PROCESSED STRONG MOTION DATA FROM THE SAN SALVADOR EARTHQUAKE OF OCTOBER 10, 1986

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
OFFICE OF STRONG MOTION STUDIES
REPORT OSMS 86-07

1986

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PROCESSED STRONG MOTION DATA
FROM THE
SAN SALVADOR EARTHQUAKE
OF OCTOBER 10, 1986

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Report No. OSMS 86-07
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INTRODUCTION

Strong-motion records were recovered from nine strong motion accelerographs of the El Salvador Geotechnical Investigation Center Strong Motion Network (ESCIGSMN) following the damaging San Salvador earthquake of October 10, 1986. The strong motion stations were installed in San Salvador by the Geotechnical Investigation Center (CIG) following the 1965 San Salvador earthquake.

During the October 10, 1986 earthquake, relatively large accelerations (in excess of 70% g) were recorded at close-in distances from an earthquake of only moderate magnitude (5.4 Ms). Because of the importance of these data not only to El Salvador but also to California, where close-in strong motion data are very limited, the California Strong Motion Instrumentation Program digitized and processed these data for distribution to engineers, seismologists and others concerned with the seismic safety problem.

The first part of this report includes a short overview of the earthquake characteristics, key aspects of the data (station distances, peak acceleration, etc.), and a description of the accelerogram digitization procedures. Reproductions of the film accelerograms are included in the Appendix A. In Appendix B the results of the accelerogram digitization and processing are presented through a series of plots of the acceleration, velocity and displacement, and the absolute acceleration and relative velocity response spectra.

EARTHQUAKE CHARACTERISTICS

The San Salvador earthquake of October 10, 1986 occurred approximately 3 km south of downtown San Salvador, the capital of El
Salvador (Figure 1). Surface rupture was observed at many places in the capital city (Geology Team, CIG, San Salvador). Openings of 15 to 30 cm were observed at many places on several faults trending north 40 degrees west.

Heavy damage occurred in the city of San Salvador and many high-rise buildings collapsed or were severely damaged. In addition, most buildings of the traditional 'bahareque' and adobe types of construction collapsed in the heavily damaged areas. (Bahareque is adobe-like construction, but with a lattice of wooden sticks similar to bamboo embedded in the walls.)

Detailed investigations of the geological and seismological aspects of the earthquake are being conducted by teams of the Centro de Investigaciones Geotecnicas and comprehensive reports on the earthquake are planned (R. Linares, CIG).

Using data from the seismic network of CIG, David Harlow of the U.S. Geological Survey and the CIG staff have estimated the following earthquake origin time and hypocenter:

- Origin Time: 17:49 GMT (11:49 local time), 10 October 1986
- Hypocenter: 13.673N, 89.203W, 8 km depth
- Magnitude: 5.4 Ms
- Intensity: VII - IX (M.M.)

The magnitude estimate (Ms) was obtained by CIG. NEIS (Denver, Colorado) also estimated a surface wave magnitude value of 5.4.

**STRONG-MOTION STATIONS AND INSTRUMENTATION**

The locations of the earthquake epicenter and of the ESCIGSNN strong motion stations in the San Salvador area are shown on the map in Figure 1. Records from a total of nine accelerographs were recovered; two other instruments malfunctioned. Eight of the nine
Fig. 1. Strong motion stations in the vicinity of the 10 October 1986 San Salvador earthquake. The stations are identified in Table 1. The stippled areas indicate the approximate locations of central San Salvador and Nueva San Salvador.

- Stations which recorded the earthquake
- Stations which did not record
- Earthquake epicenter
<table>
<thead>
<tr>
<th>Station Code</th>
<th>Station Name</th>
<th>Station No.</th>
<th>Station Coordinates</th>
<th>Site Geology</th>
<th>Structure Type</th>
<th>Size</th>
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<td>Industrias Unidas S.A.</td>
<td>1</td>
<td>13.703, 89.102</td>
<td>Fluvialite pumice</td>
<td>1-story</td>
<td>reinforced</td>
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<tr>
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<td></td>
<td></td>
<td>conc. bldg.</td>
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</tr>
<tr>
<td>IGN</td>
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<tr>
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<td>Geotech Investig Centr</td>
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<td>2-story</td>
<td>reinforced</td>
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<tr>
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<td></td>
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<td></td>
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<td>seismic vault</td>
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</tr>
<tr>
<td>IVU</td>
<td>Inst Urban Construc</td>
<td>13</td>
<td>13.721, 89.206</td>
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<td>reinforced</td>
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Footnotes:
# - Distance given relative to the presently estimated epicenter at 13.673W, 89.203N.
* - Volume 1 peak acceleration values.
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<th>Peak Velocity (cm/sec)</th>
<th>Peak Displ. (cm)</th>
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<** Peak values for OBS are from visible part of record; actual values may be higher.

