Plots to Accompany Tape: WHITTIER87-CALTECH

Processed Strong-Motion Data from Caltech stations for the Whittier Earthquake of 1 October 1987

California Strong Motion Instrumentation Program (CSHIP)

GSM 91-10

The attached plots are for 10 stations (1 building and 9 ground response) that recorded the Whittier earthquake at the California Institute of Technology (caltech). The plots for these stations are arranged as follows:

<table>
<thead>
<tr>
<th>Set No.</th>
<th>Station Name</th>
<th>No. of Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pasadena - Caltech Millikan Library</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Pasadena - Caltech Mudd Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Pasadena - Caltech Bridge Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Pasadena - Caltech Keck Laboratory</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>Pasadena - Caltech Brown Athletic Center</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Pasadena - Caltech California Blvd. House</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>Pasadena - Caltech Athenaeum</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Pasadena - Caltech Industrial Relations Center</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Pasadena - Caltech Lura Street House</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Pasadena - Caltech Kresge Seismological Laboratory</td>
<td>3</td>
</tr>
</tbody>
</table>

The set of plots for each station is identified by the above station number at the upper corner of each page. For each station, four sets of plots are presented in the following order:

1. Phase 1 (Vol. 1) data: uncorrected accelerations. Acceleration for the first 22 seconds is plotted with a common amplitude scaling factor for all channels. Three channels are plotted on one page. The plots for the data beyond 30 seconds are also included for long duration records.

2. Phase 2 (Vol. 2) data: instrument and baseline-corrected acceleration, velocity and displacement. The data for the first 22 seconds are plotted with equal scaling for all channels unless otherwise specified. Three channels are plotted on each page. The frequency bandwidth of the Phase 2 data, as determined during processing, is indicated on the plots.

3. Phase 3 (Vol. 3) data: response spectra. The pseudo-velocity spectra (PSV), the pseudo-acceleration spectra (PSA), the displacement spectra (SD) for 0%, 2%, 5%, 10% and 20% dampsings are presented on a tripartite logarithmic plot for each channel. The spectra are plotted for periods within the usable data bandwidth.

4. Phase 1 (Vol. 3) data: response spectra. The absolute acceleration spectra (SA) for 0%, 2%, 5%, 10% and 20% dampsings are plotted against period with linear-linear scaling.

**USABLE DATA BANDWIDTH**

The filter bands for each record are indicated on the plots for the Phase 2 and Phase 3 data. The digitized data are processed and filtered using Ormsby filters. The data are first low-pass filtered by a high-frequency filter (typically with a corner frequency of 23 Hz and a roll-off termination frequency of 25 Hz), and then high-pass filtered by a low-frequency filter. The corner frequency of the low-frequency filter may be different for different records. 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:

![Diagram showing Usable Data Bandwidth](image)

The **usable data bandwidth** is defined as the band between frequencies $f_u$ and $f_d$, where $f_d$ and $f_u$ 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 $f_d$ can be calculated from the corner frequencies ($f_{HC}$, $f_{LC}$) and the roll-off termination frequencies ($f_{L}$, $f_{U}$) used in the processing by using the formulas:

\[ f_u = f_{HC} + 0.3 \times (f_{HC} - f_{L}) \]
\[ f_d = f_{LC} - 0.3 \times (f_{L} - f_{U}) \]

For example, the usable data bandwidth for data bandpass-filtered with ramps at 0.25 to 0.50 Hz and 23.0 to 25.0 Hz is 0.42 Hz to 23.6 Hz.

