Introduction to 2024 Edition Seismic Design Category Maps

& FEMA's Building Code Strategy and the National Initiative to Advance Building Codes

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Building Science Branch, FEMA-Resilience

7/11/2024

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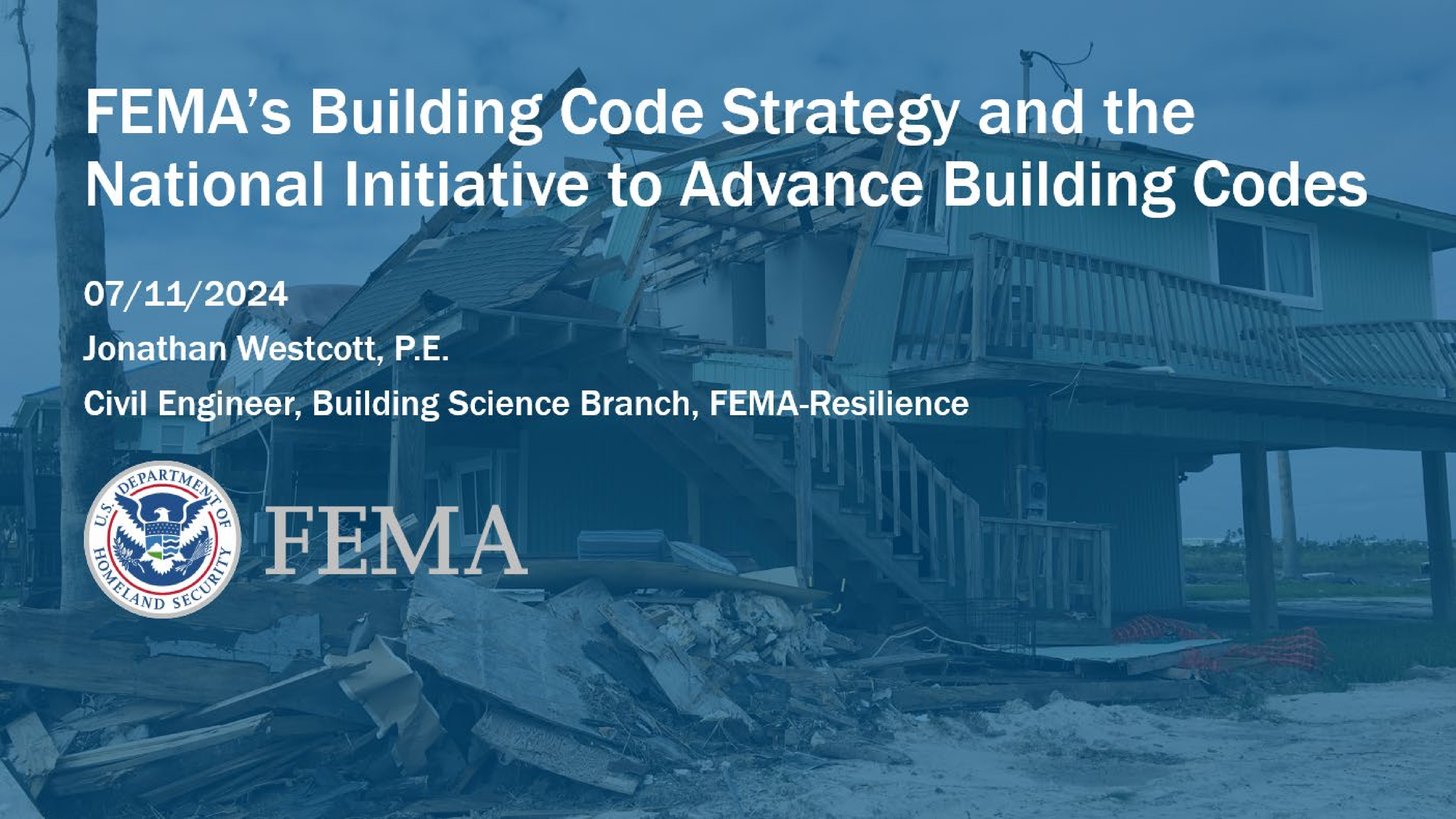

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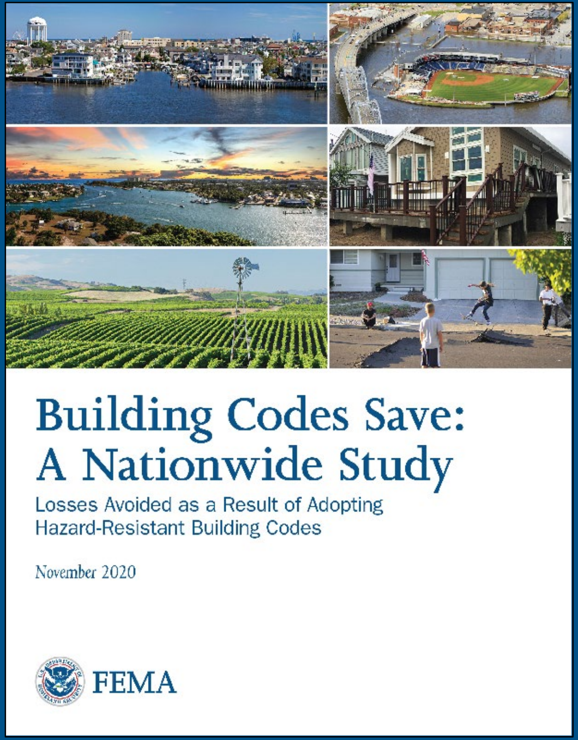
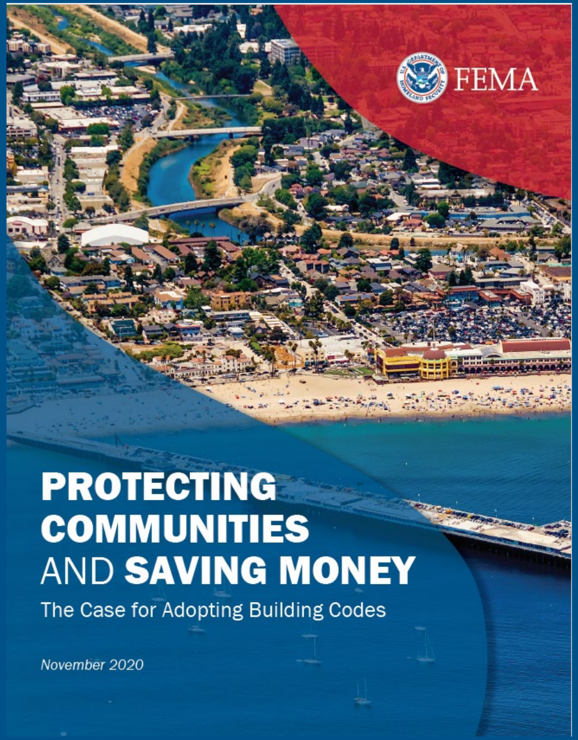
Building Codes Save

Key Highlights

- Hazards: flood, hurricane wind, seismic
- $1.6 Billion Average Annualized Loss Avoidance
- $32 Billion saved over 20 years
- $132 Billion in savings possible by 2040
- Building and contents damages only





FEMA Policies and Regulations: Building Codes and Standards

1979 → FEMA PARTICIPATING IN THE BUILDING CODE AND STANDARDS DEVELOPMENT PROCESS → TODAY

1977

1977
The National Earthquake Hazards Reduction Program (NEHRP) is established.

1979
FEMA is founded.

1982
The participation in the development and use of voluntary consensus codes and standards is required by all federal agencies.

1985
The first edition of the *NEHRP Recommended Seismic Provisions* (FEMA 95) is released.

1985
The first Southern Building Code Congress International Standard for Floodplain Management is published.

1990

1990
NEHRP is reauthorized, shifting the program's emphasis from prediction to hazard reduction.

1991
NEHRP Recommended Provisions becomes the basis for seismic code language in the following three codes and standards*:

1992
The *Code Compatibility Report* and its appendices are released.

1993
*Building Officials and Code Administrators National Building Code

1993
*ASCE 7: Minimum Design Loads for Buildings and Other Structures

1994
*Southern Building Code Congress International Standard Building Code

1994
The International Code Council (ICC) is founded.

1996
The National Technology Transfer and Advancement Act (Public Law 104–113), codifies pre-existing policies on the development and use of voluntary consensus standards in the Office of Management and Budget Circular A-119.

1997
NEHRP Recommended Provisions and the Uniform Building Code is coordinated.

1998
ASCE 24's first edition is released.

1998
FEMA releases *Taking Shelter From the Storm* (FEMA P-320).

1998
The Code Resource Development Committee facilitates the seismic provisions of the newly proposed International Codes (I-Codes®).

1998
Handbook for the Seismic Evaluation of Buildings (FEMA 310) is released.

1999
FEMA Hazard Mitigation Grant Program funds post-disaster code enforcement.

2000

2000
FEMA funds the first *Reducing Flood Losses through the International Codes.*

2000
Publication of the *Prestandard and Commentary for the Seismic Rehabilitation of Buildings* (FEMA 356).

2000
The first edition of the I-Codes® is released.

2000
FEMA releases the first edition of *Safe Rooms for Tornadoes and Hurricanes* (FEMA P-361).

2003
The first edition of the International Existing Building Code is released.

2004
The National Windstorm Impact Reduction Program is established and NEHRP is reauthorized. FEMA is tasked to work closely with national standards and model building code organizations.

2008
ICC-500 is published.

2010

2010
FEMA Hazard Mitigation Assistance Grant Program requires all hurricane or tornado safe room projects to be in accordance with the latest edition of ICC-500.

2010
FEMA Hazard Mitigation Assistance Grant Program requires all mitigation reconstruction activities to be in accordance with the latest editions of the I-Codes® and ASCE/SEI 24.

2010
FEMA Hazard Mitigation Grant Program sets aside additional 5% funding for activities that promote use of disaster-resistant codes for all hazards.

2012
Publication of *Seismic Performance Assessment of Buildings* (FEMA P-58), which allows for the seismic performance assessment of buildings to higher performance levels than code based life safety is released.

2015
FEMA Hazard Mitigation Grant Program sets aside an additional 5% of funding for activities that promote use of disaster-resistant codes for all hazards.

2015
National Windstorm Impact Reduction Act Reauthorization of 2015. FEMA shall work closely with national standards and model building code organizations.

2015
FEMA Hazard Mitigation Assistance Grant Program requires all structure elevation and dry floodproofing projects to be in accordance with latest edition of ASCE/SEI 24 Flood Resistant Design and Construction.

2016
Disaster Risk Reduction Minimum Codes and Standards FEMA Policy 204-078-2 is signed.

2016
OMB Circular A-119 is revised, detailing the federal strategy for developing standards.

2016
FEMA Public Assistance implements a new Required Minimum Codes and Standards policy generally requiring applicants to incorporate the natural hazard-resistant codes and standards and related provisions referenced in the most recent published edition of the I-Codes®.

2018
Bipartisan Budget Act of 2018 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act Sec. 406(b).

2018
NEHRP is reauthorized to encourage robust code enforcement.

2018
Goal 1 of the 2018-2022 FEMA Strategic Plan is to "Build a Culture of Preparedness."

2018
Disaster Recovery Reform Act of 2018 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act, including the addition of direct references to the adoption and enforcement of the latest published editions of relevant consensus-based codes, specifications, and standards.

2020

2020
FEMA Policy FP 204-079-01 is signed.

2022
FEMA Building Codes Strategy is released.

Timeline Key
- ● (green) = Federal law or mandate
- ● (blue) = FEMA action
- ● (red) = Building code action
- * = Grouped actions

FEMA Building Codes Strategy: Vision and Mission

Vision

A resilient nation with superior building performance in disasters.

Mission

Coordinate and prioritize FEMA's activities to advance the adoption and enforcement of disaster resistant building codes and standards for FEMA programs and for communities nationwide.

Building Codes Strategy: Goals and Objectives

Goal 1

Integrate Building Codes and Standards Across FEMA

A united FEMA moves together and speaks with a common understanding

Goal 2

Strengthen Nationwide Capability for Superior Building Performance

Coordination, training, and research improve building performance, reduce future damage, and save lives

Goal 3

Drive Public Action on Building Codes

A Nation that values and utilizes building codes is more resilient

National Initiative to Advance Building Codes (NIABC)

Key Priorities

- Modernize Building Codes
- Improve Climate Resilience
- Reduce Energy Costs
- Prioritize Underserved Communities
- Create Good Jobs

Key Activities

- **Comprehensively review federal funding and financing** to ensure federally-supported building construction projects follow modern building codes to the greatest extent feasible.
- **Provide incentives and support for communities** to adopt current building codes by providing technical assistance, implementing proven strategies and best practices.
- **Lead by example** across the federal building portfolio by seizing opportunities to advance "above-code" resilience and energy efficiency standards in new projects, to achieve net-zero emissions across federal buildings by 2045.
- Click to access SharePoint

NIABC National Initiative to Advance Building Codes

Introduction to 2024 Edition Seismic Design Category Maps

Kelly Cobeen S.E., *Wiss Janney Elstner Associates*

U.S. DEPARTMENT OF HOMELAND SECURITY

FEMA

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New Seismic Design Category Information!!