<** Peak values for 2nd and 3rd channels at HCR roof instrument are estimates.
Operational instruments were SMA-1's and one was an AR-240. Records were recovered at a total of seven stations; three instruments were deployed at one station (Hotel Camino Real). The locations of these seven stations are indicated on Figure 1, and reproductions of the film accelerograms recovered are presented in Appendix A. All seven stations were within a distance range of 1 to 6 km from the epicenter. The station codes are cross-referenced to the station names in Table 1. Table 1 also lists geographic coordinates, epicentral distances, peak values of motion, and the site geology for each of the stations.

The geologic materials underlying the stations, as well as the city of San Salvador itself, can be generally characterized as fluvialite pumice. Lomnitz and Schulz (1966) cited the potential importance of this subsurface geology during the 1965 earthquake. However, it should be noted that the depth of the fluvialite pumice varies markedly, from 10 meters west of the city of San Salvador to 200 meters east of the city, near Lake Ilopango. CIG is developing more detailed information on the subsurface geology at specific sites.

A description of the building at each strong-motion site is given in Table 1. Note that all instruments are located in buildings from 1 to 10 stories in height except the instrument at the seismological observatory (OBS), which was located in a seismic vault. Unfortunately a section of that record, which may contain the strongest shaking, is not readable (see Appendix A). As a result OBS has not been digitized, and Appendix B contains processed results for only eight of the nine accelerograms.
ACCELEROMETER DIGITIZATION AND PROCESSING

The digitization results presented in this report were obtained using the CSMIP computer-driven optical scanning system. This facility is patterned after the system developed at the University of Southern California (Trifunac and Lee, 1979; Lee and Trifunac, 1979). In these systems, a direct photographic negative copy of the film accelerometer is mounted on a rotating drum, which is scanned by a photodensitometer. The photodensitometer is mounted on a carriage moving perpendicular to the rotational direction of the drum. The resulting x-y array of optical density values is converted to raw time series through several trace-reconstruction steps. Baseline and other corrections are then applied to this raw data to obtain the acceleration data for further processing and spectral analysis. The subsequent post-digitization processing is similar to that first developed at the California Institute of Technology (Trifunac and Lee, 1973). As discussed in greater detail below, a change of operators was made to improve the instrument correction procedure at high frequencies. In addition, the results of system noise analyses are used to guide the selection of filter corner frequencies in CSMIP processing.

Seven of the eight accelerograms digitized for this report are from SMA-1 accelerographs which record on film 7 cm (2.75 in) wide. One accelerometer is from an AR-240 accelerometer which records on photographic paper approximately 30 cm (12 in) wide.

The sequence of steps in processing these records is summarized in the following:

1. For the SMA accelerograms the film record, 7 cm wide and 22 cm (22 seconds) long (or less), is contact-copied onto a 25 cm by 25
cm high-contrast photographic negative. For the one AR-240
accelerogram, the photographic paper record, 30 cm wide and about 22
cm (11 seconds) long, is contact-copied onto two 25 cm negative
panels so the 30 cm width can be accommodated by the 25 cm capacity
of the scanner.

2. The negative containing the accelerogram image is digitized
into x and y coordinates by the optical scanner. The scanner
sampling rate used for these records is 200 samples per centimeter
in x and y. This corresponds to a time step of 0.005 second (200
samples/sec) and an acceleration increment of 0.003 g, nominal, for
the SNA records, and 0.0025 second (400 samples/sec) and 0.001 g,
respectively, for the AR-240 record.

