Ontario Association of Architects

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Importance Category and Seismic Restraint

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Summary

The Ontario Building Code (OBC) requires all buildings be assigned an Importance Category of 'Low', 'Normal', 'High', or 'Post-disaster'. The Importance Category is necessary for seismic design, but can at times be overlooked because buildings are considered 'Normal' unless designated otherwise. The Importance Category should be included as part of the Code Data Matrix in building permit application submissions.

This Practice Tip describes aspects of seismic restraint and the Importance Category that must be taken into account in the design of buildings. The design requirements are mostly structural, but there are architectural, mechanical, and electrical requirements and implications to appropriately incorporate into the design.

If the Importance Category and the provisions for seismic design and restraint are not taken into account at the design stages, then the revisions needed to comply with the code requirements can be difficult and costly.

Background

Seismic design has a critical role in buildings in order to avoid casualties during earthquake events as well as for the buildings to be available after such an event for emergency responders, treatment of victims, communications, and housing of the displaced. Some areas of Ontario (e.g. the Ottawa and St. Lawrence valleys) are among the most seismically sensitive areas in North America.

Three things Certificate of Practice holders should be aware of related to seismic design are:

1) the seismic hazard index formulae calculation (this index determines the method of seismic analysis and the extent of the requirements for non-structural components);
2) the Importance Factor (I_E, earthquake importance factor); and
3) the Site Classification (assigned by a geotechnical engineer following soil tests). The formulae use both the Importance Category and the Site Classification as factors.

Importance Categories

The OBC requires all buildings be assigned an Importance Category of 'Low', 'Normal', 'High', or Post-disaster. The 'Post-disaster' category applies to buildings such as hospitals, police facilities, and telephone exchanges that need to remain operational following a disaster. The 'High' category is for buildings that are likely to become a shelter or collecting point, such as schools.

Although the requirement for the Importance Category resides in "Part 4 – Structural Design" of the OBC, the determination of Importance Category relates to the use and occupancy of the building. This has traditionally been under the purview of the holder and owner, rather than the structural engineer. To appropriately assign the Importance Category, professional judgment should be used and discussions with the owner, structural engineer, and authorities having jurisdiction (AHJs) may be needed.

The descriptions of the Importance Categories that follow are in reference to OBC Table 4.1.2.1.B.

Low

Possible examples of the 'Low' Importance Category are *low human occupancy buildings* (*farm buildings),* with one person or fewer per 40 m^2 of floor area, and '*Low' hazard industrial occupancy* (Group F, Division 3) warehouses, where structural failure causing damage to materials or equipment does not present a direct threat to human life.

It is important for the authorities having jurisdiction to be aware of when the 'Low' Importance Category is being assigned, since it enables relaxations of some code requirements. In some cases, this relaxation is inappropriate. For example, an equestrian riding facility that also has provision for permanent or temporary grandstands is an Assembly Occupancy use and should not be categorized as 'Low' Importance Category.

Normal

This category encompasses all buildings, unless classified as 'Low', 'High', or 'Post-disaster'.

High

The 'High' Importance Category applies to schools, community centres, and industrial or storage facilities having hazardous or toxic materials. This category is not limited to the specific facilities noted, but might also apply to a college, sports facility, arena, or large place of worship. The OBC uses the term "likely to be used as 'Post-Disaster' shelters." It should be noted that this is not the OBC-defined term '*Post-disaster' building,* but a lower category of Importance, which requires professional judgment in order to assign a category.

Post-disaster

A *Post-disaster building* is defined in the OBC and means a building essential to the provision of services in the event of a disaster, and includes:

(a) hospitals, emergency treatment facilities, and blood banks;
(b) telephone exchanges;
(c) power-generating stations and electrical substations;
(d) control centres for land transportation;
(e) public water treatment and storage facilities;
(f) water and sewage pumping stations;
(g) emergency response facilities;
(h) fire, rescue, and police stations;
(i) storage facilities for vehicles or boats used for fire, rescue, and police purposes; and
(j) communications facilities, including radio and television stations.

The list covers a broad range of buildings. Questions may arise for some facilities not specifically listed, such as: wind turbines, private versus public bus terminals or airports, private clinics or non-emergency treatment facilities. Such places not likely considered essential to provision of services to the public in a disaster. Discussion with the owner, structural engineer, and AHJs may be required to appropriately assign the Importance Category.