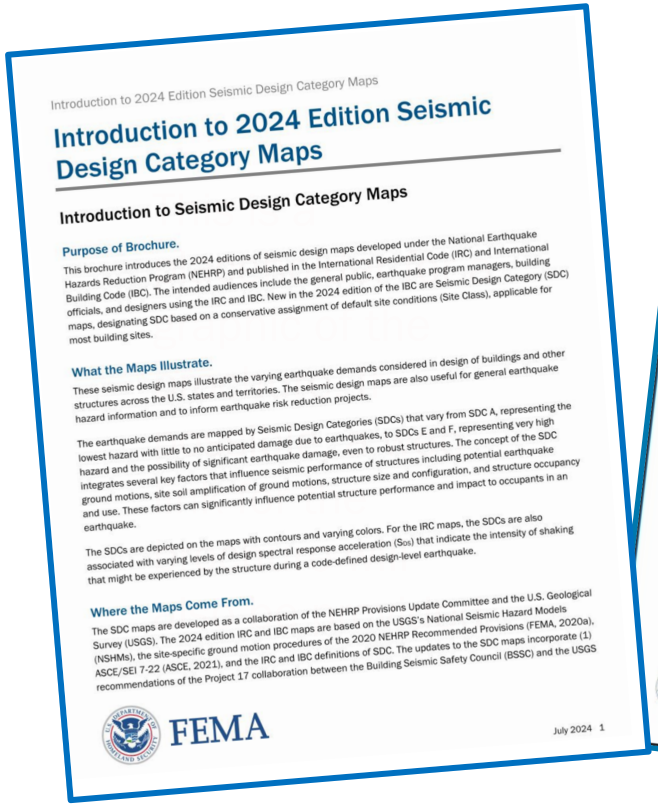
- Brochure:

  Introduction to 2024 Edition Seismic Design Category Maps

- Publication:

  FEMA P-2192-4

- For:
  - The general public
  - Earthquake program managers
  - Designers using the IRC and IBC



Introduction to 2024 Edition Seismic Design Category Maps

Introduction to 2024 Edition Seismic Design Category Maps

Introduction to Seismic Design Category Maps

Purpose of Brochure.

This brochure introduces the 2024 editions of seismic design maps developed under the National Earthquake Hazards Reduction Program (NEHRP) and published in the International Residential Code (IRC) and International Building Code (IBC). The intended audiences include the general public, earthquake program managers, building officials, and designers using the IRC and IBC. New in the 2024 edition of the IBC are Seismic Design Category (SDC) maps, designating SDC based on a conservative assignment of default site conditions (Site Class), applicable for most building sites.

What the Maps Illustrate.

These seismic design maps illustrate the varying earthquake demands considered in design of buildings and other structures across the U.S. states and territories. The seismic design maps are also useful for general earthquake hazard information and to inform earthquake risk reduction projects.

The earthquake demands are mapped by Seismic Design Categories (SDCs) that vary from SDC A, representing the lowest hazard with little to no anticipated damage due to earthquakes, to SDCs E and F, representing very high hazard and the possibility of significant earthquake damage, even to robust structures. The concept of the SDC integrates several key factors that influence seismic performance of structures including potential earthquake ground motions, site soil amplification of ground motions, structure size and configuration, and structure occupancy and use. These factors can significantly influence potential structure performance and impact to occupants in an earthquake.

The SDCs are depicted on the maps with contours and varying colors. For the IRC maps, the SDCs are also associated with varying levels of design spectral response acceleration (S_{DS}) that indicate the intensity of shaking that might be experienced by the structure during a code-defined design-level earthquake.

Where the Maps Come From.

The SDC maps are developed as a collaboration of the NEHRP Provisions Update Committee and the U.S. Geological Survey (USGS). The 2024 edition IRC and IBC maps are based on the USGS's National Seismic Hazard Models (NSHMs), the site-specific ground motion procedures of the 2020 NEHRP Recommended Provisions (FEMA, 2020a), ASCE/SEI 7-22 (ASCE, 2021), and the IRC and IBC definitions of SDC. The updates to the SDC maps incorporate (1) recommendations of the Project 17 collaboration between the Building Seismic Safety Council (BSSC) and the USGS

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July 2024 1

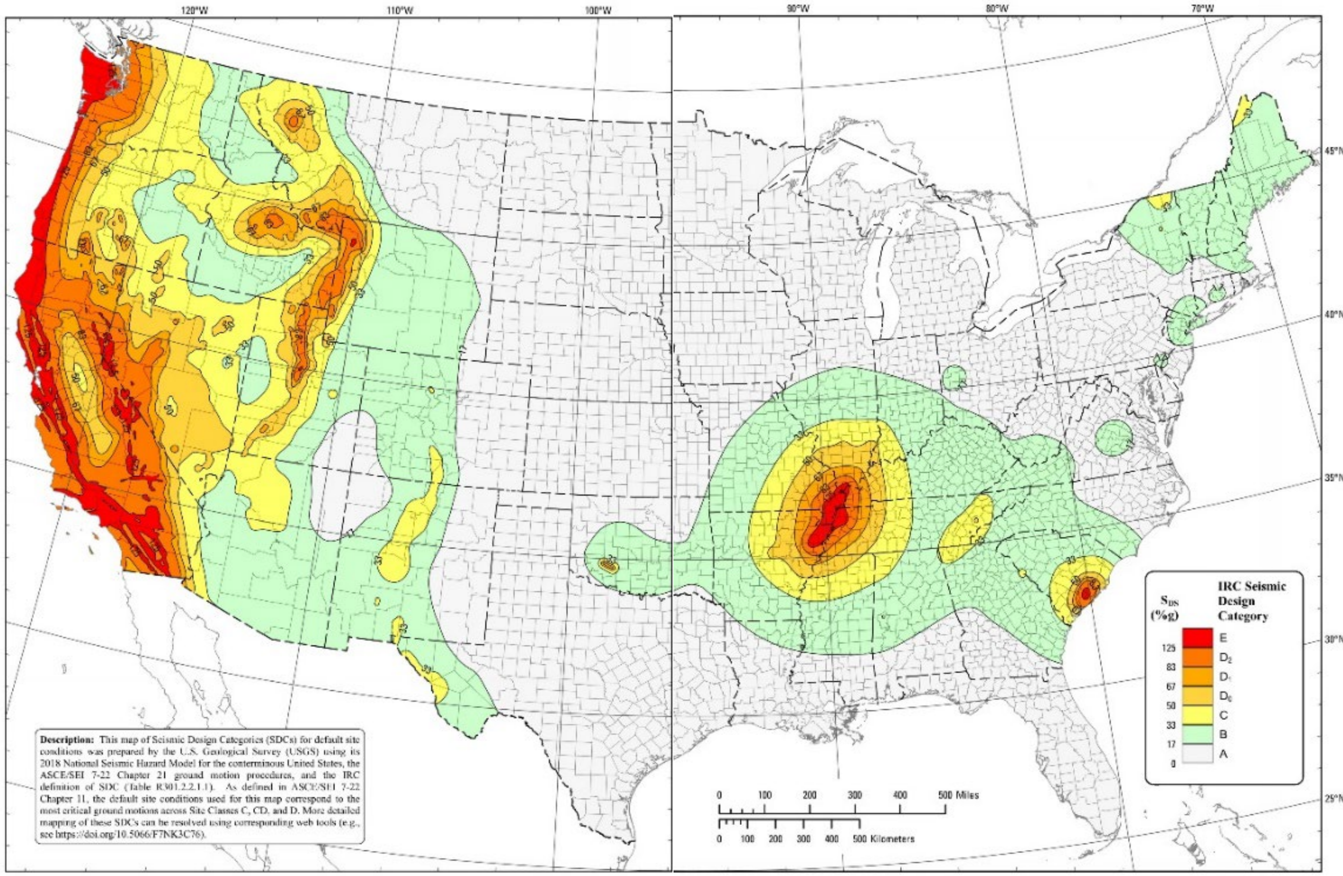
https://www.fema.gov/sites/default/files/documents/fema_p-2192-nehrp-provisions-seismic-design-maps-2024-irc-ibc.pdf

Outline

- Introduction to the Seismic Design Category Maps
- 2024 International Residential Code (IRC) Seismic Design Category Maps
- 2024 International Building Code (IBC) Seismic Deign Category Maps
- 2024 Updates to The National Seismic Hazard Models and the SDC Maps
- References and Other Resources

Introduction – What the Maps Illustrate

- The varying seismic hazard in the US and territories as used by our building codes for design of new structures
- Expressed as colored contours that assign Seismic Design Categories (SDCs)
- Considers potential EQ ground motion, site soil amplification, structure size, configuration, occupancy and use



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Introduction – What the Maps Illustrate

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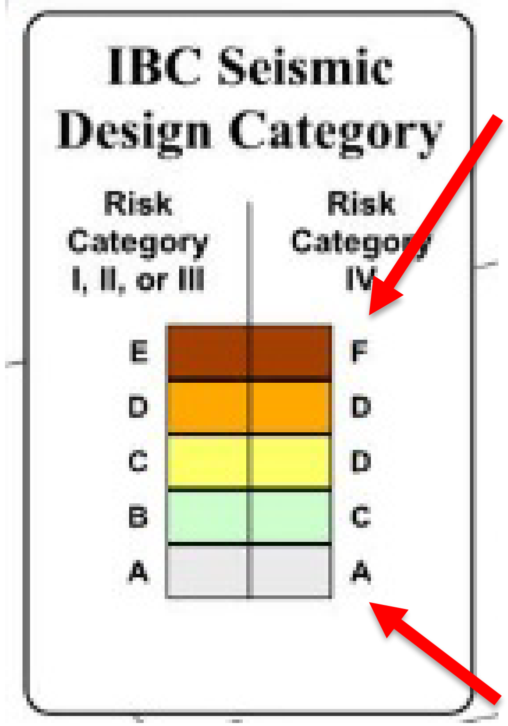
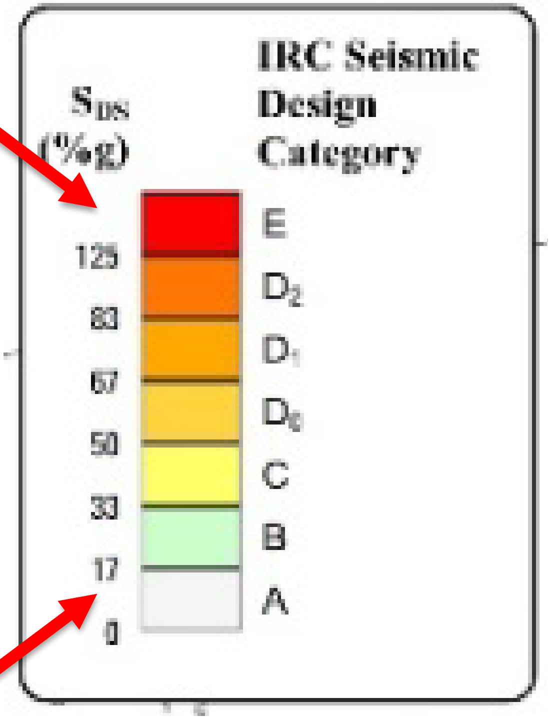


very high hazard and the possibility of very significant earthquake damage, even to robust structures



the lowest hazard with little to no anticipated damage due to earthquakes

Introduction – Why Seismic Hazard is Of Interest

- A national issue as described in FEMA P-366

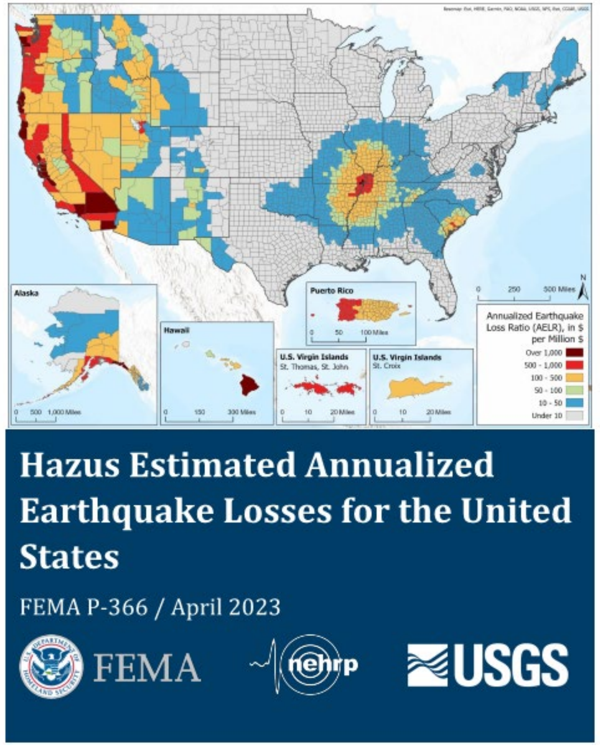
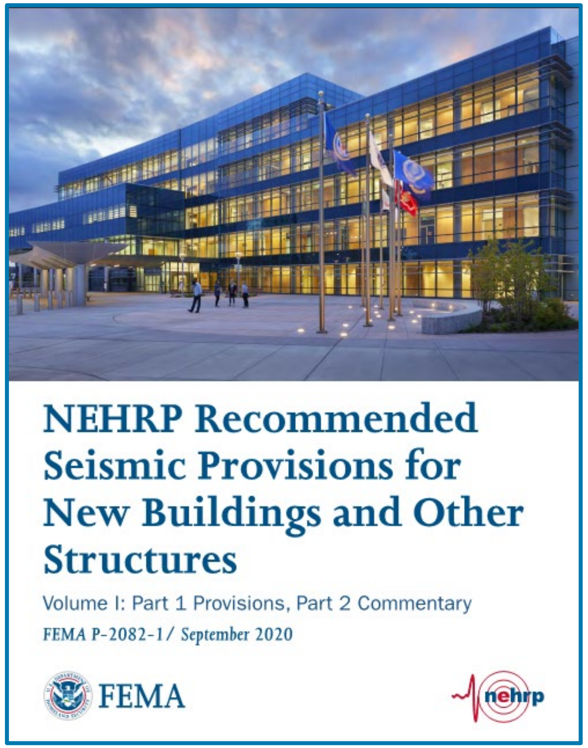
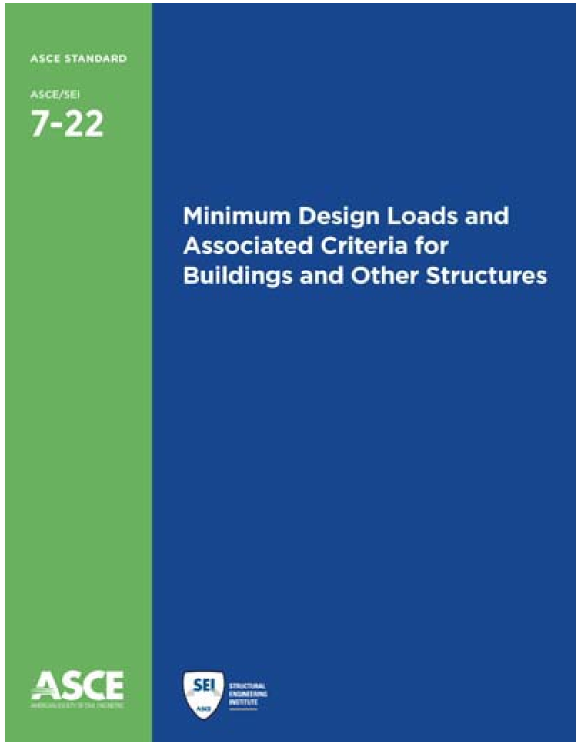


