Origins of the Lee Lecture and Reflections on Professor Lee

Jonathan P. Stewart, PhD, PE, NAE

UCLA Samueli Engineering

UCLA Samueli School of Engineering

GEO-INSTITUTE
Los Angeles Chapter

ASCE Geo-Institute Los Angeles
Queen Mary
May 7, 2026

Establishment of the Lee Lecture…

Motivation:

- Enhance prestige of Spring Seminar
- Honor a pioneer in our field & raise awareness of his contributions to Geotechnical Engineering
- Similar lectures: Casagrande Lecture (Boston), Martin Kapp Lecture (NYC), Buchanan Lecture (Texas A&M)

Establishment of the Lee Lecture…

Motivation

Vision:

- “The Kenneth L. Lee Lecture will be presented annually at the Geotechnical Group’s Spring Seminar by a noted geotechnical professional who has made significant contributions either to Geotechnical Engineering practice in southern California or to research associated with the design of earth structures or Geotechnical Earthquake Engineering”

Establishment of the Lee Lecture…

Motivation

Vision

Organizing committee (~ 2002 – May 2004):

- Anthony Augello, Golder
- Ed Kavazanjian, USC / Geosyntec
- Jasmina Matasovic
- Allen Yourman, Diaz-Yourman Associates
- Jon Stewart, UCLA

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Inaugural event May 5, 2004:

- Co-awardees: J. Michael Duncan, I.M. Idriss

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Inaugural event May 5, 2004:

- Co-awardees: J. Michael Duncan, I.M. Idriss
- Attended by Lee family members

Establishment of the Lee Lecture…

Motivation

Vision

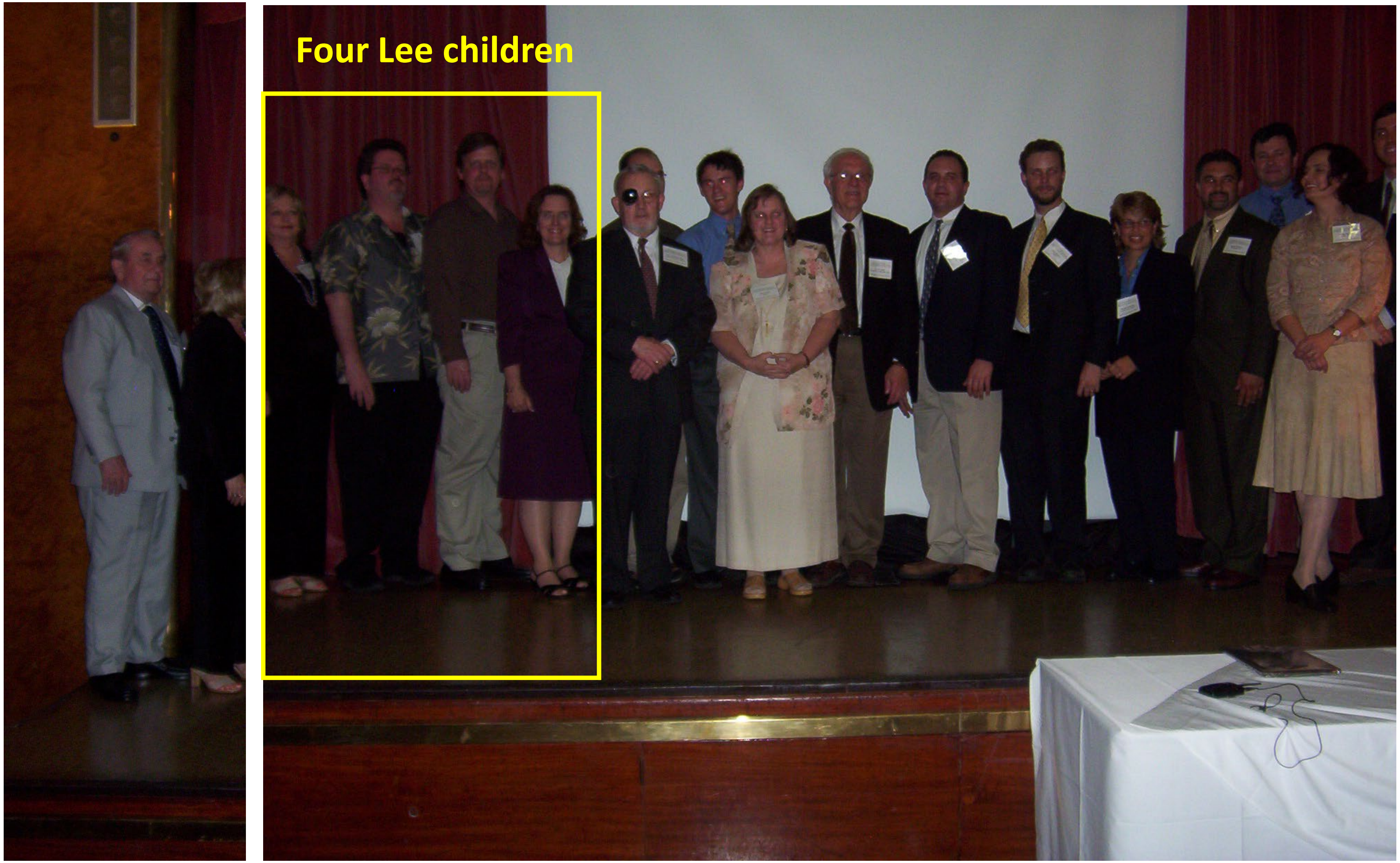
Organizing committee

Inaugural event May 5, 2004:

- Co-awardees: J. Michael Duncan, I.M. Idriss
- Attended by Lee family members
- … and former students

Allen Yourman


John Lee
(brother)



Four Lee children

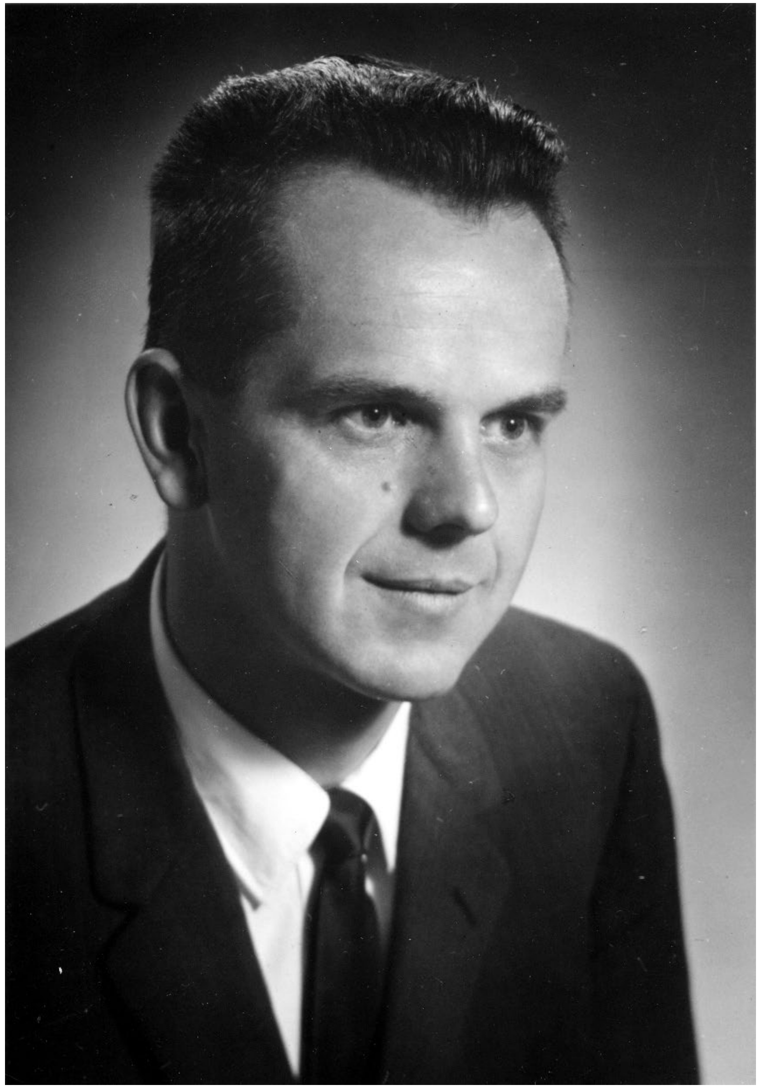
Three Lee grandchildren

Board Members: Augello, Hudson, D’Antonio, Kempton, Hadj-Hamou, Matasovic

Kenneth L. Lee

Biographical information:

- Born 1931, Albert Canada
- BS (1955), MS (1958) U. Alberta
- Soil Engineer in Canada, 1958-1961
- PhD UCB (1965), Advisor HB Seed
- UCLA faculty, 1964-1978
- Died in skiing accident, 3/1978



