Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
48	1116	1	1	A1	TS01	0.6600	0.0845	0.0000	15	5.0124	4.5751	20.9316	0.9957	0.9128
48	1116	1	2	A2	TS03	1.0212	0.1796	-1.6503	15	9.4903	3.8936	15.1599	0.9979	0.4103
48	1116	1	2	BA*	BS**	0.9684	0.6387	-2.3171	15	16.0083	3.5275	12.4434	0.9980	0.2204
48	1116	2	1	BA*	BG**	0.8627	0.6446	-0.3105	15	54.3408	7.4961	56.1922	0.9980	0.1379
48	1116	2	2	BA*	BG**	0.7072	0.7099	-0.2427	15	56.0598	2.7298	7.4521	0.9997	0.0487
48	1119	1	1	A1	TS01	0.6123	0.5002	-4.4764	15	10.1831	3.6670	13.4472	0.9906	0.3601
48	1119	1	2	A2	TS03	0.9051	0.3711	-2.2878	15	11.6729	4.6384	21.5149	0.9957	0.3974
48	1119	2	1	BA*	BG**	0.8611	0.5342	-0.2475	15	41.6198	5.8457	34.1727	0.9985	0.1405
48	1119	2	2	BA*	BG**	0.9342	0.6529	-0.4263	15	55.0876	7.1734	51.4578	0.9983	0.1302
48	1122	1	1	BA*	BS**	0.7429	0.6981	-0.7939	13	16.2678	2.8990	8.4044	0.9987	0.1782
48	1122	1	2	A2	TS03	1.3591	0.3205	-1.2279	15	14.2210	6.5101	42.3815	0.9972	0.4578
48	1122	2	1	BA*	BG**	0.6373	0.7066	-0.2534	15	49.2421	5.2154	27.2003	0.9986	0.1059
48	1122	2	2	TP1	BG56	0.7464	0.6473	-0.2806	15	48.5090	5.2748	27.8238	0.9987	0.1087
48	1122	3	1	BA*	BG**	1.5637	0.4818	-0.0042	15	80.6908	14.5067	210.4451	0.9974	0.1798
48	1122	3	2	TP1	BG55	1.3659	0.4999	0.0000	15	74.0008	7.4202	55.0590	0.9991	0.1003
48	1123	2	1	BA*	BG**	0.9039	0.6133	0.0000	15	67.8677	8.7063	75.7992	0.9980	0.1283
48	1123	2	2	TP1	BG55	1.3586	0.7716	-0.1586	15	142.7129	38.9888	1520.1290	0.9870	0.2732
48	1130	1	1	A1	TS01	0.8339	0.3785	-3.0166	15	11.0970	2.6387	6.9628	0.9981	0.2378
48	1130	1	2	A2	TS03	0.4708	0.1461	0.0000	15	7.6420	7.2012	51.8574	0.9798	0.9423
48	1168	1	1	BA*	BS**	0.5363	0.5224	-0.6130	13	9.0128	1.4398	2.0731	0.9994	0.1598
48	1168	1	2	TP1	BS55	0.7643	0.3016	-2.4930	15	9.8188	3.6417	13.2619	0.9960	0.3709
48	1168	2	1	BA*	BG**	0.8288	0.6750	0.0000	15	75.9349	18.8174	354.0960	0.9908	0.2478
48	1168	2	2	TP1	BG55	0.8960	0.7159	-0.6894	15	51.9649	8.8914	79.0570	0.9970	0.1711
48	1169	1	1	A1	TS01	0.5189	0.3640	0.0000	15	7.2526	1.8333	3.3610	0.9990	0.2528
48	1169	1	2	BA*	BS**	0.5656	0.4104	0.0000	15	9.8431	4.6508	21.6300	0.9947	0.4725
48	1169	2	1	BA*	BG**	0.9740	0.6142	-0.2792	15	57.9787	7.3459	53.9626	0.9984	0.1267
48	1169	2	2	BA*	BG**	0.8358	0.5874	0.0000	15	57.8642	6.9788	48.7036	0.9984	0.1206
