~~f) power-actuated fasteners ~~and drop-in anchors~~ shall not be used for cyclic tension loads, ~~e~~g) …	
13) Free-standing steel pallet storage racks are permitted to be designed to resist earthquake effects using rational analysis, provided the design achieves the minimum performance level required by Subsection 4.1.8. (See Note A-4.1.8.18.(13).)	**13)** Free-standing steel pallet storage racks are permitted to be designed to resist earthquake effects using rational analysis, provided the design achieves the minimum performance level required by Subsection 4.1.8. (See Note A-4.1.8.18.(13) and 4.4.3.1.(1).)	
…	…	
15) Glass need not comply with Sentence (14), provided at least one of the following conditions is met: a) $I_EF_aS_a(0.2) < 0.35$, b) the glass has sufficient clearance from its frame such that $D_{clear} \geq 1.25\ D_p$ calculated as follows: …	**15)** Glass need not comply with Sentence (14), provided at least one of the following conditions is met: a) ~~$I_EF_aS_a(0.2) < 0.35$~~ the Seismic Category is SC1 or SC2, b) the glass has sufficient clearance from its frame such that $D_{clear} \geq 1.25$~~-~~D_p calculated as follows: …	
16) For structures with supplemental energy dissipation, the following criteria shall apply: a) the value of $S_a(0.2)$ used in Sentence (1) shall be determined from the mean 5% damped floor spectral acceleration values at 0.2 s by averaging the individual 5% damped floor spectra at the base of the structure determined using Non-Linear Dynamic Analysis, and b) the value of F_a used in Sentence (1) shall be 1.	**16)** For structures with supplemental energy dissipation, ~~the following criteria shall apply~~ elements and components of *buildings* described in Table 4.1.8.18. and their connections to the structure shall be designed for a specified lateral earthquake force, V_p, determined at each floor level as follows: ~~a) the value of $S_a(0.2)$ used in Sentence (1) shall be determined from the mean 5% damped floor spectral acceleration values at 0.2 s by averaging the individual 5% damped floor spectra at the base of the structure determined using Non-Linear Dynamic Analysis, and~~ ~~b) the value of F_a used in Sentence (1) shall be 1.~~ $V_p = S_{sed}I_E(C_pA_r/R_p)W_p$	

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	where S_{sed} = peak spectral acceleration, $S_a(T,X)$, in the period range of T = 0 s to T = 0.5 s determined from the mean 5%-damped floor spectral acceleration values by averaging the individual 5%-damped floor response spectra at the centroid of the floor area at that floor level determined using Non-linear Dynamic Analysis, and I_E, C_p, A_r, R_p,W_p = as defined in Sentence (1). (See Note A-4.1.8.18.(16).) **17)** For a ballasted array of interconnected solar panels mounted on a roof, where $I_E S(0.2)$ is less than or equal to 1.0, friction due to gravity loads is permitted to be considered to provide resistance to seismic forces, provided a) the roof is not normally occupied, b) the roof is surrounded by a parapet extending from the roof surface to not less than the greater of i) 150 mm above the centre of mass of the array, and ii) 400 mm above the roof surface, c) the height of the centre of mass of the array above the roof surface is less than the lesser of i) 900 mm, and ii) one half of the smallest plan dimension of the supporting base of the array, d) the roof slope at the location of the array is less than or equal to 3°, e) the factored friction resistance calculated using the kinetic friction coefficient determined in accordance with Sentence (18) and a resistance factor of 0.7 is greater than or equal to the specified lateral earthquake force, V_p, on the array determined in accordance with Sentence (1) using values of $A_r = 1.0$, $A_x = 3.0$, $C_p = 1.0$, and $R_p = 1.25$, f) the minimum clearance between the array and other arrays or fixed objects is the greater of i) 225 mm, and ii) $1\,500(I_E S(0.2) - 0.4)^2$, in mm, and g) the minimum clearance between the array and the roof parapet is the greater of i) 450 mm, and ii) $3\,000(I_E S(0.2) - 0.4)^2$, in mm. **18)** For the purpose of Clause (17)(e), the kinetic friction coefficient shall be determined in accordance with ASTM G115, “Standard Guide for Measuring and Reporting Friction Coefficients,” through experimental testing that a) is carried out by an accredited laboratory on a full-scale array or a prototype of the array, b) models the interface between the supporting base of the array and the roof surface, and c) accounts for the adverse effects of anticipated climatic conditions on the friction resistance. (See Note A-4.1.8.18.(18).)	
