

ASCE 41-13
***Performance Based
Seismic Evaluation and Retrofit
of Existing Buildings***

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UNIFORM BUILDING CODE

TENTATIVE PROVISIONS FOR THE DEVELOPMENT OF SEISMIC REGULATIONS FOR BUILDINGS

Collaborative Effort with the Design Professions, Code Interests and the Research Community

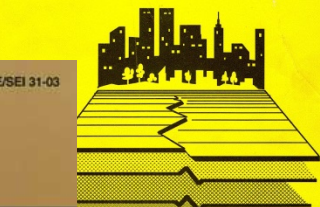
ATC 14

EVALUATING THE SEISMIC RESISTANCE OF EXISTING BUILDINGS

APPLIED TECHNOLOGY COUNCIL

ATC
APPLIED TECHNOLOGY COUNCIL

NEHRP Handbook for the Seismic Evaluation of Existing Buildings



ASCE/SEI 31-03

ASCE STANDARD

American Society of Civil Engineers
Seismic Evaluation of Existing Buildings

ASCE



ASCE STANDARD
ASCE/SEI 41-06

Seismic Rehabilitation of Existing Buildings

This document, like both the International Building Code (IBC) and International Residential Code (IRC), is a consensus document.

ASCE



Existing Building Tools

- 0.75*1976 UBC
- ATC 3-06
- ATC 14
- FEMA 178 → 310 → ASCE 31-03
Evaluating Existing Buildings
- FEMA 273 → 356 → ASCE 41-06
“Rehabilitation” of Existing Buildings
- ASCE 41-13
Evaluating and “Retrofit” of Existing Buildings

Building Performance Level

Earthquake Hazard Level

50% / 50 yr
(72 year)

20% / 50 yr
(225 year)

BSE-1
(~475 year)

BSE-2
(~2475 yr)

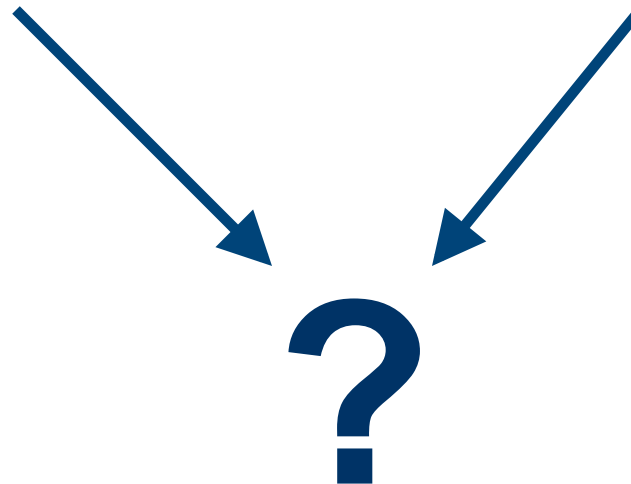
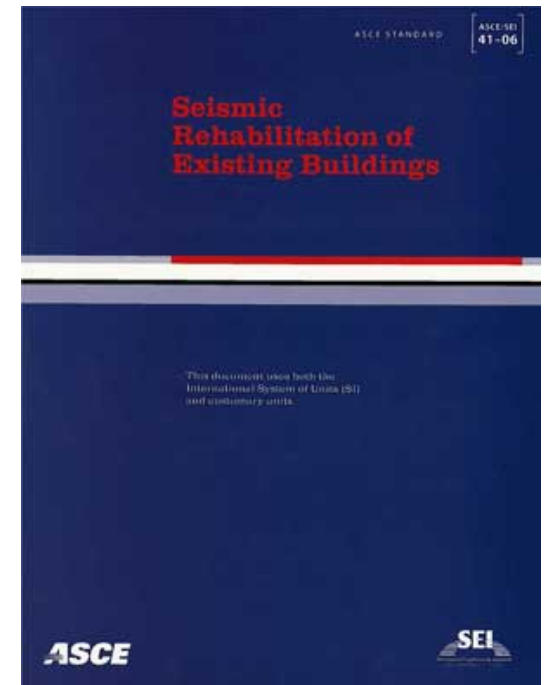
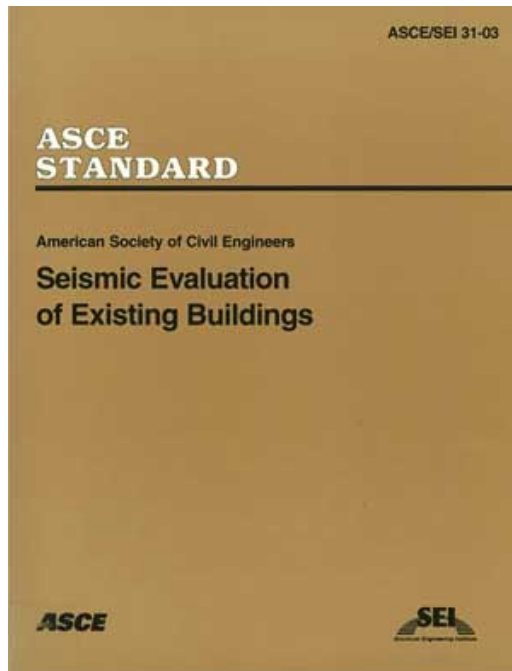
Operational Immediate Occupancy Life Safety Collapse Prevention

