Selected Strong-Motion Records For Analysis of Base-Isolated Buildings

by

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Nine strong-motion records selected for input ground motion in performing dynamic analysis of base-isolated buildings are presented in this report. These records are:

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Earthquake</th>
<th>Faulting Type</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) El Centro Array #6</td>
<td>1979 Imperial Valley</td>
<td>Strike-slip</td>
<td>USGS</td>
</tr>
<tr>
<td>2) El Centro Array #7</td>
<td>1989 Loma Prieta</td>
<td>Strike-slip</td>
<td>USGS</td>
</tr>
<tr>
<td>3) Lexington Dam Left Abut.</td>
<td>1992 Landers</td>
<td>Strike-slip</td>
<td>SCE</td>
</tr>
<tr>
<td>4) Hollister - S St. &amp; Pine</td>
<td>1992 Petrolia</td>
<td>Thrust</td>
<td>CSIMIP</td>
</tr>
<tr>
<td>5) Lucerne Valley SCE Sta.</td>
<td>1994 Northridge</td>
<td>Thrust</td>
<td>CSIMIP</td>
</tr>
<tr>
<td>6) Yermo - Pre Station</td>
<td>1994 Northridge</td>
<td>Thrust</td>
<td>CSIMIP</td>
</tr>
<tr>
<td>7) Petrolia - Fire Station</td>
<td>1994 Northridge</td>
<td>Thrust</td>
<td>CSIMIP</td>
</tr>
<tr>
<td>8) Sylmar - County Hosp. Lot</td>
<td>1994 Northridge</td>
<td>Thrust</td>
<td>CSIMIP</td>
</tr>
<tr>
<td>9) Newhall - LA County Fire Sta.</td>
<td>1994 Northridge</td>
<td>Thrust</td>
<td>CSIMIP</td>
</tr>
</tbody>
</table>

For each record, the processed-data plots are presented in the following order:

- Phase 2 (Vol. 2) data: Instrument and baseline-corrected acceleration, velocity and displacement. The data for first 40 seconds are plotted with equal scaling for all three components. The Usable Data Bandwidth used in the processing is indicated on the plots (see Definition of Usable Data Bandwidth).

- Phase 3 (Vol. 3) data: Response spectra. The pseudo-velocity spectra (PSV), the pseudo-acceleration (PSA) and the displacement spectra (SD) are presented on a tripartite logarithmic plot for each channel for 0%, 2%, 5%, 10% and 20% damping. The spectra are plotted for periods within the Usable Data Bandwidth (see Usable Data Bandwidth). The absolute acceleration spectra (AS) are plotted against period with linear-linear scaling from 0 to 6 seconds. Three channels are plotted on a single page.
For ease of comparison, the data are plotted with equal scaling for all records.

Lucerne Record An important special record is the Lucerne record from the Landers earthquake. This record is unusual in that the instrument SMA-2, owned by Southern California Edison (SCE), is quite nonstandard and its calibration at long periods can be a problem. CSMP has processed the raw data provided by SCE (decoded from the original instrument voltages by Kinematics) to include periods up to 5 seconds. This period was chosen because the instrument tests done by Prof. Hudson at Caltech several years ago showed the instrument had good calibration up to at least this period.

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The filter bands for each record are indicated on the plots for the Phase 2 and Phase 3 data. In standard processing, the digitized data are processed and filtered using ormsby filters. The data are first low-pass filtered using a high-frequency filter with a corner frequency of 23 Hz and a roll-off termination frequency of 25 Hz. Then the data are high-pass filtered using a low-frequency filter with a corner frequency of 0.07 Hz and a roll-off termination of 0.05 Hz. Therefore, the Phase 2 data is the result of the digitized data being filtered by the bandpass filter $H(f)$ with ramps as shown in the figure:

The **Usable Data Bandwidth** is defined as the band between frequencies $f_u$ and $f_l$, where $f_u$ and $f_l$ are the -3 dB points on the high-frequency and low-frequency ramps, respectively. The value of $H(f)$ is approximately equal to 0.7 for -3 dB (see Notes). The user should only use these data for analyses within this bandwidth.

Notes:

1) The values of $f_u$ and $f_l$ can be calculated from the corner frequencies ($f_{11}$, $f_{12}$) and the roll-off termination frequencies ($f_{21}$, $f_{22}$) used in the processing by using the formulas $f_u = f_{11} + 0.3 \times (f_{12} - f_{11})$ and $f_l = f_{21} - 0.3 \times (f_{22} - f_{21})$. For example, the Usable Data Bandwidth for data bandpass-filtered with ramps at 0.30 to 0.60 Hz and 21.0 to 23.0 Hz is 0.51 Hz to 23.6 Hz (0.042 to 2.0 seconds period).

