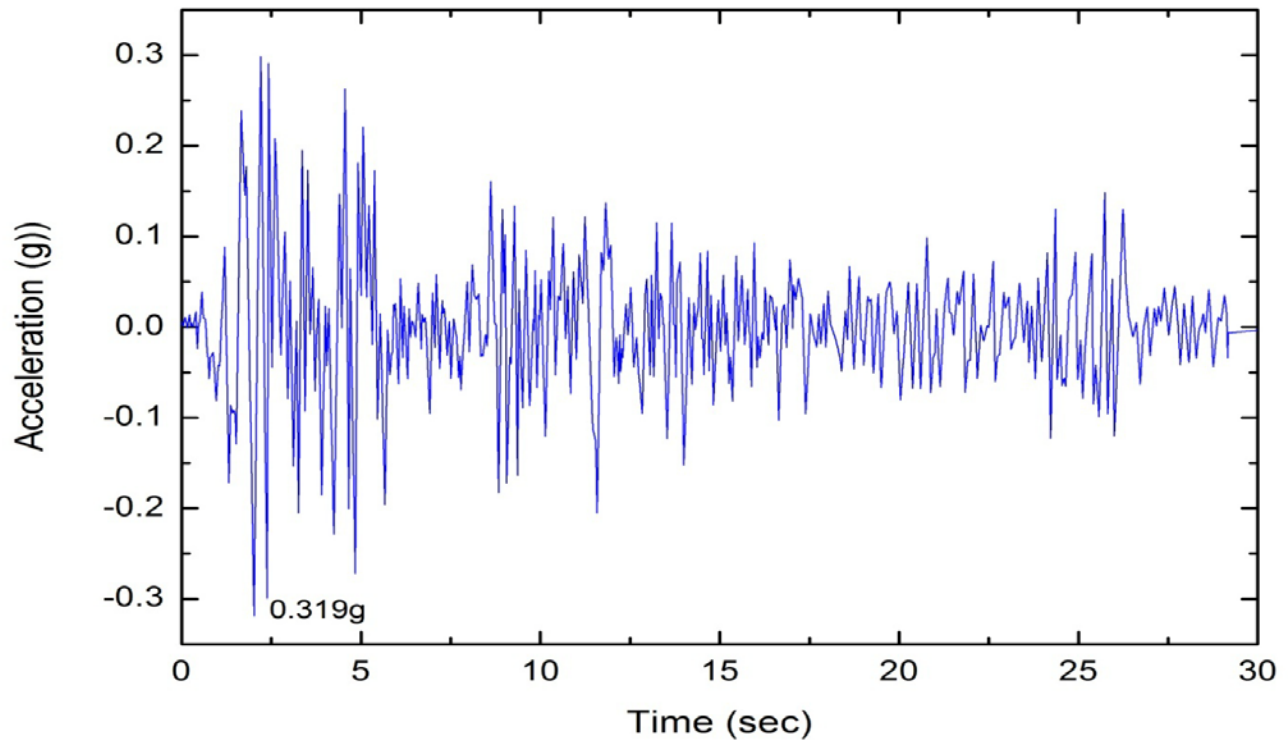# APPENDIX – I

Time History of El-Centro, 1940 Earthquake Ground Motion

The time history of acceleration of North-South component of the El-Centro, 1940 earthquake ground motion is given here at an interval of 0.02 sec. The unit of the acceleration is *g*. This is taken from the http://www.vibrationdata.com/elcentro.dat and are also given in the book by Professor A.K. Chopra (refer Chopra, 2001). This include 1559 data points to be read by row by row; the first value is at 0.02 sec and acceleration at time *t*=0 is zero. These data are also available NISEE website http://www.eerc.berkeley.edu.

