Ports of Los Angeles & Long Beach Earthquake Ground Motion Criteria

By
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California State Lands Commission
Prevention First 2008 Symposium
Long Beach, California
September 9-10, 2008

Outline

- MOTEMS Criteria vs POLA-POLB Criteria
- Purpose of Port-Wide Ground Motion Study
- Details of Ground Motion Study
- Summary

CBC 2007, Chapter 31F, Division 4

Table 31F-4-2
MOTEMS Seismic Performance Criteria

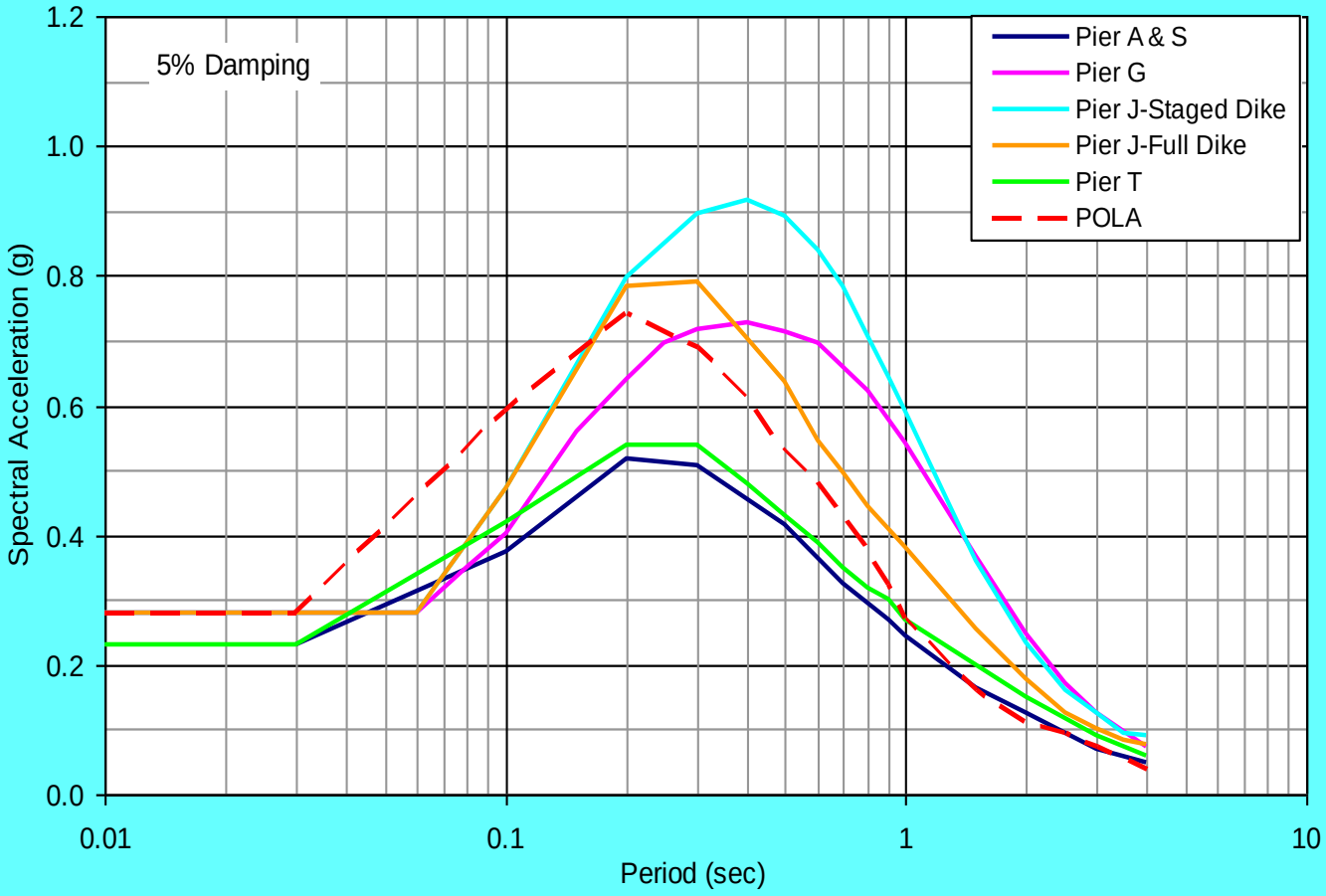
Risk Classification	Seismic Performance Level	Probability of Exceedance	Return Period
High	Level 1	50% in 50 years	72 years
	Level 2	10% in 50 years	475 years
Moderate	Level 1	65% in 50 years	48 years
	Level 2	15% in 50 years	308 years
Low	Level 1	75% in 50 years	36 years
	Level 2	20% in 50 years	224 years

POLA-POLB DESIGN GROUND MOTION CRITERIA

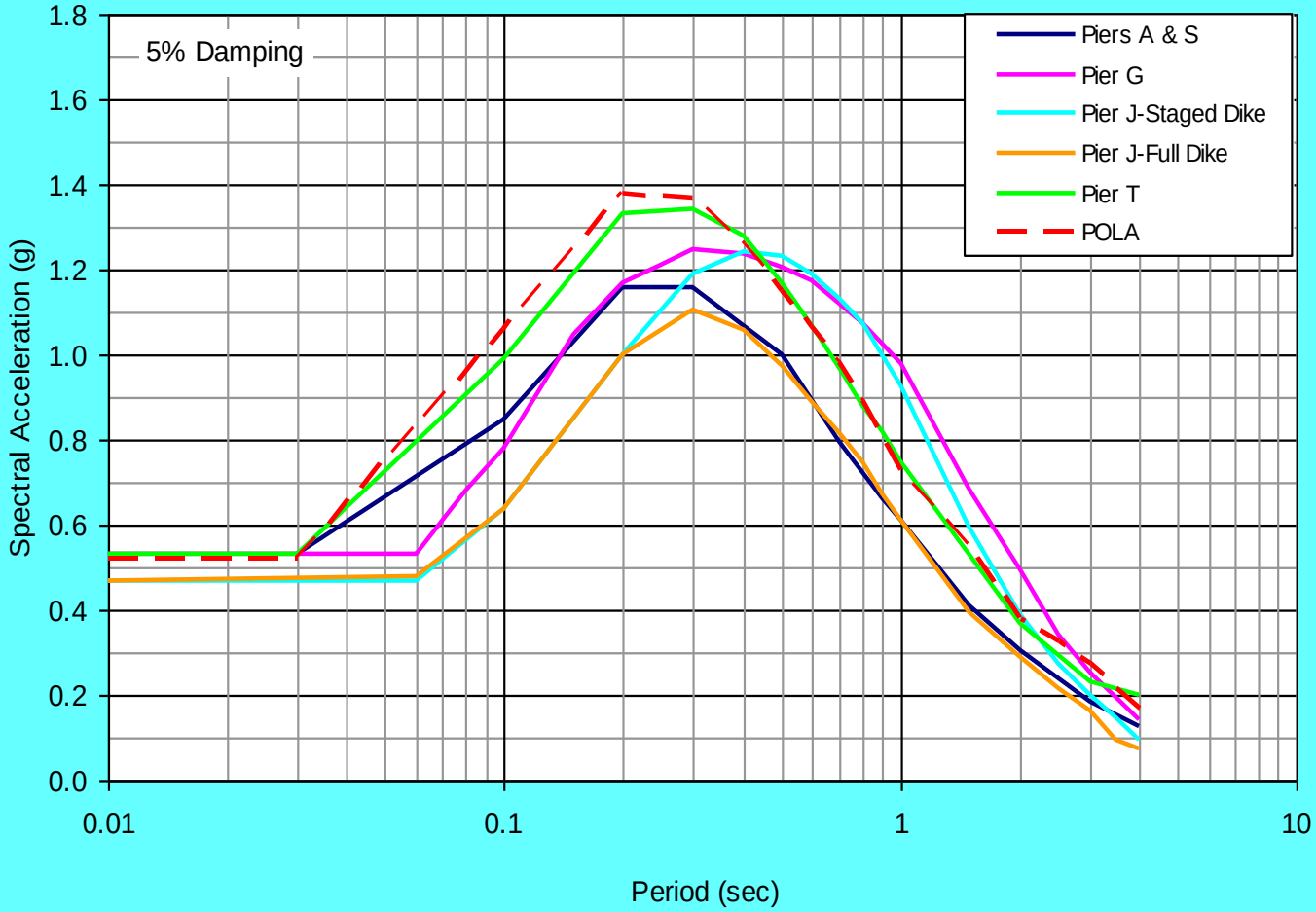
- **Two Earthquake Levels (Probabilistic Approach)**
  - **Operating-Level Earthquake (OLE)**
    - **50% Probability of Exceedance in 50 yrs. (72-yr. Return Period)**
  - **Contingency-Level Earthquake (CLE)**
    - **10% Probability of Exceedance in 50 yrs. (475-yr. Return Period)**
- **Ports' OLE and CLE Criteria are Identical to MOTEMS Level 1 and Level 2 Earthquakes for High Risk MOTs**

