Earthquake Definitions

- Maximum Credible Earthquake (MCE): The largest earthquake that appears capable of occurring under the known tectonic framework for a specific fault or seismic source, as based on geologic and seismologic data. Based on the maximum earthquake from deterministic analyses (DSHA). There may be multiple MCEs for a site, each from a different fault or seismic source.
- Controlling Earthquake or Maximum Design Earthquake (MDE): The earthquake that is expected to produce the strongest level of shaking at a site. Often used interchangeably with MCE (above), but is based on ground motions, not earthquake size. The MDE can be based on deterministic or probabilistic methods. For critical structures, the MDE may equal the MCE from a specific fault or seismic source. For other structures, the MDE is less than the MCE and may be based on probabilistic methods.
- Maximum Considered Earthquake (MCE): Used by the building codes and building code documents (IBC, ASCE 7-05, NEHRP, etc.) to define the 2%/50 year earthquake motion. It is the event considered to be applicable to building code design, and is based on probabilistic methods. Often confused with maximum credible earthquake. Only use MCE (considered) when talking about building codes, and always clarify up front which MCE is being discussed.

Earthquake Definitions

- Operating Basis or Operating Level Earthquake (OBE or OLE): The earthquake for which a structure is designed to remain operational, with the damage being readily repairable following the event. The OBE/OLE is likely to occur during the design life of the structure. Based on probababilistic methods, and is generally the 50%/50 year earthquake motion.
- Design Earthquake: Used by the building codes as 2/3 of the MCE (considered) motion.
- Contingency Level Earthquake (CLE): Earthquake event that is expected to produce significant damage, but damage that is repairable. Based on probabilistic method, and is generally the 10%/50 year earthquake motion.
- Controlling source(s) – earthquake with the greatest hazard, may be more than one source if they control in different period ranges.

2010 Oregon Structural Specialty Code

Based on the 2009 International Building Code®

Ground motions are from USGS for bedrock shaking and modified by NEHRP Provisions for Site Conditions.

USGS
science for a changing world

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EARTHQUAKES   HAZARDS   LEARN   PREPARE

Lower 48 States Maps and Data

2008

- Maps
- Data
- Source Code
- Catalogs
- Faults Database Search
- Documentation

Additional Information

- Fact Sheet
- Cascadia Subduction Zone
- Earthquake Hazard in New Madrid Seismic Zone Remains a Concern

2002

- Maps
- Data
- Source Code
- Faults Database Search
- Documentation

Additional Information

- Open File Report
- Seismic Hazrds Investigation of Puget Sound
- Earthquake Swarm near Trinidad, CO

BUILDING SEISMIC SAFETY COUNCIL

of the National Institute of Building Sciences

Program on Improved Seismic Safety Provisions

2003 Edition

NEHRP RECOMMENDED PROVISIONS FOR SEISMIC REGULATIONS FOR NEW BUILDINGS AND OTHER STRUCTURES (FEMA 450)