Limited Objectives

Enhanced Objectives

Basic Safety Objective

Overview of the New Standard



ASCE 41-13

Chapter 1	General Requirements
Chapter 2	Seismic Performance Objectives and Ground Motions
Chapter 3	Evaluation and Retrofit Requirements
Chapter 4	Tier 1 Screening
Chapter 5	Tier 2 Deficiency-Based Evaluation and Retrofit
Chapter 6	Tier 3 Systematic Evaluation and Retrofit
Chapter 7	Analysis Procedures and Acceptance Criteria
Chapter 8	Foundations and Geologic Site Hazards
Chapter 9	Steel
Chapter 10	Concrete
Chapter 11	Masonry
Chapter 12	Wood and Cold-Formed Steel
Chapter 13	Architectural, Mechanical, and Electrical Components
Chapter 14	Seismic Isolation and Energy Dissipation
Chapter 15	System-Specific Performance Procedures
Chapter 16	Tier 1 Checklists
Appendix A	Guidelines for Deficiency-Based Procedures
Appendix B	Use of ASCE 41-13 within Mitigation Programs

General Provisions

The Old

ASCE 31-03

- Two Performance Levels – Life Safety & Immediate Occupancy
- One Seismic Hazard – $(2/3)*MCE$
- Buried within the acceptance criteria is a factor of 0.75, which is intended to give existing buildings a “break”

ASCE 41-06

- Three Performance Levels – Collapse Prevention, Life Safety & Immediate Occupancy
- Performance ranges between levels
- Two Seismic Hazard – 10%/50 or $(2/3)*MCE$ and MCE
- No break for existing buildings
- Basic Safety Objective \approx Performance of Occupancy Category II

The New

New Design Equivalent Hazards – No “Break”

BSE-2N is the ASCE 7-10 MCE_R

BSE-1N is $2/3 * ASCE 7-10 MCE_R$

Existing Building Hazards – the “Break”

BSE-2E is the 5% in 50-year (975-year)

BSE-1E is the 20% in 50-year (225-year)

BSE-2E and BSE-1E cannot be greater than the BSE-2N and BSE-1N

• In SF, San Jose, parts of LA, and Oakland this means no force reduction for existing buildings



Geologic Hazards Science Center

EARTHQUAKES

LANDSLIDES

GEOMAGNETISM

Seismic Design Maps & Tools

US Seismic Design Maps

Use the Tool

Documentation & Help

Java Ground Motion Parameter Calculator

Download the Tool

Documentation & Help

Worldwide Seismic Design Values

Use the Tool

Documentation & Help

U.S. Seismic Design Maps

Please note that the most recent design code(s) (e.g., 2012 International Building Code) may not yet govern in your municipality. If you are unsure of which document is currently enforced in your area, please consult your local building or transportation official before using this application.