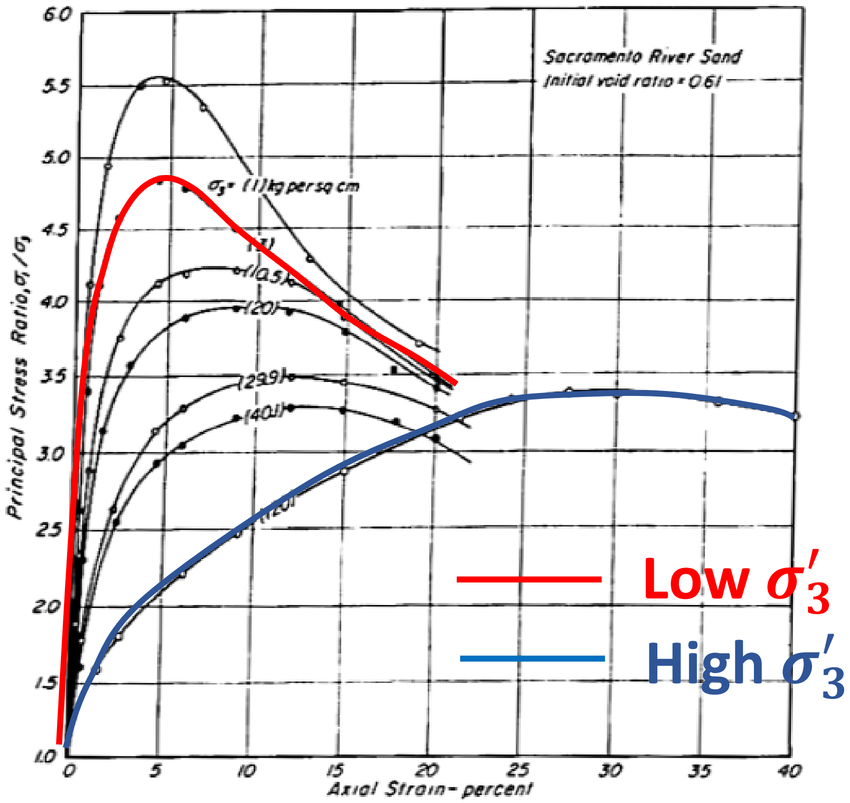
Kenneth L. Lee

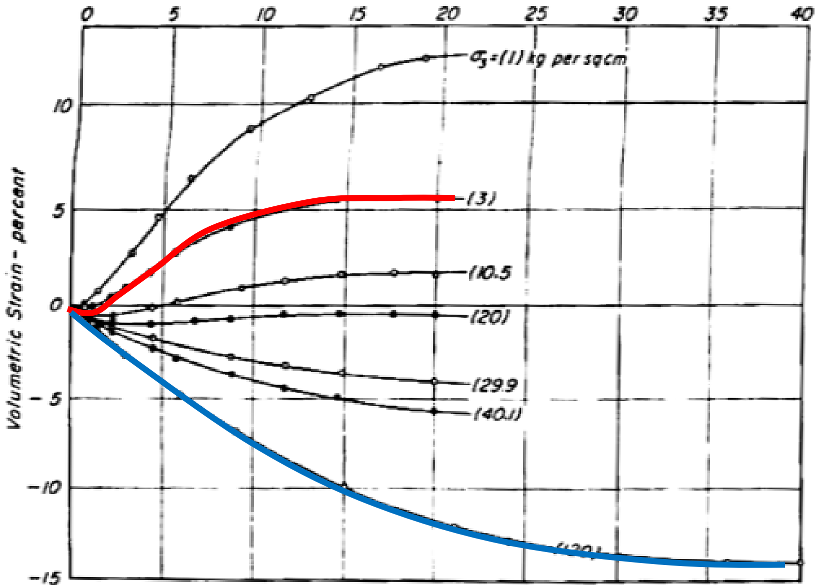
Biographical information

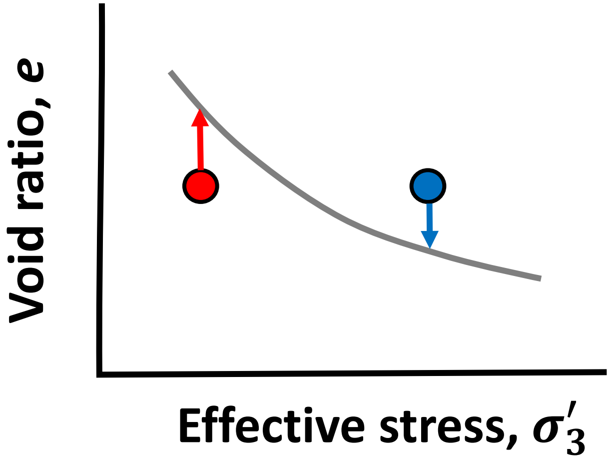
Technical contributions

- Dilatancy effects on drained behavior of sands

Dense sands







Lee and Seed, 1967

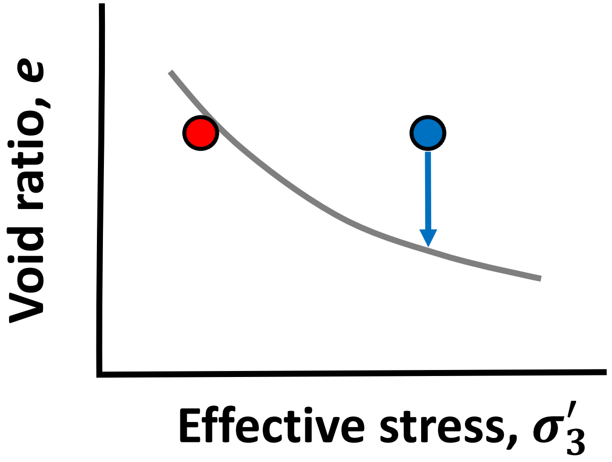
Kenneth L. Lee

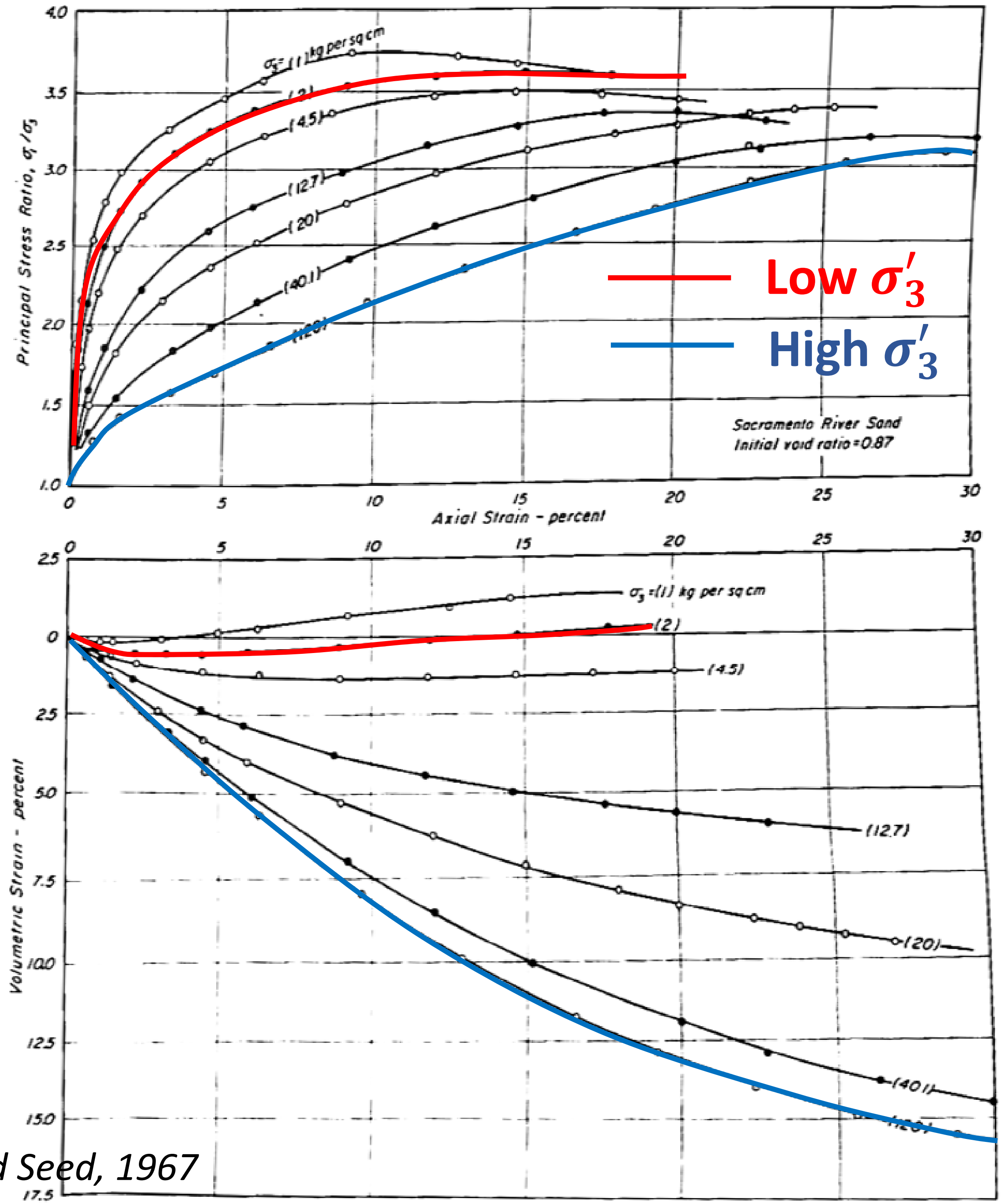
Biographical information

Technical contributions

- Dilatancy effects on drained behavior of sands

Loose sands





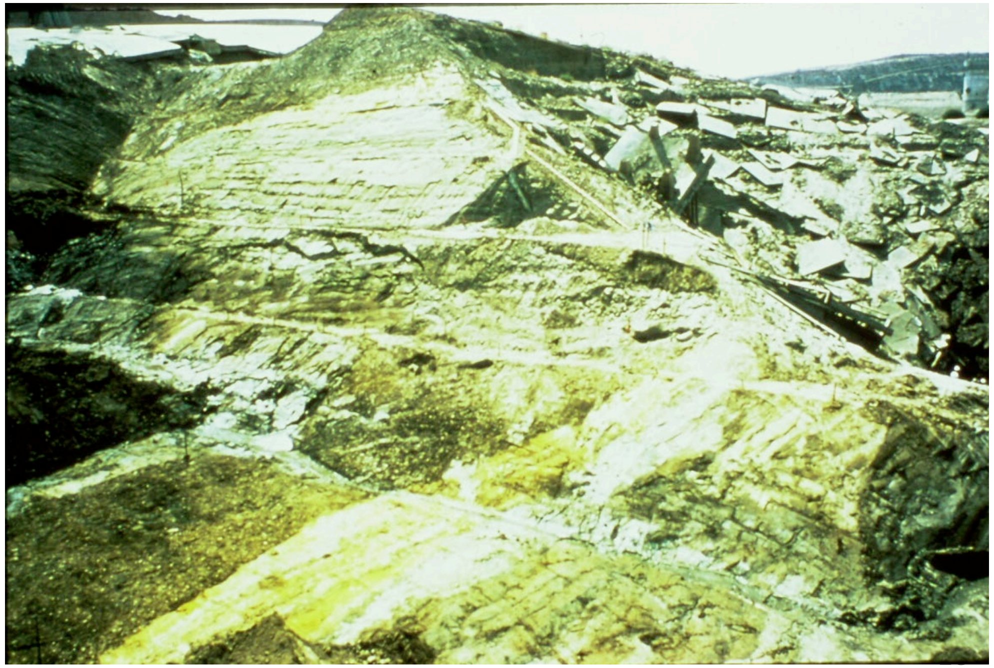
Lee and Seed, 1967

Kenneth L. Lee

Biographical information

Technical contributions

- Dilatancy effects on drained behavior of sands
- Investigation of Lower San Fernando Dam (1971-1973); co-lead with Seed of blue ribbon investigation panel



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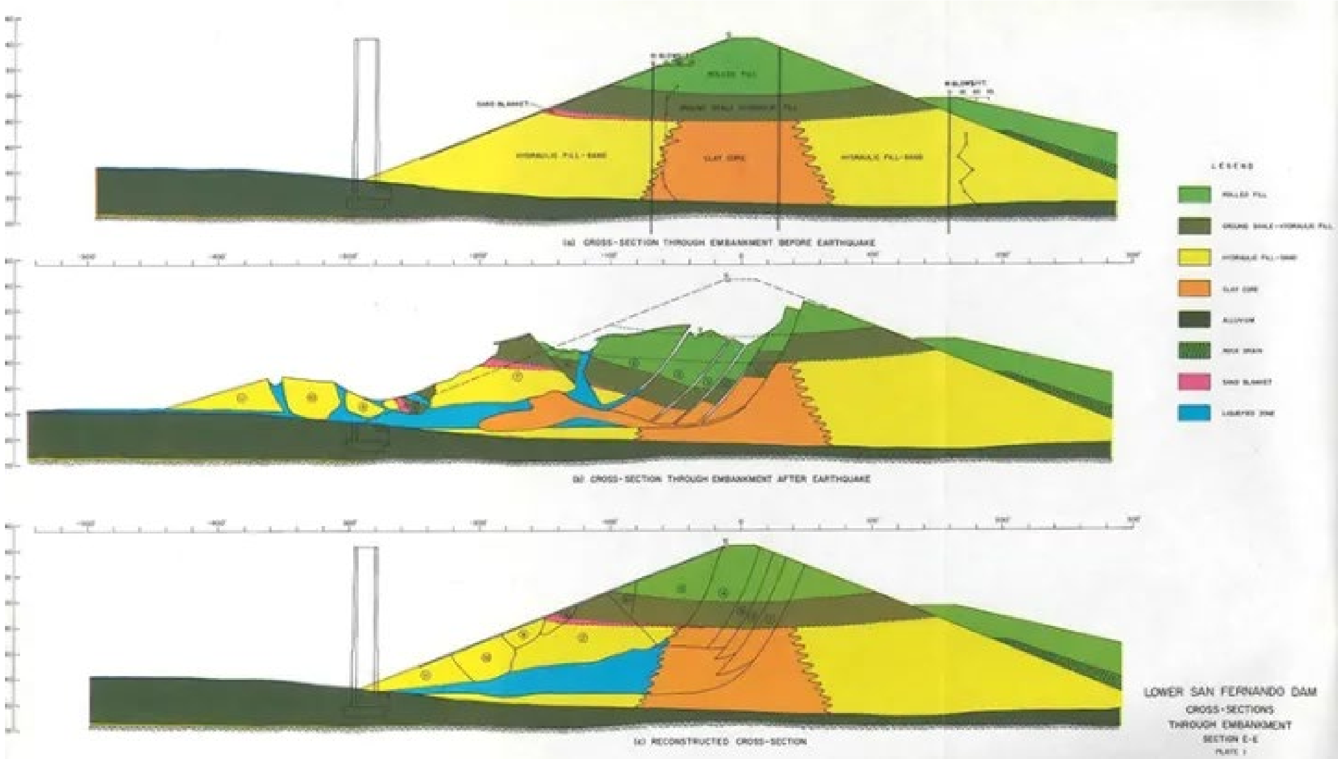


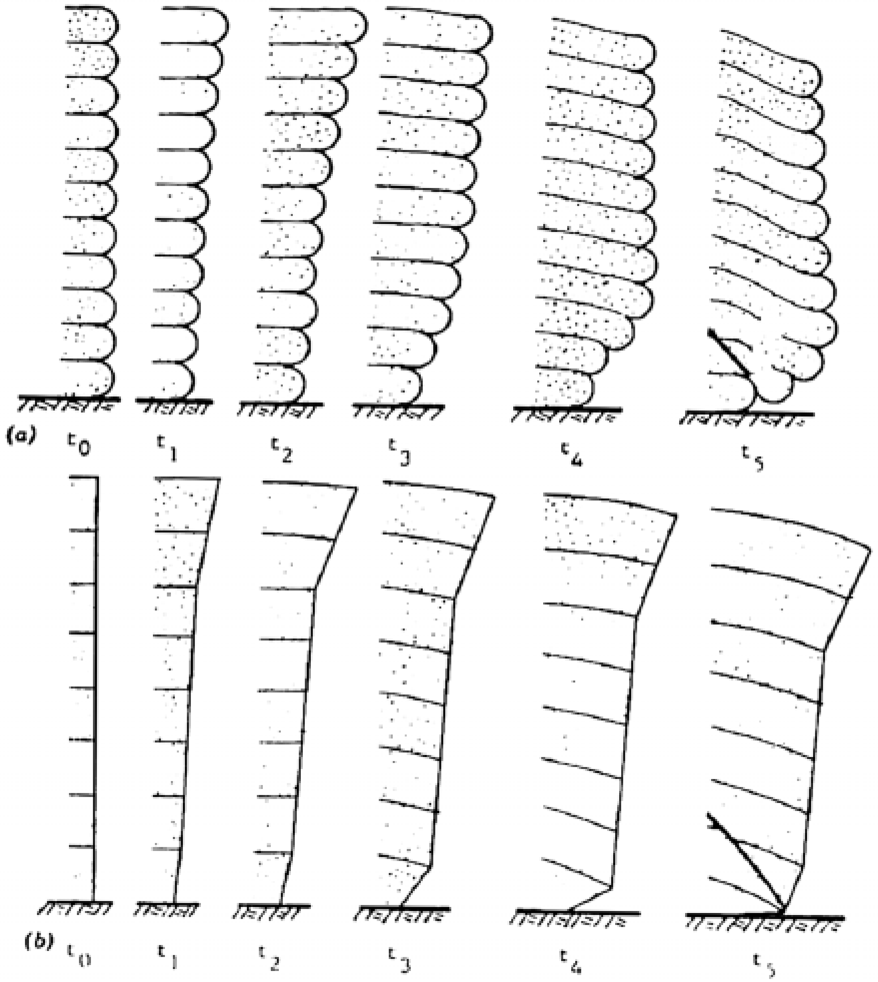
Seed et al., 1973

Kenneth L. Lee

Biographical information

Technical contributions

- Dilatancy effects on drained behavior of sands
- Investigation of Lower San Fernando Dam (1971-1973); co-lead with Seed of blue ribbon investigation panel
- Seismic design of reinforced soil walls



Tie breakage

Tie pullout

Richardson and Lee, 1975

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

- Norman Medal (1968, 1977)
- Huber Prize (1970)
- Collingwood Prize (1970)
- Middlebrooks Award (1971)
- James R. Croes Medal (1978)

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

Notable students

Ron Chaney, PhD, Humboldt State University

Claud Corvino, Nichols Consulting

Dan Feger, Burbank Airport Authority

Jean Hill, PhD, URS

Boris Korin, RT Frankian and Associates

Marshall Lew, PhD, Leroy Crandall and Associates

Bart Patton, Kleinfelder

Greg Richardson, PhD, Richardson and Associates

Wolfgang Roth, Postdoc, URS

Jean Marie Vagernon, PhD, France

Fernando Valenzuela, PhD Candidate, Chile

James Weaver, Geomatrix

Bill Wolfe, PhD, Ohio State University

Allen Yourman, Diaz-Yourman and Associates

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Major awards

Notable students

Quotes compiled by J.M. Duncan (2004)

I continued on at UCLA with the intent to get an MS in structural engineering. One day Ken came up to me in the hallway and asked if I had considered going into geotechnical engineering. I decided that he was just so enthusiastic that he thought almost everybody should be a geotechnical engineer.

\- Steve Haley

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

Notable students

Quotes compiled by J.M. Duncan (2004)

> *Other faculty members told me that they could always hear when Ken was in the classroom next door, because they could hear the students laughing at his jokes and stories.*
>
> \- Poul Lade

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

Notable students

Quotes compiled by J.M. Duncan (2004)

He wrote papers that you could understand……He taught me how to write.

- Ron Chaney

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

Notable students

Quotes compiled by J.M. Duncan (2004)

I can truthfully say that I never heard him speak ill of anyone.

- Jim Mitchell

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

Notable students

Quotes compiled by J.M. Duncan (2004)

The world is a better place for Ken having been here. He contributed enormously to our welfare and he will be missed by all.

- H Bolton Seed

Kenneth L. Lee

Biographical information

Technical contributions

Major awards

Notable students

Quotes compiled by J.M. Duncan (2004)

The best possible use of life is to spend it for something that outlasts it.

- Ken Lee

20th Kenneth L. Lee Lecture

Integration of Non-Ergodic Site Response into NEHRP Provisions & ASCE-7

Jonathan P. Stewart, PhD, PE, NAE

UCLA Samueli Engineering (& PUC Member)

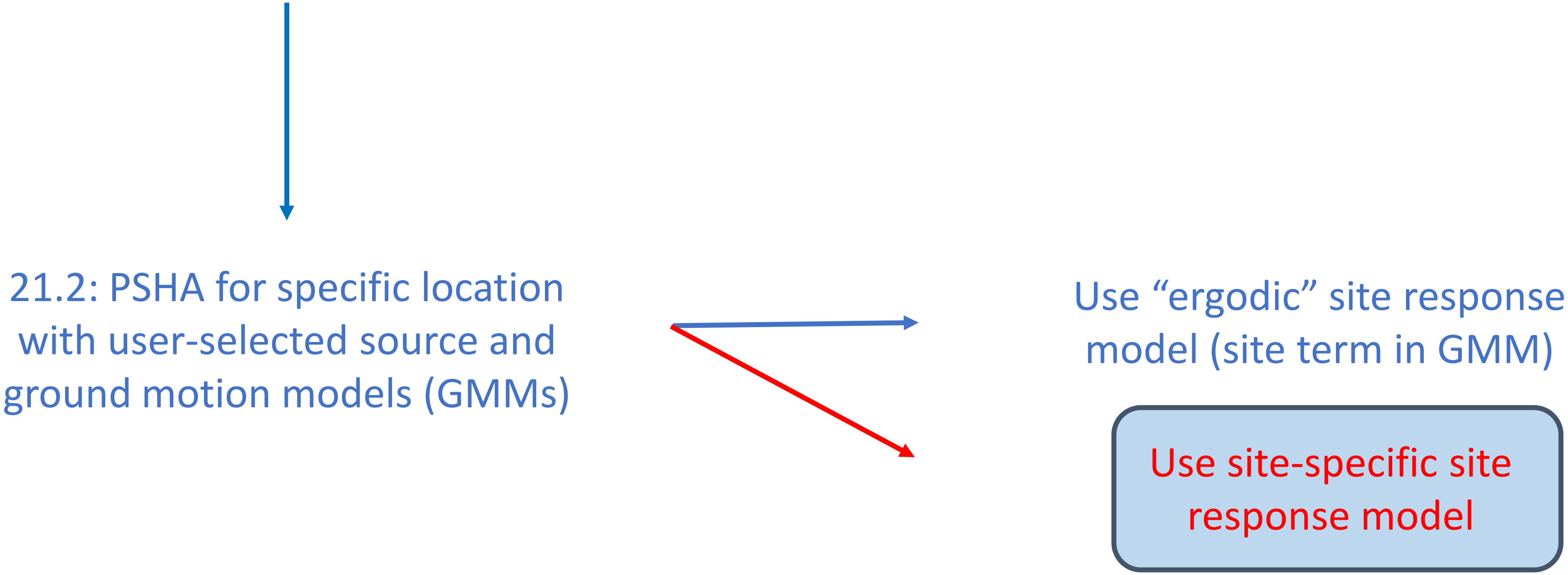
Building Seismic
Safety Council

GEO-
INSTITUTE
Los Angeles
Chapter

ASCE Geo-Institute Los Angeles
Queen Mary
May 7, 2026

Site Response in the NEHRP Provisions

- Chapter 21: Site-specific ground motion procedures



21.2: PSHA for specific location with user-selected source and ground motion models (GMMs)