3. Vol. I Processing. The reference (fixed) traces are
subtracted from the acceleration traces to remove any spurious
film-movement or drift effects. The axis of zero acceleration is
determined. The time-mark traces are used to obtain an accurate
time scale. The starting times of the acceleration channels are
adjusted so any time phasing error from one channel to another is
less than 0.02 sec (i.e., less than one time increment in the
Vol. II data). The instrument sensitivities are used to scale
ordinate values to accelerations.

4. Vol. II Processing. The Vol. I acceleration data are
interpolated to obtain exactly 200 points/sec sampling (100 Hz
Nyquist frequency). These instrumental data are corrected to true
acceleration using a simple finite-difference instrument correction
operator. A high-frequency Ormsby filter with a corner frequency of
23 Hz and a termination frequency of 25 Hz is applied. The data are
then decimated to 50 points/second (25 Hz Nyquist frequency). As
discussed in Shakal and Ragsdale (1984) this order (instrument correction before decimation) improves the accuracy of the instrument correction procedure at high frequencies while still using the same simple operator employed in the original Caltech code (Trifunac and Lee, 1973). The acceleration data are initially corrected for long-period errors by using a low-frequency Ormsby filter with a ramp from 0.05 to 0.07 Hz. Velocity and displacement are integrated from acceleration and filtered using the same low-frequency Ormsby filter as for the acceleration. To prevent the introduction of spurious long-period energy through aliasing, an Ormsby filter rather than a running mean filter is used prior to the decimation associated with the long period filtering (Shakal, 1982; Shakal and Ragsdale, 1984).

5. Vol. III Processing. The response spectra for periods from 0.04 to 15 seconds and damping values of 0, 2, 5, 10 and 20 per cent of critical are calculated from the accelerations obtained in Step 4. The Fourier amplitude spectral values are also computed for these periods. A preliminary plot of the PSV spectrum is generated for use in filter selection.

6. The Vol. II Processing of Step 4 is repeated, but with a new low-frequency Ormsby filter to remove long-period noise in the record. The corner frequency of the filter used depends on the signal-to-noise ratio in the record and the noise level of the digitizing system. The long-period intersection of the PSV spectrum obtained in Step 5 and the CSNIP system average noise spectrum shown in Fig. 2 (from Shakal and Ragsdale, 1984) indicates the long-period limit of useful information. An iterative procedure is used, with the filter corner set at progressively shorter periods in order to
remove the long period noise while preserving as much of the signal as possible. The final value of the filter corner used is shown on the titles of the plots. The acceleration, velocity and displacement time histories obtained using this filter are the final Vol. II data written on a magnetic tape and presented in this report.

The final pseudo-velocity response spectrum (PSV), relative displacement response spectrum (RD), pseudo-acceleration response spectrum (PSA), and the Fourier amplitude spectrum (FS) are computed using the final filter settings. These are plotted for this report, and are included on the magnetic tape.

Note that the optimal filter corner is obtained for each accelerogram; all accelerograms from a single earthquake are not restricted to have the same filter corner frequency. However, the same filter corner is used for all channels from a single accelerogram, to make channel-to-channel comparisons convenient.

As discussed above, Fig. 2 shows the average noise spectrum for the CSMIP digitization system. It is also useful to consider the noise characteristics in terms of actual time-domain amplitudes. Fig. 3 shows typical noise amplitudes present in acceleration, in velocity, and in displacement time histories obtained for different long-period filter cutoff settings. For example, Fig. 3 indicates that for a filter cutoff near 10 seconds, the expected noise level is near 0.002 g in acceleration, 1 cm/sec in velocity, and 1 cm in displacement.
Fig. 2. Noise-level spectra (PSV, 20% damping) for the CSNIP digitization system (from Shaked and Ragasale, 1984).
Fig. 3. Processing noise present in a typical acceleration (left), velocity (middle) and displacement (right) record processed with a long-period filter cut-off period ranging from 0.5 sec to 15 secs (from Shakal and Ragsdale, 1984).
Particular Characteristics of Accelerograms

Several of the film accelerograms recorded during this earthquake are of low contrast, as apparent in Appendix A. In addition, some of the records have other characteristics which required special care in the processing and could impact noise levels in the processing results.