Table D-1. Population Exposure by State to Seismic Design Categories (SDC) D or E

State	SDC D or E	Developed Land Area (sq. km.)	Land Area (sq. km.)
California	39,538,223	14,584	646,400
Washington	6,966,185	4,200	315,192
Oregon	4,152,460	2,775	458,298
Tennessee	4,110,419	3,309	89,333
Puerto Rico	3,285,874	1,436	9,910
Utah	3,178,870	1,672	280,063
Nevada	3,104,614	1,331	477,410
Missouri	2,875,678	2,361	107,356
Arkansas	1,667,895	1,851	118,027
Hawai'i	1,381,973	493	17,056
Illinois	1,296,573	1,591	76,303
South Carolina	1,239,371	1,017	35,423
New Mexico	1,170,446	803	88,898
Mississippi	884,693	1,082	61,819
Kentucky	884,128	1,222	50,099
Alaska	728,457	536	8,129,971

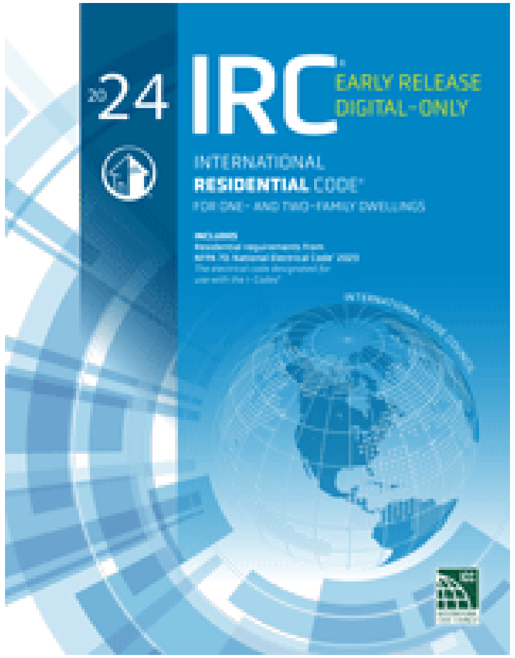
Introduction – Where the Maps Come From

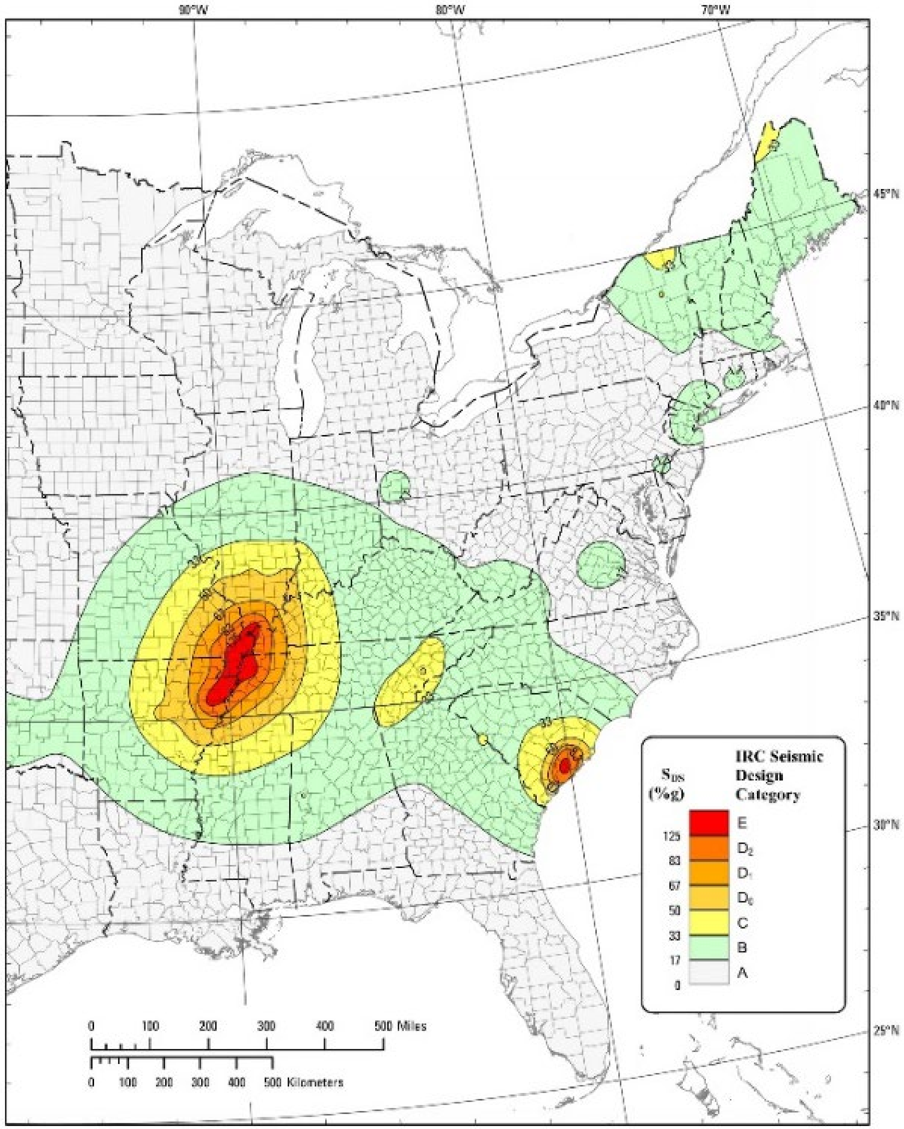




Introduction - Map Use in the International Residential Code (IRC)

- One- and two-family detached dwellings
- Townhouses up to three stories
- Prescriptive pre-engineered seismic design provisions, mostly tabulated
- Maps Identify SDC A, B, C, D_0, D_1, D_2, E





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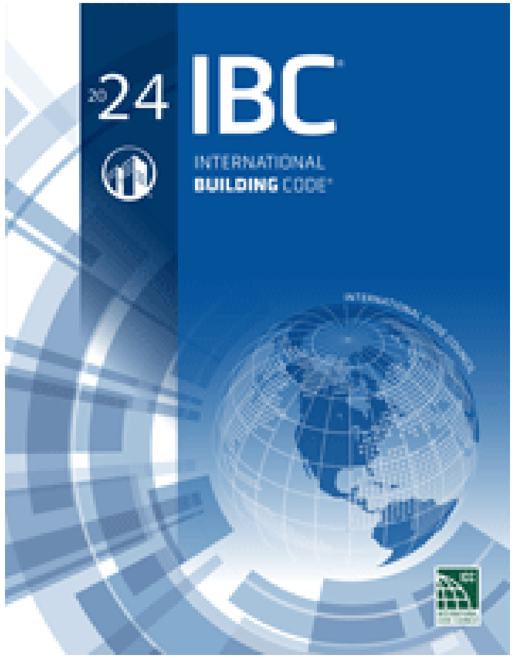
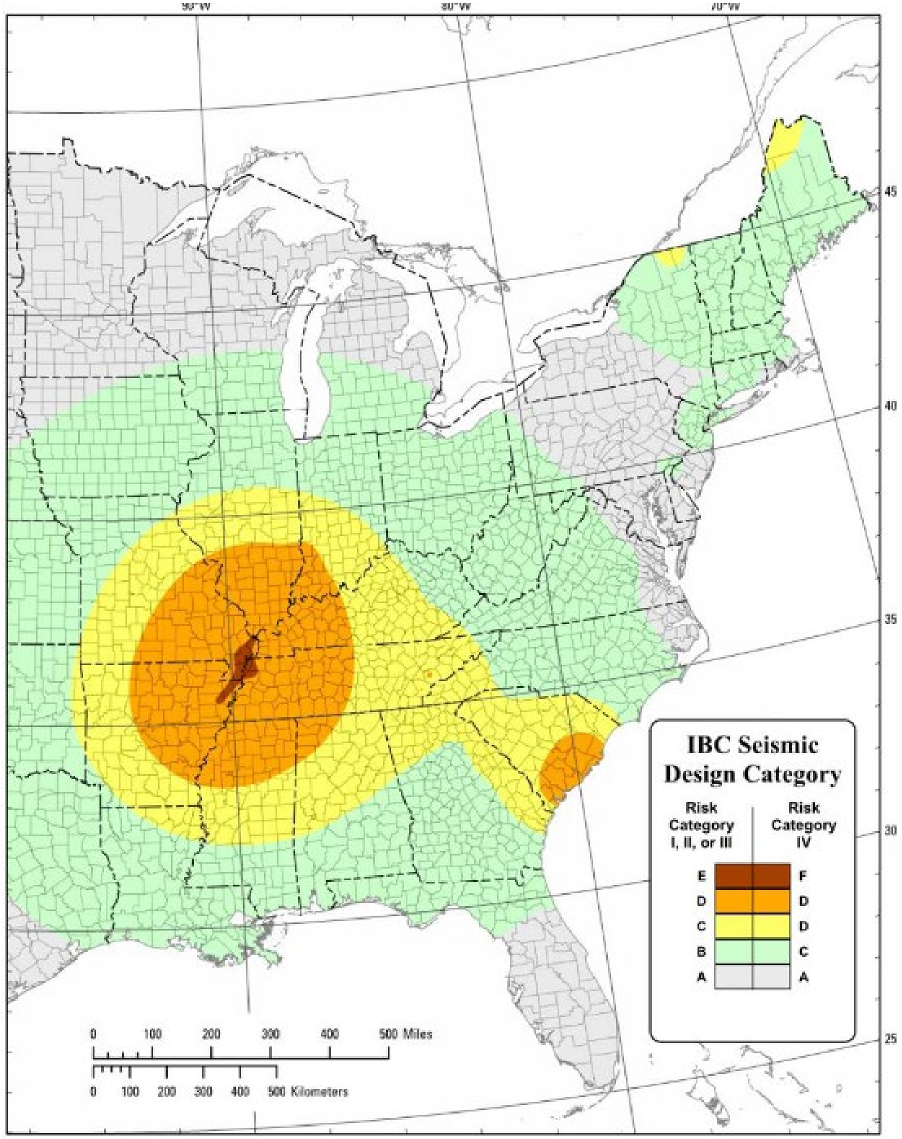
Introduction - Map Use in the International Building Code (IBC)

- Structures not addressed by IRC
- Engineered seismic design provisions
- SDC A, B, C, D, E, F





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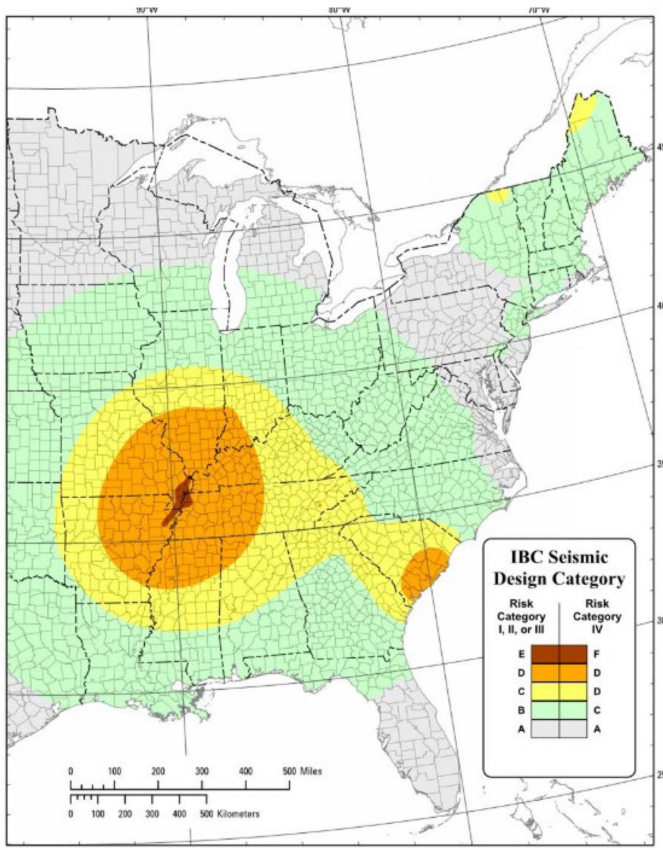
Introduction - Differences Between IRC and IBC Maps

IRC Maps Apply To:

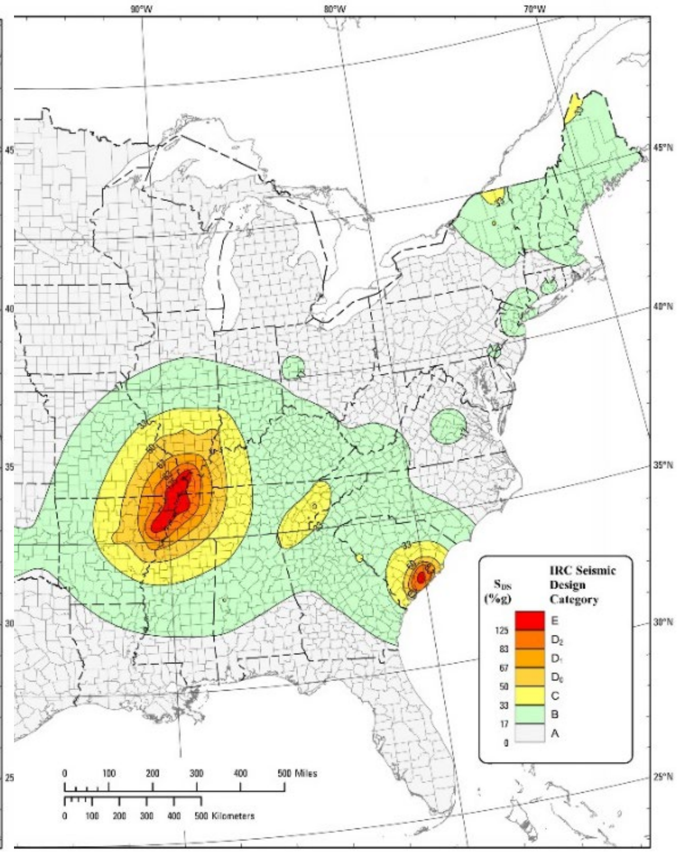
- Buildings constructed using IRC provisions
- Low-rise buildings controlled by short period (stiff building) behavior
- IRC SDC E is triggered by S_{DS} greater than 1.25g
- IRC SDCs divided into A, B, C, D_0, D_1, D_2 & E