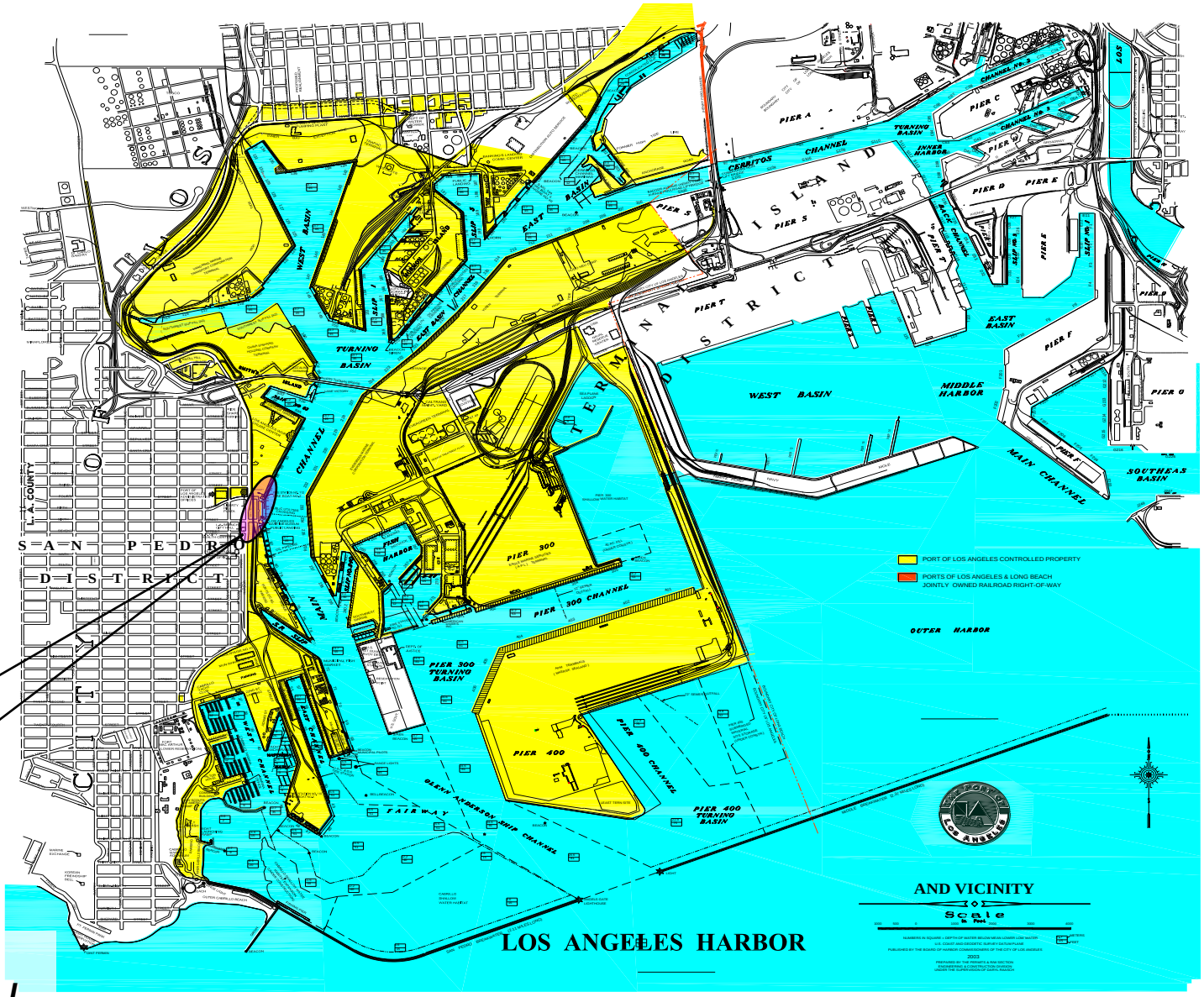
WHY PORT-WIDE GROUND
MOTION STUDY?

OLE (Level 1) RESPONSE SPECTRA FOR PAST POLA & POLB CONTAINER WHARF PROJECTS



CLE (Level 2) RESPONSE SPECTRA FOR PAST POLA & POLB CONTAINER WHARF PROJECTS




Fire Station
112
0.20g / 0.60g
0.25g / 0.38g
0.20g / 0.40g
LEGEND
OLE (Level 1) /
CLE (Level 2)
LOS ANGELES HARBOR
AND VICINITY
PORT OF LOS ANGELES CONTROLLED PROPERTY
PORTS OF LOS ANGELES & LONG BEACH JOINTLY OWNED RAILROAD RIGHT-OF-WAY
TERMINAL ISLAND
SAN PEDRO
CITY OF LOS ANGELES
L.A. COUNTY
DISTRICT
WEST BASIN
MIDDLE HARBOR
EAST BASIN
OUTER HARBOR
MAIN CHANNEL
CERRITOS CHANNEL
PIER 300
PIER 400
PIER 300 CHANNEL
PIER 400 CHANNEL
PIER 300 TURNING BASIN
PIER 400 TURNING BASIN
TURNING BASIN
INNER HARBOR
FISH HARBOR
FAIRWAY
GLENN ANDERSON SHIP CHANNEL