Application

Batch Mode

Help

Design Code Reference Document

Consult your local design official if you need help selecting this.

2013 ASCE 41 (dev only)

Earthquake Hazard Level

The particular analysis procedure to use.

BSE-2E

Report Title (Optional)

This will appear at the top of the generated report.

Site Soil Classification

This is not automatically selected based on site location.

Site Class D - "Stiff Soil" (Default)

Site Latitude

Decimal degrees for the site location.

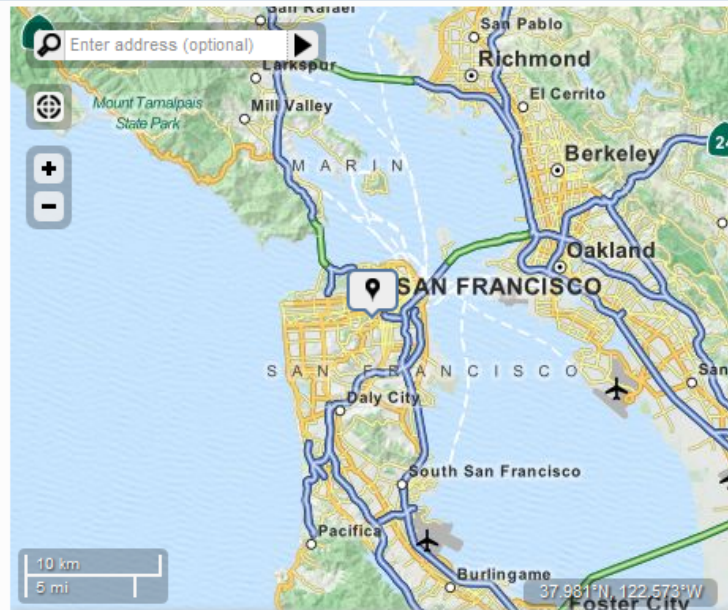
37.766

Site Longitude

Decimal degrees for the site location.

-122.435

Compute Values



Powered by [Leaflet](#) — Tiles Courtesy of [MapQuest](#) — Data © [OpenStreetMap](#) contributors, [CC](#)

EARTHQUAKES

Earthquakes

Hazards

Learn

LANDSLIDES

Research

Advisories

Monitoring

GEOMAGNETISM

Sacramento Example

New Design Equivalent Hazards – No “Break”

BSE-2N is 0.87

BSE-1N is 0.58

Existing Building Hazards – the “Break”

BSE-2E is 0.66

BSE-1E is 0.44

San Francisco Example

New Design Equivalent Hazards – No “Break”

BSE-2N is 1.50

BSE-1N is 1.00

Existing Building Hazards – the “Break”