Part 1: Provisions

NEHRP Recommended Seismic Provisions

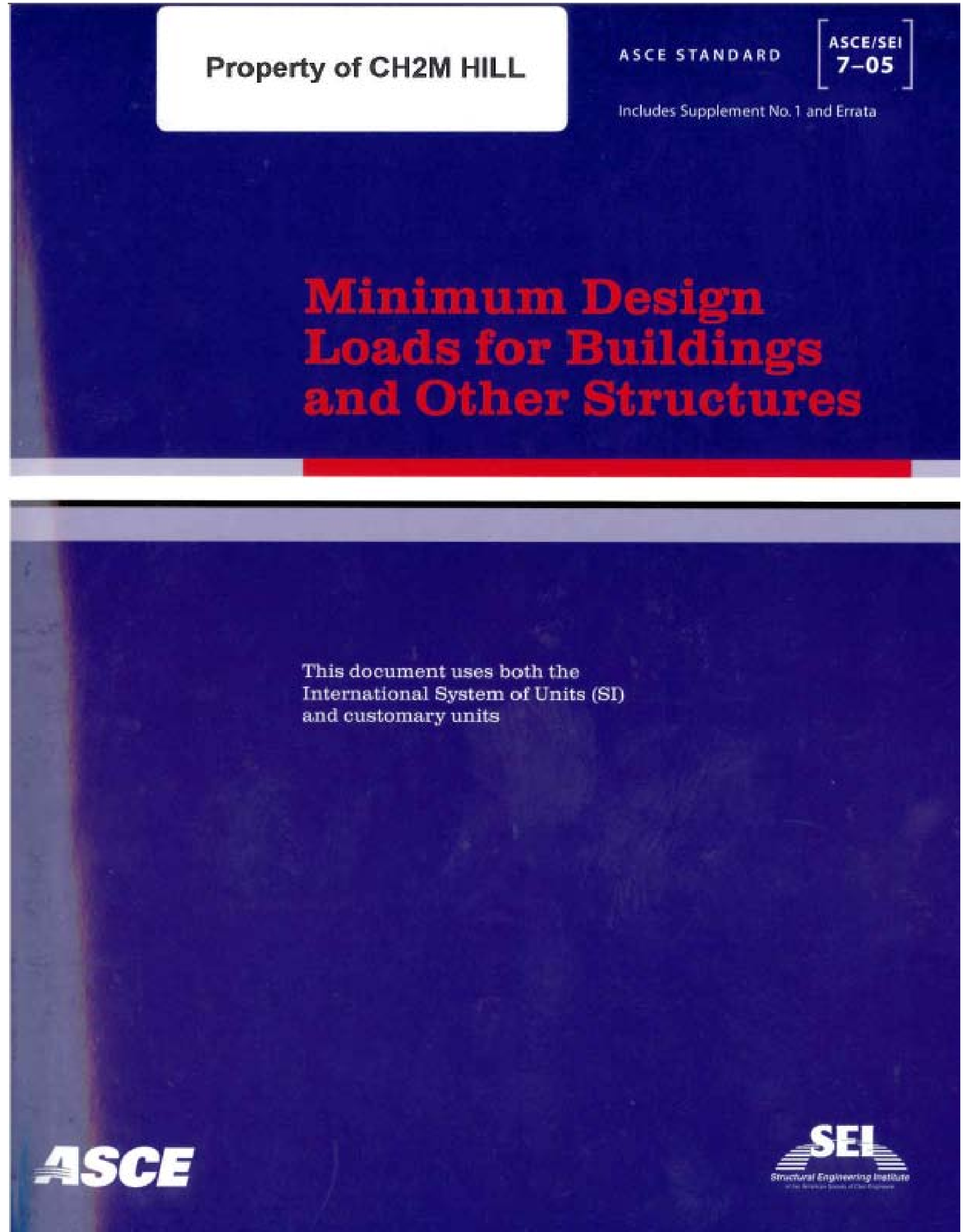
for New Buildings and Other Structures

FEMA P-750 / 2009 Edition

FEMA

nehrp

IBC references ASCE 7-05 (to be 7-10).