0.0063	0.00364	9.90E-04	0.00428	0.00758	0.01087	0.00682	0.00277	-0.00128	0.00368
0.00864	0.0136	0.00727	9.40E-04	0.0042	0.00221	2.10E-04	0.00444	0.00867	0.0129
0.01713	-0.00343	-0.024	-0.00992	0.00416	0.00528	0.01653	0.02779	0.03904	0.02449
0.00995	0.00961	0.00926	0.00892	-0.00486	-0.01864	-0.03242	-0.03365	-0.05723	-0.04534
-0.03346	-0.03201	-0.03056	-0.02911	-0.02766	-0.04116	-0.05466	-0.06816	-0.08166	-0.06846
-0.05527	-0.04208	-0.04259	-0.04311	-0.02428	-0.00545	0.01338	0.03221	0.05104	0.06987
0.0887	0.04524	0.00179	-0.04167	-0.08513	-0.12858	-0.17204	-0.12908	-0.08613	-0.08902
-0.09192	-0.09482	-0.09324	-0.09166	-0.09478	-0.09789	-0.12902	-0.07652	-0.02401	0.02849
0.08099	0.1335	0.186	0.2385	0.21993	0.20135	0.18277	0.1642	0.14562	0.16143
0.17725	0.13215	0.08705	0.04196	-0.00314	-0.04824	-0.09334	-0.13843	-0.18353	-0.22863
-0.27372	-0.31882	-0.25024	-0.18166	-0.11309	-0.04451	0.02407	0.09265	0.16123	0.22981
0.29839	0.23197	0.16554	0.09912	0.0327	-0.03372	-0.10014	-0.16656	-0.23299	-0.29941
-0.00421	0.29099	0.2238	0.15662	0.08943	0.02224	-0.04495	0.01834	0.08163	0.14491
0.2082	0.18973	0.17125	0.13759	0.10393	0.07027	0.03661	0.00295	-0.03071	-0.00561
0.01948	0.04458	0.06468	0.08478	0.10487	0.05895	0.01303	-0.03289	-0.07882	-0.03556
0.00771	0.05097	0.01013	-0.03071	-0.07156	-0.1124	-0.15324	-0.11314	-0.07304	-0.03294
0.00715	-0.0635	-0.13415	-0.2048	-0.12482	-0.04485	0.03513	0.1151	0.19508	0.12301
0.05094	-0.02113	-0.0932	-0.02663	0.03995	0.10653	0.17311	0.11283	0.05255	-0.00772
0.01064	0.029	0.04737	0.06573	0.02021	-0.0253	-0.07081	-0.04107	-0.01133	0.00288
0.01709	0.03131	-0.02278	-0.07686	-0.13095	-0.18504	-0.14347	-0.1019	-0.06034	-0.01877
0.0228	-0.00996	-0.04272	-0.02147	-2.10E-04	0.02104	-0.01459	-0.05022	-0.08585	-0.12148
-0.15711	-0.19274	-0.22837	-0.18145	-0.13453	-0.08761	-0.04069	0.00623	0.05316	0.10008
0.147	0.09754	0.04808	-0.00138	0.05141	0.1042	0.15699	0.20979	0.26258	0.16996
0.07734	-0.01527	-0.10789	-0.20051	-0.06786	0.06479	0.01671	-0.03137	-0.07945	-0.12753
-0.17561	-0.22369	-0.27177	-0.15851	-0.04525	0.06802	0.18128	0.14464	0.108	0.07137
0.03473	0.09666	0.1586	0.22053	0.18296	0.14538	0.1078	0.07023	0.03265	0.06649
0.10033	0.13417	0.10337	0.07257	0.04177	0.01097	-0.01983	0.04438	0.1086	0.17281
0.10416	0.03551	-0.03315	-0.1018	-0.07262	-0.04344	-0.01426	0.01492	-0.02025	-0.05543
-0.0906	-0.12578	-0.16095	-0.19613	-0.14784	-0.09955	-0.05127	-0.00298	-0.01952	-0.03605
-0.05259	-0.04182	-0.03106	-0.02903	-0.02699	0.02515	0.0177	0.02213	0.02656	0.00419
-0.01819	-0.04057	-0.06294	-0.02417	0.0146	0.05337	0.02428	-0.0048	-0.03389	-0.00557
