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From Discovery to Innovation...

2010 NATIONAL MODEL CONSTRUCTION CODES

Structural Loads

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Introduction

- Presentation is part of a series on the 2010 National Model Construction Codes
- Model codes developed by Canadian Commission on Building and Fire Codes
- These codes must be adopted by provincial/territorial authorities to become law

Overview

- Live Loads Due to Use and Occupancy
- Climatic/Seismic Data (Table C-2, Appendix C)
- Earthquake Design
- Wind
- Building Envelope

Structural Loads

- Live Loads Due to Use and Occupancy
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Live Loads – Crane Loads

- NBC 2005
  - Crane loads not adequately dealt with
  - Possibly unconservative when crane and snow loads act together in combination

Live Loads – Crane Loads

- New parameter – C = live load due to crane
- Additional table of load combinations
  - Previous Table 4.1.3.2. → Table 4.1.3.2.A. for no crane load considered
  - New Table 4.1.3.2.B. when considering crane loads – consistent with CSA S16

Table 4.1.3.2.B.
Load Combinations With Crane Loads for Ultimate Limit States
Forming Part of Sentences 4.1.3.2.(2), (5) to (8), and (10)

Case	Load Combination(1)	
	Principal Loads	Companion Loads
1	$(1.25\mathbf{D}^{(2)}$ or $0.9\mathbf{D}^{(3)}) + (1.5\mathbf{C} + 1.0\mathbf{L}_{XC})$	$1.0\mathbf{S}^{(4)}$ or $0.4\mathbf{W}$
2	$(1.25\mathbf{D}^{(2)}$ or $0.9\mathbf{D}^{(3)}) + (1.5\mathbf{L}_{XC}^{(5)} + 1.0\mathbf{C})$	$0.5\mathbf{S}^{(4)}$ or $0.4\mathbf{W}$
3	$(1.25\mathbf{D}^{(2)}$ or $0.9\mathbf{D}^{(3)}) + 1.5\mathbf{S}$	$(1.0\mathbf{C} + 0.5\mathbf{L}_{XC}^{(4)(6)})$
4	$(1.25\mathbf{D}^{(2)}$ or $0.9\mathbf{D}^{(3)}) + 1.4\mathbf{W}$	$(1.0\mathbf{C}^{(7)} + 0.5\mathbf{L}_{XC}^{(4)(6)})$
5	$(1.25\mathbf{D}^{(2)}$ or $0.9\mathbf{D}^{(3)}) + \mathbf{C}_7$	—
6	$1.0\mathbf{D}^{(3)} + 1.0\mathbf{E}^{(8)}$	$1.0\mathbf{C}_d + 0.5\mathbf{L}_{XC}^{(4)(6)} + 0.25\mathbf{S}^{(4)}$

Live Loads – Grandstands, Arenas, Stadia

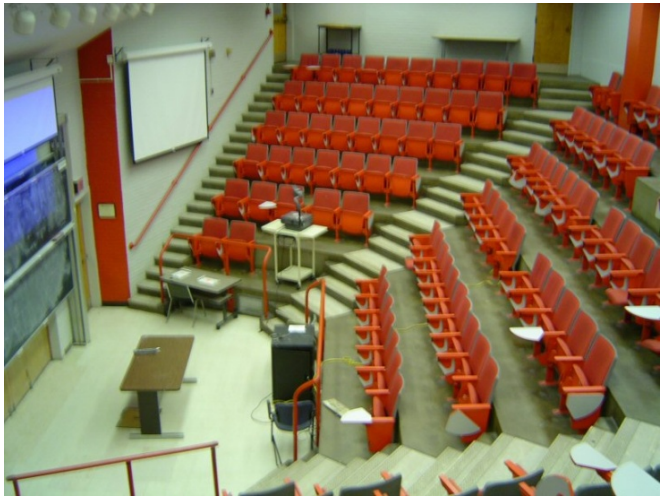
- 2005
  - Minimum 4.8 kPa
  - Excessively high for areas with fixed seats with backs
- 2010 Table 4.1.5.3.
  - Portions with fixed seats with backs ⇒ 2.9 kPa
  - Other portions ⇒ 4.8 kPa