4.1.8.19. Seismic Isolation **1)** For the purposes of this Article and Article 4.1.8.20., the following terms shall have the meanings stated herein: … d) “isolator unit” is a structural element of the isolation system that permits large lateral deformations under lateral earthquake design forces and is characterized by vertical-load-carrying capability combined with increased horizontal flexibility and high vertical stiffness, energy dissipation (hysteretic or viscous), self-centering capability, and lateral restraint (sufficient elastic stiffness) under non-seismic service lateral loads; e) … **2)** Every seismically isolated structure and every portion thereof shall be analyzed and designed in accordance with	**4.1.8.19. Seismic Isolation** **1)** For the purposes of this Article and Article 4.1.8.20., the following terms shall have the meanings stated herein: … d) “isolator unit” is a structural element of the isolation system that permits large lateral deformations under lateral earthquake ~~design~~ forces and is characterized by vertical-load-carrying capability combined with increased horizontal flexibility and high vertical stiffness, energy dissipation (hysteretic or viscous), self-centering capability, and lateral restraint (sufficient elastic stiffness) under non-seismic service lateral loads; e) … **2)** Every seismically isolated structure and every portion thereof shall be analyzed and designed in accordance with	

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a) the loads and requirements prescribed in this Article and Article 4.1.8.20., … **4)** The ground motion histories used in Sentence (3) shall be a) … b) compatible with i) a response spectrum derived from the design spectral acceleration values, S(T), defined in Sentence 4.1.8.4.(9) for ground conditions of Site Classes A, B and C, and ii) a 5% damped response spectrum based on a site-specific evaluation for ground conditions of Site Classes D, E and F, and c) amplitude-scaled in an appropriate manner over the period range of 0.2 T_1 to 1.5 T_1, where T_1 is the period of the isolated structure determined using the post-yield stiffness of the isolation system in the horizontal direction under consideration, or the period specified in Sentence 4.1.8.20.(1) if the post-yield stiffness of the isolation system is not well defined. (See Note A-4.1.8.19.(4) and 4.1.8.21.(5).)	a) ~~the loads and requirements prescribed in~~ this Article and Article 4.1.8.20., … **4)** The ground motion time histories used in Sentence (3) shall be a) … b) compatible with i) a response spectrum derived from the design spectral acceleration values, S(T), defined in Sentence 4.1.8.4.(~~9~~6) for ~~ground conditions of Site Classes A, B and C~~ site designations X_V, where V_{s30} is greater than 360 m/s, X_A, X_B and X_C, and ii) a 5%-damped response spectrum based on a site-specific evaluation for ~~ground conditions of Site Classes D, E and F~~ site designations X_V, where V_{s30} is less than or equal to 360 m/s, X_D, X_E and X_F, and c) amplitude-scaled in an appropriate manner over the period range of 0.2T_1 to 1.5T_1, where T_1 is the period of the isolated structure determined using the post-yield stiffness of the isolation system in the horizontal direction under consideration, or the period specified in Sentence 4.1.8.20.(1) if the post-yield stiffness of the isolation system is not well defined. (See Note A-4.1.8.19.(4) and 4.1.8.21.(5).)	
