

Validation of ground motion simulations through simple proxies for the response of engineered systems

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Electronic Supplement

This electronic supplement contains tables of the ground motion simulations selected to have similar response spectra to a pre-existing set of recordings. The recordings are from Baker et al. (2011) and are shown in Table S1. Simulations with comparable response spectra from the SCEC Broadband Platform validation exercise (Dreger et al., 2013) of the 1989 Loma Prieta earthquake using the stochastic finite fault (EXSIM), Graves-Pitarka hybrid broadband (GP), and composite source model (CSM) methods are shown in Tables S2 to S4, respectively.

Also included are Matlab functions to compute some of the simple proxies for the response of engineered systems:

- `baker_jayaram_correlation.m`: computes the predicted correlation of ε at two periods according to Baker and Jayaram (2008).
- `Bilinear_Newmark_withTH.m`: computes the nonlinear time history response of a bilinear oscillator to a given ground motion excitation using the Newmark method.
- `fn_analyze_record.m`: extracts a pulse from a ground motion velocity time history using wavelet analysis according to Baker (2007).

- `fn_pulsePeriod.m`: computes the predicted median pulse period and standard deviation of the natural log of pulse period according to Bray and Rodriguez-Marek (2004) and Shahi and Baker (2011).
- `fn_RotD100RotD50_ratio.m`: computes the predicted median ratio of $Sa_{RotD100}$ to $Sa_{SaRotD50}$ according to Beyer and Bommer (2006) and Shahi and Baker (2013).
- `fn_SaRotDnn.m`: computes $Sa_{RotD100}$ and Sa_{RotD50} for a given multi-component ground motion and period.
- `fn_Sdi_atten.m`: computes the predicted median ratio of inelastic to elastic displacement for a bilinear oscillator according to Tothong and Cornell (2006).
- `getLinearSpectra_withTH.m`: computes the time history and spectral response of an SDOF oscillator to a given ground motion.

Table S1: Set of PEER recordings (i.e. set #2 from Baker et al. 2011)

No.	RSN	EQ Name	Year	<i>M</i>	Station Name
1	72	San Fernando	1971	6.61	Lake Hughes #4
2	769	Loma Prieta	1989	6.93	Gilroy Array #6
3	1165	Kocaeli, Turkey	1999	7.51	Izmit
4	1011	Northridge-01	1994	6.69	LA - Wonderland Ave
5	164	Imperial Valley-06	1979	6.53	Cerro Prieto
6	1787	Hector Mine	1999	7.13	Hector
7	80	San Fernando	1971	6.61	Pasadena - Old Seismo Lab
8	1618	Duzce, Turkey	1999	7.14	Lamont 531
9	1786	Hector Mine	1999	7.13	Heart Bar State Park
10	1551	Chi-Chi, Taiwan	1999	7.62	TCU138
11	3507	Chi-Chi, Taiwan-06	1999	6.30	TCU129
12	150	Coyote Lake	1979	5.74	Gilroy Array #6
13	572	Taiwan SMART1(45)	1986	7.30	SMART1 E02
14	285	Irpinia, Italy-01	1980	6.90	Bagnoli Irpinio
15	801	Loma Prieta	1989	6.93	San Jose - Santa Teresa Hills
16	286	Irpinia, Italy-01	1980	6.90	Bisaccia
17	1485	Chi-Chi, Taiwan	1999	7.62	TCU045
18	1161	Kocaeli, Turkey	1999	7.51	Gebze
19	1050	Northridge-01	1994	6.69	Pacoima Dam (downstr)
20	2107	Denali, Alaska	2002	7.90	Carlo (temp)
21	1	Helena, Montana-01	1935	6.00	Carroll College
22	1091	Northridge-01	1994	6.69	Vasquez Rocks Park
23	1596	Chi-Chi, Taiwan	1999	7.62	WNT
24	771	Loma Prieta	1989	6.93	Golden Gate Bridge
25	809	Loma Prieta	1989	6.93	UCSC
26	265	Victoria, Mexico	1980	6.33	Cerro Prieto
27	1078	Northridge-01	1994	6.69	Santa Susana Ground
28	763	Loma Prieta	1989	6.93	Gilroy - Gavilan Coll.
29	1619	Duzce, Turkey	1999	7.14	Mudurnu
30	957	Northridge-01	1994	6.69	Burbank - Howard Rd.
31	2661	Chi-Chi, Taiwan-03	1999	6.20	TCU138
32	3509	Chi-Chi, Taiwan-06	1999	6.30	TCU138
33	810	Loma Prieta	1989	6.93	UCSC Lick Observatory
34	765	Loma Prieta	1989	6.93	Gilroy Array #1
35	1013	Northridge-01	1994	6.69	LA Dam
36	1012	Northridge-01	1994	6.69	LA 00
37	1626	Sitka, Alaska	1972	7.68	Sitka Observatory
38	989	Northridge-01	1994	6.69	LA - Chalon Rd
39	748	Loma Prieta	1989	6.93	Belmont - Envirotech
40	1549	Chi-Chi, Taiwan	1999	7.62	TCU129