IBC Maps Apply To:

- All Other Structures
- Assignment uses S_{DS} and S_{D1}
- IBC SDC E is triggered by S_1 greater than 0.75g
- IBC SDCs divided into A, B, C, D, E and F



2024 IBC

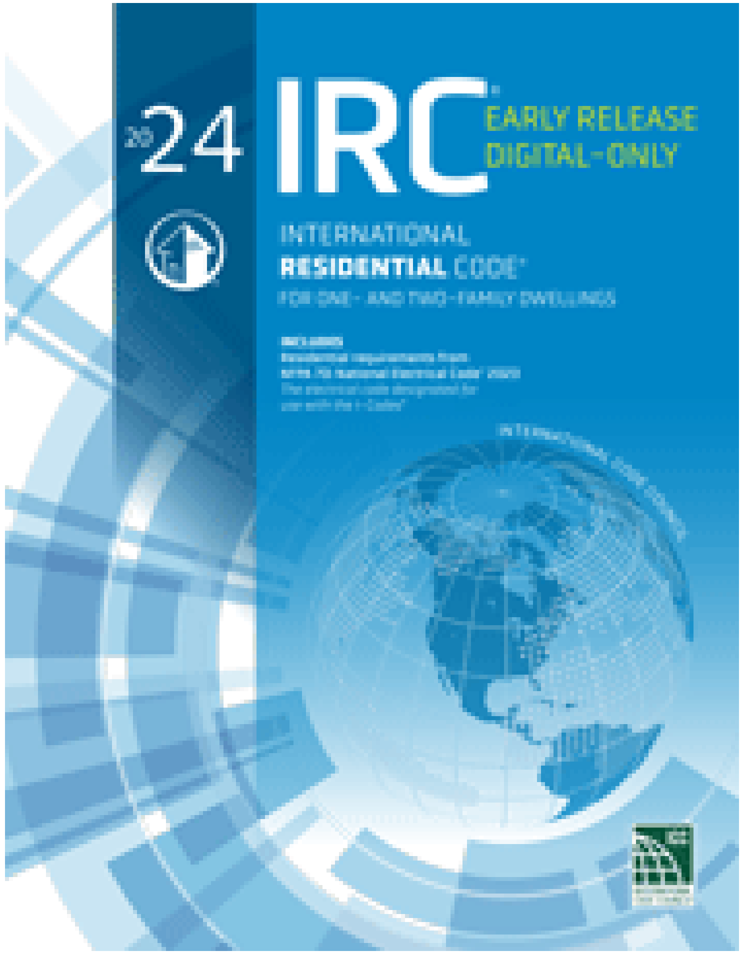


2024 IRC

Introduction - Other Uses of the Maps

- General information on seismic hazard
- NEHRP use to determine high seismic hazard states and territories eligible for Individual State Assistance Grant Programs
- FEMA tracks the building code adoption status for state, local, tribal and territorial governments across the nation to evaluate several important aspects of a community's natural hazard risks and building code adoption.

2024 IRC Seismic Design Category Maps



2024 IRC Seismic Design Category Maps – What Has Been Updated

- The most current hazard data and design map procedures have been incorporated –
  - Updated 2018 USGS National Seismic Hazard Models (NSHMs),
  - The site-specific ground motion procedures of the 2020 NEHRP Recommended Provisions
- In the 2024 update, the two sets of maps previously included in the 2018 and 2021 IRC editions have been reduced to a single 2024 edition map set
- Consistent with the 2020 NEHRP Provisions and ASCE/SEI 7-22, an expanded set or site classes is included in the mapping, providing more specific identification of site soil effects

2024 IRC Seismic Design Category Maps – Where the Maps Can Be Used

Site soils can have a significant impact on the earthquake demands on buildings,

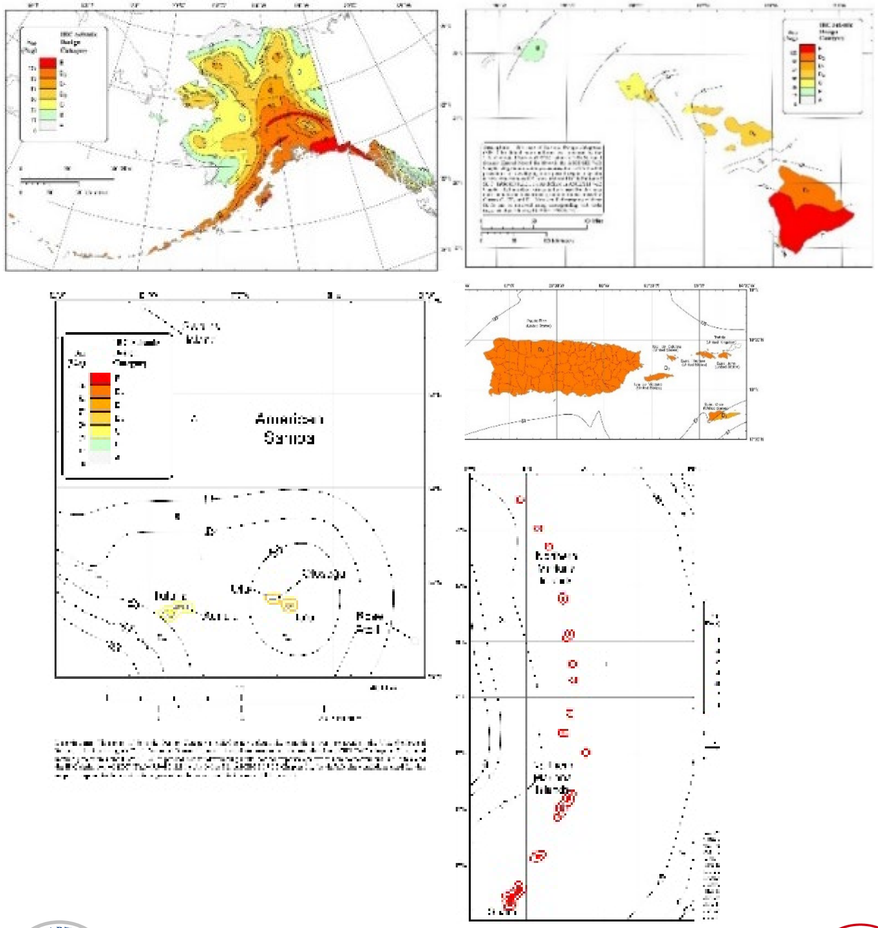
- The IRC SDC maps can be used for the majority of dwelling sites because they reflect seismic hazard for the most critical of standard site soil conditions (Site Class C, CD, D)
- The IRC SDC maps cannot be used for poor soil sites as discussed in IRC Section R401. Per IRC Section R401, the already required geotechnical study is required to include determination of SDS for purposes of seismic design, from which IRC Table R301.2.2.1.1 can be used to assign SDC.

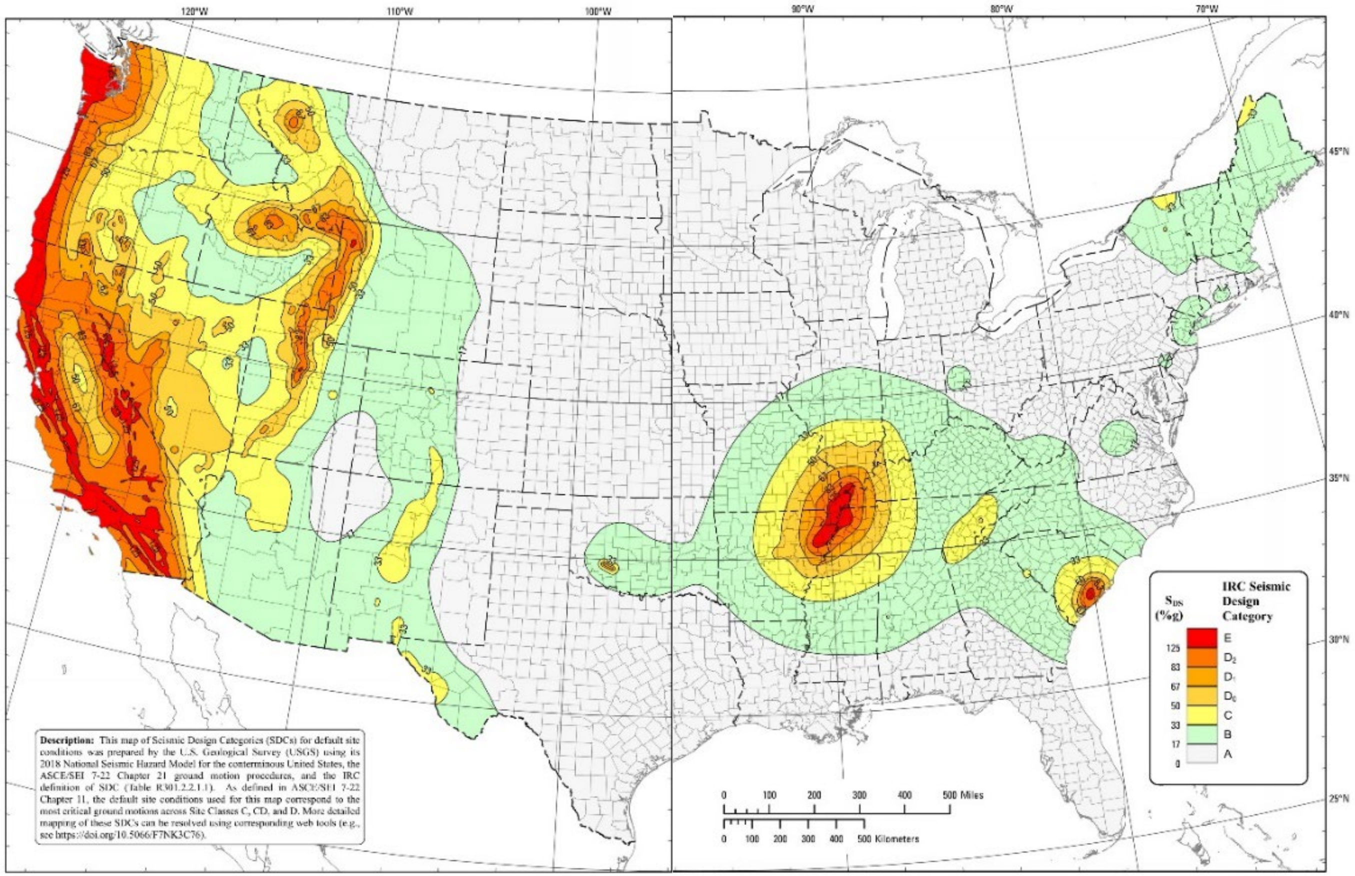
2024 IRC Seismic Design Category Maps - How to Use The IRC Maps

- In print and pdf in several publications including:
  - 2024 IRC and
  - FEMA P-2192-4
    https://www.fema.gov/sites/default/files/documents/fema_p-2192-nehrp-provisions-seismic-design-maps-2024-irc-ibc.pdf

  The state and county lines on these maps provide adequate detail for assignment of the SDC in some but not all locations.
- When more detailed information on the IRC SDC is needed:
  - As referenced in the 2024 IRC maps, USGS guidance on available tools can be found at: https://doi.org/10.5066/F7NK3C76 . This link provides guidance on determination of SDC. A step-wise explanation follows in this presentation.

2024 IRC Seismic Design Category Maps - How to Use the IRC Maps





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2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

Steps to determine SDC as assigned by the IRC SDC maps (incorporating default Site Class):

1. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
2. Enter property address,
3. Standard Version: Select ASCE 7-22,
4. Risk Category: Select Risk Category II,
5. Site Soil Class: Select Default,
6. From results (summary, detailed, or full report), determine spectral response acceleration at short periods (S_{DS}) value, and
7. Using the S_{DS} value, select the appropriate SDC per IRC Table R301.2.2.1.1.
   DO NOT USE the SDC assigned by the ASCE Hazard Tool, as it is an IBC SDC, and may not be correct for IRC use.