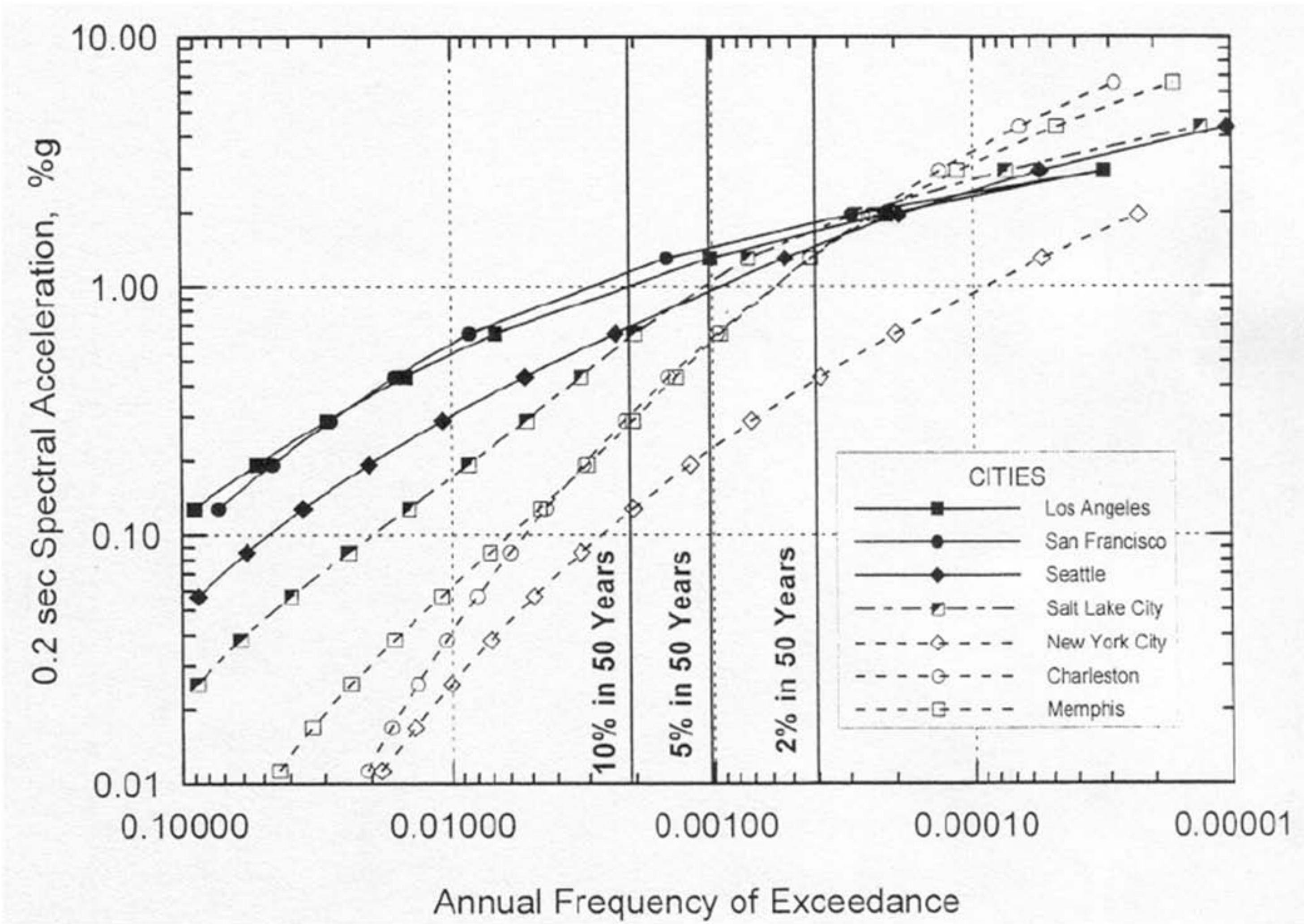
Code Usage

- 2006 IBC
  - Use 2002 USGS
  - Use 2003 NEHRP
  - USE ASCE 7-05
- 2009 IBC/2010 OSSC
  - Use 2002 USGS
  - Use 2003 NEHRP
  - USE ASCE 7-05
- 2012 IBC
  - Use 2008 USGS
  - Use 2009 NEHRP
  - USE ASCE 7-10

Need to use documents that are specific for the code being used.

IBC Code is based on 2%/50yr motions (currently)

USGS Seismic Hazard Curves for Various Cities



3.3 GENERAL PROCEDURE

3.3.1 Mapped acceleration parameters. The parameters S_S and S_1 shall be determined from the respective 0.2 sec and 1.0 sec spectral response accelerations shown on Figures 3.3-1 through Figures 3.3-14.

