

# ASCE/SEI and Functional Recovery

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# ASCE/SEI and FUNCTIONAL RECOVERY

- **ASCE/SEI**
  - Who we are and what we do
- **ASCE 7**
  - Standards Development and Adoption
- **ASCE 7 and FUNCTIONAL RECOVERY**
  - How we arrived here, and what is already included
  - FEMA P-58 and NEHRP 2020
  - Challenges
- **PATHS to FUNCTIONAL RECOVERY**



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# Who we are and what we do



**ASCE** AMERICAN SOCIETY<sup>®</sup>  
OF CIVIL ENGINEERS



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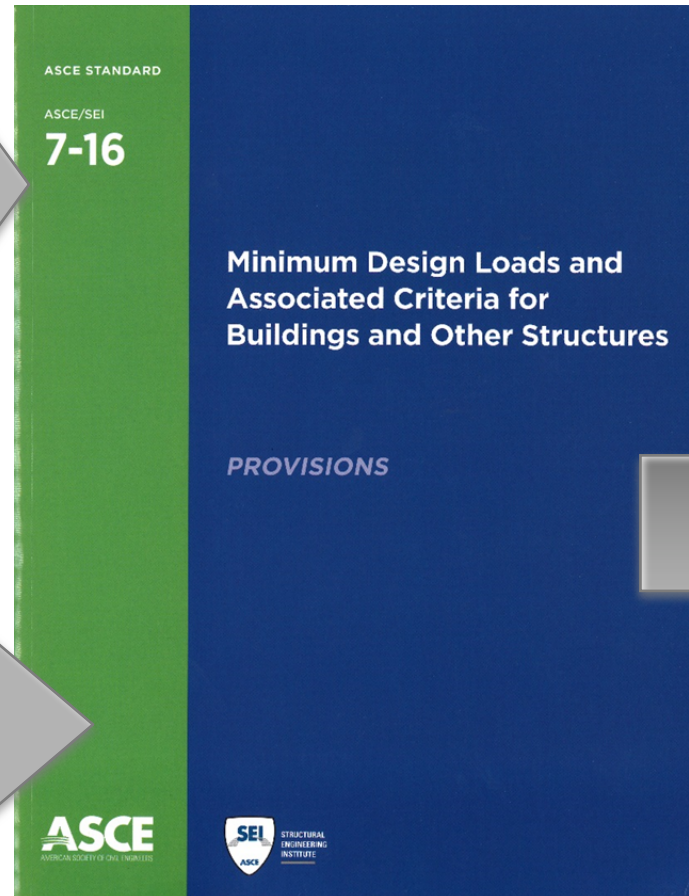
# What is ASCE 7?