0.02274	0.00679	-0.00915	-0.02509	-0.04103	-0.05698	-0.01826	0.02046	0.00454	-0.01138
-0.00215	0.00708	0.00496	0.00285	7.40E-04	-0.00534	-0.01141	0.00361	0.01863	0.03365
0.04867	0.0304	0.01213	-0.00614	-0.02441	0.01375	0.01099	0.00823	0.00547	0.00812
0.01077	-0.00692	-0.02461	-0.0423	-0.05999	-0.07768	-0.09538	-0.06209	-0.0288	0.00448
0.03777	0.01773	-0.00231	-0.02235	0.01791	0.05816	0.03738	0.0166	-0.00418	-0.02496
-0.04574	-0.02071	0.00432	0.02935	0.01526	0.01806	0.02086	0.00793	-0.00501	-0.01795
-0.03089	-0.01841	-0.00593	0.00655	-0.02519	-0.05693	-0.04045	-0.02398	-0.0075	0.00897
0.00384	-0.00129	-0.00642	-0.01156	-0.02619	-0.04082	-0.05545	-0.04366	-0.03188	-0.06964
-0.05634	-0.04303	-0.02972	-0.01642	-0.00311	0.0102	0.0235	0.03681	0.05011	0.02436
-0.00139	-0.02714	-0.00309	0.02096	0.04501	0.06906	0.05773	0.0464	0.03507	0.03357
0.03207	0.03057	0.0325	0.03444	0.03637	0.01348	-0.00942	-0.03231	-0.02997	-0.03095

-0.03192	-0.02588	-0.01984	-0.01379	-0.00775	-0.01449	-0.02123	0.01523	0.0517	0.08816
0.12463	0.16109	0.12987	0.09864	0.06741	0.03618	0.00495	0.0042	0.00345	0.00269
-0.05922	-0.12112	-0.18303	-0.12043	-0.05782	0.00479	0.0674	0.13001	0.08373	0.03745
0.06979	0.10213	-0.03517	-0.17247	-0.13763	-0.10278	-0.06794	-0.0331	-0.03647	-0.03984
-0.00517	0.0295	0.06417	0.09883	0.1335	0.05924	-0.01503	-0.08929	-0.16355	-0.06096
0.04164	0.01551	-0.01061	-0.03674	-0.06287	-0.08899	-0.0543	-0.01961	0.01508	0.04977
0.08446	0.05023	0.016	-0.01823	-0.05246	-0.08669	-0.06769	-0.0487	-0.0297	-0.01071
0.00829	-0.00314	0.02966	0.06246	-0.00234	-0.06714	-0.04051	-0.01388	0.01274	0.00805
0.03024	0.05243	0.02351	-0.00541	-0.03432	-0.06324	-0.09215	-0.12107	-0.0845	-0.04794
-0.01137	0.0252	0.06177	0.04028	0.0188	0.04456	0.07032	0.09608	0.12184	0.0635
0.00517	-0.05317	-0.03124	-0.0093	0.01263	0.03457	0.03283	0.03109	0.02935	0.04511
0.06087	0.07663	0.09239	0.05742	0.02245	-0.01252	0.0068	0.02611	0.04543	0.01571
-0.01402	-0.04374	-0.07347	-0.0399	-0.00633	0.02724	0.0608	0.03669	0.01258	-0.01153
-0.03564	-0.00677	0.0221	0.05098	0.07985	0.06915	0.05845	0.04775	0.03706	0.02636
0.05822	0.09009	0.12196	0.10069	0.07943	0.05816	0.03689	0.01563	-0.00564	-0.0269
-0.04817	-0.06944	-0.0907	-0.11197	-0.11521	-0.11846	-0.1217	-0.12494	-0.165	-0.20505
-0.15713	-0.10921	-0.06129	-0.01337	0.03455	0.08247	0.07576	0.06906	0.06236	0.08735
0.11235	0.13734	0.12175	0.10616	0.09057	0.07498	0.08011	0.08524	0.09037	0.06208
0.03378	0.00549	-0.02281	-0.05444	-0.0403	-0.02615	-0.01201	-0.02028	-0.02855	-0.06243
-0.03524	-0.00805	-0.04948	-0.03643	-0.02337	-0.03368	-0.01879	-0.00389	0.011	0.02589
0.01446	0.00303	-0.0084	0.00463	0.01766	0.03069	0.04372	0.02165	-4.20E-04	-0.02249