48	1174	1	1	BA*	BS**	0.8932	0.1124	-0.6738	15	4.0297	1.0964	1.2021	0.9998	0.2721
48	1174	1	2	TP1	BS55	0.7137	0.1437	-1.3846	15	5.3914	1.2550	1.5751	0.9996	0.2328
48	1174	2	1	BA*	BG**	1.6799	0.5421	-0.4016	15	73.7977	13.3790	178.9982	0.9977	0.1813
48	1174	2	2	TP1	BG55	0.3661	0.5938	0.0000	15	25.9945	3.2338	10.4575	0.9982	0.1244
48	1178	1	1	A1	TS02	0.7560	0.6120	-2.1811	15	12.1655	2.9447	8.6714	0.9978	0.2421
48	1178	1	2	TP1	BS55	0.4893	0.0709	-4.1166	15	6.4859	0.6759	0.4568	0.9995	0.1042
48	1178	3	1	BA*	BG**	1.0965	0.6769	-0.1937	15	82.2865	10.3738	107.6152	0.9981	0.1261
48	1178	3	2	TP1	BG55	1.2110	0.5944	0.0000	15	87.1282	16.2582	264.3297	0.9960	0.1866
48	1181	1	1	BA*	BS**	0.5584	0.0584	-0.9664	15	3.2042	0.7428	0.5518	0.9998	0.2318
48	1181	1	2	BA*	BS**	0.7741	0.3088	0.0000	15	14.3172	11.2218	125.9298	0.9829	0.7838
48	1181	3	1	BA*	BG**	0.5263	0.5941	-0.1956	15	32.0852	8.4562	71.5068	0.9931	0.2636
48	1181	3	2	BA*	BG**	0.5965	0.4934	-0.0726	15	29.6996	6.4603	41.7353	0.9963	0.2175
48	1183	1	1	A1	TS01	1.1153	0.5611	-2.5662	15	16.7838	3.4547	11.9353	0.9984	0.2058
48	1183	1	2	A2	TS03	0.5369	0.1391	-0.5341	15	4.7789	4.0887	16.7172	0.9940	0.8556
48	1183	2	1	BA*	BG**	0.9761	0.5845	-0.4770	15	45.8192	10.2230	104.5105	0.9961	0.2231
48	1183	2	2	TP1	BG55	1.1945	0.4834	-0.4498	15	41.8088	10.4902	110.0445	0.9966	0.2509
48	2133	1	1	A1	TS01	0.8825	0.2062	-0.5692	15	6.4940	3.4616	11.9824	0.9984	0.5330
48	2133	2	1	BA*	BG**	0.8670	0.3555	0.0000	15	29.4880	7.0663	49.9333	0.9972	0.2396
48	2133	2	2	TP1	BG56	0.9124	0.5934	-0.2994	15	50.4702	7.3042	53.3512	0.9981	0.1447
48	2133	3	1	BA*	BG**	1.2008	0.5362	-0.0825	15	67.2307	8.3571	69.8419	0.9986	0.1243
48	2172	1	1	BA*	BS**	1.2787	0.3241	-2.0671	15	13.9130	2.0103	4.0414	0.9996	0.1445
48	2172	1	2	A2	TS03	1.0860	0.4669	-1.3617	15	15.8198	6.9894	48.8520	0.9950	0.4418
48	2172	2	1	BA*	BG**	0.9072	0.5018	-0.3122	15	37.5204	3.2859	10.7969	0.9995	0.0876
48	2172	2	2	TP1	BG55	0.3511	0.7418	0.0000	15	36.8771	6.5394	42.7638	0.9948	0.1773
48	2176	1	1	A1	TS01	1.0513	0.3217	-1.1322	15	10.0617	2.5702	6.6062	0.9993	0.2554
48	2176	1	2	A2	TS03	0.5881	0.5567	-1.7206	15	8.8641	1.5623	2.4407	0.9991	0.1762
48	3003	1	1	A1	TS01	0.6192	0.0679	0.0000	15	4.4593	4.1960	17.6067	0.9959	0.9410
48	3003	1	2	A2	TS03	0.7775	0.1964	-1.8579	15	7.6780	1.3521	1.8281	0.9995	0.1761
48	3003	1	2	BA*	BS**	0.7511	0.3068	-1.1866	15	7.9343	3.8754	15.0188	0.9968	0.4884