Live Loads – Churches, Lecture Halls, Theatres

- 2005
  - If 80% of area has fixed seats with backs ⇒ design all for 2.4 kPa, else 4.8 kPa
- 2010 Table 4.1.5.3.
  - Portions with fixed seats with backs ⇒ 2.4 kPa
  - Other portions ⇒ 4.8 kPa

Live Loads – Lecture Halls, Classrooms

- Classrooms remain 2.4 kPa
- Clarification on difference between lecture hall and classroom
- Lecture hall – configuration similar to theatre
- Classrooms – full sized desks



Live Loads – Garage Loads (Distributed)

- 2005
  - Non-specific description
  - Passenger car, light truck
- 2010 Table 4.1.5.3.
  - Loads assigned to vehicle gross weight

Garages for	
Vehicles not exceeding 4 000 kg gross weight	2.4
Vehicles exceeding 4 000 kg but not exceeding 9 000 kg gross weight	6.0
Vehicles exceeding 9 000 kg gross weight	12.0(1)

Live Loads – Garage Loads (Concentrated)

- 2005
  - Distributed over 750 mm x 750 mm
  - Area too large
- 2010 Table 4.1.5.9.
  - Loads assigned to vehicle gross weight as per Table 4.1.5.3.
  - Area typically related to wheel contact area

Floors and areas used by vehicles not exceeding 4□000 kg gross weight	18	120 x 120
Floors and areas used by vehicles exceeding 4□000 kg but not exceeding 9□000 kg gross weight	36	120 x 120
Floors and areas used by vehicles exceeding 9□000 kg gross weight	54(1)	250 x 600(1)
Driveways and sidewalks over areaways and *basements*	54(1)	250 x 600(1)

Live Loads – Guards

- 3.0 kN/m load extended to open viewing stands without fixed seats
- Load application changed from top of guard to minimum required guard height (i.e. theoretical point of actual load application)
- Vehicle guardrail – application constraint to storage garages only removed

Live Loads – Miscellaneous

- Appendix Note re principal load acting alone needs to be considered moved to Part 4
- New Appendix Note re corridors, aisles and rows of seats
  - Spaces between rows – designed for occupancy they serve
  - Rows of seats discharge into aisles – designed for loads used for the rows of seats
  - Corridors have minimum width of 1100 mm – part of exit

Structural Loads

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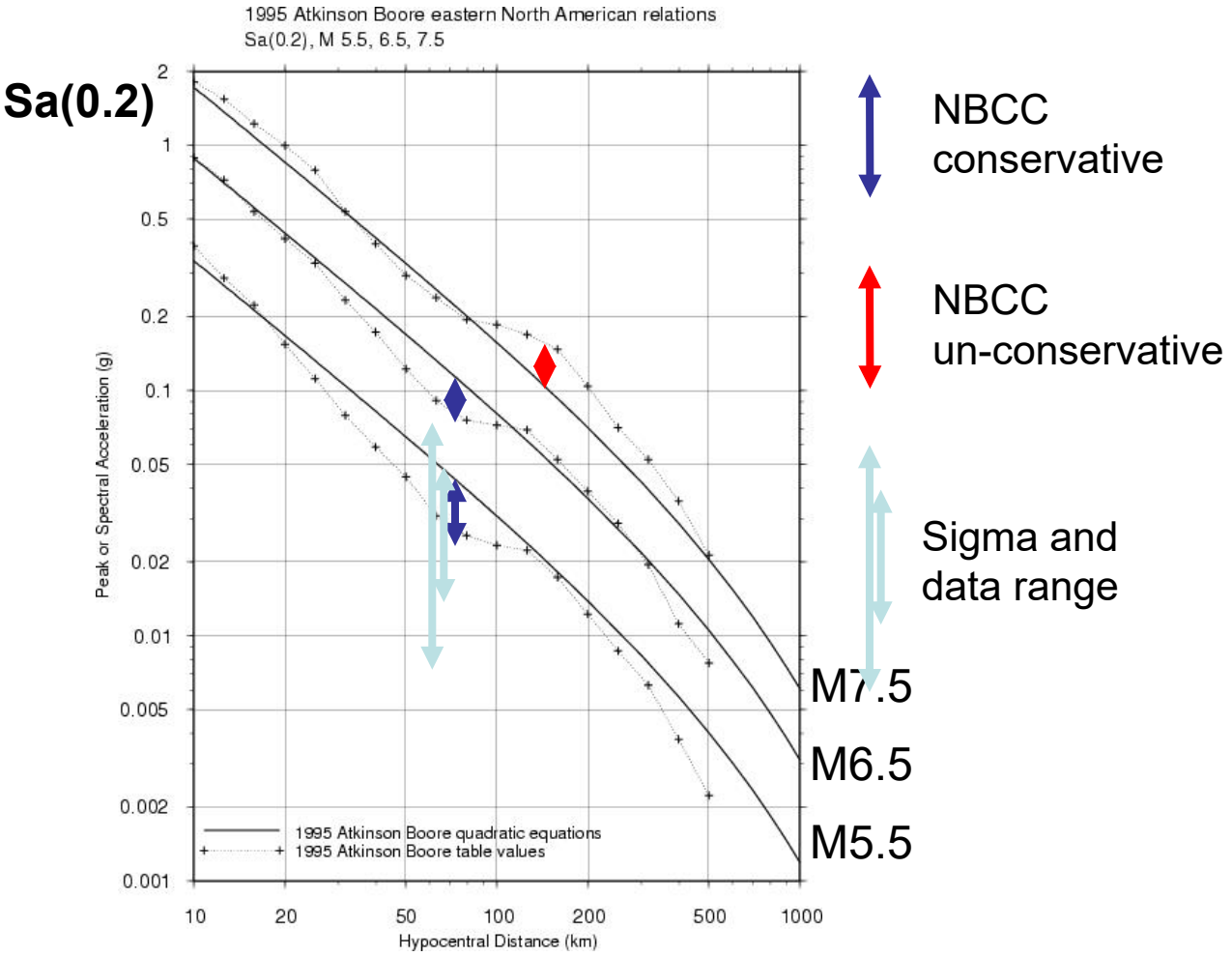
Climatic Data Table C-2