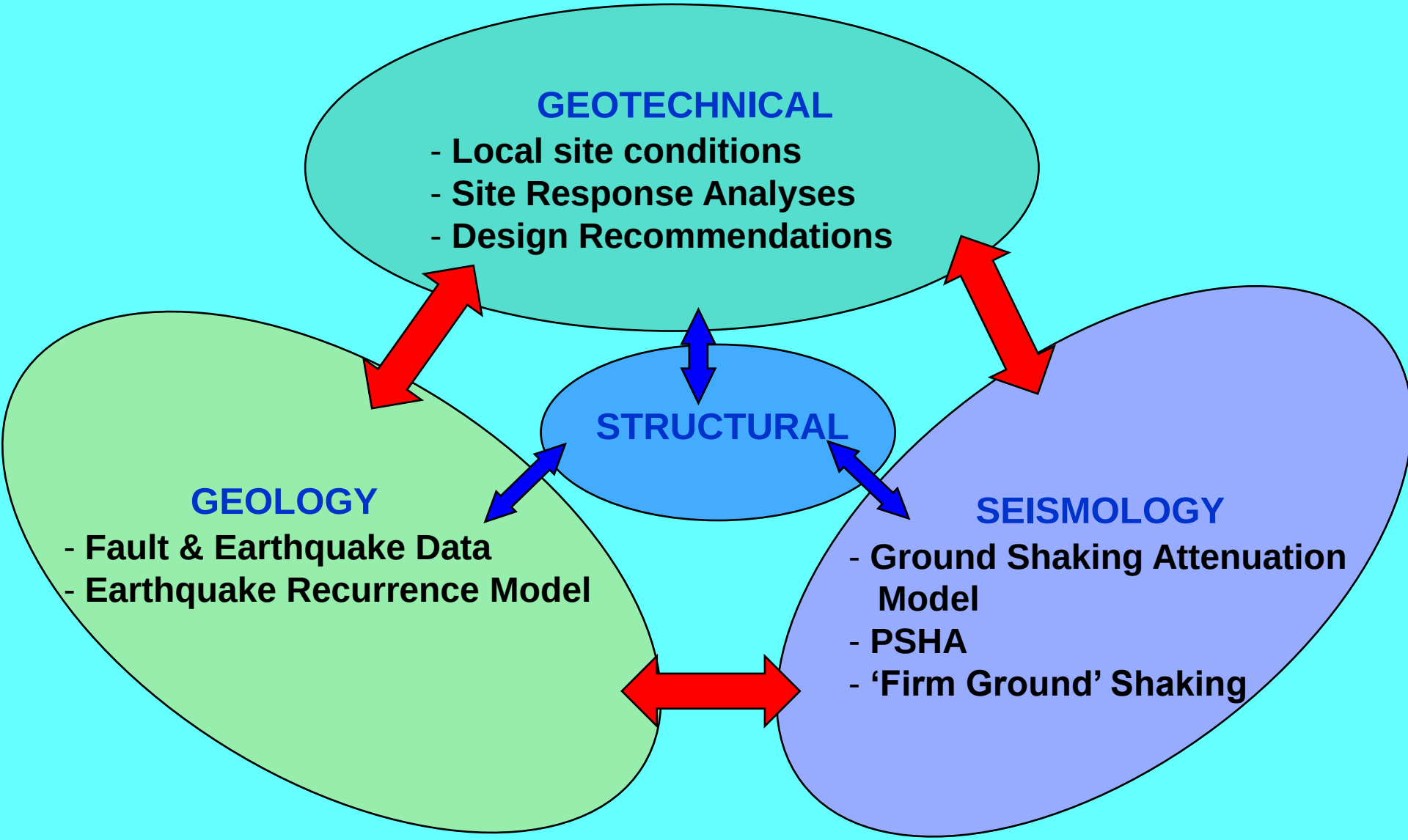
WHY PORT-WIDE GROUND MOTION STUDY?

- **To Eliminate Confusion due to Different Response Spectra Developed by Different Consultants on Future Projects**
- **To Minimize the Need for Future Project-specific Ground Motion Studies**
- **To Develop Design Recommendations Using the Latest Available Geological, Seismological, and Geotechnical Knowledge**
- **To Develop Consistent Design Recommendations for both POLA and POLB**

EXPERTISE REQUIRED FOR GROUND MOTION STUDY

- **Geologist: Defines Earthquake Fault Parameters**
- **Seismologist: Develops Ground Shaking Estimates for "Firm Ground" Using Probabilistic Seismic Hazard Analysis (PSHA)**
- **Geotechnical Engineer: Develops Design Ground Shaking Estimates by Incorporating Local Soil Conditions (*i.e.*, Site Response Analysis)**
- **Structural Engineer: Designs the Structure (PRIMARY END USER)**

GROUND MOTION STUDY PROCESS



POLA-POLB GROUND MOTION STUDY TEAM

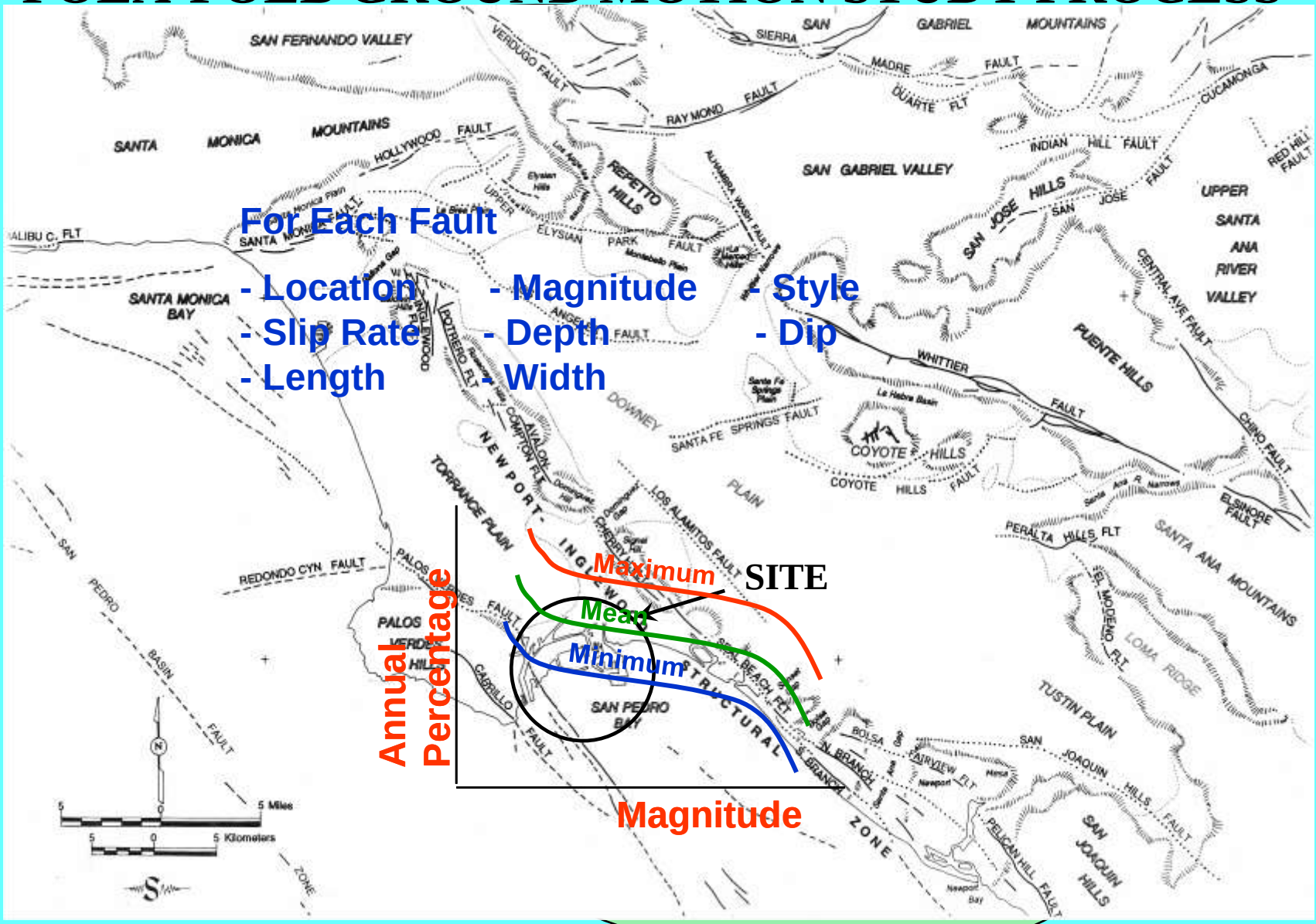
- **POLA-POLB: Owners / Structural Engineering Review**
- **Dr. Norm Abrahamson: Seismology and PSHA**
  (Principal Investigator for Pacific Earthquake Engineering Research (PEER) / Lifelines Next Generation Attenuation (NGA) Project)
- **Earth Mechanics, Inc.: Geology and Geotechnical Engineering (and Independent Check of Seismic Hazard Analysis)**

POLA-POLB GORUND MOTION STUDY TEAM (Cont.)

