Submit a comment

Proposed Change 1996

Code Reference(s):	**NBC20 Div.B 4.1.8.3. (first printing)**
Subject:	Earthquake Load and Effects — General Requirements
Title:	Clarification of Provisions for Structural and Non-Structural Elements Not Part of the SFRS
Description:	The proposed change modifies the existing Code provisions for structural and non-structural elements that are not part of the defined seismic force resisting system (SFRS) of a building.

This change could potentially affect the following topic areas:

- ☐ Division A
- ☐ Division C
- ☐ Building operations
- ☐ Small Buildings
- ☐ Fire Protection
- ☐ Accessibility
- ☐ Building Envelope
- ☐ Heating, Ventilating and Air Conditioning
- ☑ Division B
- ☑ Design and Construction
- ☐ Housing
- ☑ Large Buildings
- ☐ Occupant safety in use
- ☑ Structural Requirements
- ☐ Energy Efficiency
- ☐ Plumbing
- ☐ Construction and Demolition Sites

Problem

The ambiguity in the Code provisions for structural and non-structural elements that are not part of the designated seismic force resisting system (SFRS) in a building is a source of confusion among Code users, which has led to inconsistent interpretation of the Code.

The ambiguity causes difficulties for Code users, leads to varying compliance, and can result in unsafe structures that may carry a risk of damage and collapse that is higher than the level of risk acceptable in the NBC for a design-level earthquake event.

Justification

Earthquake design requires that a structure have a clearly defined SFRS that is designed to resist 100% of the earthquake loads and their effects. However, structural and non-structural elements that are part of the building but are not considered part of the SFRS must be accounted for, because their presence can contribute significantly to the overall behaviour of the building structure during an earthquake.

Article 4.1.8.3. of Division B of the NBC provides general requirements to help Code users deal with such elements. The provisions of the Article are currently being interpreted in different ways, leading to varying compliance. The proposed change separates non-load bearing masonry walls from other stiff non-load bearing elements, such as brick veneer and precast concrete wall panels, and provides specific requirements for each. The proposed change also provides additional guidance in explanatory Notes.

This proposed change will add clarity, reduce difficulties in complying with Article 4.1.8.3., and mitigate the risk of unsafe design resulting from incorrect interpretation of the Article.

PROPOSED CHANGE

[4.1.8.3.] 4.1.8.3. General Requirements

[1] 1) The *building* shall be designed to meet the requirements of this Subsection and of the design standards referenced in Section 4.3.

[2] 2) Structures shall be designed with a clearly defined load path, or paths, that will transfer the inertial forces generated in an earthquake to the supporting ground.

[3] 3) The structure shall have a clearly defined SFRS, as defined in Article 4.1.8.2.

[4] 4) The SFRS shall be designed to resist 100% of the earthquake loads and their effects. (See Note A-4.1.8.3.(4).)

[5] 5) ~~All s~~Structural ~~framing~~ elements that are not considered to be part of the SFRS must be investigated and shown to behave elastically or to have sufficient non-linear capacity to support their gravity loads while undergoing earthquake-induced deformations calculated from the deflections determined in Article 4.1.8.13.

[6] 6) Except as provided in Sentence (7), s~~S~~tiff non-*loadbearing* elements~~that are not considered part of the SFRS~~, such as ~~concrete, masonry,~~ brick veneer ~~or~~and precast concrete wall~~s or~~ panels, shall be separated from all structural elements of the *building* such that no interaction takes place as the *building* undergoes earthquake-induced deformations calculated from the deflections determined in Article 4.1.8.13.~~be~~

[a] a) ~~separated from all structural elements of the *building* such that no~~

~~interaction takes place as the *building* undergoes deflections due to earthquake effects as calculated in this Subsection, or~~

[b] b) ~~made part of the SFRS and satisfy the requirements of this Subsection.~~

~~(See Note A-4.1.8.3.(6).)~~

[7] --) Non-*loadbearing* masonry walls shall

[a] --) be separated from all structural elements of the *building* in accordance with Sentence (6), or

[b] --) be considered masonry infill shear walls that are part of the SFRS and satisfy the requirements of this Subsection.

(See Note A-4.1.8.3.(7)-2025.)