-0.04456	-0.03638	-0.02819	-0.02001	-0.01182	-0.02445	-0.03707	-0.04969	-0.05882	-0.06795
-0.07707	-0.0862	-0.09533	-0.06276	-0.03018	0.00239	0.03496	0.04399	0.05301	0.03176
0.01051	-0.01073	-0.03198	-0.05323	0.00186	0.05696	0.01985	-0.01726	-0.05438	-0.01204
0.03031	0.07265	0.11499	0.07237	0.02975	-0.01288	0.01212	0.03711	0.03517	0.03323
0.01853	0.00383	0.00342	-0.02181	-0.04704	-0.07227	-0.0975	-0.12273	-0.08317	-0.04362
-0.00407	0.03549	0.07504	0.1146	0.07769	0.04078	0.00387	0.00284	0.00182	-0.05513
0.04732	0.05223	0.05715	0.06206	0.06698	0.07189	0.02705	-0.01779	-0.06263	-0.10747
-0.15232	-0.12591	-0.0995	-0.07309	-0.04668	-0.02027	0.00614	0.03255	0.00859	-0.01537
-0.03932	-0.06328	-0.03322	-0.00315	0.02691	0.01196	-0.003	0.00335	0.0097	0.01605
0.02239	0.04215	0.06191	0.08167	0.03477	-0.01212	-0.01309	-0.01407	-0.05274	-0.02544
0.00186	0.02916	0.05646	0.08376	0.01754	-0.04869	-0.02074	0.00722	0.03517	-0.00528
-0.04572	-0.08617	-0.0696	-0.05303	-0.03646	-0.01989	-0.00332	0.01325	0.02982	0.01101
-0.00781	-0.02662	-0.00563	0.01536	0.03635	0.05734	0.03159	0.00584	-0.01992	-0.00201
0.01589	-0.01024	-0.03636	-0.06249	-0.0478	-0.03311	-0.04941	-0.0657	-0.082	-0.0498
-0.0176	0.0146	0.0468	0.079	0.0475	0.016	-0.0155	-0.00102	0.01347	0.02795
0.04244	0.05692	0.03781	0.0187	-4.10E-04	-0.01952	-0.00427	0.01098	0.02623	0.04148
0.01821	-0.00506	-0.00874	-0.03726	-0.06579	-0.026	0.0138	0.05359	0.09338	0.05883
0.02429	-0.01026	-0.0448	-0.01083	-0.01869	-0.02655	-0.03441	-0.02503	-0.01564	-0.00626
-0.01009	-0.01392	0.0149	0.04372	0.03463	0.02098	0.00733	-0.00632	-0.01997	0.00767
0.03532	0.03409	0.03287	0.03164	0.02403	0.01642	0.00982	0.00322	-0.00339	0.02202
-0.01941	-0.06085	-0.10228	-0.07847	-0.05466	-0.03084	-0.00703	0.01678	0.01946	0.02214
0.02483	0.01809	-0.00202	-0.02213	-0.00278	0.01656	0.0359	0.05525	0.07459	0.06203

0.04948	0.03692	-0.00145	0.04599	0.04079	0.03558	0.03037	0.03626	0.04215	0.04803
0.05392	0.04947	0.04502	0.04056	0.03611	0.03166	0.00614	-0.01937	-0.04489	-0.0704
-0.09592	-0.07745	-0.05899	-0.04052	-0.02206	-0.00359	0.01487	0.01005	0.00523	4.10E-04
-0.00441	-0.00923	-0.01189	-0.01523	-0.01856	-0.0219	-0.00983	0.00224	0.01431	0.00335
-0.0076	-0.01856	-0.00737	0.00383	0.01502	0.02622	0.01016	-0.0059	-0.02196	-0.00121
0.01953	0.04027	0.02826	0.01625	0.00424	0.00196	-3.10E-04	-0.00258	-0.00486	-0.00713
-0.00941	-0.01168	-0.01396	-0.0175	-0.02104	-0.02458	-0.02813	-0.03167	-0.03521	-0.04205
-0.04889	-0.03559	-0.02229	-0.00899	0.00431	0.01762	0.00714	-0.00334	-0.01383	0.01314
0.04011	0.06708	0.0482	0.02932	0.01043	-0.00845	-0.02733	-0.04621	-0.03155	-0.01688