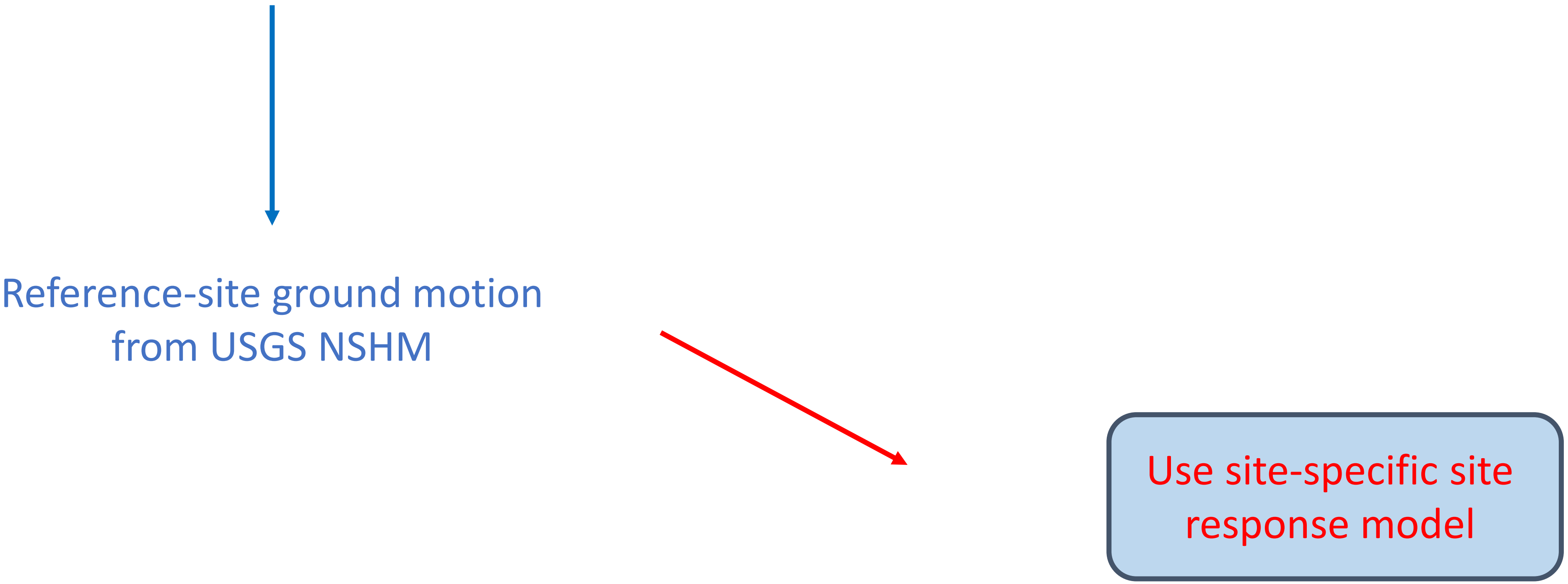
Use “ergodic” site response model (site term in GMM)

Use site-specific site response model

Section 21.1

Site Response in the NEHRP Provisions

- Chapter 21: Site-specific ground motion procedures



Reference-site ground motion
from USGS NSHM

Use site-specific site
response model

Section 21.1

IT3 / Sub-Issue Team 5

CB Crouse, AECOM, former PUC member

Gyimah Kasali, Rutherford and Chekeyne, PUC member

Debra Murphy, Slate, PUC member

Andrew Makdisi, USGS, PUC liaison

Silvia Mazzoni, consultant, IT3 and ASCE7

Zia Zafir, Kleinfelder, IT3 and ASCE7

Shahram Pezeshk, U. Memphis

David Teague, Engeo

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Outline

Current procedures

Issues motivating new procedures

Site-specific site response approach

Hybrid ground motions approach

Other technical improvements

Organization and status of document

Outline

Current procedures

Issues motivating new procedures

Site-specific site response approach

Hybrid ground motions approach

Alternative approaches in 21.1

Other technical improvements

Organization and status of document

Outline

Current procedures

Issues motivating new procedures

Site-specific site response approach

Hybrid ground motions approach

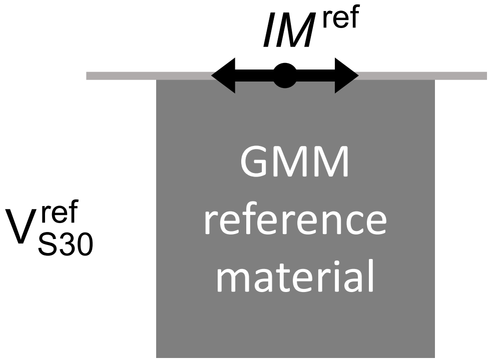
Other technical improvements

Organization and status of document

Current procedures

Base motion (21.1.1)

- Ground motion model reference motion

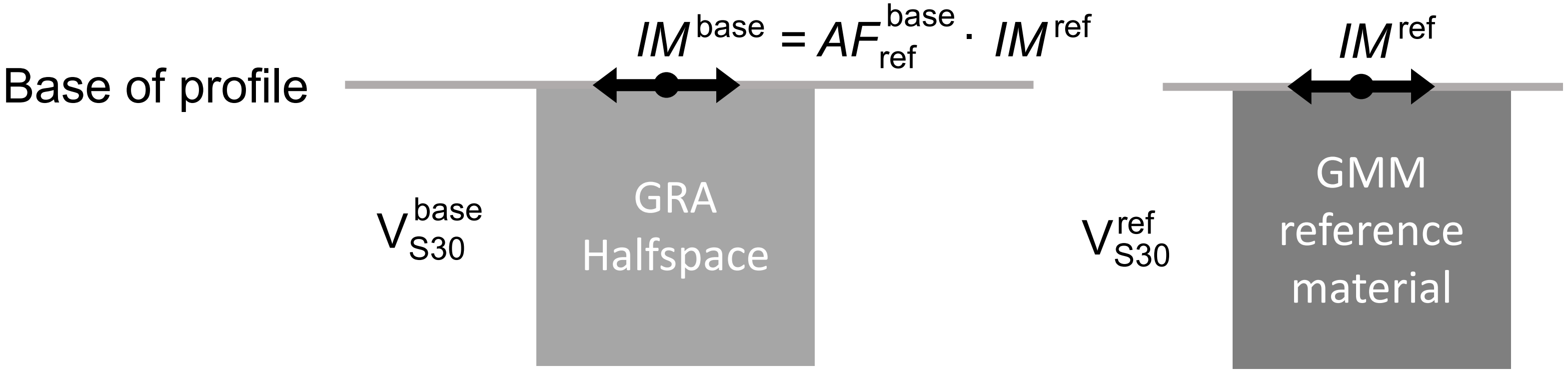


Kramer & Stewart 2025

Current procedures

Base motion (21.1.1)

- Ground motion model reference motion
- Base of profile



$$IM^{base} = AF_{ref}^{base} \cdot IM^{ref}$$

IM^{ref}

Base of profile

V_{S30}^{base}

GRA Halfspace

V_{S30}^{ref}

GMM reference material

Five time series selected for compatibility with IM^{base}

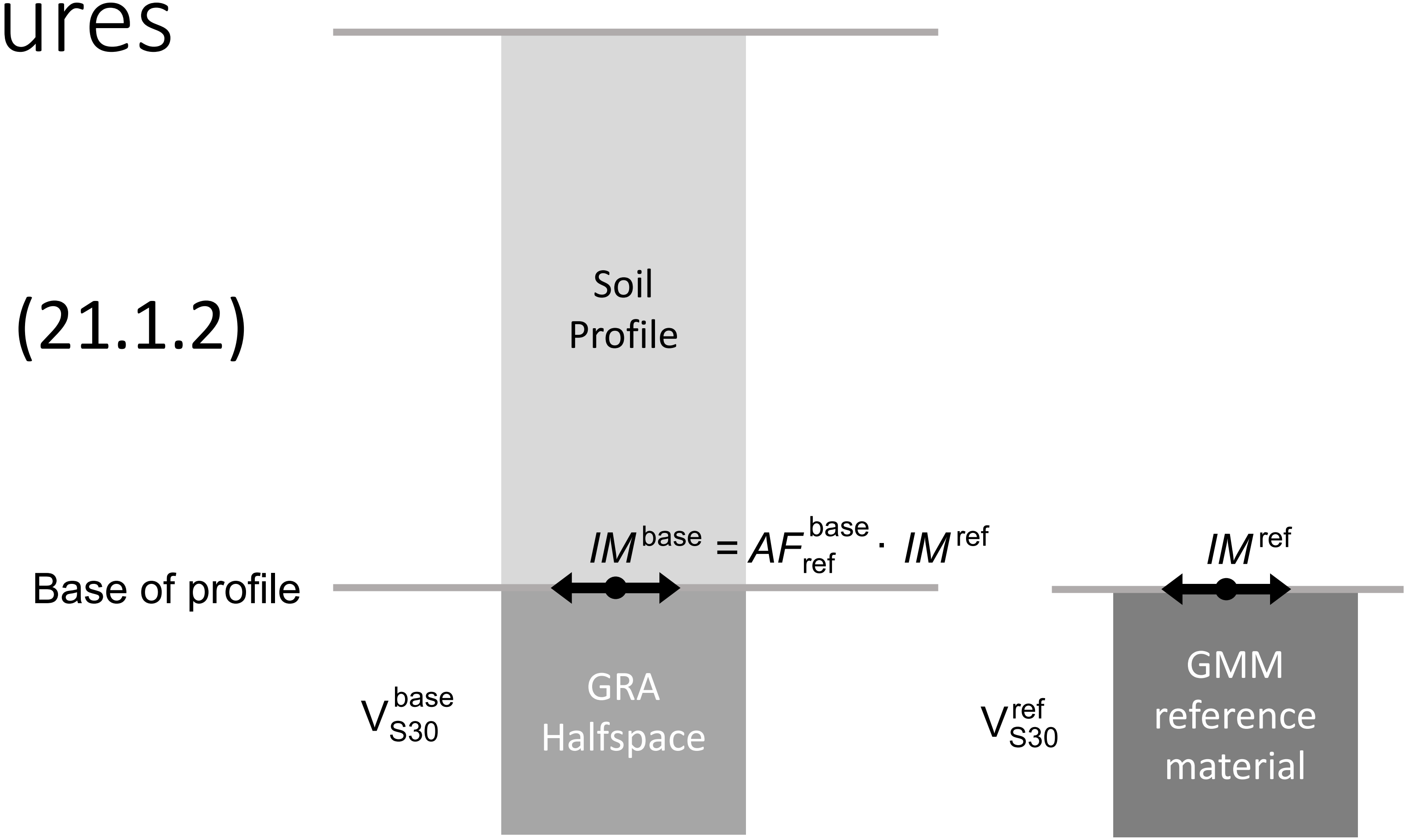
Kramer & Stewart 2025

Current procedures

Base motion (21.1.1)

Site condition model (21.1.2)

- V_S profile
- Nonlinear properties



Kramer & Stewart 2025

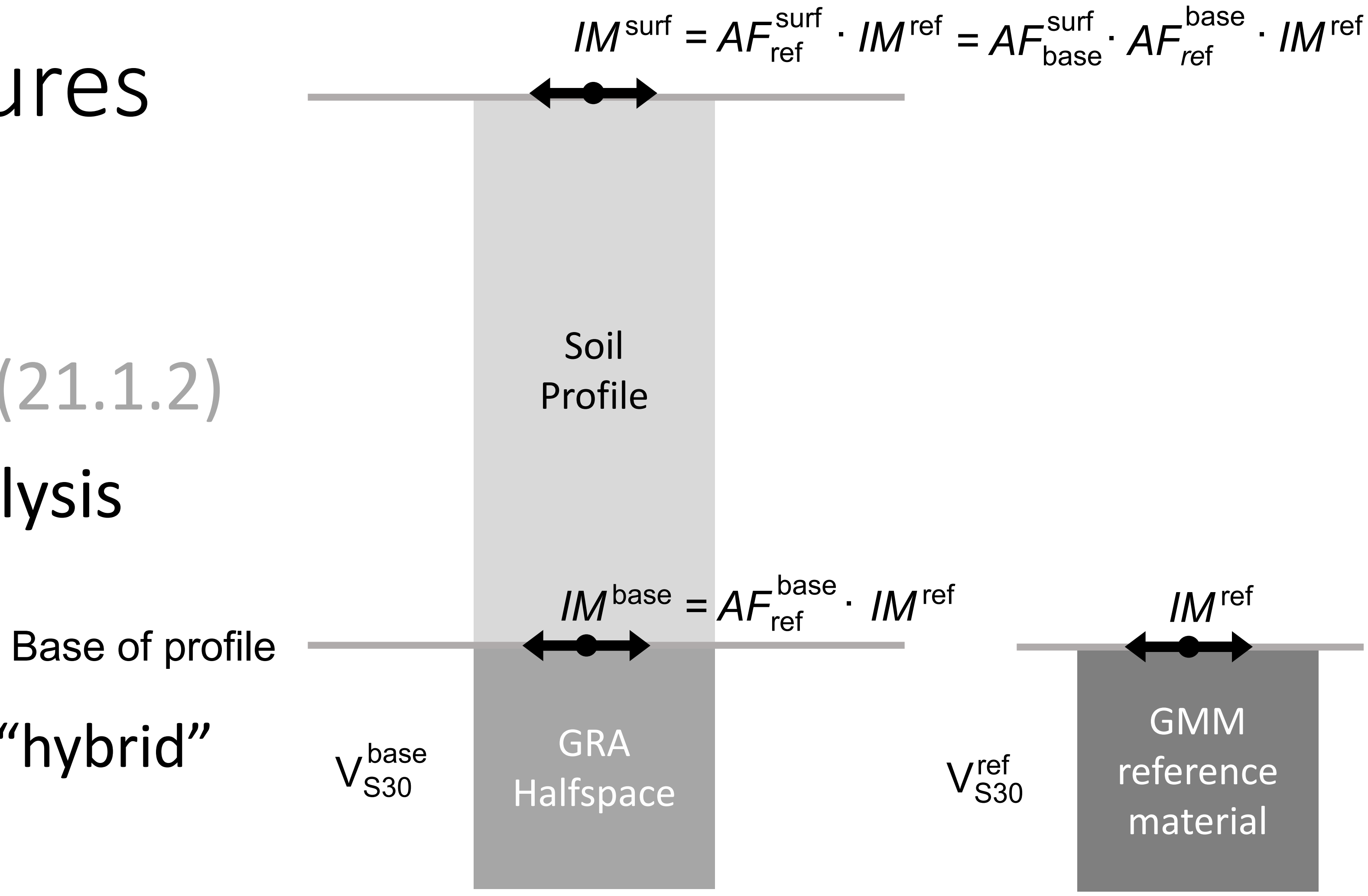
Current procedures

Base motion (21.1.1)

Site condition model (21.1.2)

Ground response analysis (21.1.3)

- NL or EQL analysis
- Computation of IM^{surf} (“hybrid” approach)
- Consider sensitivities



$IM^{surf} = AF^{surf}_{ref} \cdot IM^{ref} = AF^{surf}_{base} \cdot AF^{base}_{ref} \cdot IM^{ref}$

Soil Profile

$IM^{base} = AF^{base}_{ref} \cdot IM^{ref}$

Base of profile

V_{S30}^{base}

GRA Halfspace

IM^{ref}

V_{S30}^{ref}

GMM reference material

Kramer & Stewart 2025

Outline

Current procedures

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Other technical improvements

Organization and status of document

Issues motivating new procedures

Period limitation of ground response analysis (GRA)

Hazard (risk) level not preserved

Lack of guidance on non-ergodic site response

More to come

Issues motivating new procedures

Period limitation of GRA

Hazard (risk) level not preserved

Lack of guidance on non-ergodic site response

Content dated with respect to

- Site characterization

V_S, nonlinearity

Issues motivating new procedures

Period limitation of GRA

Hazard (risk) level not preserved

Lack of guidance on non-ergodic site response

Content dated with respect to

- Site characterization
- Analysis procedures

Liquefiable soils

Long periods

Current methods require input motion time series (thus precluding RVT)

Outline

Current procedures

Issues motivating new procedures

Site-specific site response approach

Hybrid ground motions approach

Other technical improvements

Organization and status of document

Site-specific approach

Functional definitions

Model elements

Implementation in hazard calculations

Example results

Allowable reductions

Site-specific approach: *Functional definitions*

Ergodic site response:

- Models developed from diverse (global) data set
- Conditioned on site parameters (e.g., V_{S30} and others)
- Used in National Seismic Hazard Model (NSHM)
- Preserves hazard levels, but application to specific site is accompanied by large uncertainty

Applies to Section 21.2

Site-specific approach: *Functional definitions*

Ergodic site response:

Site-specific, non-ergodic site response:

- Applicable to specific site, no site-to-site variability (ϕ_{S2S}=0)
- Model uncertainty treated as epistemic
- Merged with reference rock spectrum in relatively rigorous manner that preserves hazard level

Site-specific approach

Functional definitions

Model elements:

- **Mean model**
- **Aleatory variability**
- **Epistemic uncertainty**

Implementation in hazard calculations

Example results

Allowable reductions

Mean Site Response Model

$$\mu_{lnZ} = \underbrace{F_E + F_P}_{\text{Ergodic source \& path}} + \boxed{\mu_{lnAF}}$$

μ_{lnAF}: mean site amplification

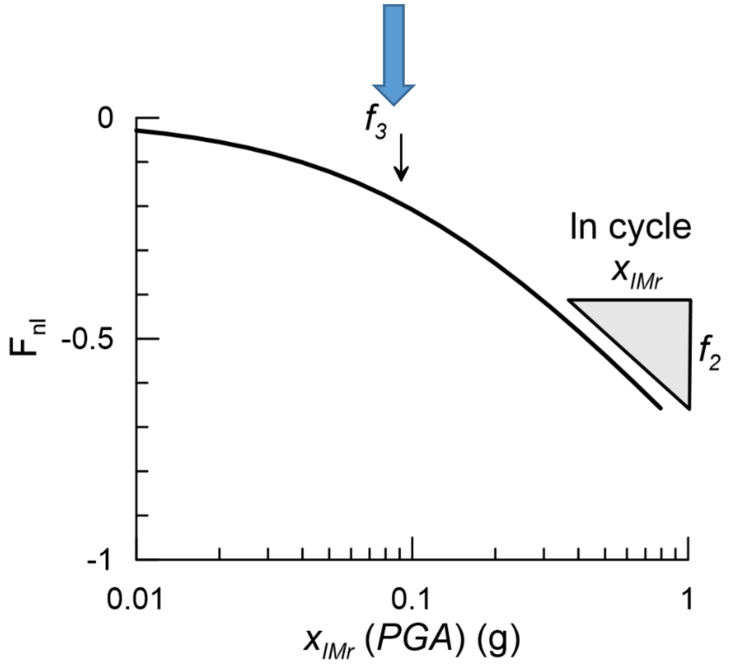
Mean Site Response Model

Function

$$\mu_{lnAF} = \underbrace{f_1}_{\boldsymbol{F_{lin}}} + \underbrace{f_2 ln\left(\frac{x_{IMr} + f_3}{f_3}\right)}_{\boldsymbol{F_{nl}}}$$