- Climatic data in Table C-2 – based on field measurements last collected in 1970s
- Wind, rain, heating degree-days, design temperatures now updated – snow for next NBC

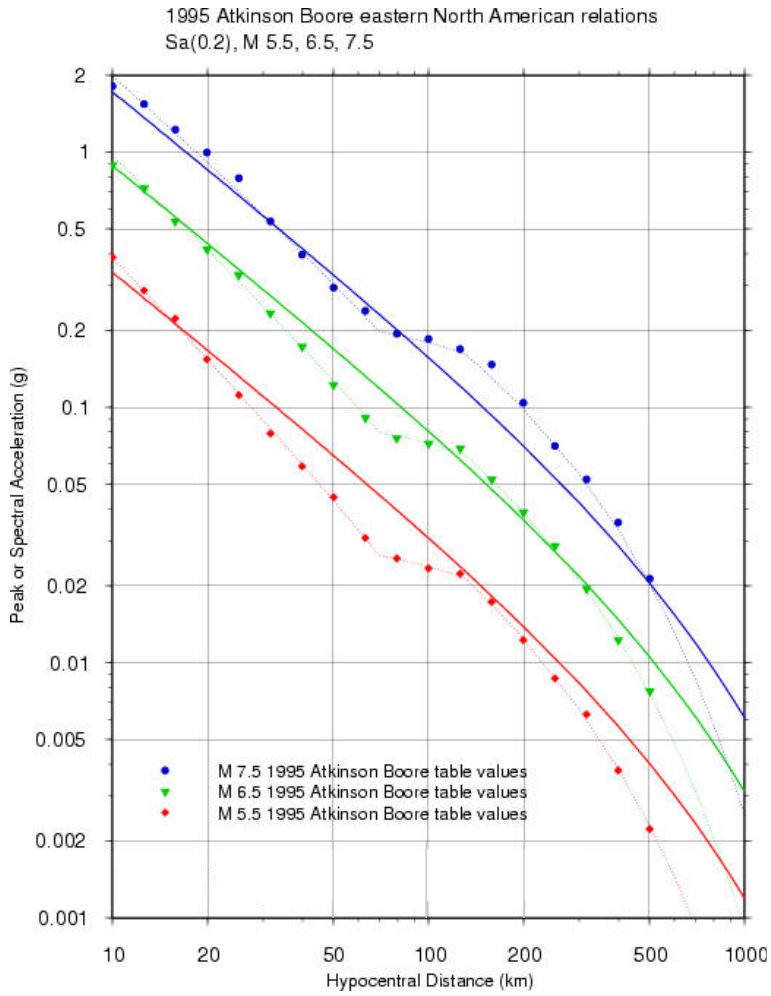
Seismic Data Table C-2

