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Characteristics of selected strong-motion records from the October 18, 1989, Loma Prieta, California, earthquake and the November-December 1985 Nahanni, Northwest Territories, Canada, earthquakes

By

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ABSTRACT

As part of a general study of earthquake-induced landslides, 87 strong-motion records from the October 18, 1989, Loma Prieta, Calif., earthquake and 17 records from the November-December 1985 Nahanni, Northwest Territories, Canada, earthquakes were edited and stored in a format suitable for further processing on a microcomputer. Values of maximum acceleration, Arias (1970) intensity, Dobry (1978) duration, and epicentral distance were determined for each record. The Loma Prieta records are of interest because of the large number of strong-motion records for a single large event, the characteristics of which may be correlated with observed ground failures. The Nahanni records are of interest because of the large peak accelerations (greater than 2.3 *g* vertical and greater than 1.3 *g* horizontal) recorded for one of the events.

DESCRIPTION OF RECORDS

Data Sources

Two sets of seismic records for the Loma Prieta earthquake were examined and edited. Strong-motion records from U.S. Geological Survey (USGS) seismic stations were obtained from the National Geophysical Data Center, Boulder, Colo. (data set SM-USACA45). Records from California Division of Mines and Geology (CDMG) seismic stations were obtained from the USGS Branch of Engineering Seismology and Geology in Menlo Park, Calif. All records are from ground-level stations; records from upper floors of buildings are not included in this report. Records of the Nahanni earthquakes recorded by three seismic stations were obtained from the National Geophysical Data Center (data set SM-CAN01). For all of the data sets, there were generally three components of motion recorded by each station.

Editing, Data Format, and File Name Convention

The original data files contained integrated velocity and displacement values in addition to the corrected acceleration values (in cm/s^2), and header data for each subset. Methods of correcting acceleration data are beyond the scope of this report, but some of the corrections are for instrument response, baseline drift, and certain frequency errors introduced by the digitizing process. Filter data used

in processing each record is contained in the appropriate header file. For an introduction to accelerogram processing see Hudson (1979). In editing the files, velocity and displacement data were stripped and discarded, and header information was stripped and stored in a separate file for each data set. The remaining acceleration values were truncated to a whole number of seconds of record, and were reformatted from eight or ten values per line to one value per line.

File names for the Loma Prieta data sets consist of a three-letter station code followed by a hyphen and the directional component of the record. No file name extensions are used for the data files. File names for the Nahanni data set consist of a two-letter station code followed by an event code number, a hyphen, and the directional component.

Lastly, each record was analyzed to determine Arias intensity and Dobry duration. Arias (1970) intensity is a measure of the severity of seismic shaking as recorded by a strong-motion record and has been empirically related to observed ground failure by Wilson and Keefer (1985). Dobry duration, called "significant duration" by Dobry and others (1978), is defined as the time needed to build up between 5 and 95 percent of the total Arias intensity of a record. Characteristics of each record are shown in tables 1 and 2 for the Loma Prieta data, and in table 3 for the Nahanni data. The original digital data sets have been released and are in the public domain, and are available from the previously mentioned sources. The edited data sets from which these characteristics are derived are not reproduced for this report. Investigators interested in the edited records should contact Randall W. Jibson, U.S. Geological Survey, Box 25046, MS 966, Denver, CO 80225.

REFERENCES

Arias, A., 1970, A measure of earthquake intensity *in* Hansen, R., ed., Seismic design for nuclear power plants: Cambridge, Mass., MIT Press, p. 438-483.

Dobry, R., Idriss, I.M., and Ng, E., 1978, Duration characteristics of horizontal components of strong-motion earthquake records: Bulletin of the Seismological Society of America, v. 68, no. 5, p. 1487-1520.

Hudson, D.E., 1979, Reading and interpreting strong motion accelerograms: Berkeley, Earthquake Engineering Research Institute, 112 p.

Wilson, R.C., and Keefer, D.K., 1985, Predicting areal limits of earthquake-induced landsliding, *in* Ziony, J.I., ed., Evaluating earthquake hazards in the Los Angeles region--An earth-science perspective: U.S. Geological Survey Professional Paper 1360, p. 317-345.

Table 1. Loma Prieta Earthquake, U.S. Geological Survey Strong-Motion Records.
Files contain corrected acceleration values at constant intervals. Records truncated to full seconds.