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
48	3010	1	1	BA*	BS**	1.3216	0.4319	-0.8315	15	16.9910	3.3028	10.9087	0.9994	0.1944
48	3010	1	2	BA*	BS**	1.2018	0.0371	-0.4498	15	5.2572	4.1184	16.9613	0.9988	0.7834
48	3559	1	1	BA*	BS**	0.5283	0.4441	-1.1081	15	7.5731	3.8451	14.7847	0.9941	0.5077
48	3559	1	2	A2	TS04	1.8621	0.3327	-2.3088	15	21.8811	5.7345	32.8850	0.9984	0.2621
48	3559	2	2	BA*	BG**	0.6777	0.7088	-0.1040	15	59.9317	2.8371	8.0489	0.9997	0.0473
48	3569	1	1	A1	TS01	1.0267	0.2027	-3.5340	15	13.3962	2.1068	4.4387	0.9991	0.1573
48	3569	1	2	A2	TS03	1.0925	0.2743	-2.7706	15	13.1595	1.7139	2.9374	0.9995	0.1302
48	3579	1	1	A1	TS01	0.9075	0.1757	-0.1934	15	6.3830	3.6998	13.6882	0.9985	0.5796
48	3579	1	2	TP1	BS55	1.3686	0.2137	-1.0404	15	10.1803	3.5574	12.6550	0.9992	0.3494
48	3579	3	1	BA2	BG02	0.8486	0.7206	-0.2323	15	70.5724	8.6469	74.7693	0.9979	0.1225
48	3579	3	2	TP1	BG55	0.9795	0.5958	-0.3799	15	51.1478	10.7036	114.5670	0.9962	0.2093
48	3589	1	1	BA*	BS**	0.8255	0.4347	-0.9027	15	10.6293	1.8368	3.3739	0.9995	0.1728
48	3589	1	2	A2	TS03	0.6124	0.2298	0.0000	15	7.6426	5.6974	32.4601	0.9927	0.7455
48	3589	2	1	BA*	BG**	0.7018	0.5286	-0.3641	15	30.9365	9.6662	93.4358	0.9930	0.3125
48	3589	2	2	BA*	BG**	0.6064	0.6015	-0.2226	15	36.3433	4.8411	23.4359	0.9983	0.1332
48	3609	1	1	A1	TS01	1.0019	0.1553	-1.1059	15	7.6613	3.9094	15.2833	0.9981	0.5103
48	3609	1	2	A2	TS03	1.1427	0.2088	0.0000	15	19.8825	17.8032	316.9555	0.9797	0.8954
48	3609	2	1	BA*	BG**	0.9874	0.6889	-0.2357	15	74.1827	7.3598	54.1660	0.9988	0.0992
48	3609	2	2	TP1	BG55	0.9310	0.6618	-0.1583	15	69.3289	7.6087	57.8930	0.9986	0.1097
48	3629	1	1	A1	TS01	0.5051	0.4218	0.0000	15	8.5373	3.1936	10.1990	0.9968	0.3741
48	3629	1	2	A2	TS03	0.6260	0.6250	-0.7440	15	12.2638	1.8072	3.2658	0.9992	0.1474
48	3669	1	1	A1	TS01	0.5386	0.5690	-0.4213	15	10.3680	1.7830	3.1792	0.9991	0.1720
48	3679	1	1	A1	TS01	0.8181	0.2984	-5.9348	15	12.6878	2.0251	4.1010	0.9979	0.1596
48	3679	1	2	A2	TS03	0.9106	0.0806	-2.0818	15	9.2618	2.8048	7.8668	0.9985	0.3028
48	3689	1	1	A1	TS01	0.7872	0.5902	-0.8875	15	14.7206	3.6583	13.3831	0.9979	0.2485
48	3689	1	2	A2	TS03	0.8658	0.2941	0.0000	15	17.2743	14.7415	217.3108	0.9766	0.8534
48	3699	1	1	A1	TS01	0.7258	0.2840	-2.2718	15	8.2451	1.9560	3.8260	0.9988	0.2372
