ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA

PRACTICE ADVISORY

SITE RESPONSE ANALYSIS AND SITE-SPECIFIC RESPONSE SPECTRA

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This practice advisory has been issued for registrants (engineering professionals and firms) of Engineers and Geoscientists BC to provide clarity on requirements for using site response analysis (SRA) as a seismic design tool for analyzing the interaction between a building structure and the soil at a specific site.

When used effectively, SRA can lead to savings in the overall cost of construction by minimizing the effect of conservative soil-structure interaction assumptions that carry through the design. However, registrants should use a high degree of caution when executing SRA and adjusting building code-based design spectral values to reflect local site conditions.

This practice advisory provides recommendations for using a site-specific response spectrum for new buildings that is in alignment with the “BC Ministry of Transportation and Infrastructure Supplement to the Canadian Highway Bridge Design Code, S6-14” (Supplement to CHBDC S6-14) and the American Society of Civil Engineers (ASCE) standard titled “ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.”

BACKGROUND

SRA is a procedure in geotechnical engineering that traditionally has been used for transportation infrastructure but is increasingly being used as a tool for analyzing the interaction between a building structure and the soil at a specific site. SRA considers the effects of near-surface soil layers that may amplify or de-amplify seismic waves from the earthquake source.

Since SRA considers the soil properties of the specific site, it can minimize the number of unknowns and assumptions otherwise required to follow the requirements and guidance published in the *British Columbia Building Code 2018* and the Vancouver Building Bylaw 2019 (collectively referred to in this advisory as the “code”) and in standards and professional practice guidelines. When used effectively, SRA can lead to savings in the overall cost of construction for various types of infrastructure, including buildings, especially where “soft” soil conditions, or highly variable near-surface soil conditions, are prevalent.

Determining earthquake-induced inertia forces in a building by using a site-specific response spectrum from SRA has gained more attention with changes to the ground motions in the code. The potential for further increases in the magnitude of the earthquake hazard in subsequent versions of the code may result in the expanded use of SRA for buildings.

The methodology for determining response spectra has evolved over the last few years and continues to do so in anticipation of further increases in the magnitude of the earthquake hazard to be published in future versions of the code.

PROFESSIONAL PRACTICE

EDUCATION AND EXPERIENCE

Registrants intending to carry out SRA must have the appropriate education, training, and experience for this area of practice, and should have a high degree of understanding of the site and its soil properties.

RISK-BASED APPROACH

Registrants must use a risk-based approach to determine whether SRA is appropriate for the project, considering the complexity of the site and the building structure, as well as the consequences of failure or errors resulting from evolving practice.

INDEPENDENT REVIEW

As structural designs require independent review, and SRA is an integral part of structural analysis and design, an independent review of the SRA should be carried out by an appropriately qualified and experienced registrant before construction or implementation. See the Engineers and Geoscientists BC *Quality Management Guides – Guide to the Standard for Documented Independent Review of High-Risk Professional Activities or Work* for more information.

A peer review of the SRA may also be required by the code, a client, or another party; however, the requirements for peer review are outside the scope of this practice advisory.

REFERENCE CODES AND STANDARDS

Following are the requirements for SRA used in the design of highway bridges in Canada and in the design of buildings and other structures in the United States:

- The Supplement to CHBDC S6-14, Section 4, Clause 4.4.3.1 states the following:
  - “Design spectral values may also be obtained using site response analysis with consent of the Ministry. The spectra from site response analysis shall not be less than 80% of the code based spectra.”
- ASCE 7-16, Chapter 21, Site-Specific Ground Motion Procedures for Seismic Design, sentence 21.3 states the following:

  - "The design spectral response acceleration at any period shall not be taken as less than 80% of S_a determined in accordance with Section 11.4.6 …", which is the determination using Site Class.
- ASCE 7-16, Commentary to Chapter 21 states the following:
  - "Eighty percent of the design response spectrum determined in accordance with Section 11.4.6 was established as the lower limit to prevent the possibility of site-specific studies generating unreasonably low ground motions from potential misapplication of site-specific procedures or misinterpretation or mistakes in the quantification of the basic inputs to these procedures."

RECOMMENDED PRACTICE

Registrants should use a high degree of caution when executing SRA and adjusting code-based design spectral values to reflect local site conditions.

In consultation with subject matter experts, and in alignment with the requirements of the Supplement to the CHBDC S6-14 and the ASCE 7-16, registrants should use a site-specific response spectrum that is not less than 80% of the code-specified response spectrum for new buildings. For Site Class F, the design spectral response spectrum should not be less than 80% of that determined for Site Class E.

REFERENCES

American Society of Civil Engineers (ASCE). 2017. ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Reston, Virginia: ASCE. [accessed: 2021 Oct 12]. https://doi.org/10.1061/9780784414248.fm.

BC MOTI. 2016. British Columbia Ministry of Transportation and Infrastructure Bridge Standards and Procedures Manual. Volume 1. Supplement to the Canadian Highway Bridge Design Code S6-14. Victoria, BC: Province of BC. [accessed: 2021 Oct 12]. https://www2.gov.bc.ca/gov/content/transportation/transportation-infrastructure/engineering-standards-guidelines/structural/standards-procedures/volume-1.

Engineers and Geoscientists BC. 2021.Quality Management Guides – Guide to the Standard for Documented Independent Review of High-Risk Professional Activities or Work. Burnaby, BC: Engineers and Geoscientists BC. [accessed: 2021 Oct 12]. https://www.egbc.ca/app/Practice-Resources/Individual-Practice/Guidelines-Advisories.

VERSION HISTORY

VERSION NUMBER	PUBLISHED DATE	DESCRIPTION OF CHANGES
1.1	February 11, 2022	Minor revision to clarify guidance for Site Class F.
1.0	November 18, 2021	Initial version.