- Ground motion look-up table values in NBC 2005 estimated by quadratic equation

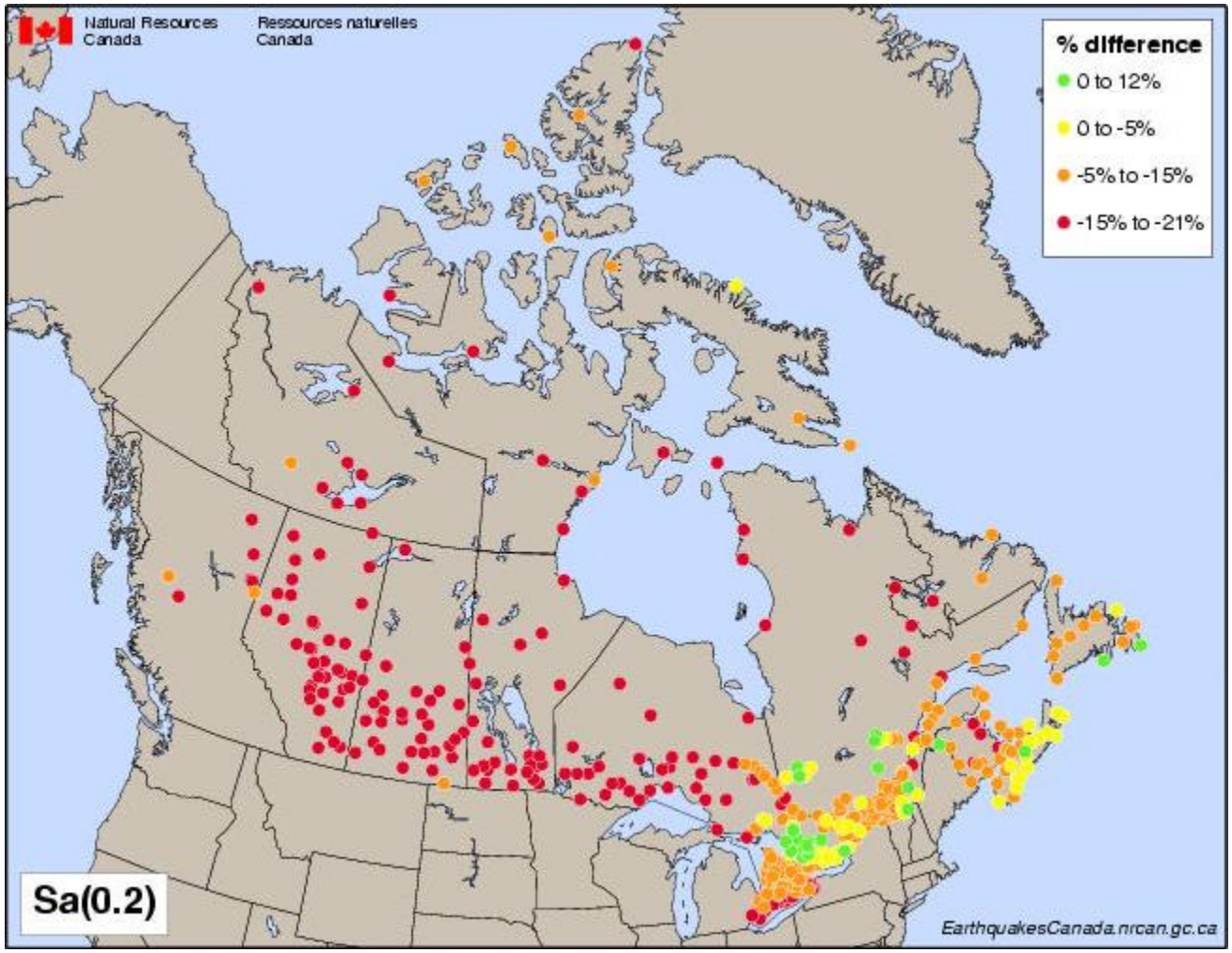


Seismic Data Table C-2

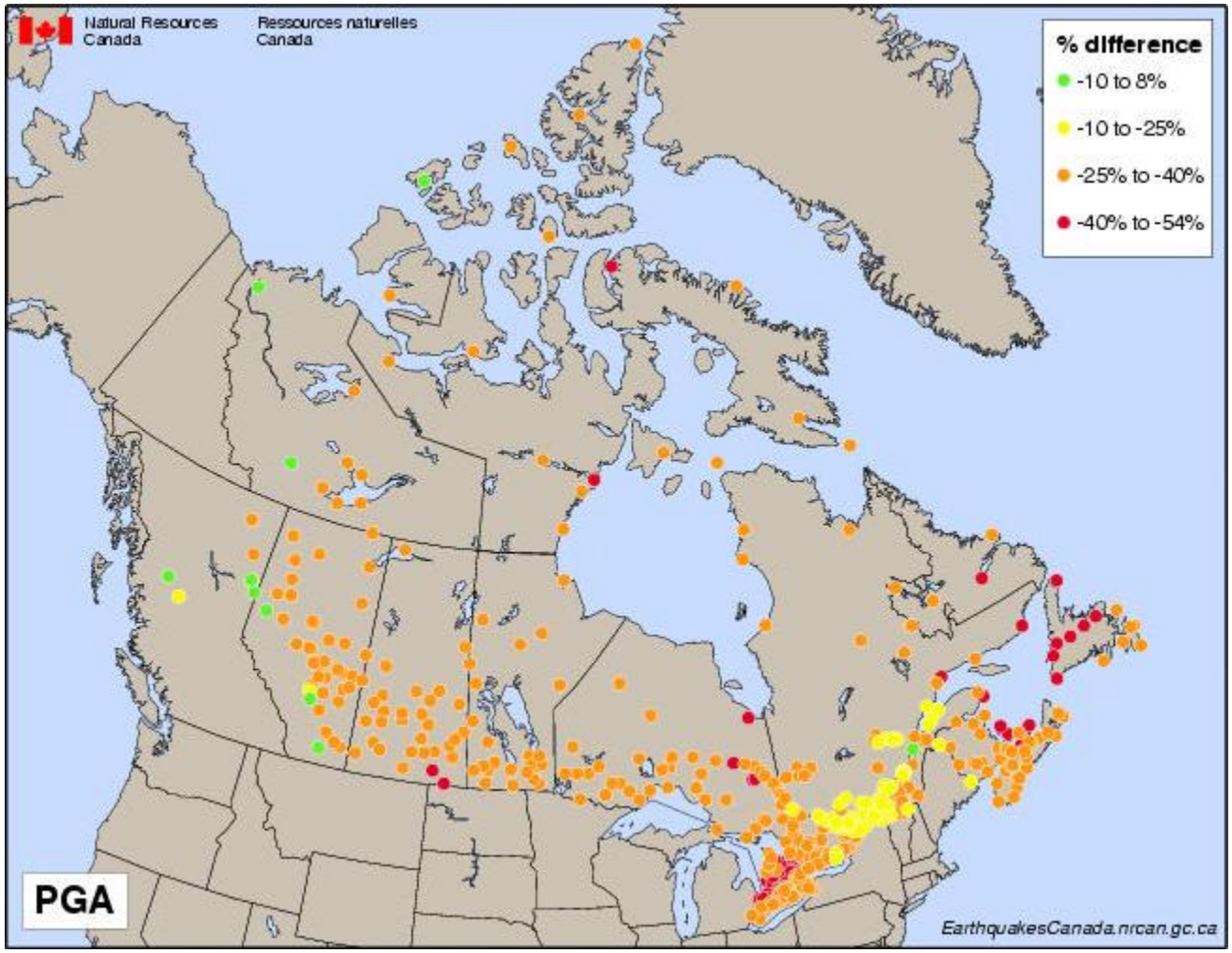
- In NBC 2010, 8 parameter equation provides better fit



Seismic Data Table C-2



Seismic Data Table C-2



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EQ Design – Site Properties

- Clarification on Site Class when soft material > 3 m above rock
- Structures with T ≤ 0.5 seconds on liquefiable soils may determine Site Class and Fa, Fv as if not liquefiable