48	3699	1	2	A2	TS3	0.5171	0.1171	-1.6449	15	4.8727	2.1237	4.5101	0.9976	0.4358
48	3719	1	1	BA*	BS**	1.0874	0.2352	-1.6164	15	9.7238	1.2773	1.6314	0.9998	0.1314
48	3719	1	2	A2	TS03	0.8553	0.0000	-2.3761	15	11.2364	4.6756	21.8614	0.9946	0.4161
48	3729	1	1	A1	TS01	0.6161	0.2844	-0.9449	15	6.9741	4.4894	20.1548	0.9941	0.6437
48	3729	1	2	A2	TS03	0.8793	0.3458	-2.7438	15	11.0419	2.2294	4.9704	0.9988	0.2019
48	3729	3	1	BA*	BG**	0.4983	0.3616	0.0000	15	18.3633	7.5055	56.3321	0.9907	0.4087
48	3729	3	2	TP1	BG55	0.3628	0.6231	-0.3130	15	22.0396	5.0054	25.0537	0.9947	0.2271
48	3739	1	1	BA*	BS**	0.7775	0.6480	-0.2105	14	18.6712	4.3894	19.2671	0.9976	0.2351
48	3739	1	2	TP1	BS55	0.7142	0.5147	-0.0185	14	14.4747	2.9015	8.4188	0.9988	0.2005
48	3749	1	1	A1	TS02	0.5443	0.0767	0.0000	15	3.3566	2.9886	8.9315	0.9973	0.8904
48	3749	1	2	A2	TS03	0.7364	0.0000	0.0000	15	8.1574	8.1574	66.5429	0.9890	1.0000
48	3749	3	1	BA*	BG**	0.7245	0.6321	-0.4749	15	39.0022	8.3789	70.2067	0.9958	0.2148
48	3749	3	2	TP1	BG55	0.7531	0.6258	-0.3916	15	42.5085	4.6821	21.9224	0.9989	0.1101
48	3769	1	1	BA*	BS**	0.7304	0.1785	-0.5835	15	5.3515	3.5912	12.8970	0.9975	0.6711
48	3769	1	2	A2	TS02	0.6608	0.4072	-1.4669	15	7.9952	2.4608	6.0555	0.9982	0.3078
48	3769	2	1	BA*	BG**	0.7405	0.7234	-0.0184	15	72.6001	6.5095	42.3737	0.9988	0.0897
48	3769	2	2	TP1	BG55	1.0551	0.6975	0.0000	15	98.6007	7.6388	58.3509	0.9991	0.0775
48	3779	1	1	A1	TS01	0.4182	0.0991	-1.9067	15	4.7729	2.8088	7.8896	0.9931	0.5885
48	3779	1	2	A2	TS03	0.5474	0.8711	-3.6300	15	11.2935	3.8440	14.7762	0.9904	0.3404
48	3779	2	1	BA*	BG**	0.8962	0.8037	-0.2238	15	91.0029	6.4221	41.2429	0.9992	0.0706
48	3779	2	2	BA*	BG**	1.3180	0.6415	-0.3775	15	78.4383	10.7225	114.9721	0.9982	0.1367
48	3845	1	1	A1	TS01	0.7689	0.0902	-1.8058	15	6.9577	1.4250	2.0307	0.9995	0.2048
48	3845	1	2	A2	TS03	0.9610	0.1262	-1.4659	15	7.5391	1.9179	3.6784	0.9995	0.2544
48	3855	1	2	BA*	BS**	0.6657	0.3326	0.0000	15	11.0182	7.4470	55.4572	0.9898	0.6759
48	3855	3	1	BA*	BG**	1.1692	0.6775	-0.1114	15	93.7113	10.6134	112.6450	0.9984	0.1133
48	3855	3	2	BA*	BG**	1.0912	0.5608	-0.1954	15	59.6986	11.0639	122.4101	0.9970	0.1853
48	3865	1	1	BA*	BS**	1.2225	0.5115	0.0000	15	38.0167	24.3138	591.1616	0.9695	0.6396
48	3865	1	2	BA*	BS**	1.0770	0.2217	-0.1799	15	8.8436	3.8086	14.5056	0.9989	0.4307