IRC Maps – ***Default*** Site Class (Soil Conditions)

2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

Steps to determine SDC as assigned by the IRC SDC maps (incorporates default Site Class):

1. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
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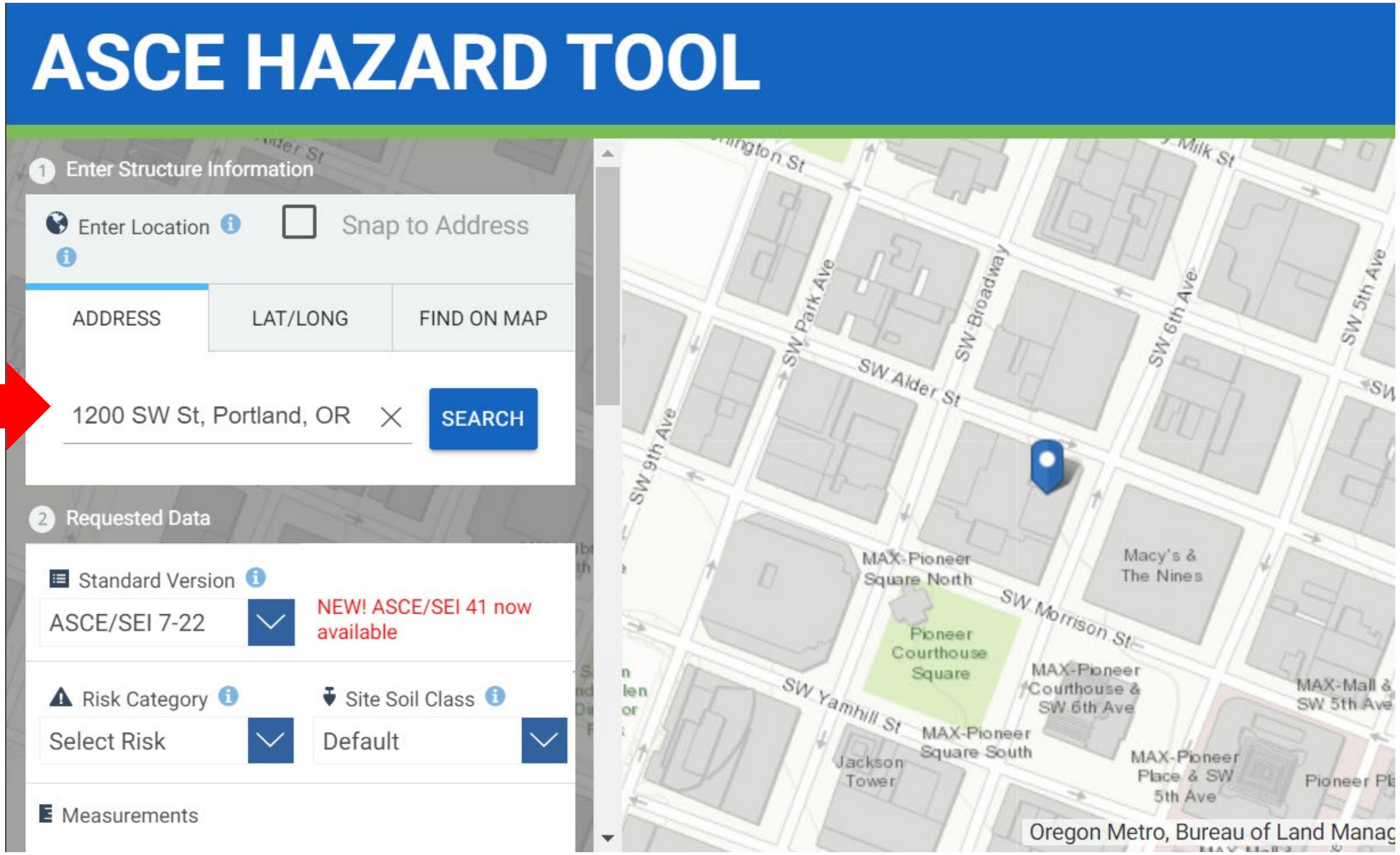
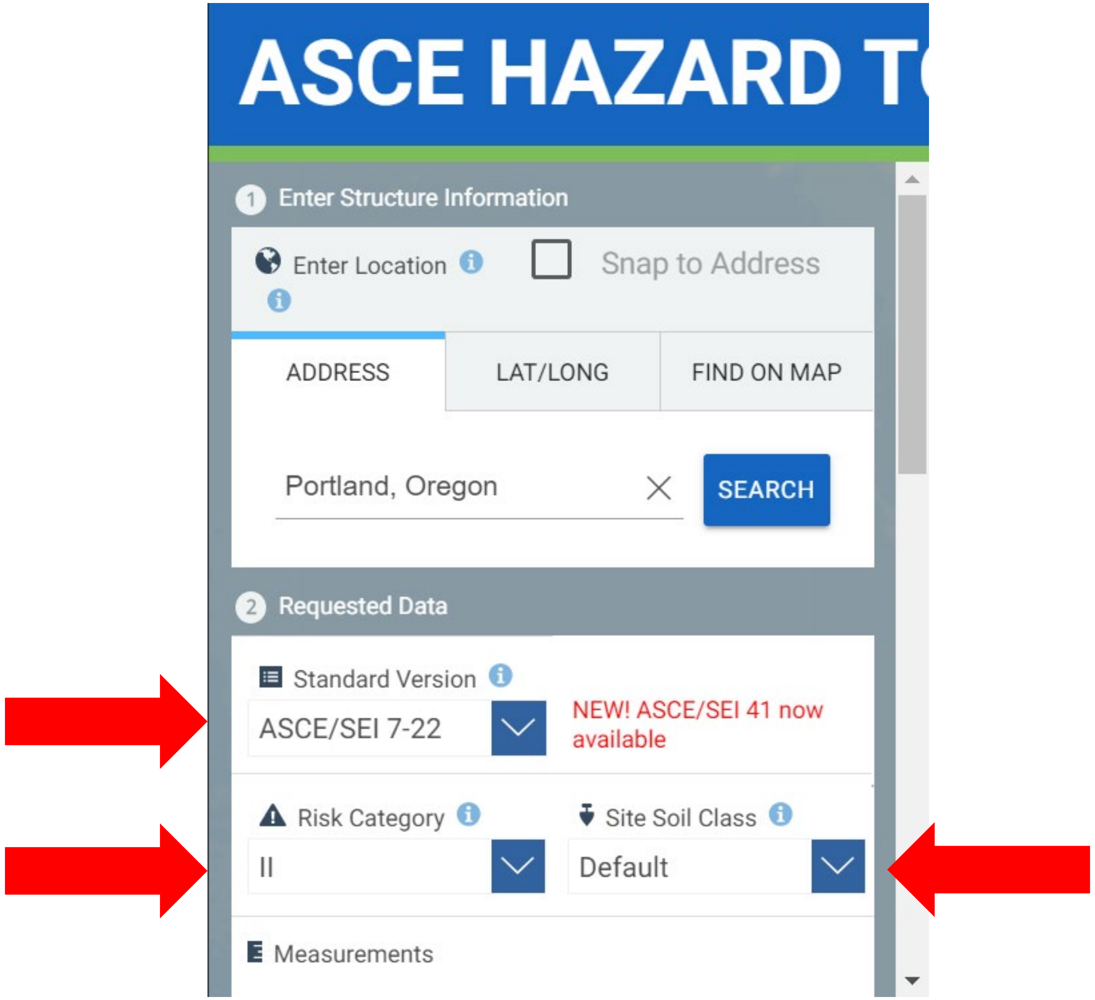


2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

3. Standard Version:
   Select ASCE 7-22
4. Risk Category:
   Select Risk Category II
5. Site Soil Class:
   Select Default



2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

6. From results (summary, detailed, or full report), determine spectral response acceleration at short periods (S_{DS}) value, and

S_{DS} = 0.77g

REPORT SUMMARY

Site Information

Address:	*Portland, Oregon, ,*
Elevation:	101 ft (NAVD 88)
Lat:	45.516018
Long:	-122.681425
Standard:	ASCE/SEI 7-22
Risk Category:	II
Soil Class:	Default

Seismic Data

S_S	0.95
S_1	0.36
S_{MS}	1.16
S_{M1}	0.79
S_{DS}	0.77
S_{D1}	0.52
T_L	16
PGA_M	0.5

2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

7. Using the S_{DS} value, select the appropriate SDC per IRC Table R301.2.2.1.1.
DO NOT USE the SDC assigned by the ASCE Hazard Tool, as it is an IBC SDC, and may not be correct for IRC use.

TABLE R301.2.2.1.1 SEISMIC DESIGN CATEGORY DETERMINATION

CALCULATED S_{DS}	SEISMIC DESIGN CATEGORY
$S_{DS} \leq 0.17g$	A
$0.17g < S_{DS} \leq 0.33g$	B
$0.33g < S_{DS} \leq 0.50g$	C
$0.50g < S_{DS} \leq 0.67g$	D_0
$0.67g < S_{DS} \leq 0.83g$	D_1
$0.83g < S_{DS} \leq 1.25g$	D_2
$1.25g < S_{DS}$	E

$S_{DS} = 0.77g$

$SDC = D_1$

2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

Steps to determine SDC as assigned by the IRC SDC maps (incorporating known Site Class):

1. Determine Site (soil) Class from site-specific geotechnical report or other reliable source acceptable to the building official,
2. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
3. Enter property address,
4. Standard Version: Select ASCE 7-22,
5. Risk Category: Select Risk Category II,
6. Site Soil Class: Select Class identified in Step 1
7. From results (summary, detailed, or full report), determine spectral response acceleration at short periods (S_{DS}) value, and
8. Using the S_{DS} value, select the appropriate SDC per IRC Table R301.2.2.1.1.
   DO NOT USE the SDC assigned by the ASCE Hazard Tool, as it is an IBC SDC, and may not be correct for IRC use.

IRC Maps – *Known* Site Class (Soil Conditions)

2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

Steps to determine SDC (incorporates known Site Class):

1. Determine Site (soil) Class from site-specific geotechnical report or other reliable source acceptable to the building official,

Geotechnical Report

2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

Steps to determine SDC as assigned by the IRC SDC maps (incorporates default Site Class):

2. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
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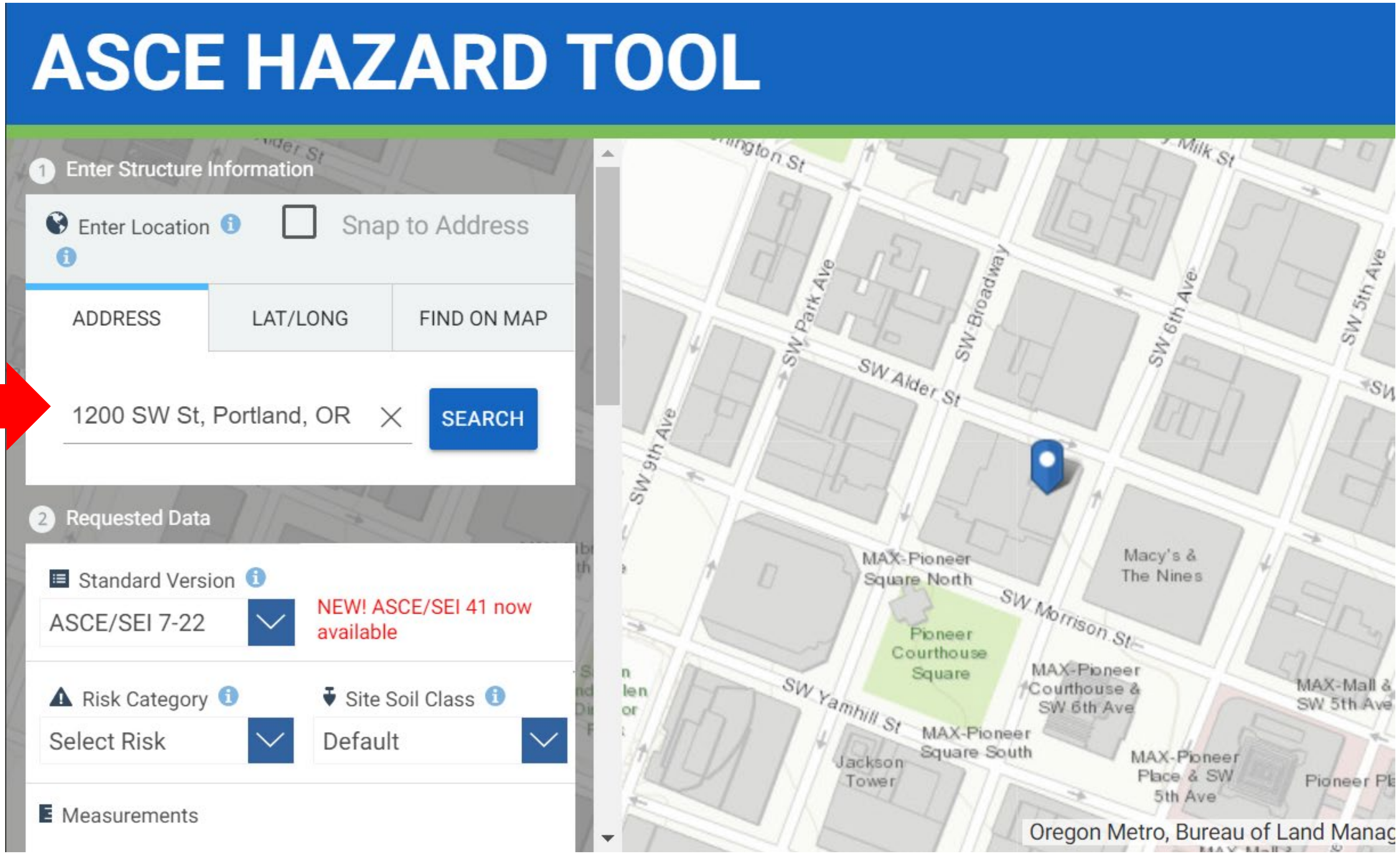


