Seismic Hazard Index Calculations - Examples

Summary

A building code data matrix presents pertinent selected elements from a detailed code analysis to provide an overview of the key code factors of the design to municipal building officials and others. The data matrices developed by the OAA are templates intended to be modified as needed to adequately present the key building code decisions made in the design of a building.

If there is insufficient space in a matrix for any information, insert additional rows or list the information in a separate table identifying to which item it relates, and cross-reference to the additional information. Where more space is provided than is needed, hide or delete the unnecessary rows.

When using the MS Excel templates (available only to OAA members), refer to additional information in the “Read Me First” tab of the Excel workbook. When using the MS Word template versions with MS Word for the Mac, the functional check-boxes may not appear or function due to updates in MS Word software that has not currently been updated in Word for Mac software.

Background

The examples that follow are representative samples only used to show how the various parameters may be used to complete this portion of a data matrix. Some of the data in the examples are fictitious. Users of the data matrices must obtain real data for the place of the work.

As noted after Example 4, the result obtained from using the same data as in the previous version of this Practice Tip is different than before due to changes in the calculations. If you are working on a subsequent phase of a project or an addition to an existing building, do not rely on previous calculations; rather, complete a new seismic analysis.

For guidance in completing each type of matrix for Parts 3, 9, 10 or 11, refer to Practice Tip PT.03 Attachment 1 – Guide to the Completion of the OAA Building Code Data Matrices.

Example 1: Elementary School in Toronto

SEISMIC DESIGN REQUIREMENTS FOR NON-STRUCTURAL ELEMENTS (CATEGORIES 6 TO 22 TABLE 4.1.8.18)						OBC REFERENCE
01	IMPORTANCE CATEGORY			High		4.1.2.1.(3). 5.2.2.1.(2)
02	SITE CLASS			D		4.1.8.4, T.4.1.8.4.A
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(0.2)$			0.249		4.1.8.4.(1), SB-1, T.3.
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(2.0)$			0.029		4.1.8.4.(1), SB-1, T.3.
04	EARTHQUAKE IMPORTANCE FACTOR (I_E ULS)			1.3		T.4.1.8.5.
05	PEAK GROUND ACCELERATION (PGA)			0.160		4.1.8.4.(1), SB-1 T.3.
06	PGA FACTOR			0.8		4.1.8.4.(4)(a)(b)
07	PGA REFERENCE (PGA ref)			0.128		4.1.8.4.(4)
08	SITE COEFFICIENT (F_a = F(0.2))			1.09		4.1.8.4.(7), T.4.1.8.4.B
09	SEISMIC HAZARD INDEX	$I_EF_aS_a(0.2)$ =	0.35	LESS THAN 0.35?	NO	4.1.8.18.(2)
10	SEISMIC ISOLATION					4.1.8.19.
	IS THE BUILDING SEISMICLY ISOLATED?			N/A		
11	SUPPLEMENTAL ENERGY DISSIPATION					4.1.8.21.
	IS A SUPPLEMENTAL ENERGY DISSIPATION SYSTEM USED?			N/A		
12	IS SEISMIC DESIGN REQUIRED FOR CATEGORIES 6 TO 22, TABLE 4.1.8.18.?			REQUIRED		4.1.8.18.(2)
	REASONING FOR REQUIREMENT:		SEISMIC HAZARD INDEX IS 0.35 OR MORE			

An elementary school is a High Importance Category. This example in Toronto has typical soil (Stiff: D). The Seismic Hazard Index calculation result is just at the threshold of 0.35, thus seismic design for non-structural elements **is required**.

Example 2: Office Building in Toronto

SEISMIC DESIGN REQUIREMENTS FOR NON-STRUCTURAL ELEMENTS (CATEGORIES 6 TO 22 TABLE 4.1.8.18)						OBC REFERENCE
01	IMPORTANCE CATEGORY			Normal		4.1.2.1.(3). 5.2.2.1.(2)
02	SITE CLASS			D		4.1.8.4, T.4.1.8.4.A
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(0.2)$			0.249		4.1.8.4.(1), SB-1, T.3.
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(2.0)$			0.029		4.1.8.4.(1), SB-1, T.3.
04	EARTHQUAKE IMPORTANCE FACTOR (I_E ULS)			1.0		T.4.1.8.5.
05	PEAK GROUND ACCELERATION (PGA)			0.160		4.1.8.4.(1), SB-1 T.3.
06	PGA FACTOR			0.8		4.1.8.4.(4)(a)(b)
07	PGA REFERENCE (PGA ref)			0.128		4.1.8.4.(4)
08	SITE COEFFICIENT (F_a = F(0.2))			1.09		4.1.8.4.(7), T.4.1.8.4.B
09	SEISMIC HAZARD INDEX	$I_EF_aS_a(0.2)$ =	0.27	LESS THAN 0.35?	YES	4.1.8.18.(2)
10	SEISMIC ISOLATION					4.1.8.19.
	IS THE BUILDING SEISMICLY ISOLATED?			N/A		
11	SUPPLEMENTAL ENERGY DISSIPATION					4.1.8.21.
	IS A SUPPLEMENTAL ENERGY DISSIPATION SYSTEM USED?			N/A		
12	IS SEISMIC DESIGN REQUIRED FOR CATEGORIES 6 TO 22, TABLE 4.1.8.18.?			NOT REQUIRED		4.1.8.18.(2)
	REASONING FOR REQUIREMENT:		CATEGORIES 6 TO 22 EXEMPTED DUE TO SEISMIC HAZARD INDEX LESS THAN 0.35			

An office building is Normal Importance Category. This example in Toronto has typical soil (Stiff: D). The calculations result in a Seismic Hazard Index below the threshold of 0.35, thus seismic design for non-structural elements **is not required**.