Station Location	File Name	No. of Points	Digitiz. Interval (s)	Record Length (s)	Maximum Accel. (cm/s^2)	Arias Intensity (m/s)	Dobry Duration (s)	Epicen. Dist. (km)
Anderson Dam, Crest	ADC-340	7800	0.005	39.0	-265.44	1.478	10.2	27
Anderson Dam, Crest	ADC-UP	7800	0.005	39.0	181.22	0.437	11.9	27
Anderson Dam, Crest	ADC-250	7800	0.005	39.0	-381.57	2.316	12.2	27
Anderson Dam, Left Abutment	ADL-340	7800	0.005	39.0	-78.88	0.090	13.4	27
Anderson Dam, Left Abutment	ADL-UP	7800	0.005	39.0	-53.63	0.053	12.7	27
Anderson Dam, Left Abutment	ADL-250	7800	0.005	39.0	-59.71	0.094	15.7	27
Anderson Dam, Downstream	ADD-340	7800	0.005	39.0	-238.79	0.840	10.9	27
Anderson Dam, Downstream	ADD-UP	7800	0.005	39.0	185.64	0.339	12.3	27
Anderson Dam, Downstream	ADD-250	7800	0.005	39.0	238.84	0.836	10.5	27
Sunnyvale, Colton Avenue	SNV-360	7800	0.005	39.0	215.15	0.786	25.3	43
Sunnyvale, Colton Avenue	SNV-UP	7800	0.005	39.0	-110.83	0.183	24.2	43
Sunnyvale, Colton Avenue	SNV-270	7800	0.005	39.0	-210.36	0.668	21.2	43
Hollister Airport Differential Array	HAD-255	7800	0.005	39.0	-281.42	1.064	13.1	45
Hollister Airport Differential Array	HAD-UP	7800	0.005	39.0	155.69	0.294	26.2	45
Hollister Airport Differential Array	HAD-165	7800	0.005	39.0	-276.98	0.821	11.8	45
Palo Alto VA Hospital, Basement	PAV-302	8000	0.005	40.0	-341.53	0.761	13.9	47
Palo Alto VA Hospital, Basement	PAV-UP	8000	0.005	40.0	-192.99	0.287	19.2	47
Palo Alto VA Hospital, Basement	PAV-212	8000	0.005	40.0	-378.16	0.823	13.0	47
Hollister City Hall Annex	HCH-180	7800	0.005	39.0	-217.07	1.081	12.1	47
Hollister City Hall Annex	HCH-UP	7800	0.005	39.0	220.12	0.383	23.4	47
Hollister City Hall Annex	HCH-090	7800	0.005	39.0	252.11	0.819	17.4	47
Stanford University, SLAC Test Lab.	SUL-360	7800	0.005	39.0	282.08	0.937	11.6	51
Stanford University, SLAC Test Lab.	SUL-UP	7800	0.005	39.0	-91.82	0.215	17.6	51
Stanford University, SLAC Test Lab.	SUL-270	7800	0.005	39.0	197.88	0.578	12.5	51
Stanford University Parking Garage	SUP-360	4000	0.010	40.0	-255.02	0.615	12.5	51
Stanford University Parking Garage	SUP-UP	4000	0.010	40.0	-151.72	0.215	18.1	51
Stanford University Parking Garage	SUP-090	4000	0.010	40.0	-215.99	0.591	12.2	51

Table 1. Loma Prieta Earthquake, U.S. Geological Survey Strong-Motion Records--continued.

Station Location	File Name	No. of Points	Digitiz. Interval (s)	Record Length (s)	Maximum Accel. (cm/s^2)	Arias Intensity (m/s)	Dobry Duration (s)	Epicen. Dist. (km)
Menlo Park VA Hospital, Bldg. 137	MPV-110	7800	0.005	39.0	-117.10	0.310	25.1	54
Menlo Perk VA Hospital, Bldg. 137	MPV-UP	7800	0.005	39.0	-96.47	0.128	17.9	54
Menlo Perk VA Hospital, Bldg. 137	MPV-020	7800	0.005	39.0	287.90	0.519	16.6	54
Calaveras Arrey, Fremont, Emerson Ct.	FRE-180	7800	0.005	39.0	-142.56	0.336	17.8	56
Calaveras Arrey, Fremont, Emerson Ct.	FRE-UP	7800	0.005	39.0	-68.46	0.102	20.3	56
Calaveras Array, Fremont, Emerson Ct.	FRE-090	7800	0.005	39.0	190.68	0.324	17.8	56
Apeel Array #2, Redwood City	RDW-133	7000	0.005	35.0	-222.52	0.743	11.8	63
Apeel Array #2, Redwood City	RDW-UP	7000	0.005	35.0	84.52	0.108	16.3	63
Apeel Array #2, Redwood City	RDW-043	7000	0.005	35.0	272.30	1.306	8.4	63
TransAmerica Building, San Francisco, Basement	TAB-261	11600	0.005	58.0	-120.23	0.210	8.0	97
TransAmerica Building, San Francisco, Basement	TAB-UP	11600	0.005	58.0	47.45	0.034	19.4	97
TransAmerica Building, San Francisco, Besement	TAB-171	11600	0.005	58.0	-104.18	0.219	10.2	97
Emeryville, 6363 Christie Ave., S Ground Suite	EMY-350	7800	0.005	39.0	210.33	0.528	15.4	97
Emeryville, 6363 Christie Ave., S Ground Suite	EMY-UP	7800	0.005	39.0	-58.52	0.057	22.2	97
Emeryville, 6363 Christie Ave., S Ground Suite	EMY-260	7800	0.005	39.0	254.69	0.914	8.9	97
Golden Gate Bridge, San Francisco	GGB-360	7600	0.005	38.0	-124.17	0.288	7.5	100
Golden Gate Bridge, San Francisco	GGB-UP	7600	0.005	38.0	-57.48	0.062	15.7	100
Golden Gete Bridge, San Francisco	GGB-270	7600	0.005	38.0	-238.75	0.512	6.0	100

