

ASCE/SEI and Functional Recovery

Presented at ICC CALBO Seismic Roundtable on July 25, 2019

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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[®]
OF CIVIL ENGINEERS



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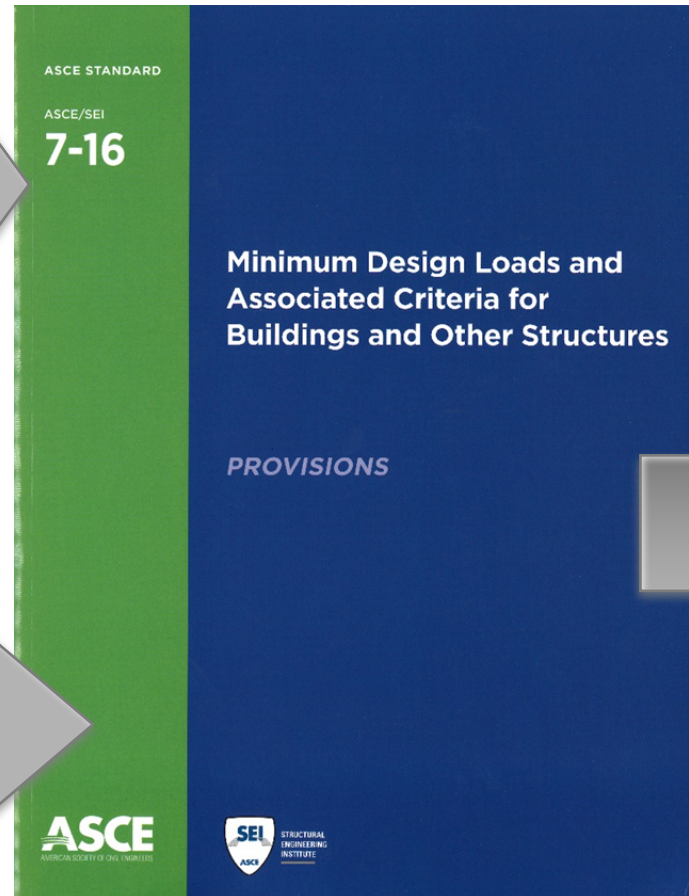
What is ASCE 7?

HAZARDS:

Seismic
Wind
Snow
Ice
Flood
Rain
Tsunami
Dead & Live
Fire

PERFORMANCE:

Economical
Constructability

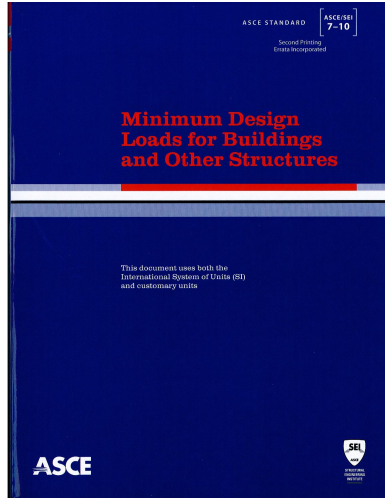


**SAFE
RELIABLE
STRUCTURES**



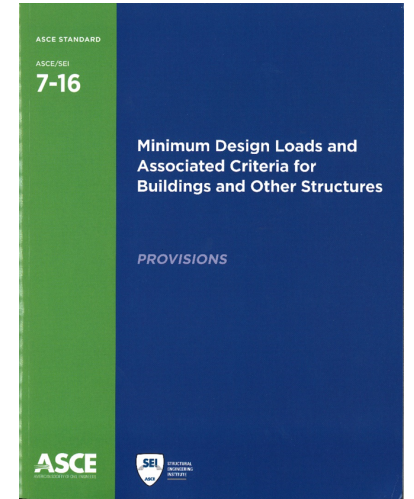
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ASCE 7 and adoption ICC Cycle



350 people + 6 years

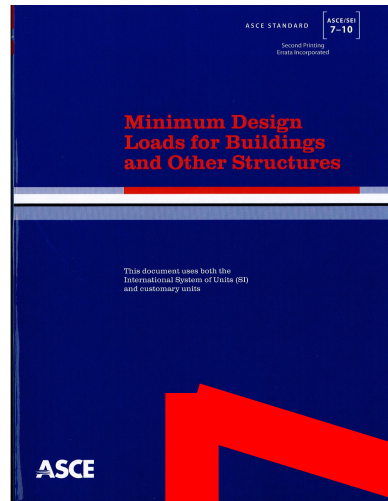
ANSI Rules
Balanced Committee
Public Comment