2) It is common in signal processing to plot $20 \log_{10}|H(f)|$ versus frequency, and express the ordinate value in decibels (abbreviated dB). Accordingly, 0 dB corresponds to a value of $H(f)$ equal to 1; 20 dB is equivalent to $H(f) = 10$, and -20 dB corresponds to $H(f) = 0.1$. Thus, at the -3 dB frequency point, the amplitude of the transfer function, $H(f)$ is reduced to 0.7, while the power transmitted by the filter, $P(f)$, is reduced to 0.5.
IMPERIAL VALLEY EARTHQUAKE OF OCTOBER 15, 1979
EL CENTRO, ARRAY 6, HUSTON RD., CHN 2: UP
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.03-1.17 TO 23.0-25.0 Hz. 00342-50000-00000.00 083095.1623-ELCENT06

ACCELERATION (G/SEC/SEC)

VELOCITY (G/SEC)

DISPLACEMENT (IN)

MAX = 1662.8
MAX = -56.4
MAX = 21.3
EL CENTRO, ARRAY 6, HUSTON RD.: CSMIP S/N 942

IMPERIAL VALLEY EARTHQUAKE
OCTOBER 15, 1979

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.13 TO 23.6 HZ
(0.04 TO 7.81 SEC)

RECORD ID: U0942-50000-00000-00

RESPONSE SPECTRA: PSV, PSA & SD
DAMPING VALUES: 0, 2, 5, 10, 20%
IMPERIAL VALLEY EARTHQUAKE OF OCTOBER 15, 1979
EL CENTRO, ARRAY B, HUSTON RD.
ACCELEROMETER BANDPASSED-FILTERED WITH RANS AT .03-0.17 TO 23.0-25.0 Hz.
USGSID-50000-00000.00 083069.1630-ELCENTO
IMPERIAL VALLEY EARTHQUAKE OF OCTOBER 15, 1979
EL CENTRO, ARRAY 7, IMPERIAL VALLEY COLL. CHN 1: 230 DEG
INSTRUMENT-Corrected AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .03=.17 TO 23.0-25.0 HZ. US026-50000-00000.00 063095.1540-ELCENT07

**Acceleration**
- MAX = 453.6

**Velocity**
- MAX = 107.8

**Displacement**
- MAX = -41.4
IMPERIAL VALLEY EARTHQUAKE OF OCTOBER 15, 1979
EL CENTRO, ARRAY 7, IMPERIAL VALLEY COLL., CHN 2: UP
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .03-.17 TO 23.0-25.0 Hz. U5028-S0000-D0000.00 083095.1548-ELCENT07

MAX = -503.5

MAX = 25.9

MAX = -10.2
EL CENTRO, ARRAY 7. IMPERIAL VALLEY COLL.: CSMIP S/N 028

IMPERIAL VALLEY EARTHQUAKE
OCTOBER 15, 1979

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.13 TO 23.8 HZ
(0.04 TO 7.81 SEC)

RECORD ID: U5028-50000-00000.00

RESPONSE SPECTRA: PSV, PSA & SD
DAMPING VALUES: 0, 2, 5, 10, 20%
SANTA CRUZ MTNS (LOMA PRIETA) EARTHQUAKE OCTOBER 17, 1989 17:04 PDT
LEXINGTON DAM CHN 1: 90 DEG (LEFT ABUTMENT)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .05-.10 TO 23.0-25.0 HZ.  57180-52130-89292.02  081695.1412-08HPD

ACCELERATION (CM/SEC/SEC)

MAX = -401.6

VELOCITY (CM/SEC)

MAX = -95.0

DISPLACEMENT (CM)

MAX = 25.8
SANTA CRUZ MTNS (LOMA PRIETA) EARTHQUAKE  OCTOBER 17, 1989  17:04 PDT
LEXINGTON DAM  CHN 3:  0 DEG  (LEFT ABUTMENT)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .05-.10 TO 23.0-25.0 Hz.  57180-52130-06292.02  081895.1412-05hpo

MAX = -433.6

MAX = -84.4

MAX = -14.7
LEXINGTON DAM: CSMIP S/N 180

SANTA CRUZ MTNS (LOMA PRIETA) EARTHQUAKE
OCTOBER 17, 1989 17:04 PDT

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.09 TO 23.6 Hz
(0.04 TO 11.8 Sec)

RECORD ID: 57180-52130-89292.02

RESPONSE SPECTRA: PSV, PSA & SO
DAMPING VALUES: 0, 2, 5, 10, 20%
HOLLISTER - SOUTH STREET AND PINE DRIVE: CSMIP S/N 524

SANTA CRUZ MTS (LOMA PRIETA) EARTHQUAKE
OCTOBER 17, 1989 17:04 PDT

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.09 TO 23.6 Hz
(0.04 TO 11.8 SEC)

RECORD ID: 47524-51565-69291.02

RESPONSE SPECTRA: PSV, PSA & SD
DAMPING VALUES: 0, 2, 5, 10, 20%
LANDERS EARTHQUAKE OF JUNE 28, 1992
LUCERNE VALLEY CHN 1: L
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .12-.24 Hz 23.0-25.0 Hz.
S00601-V0000-00000.00 083195.1544-05HPOD

MAX = -599.4

MAX = 25.7

MAX = -0.62

TIME (SEC)
0 10 20 30 40

ACCELERATION (G)