## HAZARDS:

Seismic  
Wind  
Snow  
Ice  
Flood  
Rain  
Tsunami  
Dead & Live  
Fire

## PERFORMANCE:

Economical  
Constructability

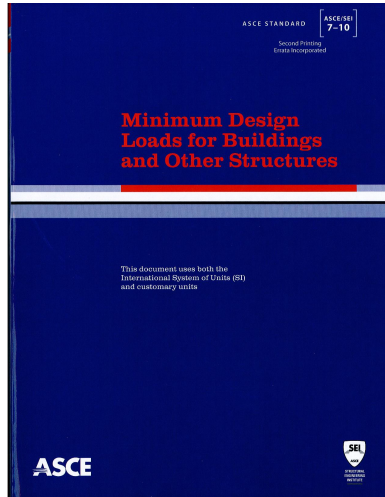


**SAFE  
RELIABLE  
STRUCTURES**



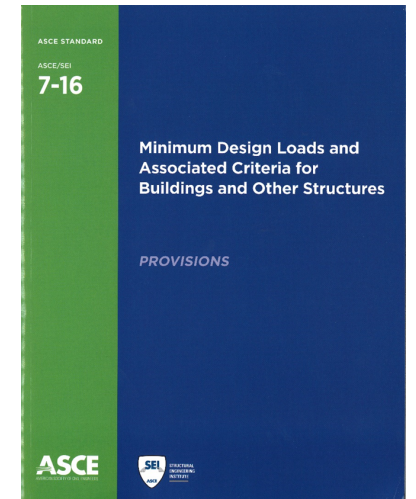
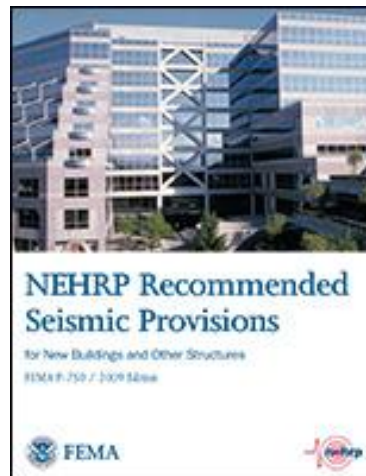
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# ASCE 7 and adoption ICC Cycle



350 people + 6 years

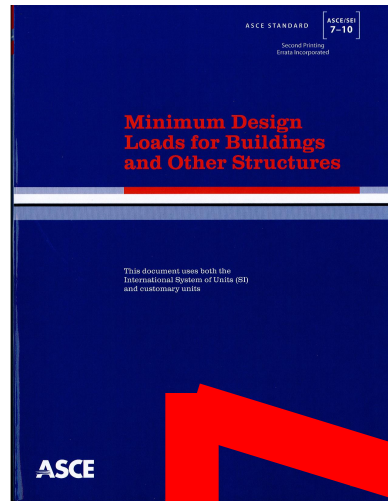
ANSI Rules  
Balanced Committee  
Public Comment



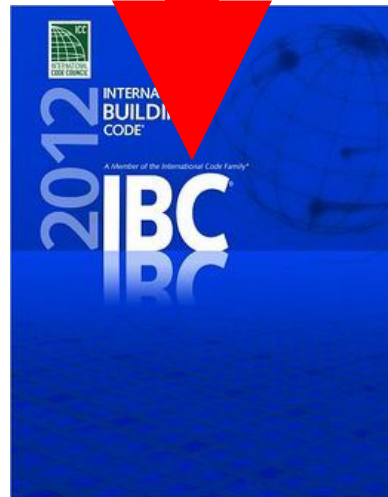
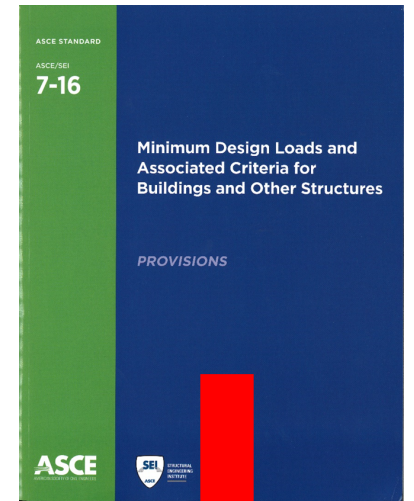


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# ASCE 7 and adoption ICC Cycle



350 people + 6 years



3 years



3 years





# Standard versus Code

## Standards (ASCE 7)

- How to design and construct variety of buildings/infrastructure



## National Codes (IBC)

- Govern all aspects of buildings/infrastructure and construction by adopting **Standards + Policy**



## State/Local Building Officials (AHJ)

- Adopt and enforce **Codes** to  
protect public health, safety, and welfare



# ASCE 7 and FUNCTIONAL RECOVERY

Structural design for all loads (earthquake, snow, wind, ice, rain, etc.) considers two limit states:

- *Serviceability* – No impairment of function, no repair required
- *Safety* – Failure involving loss of function

Design criteria seeks to ensure:

