A COLLECTION OF PROCESSED NEAR-FIELD EARTHQUAKE ACCELEROMGRAMS WITH RESPONSE AND DRIFT SPECTRA

BY

LUO-JIA WANG, QUN GU, AND W. D. IWAN

REPORT NO. EERL 96-05

PASADENA, CALIFORNIA

NOVEMBER 1996
This investigation was supported in part by Grant Nos. CMS-9223680, CMS-9509877, and CMS-9416174 from the National Science Foundation under the direction of Program Managers William A. Anderson and Clifford J. Astill. Any opinions, findings, conclusions or recommendations expressed in the publication are those of the author and do not necessarily reflect the views of the National Science Foundation.
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A Report on Research Conducted under Grants from the National Science Foundation

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Earthquake Engineering Research Laboratory
California Institute of Technology

A number of particularly important earthquake accelerograms were measured by instruments that were located in the Near-Field region of several recent earthquakes. For a strike-slip or a thrust fault earthquake, this region is taken to be the area within and immediately adjacent to the surface trace or the surface prediction of the fault rupture plane and its extension to the earth’s surface. Such accelerograms are termed near-field earthquake accelerograms. They possess the following features that differ from other earthquake accelerograms:

- distinctive pulse-like time histories,
- high peak velocities, and
- high ground displacements.

These features of near-field ground motion have not yet been well documented and are generally not considered in seismic design. It has been shown, however, that they can place very serious demand on structures located in the near-field region of an earthquake [1].

This report presents uniformly processed data for 12 near-field earthquake accelerograms obtained from four recent earthquakes. The results are presented in the following format:

- time histories of acceleration, velocity, and displacement rotated to east-west, north-south, and maximum velocity directions,
- horizontal particle trajectories,
- Response Spectra for the east-west, north-south, and maximum velocity directions, and
- Drift Demand Spectra for the east-west, north-south, and maximum velocity directions.
Tables 1-4 summarize the relevant information for the earthquakes and near-field accelerograms in this report. Plots of time histories, horizontal particle trajectories, Response Spectra and Drift Demand Spectra are presented in the figures following Table 4.

All accelerograms were uniformly corrected using the processing scheme developed by Iwan and Chen [2]. This includes appropriate instrument correction according to the instrument type and baseline correction without band-pass filtering.

The time history, Response Spectrum and Drift Demand Spectrum for the north-south component of the El Centro (ELC) accelerogram obtained in the 1940 Imperial Valley earthquake are included in Appendix 1 for purposes of comparison. As shown by their response and Drift Demand Spectra, all 12 earthquake accelerograms featured in this report place much higher demands on the response and interstory drift of structures than does the standard ELC ground motion. This suggests that the widely used ELC accelerogram may be inadequate for some design purposes.

All data processing, response and Drift Demand Spectral computations, and plotting were performed using a Matlab-based package [4].

REFERENCES


Table 1. Twelve selected near-field earthquake accelerograms presented in this report

<table>
<thead>
<tr>
<th>Station Name</th>
<th>Tick</th>
<th>Earthquake</th>
<th>Epic. Dist. (km)</th>
<th>Soil Condition</th>
<th>Page</th>
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<td>61</td>
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<td>Northridge</td>
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<td>Erzincan</td>
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Table 2. Four recent earthquakes from which near-field earthquake accelerograms were obtained

<table>
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<td>Blind Thrust</td>
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<td>Erzincan, Turkey</td>
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Table 3. Parameters of strong motion accelerographs

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<th>Instrument Type</th>
<th>Time Step (second)</th>
<th>Sensor Directions</th>
<th>Frequency (Hz)</th>
<th>Damping Ratio</th>
<th>Baseline Parameters</th>
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<td>PV (cm/s)</td>
<td>PD (cm)</td>
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<td>PV (cm/s)</td>
<td>PD (cm)</td>
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<td>-47</td>
<td>390</td>
<td>-110</td>
<td>-40</td>
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LUCERNE VALLEY STATION (LUC)
LUC Particle Trajectory

North (cm)

East (cm)
LUC (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
LUC (East)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
LUC (N80W)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
RINALDI RECEIVING STATION (RRS)
RRS (North)

Max = 805 cm/s/s

Max = -159 cm/s

Max = -59 cm

Time (second)
RRS (East)

Max = 555 cm/s/s

Max = -102 cm/s

Max = -74 cm

Time (second)
RRS (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SYLMAR CONVERTER STATION (SCS)
SCS (East)

Max = 563 cm/s/s

Max = -77 cm/s

Max = 45 cm
SCS (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SCS (East)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SYLMAR CONVERTER STATION - EAST (SCE)
SCE (East)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SCE (S22W)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SYLMAR COUNTY HOSPITAL PARKING LOT (SCH)
SCH (S10W)

Max = -848 cm/s/s

Max = 138 cm/s

Max = 49 cm
SCH (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SCH (East)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SCH (S10W)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
ARLETA NORDHOFF AVENUE FIRE STATION (ARL)
NEWHALL, LA COUNTY FIRE STATION (NHL)
NHL (S37W)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SANTA MONICA CITY HALL GROUNDS (SMC)
SMC (East)

Max = -855 cm/s/s

Max = 41 cm/s

Max = -17 cm
SMC (N89E)

Max = -855 cm/s/s

Max = 41 cm/s

Max = -17 cm

Acceleration (cm/s/s)

Velocity (cm/s)

Displacement (cm)

Time (second)
SMC (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
SMC (N89E)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
PARDEE STATION (PAR)
PAR (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
PAR (East)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
TAKATORI STATION (TAK)
TAK (North)

Max = 600 cm/s/s

Max = 121 cm/s

Max = -39 cm
TAK (East)

Max = 637 cm/s/s

Max = -124 cm/s

Max = 30 cm
TAK (North)

Damping Ratio = 0, 2, 5, and 10%
TAK (East)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
TAK (N49E)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
KOBE STATION (KOB)
KOB (North)

Max = -802 cm/s/s

Max = 92 cm/s

Max = 26 cm
KOB (East)

Max = 607 cm/s/s

Max = −76 cm/s

Max = −17 cm

Time (second)
KOB Particle Trajectory
KOB (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
KOBO (N35W)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)

0 1 2 3 4 5

0 1 2 3 4 5 6 7 8 9 10 11 12 13

126
ERZINCAN STATION (ERZ)
ERZ (S31W)

Max = -433 cm/s/s

Max = 126 cm/s

Max = 52 cm
ERZ (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
ERZ (S31W)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)
APPENDIX 1

TIME HISTORY, RESPONSE SPECTRUM, AND

DRIFT DEMAND SPECTRUM OF

EL CENTRO (ELC) NORTH
ELC (North)

Damping Ratio = 0, 2, 5, and 10%

Maximum Drift Ratio (percent)

Period (second)