EQ Design – Other

- Type 4 Irregularity – In-Plane Discontinuity in Vertical Lateral-Force-Resisting Element, exemption for braced and moment-resisting frames
- Penthouse exemption to vertical variations of R_dR_o extended to rooftop structures and criteria revised
- Post-disaster buildings – lateral stiffness can't decrease from top to bottom

EQ Design – R_d, R_o, General Restrictions

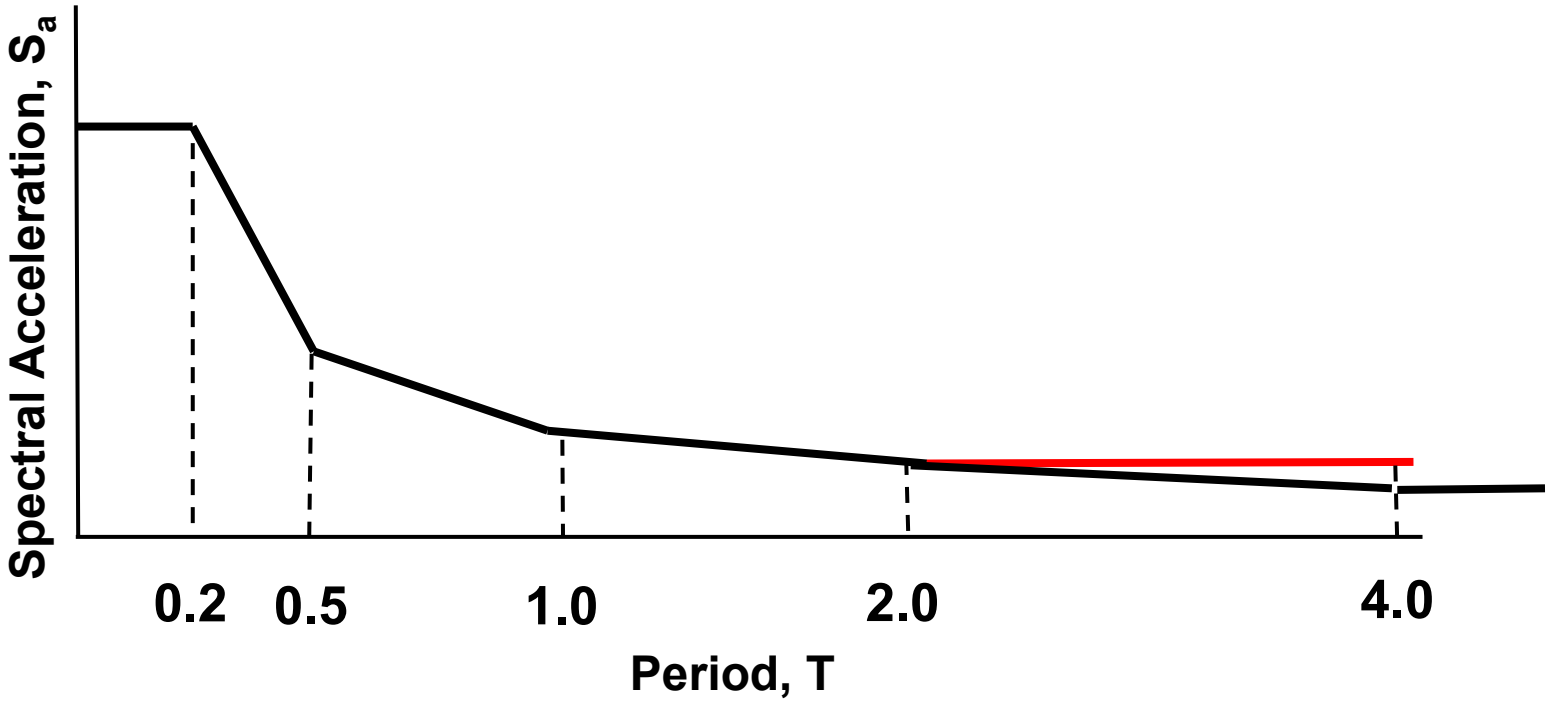
- Steel
  - Terminology updated
  - New system → ductile buckling-restrained braced frames
  - Conventional construction height limit shouldn't apply to non-assembly occupancies – restriction removed