3.3.2 Site coefficients and adjusted acceleration parameters. The maximum considered earthquake (MCE) spectral response acceleration parameters S_{MS} and S_{M1}, adjusted for site class effects, shall be determined using Eq. 3.3-1 and 3.3-2, respectively:

$$S_{MS} = F_a S_S \quad (3.3\text{-}1)$$

and

$$S_{M1} = F_v S_1 \quad (3.3\text{-}2)$$

where *Fa* and *Fv* are defined in Tables 3.3-1 and 3.3-2, respectively.

Table 3.3-1 Values of Site Coefficient F_a

Site Class	**Mapped MCE Spectral Response Acceleration Parameter at 0.2 Second Period** [a]				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	—[b]	—[b]	—[b]	—[b]	—[b]

[a] Use straight line interpolation for intermediate values of S_S.
[b] Site-specific geotechnical investigation and dynamic site response analyses shall be performed.

Table 3.3-2 Values of Site Coefficient F_v

Site Class	Mapped MCE Spectral Response Acceleration Parameter at 1 Second Period [a]				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	—[b]	—[b]	—[b]	—[b]	—[b]

[a] Use straight line interpolation for intermediate values of S_1.
[b] Site-specific geotechnical investigation and dynamic site response analyses shall be performed.

3.3.3 Design acceleration parameters. The parameters S_{DS} and S_{D1} shall be determined from Eq. 3.3-3 and 3.3-4, respectively:

$$S_{DS} = \frac{2}{3} S_{MS} \qquad (3.3\text{-}3)$$

and

$$S_{D1} = \frac{2}{3} S_{M1} \qquad (3.3\text{-}4)$$

3.3.4 Design response spectrum. Where a design response spectrum is required by these *Provisions* and site-specific procedures are not used, the design response spectrum shall be developed as indicated in Figure 3.3-15 and as follows:

1. For periods less than or equal to T_0, S_a shall be taken as given by Eq. 3.3-5:

$$S_a = 0.6\frac{S_{DS}}{T_0}T + 0.4S_{DS} \tag{3.3-5}$$

2. For periods greater than or equal to T_0 and less than or equal to T_S, S_a shall be taken as equal to S_{DS}.
3. For periods greater than T_S and less then or equal to T_L, S_a shall be taken as given by Eq. 3.3-6:

$$S_a = \frac{S_{D1}}{T} \tag{3.3-6}$$

4. For periods greater than T_L , S_a shall be taken as given by Eq. 3.3-7.

$$S_a = \frac{S_{D1}T_L}{T^2} \tag{3.3-7}$$

where:

S_{DS} = the design spectral response acceleration parameter at short periods

S_{D1} = the design spectral response acceleration parameter at 1 second period

T = the fundamental period of the structure (sec)

T_0 = $0.2S_{D1}/S_{DS}$

T_S = S_{D1}/S_{DS}

T_L = *Long-period* transition period shown in Figure 3.3-16 (conterminous U.S. except California), Figure 3.3-17 (California), Figure 3.3-18 (Alaska), Figure 3.3-19 (Hawaii), Figure 3.3-20 (Puerto Rico), and Figure 3.3-21 (Guam and Tutuila).

IBC (code-based) design spectra.

Buildings designed following code provisions are assumed to have a margin of collapse of 1.5.