Table S2: EXSIM simulations selected from multiple realizations of the Loma Prieta earthquake that have similar response spectra to the PEER records in Table S1.

No.	EQ Name	Sim. Method	Realiz No.	Station Name	Lon	Lat
1	Loma Prieta	EXSIM	10000044	8001-CLS	-121.8030	37.0500
2	Loma Prieta	EXSIM	10000014	8022-AND	-121.6280	37.1660
3	Loma Prieta	EXSIM	10000014	8018-SG3	-121.3950	36.7530
4	Loma Prieta	EXSIM	10000014	8020-G06	-121.4840	37.0260
5	Loma Prieta	EXSIM	10000044	8015-GMR	-121.4340	37.0330
6	Loma Prieta	EXSIM	10000014	8016-LOB	-122.0600	37.0010
7	Loma Prieta	EXSIM	10000044	8035-GGB	-122.4760	37.8080
8	Loma Prieta	EXSIM	10000044	8014-UC2	-122.0620	37.0010
9	Loma Prieta	EXSIM	10000014	8023-CLR	-121.8070	37.4520
10	Loma Prieta	EXSIM	10000044	8031-CFH	-122.5130	37.7780
11	Loma Prieta	EXSIM	10000044	8037-DFS	-121.9320	37.7090
12	Loma Prieta	EXSIM	10000014	8035-GGB	-122.4760	37.8080
13	Loma Prieta	EXSIM	10000014	8030-A3E	-122.0610	37.6570
14	Loma Prieta	EXSIM	10000014	8029-RIN	-122.3910	37.7860
15	Loma Prieta	EXSIM	10000044	8022-AND	-121.6280	37.1660
16	Loma Prieta	EXSIM	10000014	8025-SGI	-121.4460	36.7650
17	Loma Prieta	EXSIM	10000044	8039-PTB	-122.5270	37.8220
18	Loma Prieta	EXSIM	10000044	8023-CLR	-121.8070	37.4520
19	Loma Prieta	EXSIM	10000014	8001-CLS	-121.8030	37.0500
20	Loma Prieta	EXSIM	10000044	8025-SGI	-121.4460	36.7650
21	Loma Prieta	EXSIM	10000044	8003-LEX	-121.9910	37.2020
22	Loma Prieta	EXSIM	10000014	8010-G03	-121.5360	36.9870
23	Loma Prieta	EXSIM	10000044	8024-SJW	-121.6420	36.6710
24	Loma Prieta	EXSIM	10000044	8018-SG3	-121.3950	36.7530
25	Loma Prieta	EXSIM	10000014	8004-STG	-122.0310	37.2550
26	Loma Prieta	EXSIM	10000014	8028-XSP	-122.3610	37.5290
27	Loma Prieta	EXSIM	10000014	8005-WVC	-122.0090	37.2620
28	Loma Prieta	EXSIM	10000044	8002-LGP	-122.0100	37.1720
29	Loma Prieta	EXSIM	10000044	8028-XSP	-122.3610	37.5290
30	Loma Prieta	EXSIM	10000044	8010-G03	-121.5360	36.9870
31	Loma Prieta	EXSIM	10000014	8040-BES	-122.3080	37.5120
32	Loma Prieta	EXSIM	10000014	8039-PTB	-122.5270	37.8220
33	Loma Prieta	EXSIM	10000014	8011-SJTE	-121.8030	37.2100
34	Loma Prieta	EXSIM	10000044	8020-G06	-121.4840	37.0260
35	Loma Prieta	EXSIM	10000014	8027-BVF	-121.1840	36.5730
36	Loma Prieta	EXSIM	10000044	8006-G01	-121.5720	36.9730
37	Loma Prieta	EXSIM	10000014	8017-SLC	-122.2100	37.4200
38	Loma Prieta	EXSIM	10000044	8019-WDS	-122.2580	37.4290
39	Loma Prieta	EXSIM	10000044	8034-BRK	-122.2490	37.8760
40	Loma Prieta	EXSIM	10000014	8019-WDS	-122.2580	37.4290