- Cold-formed steel
  - R_d, R_o, general restrictions now added

Cold-Formed Steel Structures Designed and Detailed According to CAN/CSA-S136							
Shear walls							
Screw-connected shear walls – wood-based panels	2.5	1.7	20	20	20	20	20
Screw-connected shear walls – wood-based and gypsum panels in combination	1.5	1.7	20	20	20	20	20
Diagonal strap concentrically braced walls							
Limited ductility	1.9	1.3	20	20	20	20	20
Conventional construction	1.2	1.3	15	15	NP	NP	NP
Other cold-formed SFRS(s) not defined above	1.0	1.0	15	15	NP	NP	NP

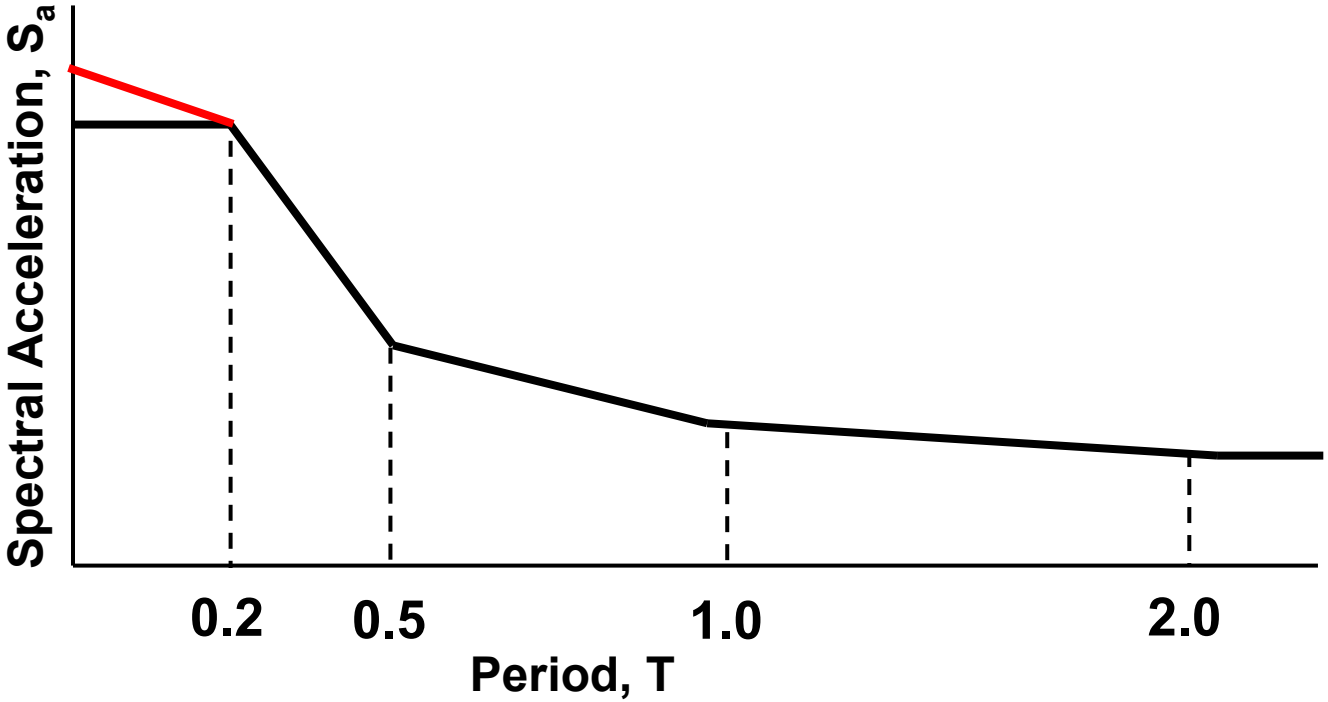
EQ Design – Long Period Cutoff – ESFP

- 2005 force cut-off of 2.0 seconds conservative for walls, coupled-walls and wall-frames
- Force cut-off extended to 4.0 seconds, and tied to T for deflection limit calculation