48	3865	2	1	BA*	BG**	1.2664	0.5259	0.0000	15	75.0102	12.9163	166.8304	0.9972	0.1722

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
48	3865	3	1	BA*	BG**	1.3101	0.4971	0.0000	15	72.1820	16.8039	282.3720	0.9952	0.2328
48	3865	3	2	BA*	BG**	1.4621	0.4890	0.0000	15	79.7790	24.1432	582.8943	0.9920	0.3026
48	3875	1	1	A1	TS02	0.8909	0.4123	-1.3360	15	10.8153	2.6377	6.9574	0.9989	0.2439
48	3875	1	2	A2	TS04	0.8356	0.1845	-1.0435	15	6.4016	3.3320	11.1023	0.9981	0.5205
48	3875	2	1	BA*	BG**	0.8527	0.5775	0.0000	15	57.9665	7.5989	57.7437	0.9981	0.1311
48	3875	2	2	TP1	BG55	1.0719	0.5824	-0.4320	15	51.7045	10.9626	120.1779	0.9964	0.2120
48	4142	1	1	A1	TS01	1.1171	0.1876	0.0000	15	11.8491	9.0519	81.9362	0.9943	0.7639
48	4142	1	2	A2	TS03	0.8534	0.5502	-2.7885	15	13.0377	2.7326	7.4672	0.9982	0.2096
48	4142	2	1	BA*	BG**	0.6898	0.6644	-0.1726	15	51.6384	3.8000	14.4396	0.9993	0.0736
48	4143	1	1	A1	TS01	0.5192	0.1006	-3.3748	15	6.4991	0.9771	0.9546	0.9992	0.1503
48	4143	1	2	A2	TS03	0.6944	0.0709	-3.7478	15	9.4466	0.6026	0.3632	0.9998	0.0638
48	4146	1	1	A1	TS01	0.8967	0.0960	-2.6418	15	10.2804	1.0173	1.0349	0.9998	0.0990
48	4146	1	2	BA*	BS**	0.7922	0.1042	-1.4312	15	6.1179	1.3984	1.9555	0.9996	0.2286
48	4152	1	1	A1	TS01	1.0009	0.4958	-3.4883	15	15.7918	4.4307	19.6312	0.9957	0.2806
48	4152	1	2	A2	TS03	0.5188	0.7056	-3.9887	15	9.1376	2.2527	5.0747	0.9956	0.2465
48	5024	1	1	A1	TS01	0.7839	0.6234	-1.0216	15	14.4133	1.5606	2.4356	0.9996	0.1083
48	5024	1	2	A2	TS03	0.6295	0.5079	-1.2612	15	9.1610	1.8537	3.4360	0.9990	0.2023
48	5026	1	1	A1	TS01	0.4942	0.0000	0.0000	15	3.3267	3.3267	11.0667	0.9959	1.0000
48	5026	1	2	A2	TS03	0.6330	0.0982	-1.8711	15	6.1513	2.6269	6.9004	0.9974	0.4270
48	5035	1	1	BA*	BS**	1.4983	0.2332	-1.6172	15	15.0545	7.3138	53.4921	0.9966	0.4858
48	5035	1	2	A2	TS01	0.6420	0.5294	-1.2696	15	10.3418	3.7580	14.1228	0.9961	0.3634
48	5154	1	1	A1	TS02	0.6028	0.0000	0.0000	15	9.0196	9.0196	81.3524	0.9800	1.0000
48	5154	1	2	A2	TS03	1.3451	0.4239	-1.0231	15	17.2232	5.1358	26.3760	0.9984	0.2982
48	5274	1	1	A1	TS01	0.8072	0.3649	-0.4367	15	9.6249	2.2282	4.9648	0.9993	0.2315
48	5274	1	2	BA*	BS**	0.6108	0.0003	-4.9793	15	9.8764	1.4840	2.2021	0.9981	0.1503
48	5278	1	1	BA*	BS**	0.7006	0.2426	-0.5890	15	6.6940	4.2286	17.8809	0.9963	0.6317
48	5278	1	2	BA*	BS**	1.0431	0.3908	-0.7118	15	12.5634	3.1848	10.1428	0.9991	0.2535