Teble 2. Loma Prieta Earthquake, California Division of Mines and Geology (CDMG) Strong-Motion Records.
Files contain corrected acceleration velues et constant intervals. Records truncated to full seconds.

Station Location and Number	File Name	No. of Points	Digitiz. Interval (s)	Record Length (s)	Maximum Accel. (cm/s^2)	Arias Intensity (m/s)	Dobry Duration (s)	Epicen. Dist. (km)
San Frencisco - Cliff House #58132	CLF-000	2000	0.020	40.0	-73.118	0.092	10.3	99
San Francisco - Cliff House #58132	CLF-090	2000	0.020	40.0	-105.734	0.136	7.3	99
San Francisco - Cliff House #58132	CLF-UP	2000	0.020	40.0	60.564	0.042	12.0	99
Cepitola - Fire Station #47125	CPT-000	2000	0.020	40.0	-462.922	4.382	12.2	9
Capitola - Fire Stetion #47125	CPT-090	2000	0.020	40.0	-390.792	2.373	13.2	9
Capitola - Fire Station #47125	CPT-UP	2000	0.020	40.0	-500.053	4.279	10.6	9
Corralitos - Eureka Canyon Rd. #57007	CRL-000	2000	0.020	40.0	617.695	3.256	6.9	7
Corralitos - Eureka Canyon Rd. #57007	CRL-090	2000	0.020	40.0	469.384	2.572	8.0	7
Corralitos - Eureka Canyon Rd. #57007	CRL-UP	2000	0.020	40.0	431.056	0.908	8.2	7
San Francisco - Diamond Heights #58130	DHT-000	2000	0.020	40.0	-96.433	0.140	8.8	92
San Francisco - Diamond Heights #58130	DHT-090	2000	0.020	40.0	-110.801	0.106	9.4	92
San Francisco - Diamond Heights #58130	DHT-UP	2000	0.020	40.0	42.397	0.030	15.6	92
Hollister - South Street and Pine Drive #47524	HSP-000	3000	0.020	60.0	361.900	2.222	16.5	48
Hollister - South Street end Pine Drive #47524	HSP-090	3000	0.020	60.0	-174.549	0.791	29.7	48
Hollister - South Street and Pine Drive #47524	HSP-UP	3000	0.020	60.0	-193.207	0.436	25.1	48
Oakland - 2-Story Office Bldg. #58224	OAK-200	2000	0.020	40.0	187.280	0.406	11.9	92
Oakland - 2-Story Office Bldg. #58224	OAK-290	2000	0.020	40.0	238.329	0.656	12.7	92
Oakland - 2-Story Office Bldg. #58224	OAK-UP	2000	0.020	40.0	-141.272	0.121	20.2	92
Oakland - Outer Harbor Wherf #58472	OHW-035	2000	0.020	40.0	281.366	0.722	8.7	94
Oakland - Outer Harbor Wharf #58472	OHW-305	2000	0.020	40.0	265.504	0.990	7.0	94
Oakland - Outer Harbor Wherf #58472	OHW-UP	2000	0.020	40.0	-65.087	0.103	19.7	94
San Francisco - Pacific Heights #58131	PHT-270	2000	0.020	40.0	60.207	0.054	11.1	84
San Frencisco - Pacific Heights #58131	PHT-360	2000	0.020	40.0	-46.338	0.040	12.4	84
San Frencisco - Pacific Heights #58131	PHT-UP	2000	0.020	40.0	30.528	0.017	24.3	84
San Frencisco - Presidio #58222	PRS-000	2000	0.020	40.0	-97.912	0.155	10.5	98
San Frencisco - Presidio #58222	PRS-090	2000	0.020	40.0	-194.873	0.265	8.6	98
San Francisco - Presidio #58222	PRS-UP	2000	0.020	40.0	56.222	0.069	17.7	98

Table 2. Loma Prieta Earthquake, California Division of Mines and Geology (CDMG) Strong-Motion Records--continued.