Table S3: GP simulations selected from multiple realizations of the Loma Prieta earthquake that have similar response spectra to the PEER records in Table S1.

No.	EQ Name	Sim. Method	Realiz No.	Station Name	Lon	Lat
1	Loma Prieta	GP	10000030	8009-GOF	-121.5690	37.0090
2	Loma Prieta	GP	10000005	8016-LOB	-122.0600	37.0010
3	Loma Prieta	GP	10000030	8005-WVC	-122.0090	37.2620
4	Loma Prieta	GP	10000005	8006-G01	-121.5720	36.9730
5	Loma Prieta	GP	10000005	8038-BVR	-121.1430	36.5320
6	Loma Prieta	GP	10000005	8036-BVW	-121.2490	36.6580
7	Loma Prieta	GP	10000007	8010-G03	-121.5360	36.9870
8	Loma Prieta	GP	10000005	8021-ADL	-121.6280	37.1660
9	Loma Prieta	GP	10000007	8026-CYC	-121.5500	37.1180
10	Loma Prieta	GP	10000007	8034-BRK	-122.2490	37.8760
11	Loma Prieta	GP	10000030	8021-ADL	-121.6280	37.1660
12	Loma Prieta	GP	10000007	8038-BVR	-121.1430	36.5320
13	Loma Prieta	GP	10000030	8027-BVF	-121.1840	36.5730
14	Loma Prieta	GP	10000030	8003-LEX	-121.9910	37.2020
15	Loma Prieta	GP	10000007	8022-AND	-121.6280	37.1660
16	Loma Prieta	GP	10000030	8028-XSP	-122.3610	37.5290
17	Loma Prieta	GP	10000007	8021-ADL	-121.6280	37.1660
18	Loma Prieta	GP	10000030	8031-CFH	-122.5130	37.7780
19	Loma Prieta	GP	10000030	8010-G03	-121.5360	36.9870
20	Loma Prieta	GP	10000030	8016-LOB	-122.0600	37.0010
21	Loma Prieta	GP	10000005	8010-G03	-121.5360	36.9870
22	Loma Prieta	GP	10000030	8007-GIL	-121.5680	36.9730
23	Loma Prieta	GP	10000030	8001-CLS	-121.8030	37.0500
24	Loma Prieta	GP	10000005	8027-BVF	-121.1840	36.5730
25	Loma Prieta	GP	10000007	8005-WVC	-122.0090	37.2620
26	Loma Prieta	GP	10000005	8017-SLC	-122.2100	37.4200
27	Loma Prieta	GP	10000005	8007-GIL	-121.5680	36.9730
28	Loma Prieta	GP	10000030	8008-BRN	-121.9840	37.0470
29	Loma Prieta	GP	10000007	8020-G06	-121.4840	37.0260
30	Loma Prieta	GP	10000030	8026-CYC	-121.5500	37.1180
31	Loma Prieta	GP	10000005	8040-BES	-122.3080	37.5120
32	Loma Prieta	GP	10000030	8034-BRK	-122.2490	37.8760
33	Loma Prieta	GP	10000030	8006-G01	-121.5720	36.9730
34	Loma Prieta	GP	10000030	8011-SJTE	-121.8030	37.2100
35	Loma Prieta	GP	10000030	8038-BVR	-121.1430	36.5320
36	Loma Prieta	GP	10000030	8035-GGB	-122.4760	37.8080
37	Loma Prieta	GP	10000005	8005-WVC	-122.0090	37.2620
38	Loma Prieta	GP	10000030	8036-BVW	-121.2490	36.6580
39	Loma Prieta	GP	10000005	8035-GGB	-122.4760	37.8080
40	Loma Prieta	GP	10000005	8011-SJTE	-121.8030	37.2100

Table S4: CSM simulations selected from multiple realizations of the Loma Prieta earthquake that have similar response spectra to the PEER records in Table S1.