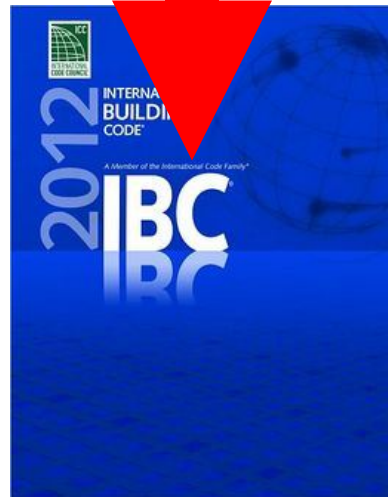
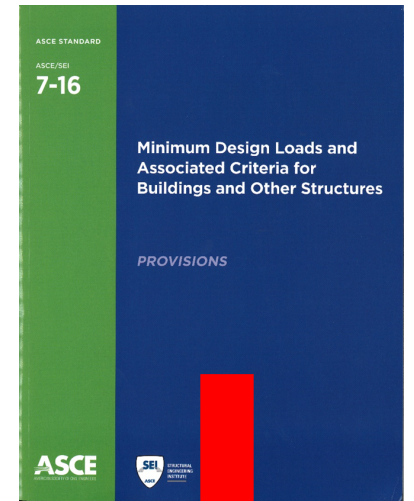


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ASCE 7 and adoption ICC Cycle



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.



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
Risk Category II – Office		
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%
Risk Category II – Healthcare (Medical Office Building or Laboratory)		
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%
Risk Category IV – Office (Emergency Operations Center)		
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%
Risk Category IV – Healthcare (Hospital)		
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*

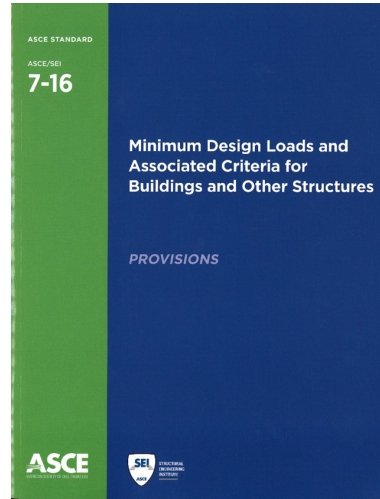
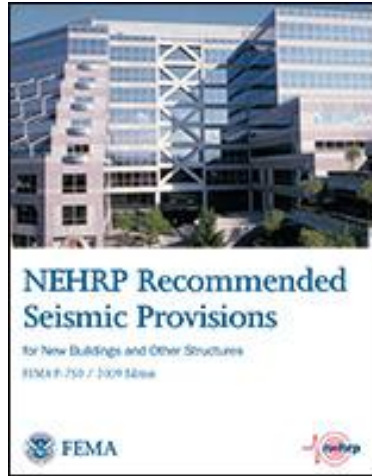
3) If voluntary *serviceability* goals were included in standards, communities will have to choose:

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



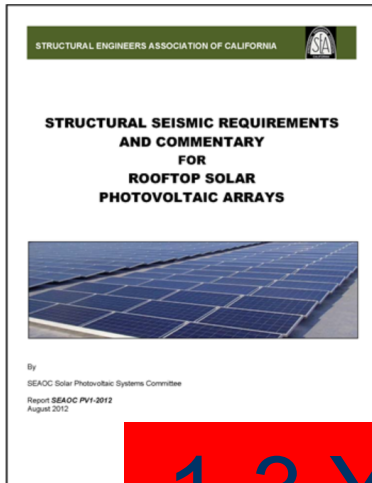
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PATHS to FUNCTIONAL RECOVERY



