PROCESSED STRONG-MOTION DATA
FROM THE BASE-ISOLATED
SAN BERNARDINO COUNTY LAW AND JUSTICE CENTER
FOR THE UPLAND EARTHQUAKE OF 28 FEBRUARY 1990

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INTRODUCTION

Strong shaking was recorded during the 5.5 ML Upland earthquake of February 29, 1990 in the base-isolated San Bernardino County Law and Justice Center (Ref. 1). The building is located in Rancho Cucamonga, approximately 12 km from the earthquake epicenter. This report presents results of the digitization and processing performed on the record from this building.

The Law and Justice Center is instrumented with 16 accelerometers; 6 in the building and three accelerometers about 330 feet from the building to record free-field ground motion. The locations of the accelerometers are shown schematically in Figure 1. The accelerometers are connected to two centrally-located recorders. Sensors 1 to 13 are connected to one recorder and 14 to 19 are connected to the second. Strong-motion records were also obtained from this building during the 1985 Redlands earthquake (Ref. 2), the 1986 Palm Springs earthquake (Ref. 3), and the 1987 Whittier earthquake (Ref. 4). Although these records were of low amplitude, they have been digitized and the processed data are available from CSMIP.

The level of shaking during the 1990 Upland earthquake was significantly greater than that recorded during the previous events. The peak horizontal acceleration at the free-field site was 0.26 g. This is almost twice the amplitude at the foundation level. Figure 2 shows the accelerations in the transverse direction from the sensors located at the center of the building. The peak acceleration recorded at the foundation level (below the isolators) was 0.14 g. The peak acceleration values recorded by the three transverse sensors in the basement (above the isolators) range from 0.05 to 0.08 g. The peak motion at the roof was 0.16 g.

Comparison of the records above and below the isolators shows that high-frequency horizontal motions were filtered out by the isolator, which was also observed in the records from previous earthquakes. The period of the structure vibration during this event was near 0.75 second; this is longer than the 0.6 second period present in the other low-amplitude records. The differences in the horizontal motions at different levels in the structure can also be compared in the response spectra in Figure 3. They show a reduction at high frequency as well as amplification at the structural period.

PLOTS OF PROCESSED DATA

The processed data plots are presented in the following order:

1. The raw record for the first 22 seconds with all channels from a recorder shown on a single page. There are two recorders in the building.

2. Phase 1 (Vol. 1) data: uncorrected accelerations. Accelerations for the first 22 seconds are plotted with a common scaling factor for all channels; three channels are plotted on one page. These plots are followed by another set of plots of the full processed length (60 seconds), with each channel individually scaled.

3. Phase 2 (Vol. 3) data: instrument and baseline-corrected acceleration, velocity and displacement. The data for the first 22 seconds are plotted
Fig. 1. Locations of acceleration sensors in the San Bernardino County Law and Justice Center. Arrows show the location and positive direction of the accelerometers. Dots indicate positive direction out of the plane of the figure.
Fig. 2. Cross-section of the San Bernardino County Law and Justice Center and accelerations in the transverse direction at the roof, 2nd floor, basement (above the isolators) and foundation (below the isolators) during the Upland earthquake of February 28, 1990.

Fig. 3. Response spectra (5% damping) for motions in the transverse direction at the roof, 2nd floor, basement and foundation of the San Bernardino County Law and Justice Center from the Upland earthquake of February 28, 1990.
with equal scaling for all channels. The filter bandwidth, determined by signal and noise analyses during processing, is indicated on the plots.

4. Phase 3 (Vol. 3) data: response spectra. The pseudo-velocity spectra (PSV), the pseudo-acceleration spectra (PSA), the displacement spectra (SD), and the Fourier amplitude spectra (FS) are presented on a tripartite logarithmic plot for each channel. The spectra are plotted for periods within the filter bandwidth used in the Vol. 2 processing. In addition, the absolute acceleration spectra (SA) for 0%, 2%, 5%, 10%, and 20% dampings are plotted against period for periods from 0 to 2 seconds with linear-linear scaling.

REFERENCES


UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
UNCORRECTED ACCELEROMETER 23497-C0273-90050.01  033090.00443-QU0A497

-0.3  0  0.3
ACCELERATION (G)

0.3

CHN 1: UP  
(FOUNDATION, AT SOUTH WALL)  MAX = 0.092 G

CHN 2: UP  
(FOUNDATION, AT NORTH WALL)  MAX = -0.078 G

CHN 3: UP  
(BASEMENT, AT SOUTH WALL)  MAX = 0.107 G

0  5  10  15  20
TIME (SEC)
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
UNCORRECTED ACCELEROMETER 23497-C0275-90059.01  033090.0443-QU90A#97

CHN 4: UP  (BASEMENT, AT NORTH WALL)  MAX = 0.107 G

CHN 5: 360 DEG  (ROOF, AT WEST WALL)  MAX = -0.152 G

CHN 6: 360 DEG  (ROOF, AT CENTER)  MAX = -0.152 G

ACCELERATION (G)

TIME (SEC)
UPLAND EARTHQUAKE FEBRUARY 28, 1990 15:43 PST
RANCHO CUCAMUNGA - LAW & JUSTICE CENTER
UNCORRECTED ACCELEROMETER 23497-C0273-90059.01 033090.0443-0090A97

CHN 13: 360 DEG (FOUNDATION, AT EAST WALL) MAX = 0.128 G

ACCELERATION (G)

0.3

0

-0.3

TIME (SEC)

0 5 10 15 20
UPLAND EARTHQUAKE   FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
UNCORRECTED ACCELEROMETER 23497-C0110-90059.01  033090.1501-QU90A497B