48	5283	1	1	BA*	BS**	1.1492	0.2770	-2.1357	15	12.6201	2.4808	6.1543	0.9992	0.1966
48	5283	1	2	A2	TS03	1.0381	0.2403	-2.2314	15	11.5478	3.0142	9.0856	0.9986	0.2610
48	5284	1	1	BA*	BS**	0.8908	0.4057	-1.8433	15	11.9032	6.3418	40.2184	0.9928	0.5328
48	5284	1	2	BA*	BS**	1.2864	0.2540	-1.5777	15	11.8048	2.8857	8.3275	0.9993	0.2445
48	5287	1	1	A1	TS01	1.0870	0.5970	-1.0263	15	20.7876	7.9700	63.5210	0.9945	0.3834
48	5287	1	2	A2	TS03	1.0347	0.1660	-1.2314	15	7.2651	1.4041	1.9716	0.9998	0.1933
48	5301	1	1	BA*	BS**	1.5556	0.2404	-1.8881	15	16.1372	5.2772	27.8490	0.9982	0.3270
48	5310	1	1	BA*	BS**	1.5817	0.2623	-0.9995	15	13.4953	5.0810	25.8164	0.9988	0.3765
48	5310	1	2	BA*	BS**	1.1585	0.3833	0.0000	15	21.3370	13.7334	188.6076	0.9888	0.6436
48	5317	1	2	BA*	BS**	1.1854	0.1472	-0.1649	15	6.1860	2.4602	6.0524	0.9996	0.3977
48	5323	1	1	A1	TS01	0.7712	0.2614	-1.7482	15	7.9144	2.9943	8.9661	0.9978	0.3783
48	5323	1	2	A2	TS03	0.5231	0.1702	0.0000	15	10.5978	10.0911	101.8306	0.9688	0.9522
48	5328	1	1	BA*	BS**	0.6195	0.2964	0.0000	15	7.7533	3.5977	12.9435	0.9972	0.4640
48	5328	1	2	BA*	BS**	0.9400	0.2737	-0.7221	15	7.9325	2.4006	5.7631	0.9993	0.3026
48	5328	2	1	BA*	BG**	1.2057	0.6678	-0.5053	15	70.0284	15.2927	233.8654	0.9953	0.2184
48	5328	2	2	BA*	BG**	1.3066	0.6749	-0.3716	15	84.9276	13.1606	173.2012	0.9974	0.1550
48	5334	1	1	A1	TS01	1.1230	0.3507	-2.1864	15	13.0760	2.3668	5.6017	0.9993	0.1810
48	5334	1	2	A2	TS03	0.4436	0.2779	-2.0031	15	5.3032	2.7747	7.6991	0.9940	0.5232
48	5334	2	1	BA*	BG**	0.8673	0.6713	-0.2076	15	63.3952	7.6303	58.2211	0.9983	0.1204
48	5334	2	2	BA*	BG**	0.6408	0.8223	-0.4483	15	57.1899	6.5150	42.4458	0.9981	0.1139
48	5335	1	1	A1	TS01	1.0870	0.2442	-1.9767	15	11.3167	3.8455	14.7879	0.9981	0.3398
48	5335	1	2	BA*	BS**	0.8031	0.2092	0.0000	15	15.6510	14.3869	206.9826	0.9733	0.9192
48	5336	1	1	A1	TS02	0.6660	0.7842	-1.1332	15	15.8601	3.0139	9.0838	0.9980	0.1900
48	5336	1	2	A2	TS03	0.5993	0.0394	0.0000	15	10.9870	10.9548	120.0075	0.9708	0.9971
48	6079	1	1	A1	TS01	0.6642	0.2998	-1.5951	15	7.1534	3.0129	9.0776	0.9972	0.4212
48	6079	1	2	A2	TS03	0.6024	0.6458	-0.2059	15	15.2447	4.9298	24.3025	0.9948	0.3234
48	6079	2	1	BA*	BG**	0.8312	0.6924	-0.2645	15	63.3301	7.1331	50.8813	0.9984	0.1126
48	6079	2	2	TP1	BG55	1.0314	0.6060	-0.1234	15	68.9553	6.7147	45.0871	0.9990	0.0974