VELOCITY (G)

DISPLACEMENT (G)

0 -1000 -800 -600 -400 -200 0 200 400 600 800 1000

0 -150 -100 -50 0 50 100 150

0 -80 -60 -40 -20 0 20 40 60 80
LANDERS EARTHQUAKE
JUNE 28, 1992

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.20 TO 23.6 HZ
0.04 TO 4.90 SEC

RECORD NO: SD0601-V0000-00000.00

RESPONSE SPECTRA: PSV, PSA & SD
DAMPING VALUES: 0, 2, 5, 10, 20%
LANDERS EARTHQUAKE (PRELIM. PROCESSING)  JUNE 28, 1992 04:58 POT
YERMO - FIRE STATION  CHN 3: 270 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .05-.07 TO 23.0-25.0 HZ.  22074-51695-92189.02  101192.0031-05HPD

MAX = -240.0

MAX = -50.8

MAX = 41.3

TIME (SEC)
0  5  10  15  20  25  30  35  40
LANDERS EARTHQUAKE (PRELIM. PROCESSING)
JUNE 28, 1992 04:58 PDT

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.06 TO 23.6 Hz
(0.04 TO 15.6 SEC)

RECORD ID: 22074-516695-921999.02

RESPONSE SPECTRA: PSV, PSA & 50
DAMPING VALUES: 0, 2, 5, 10, 20%
LANDERS EARTHQUAKE (PRELIM. PROCESSING) JUNE 28, 1992 04:58 PDT
VERMILION FIRE STATION
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .05-.07 TO 23.0-25.0 Hz.
2207H-S1895-20148-02 15145E.0048-0049

CHN 1: 90 DEG
DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 2: UP
DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 3: 270 DEG
DAMPING VALUES: 0, 2, 5, 10, 20%
CAPE MENDOCINO EQ. (PRELIM. PROCESS.)  APRIL 25, 1992 11:06 PDT
PETROLIA CHN 1: 90 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .05-.07 TO 23.0-25.0 HZ.  89156-52597-92118.03 112192.1640-05HPD

MAX = 549.4

MAX = -89.5

MAX = 580.6
PETROLIA: CSMIP S/N 156

CAPE MENDOCINO EQ. (PRELIM. PROCESS.)
APRIL 25, 1992 11:06 PDT

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.06 TO 23.6 Hz
(0.04 TO 15.6 sec)

RECORD ID: 89156-52597-92118-03

RESPONSE SPECTRA: PSV, PSA & SOP
DAMPING VALUES: 0, 2.5, 10, 20%
NORTHRIDGE EARTHQUAKE, JANUARY 17, 1994 04:31 PST
SYLMAR - COUNTY HOSP. PARKING LOT, CHN 1: 90 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .06-.12 TO 23.0-25.0 HZ.
24514-55254-94017.03 020394.1803-05HPD

MAX = 592.6

MAX = -76.9

MAX = -15.2

TIME (SEC)
SYLMAR - COUNTY HOSP. PARKING LOT: CSMIP S/N 514

NORTHRIDGE EARTHQUAKE
JANUARY 17, 1994 04:31 PST

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.10 TO 23.8 Hz
0.04 TO 5.88 SEC

RECORD ID: 24514-95254-84017.09

RESPONSE SPECTRA: PSV, PSA & SD
DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 1: 90 DEG

CHN 2: UP

CHN 3: 360 DEG
NORTHRIDGE EARTHQUAKE  JANUARY 17, 1994 04:31 PST  
NEWHALL - LA COUNTY FIRE STATION - CHN 11: 90 DEG  
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT  
FILTER BAND: .06-.12 TO 23.0-25.0 HZ.  24273-52499-94021.02  020394.1908-GSHPO  

ACCELERATION (G's/sec)  
MAX = -571.6  

VELOCITY (cm/sec)  
MAX = -74.8  

DISPLACEMENT (cm)  
MAX = 17.6  

TIME (SEC)  
0  5  10  15  20  25  30  35  40
NEWHALL - LA COUNTY FIRE STATION  CSMIP S/N 279

NORTH RIDGE EARTHQUAKE
JANUARY 17, 1994 04:31 PST

PHASE 3 DATA: RESPONSE SPECTRA
USABLE DATA BANDWIDTH: 0.10 TO 23.6 Hz
(0.04 TO 9.00 SEC)

RECORD ID: 24278-82499-94021.02

RESPONSE SPECTRA: PSV, PSA & SO
DAMPING VALUES: 0, 2, 5, 10, 20%
NORTHridge EARTHQUAKE  JANUARY 17, 1994 04:31 PST  
NEWHALL - LA COUNTY FIRE STATION  
ACCELEROMETER BANDPASS-FILTERED WITH RAPS AT 0.5-12 TO 23.0-25.0 HZ.  
24279-52499-94051.02  02/25/94 09:47-559493

CHN 1: 90 DEG

DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 2: UP

DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 3: 360 DEG

DAMPING VALUES: 0, 2, 5, 10, 20%