- *Serviceability* - routine loads, expected to occur many times during the life of a structure (continued function)
- *Safety* - very low probability the ultimate state will be exceeded or that failure will occur under any loading

Simply stated:

- Structures should be useable and functional, nearly always
- Structures should protect safety





# What are the current ASCE 7 goals?

## Live, Snow, Wind

- *Serviceable* for 50-year loads
  - Note for tall buildings, it is common to accept temporary disruption of use due to wind during storms having a 10-year return period
- *Safety* for failure probability for any element
  - Risk Category II – 1 in 100,000 years
  - Risk Category IV – 1 in 200,000 years

## Earthquake

- *Serviceability*
  - Risk Category II ~ 25 -50 years (depending on structure type)
  - Risk Category IV ~ 50-75 years (structure) – ~500 years nonstructural
- *Safety*
  - Risk Category II – 1 in 5,000 years
  - Risk Category IV – 1 in 12,000 years



## Some observations

- **Serviceability goals** for earthquake are comparable to those for wind, snow and other hazards
- **Safety goals** are two orders of magnitude poorer for earthquake than other hazards
  - Wind, snow, and other hazards
    - High frequency, low variability – small factors of safety provide higher amount of protection
  - Earthquakes
    - Low frequency, high variability – large factors of safety provide smaller amount of protection

\*\*\*Protection is easily and economically obtained for most hazards, but is expensive and difficult to obtain for earthquakes



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# FUNCTIONALITY in ASCE 7

In addition to *Serviceability* and *Safety defined in ASCE 7*, **Functionality** is specified for RC IV:

## **Section 1.3.3 Functionality.**

*...Risk Category IV shall be designed ... to not prevent function of the facility immediately following the design level hazard events.*



# Some insights

FEMA P58 assessment of the adequacy of current codes:

- Typical buildings (RC II) in design earthquake (500-year)
  - Repair times 45-60 days
- Essential buildings (RC IV) in design earthquake
  - Repair times 30-45 days

NEHRP 2020 Part 3 Paper

Performance Measure	Performance Expectation	
	Design EQ	MCE
<b>Risk Category II – Office</b>		
Repair Cost	10%	30%
Repair Time	45 days	150 days
Casualty Rate	1.0%	2.0%
Probability of Unsafe Placard	20%	40%
Repairability	95%	80%
<b>Risk Category II – Healthcare (Medical Office Building or Laboratory)</b>		
Repair Cost	20%	40%
Repair Time	60 days	180 days
Casualty Rate	1.0%	2.0%
Probability of Unsafe Placard	20%	40%
Repairability	85%	65%
<b>Risk Category IV – Office (Emergency Operations Center)</b>		
Repair Cost	5%	15%
Repair Time	30 days	75 days
Casualty Rate	0.5%	1.5%
Probability of Unsafe Placard	10%	25%
Repairability	98%	90%
<b>Risk Category IV – Healthcare (Hospital)</b>		
Repair Cost	10%	20%
Repair Time	45 days	100 days
Casualty Rate	0.5%	1.5%
Probability of Unsafe Placard	10%	25%
Repairability	95%	85%



# Is there really a problem?

## ***Occasional*** earthquakes

- 1971 San Fernando, 1979 Imperial Valley
- 1982 Morgan Hill, 1983 Coalinga, 1987 Whittier, 1989 Loma Prieta
- 1994 Northridge
- 2001 Nisqually

>> Caused limited damage, and did not significantly affected city resilience.

## ***Great*** earthquakes

- 1906 San Francisco
- 1923 Tokyo
- 1964 Anchorage

>> Caused near total destruction of the affected cities.

>> Such earthquakes occur hundreds of years apart at any given location.