TECHNICAL ADVISORY BOARD – EXPERT REVIEW

- **Geology & Seismology: Dr. Tom Henyey (Emeritus Professor of Geological Sciences and Geophysics, USC & Director Emeritus, Southern California Earthquake Center)**
- **Geotechnical Engineering: Dr. Geoff Martin (Professor of Civil Engineering, USC)**
- **Structural Engineering: Dr. Nigel Priestley (Emeritus Professor of Structural Engineering, UCSD)**

POLA-POLB GROUND MOTION STUDY PROCESS



POLA-POLB GROUND MOTION STUDY PROCESS

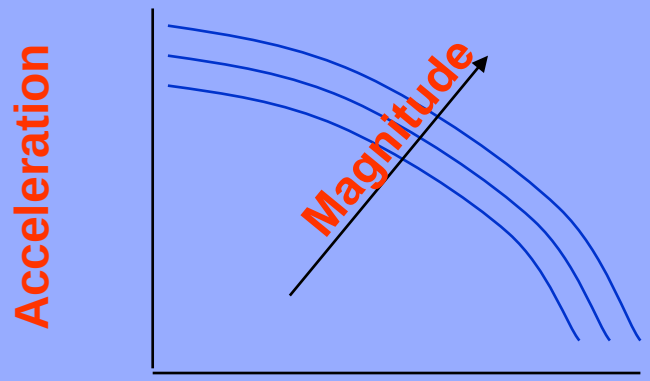
SEISMOLOGY

GEOTECHNICAL

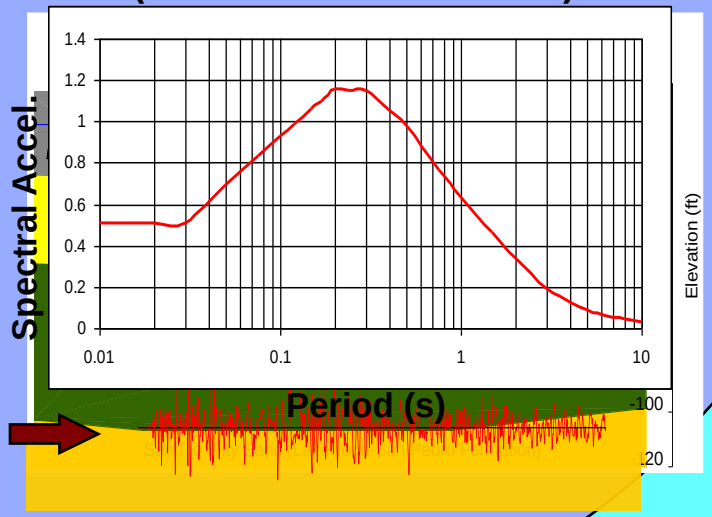
STRUCTURAL

GEOLOGY

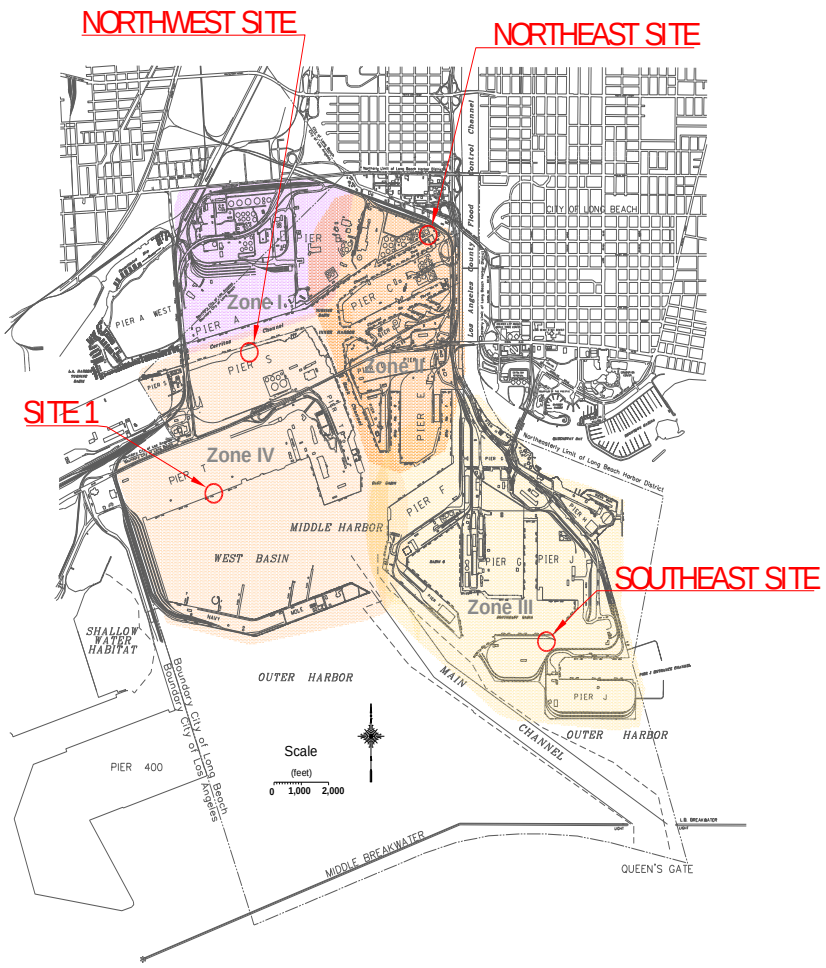
- Attenuation Model



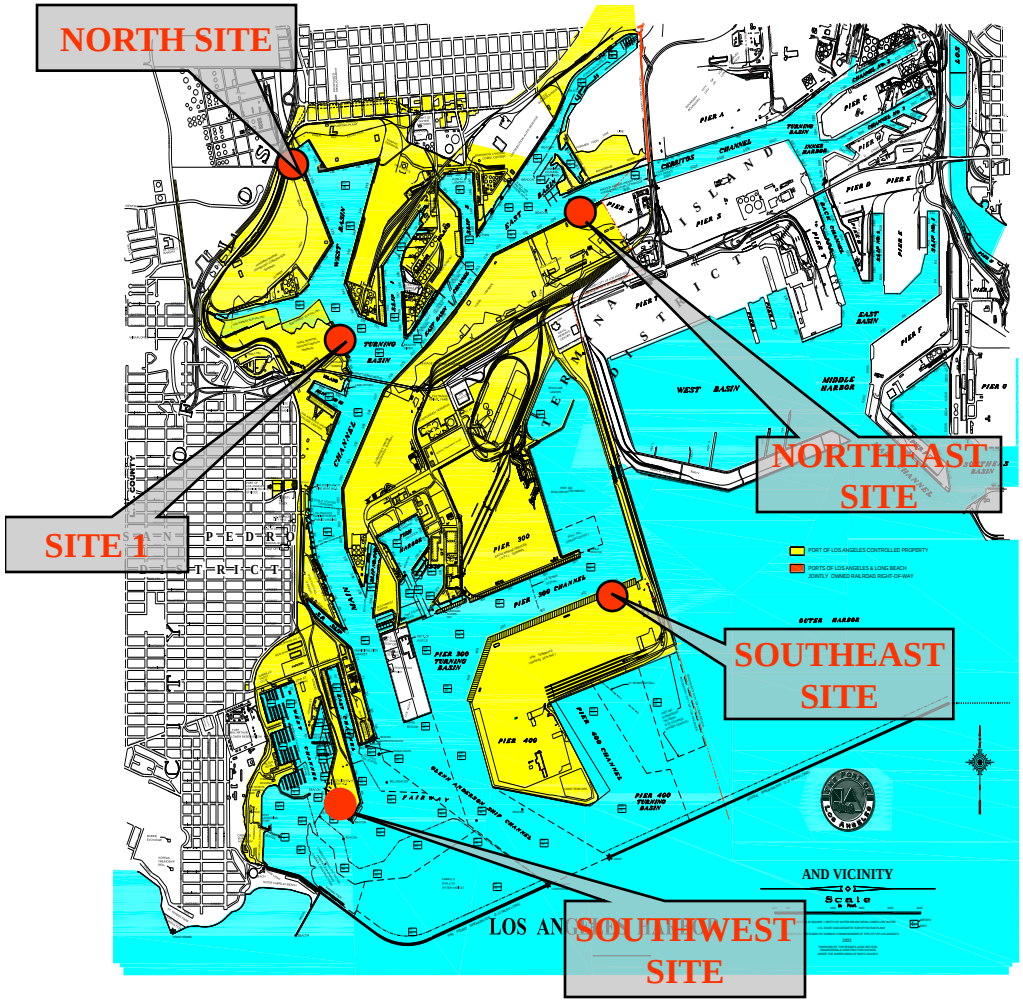
- PSHA (for “Firm Ground”)



