Project 17 Topic
Deterministic Caps on MCE₉

C. B. Crouse

2016 BSSC Colloquium
Sect. 21.2.1: Probabilistic $\text{MCE}_R \rightarrow S_a^{\text{Prob}}$

Sect. 21.2.2: Deterministic $\text{MCE}_R \rightarrow S_a^{\text{Det}}$

Sect. 21.2.3: Site-Specific $\text{MCE}_R$

$S_{aM}(T) = \min[S_a^{\text{Prob}}(T), S_a^{\text{Det}}(T)]$
Reason for Deterministic Caps

- Probabilistic $\text{MCE}_R$ are too high near highly active faults

Consequence of using Deterministic Cap
- Collapse risk ↑
Deterministic MCE\(_R\)

1. Identify Controlling Faults
2. Postulate \(M_{\text{MAX}}\) for each Fault
3. Use same GMPE’s & weights in PSHA

\[84^{\text{th}} \text{ Percentile } S_a(T)\]

Increase \(S_a(T)\) for Dir. Max. motion
Selection on $M_{\text{MAX}}$ ("Characteristic Earthquake")
San Andreas Fault

- **Likely**: $M 7.8$ (1857)
- **Less Likely?**: $M 8$ (1525?)
- **Highly Unlikely**: $M 8.5$ (??)

Source: Time Life Books
Example: $M_{\text{MAX}}$ for San Andreas Fault

- $M_{\text{MAX}} =$ weighted average $M_{\text{MAX}}$ for each fault-rupture scenario
- Worst case
- Something else
Uncertainty in $M_{\text{MAX}}$ for Given Rupture Scenario

Source: Hanks & Bakun (2008)
Deterministic MCE$_R$

Use Envelop $S_a$

Local Fault

San Andreas Fault

$S_a$

$T$
Deterministic MCE$_R$

- Local Fault
- Deterministic Lower Limit
  (Sect. 21.2.2, Fig. 21.2.1)
- SAF

$S_a$ vs. $T$
Deterministic $MCE_R$ Calculation for Sites Close to Active Faults

Strike Slip

Normal or Reverse

Hanging Wall

Footwall
Directivity

Example: Strike-Slip Fault

Forward Directivity

Backward Directivity

Rupture Direction

Epic.
1992 Landers, CA M 7.3 Earthquake

Sommerville et al. (1997)
Lucerne Record, 1992 Landers Earthquake

Fault Normal (FN)

699.62 cm/(s^2)

136.04 cm/s

229.77 cm

Fault Parallel (FP)

783.89 cm/(s^2)

70.26 cm/s

183.79 cm

Sommerville et al. (1997)
Lucerne Response Spectra

M=7.3, Landers 92
R=1.1 km

Spectral Displacement (cm)

Period (sec)

Sommerville et al. (1997)
Deterministic caps may be eliminated if:

- **Target risk ↑**

  Effectively return period on ground motion ↓
  
  e.g. 2,500 years → ~1,000–1,500 years

- **Current 1% in 50 yr target collapse risk is required everywhere**

  Higher design $S_a(T)$ near highly active faults