48	6086	1	1	BA*	BS**	1.0420	0.2928	-0.4239	15	9.7160	2.2405	5.0197	0.9996	0.2306

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
48	6086	1	2	BA*	BS**	1.2088	0.4265	-0.9874	15	15.2431	4.6335	21.4689	0.9984	0.3040
48	6086	3	1	BA*	BG**	0.5267	0.8172	-0.4793	15	45.8608	3.8488	14.8132	0.9990	0.0839
48	6086	3	2	BA*	BG**	0.3105	0.6743	0.0000	15	26.6508	8.7508	76.5773	0.9849	0.3284
48	6160	1	1	A1	TS01	0.8030	0.5282	-1.5959	15	11.7100	2.4616	6.0595	0.9988	0.2102
48	6160	1	2	A2	TS03	0.7838	0.3104	-1.8914	15	8.8307	3.1643	10.0130	0.9975	0.3583
48	6160	2	1	BA*	BG**	0.8726	0.5779	-0.4339	15	41.4319	8.9644	80.3599	0.9964	0.2164
48	6160	2	2	TP1	BG56	0.9748	0.5737	-0.6729	15	38.2874	8.8441	78.2183	0.9965	0.2310
48	6160	3	2	TP1	BG55	0.6736	0.7802	-0.4673	15	54.0436	9.6652	93.4165	0.9957	0.1788
48	6179	1	1	A1	TS01	0.4822	0.2125	-1.0385	15	5.2490	4.1291	17.0495	0.9913	0.7866
48	6179	1	2	TP1	BS55	0.8004	0.4316	-0.9298	15	10.1009	2.2976	5.2789	0.9991	0.2275
48	6179	2	1	BA*	BG**	0.8907	0.4659	-0.3075	15	33.4070	9.2941	86.3811	0.9955	0.2782
48	6179	2	2	TP1	BG56	1.3590	0.4119	-0.0515	15	52.8315	6.4993	42.2415	0.9991	0.1230
48	6179	3	1	BA*	BG**	0.6677	0.8267	-0.3630	15	64.4824	4.9904	24.9042	0.9991	0.0774
48	6179	3	2	TP1	BG55	0.9588	0.5936	-0.4588	15	46.6597	8.1894	67.0668	0.9975	0.1755
48	7165	1	1	BA*	BS**	1.1862	0.1231	-0.7905	15	5.9936	1.6291	2.6540	0.9998	0.2718
48	7165	1	2	BA*	BS**	0.9013	0.0985	-0.6833	15	4.1748	1.8001	3.2403	0.9996	0.4312
48	9005	1	1	A1	TS01	0.3172	0.0000	-0.4635	15	2.6241	2.4190	5.8515	0.9939	0.9218
48	9005	1	2	A2	TS02	0.7919	0.1162	0.0000	15	5.8039	4.7482	22.5456	0.9968	0.8181
48	9005	2	1	BA*	BG**	1.3612	0.4785	-0.3394	15	51.6156	9.7545	95.1502	0.9979	0.1890
48	9005	2	2	TP1	BG55	1.0147	0.5039	-0.1886	15	47.5197	11.7760	138.6751	0.9955	0.2478
48	9167	1	1	A1	TS02	0.8812	0.1315	-1.8578	15	7.9180	1.4721	2.1670	0.9996	0.1859
48	9167	1	2	A2	TS04	0.4121	0.1762	-3.8694	15	5.5274	2.1224	4.5044	0.9942	0.3840
48	9167	3	1	BA*	BG**	0.5166	0.7905	-0.3504	15	45.8396	5.2235	27.2846	0.9981	0.1140
48	9167	3	2	BA4	BG04	0.6355	0.6545	0.0000	15	68.4114	46.7841	2188.7500	0.9032	0.6839
48	9355	1	1	A1	TS01	0.8326	0.9215	-6.5304	15	16.5550	4.2824	18.3393	0.9903	0.2587
48	9355	1	2	A2	TS03	0.9827	0.3819	-2.7108	15	12.5098	2.4174	5.8439	0.9989	0.1932
48	9355	2	1	BA*	BG**	1.1978	0.5980	-0.5399	15	55.4975	9.5098	90.4357	0.9977	0.1714