2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

4. Standard Version:

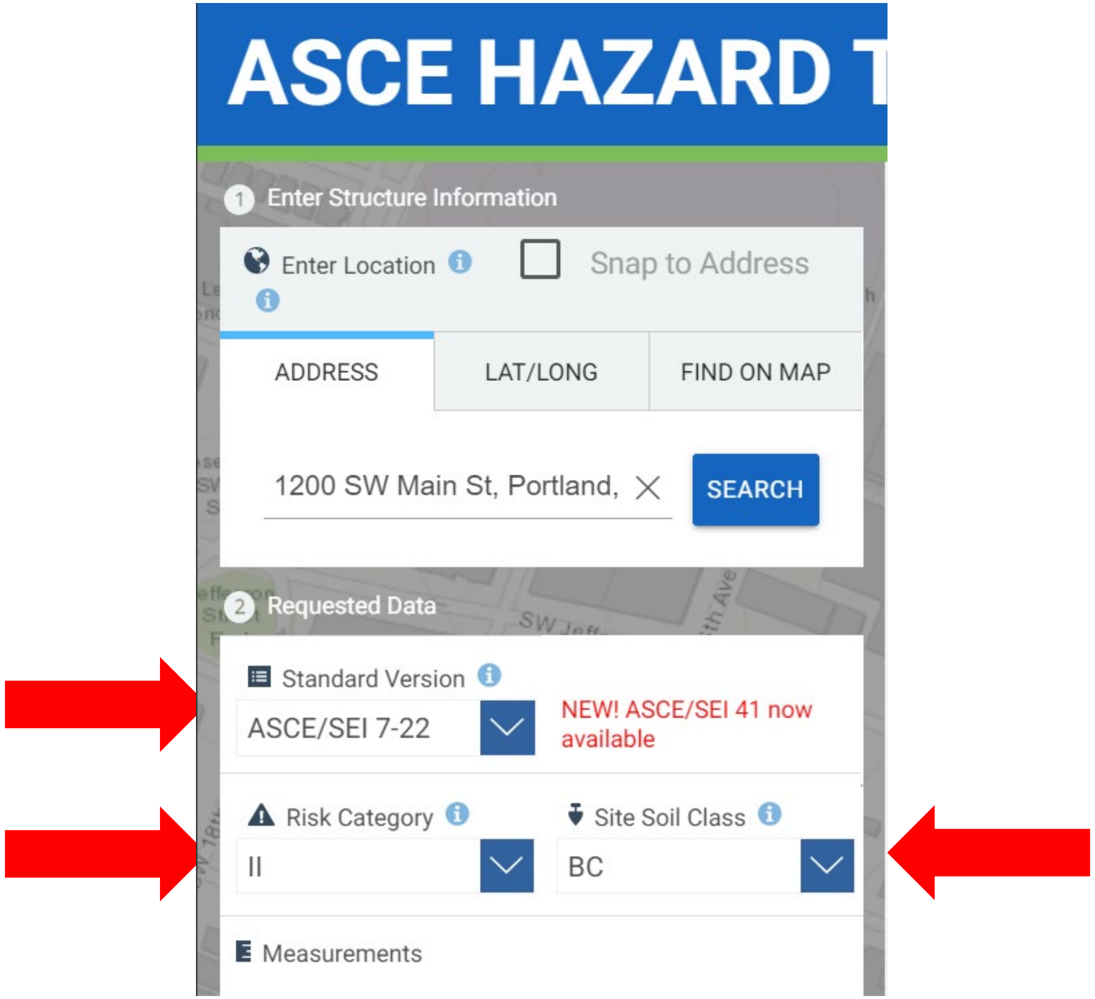
   Select ASCE 7-22

5. Risk Category:

   Select Risk Category II

6. Site Soil Class:

   Select Site Class identified in Step 1 (example uses BC)



2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

7. From results (summary, detailed, or full report), determine spectral response acceleration at short periods (S_{DS}) value, and

S_{DS} = 0.57g

REPORT SUMMARY

Site Information

Address:	*1200 SW Main St, Portland, Oregon, 97205*
Elevation:	129 ft (NAVD 88)
Lat:	45.517901
Long:	-122.686466
Standard:	ASCE/SEI 7-22
Risk Category:	II
Soil Class:	BC

Seismic Data

S_S	0.95
S_1	0.36
S_{MS}	0.85
S_{M1}	0.36
S_{DS}	0.57
S_{D1}	0.24
T_L	16
PGA_M	0.4

2024 IRC Seismic Design Category Maps – How to Use the IRC Maps

8. Using the S_{DS} value, select the appropriate SDC per IRC Table R301.2.2.1.1.
   DO NOT USE the SDC assigned by the ASCE Hazard Tool, as it is an IBC SDC, and may not be correct for IRC use.

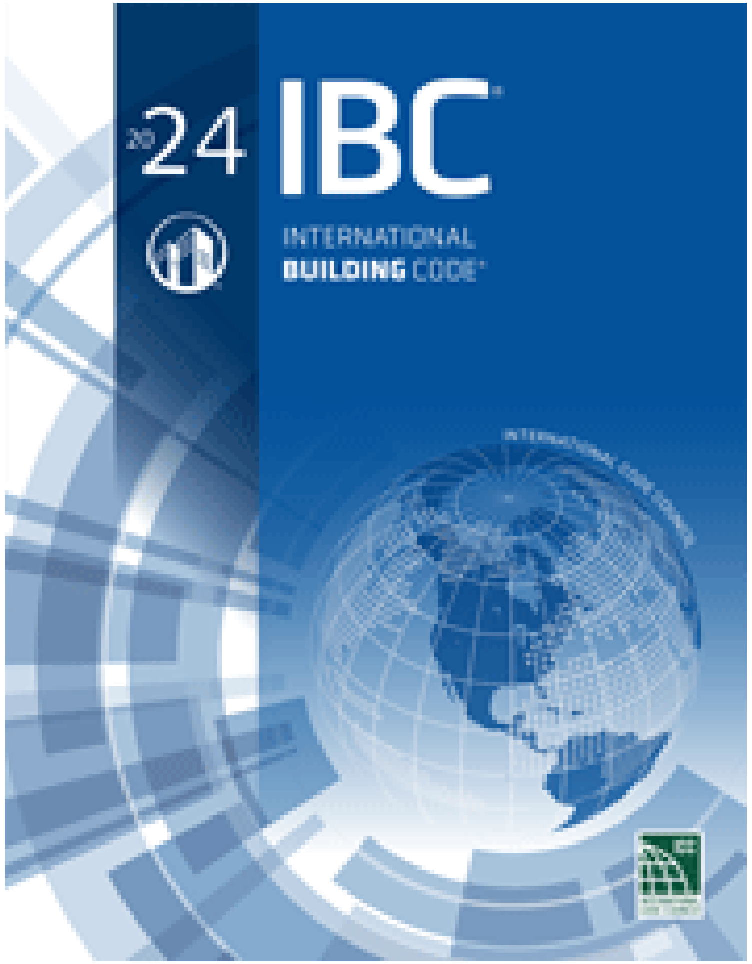
TABLE R301.2.2.1.1 SEISMIC DESIGN CATEGORY DETERMINATION

CALCULATED S_{DS}	SEISMIC DESIGN CATEGORY
$S_{DS} \le 0.17g$	A
$0.17g < S_{DS} \le 0.33g$	B
$0.33g < S_{DS} \le 0.50g$	C
$0.50g < S_{DS} \le 0.67g$	D_0
$0.67g < S_{DS} \le 0.83g$	D_1
$0.83g < S_{DS} \le 1.25g$	D_2
$1.25g < S_{DS}$	E

$S_{DS} = 0.57g$

$SDC = D_0$

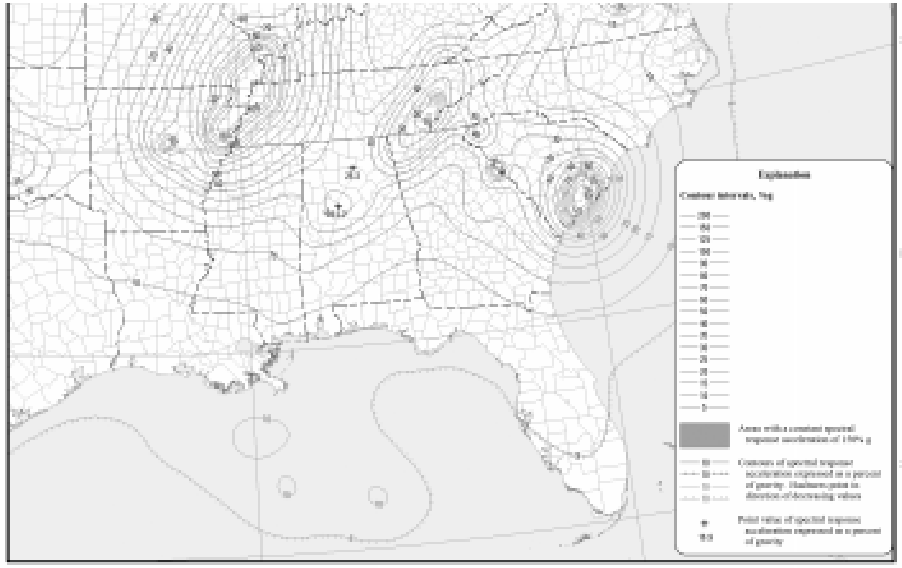
2024 IBC Seismic Design Category Maps



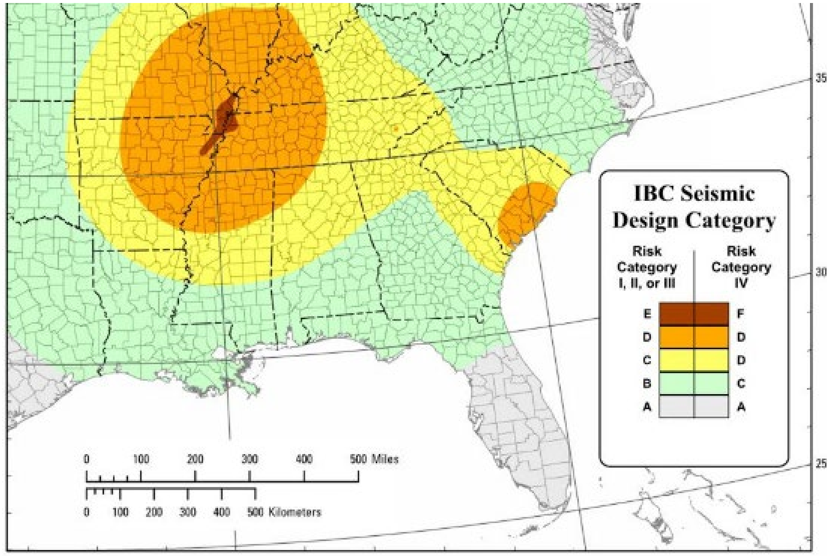
2024 IBC Seismic Design Category Maps – What Has Been Updated

New in the 2024 edition, IBC seismic hazard maps are now presented as SDC maps, similar but not identical to IRC SDC maps.

- Replace spectral response acceleration maps that were provided in previous editions of the IBC.



2021 IBC Seismic Design Map



2024 IBC Seismic Design Map

2024 IBC Seismic Design Category Maps – What Has Been Updated

- The user of the IBC is no longer required to multiply mapped spectral response accelerations by Site Coefficients Fa and Fv. The Site Coefficients have been deleted from both the IBC and ASCE/SEI 7, and the site adjustments are applied in the USGS database. The user simply needs to select the applicable Site Class when using the ASCE Hazard Tool.

GONE FROM 2024 IBC AND ASCE 7-22

TABLE 1613.2.3(1)
VALUES OF SITE COEFFICIENT F_a [a]

SITE CLASS	MAPPED RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) SPECTRAL RESPONSE ACCELERATION PARAMETER AT SHORT PERIOD					
	$S_s \le 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s = 1.25$	$S_s \ge 1.5$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.3	1.2	1.2	1.2	1.2
D	1.6	1.4	1.2	1.1	1.0	1.0
E	2.4	1.7	1.3	Note b	Note b	Note b
F	Note b	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at short period, S_s.
b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.

TABLE 1613.2.3(2)
VALUES OF SITE COEFFICIENT F_V [a]

SITE CLASS	MAPPED RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE_R) SPECTRAL RESPONSE ACCELERATION PARAMETER AT 1-SECOND PERIOD					
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 = 0.5$	$S_1 \ge 0.6$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.8	0.8	0.8	0.8	0.8	0.8
C	1.5	1.5	1.5	1.5	1.5	1.4
D	2.4	2.2[c]	2.0[c]	1.9[c]	1.8[c]	1.7[c]
E	4.2	3.3[c]	2.8[c]	2.4[c]	2.2[c]	2.0[c]
F	Note b	Note b	Note b	Note b	Note b	Note b

a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period, S_1.
b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.
c. See requirements for site-specific ground motions in Section 11.4.8 of ASCE 7.

2024 IBC Seismic Design Category Maps – What Has Been Updated

- Includes the most current seismic hazard data and design map procedures via the USGS's 2018 National Seismic Hazard Models (NSHMs) and the site-specific ground motion procedures of the 2020 NEHRP Recommended Provisions.
- Under the 2024 IBC, designers have the choice to use the IBC SDC maps or the provisions of ASCE/SEI 7 to determine SDC.
- It is anticipated that many design professionals will use the ASCE/SEI 7 provisions, particularly where Site Classes A through BC are applicable in which case a lower SDC might be assigned.
- Consistent with the 2020 NEHRP Provisions and ASCE/SEI 7-22, an expanded set or site classes is included in the mapping, providing more specific identification of site soil effects

2024 IBC Seismic Design Category Maps – Where the Maps Can Be Used

The site soils can have a significant impact on the earthquake demands on buildings, with buildings on soft soils seeing increased demands.