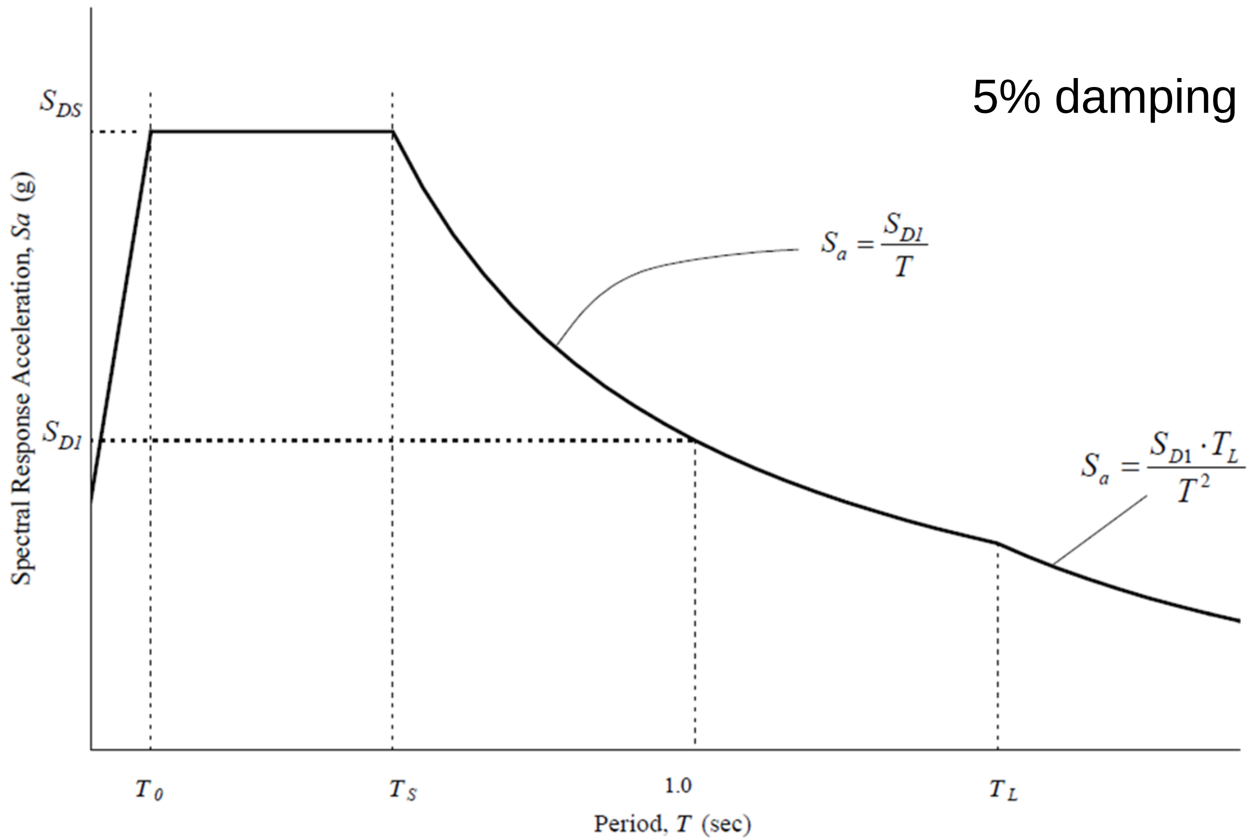
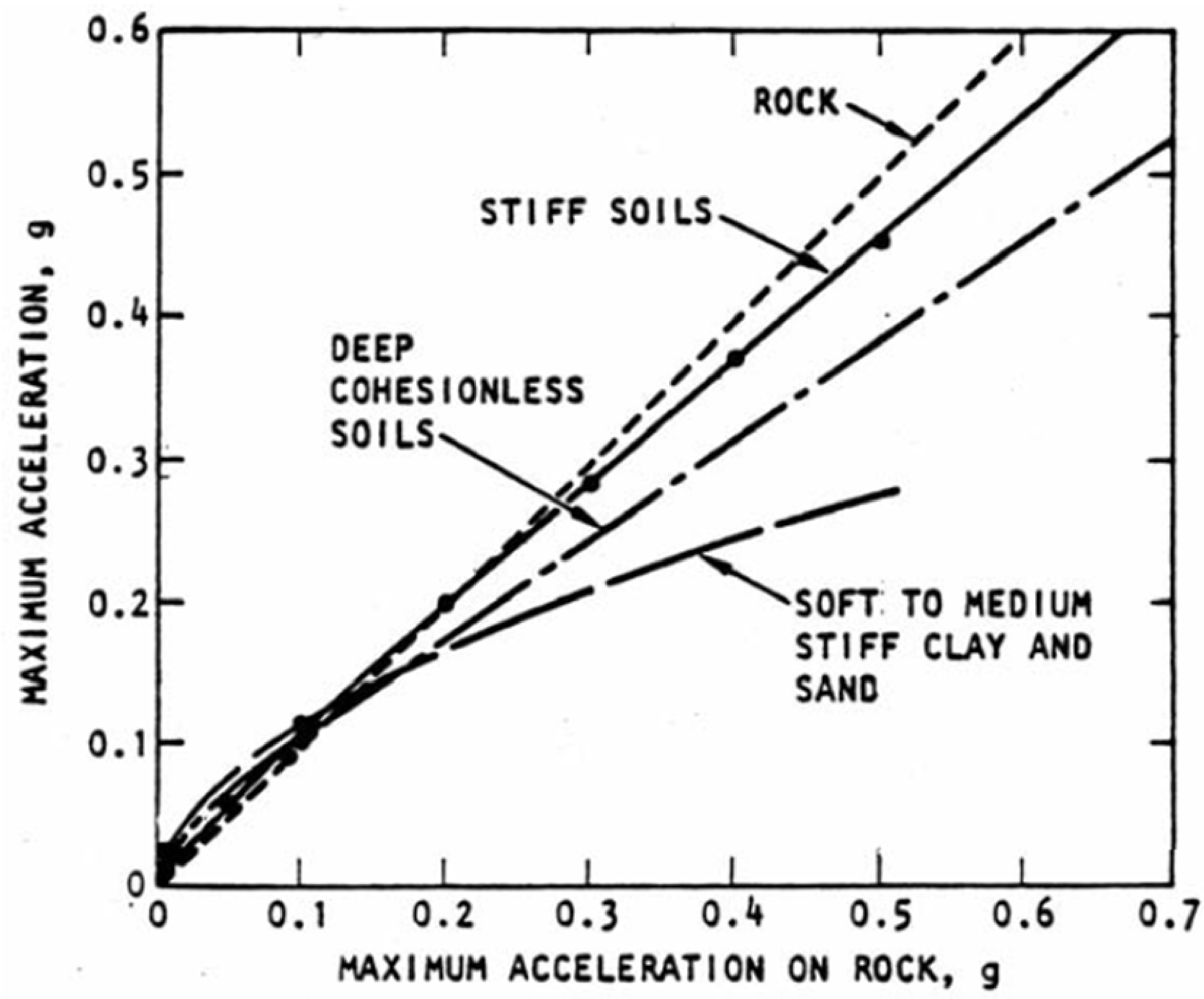