1) The ASCE 7 standards committee has been reluctant to adopt explicit *serviceability* goals

- Primary concern is economics (of the individual owner)

2) The ASCE 7 standards committee would likely be willing to develop voluntary criteria for *serviceability*

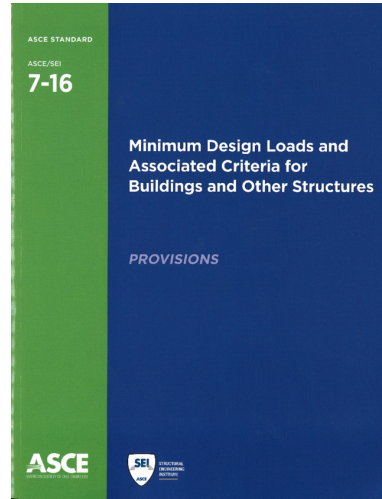
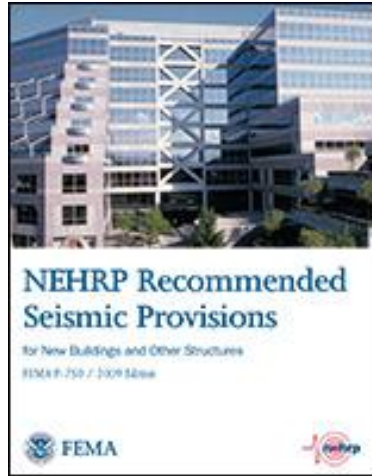
3) If voluntary *serviceability* goals were included in standards, communities will have to choose:

- Whether to require this or not
- What risk is acceptable



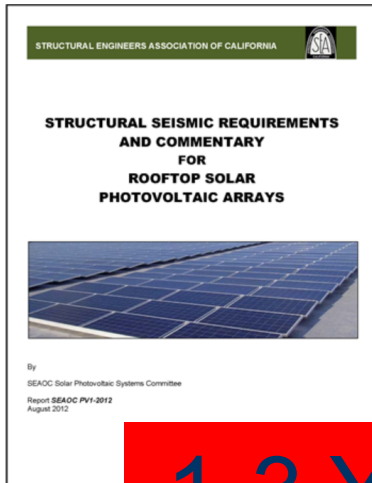
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# PATHS to FUNCTIONAL RECOVERY



5-6 Years

3-6 Years



1-3 Years

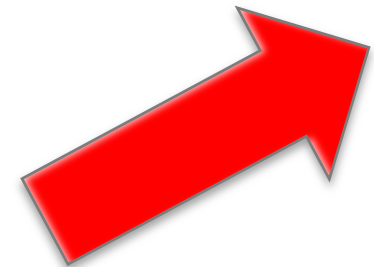
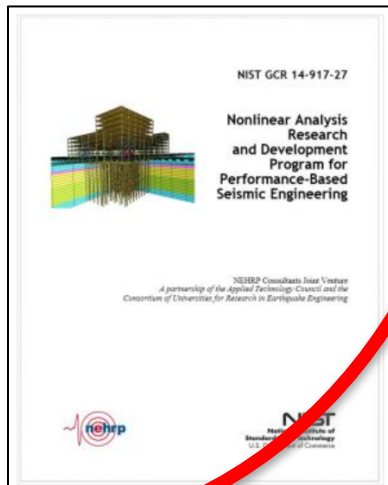
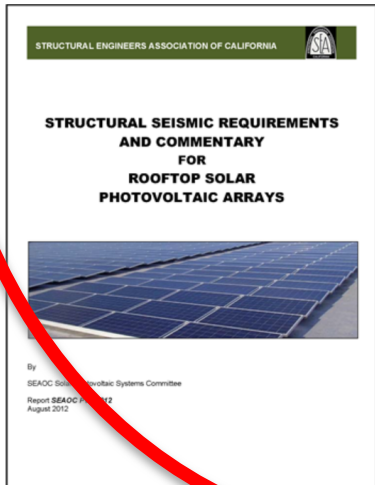
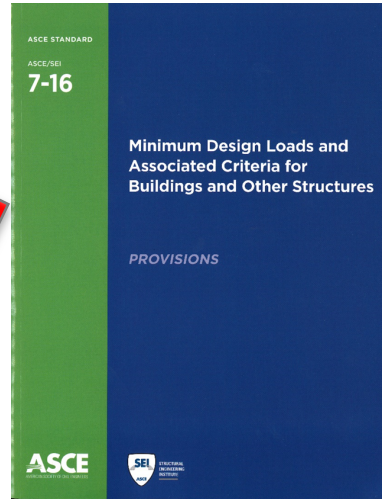
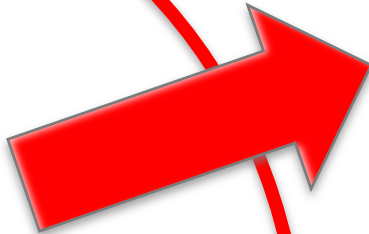
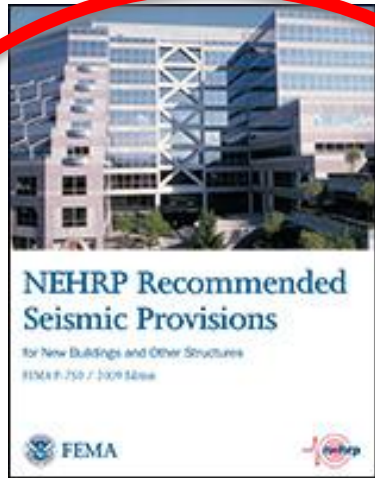