BSE-2E is 1.48

BSE-1E is 0.99

Old Structural Performance Levels & Ranges

Immediate Occupancy

Life Safety

Collapse Prevention



Damage Control

Limited Safety

New Structural Performance Levels & Ranges

Immediate Occupancy

Damage Control

Life Safety

Limited Safety

Collapse Prevention



Enhanced Safety

Reduced Safety

'06 Nonstructural Performance Levels

Operational

Immediate Occupancy

Life Safety

Hazards Reduced

Not Considered



Nonstructural Performance Levels

Operational

ASCE 7 $I_p = 1.5$

Position Retention

ASCE 7 $I_p = 1.0$

Life Safety

Actually can seriously injure or kill

Not Considered



Basic Performance Objective for Existing Buildings - BPOE

	Tier 1	Tier 2	Tier 3	
Risk Category	BSE-1E	BSE-1E	BSE-1E	BSE-2E
I & II	<p>Life Safety Structural Performance</p> <p>Life Safety Nonstructural Performance (3-C)</p>	<p>Life Safety Structural Performance</p> <p>Life Safety Nonstructural Performance (3-C)</p>	<p>Life Safety Structural Performance</p> <p>Life Safety Nonstructural Performance (3-C)</p>	<p>Collapse Prevention Structural Performance</p> <p>Nonstructural Performance Not Considered (5-D)</p>
III	<p>Damage Control Structural Performance</p> <p>Position Retention Nonstructural Performance (2-B)</p>	<p>Damage Control Structural Performance</p> <p>Position Retention Nonstructural Performance (2-B)</p>	<p>Damage Control Structural Performance</p> <p>Position Retention Nonstructural Performance (2-B)</p>	<p>Limited Safety Structural Performance</p> <p>Nonstructural Performance Not Considered (4-D)</p>
IV	<p>Immediate Occupancy Structural Performance</p> <p>Position Retention Nonstructural Performance</p>	<p>Immediate Occupancy Structural Performance</p> <p>Position Retention Nonstructural Performance</p>	<p>Immediate Occupancy Structural Performance</p> <p>Position Retention Nonstructural Performance</p>	<p>Life Safety Structural Performance</p> <p>Nonstructural Performance Not Considered</p>

Basic Performance Objective Equivalent to New Building Standards - BPON

	Tier 3	
Risk Category	BSE-1N	BSE-2N
I & II	Life Safety Structural Performance Position Retention Nonstructural Performance (3-C)	Collapse Prevention Structural Performance Nonstructural Performance Not Considered (5-D)
III	Damage Control Structural Performance Position Retention Nonstructural Performance (2-B)	Limited Safety Structural Performance Nonstructural Performance Not Considered (4-D)
IV	Immediate Occupancy Structural Performance Operational Nonstructural Performance (1-A)	Life Safety Structural Performance Nonstructural Performance Not Considered (3-D)

Limits on Deficiency-Based Procedures

Only allowed for
Model Bldg type in
each direction

Limited use for mixed
systems

Tier 2 now allowed
for IO retrofit

Table 3-2 Limitations on the Use of the Tier 1 and Tier 2 Procedures¹

Common Building Type ²	Number of Stories ³ beyond which the Tier 3 Systematic Procedures are Required							
	Level of Seismicity							
	Very Low		Low		Moderate		High	
	S-3	S-1	S-3	S-1	S-3	S-1	S-3	S-1
Wood Frames								
Light (W1)	NL	NL	NL	4	4	4	4	4
Multi-Story, Multi-Unit Residential (W1A)	NL	NL	NL	6	6	6	6	4
Commercial and Industrial (W2)	NL	NL	NL	6	6	6	6	4
Steel Moment Frames								
Rigid Diaphragm (S1)	NL	NL	NL	12	12	8	8	6
Flexible Diaphragm (S1A)	NL	NL	NL	12	12	8	8	6
Steel Braced Frames								
Rigid Diaphragm (S2)	NL	NL	NL	8	8	8	8	6
Flexible Diaphragm (S2A)	NL	NL	NL	8	8	8	8	6
Steel Light Frames (S3)	NL	1	1	1	1	1	1	1
Dual Systems with Backup Steel Moment Frames (S4)	NL	NL	NL	12	12	8	8	6
Steel Frames with Infill Masonry Shear Walls								
Rigid Diaphragm (S5)	NL	NL	NL	12	12	8	8	4
Flexible Diaphragm (S5A)	NL	NL	NL	12	12	8	8	4
Concrete Moment Frames (C1)	NL	NL	NL	12	12	8	8	6
Concrete Shear Walls								
Rigid Diaphragm (C2)	NL	NL	NL	12	12	8	8	6
Flexible Diaphragm (C2A)	NL	NL	NL	12	12	8	8	6
Concrete Frame with Infill Masonry Shear Walls								
Rigid Diaphragm (C3)	NL	NL	NL	12	12	8	8	4
Flexible Diaphragm (C3A)	NL	NL	NL	12	12	8	8	4
Precast/Tilt-up Concrete Shear Walls								
Flexible Diaphragm (PC1)	NL	NL	3	2	2	2	2	2
Rigid Diaphragm (PC1A)	NL	NL	3	2	2	2	2	2
Precast Concrete Frames								
With Shear Walls (PC2)	NL	NL	NL	6	6	NP	4	NP
Without Shear Walls (PC2A)	NL	NL	NL	6	6	NP	4	NP
Reinforced Masonry Bearing Walls								
Flexible Diaphragm (RM1)	NL	NL	NL	8	8	8	8	6
Rigid Diaphragm (RM2)	NL	NL	NL	8	8	8	8	6
Unreinforced Masonry Bearing Walls								
Flexible Diaphragm (URM)	NL	NL	6	4	6	NP	4	NP
Rigid Diaphragm (URMA)	NL	NL	6	4	6	NP	4	NP

¹The Tier 3 Systematic procedures are required for buildings with more than the number of stories listed herein.