Figure 3.3-15 Long-Period transition Period.

Do not use this figure, but use for understanding of response. The Deep Cohesionless curves is unconservative (see next slide).



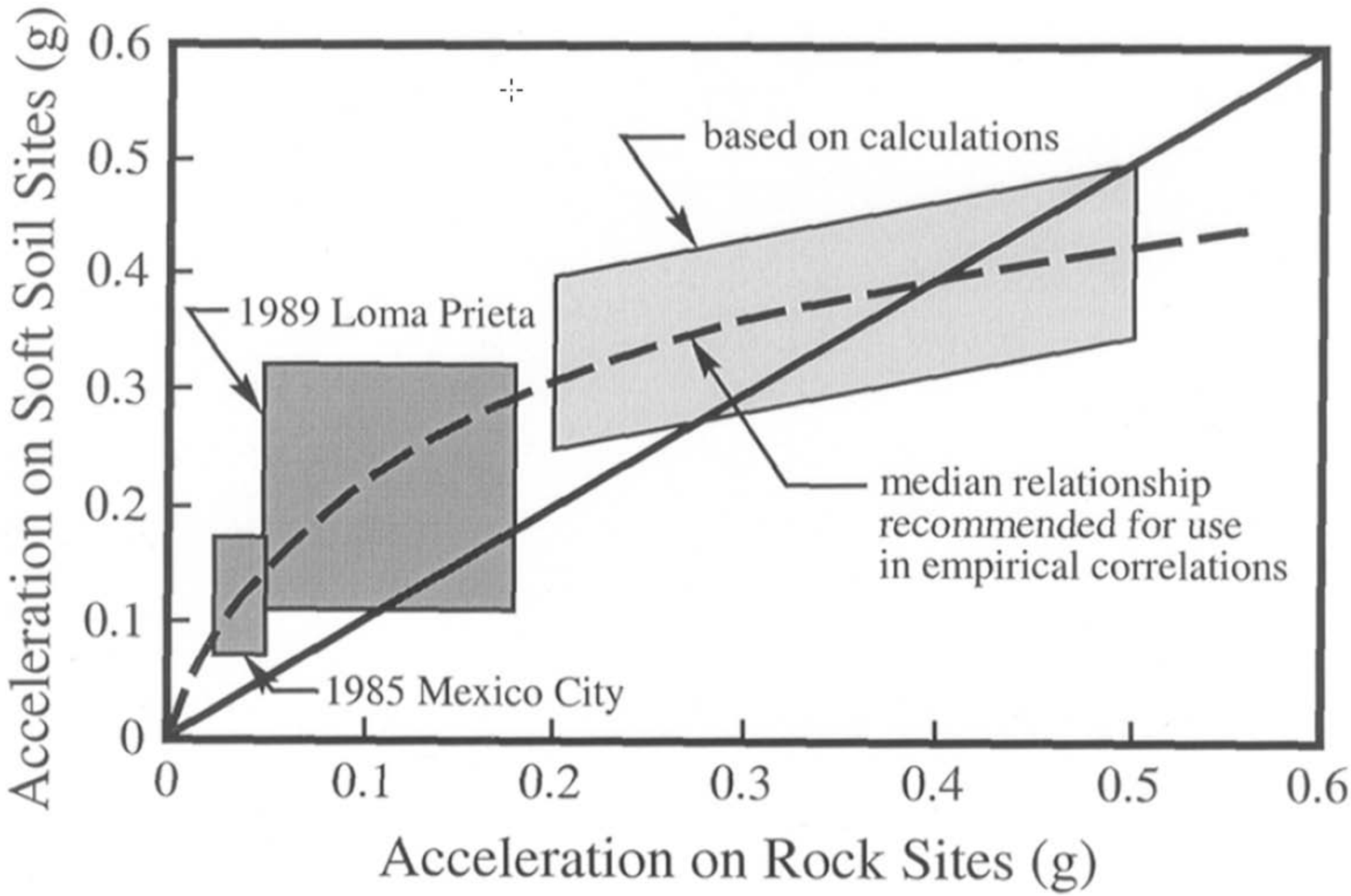
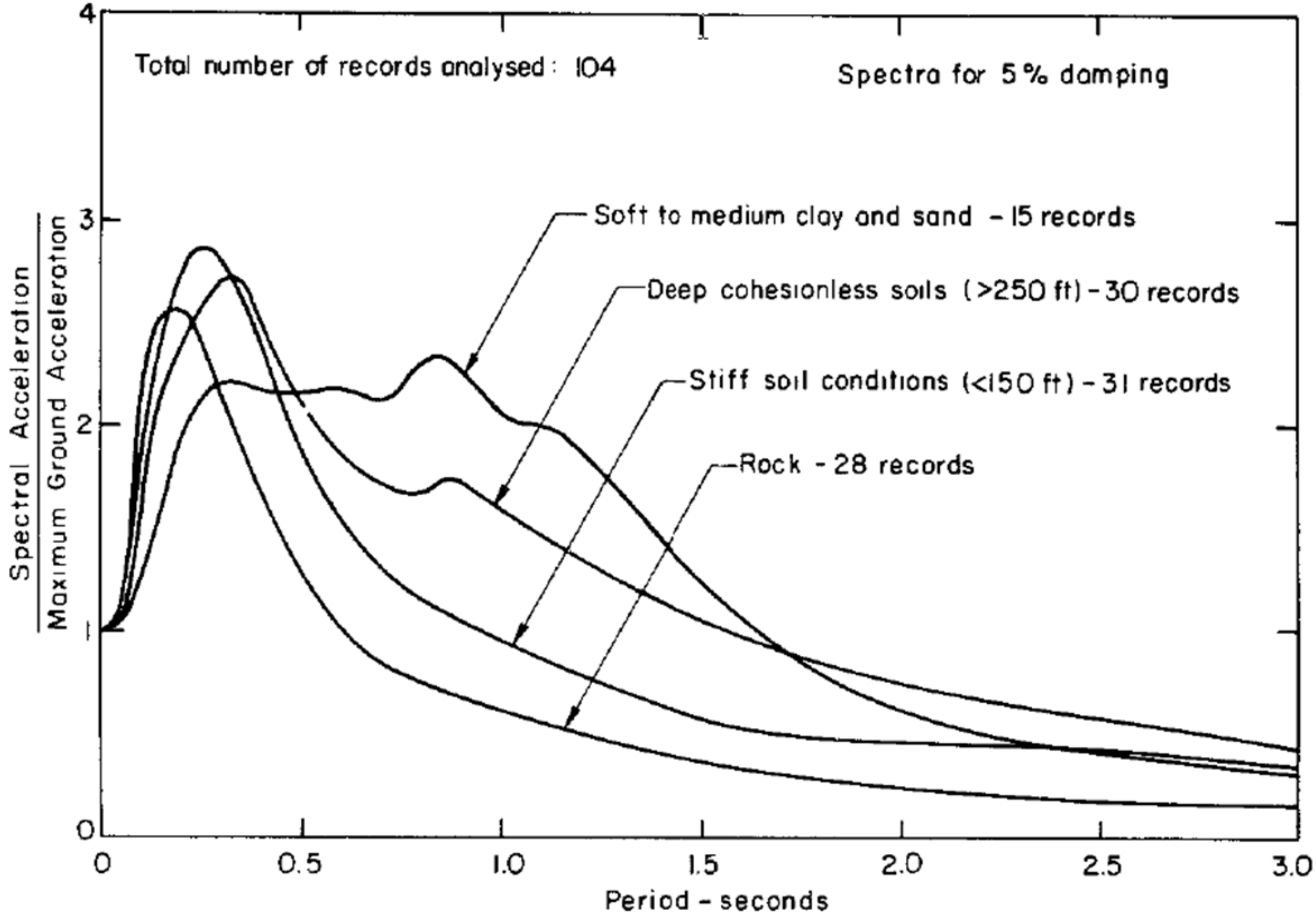