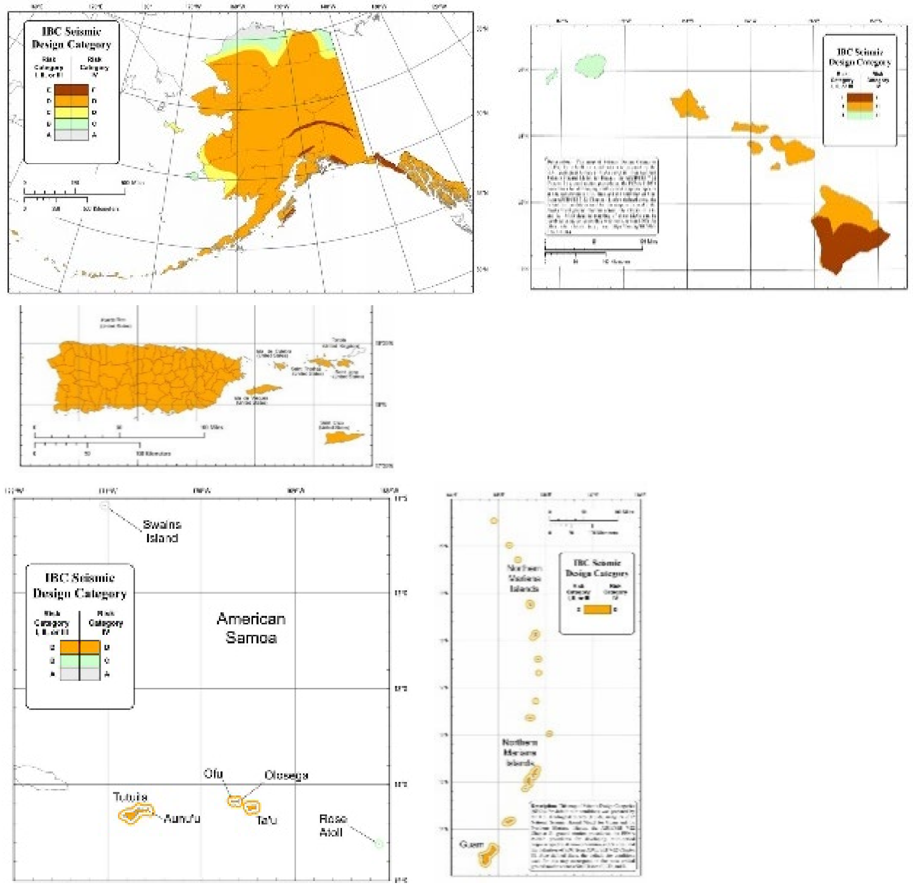
- The IBC SDC maps can be conservatively used for most sites, the IBC maps are developed based on default site (soil) conditions (most critical of Site Classes C, CD, and D).
- IBC SDC maps are not permitted to be used for Site Classes DE, E, or F. For these Site Classes the IBC requires that the SDC be determined in accordance with ASCE/SEI 7.

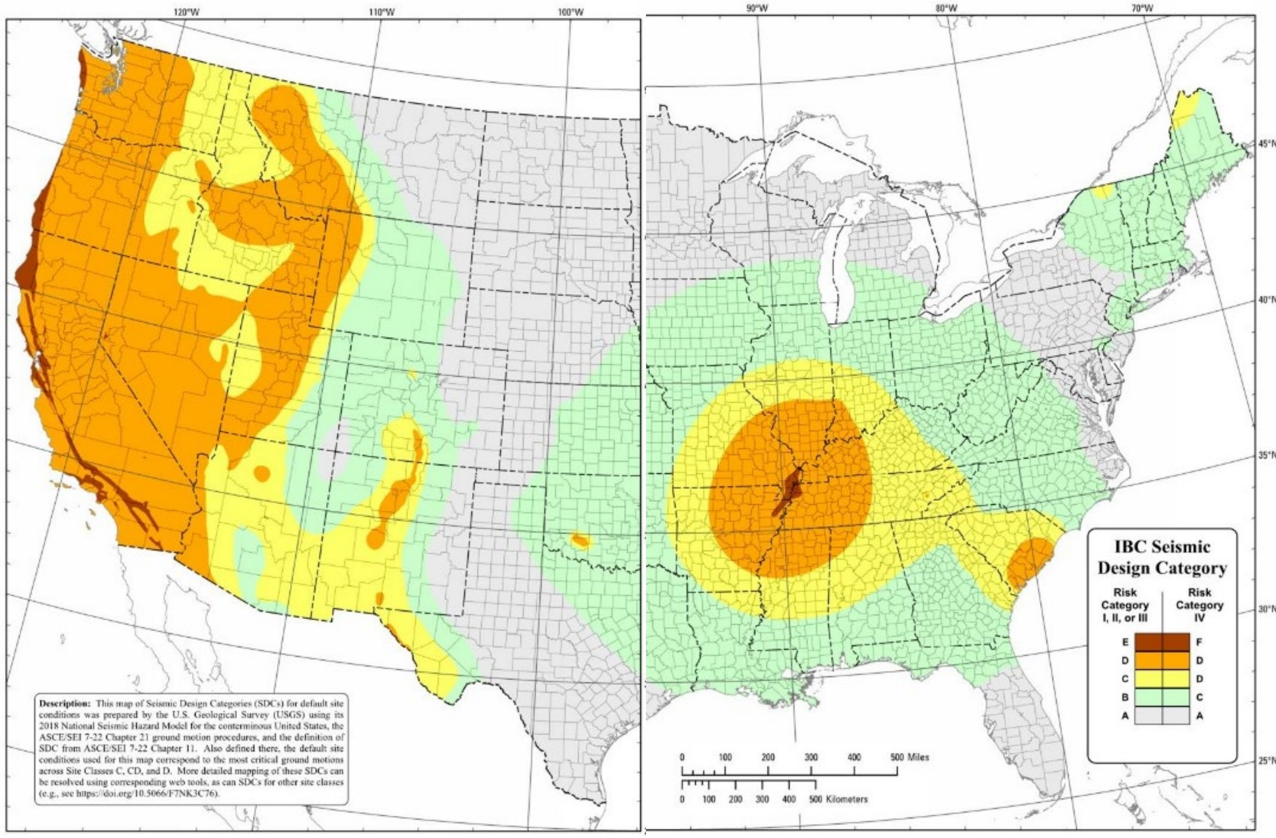
2024 IBC Seismic Design Category Maps - How to Use The IBC Maps

- The maps can be found in print and pdf in several publications including:
  - 2024 IBC and
  - FEMA P-2192-4. https://www.fema.gov/sites/default/files/documents/fema_p-2192-nehrp-provisions-seismic-design-maps-2024-irc-ibc.pdf

  The state and county lines on these maps provide adequate detail for assignment of the SDC in some but not all locations.
- When more detailed information on the IBC SDC maps are needed, USGS guidance on available tools can be found at:
  - https://doi.org/10.5066/F7NK3C76. This link provides guidance on determination of SDC. The following is a step-wise explanation:

2024 IBC Seismic Design Category Maps - How to Use the IBC Maps





https://www.fema.gov/sites/default/files/documents/fema_p-2192-nehrp-provisions-seismic-design-maps-2024-irc-ibc.pdf

2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

Steps to determine SDC as assigned by the IBC SDC maps (incorporating default Site Class):

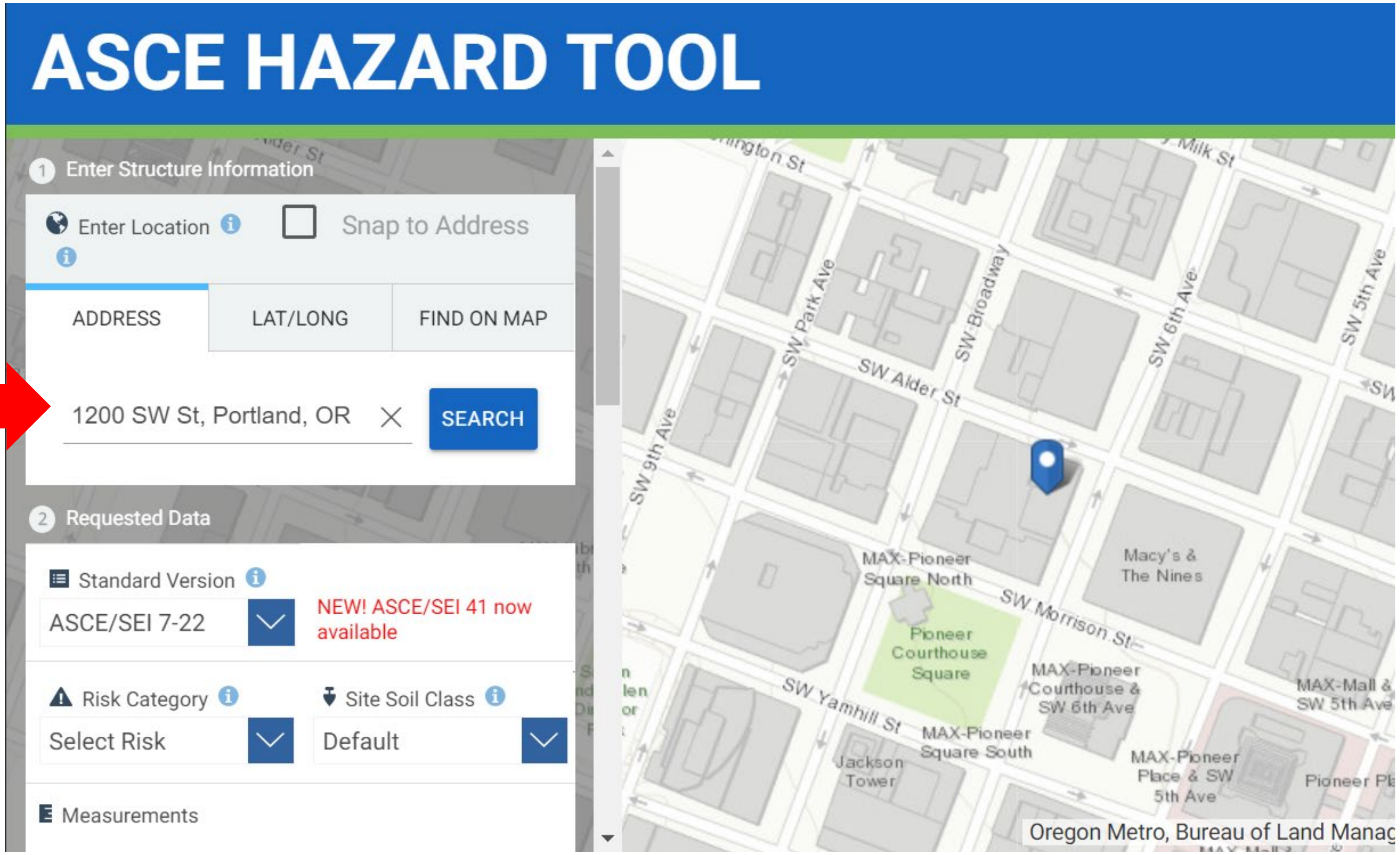
1. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
2. Enter property address,
3. Standard Version: Select ASCE 7-22,
4. Risk Category: Select applicable Risk Category based on IBC Table 1604.5
5. Site Soil Class: Select Default,
6. From results (summary, detailed, or full report), determine the Seismic Design Category

IBC Maps – ***Default*** Site Class (Soil Conditions)

2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

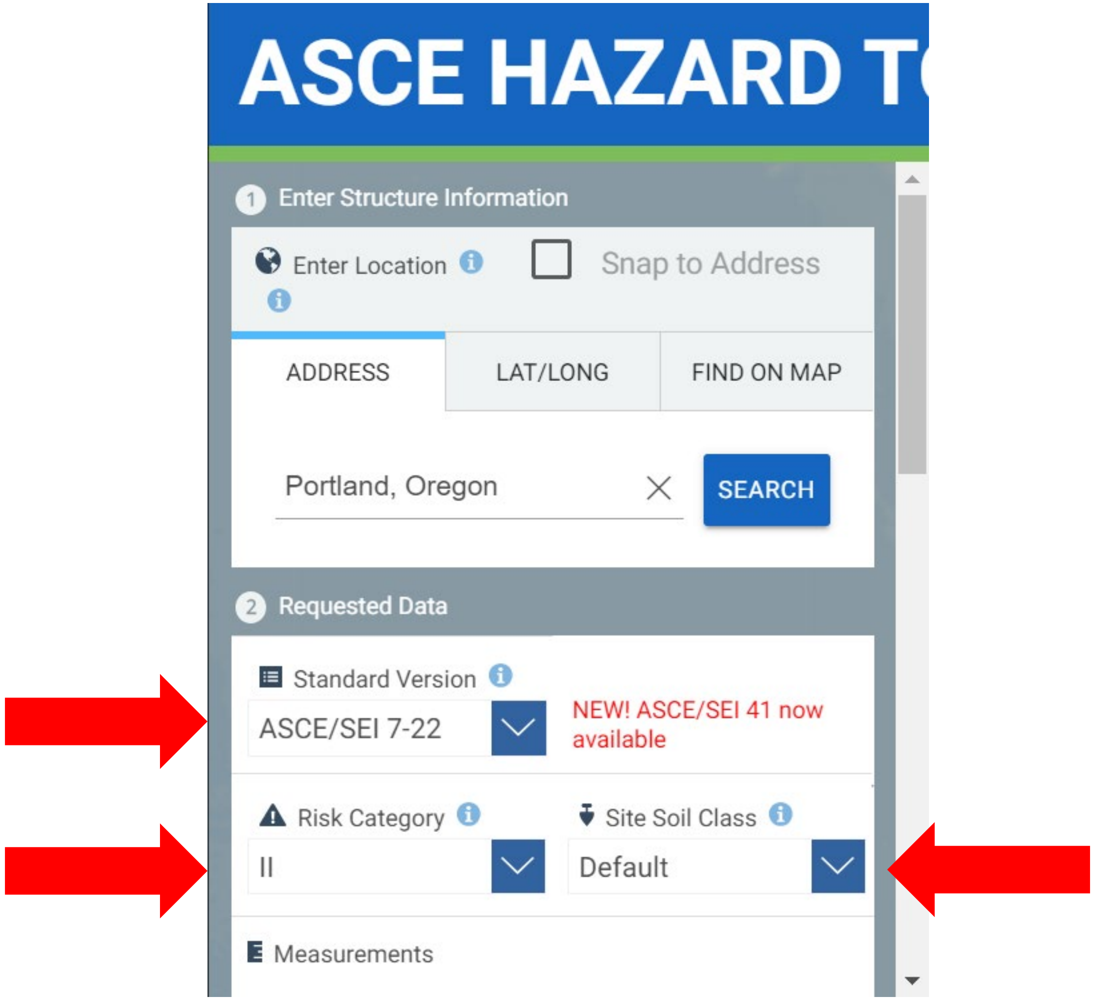
Steps to determine SDC as assigned by the IRC SDC maps (incorporates default Site Class):

1. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
2. Enter property address,



2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

3. Standard Version:
   Select ASCE 7-22
4. Risk Category:
   Select applicable Risk Category (Risk Category II selected for this example)
5. Site Soil Class:
   Select Default