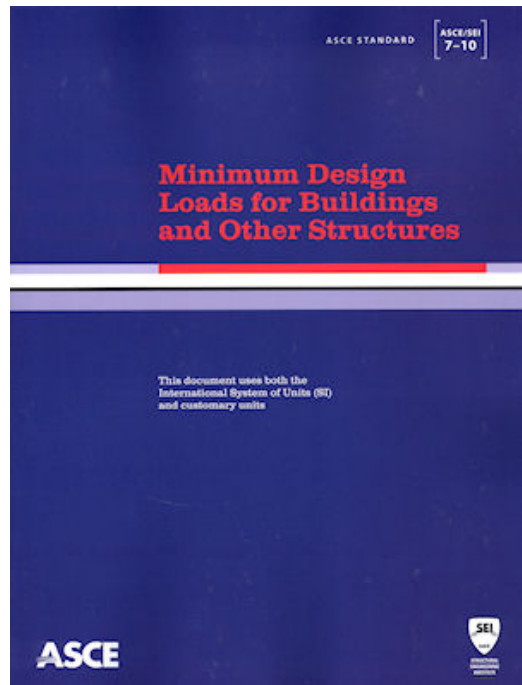
²Common Building Types are defined in Section 3.2.1.

³Number of stories shall be considered as the number of stories above lowest adjacent grade.

NL = No Limit (No limit on the number of stories).

NP = Not Permitted (Tier 3 Systematic procedures are required).

Current Issues



Reality

Greatest Impediments

It's too @\$% Conservative!

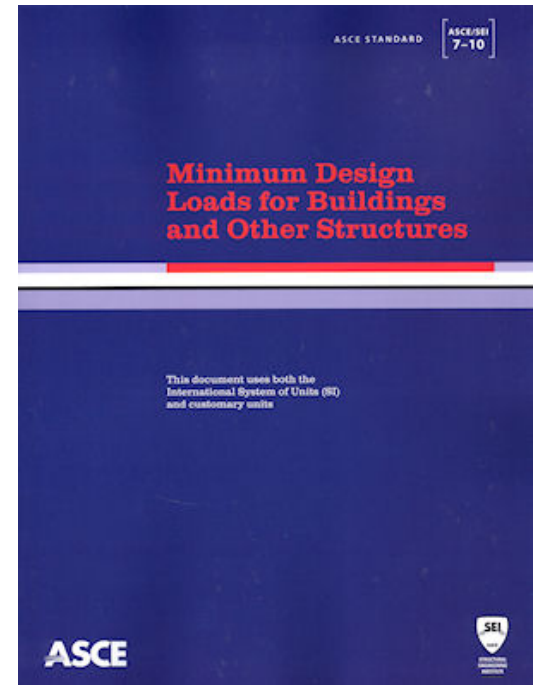
Greatest Impediments

DCR = 0.99 => Life Safe

DCR = 1.06 => Not Life Safe

Deterministic Standard for a
Probabilistic Phenomena

Possible Future Directions



“Consistency”

Probability Of Achieving a Performance Level

Immediate Occupancy

90% in BSE-1N

75% in BSE-1N

50% in BSE-1N

Collapse Prevention

97% in BSE-2N

94% in BSE-2N

90% in BSE-2N



Probability Of Achieving a Performance Level

Immediate Occupancy

90% in BSE-1N

75% in BSE-1N

50% in BSE-1N

Collapse Prevention

97% in BSE-2N

94% in BSE-2N

90% in BSE-2N



Reduce the “false positives”

ASCE 41-13

***Seismic Evaluation and
Retrofit of Existing Buildings***

**Your Thoughts &
Questions?**