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, $H^2(f)$, is reduced to 0.5.
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH MILLIKAN LIBRARY
UNCORRECTED ACCELEROMGRAM 80045-C0146-87000.03 090789.1049-QM87A045

CHN 1: 360 DEG (ROOF. AT WEST END) MAX = 0.541 G

CHN 2: UP (ROOF. AT WEST END) MAX = -0.251 G

CHN 3: 90 DEG (ROOF. AT WEST END) MAX = -0.273 G
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA - CALTECH MILLIKAN LIBRARY
UNCORRECTED ACCELEROMGRAM  B0045-C0146-87000.03  0907899.1049-QM07A045

CHN 4: 360 DEG  (6TH FLOOR, AT WEST END)  MAX = 0.350 G

CHN 5: 90 DEG  (6TH FLOOR, AT WEST END)  MAX = 0.198 G

CHN 6: 360 DEG  (ROOF, AT EAST END)  MAX = 0.554 G

ACCELERATION (G)  TIME (SEC)
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH WIL LIKAN LIBRARY
UNCORRECTED ACCELEROMGRAM 80045-C0146-87000.03 090789.1049-QWB7A045

CHN 4: 360 DEG

(6TH FLOOR, AT WEST END) MAX = 0.350 G

CHN 5: 90 DEG

(6TH FLOOR, AT WEST END) MAX = 0.198 G

CHN 6: 360 DEG

(ROOF, AT EAST END) MAX = 0.554 G

ACCELERATION (G)

TIME (SEC)

0 5 10 15 20 25 30

-0.6 0 0.6

-0.4 0 0.4
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH MILLIKAN LIBRARY CHN 3: 90 DEG (ROOF, AT WEST END)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 20-.40 TO 20-0.50 HZ. 80645-00146-87000.03 090789.1149-QW87A045

ACCELERATION (GM/SEC^2)

VELOCITY (GM/SEC)

DISPLACEMENT (CM)

TIME (SEC)
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH MILLIKAN LIBRARY
CHN 1: 360 DEG (ROOF, AT WEST END)
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .20-.40 TO 23-0-25.0 HZ.
B0045-C0146-87000.03 090789.1223-QWB7AG45

RESPONSE SPECTRA: PSV, PSA & SD
- FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%

FREQUENCY (HZ)

PSV, FS (IN/SEC)

PSA (G)

SD (IN)

PERIOD (SEC)

.10 1 10

10 100

1000

10 100

100
RESPONSE SPECTRA: PSV, PSA & SD

FOURIER AMPLITUDE SPECTRUM: FS

DAMPING VALUES: 0.2, 5, 10, 20%

FREQUENCY (HZ)
RESPONSE SPECTRA: PSV, PSA & SD

FOURIER AMPLITUDE SPECTRUM: FS

DAMPING VALUES: 0.2, 5, 10, 20%
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 POT
PASADENA - CALTECH MILLIKAN LIBRARY
CHN 5:  360 DEG  (ROOF. AT EAST END)
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT 0.20-40 TO 23.0-25.0 Hz.
B0045-C0146-87000.03  090789.1223-QW67AO45

RESPONSE SPECTRA: PSV, PSA & SD  
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 20%
RESPONSE SPECTRA: PSV, PSA & SB
- FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 20%

FREQUENCY (HZ)

PSA (G)

SD (IN)

PSV, FS (IN/SEC)

FS (IN/SEC)

PERIOD (SEC)
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42  PDT
PASADENA - CALTECH MILLikan LIBRARY
CHN 10: 90 DEG  (BASEMENT, AT NORTH WALL)
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .20-.40 TO 23.0-25.6 HZ.
80045-60146-87070.03  090789.1223-QW07A045

RESPONSE SPECTRA:  PSV, PSA & SD  ---- FOURIER AMPLITUDE SPECTRUM:  FS
DAMPING VALUES:  0.2, 5.10, 20%

<table>
<thead>
<tr>
<th>FREQUENCY (HZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
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<tr>
<td>1</td>
</tr>
<tr>
<td>.1</td>
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<td>.01</td>
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<table>
<thead>
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<th>PERIOD (SEC)</th>
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<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>1000</td>
</tr>
</tbody>
</table>