Site Class (Table 4.1.8.4.A)

A Site Class (designated by the letters A to F), relative to substrate type (e.g. rock, hard, or soft soil), is one of three factors required for the calculation of the seismic hazard index. The Site Class is assigned by a geotechnical engineer following soil tests. A Shear Wave Velocity Test may be required by the geotechnical engineers to assign a Site Class more accurately than can be ascertained without the test. The shear wave test would be an additional cost over simple borehole analysis, but may save the project considerable construction cost (i.e. due to test result values, the engineer may be able to assign Site Class C, rather than D). Additionally, site stability should be evaluated based on site-specific soil properties to take into account the potential for slope displacement in the design of the structure and its foundations.

Without an understanding of the underlying geologic structure, the Site Class of adjacent properties cannot be used as a guide to the site class of any other property. Similarly, one portion of a site may be different from another portion. As with bore holes, the number and location of shear wave tests is a matter of professional judgment typically by the architect or structural engineer.

The Seismic Hazard Index

While the structural design of the building involves complex seismic restraint calculations, a reasonably simple formula is used to determine the seismic hazard index.

The seismic hazard index formula is: $I_E F_a S_a(0.2)$ where:

- I_E Earthquake importance factor for the structure (OBC Table 4.1.8.5.);
- F_a Acceleration-based site coefficient (OBC Tables 4.1.8.4.B to I);
- S_a (T) 5% damped spectral response acceleration for period T (MMAH SB-1, Table 3).

If the value of the seismic hazard index is equal or greater than 0.35, this triggers the need to restrain architectural elements like suspended ceilings, parapets, ornamentations, masonry veneer connectors, etc., as well as restraints for mechanical and electrical systems and equipment in all buildings (refer to OBC 4.1.8.6.(3) and OBC 4.1.8.18.(2)).

The chart below shows some of the requirements for various seismic hazard index values that affect architectural and engineered parts of buildings.

Value of seismic hazard index	Requirements	Reference
≥ 0.2	Buildings are not permitted to have a 'weak storey' (e.g. where an open floor area, such as a parking garage, is on a level below a level having numerous shear walls). A formal definition of what constitutes this condition is given in the OBC.	OBC 4.1.8.10 (1)
≥ 0.35	Elements of structures and non-structural components and equipment (categories 6 through 22 of Table 4.1.8.18) must be seismically restrained. This includes suspended ceilings, light fixtures, masonry veneer ties, access floors, machinery, fixtures, ducts, pipes, cable trays, and tanks, along with similar items noted in the OBC.	OBC 4.1.8.18 (2)
≥ 0.35	Basement walls must be designed to resist earthquake lateral pressures from backfill or natural ground.	OBC 4.1.8.16 (7)
≥ 0.35	The prescriptive masonry veneer tie spacing given in CSA Standard A370, cannot be used. The ties must be engineered.	CSA A370 10.2.2
≥ 0.35	Unreinforced masonry is not permitted.	CSA S304.1 4.5.1
≥ 0.35	Minimum amounts of reinforcement are required for all loadbearing and lateral load-resisting masonry, masonry used around stairwells and elevators, exterior cladding (excluding veneer), and certain partitions.	CSA S304.1 4.6.1, 10.15.2.2, 10.15.2.4
≥ 0.75	All partitions must be reinforced.	CSA S304.1 4.6.1, 10.15.2.3
≥ 0.35	Composite and multi-wythe solid walls must have grouted collar joists and ties.	CSA S304.1 10.7.1.3

≥ 0.75	Ties for masonry must be placed in grout, not in the horizontal mortar joints.	CSA S304.1 12.2.5
≥ 0.35	The empirical design method for masonry cannot be used – all masonry must be engineered.	CSA S304.1 F.1.1(f)
≥ 0.35	Wood-framed structures must include special requirements for shear walls and diaphragms.	CSA O86 9.8.1

Part 9 Buildings

Schools, community centres, other assembly occupancies and 'F1' group high hazard industrial (all 'High' Importance Category buildings) are excluded from design under OBC Part 9, but some '*Post-disaster' buildings* can fall within the acceptable application of Part 9. All buildings that fall under the definition of *'Post-disaster' building* must be designed to OBC Part 4 (refer to OBC Div. A, 1.1.2.2.(2)).