Figure C3.3.2-5. Relationships between maximum acceleration on rock and other local site conditions (Idriss, 1990, 1991).



Total number of records analysed: 104
Spectra for 5% damping
Soft to medium clay and sand - 15 records
Deep cohesionless soils (>250 ft) - 30 records
Stiff soil conditions (<150 ft) - 31 records
Rock - 28 records
Spectral Acceleration / Maximum Ground Acceleration
Period - seconds
0
1
2
3
4
0.5
1.0
1.5
2.0
2.5
3.0

from 2003 NEHRP same as 2006 IBC

Table 3.3-1 Values of Site Coefficient F_a

Site Class	Mapped MCE Spectral Response Acceleration Parameter at 0.2 Second Period[a]				
	$S_S \leq 0.25$	$S_S = 0.50$	$S_S = 0.75$	$S_S = 1.00$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	—[b]	—[b]	—[b]	—[b]	—[b]

[a] Use straight line interpolation for intermediate values of S_S.
[b] Site-specific geotechnical investigation and dynamic site response analyses shall be performed.

from 2003 NEHRP
same as 2006 IBC

Table 3.3-2 Values of Site Coefficient F_v

Site Class	Mapped MCE Spectral Response Acceleration Parameter at 1 Second Period[a]				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	—[b]	—[b]	—[b]	—[b]	—[b]

[a] Use straight line interpolation for intermediate values of S_1.
[b] Site-specific geotechnical investigation and dynamic site response analyses shall be performed.