Can be derived from:

- Approach 1: Ground motion data
- Approach 2: Ground response analyses
- Combinations of 1 & 2



Aleatory Variability

GMM equation

$$\mu_{lnZ} = F_E + F_P + \mu_{lnAF}$$

Aleatory Variability

GMM equation

Residual terms

$$\underbrace{\mu_{lnZ}}_{\delta_{ij}} = \underbrace{F_E}_{\eta_{Ei}} + \underbrace{F_P + \mu_{lnAF}}_{\delta W_{ij}}$$

Aleatory Variability

GMM equation

$$\underbrace{\mu_{lnZ}}_{\delta_{ij}} = \underbrace{F_E}_{\eta_{Ei}} + \underbrace{F_P + \mu_{lnAF}}_{\delta W_{ij}}$$

Residual terms

δ_{ij} ⬇ σ_{ln}

η_{Ei} ⬇ τ_{ln}

δW_{ij} ⬇ ϕ_{ln}

Std. deviation terms

σ_{ln} τ_{ln} ϕ_{ln}

Aleatory Variability

GMM equation

$$\underbrace{\mu_{lnZ}}_{\delta_{ij}} = \underbrace{F_E}_{\eta_{Ei}} + \underbrace{F_P + \mu_{lnAF}}_{\delta W_{ij}}$$

Residual terms

δ_{ij} $\downarrow$ η_{Ei} $\downarrow$ δW_{ij} $\downarrow$

Std. deviation terms

σ_{ln} τ_{ln} ϕ_{ln}

$\downarrow$

~~Site-to-site variability, ϕ_{S2S}~~ ←

Null for site-specific, non-ergodic site response

Single-station variability, ϕ_{SS}

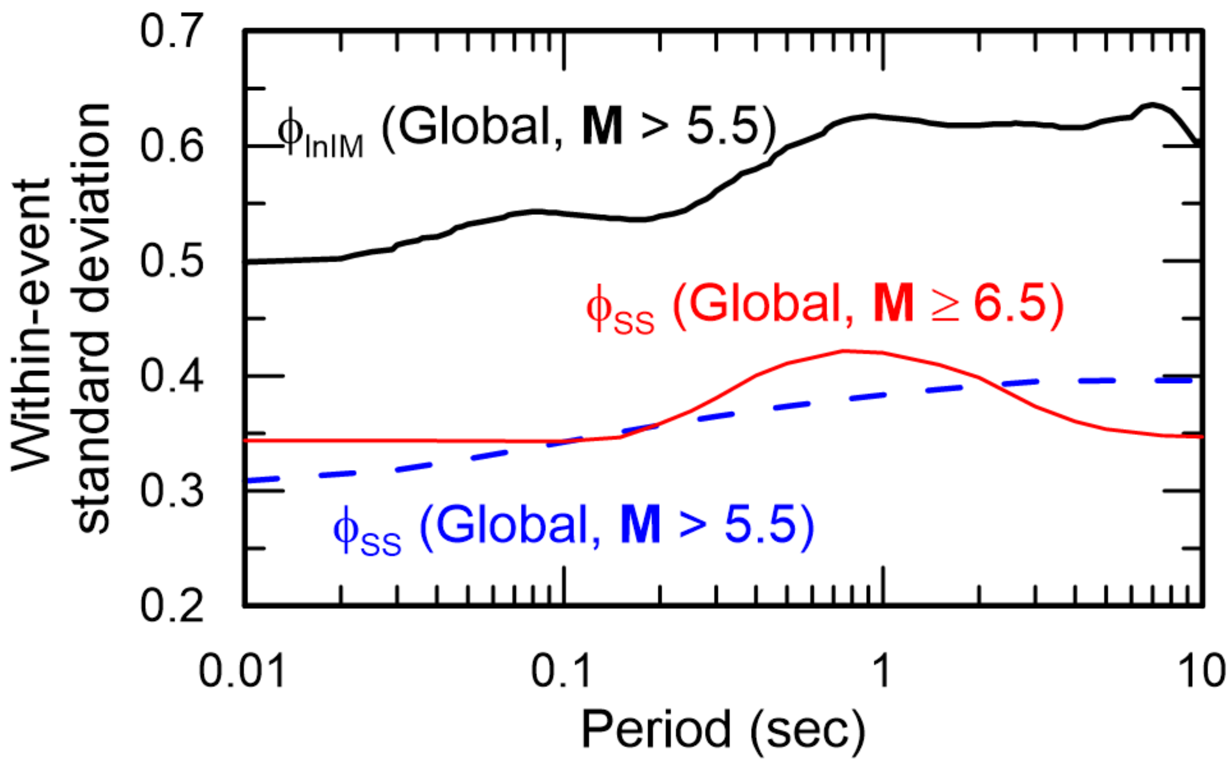
$$\sigma_{ln} = \sqrt{\tau_{ln}^2 + \phi_{SS}^2}$$

Aleatory Variability

GMM equation

Residual terms

Std. deviation terms



Kramer and Stewart, 2025

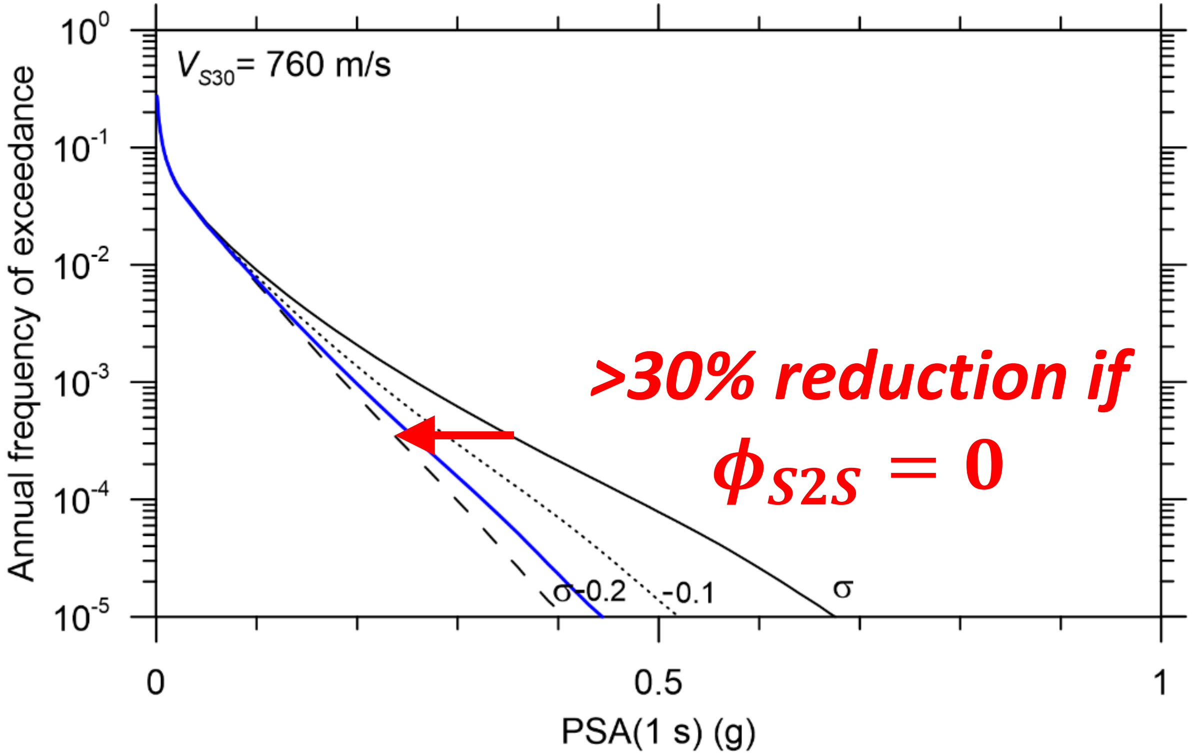
Aleatory Variability

GMM equation

Residual terms

Std. deviation terms

Effect of non-ergodic site response on hazard



>30% reduction if

$\phi_{S2S} = 0$

Site-specific approach

Functional definitions

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Example results

Allowable reductions

Hazard Analysis Implementation

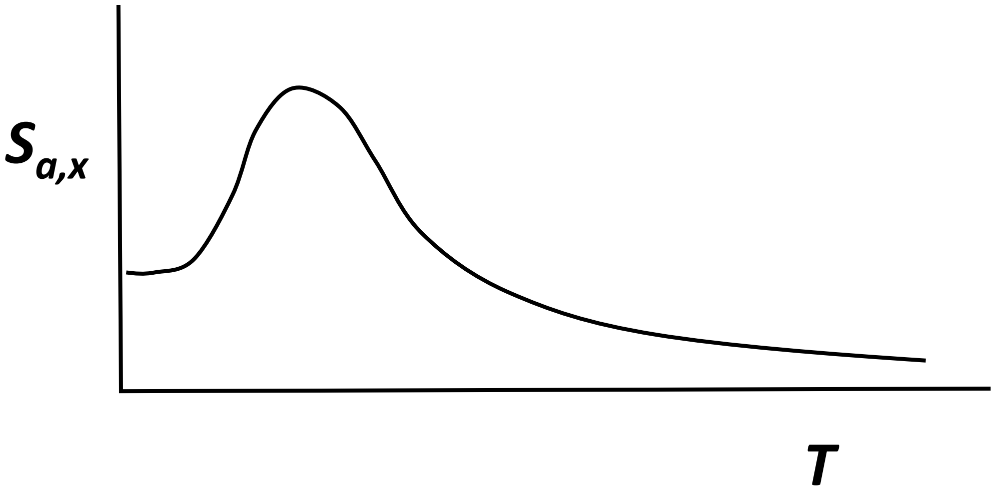
Hybrid: PSHA for reference site with deterministic site effect

PSHA with convolution

PSHA with modified GMM in hazard integral

Hybrid

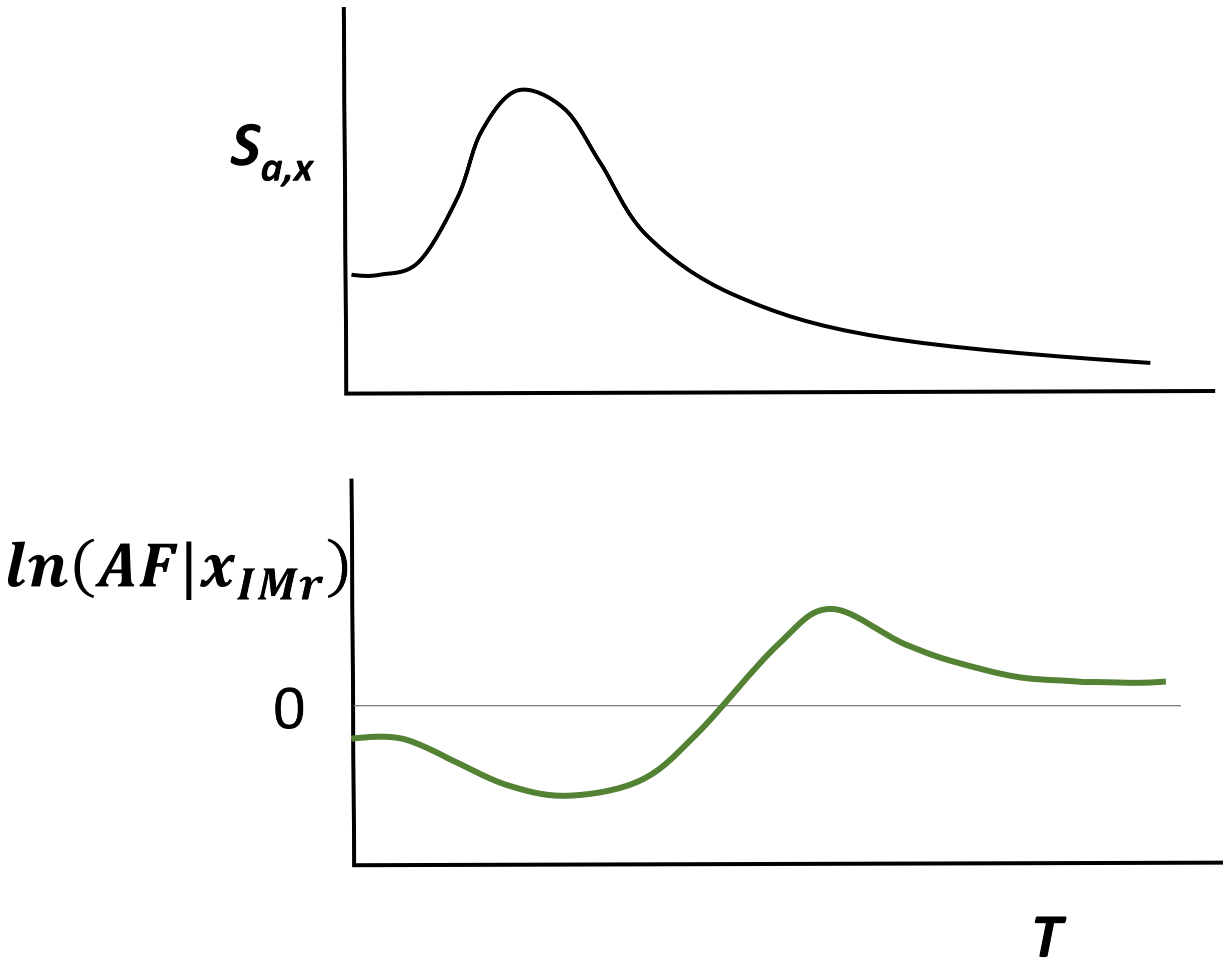
Develop reference site (*X*) hazard curves & UHS ordinates



Hybrid

Develop reference site (*X*) hazard curves & UHS ordinates

Develop period-dependent amplification (*AF*) corresponding to reference site ground motion



Hybrid

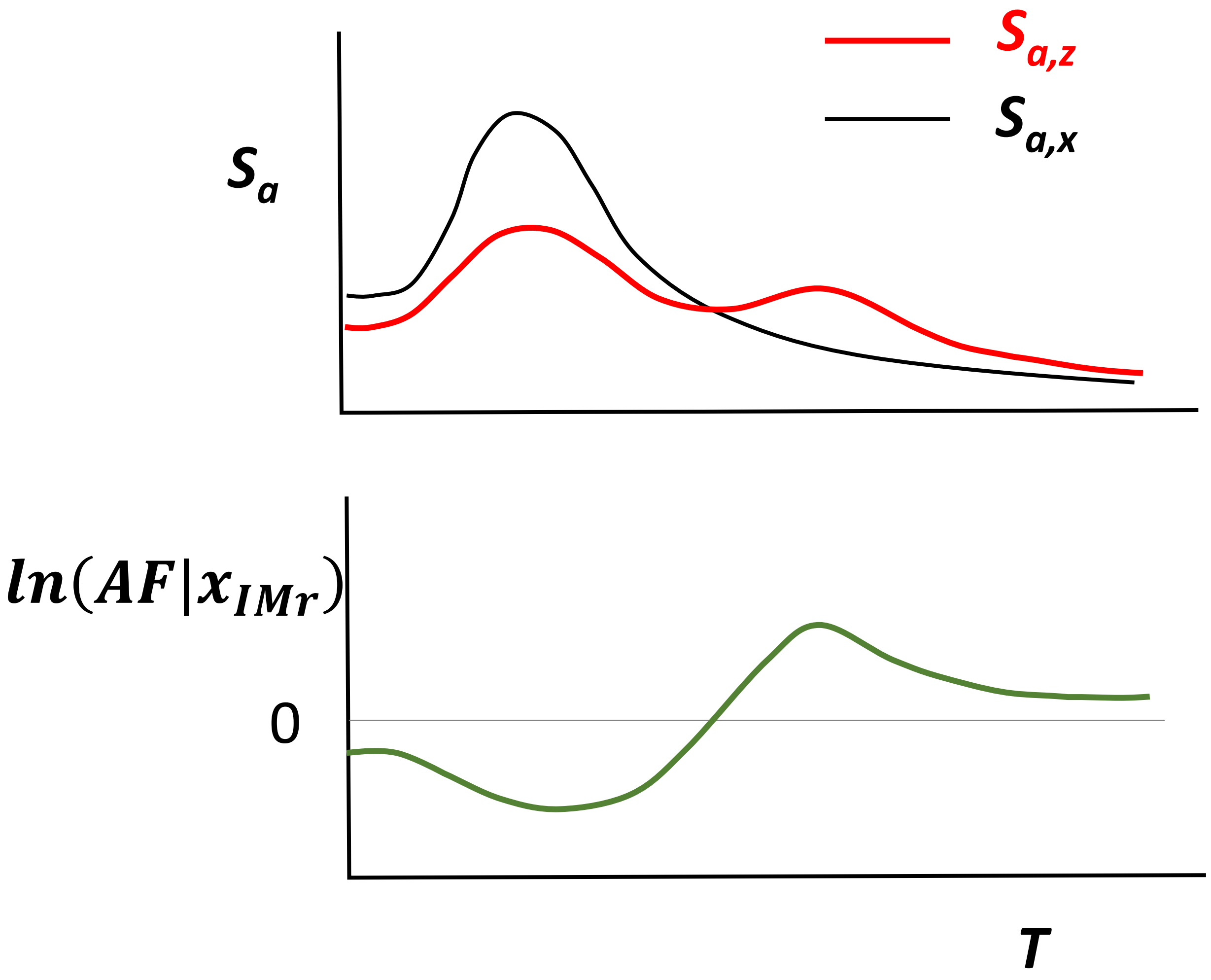
Develop reference site (*X*) hazard curves & UHS ordinates