-0.00222	0.01244	0.02683	0.04121	0.05559	0.03253	0.00946	-0.0136	-0.01432	-0.01504
-0.01576	-0.04209	-0.02685	-0.01161	0.00363	0.01887	0.03411	0.03115	0.02819	0.02917
0.03015	0.03113	0.00388	-0.02337	-0.05062	-0.0382	-0.02579	-0.01337	-9.50E-04	0.01146
0.02388	0.03629	0.01047	-0.01535	-0.04117	-0.06699	-0.05207	-0.03715	-0.02222	-0.0073
0.00762	0.02254	0.03747	0.04001	0.04256	0.04507	0.04759	0.0501	0.04545	0.0408
0.02876	0.01671	0.00467	-0.00738	-0.00116	0.00506	0.01128	0.0175	-0.00211	-0.02173
-0.04135	-0.06096	-0.08058	-0.06995	-0.05931	-0.04868	-0.03805	-0.02557	-0.0131	-6.30E-04
0.01185	0.02432	0.0368	0.04927	0.02974	0.01021	-0.00932	-0.02884	-0.04837	-0.0679
-0.04862	-0.02934	-0.01006	0.00922	0.02851	0.04779	0.02456	0.00133	-0.0219	-0.04513
-0.06836	-0.04978	-0.0312	-0.01262	0.00596	0.02453	0.04311	0.06169	0.08027	0.09885
0.06452	0.03019	-0.00414	-0.03848	-0.07281	-0.05999	-0.04717	-0.03435	-0.03231	-0.03028
-0.02824	-0.00396	0.02032	0.00313	-0.01406	-0.03124	-0.04843	-0.06562	-0.05132	-0.03702
-0.02272	-0.00843	0.00587	0.02017	0.02698	0.03379	0.04061	0.04742	0.05423	0.03535
0.01647	0.01622	0.01598	0.01574	0.00747	-8.00E-04	-0.00907	7.20E-04	0.01051	0.0203
0.03009	0.03989	0.03478	0.02967	0.02457	0.03075	0.03694	0.04313	0.04931	0.0555
0.06168	-0.00526	-0.0722	-0.06336	-0.05451	-0.04566	-0.03681	-0.03678	-0.03675	-0.03672
-0.01765	0.00143	0.02051	0.03958	0.05866	0.03556	0.01245	-0.01066	-0.03376	-0.05687
-0.04502	-0.03317	-0.02131	-0.00946	0.00239	-0.00208	-0.00654	-0.01101	-0.01548	-0.012
-0.00851	-0.00503	-0.00154	0.00195	5.10E-04	-9.20E-04	0.01135	0.02363	0.0359	0.04818
0.06045	0.07273	0.02847	-0.01579	-0.06004	-0.05069	-0.04134	-0.03199	-0.03135	-0.03071
-0.03007	-0.01863	-0.00719	0.00425	0.0157	0.02714	0.03858	0.02975	0.02092	0.02334
0.02576	0.02819	0.03061	0.03304	0.01371	-0.00561	-0.02494	-0.02208	-0.01923	-0.01638
-0.01353	-0.01261	-0.0117	-0.00169	0.00833	0.01834	0.02835	0.03836	0.04838	0.03749
0.0266	0.01571	0.00482	-0.00607	-0.01696	-0.0078	0.00136	0.01052	0.01968	0.02884
-0.00504	-0.03893	-0.02342	-0.00791	0.00759	0.0231	0.00707	-0.00895	-0.02498	-0.041
-0.05703	-0.0292	-0.00137	0.02645	0.05428	0.03587	0.01746	-9.60E-04	-0.01937	-0.03778
-0.02281	-0.00784	0.00713	0.0221	0.03707	0.05204	0.06701	0.08198	0.03085	-0.02027
-0.0714	-0.12253	-0.08644	-0.05035	-0.01426	0.02183	0.05792	0.094	0.13009	0.03611
-0.05787	-0.04802	-0.03817	-0.02832	-0.01846	-0.00861	-0.03652	-0.06444	-0.06169	-0.05894
-0.05618	-0.06073	-0.06528	-0.04628	-0.02728	-0.00829	0.01071	0.0297	0.03138	0.03306
0.03474	0.03642	0.04574	0.05506	0.06439	0.07371	0.08303	0.03605	-0.01092	-0.0579