No.	EQ Name	Sim. Method	Realiz No.	Station Name	Lon	Lat
1	Loma Prieta	CSM	10000017	8001-CLS	-121.8030	37.0500
2	Loma Prieta	CSM	10000040	8025-SGI	-121.4460	36.7650
3	Loma Prieta	CSM	10000040	8031-CFH	-122.5130	37.7780
4	Loma Prieta	CSM	10000017	8004-STG	-122.0310	37.2550
5	Loma Prieta	CSM	10000040	8034-BRK	-122.2490	37.8760
6	Loma Prieta	CSM	10000017	8013-HSP	-121.3970	36.8480
7	Loma Prieta	CSM	10000040	8030-A3E	-122.0610	37.6570
8	Loma Prieta	CSM	10000040	8017-SLC	-122.2100	37.4200
9	Loma Prieta	CSM	10000040	8013-HSP	-121.3970	36.8480
10	Loma Prieta	CSM	10000040	8039-PTB	-122.5270	37.8220
11	Loma Prieta	CSM	10000038	8023-CLR	-121.8070	37.4520
12	Loma Prieta	CSM	10000038	8031-CFH	-122.5130	37.7780
13	Loma Prieta	CSM	10000017	8035-GGB	-122.4760	37.8080
14	Loma Prieta	CSM	10000038	8034-BRK	-122.2490	37.8760
15	Loma Prieta	CSM	10000038	8001-CLS	-121.8030	37.0500
16	Loma Prieta	CSM	10000017	8038-BVR	-121.1430	36.5320
17	Loma Prieta	CSM	10000040	8036-BVW	-121.2490	36.6580
18	Loma Prieta	CSM	10000017	8023-CLR	-121.8070	37.4520
19	Loma Prieta	CSM	10000017	8037-DFS	-121.9320	37.7090
20	Loma Prieta	CSM	10000038	8040-BES	-122.3080	37.5120
21	Loma Prieta	CSM	10000040	8015-GMR	-121.4340	37.0330
22	Loma Prieta	CSM	10000040	8040-BES	-122.3080	37.5120
23	Loma Prieta	CSM	10000038	8013-HSP	-121.3970	36.8480
24	Loma Prieta	CSM	10000038	8035-GGB	-122.4760	37.8080
25	Loma Prieta	CSM	10000040	8020-G06	-121.4840	37.0260
26	Loma Prieta	CSM	10000017	8036-BVW	-121.2490	36.6580
27	Loma Prieta	CSM	10000038	8008-BRN	-121.9840	37.0470
28	Loma Prieta	CSM	10000038	8030-A3E	-122.0610	37.6570
29	Loma Prieta	CSM	10000040	8021-ADL	-121.6280	37.1660
30	Loma Prieta	CSM	10000040	8027-BVF	-121.1840	36.5730
31	Loma Prieta	CSM	10000038	8033-BVU	-121.0430	36.5690
32	Loma Prieta	CSM	10000038	8038-BVR	-121.1430	36.5320
33	Loma Prieta	CSM	10000040	8008-BRN	-121.9840	37.0470
34	Loma Prieta	CSM	10000040	8032-SUF	-121.8800	37.5970
35	Loma Prieta	CSM	10000038	8039-PTB	-122.5270	37.8220
36	Loma Prieta	CSM	10000017	8025-SGI	-121.4460	36.7650
37	Loma Prieta	CSM	10000017	8026-CYC	-121.5500	37.1180
38	Loma Prieta	CSM	10000040	8005-WVC	-122.0090	37.2620
39	Loma Prieta	CSM	10000017	8031-CFH	-122.5130	37.7780
40	Loma Prieta	CSM	10000038	8021-ADL	-121.6280	37.1660

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