Develop period-dependent amplification (*AF*) corresponding to reference site ground motion

Compute ground surface motion:

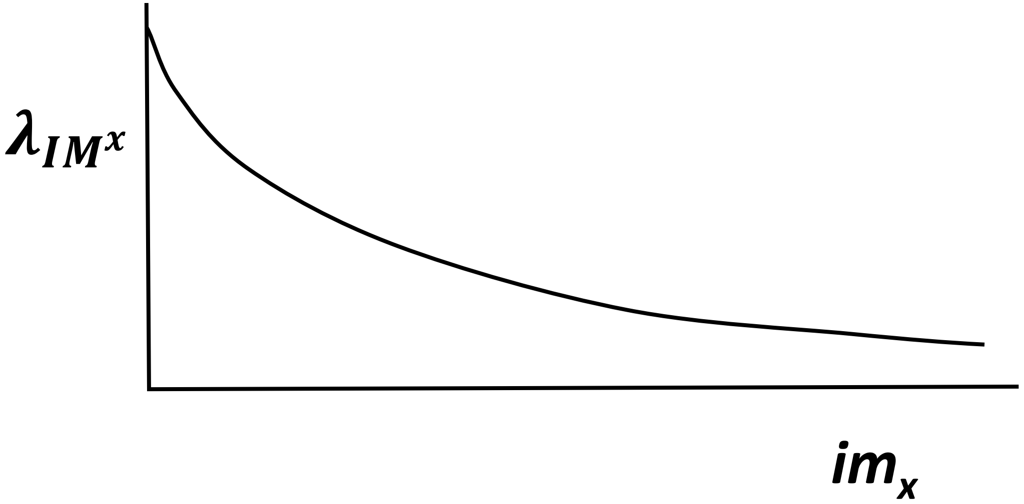
$$ln(S_{a,z}) = ln(S_{a,x}) + ln(AF|x_{IMr})$$

NRC Approach 2 (see also Cramer 2003)



Convolution

Develop reference site (*X*) hazard curves & UHS ordinates



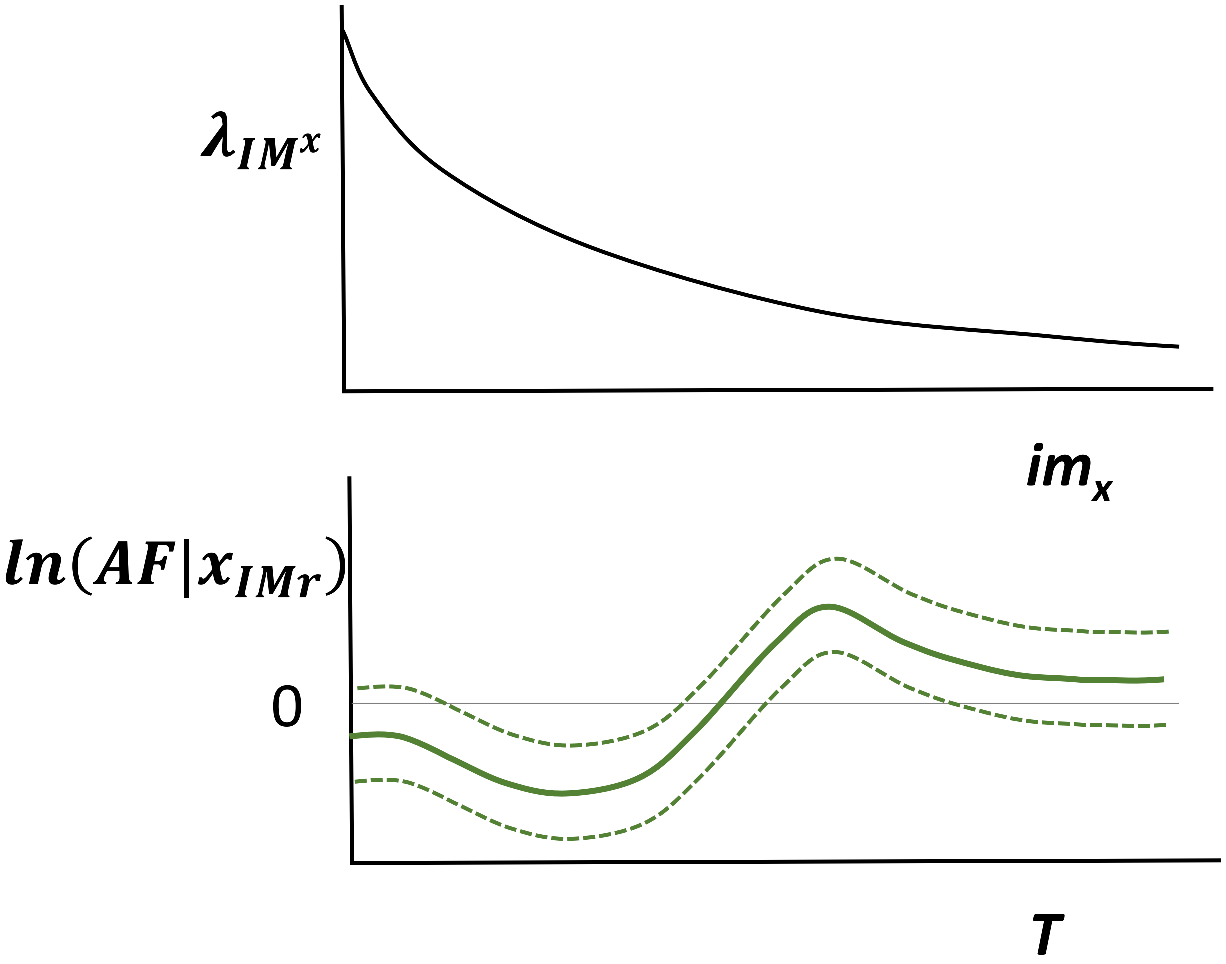
Convolution

Develop reference site (*X*) hazard curves & UHS ordinates

Develop x_{IMr}–dependent probabilistic amplification model:

$$\mu_{lnAF} = f_1 + f_2\left(\frac{x_{IMr} + f_3}{f_3}\right)$$

$$\phi_{lnAF}$$



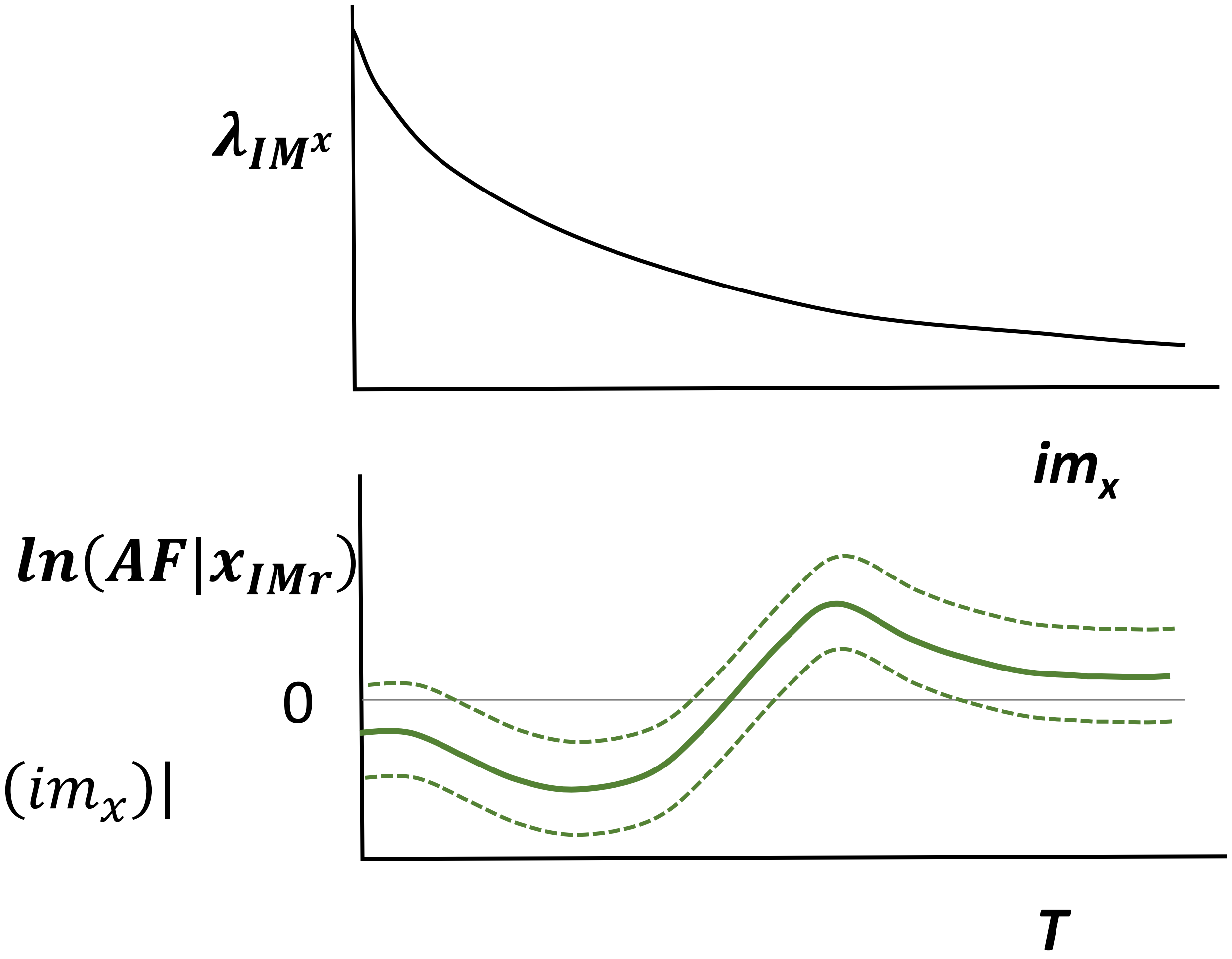
Convolution

Develop reference site (*X*) hazard curves & UHS ordinates

Develop x_{IMr}–dependent probabilistic amplification model

Convolve reference hazard with amplification model:

$$\lambda_{IM^z}(im_z) = \int_0^\infty P(IM_z > im_z | IM_X = im_x) |d\lambda_{IM^x}(im_x)|$$



Convolution

Develop reference site (*X*) hazard curves & UHS ordinates

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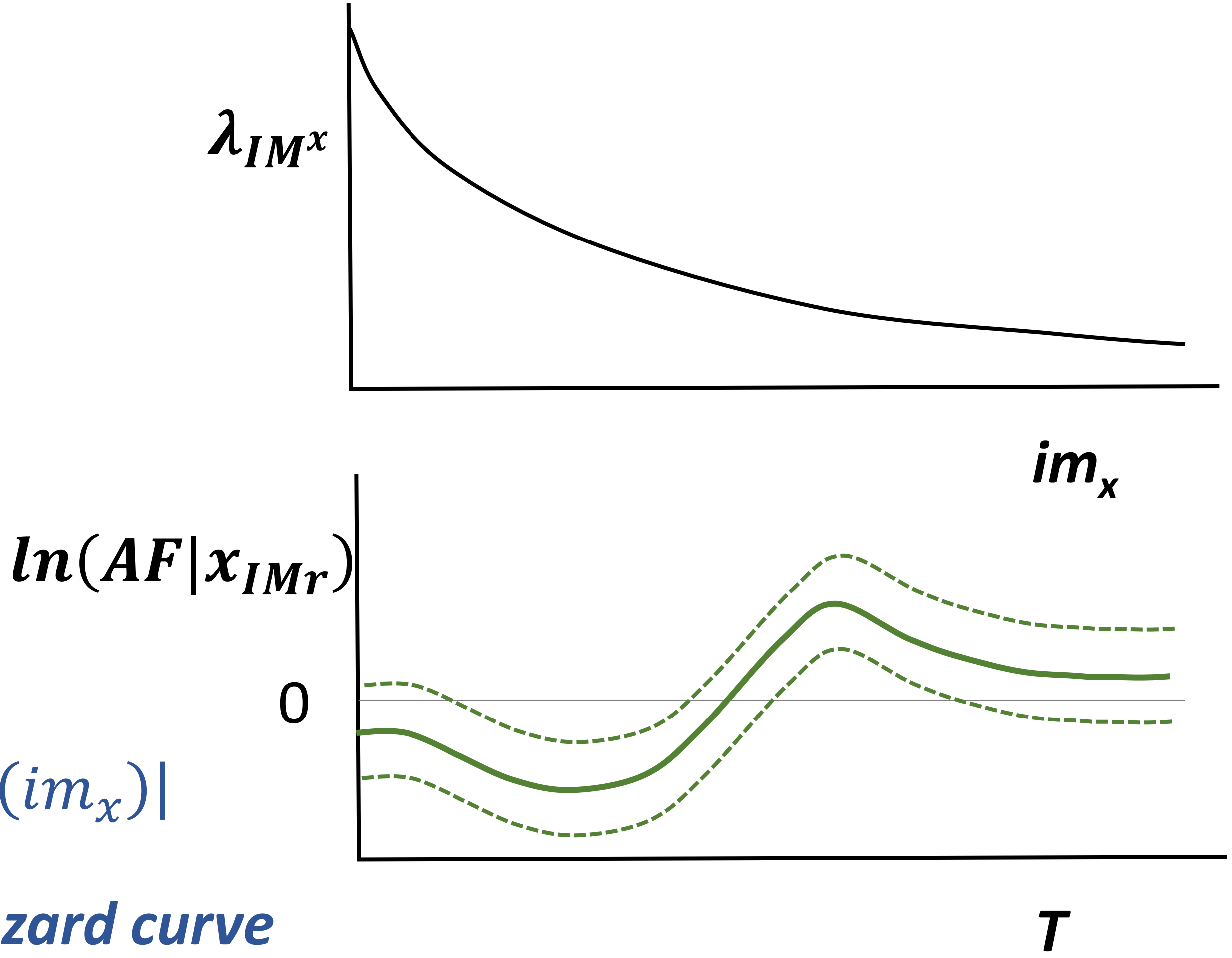
Convolve reference hazard with amplification model:

$$\lambda_{IM^z}(im_z) = \int_0^\infty P(IM_z > im_z | IM_X = im_x) |d\lambda_{IM^x}(im_x)|$$