Station Location and Number	File Name	No. of Points	Digitiz. Interval (s)	Record Length (s)	Maximum Accel. (cm/s^2)	Arias Intensity (m/s)	Dobry Duration (s)	Epicen. Dist. (km)
San Francisco - Rincon Hill #58151	RNC-000	2000	0.020	40.0	-78.611	0.055	13.9	95
San Francisco - Rincon Hill #58151	RNC-090	2000	0.020	40.0	88.515	0.068	11.5	95
San Francisco - Rincon Hill #58151	RNC-UP	2000	0.020	40.0	-28.429	0.018	19.7	95
Santa Cruz - UCSC/Lick Lab. #58135	SCZ-000	2000	0.020	40.0	-433.117	2.666	9.5	16
Santa Cruz - UCSC/Lick Lab. #58135	SCZ-090	2000	0.020	40.0	401.543	2.044	9.7	16
Santa Cruz - UCSC/Lick Lab. #58135	SCZ-UP	2000	0.020	40.0	-324.573	1.072	9.7	16
San Francisco - Telegraph Hill #58133	TGH-000	2000	0.020	40.0	-51.207	0.026	11.5	97
San Francisco - Telegraph Hill #58133	TGH-090	2000	0.020	40.0	90.514	0.046	9.5	97
San Francisco - Telegraph Hill #58133	TGH-UP	2000	0.020	40.0	-31.855	0.009	23.0	97
Treasure Island #58117	TRI-000	2000	0.020	40.0	97.935	0.144	6.0	98
Treasure Island #58117	TRI-090	2000	0.020	40.0	-155.849	0.361	4.5	98
Treasure Island #58117	TRI-UP	2000	0.020	40.0	15.858	0.002	25.4	98
Yerba Buena Island #58163	YBI-000	2000	0.020	40.0	28.081	0.016	21.7	96
Yerba Buena Island #58163	YBI-090	2000	0.020	40.0	-65.843	0.043	8.3	96
Yerba Buena Island #58163	YBI-UP	2000	0.020	40.0	26.952	0.012	21.0	96

Table 3. Nahanni, Northwest Territories, Earthquakes of November-December 1985. Geological Survey of Canada Strong-Motion Records. Files contain corrected acceleration values at constant intervals. Records truncated to full seconds.

Station Location	File Name	No. of Points	Digitiz. Interval (s)	Record Length (s)	Maximum Accel. (cm/s^2)	Arias Intensity (m/s)	Dobry Duration (s)	Epicen. Dist. (km)
Earthquake of November 9, 1985, 0446 GMT								
Slide Mountain (Site 2)	SM1-330	1800	0.005	9.0	-374.27	0.085	0.6	6
Slide Mountain (Site 2)	SM1-UP	1800	0.005	9.D	-249.08	0.051	0.7	6
Slide Mountain (Site 2)	SM1-24D	1800	0.005	9.0	-45D.96	0.098	0.4	6
Earthquake of December 23, 1985, D515 GMT								
Iverson (Site 1)	IV2-010	4000	0.005	20.0	956.66	4.447	8.0	7
Iverson (Site 1)	IV2-UP	4000	0.005	20.0	2322.38	4.571	7.5	7
Iverson (Site 1)	IV2-280	4000	0.005	20.D	-1319.08	4.044	8.0	7
Slide Mountain (Site 2)	SM2-330	3600	0.005	18.0	386.46	1.064	9.6	7
Slide Mountain (Site 2)	SM2-240	3600	0.005	18.0	534.44	0.992	9.9	7
Battlement Creek (Site 3)	BC2-360	3800	0.0D5	19.0	-190.20	0.417	12.0	22
Battlement Creek (Site 3)	BC2-UP	3800	0.0D5	19.0	178.04	0.285	11.7	22
Battlement Creek (Site 3)	BC2-270	3800	0.005	19.0	191.64	0.406	11.3	22
Earthquake of December 23, 1985, 0548 GMT								
Iverson (Site 1)	IV3-010	2000	0.005	10.0	224.13	0.079	4.1	7
Iverson (Site 1)	IV3-UP	2000	0.005	10.0	110.06	0.D33	4.6	7
Iverson (Site 1)	IV3-280	2000	0.005	10.0	87.69	D.035	4.5	7
Earthquake of December 25, 1985, 1543 GMT								
Battlement Creek (Site 3)	BC4-360	1800	0.005	9.D	-103.19	0.028	3.8	19
Battlement Creek (Site 3)	BC4-UP	1800	0.005	9.0	-72.80	0.019	4.5	19
Battlement Creek (Site 3)	BC4-270	1800	0.005	9.0	-88.41	0.024	3.5	19