EQ Design – Short Period Cutoff – ESFP

- Short period cutoff removed for buildings on Site Class F → soil amplification



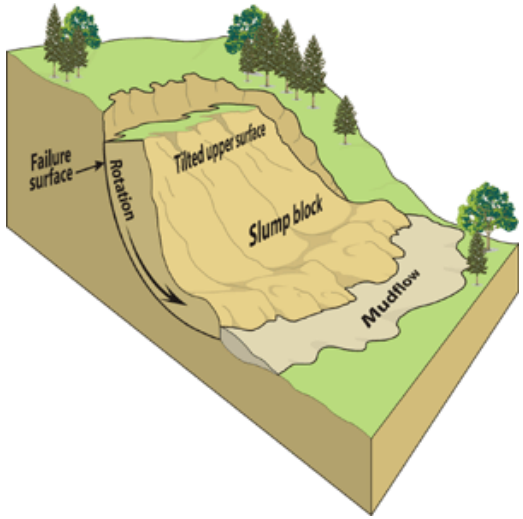
EQ Design – Other

- ESFP – long period cutoff extension to 4 seconds → M_v (higher mode factor) and J (overturning moment factor) values revised to be compatible
- Dynamic analysis procedure revised to be compatible with Site Class F and short period cutoff
- Steel roof deck, timber diaphragms of < 4 storeys can yield when designed and detailed accordingly
- Capacity design cutoff relaxed to $R_dR_o = 1.3$

EQ Design – Site Stability

2005

- Slope stability assessed using PGA
- Geotechnical analysis not revised when 10% in 50 year probability of exceedance revised to 2% in 50 years
- Slope stability and consequences now require assessment
- Guidance given in Commentary J with reference to Vancouver Task Force document "*Geotechnical Design Guidelines for Buildings on Liquefiable Sites in Accordance with NBC 2005*"



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Wind – Exposure Factor

- C_e for rough terrain factor – criteria changed from 10 to 20 times building height based on research
- In Commentary I for dynamic procedure – research shows C_e for very rough terrain not valid and has been deleted

Wind – Dynamic Effects

- Buildings with n < ¼ Hz → experimental method only
  - Dynamic effects dominate gust component
  - Dynamic approach not valid (vortex excitation, across-wind loading, wake buffeting and channeling)
- 120 m height limit revised to 60 m and criteria H/w < 4 added → significant dynamic response

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BE – Existing
Structural Loads Provisions

2005

- **5.2.2. Structural Loads and Design Procedures**
- **5.2.2.1. Determination of Structural Loads**

…

2) The structural loads referred to in Sentence (1) shall include

a) *dead loads transferred from structural elements*,

b) wind, snow, rain, hydrostatic and earth pressures, as well as earthquake loads and effects,

c) *live loads due to use and occupancy, and*

d) loads due to thermal or moisture-related expansion and contraction, deflection, deformation, creep, shrinkage, settlement, and differential movement.

BE – Existing
Structural Loads Provisions

2005

- **5.2.2.2. Wind Load and Other Air Pressure Loads**

  (See Appendix A.)

  …

  2) Except as provided in Sentence (3), the wind load referred to in Sentence (1)

  shall be 100% of the specified wind load determined in accordance with Part 4 and based on

  a) the reference velocity pressure defined in Sentence 4.1.7.1.(4), and

  b) the gust effect factor defined in Sentence 4.1.7.1.(6).

BE – 2010
Structural Loads Provisions

- **5.2.2. Structural Loads and Design Procedures**
- **5.2.2.1. Determination of Structural Loads and Effects**

…

2) The structural loads referred to in Sentence (1) and their related effects shall include

a) *dead loads transferred from structural elements,*

b) wind, snow, rain, hydrostatic and earth pressures~~, as well as earthquake loads and effects,~~

c) earthquake effects for post-disaster buildings, depending on their intended function (see Appendix A)

d) *live loads due to use and occupancy, and*

e) loads due to thermal or moisture-related expansion and contraction, deflection, deformation, creep, shrinkage, settlement, and differential movement.

BE – 2010
Structural Loads Provisions

- **5.2.2.2. Determination of Wind Load ~~and Other Air Pressure Loads~~**

  (See Appendix A.)

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  ~~a) the reference velocity pressure defined in Sentence 4.1.7.1.(4), and~~

  ~~b) the gust effect factor defined in Sentence 4.1.7.1.(6).~~

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Questions?

Send them to us at codes@nrc-cnrc.gc.ca

Thank you!