CHN 1 (STA CHN 14): 90 DEG (ROOF, AT CENTER) MAX = 0.088 G

CHN 2 (STA CHN 15): 90 DEG (BASEMENT, AT CENTER) MAX = -0.043 G

CHN 3 (STA CHN 16): 90 DEG (FOUNDATION, AT CENTER) MAX = -0.114 G

ACCELERATION (G)

TIME (SEC)
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
UNCORRECTED ACCELEROMETER 23497-C0273-90059.01  033090.0443-QU90A497

CHN 1: UP  (FOUNDATION, AT SOUTH WALL)  MAX = 0.092 G

CHN 2: UP  (FOUNDATION, AT NORTH WALL)  MAX = -0.076 G

CHN 3: UP  (BASEMENT, AT SOUTH WALL)  MAX = 0.107 G

TIME (SEC)
UPLAND EARTHQUAKE FEBRUARY 28, 1990 15:43 PST
RANCHO CUCAMONGA — LAW & JUSTICE CENTER CHN 6: 3RD FLO (ROOF, AT CENTER)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.0-60 TO 23.0-25.0 HZ. 23497-C0273-90059.01 033090.1147-Q/90A497

MAX = -152.8

MAX = -16.1

MAX = 1.86
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
FANCHO CUCAMONGA  CEMEN IL JUSTICE CENTER  CHN 7: 360 Deg (2nd floor, at center)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 30-60 TO 23.9-25.0 Hz  23497-00273-9009.01  033090-1147-0904497

MAX = 69.4

MAX = -7.25

MAX = -0.94
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER  CHN 9: 360 DEG (BASEMENT, AT CENTER)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.01-0.60 TO 23.0-25.0 HZ.  23497-C0273-90059.01  033090.1147-04904a97

MAX = 0.17

MAX = -0.50

MAX = -0.50

MAX = 5.60

MAX = 0.17
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER  CHN 11: 360 DEG (FOUNDATION, AT WEST WALL)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.0-60 70 23.0-25.0 HZ  23497-00273-90055.01  033090.1147-0/504497

ACCELERATION (CM/SEC/SEC)

VELOCITY (CM/SEC)

DISPLACEMENT (CM)

TIME (SEC)

WAX = 104.2

WAX = 5.10

WAX = 0.57
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER CHN 2 (STA CHN 15): 90 DEG (BASEMENT, AT CENTER)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: .30-.60 TO 23.0-25.0 HZ, 23487-C00118-00009.01 035900.1645-0090A4478

MAX = -37.8

MAX = 3.38

MAX = 0.41
UPLAND EARTHQUAKE    FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER  CHN 5 (STA CHN 18): UP  (FREE FIELD)
INSTRUMENT-CORRECTED AND BANDPASS-FILTERED ACCELERATION, VELOCITY AND DISPLACEMENT
FILTER BAND: 0.30-60 TO 23.0-25.0 HZ.  23487-C0118-90059.01  033090.1545-Q090A497B

MAX = 152.7

MAX = 3.08

MAX = 0.23
RESPONSE SPECTRA: PSA, 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, 1, 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)

PERIOD (SEC)
RESPONSE SPECTRA: PSV, PSA & SD

FOURIER AMPLITUDE SPECTRUM: FS

DAMPING VALUES: 0, 2, 5, 10, 20%
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
CHN 12: 360 DEG (FOUNDATION, AT CENTER)
ACCELEROMETER BANDPASS-FILTERED WITH RAMP AT .30-50 TO 23.0-25.0 Hz.
23497-C027L-90059.01  033590.1305-QU90497

RESPONSE SPECTRA: PSV, PSA & SD  --  FOURIER AMPLITUDE SPECTRUM: FS
COURTIER VALUES: 0.2, 5, 10.25%
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)

PSV, FS (IN/SEC)

SD (IN)

SD (CM)

PERIOD (SEC)
RESPONSE SPECTRA: PSV, PSA & SD  ---  FOURIER AMPLITUDE SPECTRUM: FS
DAMPING VALUES: 0, 2, 5, 10, 20%
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA – LAW & JUSTICE CENTER
CHN 4 (STA CHN 17):  90 DEG  (FREE FIELD)
ACCELEROGAM BANDPASS-FILTERED WITH RAPID 1  .30-.60 10  23.0–25.0 HZ.
22497-C0118-92089.01  0330W0.1633--QU1044978

--- RESPONSE SPECTRA: PSV, PSA & 50 ---  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%
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:43 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
ACCELEROMETER BANDPASS-FILTERED WITH RAPPS AT .05 TO 3.0 TO 25.0 Hz.
23497-C0723-90GS9.01  035090. 1305-2049A497

CHN 7: 360 DEG  2ND FLOOR, AT CENTER
DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 8: 360 DEG  BASEMENT, AT WEST WALL
DAMPING VALUES: 0, 2, 5, 10, 20%

CHN 9: 360 DEG  BASEMENT, AT CENTER
DAMPING VALUES: 0, 2, 5, 10, 20%

PERIOD (SEC)
UPLAND EARTHQUAKE  FEBRUARY 28, 1990  15:41 PST
RANCHO CUCAMONGA - LAW & JUSTICE CENTER
ACCELEROMETER BANDPASS-FILTERED WITH HAMPS AT .30-15 TO 23.0-25.0 HZ.
23417-C0273-00059.01  033090:1335-QU960497

CHN 13: 360 DEG
FOUNDATION, AT EAST WALL

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

PERIOD (SEC)