[8] --) Structural elements that have significant lateral stiffness, such as concrete walls, shall

[a] --) be made part of the SFRS and satisfy the requirements of this Subsection, or

[b] --) satisfy the requirements of Sentences (5) and (9)-2025.

(See Note A-4.1.8.3.(8)-2025.)

[9] 7) Stiffness imparted to the structure from structural elements that are not considered to be part of the SFRS, as described in Sentence (5) and Clause (8)(b)-2025~~, other than those described in Sentence (6)~~, shall not be used to resist earthquake deflections but shall be accounted for

[a] a) in calculating the period of the structure for determining ~~forces~~the earthquake loads and effects referred to in Sentence (4) if the added stiffness decreases the fundamental lateral period by more than 15%,

[b] b) in determining the irregularity of the structure, except the additional stiffness shall not be used to make an irregular SFRS regular or to reduce the effects of torsion ~~(see Note A-4.1.8.3.(7)(b) and (c))~~, and

[c] c) in designing the SFRS if inclusion of the structural elements that are not considered to be part of the SFRS in the analysis has an adverse effect on the SFRS. ~~(see Note A-4.1.8.3.(7)(b) and (c)).~~

(See Note A-4.1.8.3.(9)-2025.)

[10] 8) Structural modeling shall be representative of the magnitude and spatial distribution of the mass of the *building*, and of the stiffness ~~of all elements~~ of the SFRS~~, including stiff elements that are not separated in accordance with Sentence 4.1.8.3.(6),~~ and the elements described in Sentence (9)-2025, where appropriate, and shall account for

[a] a) the effect of cracked sections in reinforced concrete and reinforced masonry elements,

[b] b) the effect of the finite size of members and joints,

[c] c) sway effects arising from the interaction of gravity loads with the displaced configuration of the structure, and

[d] d) other effects that influence the lateral stiffness of the *building*.

(See Note A-4.1.8.3.(10~~8~~)-2025.

~~**Note A-4.1.8.3.(6) General Design of Stiff Elements.**~~

~~Information on the general design requirements for stiff elements can be found in the Commentary entitled Design for Seismic Effects in the "Structural Commentaries (User's Guide – NBC 2020: Part 4 of Division B)".~~

Note A-4.1.8.3.(7)-2025 Non-Loadbearing Masonry Walls.

When gaps are provided at the top and sides of a non-loadbearing masonry wall that are sufficient to ensure that no interaction takes place between the wall and the structural elements as the building undergoes earthquake-induced deformations, the wall will not contribute to the lateral stiffness of the structure and will not attract a significant portion of the earthquake loads. In this case, the wall would only need to be designed in accordance with Article 4.1.8.18. and CSA S304, "Design of masonry structures."

When sufficient gaps are not provided, the wall may attract a significant lateral earthquake force and, therefore, must be designed to act as a masonry infill shear wall in accordance with CSA S304 to resist in-plane earthquake loads. Such walls are permitted to be included as "unreinforced masonry," as defined in Table 4.1.8.9., in buildings in Seismic Categories SC1 and SC2 up to the permitted heights. In this case, the R_dR_o value of the combined SFRS with the "unreinforced masonry" must be taken as 1.0, in accordance with Table 4.1.8.9. and Sentence 4.1.8.9.(3).

For taller buildings in Seismic Categories SC1 and SC2 and for all buildings in Seismic Categories SC3 and SC4, the use of "unreinforced masonry" as an SFRS is not permitted. Therefore, any masonry walls that are made part of the SFRS in such buildings must satisfy, for the type of SFRS selected, the restrictions in Table 4.1.8.9. and the design and detailing requirements of CSA S304 corresponding to the appropriate value of R_dR_o.

Further information can be found in the Commentary entitled Design for Seismic Effects in the "Structural Commentaries (User's Guide – NBC 2025: Part 4 of Division B)."

Note A-4.1.8.3.(8)-2025 Concrete Walls.

A long concrete wall provided for architectural purposes, fire separation or another reason will often have high lateral stiffness in its strong-axis bending direction. Depending on how it is supported and connected to the floor diaphragms or other structural elements, the wall may attract a large portion of the earthquake loads. If this is the case, the wall should be made part of the SFRS. Such walls are permitted to be included, without any special seismic detailing, as "other concrete SFRSs not listed above," as defined in Table 4.1.8.9., in buildings in Seismic Categories SC1 and SC2 up to the permitted heights. In this case, the R_dR_o value of the combined SFRS with the "other concrete SFRSs" must be taken as 1.0, in accordance with Table 4.1.8.9. and Sentence 4.1.8.9.(3).