4.1.8.21. Supplemental Energy Dissipation **2)** Every structure with a supplemental energy dissipation system and every portion thereof shall be designed and constructed in accordance with a) the loads and requirements prescribed in this Article and Article 4.1.8.22., b) … **4)** For the analysis and modeling of structures with supplemental energy dissipation devices, the following criteria shall apply: a) … b) for SFRS with R_d > 1.0, the non-linear hysteretic behaviour of the SFRS shall be explicitly—with sufficient detail—accounted for in the modeling and analysis of the structure, c) … **5)** The ground motion histories used in Sentence (4) shall be a) … b) compatible with a 5% damped response spectrum derived from the design spectral acceleration values, S(T), defined in Sentence 4.1.8.4.(9), and c) amplitude-scaled in an appropriate manner over the period range of 0.2 T_1 to 1.5 T_1, where T_1 is the fundamental lateral period of the structure with the supplemental energy dissipation system. (See Note A-4.1.8.19.(4) and 4.1.8.21.(5).)	**4.1.8.21. Supplemental Energy Dissipation** **2)** Every structure with a supplemental energy dissipation system and every portion thereof shall be designed and constructed in accordance with a) ~~the loads and requirements prescribed in~~ this Article and Article 4.1.8.22., b) … **4)** For the analysis and modeling of structures with supplemental energy dissipation devices, the following criteria shall apply: a) … b) for an SFRS with R_d > 1.0, the non-linear hysteretic behaviour of the SFRS shall be explicitly—with sufficient detail—accounted for in the modeling and analysis of the structure, c) … **5)** The ground motion time histories used in Sentence (4) shall be a) … b) compatible with a 5%-damped response spectrum derived from the design spectral acceleration values, S(T), defined in Sentence 4.1.8.4.(~~9~~6), and c) amplitude-scaled in an appropriate manner over the period range of 0.2T_1 to 1.5T_1, where T_1 is the fundamental lateral period of the structure with the supplemental energy dissipation system. (See Note A-4.1.8.19.(4) and 4.1.8.21.(5).)	
4.1.8.22. Supplemental Energy Dissipation Design Considerations **5)** Elements of the supplemental energy dissipation system, except the supplemental energy dissipation devices themselves, shall be designed to remain elastic for the design loads. **7)** Supplemental energy dissipation devices and other components of the supplemental energy dissipation system shall be designed in accordance with Sentence (1) with consideration of the following: a) low-cycle, large-displacement degradation due to seismic loads, b) …	**4.1.8.22. Supplemental Energy Dissipation Design Considerations** **5)** ~~Elements~~ All components of ~~the~~ a supplemental energy dissipation ~~system~~ device, except that portion of the ~~supplemental~~ device that dissipates energy ~~dissipation devices themselves~~, shall be designed to remain elastic ~~for the design loads~~. **7)** Supplemental energy dissipation devices and other components of the supplemental energy dissipation system shall be designed in accordance with Sentence (1) with consideration of the following: a) low-cycle, large-displacement degradation due to ~~seismic~~ earthquake loads, b) …	
N/A	**4.1.8.23. Additional Performance Requirements for Post-disaster Buildings, High Importance Category Buildings, and a Subset of Normal Importance Category Buildings** 1) *Buildings* designed in accordance with Articles 4.1.8.19. to 4.1.8.22. need not comply with this Article.	

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	2) The design of *post-disaster buildings* in Seismic Category SC2, SC3 or SC4 shall be verified using 5%-damped spectral acceleration values based on a 5% probability of exceedance in 50 years and shall satisfy the following requirements: a) the *building* shall be shown to behave elastically for a specified lateral earthquake force, V, determined in accordance with Sentence 4.1.8.11.(2) using I_E = 1.0 and R_dR_o = 1.3, b) the largest inter*storey* deflection at any level of the *building*, as determined in accordance with Sentence 4.1.8.13.(2) using I_E = 1.0 and R_dR_o = 1.0, shall not exceed 0.005h_s, and c) the connections of elements and components of the *building* described in Table 4.1.8.18. with R_p > 1.5 shall be shown to behave elastically for a specified lateral earthquake force, V_p, determined in accordance with Sentence 4.1.8.18.(1) using R_p = 1.5. **3)** The design of High Importance Category *buildings* in Seismic Category SC3 or SC4 shall be verified using 5%-damped spectral acceleration values based on a 10% probability of exceedance in 50 years and shall satisfy the following requirements: a) the *building* shall be shown to behave elastically for a specified lateral earthquake force, V, determined in accordance with Sentence 4.1.8.11.(2) using I_E = 1.0 and R_dR_o = 1.3, b) the largest inter*storey* deflection at any level of the *building*, as determined in accordance with Sentence 4.1.8.13.(2) using I_E = 1.0 and R_dR_o = 1.0, shall not exceed 0.005h_s, and c) the connections of elements and components of the *building* described in Table 4.1.8.18. with R_p > 1.3 shall be shown to behave elastically for a specified lateral earthquake force, V_p, determined in accordance with Sentence 4.1.8.18.(1) using R_p = 1.3. **4)** For Normal Importance Category *buildings* in Seismic Category SC4 with a height above *grade* of more than 30 m, the structural framing elements not considered to be part of the SFRS shall be designed to behave elastically for a specified lateral earthquake force, V, determined in accordance with Sentence 4.1.8.11.(2) using spectral acceleration values based on a 10% probability of exceedance in 50 years and R_dR_o = 1.3. **5)** For the purposes of applying Sentences (2) to (4), torsional moments due to accidental eccentricities need not be considered if B, as determined in accordance with Sentence 4.1.8.11.(10), does not exceed 1.7. **6)** For the purposes of applying Sentences (2) to (4), elements of the SFRS and structural framing elements not considered to be part of the SFRS, when included in the analysis, shall be modeled in accordance with Sentence 4.1.8.3.(8) using elastic properties. **7)** All other requirements of Articles 4.1.8.2. to 4.1.8.18. shall be satisfied in meeting the additional requirements of this Article.	