“Firm Ground” motion from PSHA

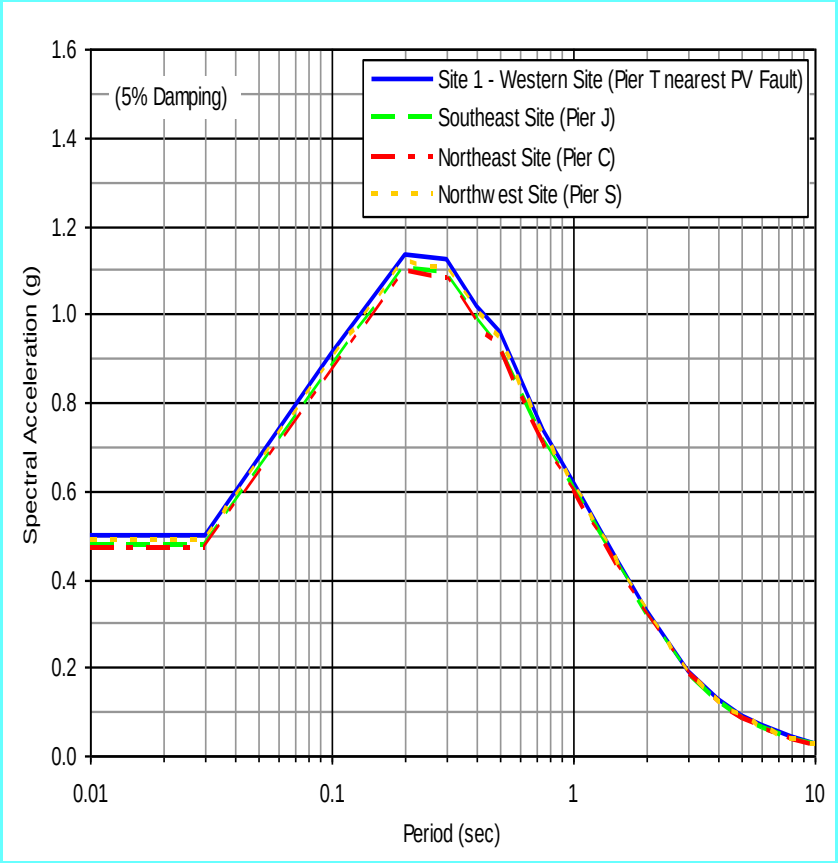


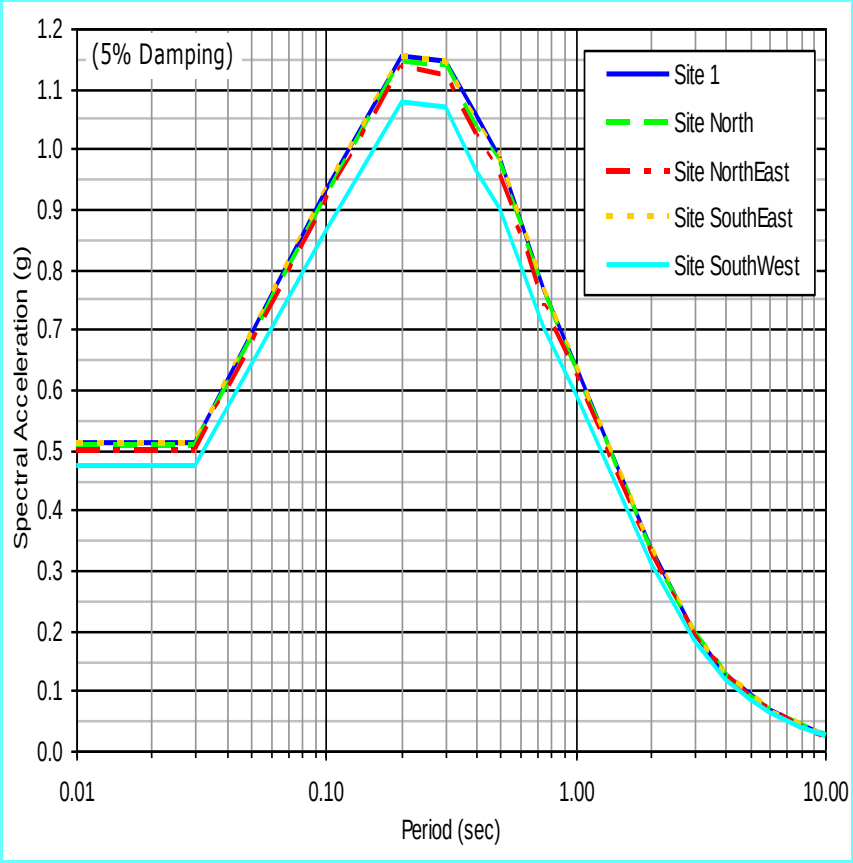
POLB



POLA

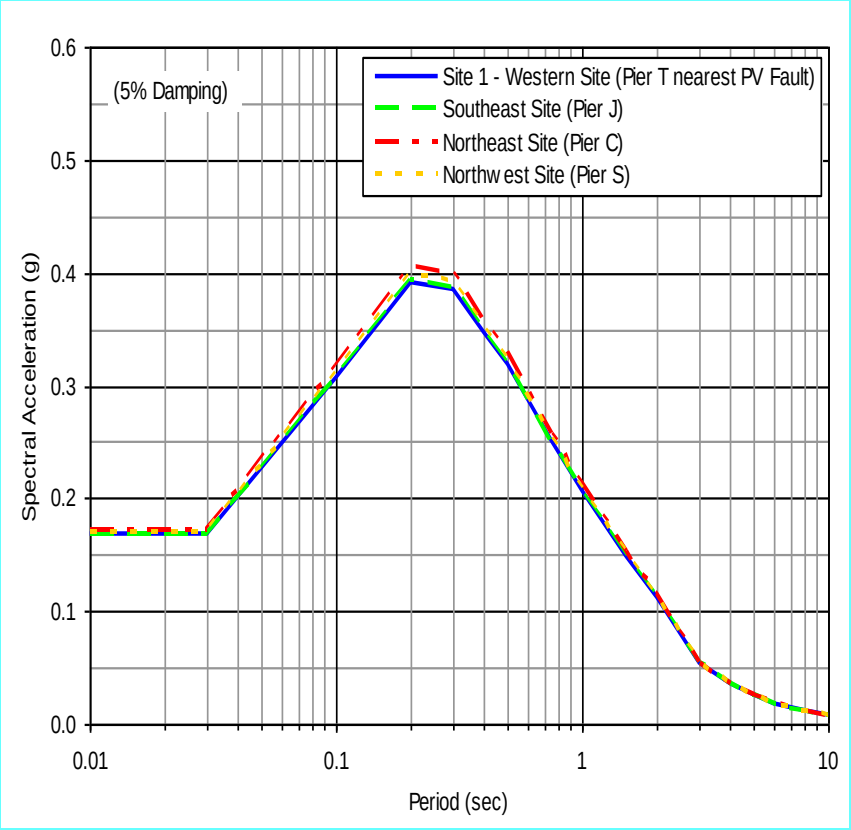
SITES SELECTED FOR PSHA ("FIRM GROUND")