Slope of hazard curve



Convolution

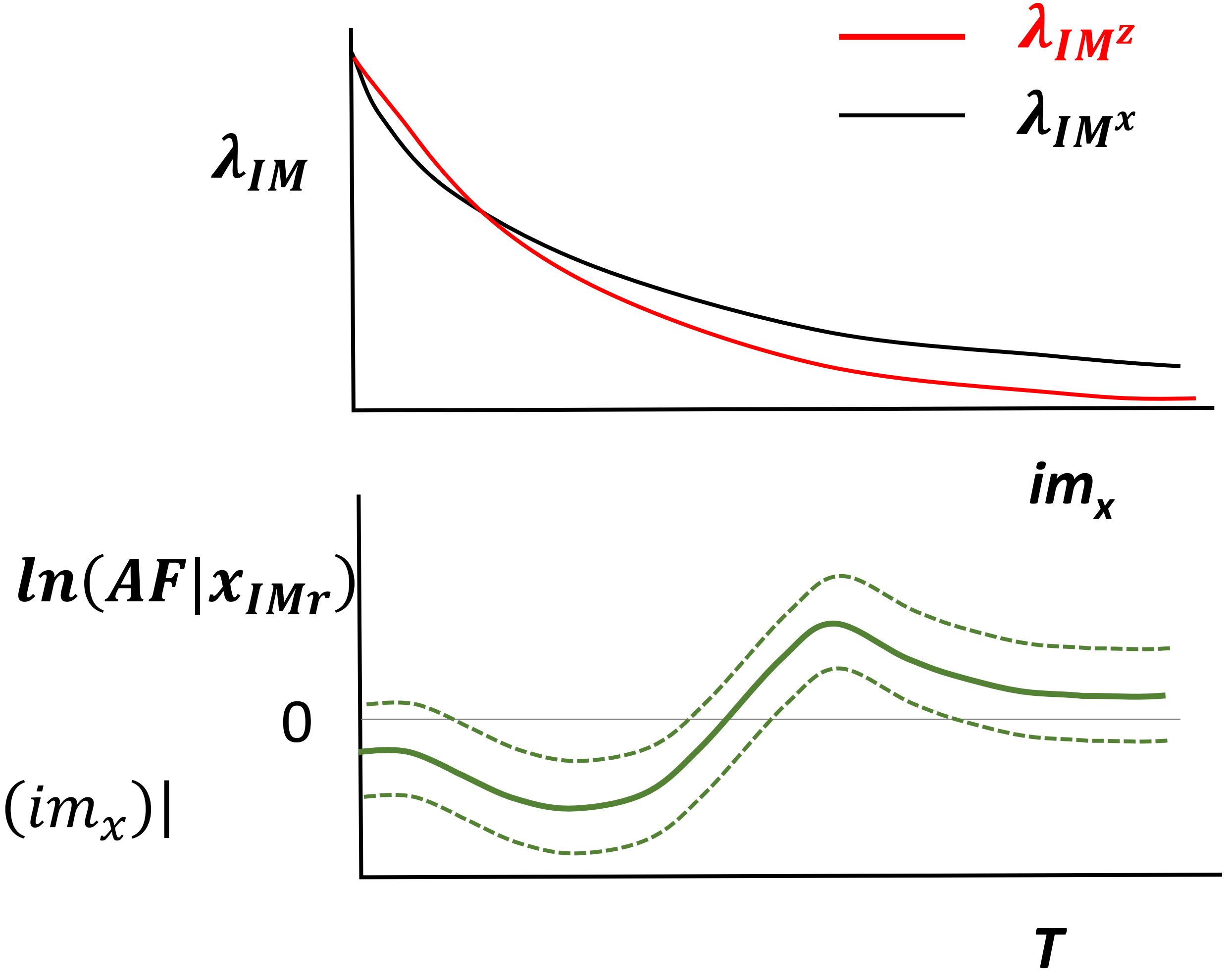
Develop reference site (X) hazard curves & UHS ordinates

Develop x_{IMr}–dependent probabilistic amplification model

Convolve reference hazard with amplification model:

$$\lambda_{IM^z}(im_z) = \int_0^\infty P(IM_z > im_z | IM_X = im_x) |d\lambda_{IM^x}(im_x)|$$

Probability computed using amplification function



Convolution

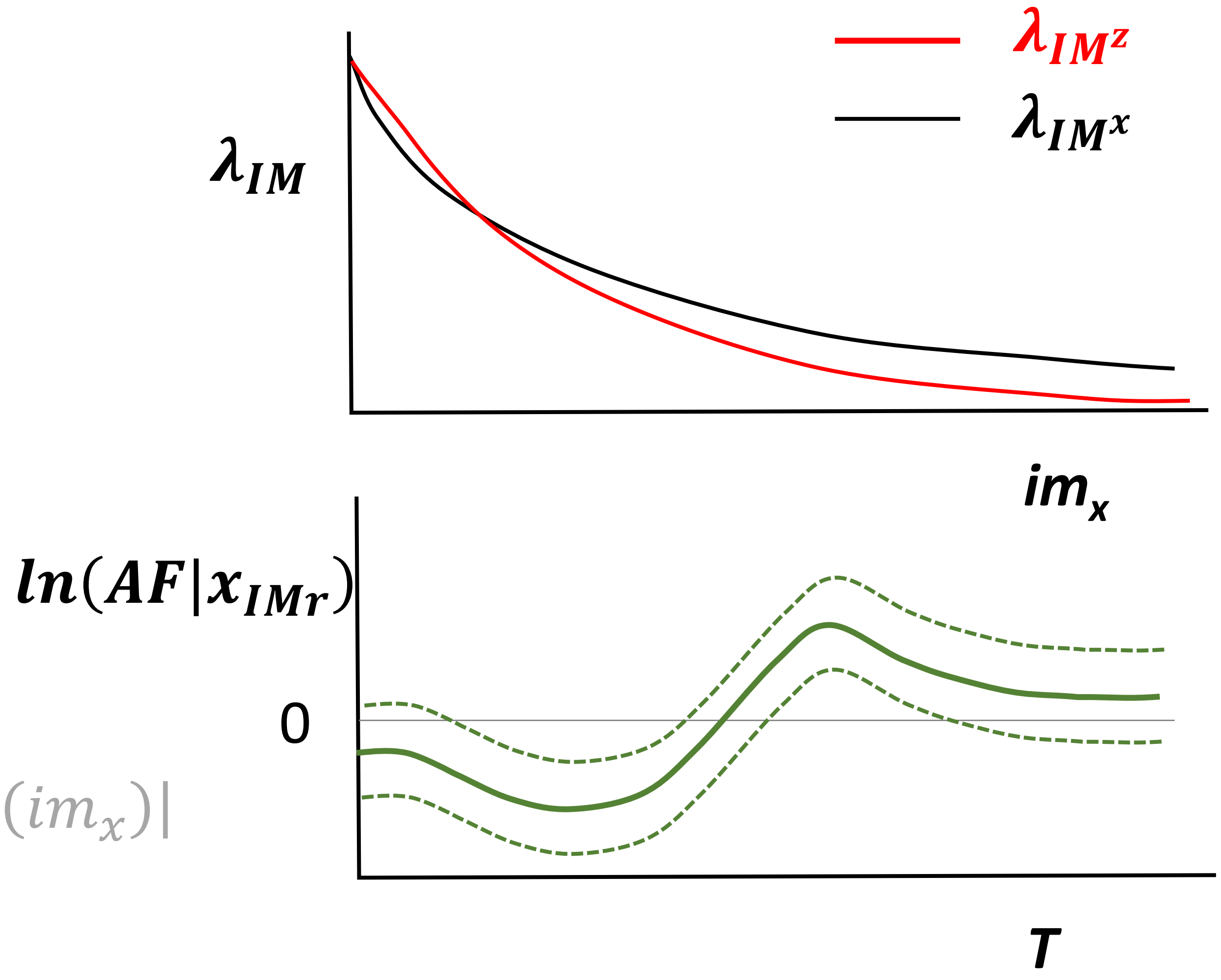
Develop reference site (*X*) hazard curves & UHS ordinates

Develop x_{IMr}–dependent probabilistic amplification model

Convolve reference hazard with amplification model:

$$\lambda_{IM^z}(im_z) = \int_0^\infty P(IM_z > im_z | IM_X = im_x) |d\lambda_{IM^x}(im_x)|$$

NRC Approach 3 (Bazzurro and Cornell, 2004)



Modified GMM

Select GMMs

Remove ergodic site terms

Add site-specific mean site term, being sure to maintain reference condition

Modify aleatory variability & implement logic tree that accounts for site response uncertainty

Run PSHA with modified GMM

NRC Approach 4

Site-specific approach

Functional definitions

Model elements

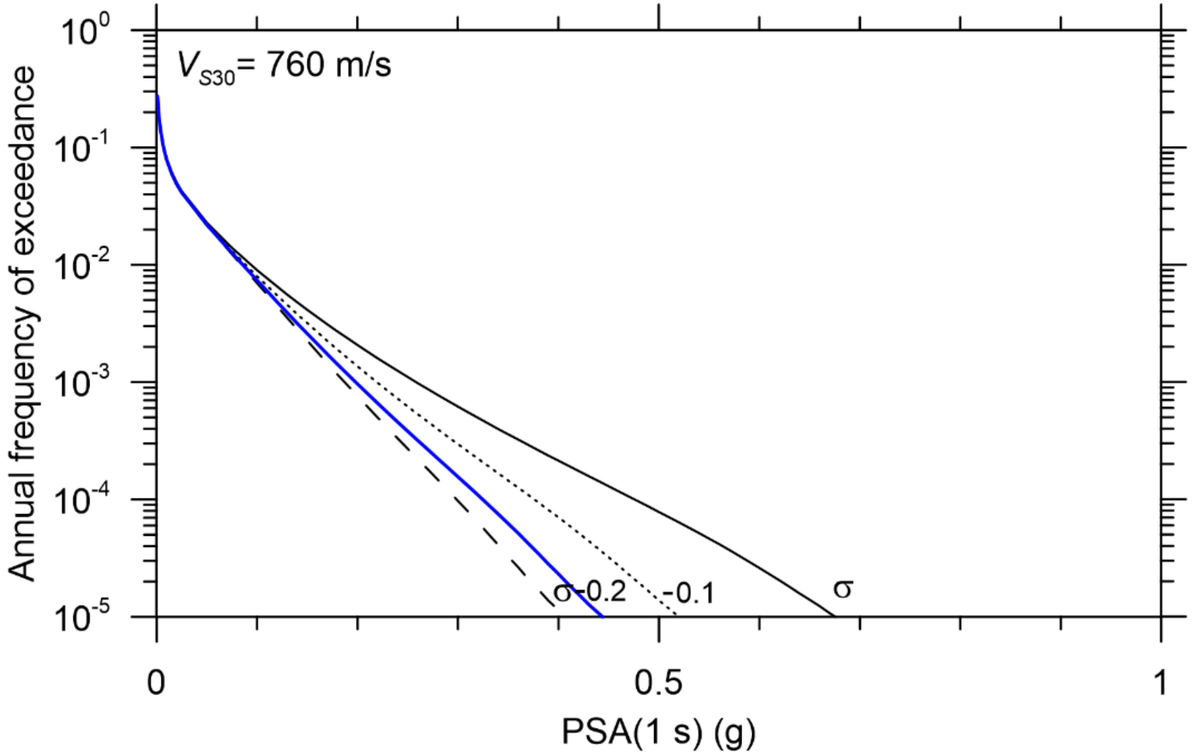
Implementation in hazard calculations

Example results

Allowable reductions

Example results

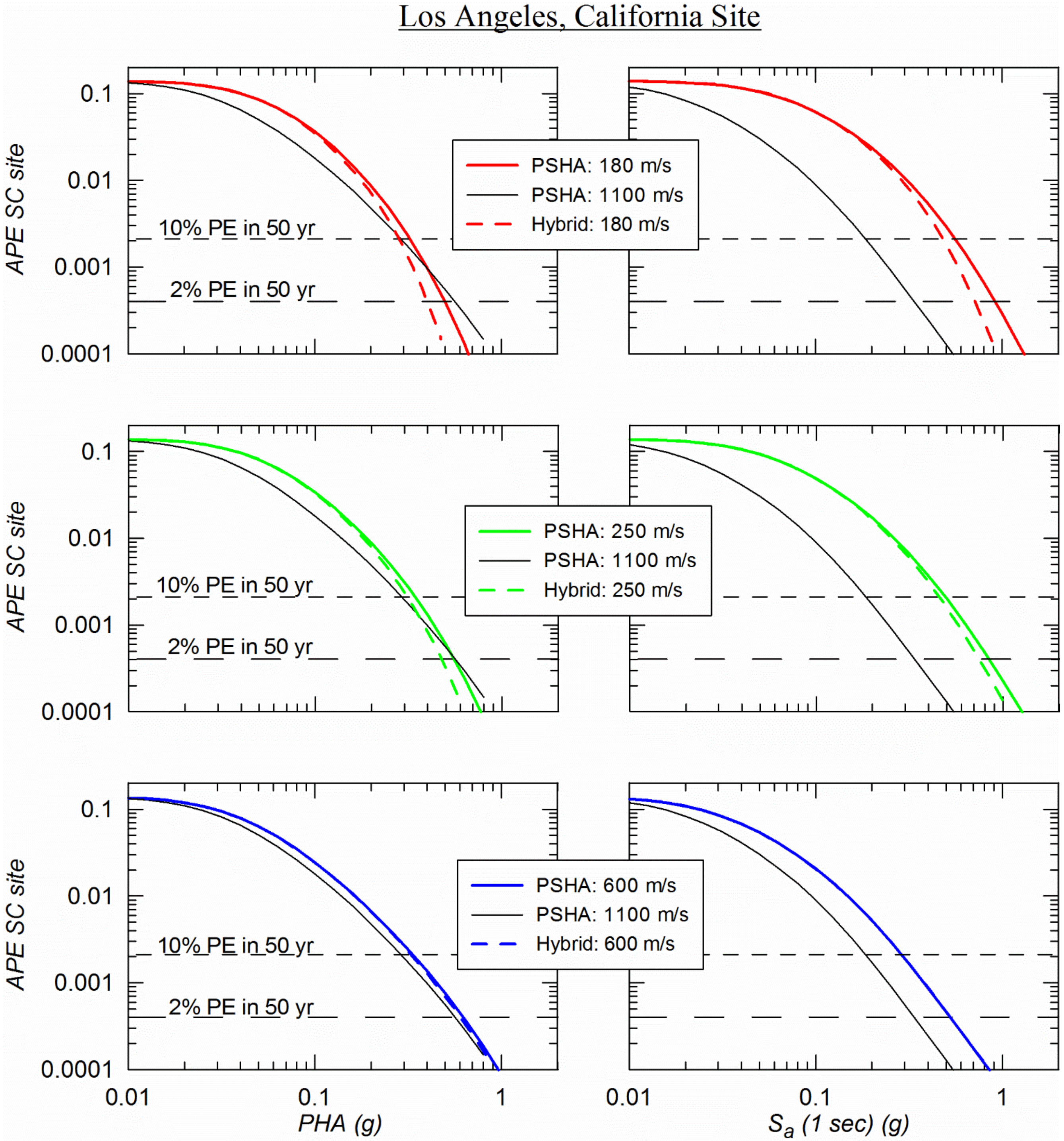
Steepens hazard curve slopes



Example results

Steepens hazard curve slopes

Hybrid vs. hazard integral implementation



Comparison of hazard curves derived from PSHA and the hybrid procedure at Los Angeles site location for three site conditions. Goulet et al. (2009)