2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

6. From results (summary, detailed, or full report), determine the Seismic Design Category

SDC = D

REPORT SUMMARY

Standard:	ASCE/SEI 7-22
Risk Category:	II
Soil Class:	Default

Seismic Data

S_S	0.95
S_1	0.36
S_{MS}	1.16
S_{M1}	0.79
S_{DS}	0.77
S_{D1}	0.53
T_L	16
PGA_M	0.51
V_{S30}	260
Seismic Design Category	D
Note	Where values of the multi-period 5%-damped MCER response spectrum are not available from the USGS Seismic Design Geodatabase, the design response spectrum shall be permitted to be determined in accordance with Section

2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

Steps to determine SDC as assigned by the IBC SDC maps (incorporating known Site Class):

1. Determine Site (soil) Class from site-specific geotechnical report or other reliable source acceptable to the building official,
2. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
3. Enter property address,
4. Standard Version: Select ASCE 7-22,
5. Risk Category: Select applicable Risk Category from IBC Table 1604.5
6. Site Soil Class: Select Default,
7. From results (summary, detailed, or full report), determine Seismic Design Category (SDC)

IBC Maps – Known Site Class (Soil Conditions)

2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

Steps to determine SDC as assigned by the IBC and ASCE 7 (incorporates known Site Class):

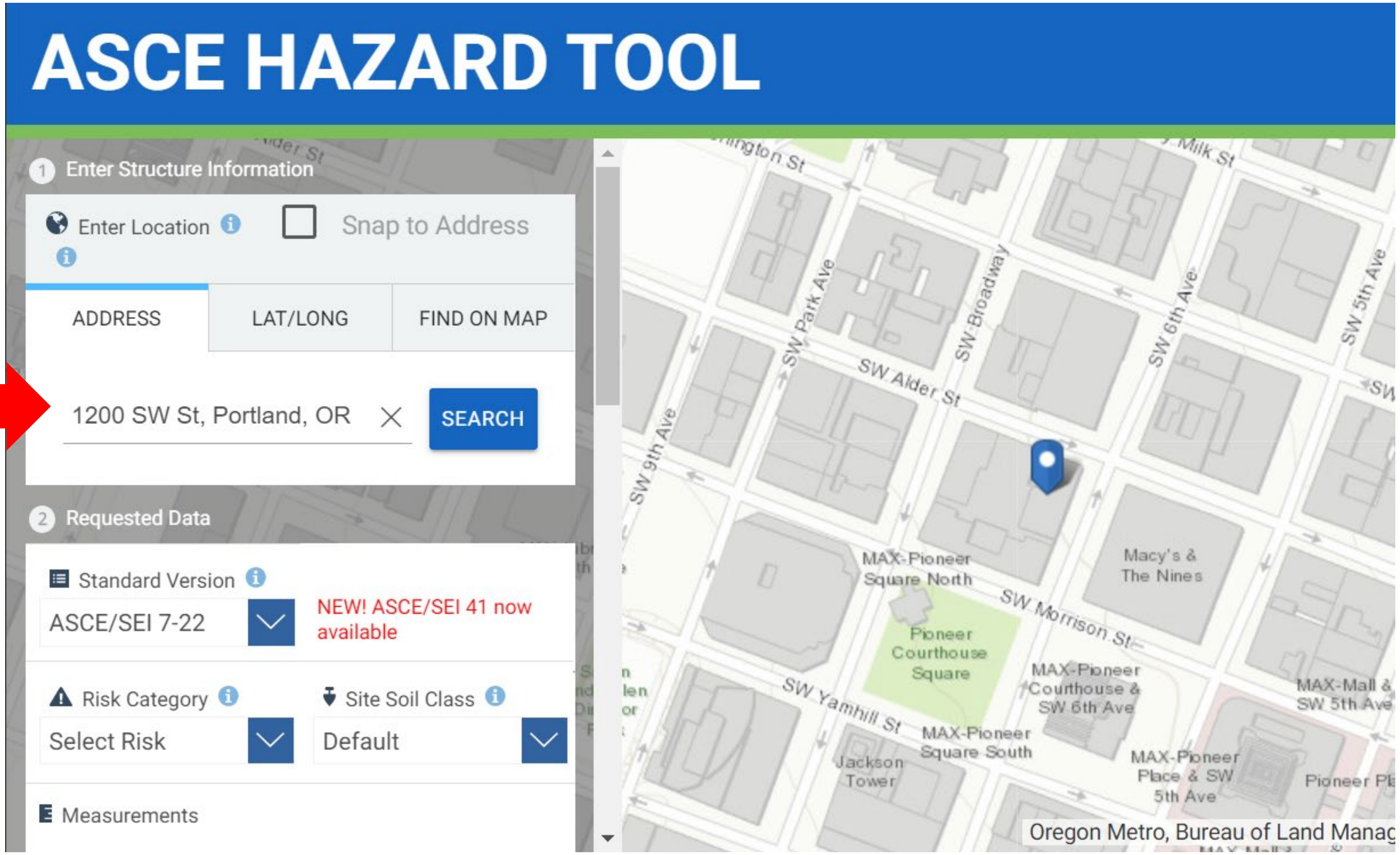
1. Determine Site (soil) Class from site-specific geotechnical report or other reliable source acceptable to the building official,

Geotechnical Report

2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

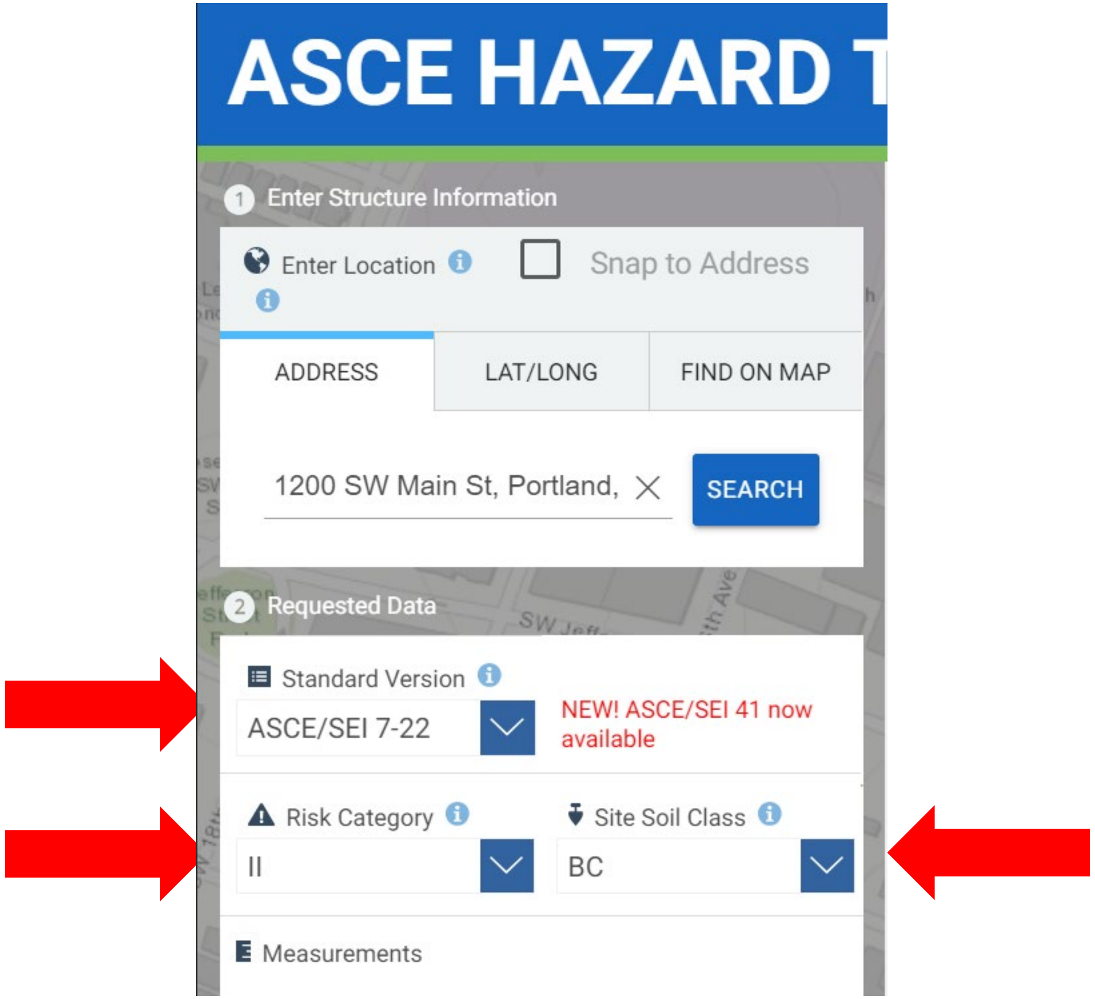
Steps to determine SDC as assigned by the IRC SDC maps (incorporates default Site Class):

2. Go to the ASCE Hazard Tool site: https//ascehazardtool.org,
3. Enter property address,



2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

4. Standard Version:
   Select ASCE 7-22
5. Risk Category:
   Select applicable Risk Category II (RC II used for example)
6. Site Soil Class:
   Select Site Class identified in Step 1 (example uses BC)



2024 IBC Seismic Design Category Maps – How to Use the IBC Maps

6. From results (summary, detailed, or full report), determine the Seismic Design Category

SDC = D

REPORT SUMMARY

Standard:	ASCE/SEI 7-22
Risk Category:	II
Soil Class:	BC

Seismic Data

S_S	0.95
S_1	0.36
S_{MS}	0.85
S_{M1}	0.36
S_{DS}	0.57
S_{D1}	0.24
T_L	16
PGA_M	0.4
V_{S30}	760
Seismic Design Category	D
Note	Where values of the multi-period 5%-damped MCER response spectrum are not available from the USGS Seismic Design Geodatabase, the design response spectrum shall be permitted to be determined in accordance with Section

2024 IBC Seismic Design Category Maps

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National Seismic Hazard Model

ACTIVE

By Earthquake Hazards Program March 9, 2022

Overview Science

Earthquakes cause an estimated annualized loss to the U.S. of several billions of dollars. To mitigate earthquake losses, it is necessary to evaluate the earthquake hazards across the country.

2024 Updates to The National Seismic Hazard Models and the SDC Maps

The updates to the IRC and IBC maps are based on:

(1) Recommendations of the Project 17 collaboration between the Building Seismic Safety Council (BSSC) and the USGS (BSSC, 2019), and

(2) The 2018 update of the USGS NSHM for the conterminous U.S..

Included are the following:

- The Project 17 recommendations include improvements to site-class effects,
- Spectral periods defining short-period and one-second ground-motion parameters,
- Deterministic caps on the otherwise probabilistic ground motions, and
- Maximum-direction scale factors.

2024 Updates to The National Seismic Hazard Models and the SDC Maps

The updates in the 2018 USGS NSHM from the previous (2014) version (used in the 2018 and 2021 versions of the IBC and IRC) include incorporation of:

- New NGA-East and other ground-motion models for the central and eastern U.S.,
- Deep sedimentary basin effects in the Los Angeles, Seattle, San Francisco, and Salt Lake City regions,
- Earthquakes that occurred in 2013 through 2017, and
- Updated weights for the western U.S. ground-motion models.

2024 Updates to The National Seismic Hazard Models and the SDC Maps

- In general, the Project 17 and NSHM updates have not resulted in significant changes to the spectral response acceleration parameters SDS and SD1 at default site conditions (Site Class).
- As a result, IRC and IBC mapped SDCs at default site conditions have generally stayed the same or increased or decreased by one. This is illustrated in the 34 predominantly western U.S. cities discussed in the commentary to Chapter 22 of the 2020 NEHRP Provisions.
- It is known, however, that larger changes have occurred in spectral response accelerations in parts of the central and eastern U.S. This is particularly true for soft soil sites, where changes of up to two SDCs have occurred because the site coefficients of previous editions of the IRC and IBC, which were predominantly based on western U.S. data, have in 2024 editions been replaced with eastern U.S. data.

2024 Updates to The National Seismic Hazard Models and the SDC Maps

Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, Guam, the Northern Mariana Islands, and American Samoa:

- For the states and territories outside of the conterminous U.S., where the existing USGS NSHMs did not yet support direct development of multi-period response spectra (MPRS) needed for the above- mentioned modifications to site-class effects and spectral periods, MPRS were developed using the FEMA P-2078 “Procedures for Developing Multi-Period Response Spectra at Non-Conterminous United States Sites” (FEMA, 2020b).

References

- ASCE, 2021. Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE/SEI 7-22), American Society of Civil Engineers, Reston VA.
- BSSC, December 2019. Project 17 Final Report Development of the Next Generation of Seismic Design Value Maps for the 2020 NEHRP Provisions.
- FEMA, 2020a. NEHRP Recommended Seismic Provisions for New Buildings and Other Structures, 2020 Edition (FEMA P-2082-1), Federal Emergency Management Agency, Washington, DC.
- FEMA, 2020b. Procedures for Developing Multi-Period Response Spectra at Non-Conterminous United States Sites (FEMA P-2078).

References

- FEMA, 2023. 2020 NEHRP Recommended Seismic Provisions: Seismic Design Category Maps for 2024 International Residential Code (IRC) and International Building Code (IBC) (FEMA P-2192-4).
- ICC, 2024 a. International Building Code, 2024 Edition, international Code Council, Country Club Hills, IL.
- ICC, 2024 b. International Building Code Commentary, 2024 Edition, international Code Council, Country Club Hills, IL.
- ICC, 2024 c. International Residential Code, 2024 Edition, international Code Council, Country Club Hills, IL.

Other Resources

- FEMA, 2023. Earthquake-Resistant Design Concepts: An Introduction to Seismic Provisions for New Buildings (FEMA P-749).
- FEMA, 2021. The Role of the NEHRP Recommended Seismic Provisions in the Development of Nationwide Seismic Building Code Regulations: A Thirty-Five-Year Retrospective (FEMA P-2156).

Thank you!

Questions?

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The 2024 Seismic Design Maps for IRC/IBC Fact Sheet and Webinar material have been delivered through the National Institute of Building Sciences' Building Seismic Safety Council under a FEMA NEHRP A&E contract