4.2.2.1. Subsurface Investigation **1)** A *subsurface investigation*, including *groundwater* conditions, shall be carried out by or under the direction of a *registered engineering professional* having knowledge and experience in planning and executing such investigations to a degree appropriate for the *building* and its use, the ground and the surrounding site conditions. (See Note A-4.2.2.1.(1).)	**4.2.2.1. Subsurface Investigation** **1)** A *subsurface investigation*, including *groundwater* conditions, shall be carried out by or under the direction of a *registered* ~~*engineering*~~ *professional* having knowledge and experience in planning and executing such investigations to a degree appropriate for the *building* and its use, the ground and the surrounding site conditions. (See Note A-4.2.2.1.(1).)	Change reflects updated definition in the National Building Code - Alberta Edition 2023.
4.2.3.2. Preservation Treatment of Wood **1)** Wood exposed to *soil* or air above the lowest anticipated *groundwater* table shall be treated with preservative in conformance with CAN/CSA-O80 Series, “Wood Preservation,” and the requirements of the appropriate commodity standard as follows:	**4.2.3.2. Preservation Treatment of Wood** **1)** Wood exposed to *soil*, *rock* or air above the lowest anticipated *groundwater* table shall be treated with preservative in conformance with CAN/CSA-O80 Series, “Wood ~~P~~preservation,” and the requirements of the appropriate ~~commodity~~ standard as follows: a) CAN/CSA-O80.1, “Specification of treated wood,”	

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a) CAN/CSA-O80.2, “Processing and Treatment,” b) CAN/CSA-O80.3, “Preservative Formulations,” or c) CSA O80.15, “Preservative Treatment of Wood for Building Foundation Systems, Basements, and Crawl Spaces by Pressure Processes.” **2)** Where timber has been treated as required in Sentence (1), it shall be cared for as provided in AWPA M4, “Care of Preservative-Treated Wood Products,” as revised by Clause 6 of CAN/CSA-O80 Series, “Wood Preservation.”	~~a~~b) CAN/CSA-O80.2, “Processing and ~~T~~treatment,” or ~~b~~c) CAN/CSA-O80.3, “Preservative ~~F~~formulations~~,~~.” ~~or~~ ~~c) CSA O80.15, “Preservative Treatment of Wood for Building Foundation Systems, Basements, and Crawl Spaces by Pressure Processes.”~~ **2)** ~~Where timber has been~~ Wood treated as required in Sentence (1)~~, it~~ shall be cared for as provided in ~~AWPA M4, “Care of Preservative-Treated Wood Products,” as revised by~~ Clause ~~6~~4 of CAN/CSA-O80.0 ~~Series~~, “General requirements for ~~W~~wood ~~P~~preservation.”	