For taller buildings in Seismic Categories SC1 and SC2 and for all buildings in Seismic Categories SC3 and SC4, the use of "other concrete SFRSs" is not permitted. Therefore,

any concrete walls that are made part of the SFRS in such buildings must satisfy, for the type of SFRS selected, the restrictions in Table 4.1.8.9. and meet the design and detailing requirements of CSA A23.3, "Design of concrete structures," corresponding to the appropriate value of $R_d R_o$.

To be permitted to not be included as part of the SFRS, concrete walls must be sufficiently slender to remain elastic or must be subjected to sufficiently low levels of axial compression to have the necessary ductility, in order to meet the requirements of Sentence 4.1.8.3.(5). See CSA A23.3 for information on the design of concrete walls that are not part of the SFRS.

Further information can be found in the Commentary entitled Design for Seismic Effects in the "Structural Commentaries (User's Guide – NBC 2025: Part 4 of Division B)."

Note A-4.1.8.3.~~(7)(b) and (c)~~(9)-2025 Stiffness Imparted to the Structure from Structural Elements Not Part of the SFRS.

Information on stiffness imparted to the structure from structural elements that are not considered to be part of the SFRS can be found in the Commentary entitled Design for Seismic Effects in the "Structural Commentaries (User's Guide – NBC 2020: Part 4 of Division B)".

Note A-4.1.8.3.(~~8~~10)-2025 Structural Modeling.

The requirement in Sentence 4.1.8.3.(4) that the SFRS be designed to resist 100% of the earthquake loads and their effects and the requirement in Sentence 4.1.8.3.(9)-2025 that the structural modeling include the stiffness of all elements that influence the lateral stiffness of the building imply that two different structural models are necessary: a first model including the stiffness of the SFRS only and a second model including the stiffness of the SFRS and the additional elements that are not part of the SFRS. The results from the analysis of these models can be compared in order to determine whether a reduction in fundamental lateral period, a change in irregularity or any other adverse effect arises from the inclusion of the stiffness of the additional elements. Where required by Clause 4.1.8.3.(9)(c)-2025, the second model is used to scale the specified lateral earthquake force, V_d, determined for the first model.

Further ~~I~~information on structural modeling can be found in the Commentary entitled Design for Seismic Effects in the "Structural Commentaries (User's Guide – NBC 2020: Part 4 of Division B)".

Impact analysis

The proposed change clarifies the existing requirements of Article 4.1.8.3. It would help to ensure that interpretation and compliance are consistent with the intent of the Code and uniform across jurisdictions.

As a result, the impact of the proposed change is expected to be positive for Code users. As no new requirements are being proposed, the change would be cost neutral.

Enforcement implications

The proposed change clarifies the existing requirements of Article 4.1.8.3. It would help to ensure that interpretation and compliance are consistent with the intent of the Code and uniform across jurisdictions. Therefore, the proposed change is expected to have a positive impact on enforcement.

Who is affected

Owners, architects, designers and enforcement staff involved in building design and construction.

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

[4.1.8.3.] 4.1.8.3. ([1] 1) no attributions

[4.1.8.3.] 4.1.8.3. ([2] 2) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([2] 2) [F20-OP2.1,OP2.4]

[4.1.8.3.] 4.1.8.3. ([3] 3) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([3] 3) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] 4.1.8.3. ([4] 4) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([4] 4) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] 4.1.8.3. ([5] 5) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([5] 5) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] 4.1.8.3. ([6] 6) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([6] 6) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] -- ([7] --) [F20-OS2.1]

[4.1.8.3.] -- ([7] --) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] -- ([8] --) [F20-OS2.1]

[4.1.8.3.] -- ([8] --) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] 4.1.8.3. ([9] 7) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([9] 7) [F20-OP2.1] [F22-OP2.4]

[4.1.8.3.] 4.1.8.3. ([10] 8) [F20-OS2.1]

[4.1.8.3.] 4.1.8.3. ([10] 8) [F20-OP2.1] [F22-OP2.4]