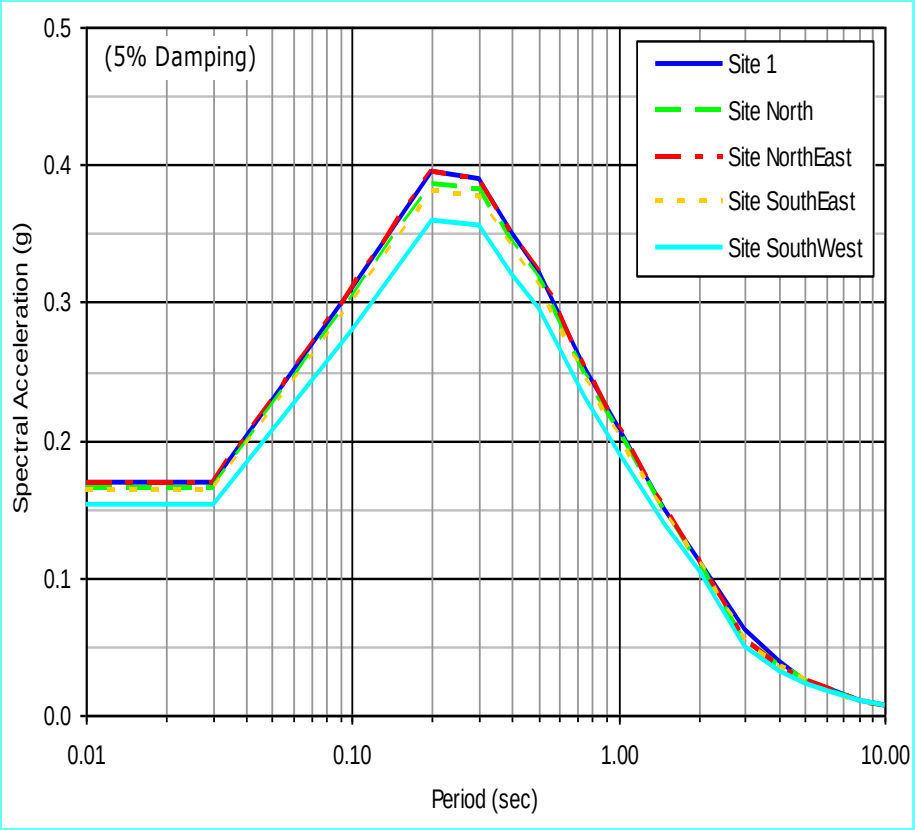




POLB **POLA**

“Firm-Ground” CLE (Level 2) Acceleration Spectra at Different Sites





POLB

POLA

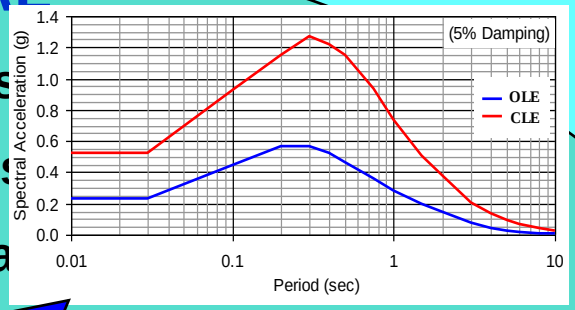
“Firm-Ground” OLE (Level 1) Acceleration Spectra at Different Sites

POLA-POLB GROUND MOTION STUDY PROCESS

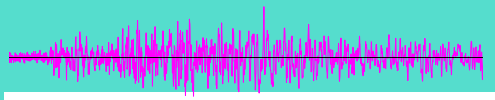
GEOTECHNICAL

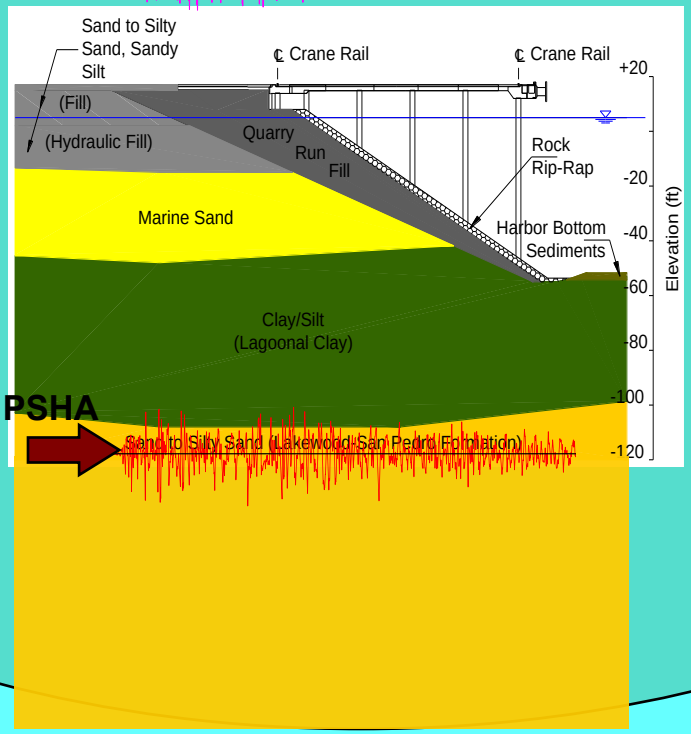
- Local Soil Conditions
- Site Response Analys
- Design Recommenda