4.2.4.1. Design Basis **1)** The design of *foundations*, *excavations* and *soil-* and *rock*-retaining structures shall be based on a *subsurface investigation* carried out in conformance with the requirements of this Section, and on any of the following, as appropriate: a) application of generally accepted geotechnical and civil engineering principles by a *registered engineering professional* especially qualified in this field of work, as provided in this Section and other Sections of Part 4, b) … **3)** For the purpose of the application of the load combinations given in Table 4.1.3.2.-A, the geotechnical components of loads and the factored geotechnical resistances at ULS shall be determined by a suitably qualified and experienced *registered engineering professional*. (See Note A-4.2.4.1.(3).) **4)** Geotechnical components of service loads and geotechnical reactions for SLS shall be determined by a suitably qualified and experienced *registered engineering professional*. **6)** Communication, interaction and coordination between the *designer* and the *registered engineering professional* responsible for the geotechnical aspects of the *project* shall take place to a degree commensurate with the complexity and requirements of the *project*.	**4.2.4.1. Design Basis** **1)** The design of *foundations*, *excavations* and *soil-* and *rock*-retaining structures shall be based on a *subsurface investigation* carried out in conformance with the requirements of this Section, and on any of the following, as appropriate: a) application of generally accepted geotechnical and civil engineering principles by a *registered ~~engineering~~ professional* especially qualified in this field of work, as provided in this Section and other Sections of Part 4, b) … **3)** For the purpose of the application of the load combinations given in Table 4.1.3.2.-A, the geotechnical components of loads and the factored geotechnical resistances at ULS shall be determined by a suitably qualified and experienced *registered ~~engineering~~ professional*. (See Note A-4.2.4.1.(3).) **4)** Geotechnical components of service loads and geotechnical reactions for SLS shall be determined by a suitably qualified and experienced *registered ~~engineering~~ professional*. **6)** Communication, interaction and coordination between the *designer* and the *registered ~~engineering~~ professional* responsible for the geotechnical aspects of the *project* shall take place to a degree commensurate with the complexity and requirements of the *project*.	Change reflects updated definition in the National Building Code - Alberta Edition 2023.
4.2.7.2. Design of Deep Foundations **2)** Where *deep foundation units* are load tested, as required in Clause 4.2.4.1.(1)(c), the determination of the number and type of load test and the interpretation of the results shall be carried out by a *registered engineering professional* especially qualified in this field of work. (See Note A-4.2.7.2.(2).)	**4.2.7.2. Design of Deep Foundations** **2)** Where *deep foundation units* are load tested, as required in Clause 4.2.4.1.(1)(c), the determination of the number and type of load test and the interpretation of the results shall be carried out by a *registered ~~engineering~~ professional* especially qualified in this field of work. (See Note A-4.2.7.2.(2).)	Change reflects updated definition in the National Building Code - Alberta Edition 2023.
4.4.1. Air-Supported Structures	**4.4.1. Air-, Cable- and Frame-Supported Membrane Structures**	
4.4.1.1. Design Basis for Air-Supported Structures **1)** The structural design of *air- supported structures* shall conform to CSA S367, “Air-, Cable-, and Frame-Supported Membrane Structures,” using the loads stipulated in Section 4.1., in accordance with limit states design in Subsection 4.1.3.	**4.4.1.1. Design Basis for Air-, Cable- and Frame-Supported Membrane Structures** **1)** The structural design of ~~*air- supported structures*~~ air-, cable- and frame- membrane shall conform to CSA S367, “Air-, ~~C~~cable-, and ~~F~~frame-~~S~~supported ~~M~~membrane ~~S~~structures,” using the loads stipulated in Section 4.1., in accordance with limit states design in Subsection 4.1.3.	
4.4.2.1. Design Basis for Parking Structures and Repair Garages **1)** Parking structures and *repair garages* shall be designed in conformance with CSA S413, “Parking Structures.” (See Note A-4.4.2.1.(1).)	**4.4.2.1. Design Basis for ~~Parking Structures~~ Storage Garages and Repair Garages** **1)** ~~Parking structures~~ *Storage garages* and *repair garages*, including associated ramps and pedestrian areas, shall be designed in conformance with the performance requirements of CSA S413, “Parking ~~S~~structures.” (See Note A-4.4.2.1.(1).)	
N/A	**4.4.3. Storage Racks**	
N/A	**4.4.3.1. Design Basis for Storage Racks** 1) Storage racks, including anchorage of racks, shall be designed for loads in accordance with this Part. (See Note A-4.1.8.18.(13) and 4.4.3.1.(1).)	