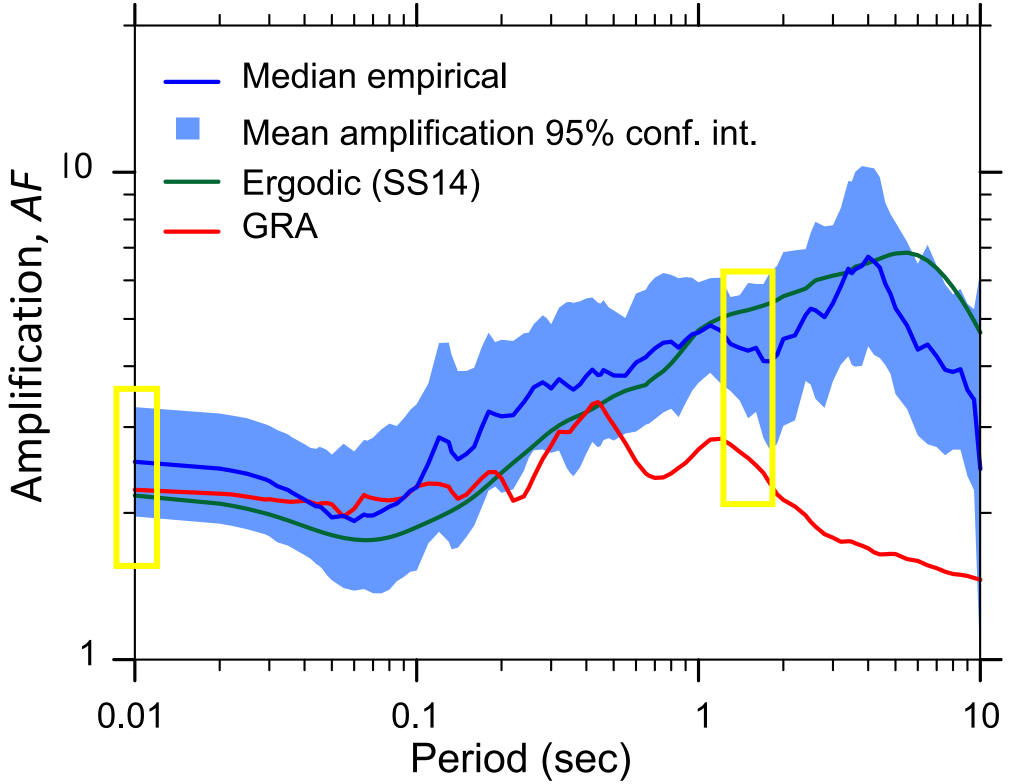
Example results

Steepens hazard curve slopes

Hybrid vs. hazard integral implementation

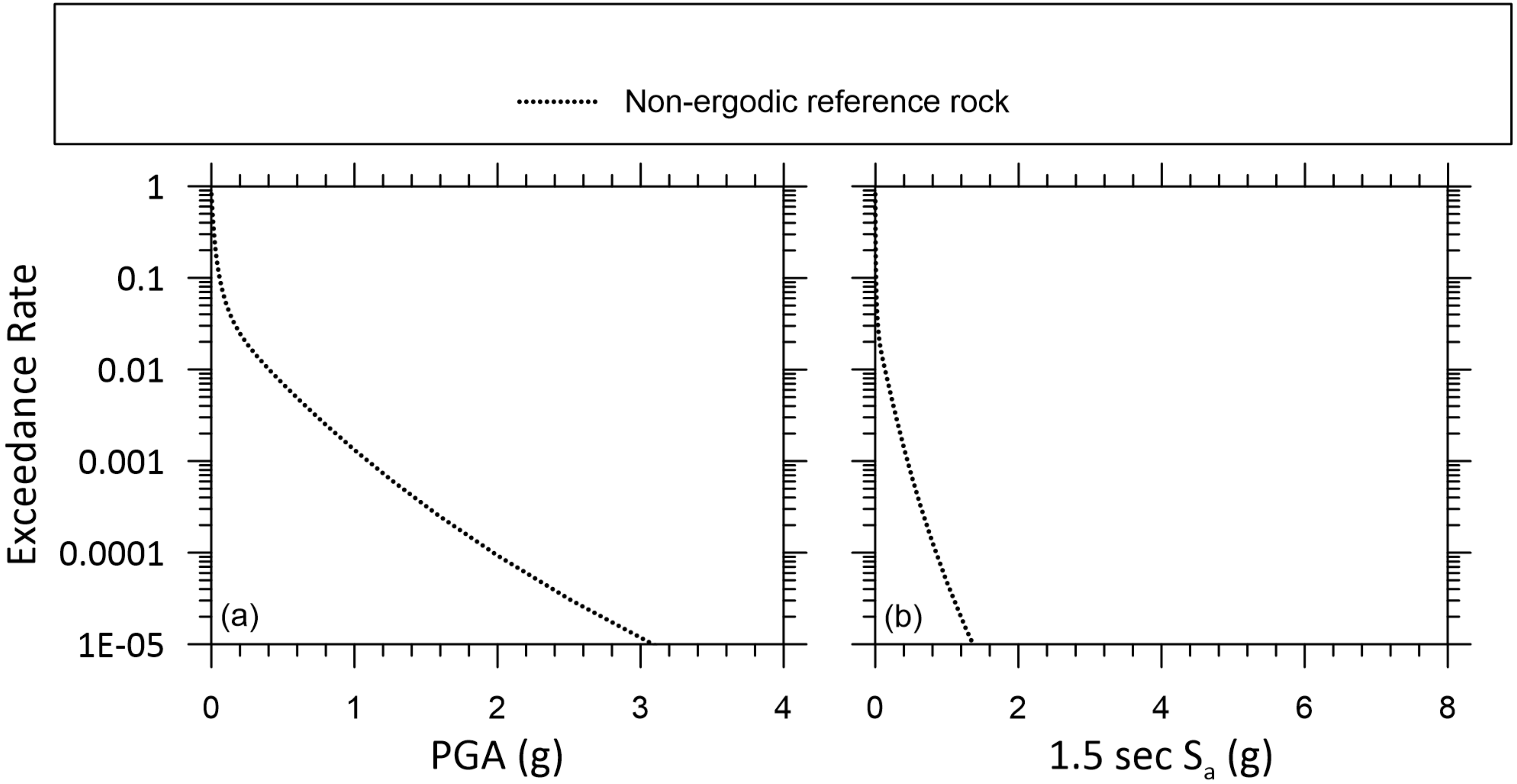
Convolution implementation vs. ergodic

El Centro 7 Site: Linear Amplification



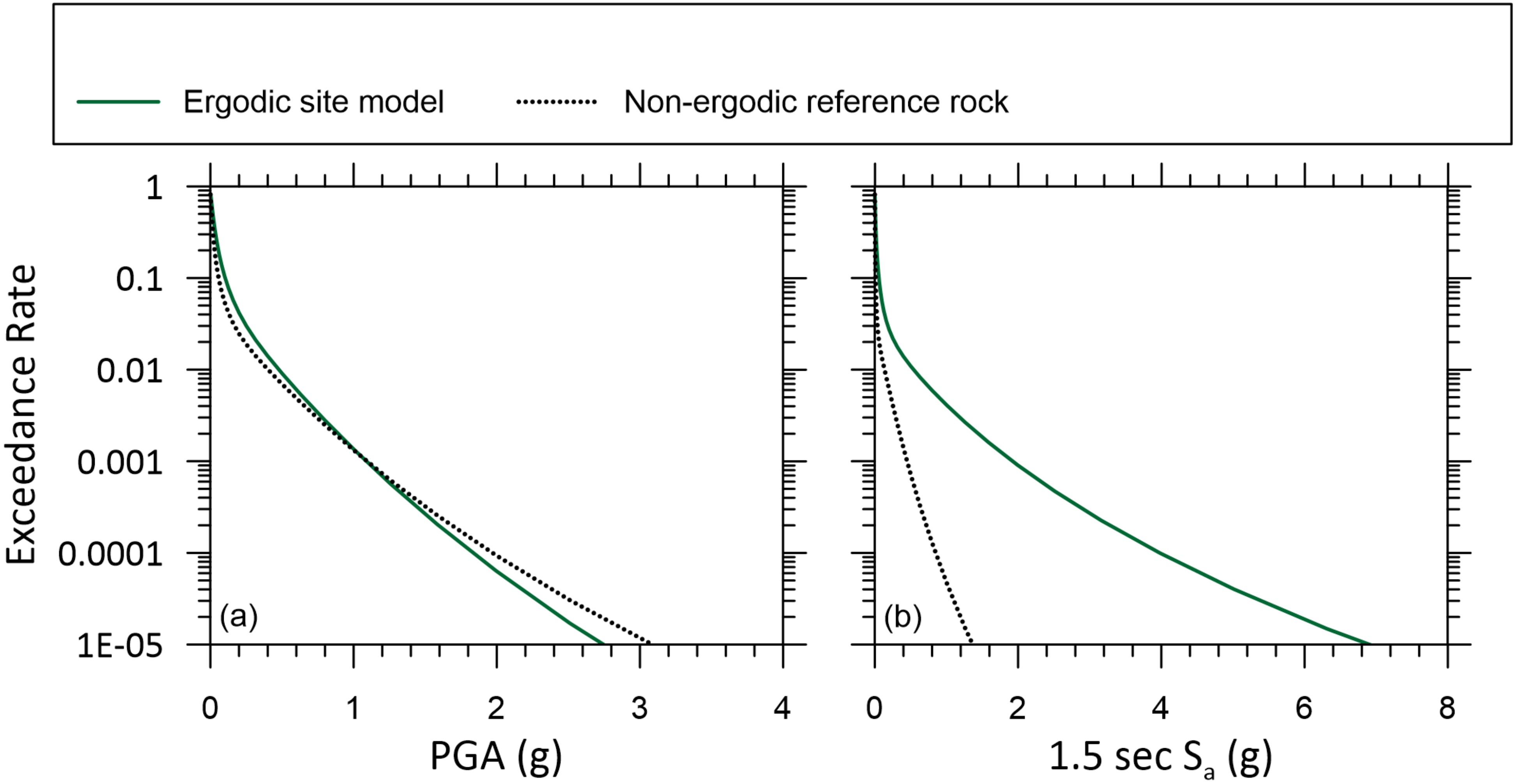
Modified from Stewart et al. 2017

El Centro 7 site (soft soil)



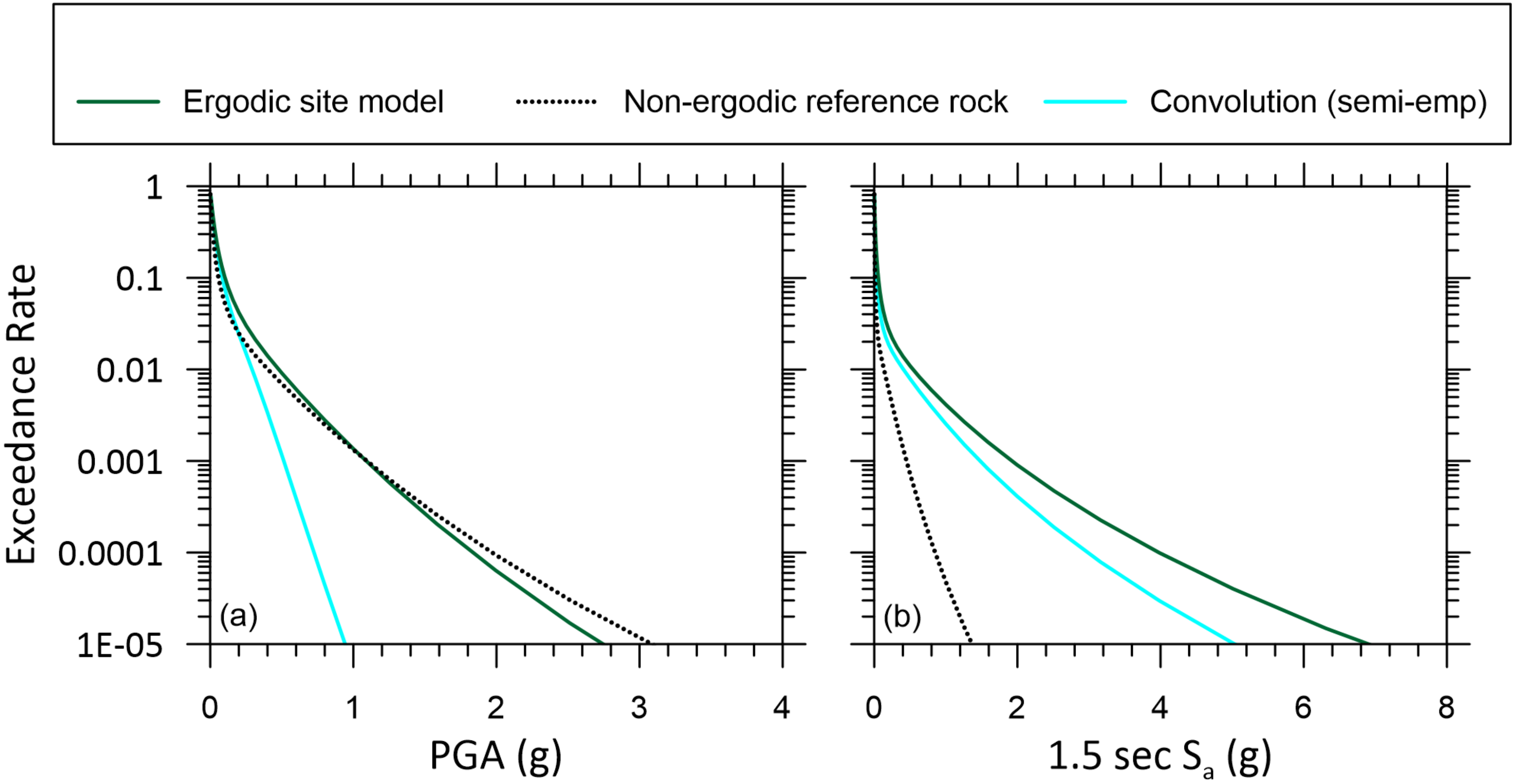
Modified from Stewart et al. 2017

El Centro 7 site (soft soil)



Modified from Stewart et al. 2017

El Centro 7 site (soft soil)



Modified from Stewart et al. 2017

Site-specific approach

Functional definitions

Model elements

Implementation in hazard calculations

Example results

Allowable reductions

Allowable reductions

Point of comparison is MCE_R spectrum from USGS seismic design Geo-Database

NEHRP 2020 (ASCE-7/22) and before: maximum 20% reduction

NEHRP 2026, site-specific approach: maximum 30% reduction

Outline

Current procedures

Issues motivating new procedures

Site-specific site response approach

Hybrid ground motions approach

Other technical improvements

Organization and status of document

Hybrid ground motions approach

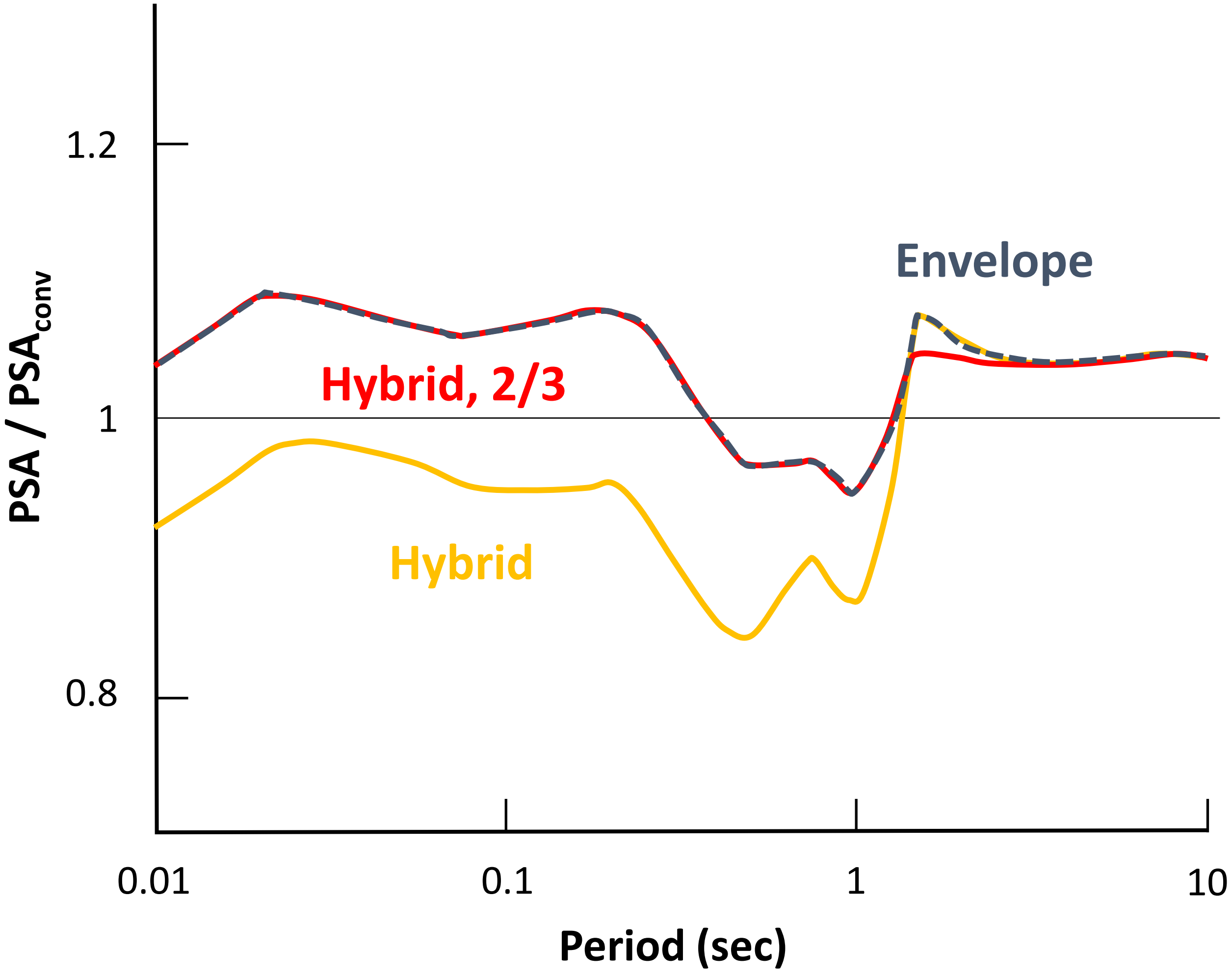
Amplification computed using GRA with MCE_R and $\frac{2}{3}MCE_R$

No amplification models (f_1, f_2, f_3) required

Hazard computed using full ϕ_{S2S} (IM^{ref})

Enveloped hybrid approach, $IM^{surf} = \max\left(AF^{MCE_R}, AF^{\frac{2}{3}MCE_R}\right) \times IM^{ref}$