Part 9 also has some individual clauses related to seismic design and restraint, such as masonry reinforcement or the restraint of water heaters, based on seismic spectral response acceleration for the location of the building (Refer to OBC 9.20.1.2. & 9.31.6.2 (3)).

Renovations

For renovation projects, a soils report and determination of Site Class by a geotechnical engineer may not be available. With some exceptions, OBC seismic design requirements are not applicable for renovation projects.

OBC, Div. B, Section 11.5 deals with *compliance alternatives (C.A.)*, a term defined as "a substitute for a requirement in another Part of Division B that is listed in Part 10 or 11 of Division B and *C.A.* has a corresponding meaning." (refer to OBC Div. A, 1.4.1.2.(1)(c)).

Various *C.A.s* are listed in Tables 11.5.1.1.A. to 11.5.1.1.F, corresponding to occupancies A, B, C, D/E, and F respectively. *C.A.s* No. A77, B78, C88, DE81, and F82 all state that the requirements under Div. B, 4.1.8. Earthquake Loads and Effects, do not apply (i.e., the seismic design requirements of the OBC do not apply to renovations).

Having said this, since seismic requirements are in Div. B, Part 4 of the Code, the application of the *C.A.* is somewhat restricted because Div. B, 11.5.1.1.(1) allows *C.A.s* to be substituted for requirements found in Parts 3, 4, 6, or 8 only if Chief Building Official (CBO) approval is obtained. Note that Div. B, 11.5.1.1.(2) allows *C.A.s* to be substituted for Part 9 and 12 requirements without having to seek CBO approval.

It is expected that building officials would generally accept that seismic design requirements for a renovation would not apply, but anticipate a code-based explanation may be requested by building officials.

Building Code Data Matrix (Refer to PT.03))

The OAA template for the Building Code Data Matrix includes a section for recording the assigned Importance Category and the seismic hazard index calculation. This information should be included as part of building permit applications. If the Importance Category is not identified on the drawings, the determination and designation of a classification may not be clear because in accordance with the OBC, the 'Normal' category applies, unless another category has been explicitly assigned.

Suggested Procedures

1. Become familiar with Importance Categories, seismic design requirements, non-structural component requirements, and alternative seismic design options (such as seismic isolation and supplemental energy dissipation).
2. In the building code review process, determine if the Importance Category of the building is 'Low', 'Normal', 'High', or 'Post-disaster'. Discuss with the client, confirm, and document.
3. In cases where the classification is not clear, discuss with the Building Department and document the discussions and, most importantly, any decisions and agreements.

4. A geotechnical report should be provided by the owner. The report should include the Site Class and the factors for the seismic hazard index calculations. This information should appear on structural engineering drawings.
5. Determine if the seismic hazard index meets the thresholds discussed above and what set of seismic restraints for non-structural elements are required.
6. Include the Importance Category and seismic hazard index information in the Building Code Data Matrix on the drawings.
7. Where responsible for the coordination of consultants, distribute the information to all consultants so they can interpret the applicable OBC requirements and provide appropriate seismic design and restraints where required.
8. Become familiar with the types of Structural Irregularities described in OBC Table 4.1.8.6., and when applicable, consider the architectural form and interior spaces in relation to the Structural Irregularities.

References

Practice Tip PT.03 – Building Code Data Matrix

OBC 4.1.2 – Specified Loads and Effects

OBC 4.1.8 – Earthquake Loads and Effects

OBC 9.4.1 – Structural Design Requirements and Application Limitations

MMAH Supplementary Standard SB-1 – Climate and Seismic Data, Table 3

2015 Structural Commentaries (User's Guide – NBC 2015: Part 4 of Div. B)

Practice Tip PT.30 Retention of Specialist Consultants

Attachments

Attachment 1 Seismic Hazard Index Calculation Examples

The OAA does not provide legal, insurance, or accounting advice. Readers are advised to consult their own legal, accounting, or insurance representatives to obtain suitable professional advice in those regards.