-0.04696	-0.03602	-0.02508	-0.01414	-0.03561	-0.05708	-0.07855	-0.06304	-0.04753	-0.03203
-0.01652	-0.00102	0.00922	0.01946	0.0297	0.03993	0.05017	0.06041	0.07065	0.08089
-0.00192	-0.08473	-0.07032	-0.0559	-0.04148	-0.05296	-0.06443	-0.0759	-0.08738	-0.09885

-0.06798	-0.0371	-0.00623	0.02465	0.05553	0.0864	0.11728	0.14815	0.08715	0.02615
-0.03485	-0.09584	-0.071	-0.04616	-0.02132	0.00353	0.02837	0.05321	-0.00469	-0.06258
-0.12048	-0.0996	-0.07872	-0.05784	-0.03696	-0.01608	0.0048	0.02568	0.04656	0.06744
0.08832	0.1092	0.13008	0.10995	0.08982	0.06969	0.04955	0.04006	0.03056	0.02107
0.01158	0.0078	0.00402	2.40E-04	-0.00354	-0.00732	-0.0111	-0.0078	-0.0045	-0.0012
0.0021	0.0054	-0.00831	-0.02203	-0.03575	-0.04947	-0.06319	-0.05046	-0.03773	-0.025
-0.01227	4.60E-04	0.00482	0.00919	0.01355	0.01791	0.02228	0.00883	-0.00462	-0.01807
-0.03152	-0.02276	-0.01401	-0.00526	0.0035	0.01225	0.02101	0.01437	0.00773	0.0011
0.00823	0.01537	0.02251	0.01713	0.01175	0.00637	0.01376	0.02114	0.02852	0.03591
0.04329	0.03458	0.02587	0.01715	0.00844	-2.70E-04	-0.00898	-0.00126	0.00645	0.01417
0.02039	0.02661	0.03283	0.03905	0.04527	0.03639	0.0275	0.01862	0.00974	8.60E-04
-0.01333	-0.02752	-0.04171	-0.02812	-0.01453	-9.40E-04	0.01264	0.02623	0.0169	0.00756
-0.00177	-0.01111	-0.02044	-0.02977	-0.03911	-0.02442	-0.00973	0.00496	0.01965	0.03434
0.02054	0.00674	-0.00706	-0.02086	-0.03466	-0.02663	-0.0186	-0.01057	-0.00254	-6.30E-04
0.00128	0.00319	0.0051	0.00999	0.01488	0.00791	9.30E-04	-0.00605	0.00342	0.01288
0.02235	0.03181	0.04128	0.02707	0.01287	-0.00134	-0.01554	-0.02975	-0.04395	-0.03612
-0.02828	-0.02044	-0.0126	-0.00476	0.00307	0.01091	0.00984	0.00876	0.00768	0.00661
0.01234	0.01807	0.0238	0.02953	0.03526	0.02784	0.02042	0.013	-0.03415	-0.00628
-0.00621	-0.00615	-0.00609	-0.00602	-0.00596	-0.0059	-0.00583	-0.00577	-0.00571	-0.00564
-0.00558	-0.00552	-0.00545	-0.00539	-0.00532	-0.00526	-0.0052	-0.00513	-0.00507	-0.00501
-0.00494	-0.00488	-0.00482	-0.00475	-0.00469	-0.00463	-0.00456	-0.0045	-0.00444	-0.00437
-0.00431	-0.00425	-0.00418	-0.00412	-0.00406	-0.00399	-0.00393	-0.00387	-0.0038	-0.00374
-0.00368	-0.00361	-0.00355	-0.00349	-0.00342	-0.00336	-0.0033	-0.00323	-0.00317	-0.00311
-0.00304	-0.00298	-0.00292	-0.00285	-0.00279	-0.00273	-0.00266	-0.0026	-0.00254	-0.00247
-0.00241	-0.00235	-0.00228	-0.00222	-0.00216	-0.00209	-0.00203	-0.00197	-0.0019	-0.00184
-0.00178	-0.00171	-0.00165	-0.00158	-0.00152	-0.00146	-0.00139	-0.00133	-0.00127	-0.0012
-0.00114	-0.00108	-0.00101	-9.50E-04	-8.90E-04	-8.20E-04	-7.60E-04	-7.00E-04	-6.30E-04	-5.70E-04
-5.10E-04	-4.40E-04	-3.80E-04	-3.20E-04	-2.50E-04	-1.90E-04	-1.30E-04	-6.00E-05	0	