Max 20% reduction



Figures: David Teague

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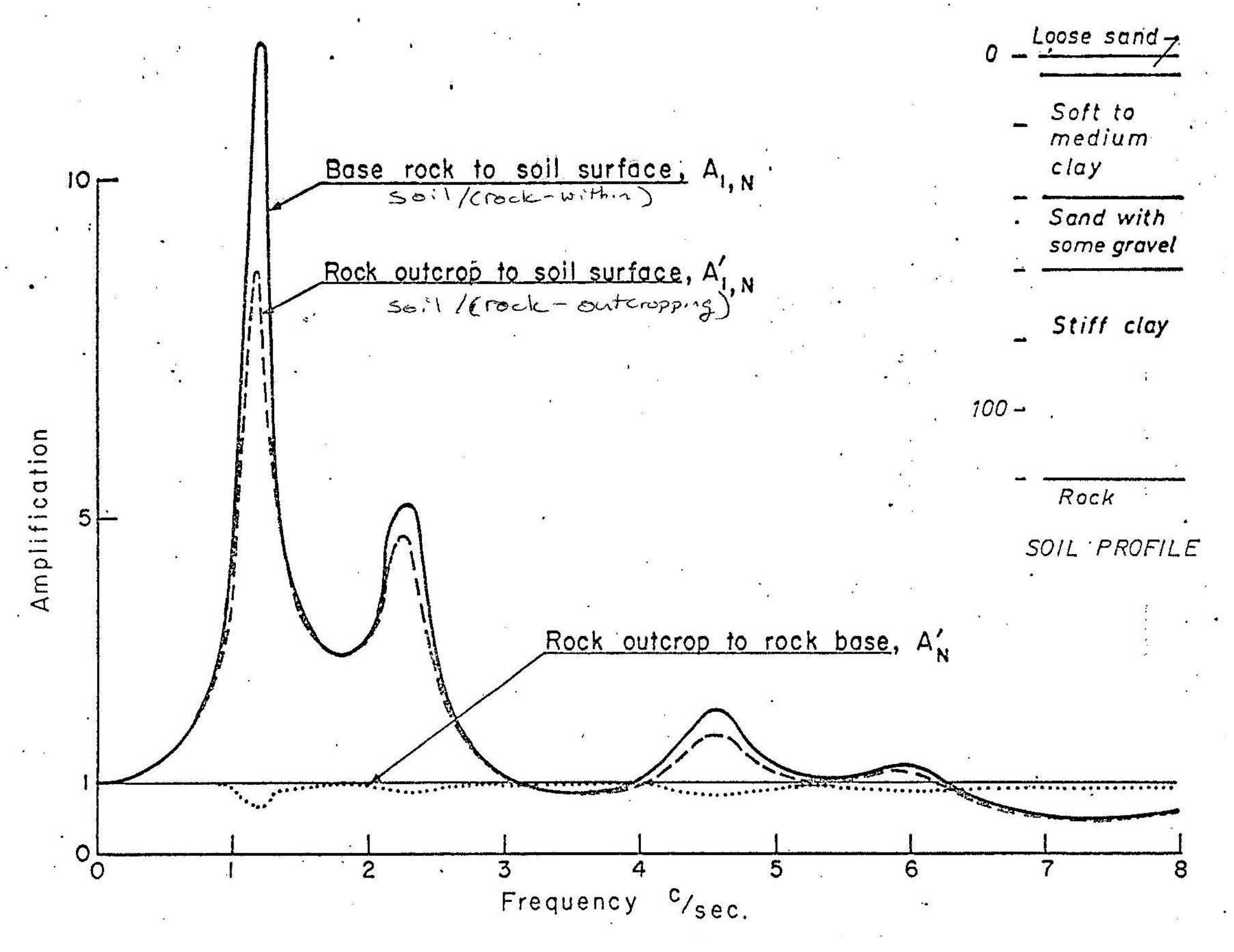
Other technical improvements

Long period problem

- GRA usable for $T \leq xT_{site}$ ($x \sim$ 1-2)



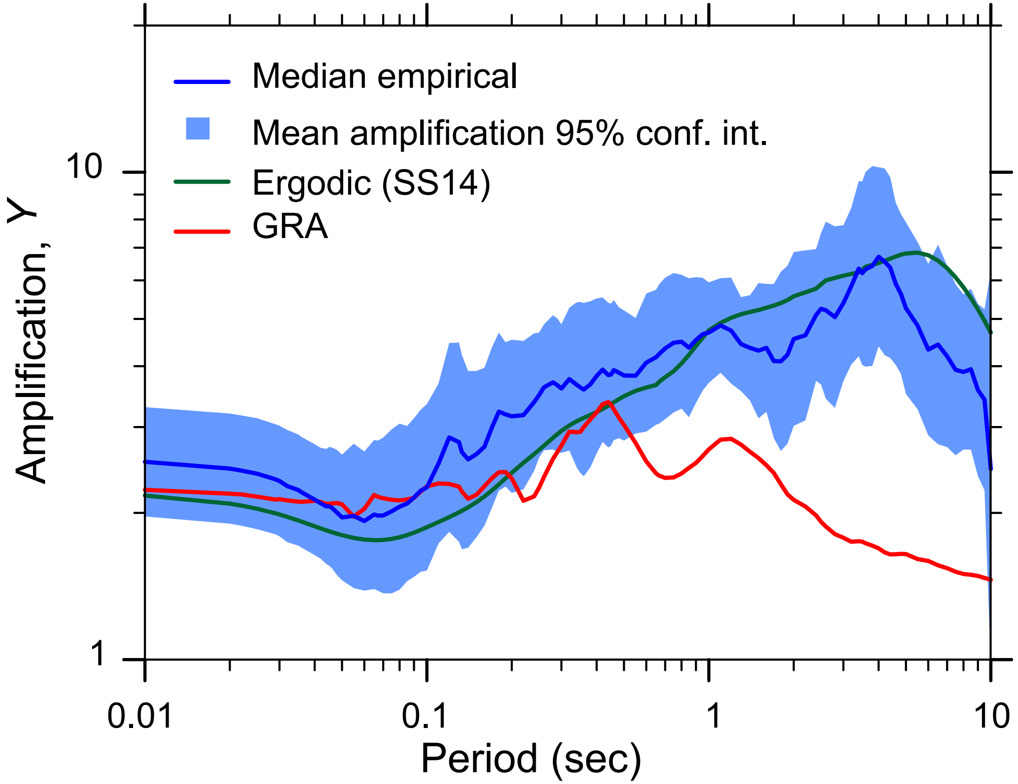
Transfer functions for elastic site response. Schnabel, 1973

Other technical improvements

Long period problem

- GRA usable for $T \leq xT_{site}$ ($x \sim$ 1-2)
- Example results
- Fix by transitioning to ergodic model for $T > xT_{site}$

El Centro 7 Site



Modified from Stewart et al. 2017

Other technical improvements

Long period problem

Site characterization

- V_S profiles – credible methods

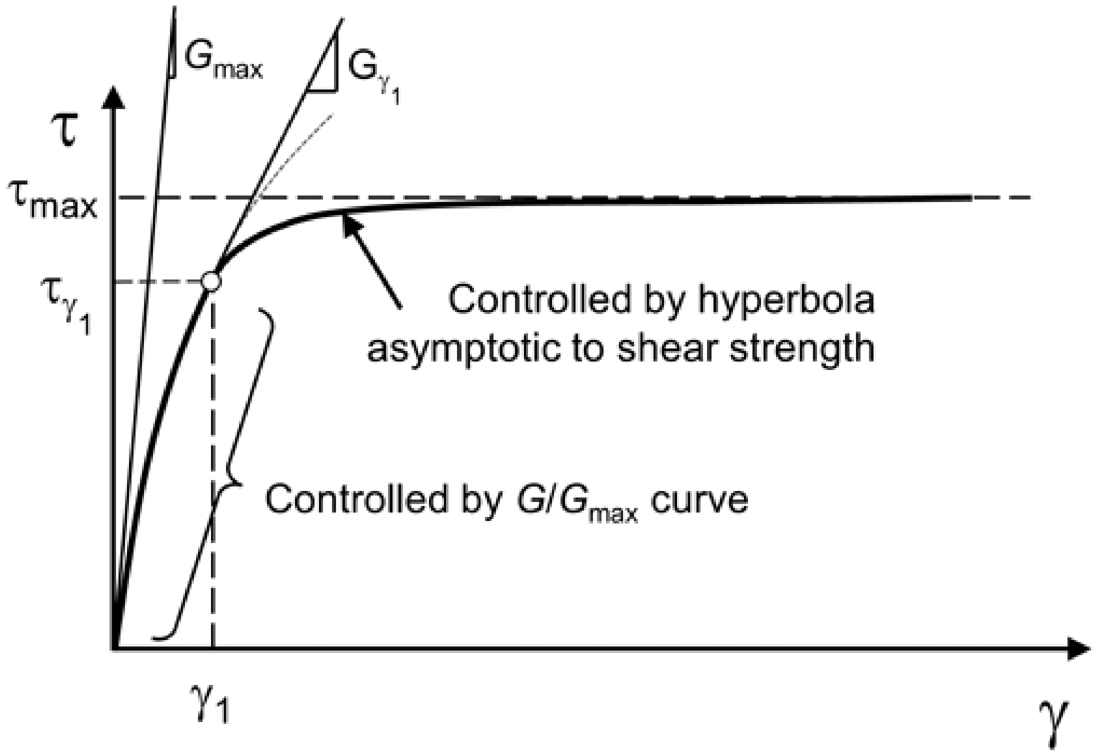
"Methods based on a single-direction linear array of surface instruments without a controlled vibration source are considered not credible in this standard and shall not be used for the derivation of V_S profiles."

Other technical improvements

Long period problem

Site characterization

- V_S profiles – credible methods
- Adjust modulus reduction curves for shear strength if large strains develop



Kramer & Stewart 2025

Other technical improvements

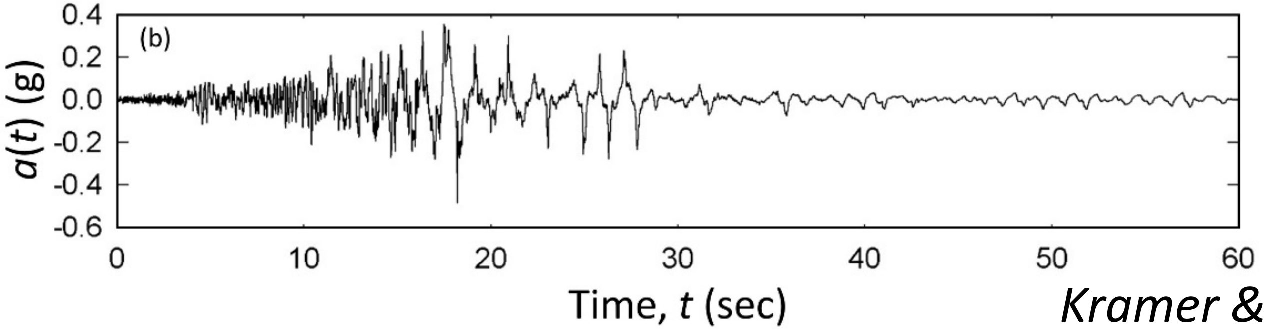
Long period problem

Site characterization

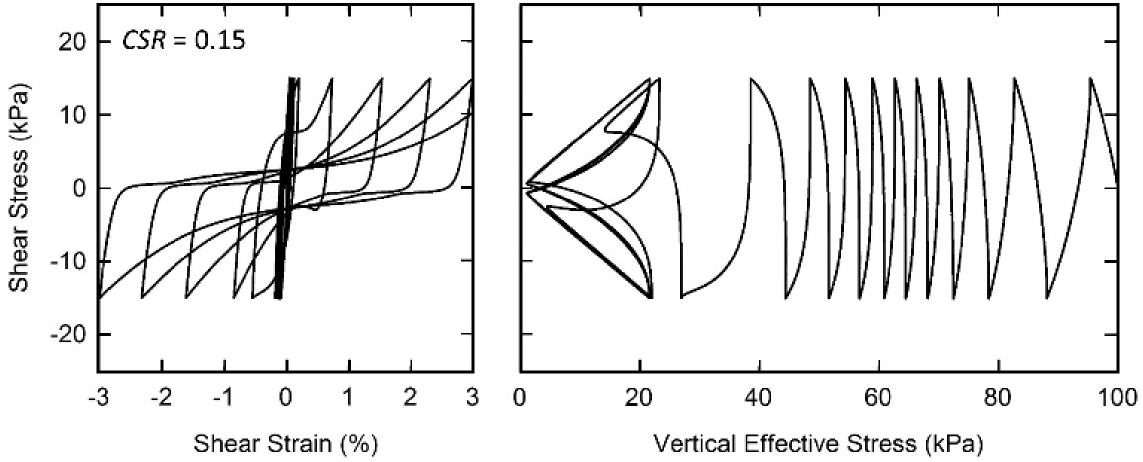
Modeling liquefaction

- Constitutive models that capture phase transformation (generally) required

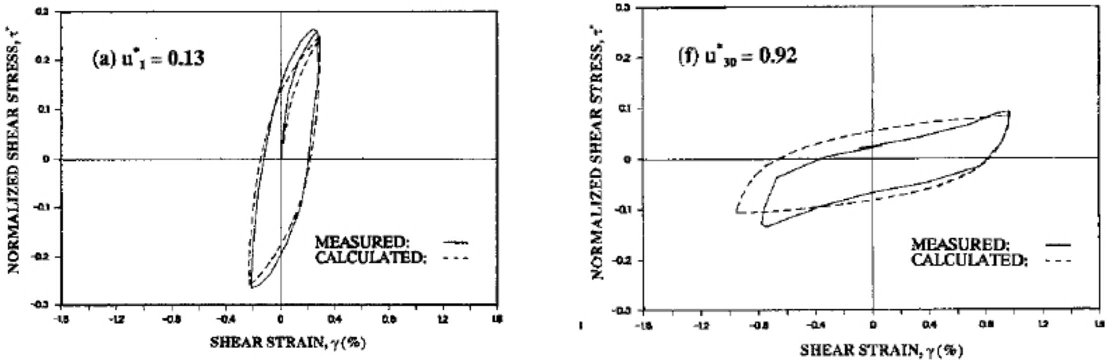
Kushiro Port record from Kushiro-Oki earthquake



Model with dilation



Model without dilation



Kramer & Stewart 2025; Matasović and Vucetic 1993

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Organization

Introduction

21.1.1: Reference site motion

21.1.2: Site properties model

21.1.3: Site response modeling

21.1.4: Ground motion variability and uncertainty

21.1.5: Analysis of ground motion hazard including site response

Organization

Introduction

- Charging language
- Definitions of *Site-specific site response* and *Hybrid ground motions*
- *Site-specific site response* requires peer review

Organization

21.1.1: Reference site motion

- *Site-specific site response* requires either hazard curves or UHS for reference site. Various ways to define reference site provided
- *Hybrid* requires reference site MCE_R
- Depending on GRA methods, need time series or spectra

Organization

21.1.2: Site properties model

- V_S profiles, MRD
- Liquefaction modeling guidelines, including consideration of phase transformation behavior
- Consider uncertainties

Organization

21.1.3: Site response modeling

- *Site-specific site response*: define mean amplification function and uncertainty (Approach 1 or 2). Procedures to address long-period problem.
- *Hybrid*: no amp function, amp factors derived using MCE_R input and scaled version thereof (2/3). Addresses long period problem.

Organization

21.1.4: Ground motion variability and uncertainty

- *Site-specific site response*: can eliminate ϕ_{S2S}.
- *Hybrid*: cannot eliminate ϕ_{S2S}.

Organization

21.1.5: Analysis of ground motion hazard including site response

- *Site-specific site response*: convolution or modified GMM in hazard integral
- *Hybrid*: enveloping procedure for site amp. Envelop used to adjust MCE_R (reference site) to MCE_R (ground surface)

Status

Approved for 2026 *NEHRP Provisions and Commentary*

ASCE 7-28:

- Approved by TC1 and SSC
- Resolution of comments from main committee pending

Closure

New site-specific procedure introduced to the *Provisions*

A hybrid approach is retained, allowing continuation of current practice, but with tweaks to avoid unconservatism

We advanced this proposal because:

- Non-ergodic site response is being used; needs to be reflected in *NEHRP Provisions & Commentary* for guidance / guardrails
- Current procedures in Sec. 21.1 frequently unconservative
- Other improvements were needed

References

Bazzurro P, CA Cornell (2004). Nonlinear soil-site effects in probabilistic seismic-hazard analysis, *Bull. Seismol. Soc. Am.*, 94:2110–2123.

Cramer CH (2003). Site-specific seismic-hazard analysis that is completely probabilistic, *Bull. Seismol. Soc. Am.*, 93:1841–1846.

Goulet CA and JP Stewart (2009). Pitfalls of deterministic application of nonlinear site factors in probabilistic assessment of ground motions, *Earthquake Spectra*, 25(3): 541-555.

Goulet CA, Y Bozorgnia, N Kuehn, L Al Atik, RR Youngs, RW Graves, GM Atkinson (2021). NGA-East Ground-Motion Characterization model part I : Summary of products and model development. *Earthquake Spectra*, 37:1231–1282.

Matasovic N, M Vucetic (1993). Cyclic characterization of liquefiable sands, *J. Geotech. Eng.*, 119(11):1805-1822.

McGuire RK, WJ Silva, CJ Costantino (2001). Technical basis for revision of regulatory guidance on design ground motions: Hazard-and risk-consistent ground motion spectra guidelines. *NUREG/CR-6728*, United States NRC.

Rodriguez-Marek A, EM Rathje, JP Ake, C Munson, S Stovall, T Weaver, K Ulmer, M Juckett (2021). Documentation Report for SSHAC Level 2: Site Response. US Nuclear Regulatory Commission, *RIL 2021-15*.

Schnabel PB (1973). Effects of local geology and distance from source on earthquake ground motions, PhD Dissertation, UC Berkeley.

Stewart JP and K Afshari (2021). Epistemic uncertainty in site response as derived from one-dimensional ground response analyses, *J. Geotech. Geoenv. Eng.*, 147:04020146.

Stewart JP, K Afshari, CA Goulet (2017). Non-ergodic site response in seismic hazard analysis, *Earthquake Spectra*, 33:1385-1414.