The record from CIG is of high quality, although short (approximately 9 seconds in length). In view of this length, the long period filter corner was constrained to 9 seconds or less. As it turned out, the filter used for the CIG record (a ramp from 0.08 to 0.16 Hz, or 6.25 to 12.5 seconds period) was satisfactory for the other records and so a single filter cutoff is used for the entire data set.

The IGN record is of reasonable quality, although the scratching required special care in the curve following procedures. The OBS record, as noted above, was not digitized because of the opaque strip across the record between 2 and 5 seconds. The IVU record is unusual in that it is from an AR-240 accelerograph. This particular record (photographic paper rather than film) has very low contrast, especially during the strong shaking phase. The record was digitized successfully, though the results may have higher intrinsic noise because of the problems resulting from the low contrast. Note that the vertical channel malfunctioned, so only the two horizontal channels were digitized.

At the Hotel Camino Real (HCR), the basement record presented no particular problems once the scratching was resolved. However, the second floor and roof records present special problems because they have no fixed, or reference, traces. The upper time trace was
used in lieu of a fixed trace in the film drift correction procedure discussed above. Although the film drift correction is expected to be less accurate as a result, no evidence of increased processing noise is apparent in the final results. In the roof record, the lower two acceleration traces are severely intertwined; only the top trace has been digitized and included in this report.

An important aspect of the Hotel Camino Real roof record is that post-earthquake inspection of the roof instrument indicated that the instrument anchor was loose at that time (A. Kiremidjian, personal communication). However, CIG technical staff performed routine maintenance at the site one week before the earthquake and report that the anchor was tight at that time. The anchor may have become loose during the earthquake shaking itself. The record does not have the characteristic high-frequency signal which has been observed in a few known cases of loose instruments.

In general, the noise levels present in the digitization results for this set of records are lower than normally present for records processed by the CSMIP system. This is a positive effect of the short record length of these accelerograms. The processing noise level tends to increase with the length of the record for the CSMIP system. As a result, the noise levels actually present for most of the processed records in this data set are probably lower than those indicated in Figures 2 and 3 in the previous section.
ACKNOWLEDGMENTS

The accelerographs of the El Salvador Geotechnical Investigation Center Strong Motion Network (ESCIGSMN) were installed and maintained by Manuel Calderon and Alvaro Hidalgo Urrutia of CIG. The U.S. Geological survey provided training in techniques of installing and maintaining strong-motion accelerographs to M. Calderon and A. Hidalgo. The accelerographs were made available to CIG through the U.S. Agency for International Development.

The efforts of Mete Sozen of the University of Illinois made it possible for Roberto Linares to bring the accelerographs to CSIMP shortly after the earthquake so they could be quickly digitized and results made available to guide reconstruction in San Salvador.

REFERENCES


DATA AVAILABILITY

The processed data for the strong motion records presented in this report are available on a magnetic tape (named SANSALVADOR86) which contains the Vol. I, II and III results. The tape is written in a standard CSMIP format, similar to that of the Caltech tapes, which is documented in Shakal and Huang (1985). The tape is available in standard ASCII or EBCDIC blocked (unlabeled) coding, and can be obtained at nominal cost from either of the two institutions:

Office of Strong Motion Studies
Division of Mines and Geology
California Department of Conservation
630 BerCut Drive
Sacramento, California  95814

Dpto. de Sismologia
Centro de Investigaciones Geotécnicas
Apdo. Postal 06-109
San Salvador, El Salvador
APPENDIX A

REPRODUCTIONS OF
FILM ACCELEROGRAMS

Note: Because of the low contrast of the original film accelerograms portions of the following reproductions are of low legibility.
Institute Urban Construction
(Nivel/Floor: 1)

Record 90013-A0013-B6283.01

Max. Accel.

1 sec.

Reak

90°

0.37 g

Up

Channel Malfunction

180°

0.72 g
APPENDIX B
PLOTS OF PROCESSED DATA

Organization and order of Plots

In this appendix, the processed data plots and related information for each station are presented in the following order:

1. Colored title page.

2. Uncorrected accelerograms (Vol. I data). The three components of the acceleration for the first 22 seconds are plotted with a common scaling factor and a common 22-second time axis length (which corresponds to a time scale of approximately 1 second per centimeter, like an SMA film). This plot is followed by another of the full digitized length with each component individually scaled.