Design Recommendations

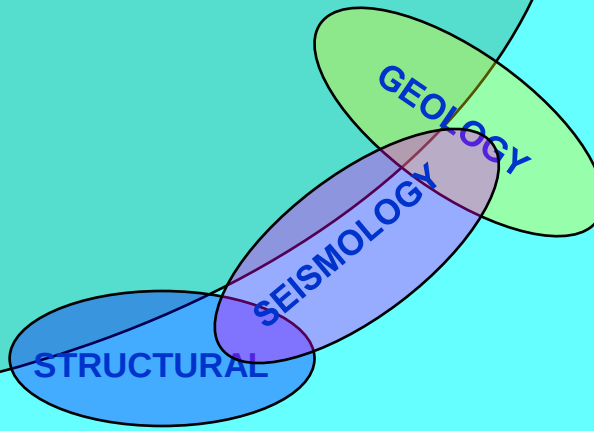


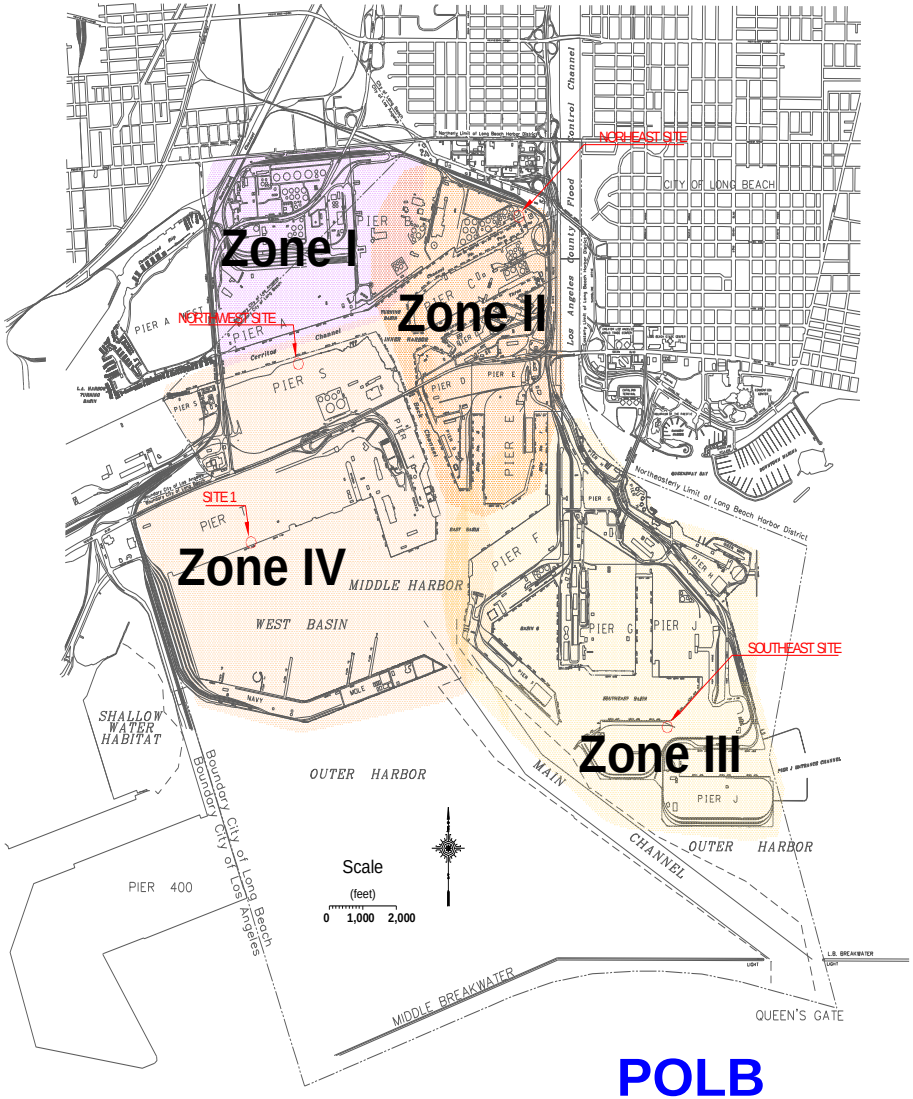
Output from Site Response Analyses



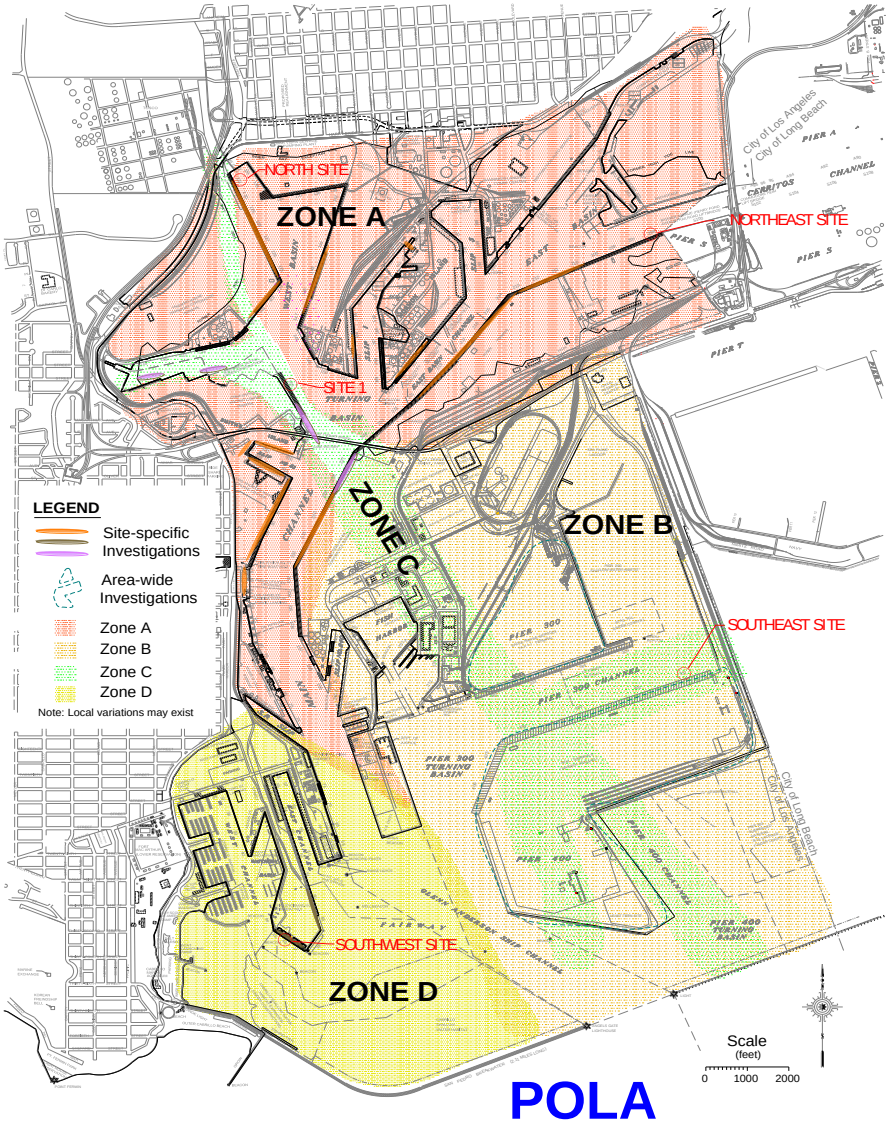


"Firm Ground" Within Motion from PSHA



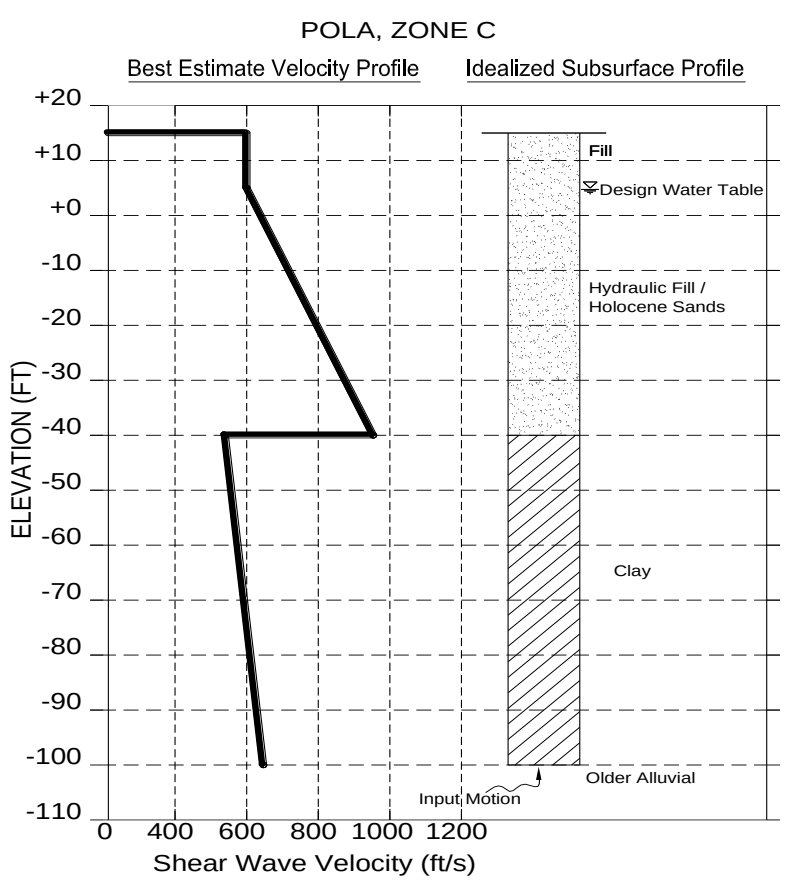


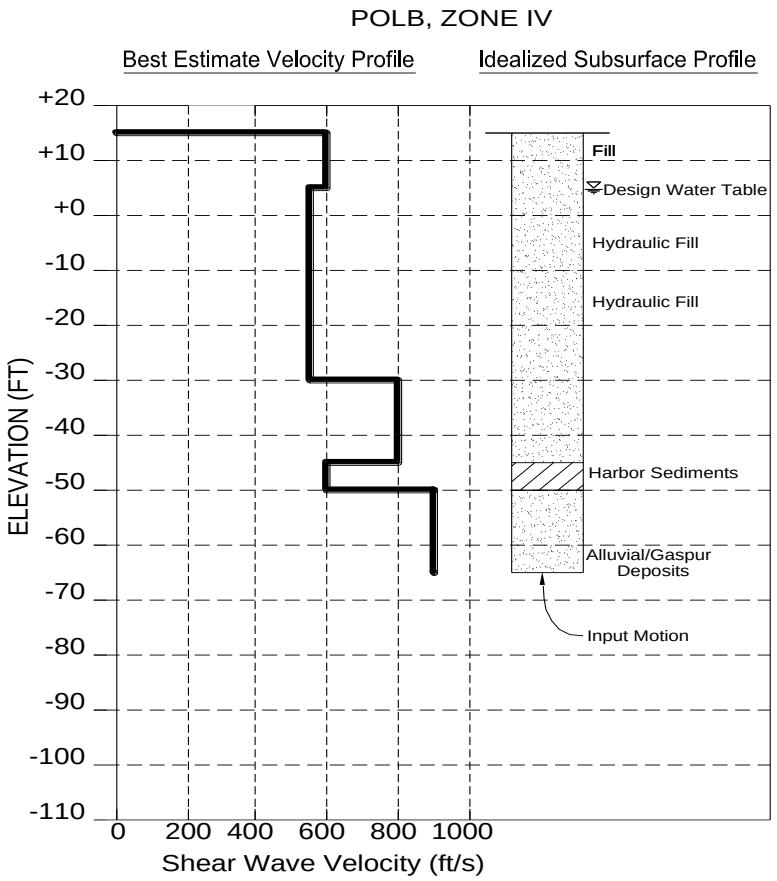
POLB



POLA

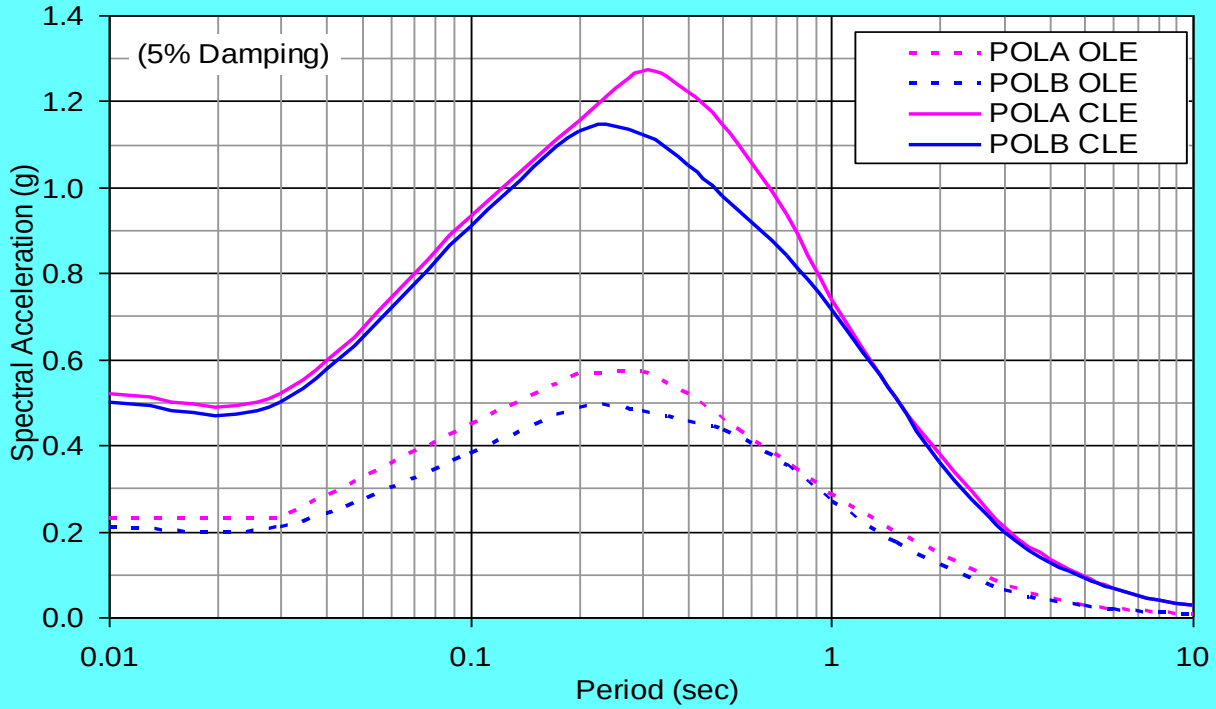
Soil Zones Used for Seismic Response Analyses





Selected Soil Profiles Used for Site Response Analyses

POLA-POLB DESIGN OLE (LEVEL 1) & CLE (LEVEL 2) COMPARISONS



SUMMARY
TWO LEVELS OF GROUND MOTIONS

- **POLA-POLB Port-Wide Ground Motion Study is Based on:**
  - **Latest Geologic and Seismic Knowledge**
  - **Extensive Local Geotechnical Information**
  - **Independent Review by a Panel of Experts**
- **This Study Provides the Following Recommendations:**
  - **Unified Sets of OLE (Level 1) and CLE (Level 2) Response Spectra for Future Design**
  - **Unified Set of Geotechnical Recommendations for Seismic Evaluations**
  - **Seven Sets of Acceleration-Time Histories (For Complex Structural and Geotechnical Evaluations, if Needed)**

PORT-WIDE GROUND MOTION STUDY
PORT OF LONG BEACH, CALIFORNIA
FINAL REPORT

Prepared For:

THE PORT OF LONG BEACH

The Port of Long Beach
925 Harbor Plaza
Long Beach, CA 90801

Prepared By:

Earth Mechanics, Inc.

Earth Mechanics, Inc.
17660 Newhope Street, Suite E
Fountain Valley, CA 92708

EMI Project No. 01-143

August 7, 2006

PORT-WIDE GROUND MOTION AND
PALOS VERDES FAULT STUDY
PORT OF LOS ANGELES, CALIFORNIA
FINAL REPORT

Prepared For:

THE PORT OF LOS ANGELES