Example 3: Office Building in Ottawa

SEISMIC DESIGN REQUIREMENTS FOR NON-STRUCTURAL ELEMENTS (CATEGORIES 6 TO 22 TABLE 4.1.8.18)					OBC REFERENCE
01	IMPORTANCE CATEGORY		Normal		4.1.2.1.(3). 5.2.2.1.(2)
02	SITE CLASS		D		4.1.8.4, T.4.1.8.4.A
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(0.2)$		0.439		4.1.8.4.(1), SB-1, T.3.
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(2.0)$		0.056		4.1.8.4.(1), SB-1, T.3.
04	EARTHQUAKE IMPORTANCE FACTOR (I_E ULS)		1.0		T.4.1.8.5.
05	PEAK GROUND ACCELERATION (PGA)		0.281		4.1.8.4.(1), SB-1 T.3.
06	PGA FACTOR		0.8		4.1.8.4.(4)(a)(b)
07	PGA REFERENCE (PGA ref)		0.2248		4.1.8.4.(4)
08	SITE COEFFICIENT (F_a = F(0.2))		1.0		4.1.8.4.(7), T.4.1.8.4.B
09	SEISMIC HAZARD INDEX	$I_E F_a S_a(0.2)$ = 0.44	LESS THAN 0.35?	NO	4.1.8.18.(2)
10	SEISMIC ISOLATION				4.1.8.19.
	IS THE BUILDING SEISMICLY ISOLATED?		N/A		
11	SUPPLEMENTAL ENERGY DISSIPATION				4.1.8.21.
	IS A SUPPLEMENTAL ENERGY DISSIPATION SYSTEM USED?		N/A		
12	IS SEISMIC DESIGN REQUIRED FOR CATEGORIES 6 TO 22, TABLE 4.1.8.18.?		REQUIRED		4.1.8.18.(2)
	REASONING FOR REQUIREMENT:	SEISMIC HAZARD INDEX IS 0.35 OR MORE			

An office building in Ottawa with the same soil (Stiff: D). The Sa(0.2) is almost double that of Toronto and the calculation for Seismic Hazard Index is above 0.35; seismic design for non-structural elements **is required.**

Example 4: Warehouse in Ottawa

SEISMIC DESIGN REQUIREMENTS FOR NON-STRUCTURAL ELEMENTS (CATEGORIES 6 TO 22 TABLE 4.1.8.18)					OBC REFERENCE
01	IMPORTANCE CATEGORY		Low		4.1.2.1.(3). 5.2.2.1.(2)
02	SITE CLASS		D		4.1.8.4, T.4.1.8.4.A
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(0.2)$		0.439		4.1.8.4.(1), SB-1, T.3.
03	5% SPECTRAL RESPONSE ACCELERATION $S_a(2.0)$		0.056		4.1.8.4.(1), SB-1, T.3.
04	EARTHQUAKE IMPORTANCE FACTOR (I_E ULS)		0.80		T.4.1.8.5.
05	PEAK GROUND ACCELERATION (PGA)		0.281		4.1.8.4.(1), SB-1 T.3.
06	PGA FACTOR		0.8		4.1.8.4.(4)(a)(b)
07	PGA REFERENCE (PGA ref)		0.2248		4.1.8.4.(4)
08	SITE COEFFICIENT (F_a = F(0.2))		1.0		4.1.8.4.(7), T.4.1.8.4.B
09	SEISMIC HAZARD INDEX	$I_E F_a S_a(0.2)$ = 0.35	LESS THAN 0.35?	NO	4.1.8.18.(2)
10	SEISMIC ISOLATION				4.1.8.19.
	IS THE BUILDING SEISMICLY ISOLATED?		N/A		
11	SUPPLEMENTAL ENERGY DISSIPATION				4.1.8.21.
	IS A SUPPLEMENTAL ENERGY DISSIPATION SYSTEM USED?		N/A		
12	IS SEISMIC DESIGN REQUIRED FOR CATEGORIES 6 TO 22, TABLE 4.1.8.18.?		REQUIRED		4.1.8.18.(2)
	REASONING FOR REQUIREMENT:	SEISMIC HAZARD INDEX IS 0.35 OR MORE			

Even a Low Importance Category warehouse has a Seismic Hazard Index value just at the threshold of 0.35; seismic design for non-structural elements **is required**.

Note that in the previous version of this calculation, the seismic hazard index value was below the threshold. If a design for this building was completed a few years ago, the seismic design for non-structural elements may not have been required, but may be for the same building designed today.

References

Practice Tip PT.03 Building Code Data Matrix and Attachment 1 – Guide to the Completion of the OAA Building Code Data Matrices

Practice Tip PT.35 Importance Category and Seismic Restraint

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.