3 Years



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# PATHS to FUNCTIONAL RECOVERY

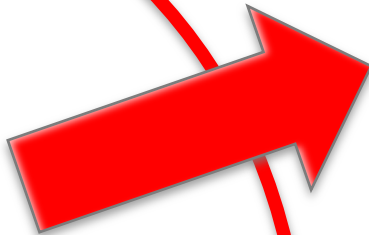
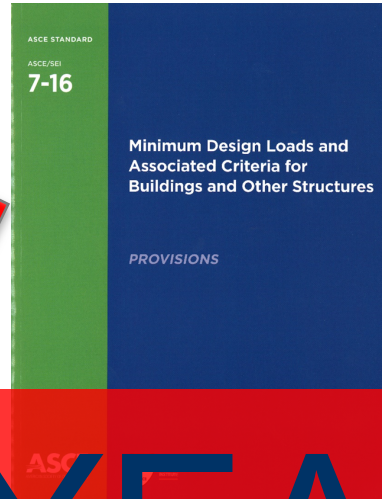
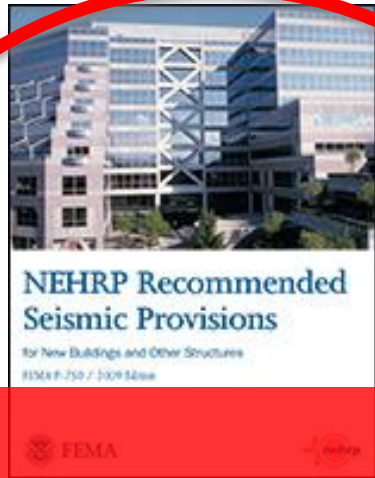




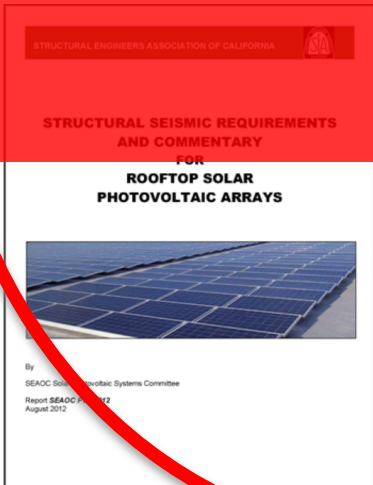


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# PATHS to FUNCTIONAL RECOVERY



# 10 YEARS!!!



# THANK YOU

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