5-6 Years

3-6 Years



1-3 Years

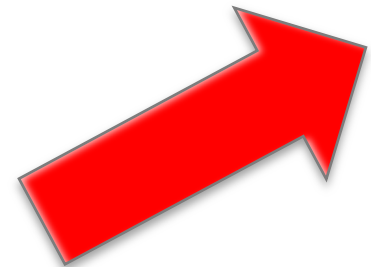
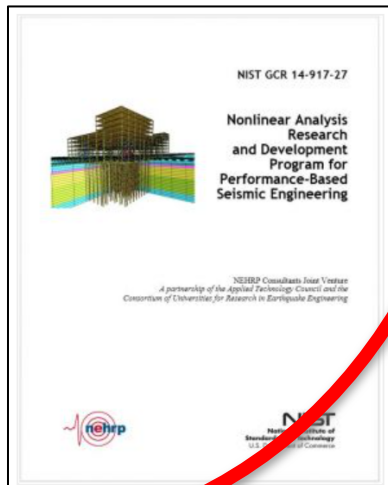
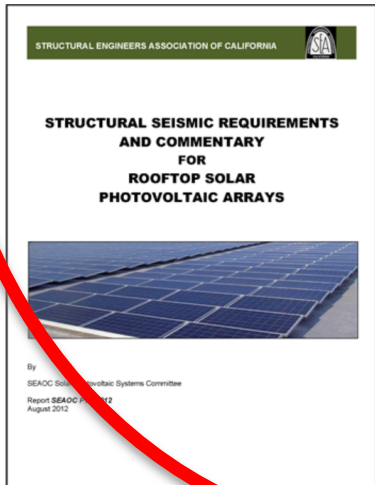
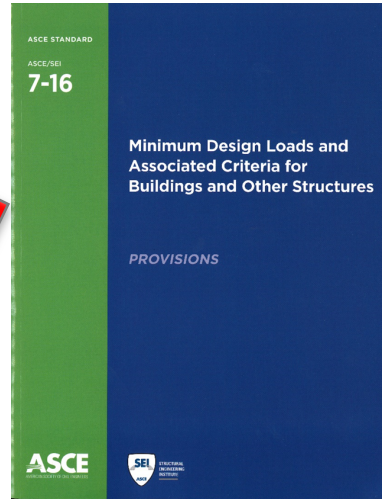
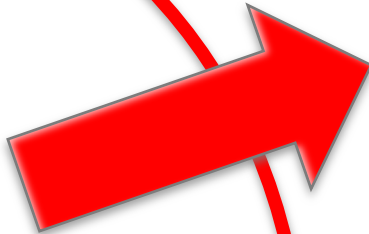
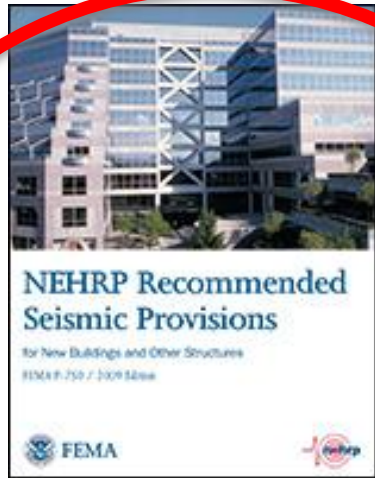


3 Years



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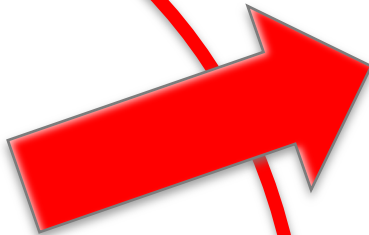
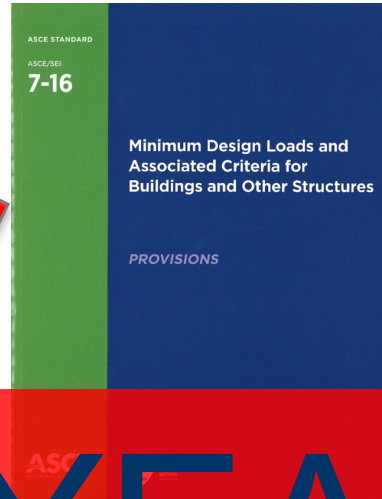
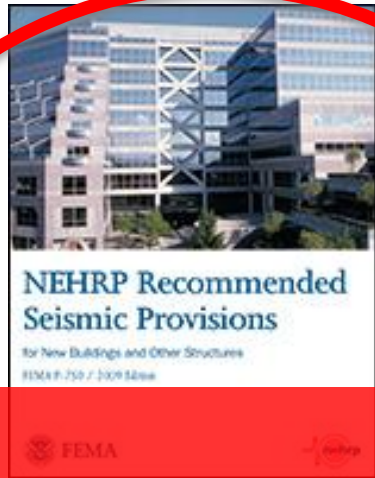
PATHS to FUNCTIONAL RECOVERY



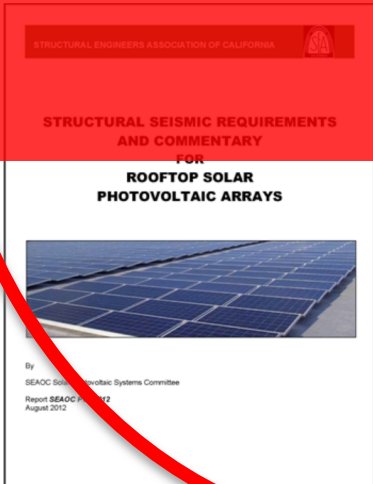


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10 YEARS!!!



THANK YOU

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