PSL/FS (IN/SEC)
PSV/FS (OM/SEC)
PSA (G)
SD (IN)
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH MILLIKAN LIBRARY
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT 20-40 TO 23.0-25.0 HZ.
BS045-0148-67000-03 090789.1223-WB7A045

**CHN 4: 360 DEG**
6TH FLOOR, AT WEST END

**DAMPING VALUES: 0.2, 5, 10, 20%**

**CHN 5: 90 DEG**
6TH FLOOR, AT WEST END

**DAMPING VALUES: 0.2, 5, 10, 20%**

**CHN 6: 360 DEG**
ROOF, AT EAST END

**DAMPING VALUES: 0.2, 5, 10, 20%**

PERIOD (SEC)
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA - CALTECH KRESGE SEISMO. LAB.
UNCORRECTED ACCELEROMGRAM  80054-S3000-88000.02.1  042789.1043-QW87A054

CHN 1: 90 DEG
MAX = 0.113 G

CHN 2: UP
MAX = 0.076 G

CHN 3: 360 DEG
MAX = 0.094 G

ACCELERATION (G)

TIME (SEC)
Mittie Earthquake  October 1, 1987  07:42 PDT
Pasadena - Caltech Kresge Seismo. Lab.
CHN 1: 90 deg
Accelerogram Bandpass-Filtered with Ramps at .20-.40 to 23.0-.26.0 Hz.
B054-53000-B000-02 1 060189 1020-DMB7A054

Response Spectra: PSV, PSA, & SD
Fourier Amplitude Spectrum: FS
Damping Values: 0, 1, 5, 10, 20%
RESPONSE SPECTRA: PSV, PSA & SD

FOURIER AMPLITUDE SPECTRUM: FS

DAMPING VALUES: 0.1, 5, 10, 20%
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH ATENAEUM
CHN 1: 270 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .20-1.0 TO 23.0-25.0 HZ.
80053-50124-87000-02 090789-0930-0807A053

RESPONSE SPECTRA: PGV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%

FREQUENCY (HZ)

PSA (G)

SD (IN)

SD (CM)

PSV, FS (IN/SEC)

FS, FS (IN/SEC)

PERIOD (SEC)
RESPONSE SPECTRA: PSV, PSA & SD — FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT  
PASADENA - CALTECH INDUSTRIAL REL. CNTR  CHN 3: 90 DEG  
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT  
FILTER BAND:  20-.40 TO 23.0-25.0 HZ.  80051-50911-87000.03  050289.0032-0WR7A051  

**ACCELERATION (cm/sec/sec)**  
MAX = 233.8  

**VELOCITY (cm/sec)**  
MAX = -7.94  

**DISPLACEMENT (cm)**  
MAX = -0.92  

**TIME (sec)**
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH INDUSTRIAL REL. CNTR
CHN 1: 180 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .20- .40 TO 23.0-25.0 HZ.
80051-S0911-87000.03 060289.0850-QW87A051

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

FOURIER AMPLITUDE SPECTRUM: FS

DAMPING VALUES: 0, 3, 5, 10, 20%
RESPONSE SPECTRA: PSV, PSA & SD

FOURIER AMPLITUDE SPECTRUM: FS

DAMPING VALUES: 0.2, 5, 10, 20%

FREQUENCY (HZ)

PSA (G)

SD (IN)

SD (CM)

PSV/FS (IN/sec)

PSV/FS (m/SEC)

PERIOD (SEC)
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA  -  CALTECH WUDD LABORATORY
CHN 1:  90 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT  20-40 TO 23.0-25.0 HZ.
80050-50621-87000.04  060186.1239-QM67A050

RESPONSE SPECTRA: PSV, PSA & SD  —  FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
RESPONSE SPECTRA: PSA, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2.5, 10, 20%
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH MUDD LABORATORY
CHN 3: 360 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAWS AT 20-40 TO 23.0-25.0 Hz.
80020-50211-87000.04 040199.1239-2QB7A050

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

FREQUENCY (HZ)