3. Instrument and baseline-corrected acceleration, velocity and displacement (Vol. II data). The filters used are indicated on the plots. There is one 22-second plot per component; they are plotted with equi scaling for all three components.

4. Absolute acceleration response spectra (Vol. III data). The absolute acceleration (Sa) spectra for 5% damping are plotted, all three components on a single page, with linear-linear scaling.

5. Response and Fourier amplitude spectra (Vol. III data). One spectral plot per component. The spectra are plotted for periods from 0.04 second (25 Hz) to 9.0 seconds (0.11 Hz) in these figures. This period range corresponds to the final filters used in the Vol. II processing.
NATL. GEOGRAFICAL INST. (IGN)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
NATL GEOGRAPHICAL INST - (NIVEL/FLOOR: 1)
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT 0.8-16 TO 33.0-25.0 Hz.
90005-50005-86283.03  102886 2007-05884A05

CHNL 1: 270 DEG
DAMPING VALUE: 3X

CHNL 2: UP
DAMPING VALUE: 3X

CHNL 3: 180 DEG
DAMPING VALUE: 3X

PERIOD (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
NATL GEORAPICAL INST – (NIVEL/FLOOR: 1)
CHN 2: UP
ACCELEROGRAM BANDPASS-FILTERED WITH RAMPS AT .08-.16 TO 23.0-25.0 HL
90005-50005-86283 03 102886.0159-0538A005

RESPONSE SPECTRA: PSV, PSA & SD – FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:45 GMT
NATL GEOGRAFICAL INST - (LEVEL/FLOOR: 1)
CHN 3: 180 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT: 0.05 TO 23.0-25.0 KHZ.
90005-50005-86283.03 102886.0159-0586A005

RESPONSE SPECTRA: PSV, PSA & SD  FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5.10, 20%
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
GEOTECH INVESTIG CENTR - (LEVEL/FLOOR: 1)
UNCORRECTED ACCELEROMETER 90006-50006-86283.01  102786.2340-0586A006

CHN 1: 180 DEG
MAX = 0.423 G

CHN 2: UP
MAX = 0.399 G

CHN 3: 90 DEG
MAX = -0.705 G

ACCELERATION (G)
TIME (SEC)
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
GEOTECH INVESTIG CENTR. - (NIVEL/FLOOR-1) CHN 3: 90 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.16 TO 23.0-25.0 HZ. 90066-50066-BS283.01 102886.0003-QS86A006

MAX = -480.8

MAX = 80.0

MAX = -11.9

TIME (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
GEOTECH INVESTIG CENVR - (FLOOR/LEVEL: 1)
ACCELEROMAP BANDPASS-FILTERD WITH RAMPS AT 0.8 - 2.6 TO 23.0 - 25.0 HZ.
50008-50009-88283.01  10/86  8800-00803008

CHN 1: 180 DEG
DAMPING VALUE: 5X

CHN 2: UP
DAMPING VALUE: 5X

CHN 3: 90 DEG
DAMPING VALUE: 1X
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
GOTECH INVESTIG CENTR  -  (NIVEL/ FLOOR: 1)
CHN  1:  180 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMP  AT  0.08-0.16 TO 23.0-75.0 HZ.
9006-50006-860200.01  102864-0010-00864006

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

FREQUENCY (HZ)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986 17:49 GMT
GOTECH INVESTIG CENTR. - (LEVEL/FLOOR: 1)
CHN: 90 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT 0.08-16 TO 23.0-25.0 HZ.
90006-50006-66283.01 102866.0010-0566A006

RESPONSE SPECTRA: PSV, PSA & SD — — FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
INST. URBAN CONSTRUC. (IVU)
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
INST. URBAN CONSTRUC. - (LEVEL/FLOOR: 1) CHN 1: 90 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .08-16 TO 23.0-25.0 HZ. 90013-A0013-86283.01 111286.1731-OS86/A013A