The Port of Los Angeles
425 South Palos Verdes St.
San Pedro, CA 90731

Prepared By:

Earth Mechanics, Inc.

Earth Mechanics, Inc.
17660 Newhope Street, Suite E
Fountain Valley, CA 92708

EMI Project No. 02-131-11

December 22, 2006

STATE OF CALIFORNIA ARNOLD SCHWARZENEGGER, *Governor*

CALIFORNIA STATE LANDS COMMISSION
200 Oceangate, Suite 900
Long Beach, CA 90802

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Contact Phone: **(562) 499.6312**
Contact FAX: **(562) 499.6316**

August 13, 2007

File Ref: W9777.226

Mr. xxxx
Engineering Company

Dear Mr. xxx:

SUBJECT: MOTEMS Changes for Site Specific Response Spectra and Tsunami Run-up Heights

Attached is a letter sent to marine oil terminal operators in the Ports of Los Angeles and Long Beach. As many of you already know, there are now final reports for site-specific response spectra and tsunami run-up values. For all MOTEMS compliance work, please use these documents that supersede the curves/tables provided in the current version of the MOTEMS (Section 3103F.4.2.3 and 3103F.5.7).

If you have any questions about these studies or the audit process, please don't hesitate to call.

Sincerely,

Martin L. Eskijian, P.E.
Supervisor, Engineering Branch, MFD

Attachment

Acknowledgement

- Peter Yin, Angel Lim (Port of Los Angeles)
- Jim Santa Ana, Cheng Lai (Port of Long Beach)
- Nigel Priestley (Professor Emeritus, UCSD)
- Geoff Martin (Professor, USC)
- Tom Henyey (Professor Emeritus, USC)
- Norm Abrahamson (Consultant)
- Po Lam & Bruce Schell (Earth Mechanics, Inc.)
- Staff at Earth Mechanics

Thank You!