PSA (G)

SD (IN)

SD (CM)

PSV, FS (IN/SEC)

PERIOD (SEC)
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA – CALTECH KECK LABORATORY
UNCORRECTED ACCELEROMGRAM  B0049-50126-87000.03  042789.1679-CW87A049

CHN 1: 360 DEG  MAX = 0.177 G

CHN 2:  UP  MAX = 0.092 G

CHN 3:  270 DEG  MAX = −0.145 G

ACCELERATION (G)  TIME (SEC)
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH KECK LABORATORY CHN 1: 360 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .20 - 40 TO 23.0 - 25.0 HZ. 86040-50126-87000.03 050189.2115-QW870A049

MAX = 167.0

MAX = 16.0

MAX = 1.84
RESPONSE SPECTRA: PSV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 20%
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA - CALTECH KECK LABORATORY
CHN 3:  270 OEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .20-.40 TO 23.0-25.0 HZ.
6049-50126-8700.00  060189.1228-QW87A349

RESPONSE SPECTRA: PSA, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.1, 1.0, 10%
CHN 1: 360 DEG
DAMPING VALUES: 0.2.5.10.20%

CHN 2: UP
DAMPING VALUES: 0.2.5.10.10%

CHN 3: 270 DEG
DAMPING VALUES: 0.2.5.10.20%
WHITIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA - CALTECH LURA STREET HOUSE
CHN 1:  180 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .2- .40 TO 23.0-25.0 HZ.
80040-51468-87000. 01. 1  080189. 1206-QW67A048

RESPONSE SPECTRA: PSV, PSA & SD  — — FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 20%
WHITTIER EARTHQUAKE  OCEMBER 1, 1987  07:42 PD
PASADENA - CALTECH CALIF. BLVD. HOUSE  CHN 1: 360 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.1-40 TO 23.0-25.0 HZ  80047-50914-87000.02  050189.1749-DMB7A047

MAX = 231.6

MAX = 19.9

MAX = -2.02

TIME (SEC)
WHITTIER EARTHQUAKE OCTOBER 1, 1987 07:42 PDT
PASADENA - CALTECH CALIF. BLVD. HOUSE CHN 3: 270 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 20-.40 TO 23.0-25.0 HZ. 80047-50914-B7004.02 050169.1749-QWB7A047

MAX = 162.1

MAX = 9.34

MAX = -1.02

TIME (SEC)
RESPONSE SPECTRA: PSV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
RESPONSE SPECTRA: PSI, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  97:42 PDT
PASADENA - CALTECH BROWN ATHLETIC CENTER
UNCORRECTED ACCELEROMETER  80046-51257-07000.03  042889.1019-QM07A046

CHN 1: 270 DEG
MAX = 0.133 G

CHN 2: UP
MAX = -0.148 G

CHN 3: 180 DEG
MAX = -0.163 G

ACCELERATION (g)

TIME (SEC)
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA - CALTECH BROWN ATHLETIC CENTER CHN 2: UP
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 20.4 TO 23.0-25.0 HZ  80046-51257-87000.03  050189.1623-QM57A046

MAX = -135.3
MAX = -3.82
MAX = -0.47
RESPONSE SPECTRA: PSV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 20%

FREQUENCY (HZ)

PSA (4)
SD (IN)
SD (CM)

PSV, FS (IN/SEC)
PSV, FS (M/SEC)

PERIOD (SEC)
WHITTIER EARTHQUAKE  OCTOBER 1, 1987  07:42 PDT
PASADENA - CALTECH BROWN ATHLETIC CENTER
CHN 2: UP
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .20-40 TO 23.0-25.0 HZ.
80048-S1257-B7000.03  050189.1055-DNM7A046

RESPONSE SPECTRA: PSV, PSA & SD  FOURIER AMPLITUDE SPECTRUM: F,S
DAMPING VALUES: 0, 2, 5, 10, 20%