MAX = 379.8

MAX = -39.2

MAX = -9.75

TIME (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
INST. URBAN CONSTRUC.  - (NIVEL/FLOOR: 1)  CHN 3: 180 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 08-.16 TO 23.0-25.0 Hz.  90013-A0013-86283.01  111286.1751-05664013A

MAX = 667.8

MAX = -55.6

MAX = -7.09
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:40 GMT
INST. URBAN CONSTRUC.  - (HIVEL/FLOOR: 1)
CPN 1:  90 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS A1 .08- 1.6 TO 21.0-25.0 HZ.
90013-A0013-88283-01  111286.175T-0586A013A

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

---

FREQUENCY (HZ)

PSA (G)

SD (IN)

SD (CM)

PSV/FS (IN/SQ/SEC)

PERIOD (SEC)
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
INST. URBAN CONSTRUCT. - (LEVEL/FLOR: 1)
CHN 3: 180 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAILS AT 0.8-16 TO 23.0-25.0 Hz.
90013-A0013-86283.D1 111286.1757-0586013A

RESPONSE SPECTRA: PSV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.7, 5, 10, 20%
HOTEL CAMINO REAL (HCR)
(SOTANO/BASAMENT)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:48 GMT
HOTEL CAMINO REAL - (SOTANO/BASEMENT)  CHN 1: 90 DEC
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND:  0.16 TO 23.0-25.0 HZ.  90014-50114-86283.01  102886.0128-QS86A114

MAX = 338.7

MAX = -32.3

MAX = -4.21

TIME (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL CAMINO REAL - (SOTANO/BASAMENT)
CHN 2:  UP
ACCELEROMETER BANDPASS-FILTERED WITH RAPMS AT .08-.16 TO 23.0-25.0 HZ.
90014-SD14-86283.01  102886.0148-Q98A114

RESPONSE SPECTRA:  PSV, PSA & SD  --  FOURIER AMPLITUDE SPECTRUM FS
DAMPING VALUES:  0, 2, 5, 10, 20%
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
HOTEL CAMINO REAL - (SOTANO/BASEMENT)
CHN 3: 0 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .08-.16 TO 23.0-25.0 HZ.
90014-50114-86283.01 102886.0148-0586A14

RESPONSE SPECTRA: PSV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2.5, 10, 20%
HOTEL CAMINO REAL (HCR)
(NIVEL/FLOOR: 2)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL CAMINO REAL - (NIVEL/FLOOR: 2)
UNCORRECTED ACCELEROMGRAM  90014-50214-86283-03  102886.1515-0586A214

CHN 1: 90 DEG
MAX = 0.691 G

CHN 2: UP
MAX = -0.365 G

CHN 3: 0 DEG
MAX = 0.529 G

TIME (SEC)
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
HOTEL CAMINO REAL - (NIVEL/FLOOR: 2)
UNCORRECTED ACCELEROMGRAM 90014-59214-86283 D3 102886. 1515-0586214

CHN 1: 50 DEG
MAX = 0.691 G

CHN 2: UP
MAX = -0.365 G

CHN 3: 90 DEG
MAX = 0.529 G

ACCELERATION (G)

TIME (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL CAMINO REAL - (LEVEL/FLOOR: 2)  CHN 2: UP
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 05. - 16 TO 23.0 - 25.0 HZ.  90014-50214-86283.03  102866.1541-DS86A214

MAX = 336.5

MAX = -17.4

MAX = -2.41

TIME (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL CAMINO REAL - (NIVEL/FLOOR: 2)  CHN 3: 0 DEG
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND:  0.8-16 TO 23.0-25.0 HZ.  90014-S0214-86283.03  102886.1541-0586A214

MAX = 493.9

MAX = -40.6

MAX = -13.9

TIME (SEC)
SAN SALVADOR EARTHQUAKE  
OCTOBER 10, 1986  17:49 GMT  
HOTEL CAMINO REAL  - (LEVEL/FLOOR: 2)  
CHN 1:  90 DEG  
ACCELEROMETER BANDPASS-FILTERED WITH RAMP AT .08-.16 TO 23.0-25.0 HZ.  
90014-50214-86283.03  102886.1713-QS86A214  

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

--- FREQUENCY (HZ) ---  
--- PERIOD (SEC) ---  
--- PSV, FS (IN/SEC) ---  
--- PSA (G) ---  
--- SD (IN) ---  
--- SD (CM) ---
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL CAMINO REAL  (LEVEL/FLOOR: 2)
CPN 2: UP
ACCELEROMETER BANDPASS-FILTERED WITH RAPS AT .08-.16 TO 23.0-25.0 HZ.
90014-50214-86283.03  102886.1713-QS86A214

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, 2, 5, 10, 20%

FREQUENCY (HZ)

PSA (G)

SD (IN)

SD (CM)

PSV/FS (IN/SEC)

PSV/FS (CM/SEC)

PERIOD (SEC)
HOTEL CAMINO REAL (HCR)
(AZOTEA/ROOF)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL CAMINO REAL  (AZOTEA/ROOF)
UNCORRECTED ACCELEROMETER  90014-S0314-86283.05  102786.1855-0586A314

MAX = 0.909 G

CHN 1: 90 DEG

ACCELERATION (G)

TIME (SEC)
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
HOTEL CAMINO REAL - (AZOTEA/ROOF)
UNCORRECTED ACCELEROMGRAM 90014-50314-86283.05 102786.1855-0986A314

MAX = 0.909 G

CHN 1: 90 DEG
SAN SALVADOR EARTHQUAKE OCTOBER 10, 1986 17:49 GMT
HOTEL CANIND REAL – (AZOTEA/ROOF)
ACCELEROMETER BANDPASS-FILTERED WITH RAMP AT 0.8 TO 23.0-25.0 Hz.
92214-02014-84183.05 1106881.05-35885A314

CHN 1: 90 DEC

DAMPING VALUE: 5%

ABSOLUTE ACCELERATION 1a (g)
RESPONSE SPECTRA: PSV, PSA & SD
FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 30%
CENTRO AMERICANA UNIV. (UCA)
SANTO DOMINGO EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT  
CENTRO AMERICANA UNIV.  -  (LEVEL/FLOOR: 1)  
UNCORRECTED ACCELEROMETER 90016-50016-86283.01  110686.1825-58848.016

CHIN 1: 180 DEG  MAX = -0.389 G

CHIN 2: UP  MAX = 0.236 G

CHIN 3: 90 DEG  MAX = 0.425 G

ACCELERATION (G)

TIME (SEC)
SAN SALVADOR EARTHQUAKE
OCTOBER 10, 1996 17:49 GMT
CENTRO AMERICANA UNIV. - (NIVEL/FLOOR: 1)
CHN 1: 180 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT 0.85-16.0 TO 23.0-25.0 HZ.
90016-50016-86283.01 110685.1907-0586AD16

RESPONSE SPECTRA: PSV, PSA & SD
-- FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
HOTEL SHERATON (HSH)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL SHERATON — (LEVEL/FLOOR: 1)
UNCORRECTED ACCELEROMGRAM  90018-50018-86203.06  111286.1824-QS86A018

CHN 1: 0 DEG
MAX = 0.219 G

CHN 2: UP
MAX = -0.150 G

CHN 3: 170 DEG
MAX = 0.318 G

ACCELERATION (G)

TIME (SEC)
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL SHERATON – (LEVEL/FLOOR: 1)
CHN 1: 0 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT .08-.16 TO 23.0-25.0 HZ.
90018-S001A-B2283.06  111286.1848-0586AD18

RESPONSE SPECTRA: PSV, PSA & SD
- FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL SHERATON   (NIVEL/FOLOOR: 1)
CHN 2: UP
ACCELEROMETER BANDPASS-FILTERED WITH RAPIDS AT 0.8-16 TO 23.0-25.0 Hz.
00018-50010-86283-06   111286-1848-0586A018

RESPONSE SPECTRA: PSV, PSA & SD  —  FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0.2, 5, 10, 20%
SAN SALVADOR EARTHQUAKE  OCTOBER 10, 1986  17:49 GMT
HOTEL SHERATON  -  (LEVEL/FLOOR: 3)
CHAN 3:  270 DEG
ACCELEROMETER BANDPASS-FILTERED WITH RAMPS AT 0.08-16 TO 23.0-25.0 HZ.
90018-50018-86283.06  111286.1848-0586A018

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