48	9355	2	2	BA*	BG**	1.0700	0.5730	-0.1388	15	63.6345	10.0938	101.8849	0.9976	0.1586
49	1001	1	2	TP1	BS92	0.6573	0.2997	-0.6944	15	6.1875	2.1911	4.8007	0.9988	0.3541
49	1004	1	2	TP1	BS92	0.5560	0.4624	-1.7032	15	7.3666	2.1936	4.8120	0.9979	0.2978
49	1004	2	1	BA*	BG**	0.5228	0.4641	-0.0590	15	23.9394	4.1392	17.1331	0.9979	0.1729
49	1005	1	2	TP1	BS92	0.4435	0.5445	-0.1073	15	8.7788	1.4289	2.0416	0.9992	0.1628
49	1005	2	1	BA*	BS**	0.4553	0.6050	-0.3851	15	24.1858	4.2698	18.2313	0.9973	0.1765
49	1006	1	1	BA*	BS**	0.4898	0.3852	-1.1293	15	5.3940	0.8337	0.6951	0.9997	0.1546
49	1006	1	2	TP1	BS92	1.2204	0.2152	0.0000	15	11.4642	6.2059	38.5127	0.9978	0.5413
49	1007	1	1	BA*	BS**	0.7531	0.2743	-0.9425	15	6.4528	1.9615	3.8473	0.9992	0.3040
49	1007	1	2	TP1	BS92	0.4903	0.5820	-2.3478	15	7.7337	2.2605	5.1101	0.9967	0.2923
49	1007	2	1	BA*	BG**	0.8246	0.3053	-0.2227	15	17.7555	4.4907	20.1663	0.9983	0.2529
49	1008	1	1	BA*	BS**	0.8006	0.2097	-1.6247	15	7.1481	1.5569	2.4239	0.9995	0.2178
49	1008	1	2	TP1	BS92	0.1806	0.0191	0.0000	15	1.9881	1.9842	3.9369	0.9892	0.9980
49	1017	1	2	TP1	BS93	0.4876	0.5832	-2.4639	15	7.7355	2.5250	6.3758	0.9957	0.3264
49	1017	2	2	TP1	BG92	0.3212	0.6559	-0.3865	15	19.7441	4.1297	17.0541	0.9955	0.2092
49	3010	1	1	BA*	BS**	0.7527	0.1979	-0.9158	15	5.1501	1.6498	2.7218	0.9994	0.3203
49	3010	1	2	BA*	BS**	1.0737	0.2270	0.0000	15	10.8790	6.2007	38.4482	0.9972	0.5700
49	3010	2	1	BA*	BG**	1.4775	0.1875	0.0000	15	23.0145	5.0178	25.1778	0.9993	0.2180
49	3011	1	1	BA*	BS**	0.5780	0.5443	-1.6765	15	8.6261	2.1050	4.4310	0.9983	0.2440
49	3011	1	2	BA*	BS**	0.8525	0.1971	-0.4863	15	5.6753	2.5078	6.2888	0.9991	0.4419
49	3015	1	1	BA*	BS**	0.4704	0.6380	-0.3831	15	10.1686	1.5138	2.2915	0.9992	0.1489
49	3015	1	2	BA*	BS**	0.5093	0.6040	-0.7390	15	9.4783	1.6176	2.6166	0.9991	0.1707
49	7083	1	1	BA*	BS**	0.8152	0.2173	-1.3587	15	6.7485	1.7632	3.1087	0.9994	0.2613
49	7083	1	2	BA*	BS**	0.6113	0.3619	-1.2624	15	6.6246	1.8816	3.5404	0.9988	0.2840
49	7083	2	1	BA*	BG**	0.8260	0.3036	-0.4199	15	14.9736	6.2237	38.7348	0.9962	0.4156
49	7083	2	2	BA*	BG**	0.6247	0.4793	-0.2354	15	25.6539	4.6513	21.6346	0.9979	0.1813
49	7086	1	2	TP1	BS91	0.9678	0.1569	-0.0136	15	6.1582	2.7988	7.8336	0.9993	0.4545
50	1004	1	1	BA*	BS**	1.1439	0.4125	-1.4476	13	14.0060	4.2195	17.8039	0.9984	0.3013
50	1004	1	2	TP	BS55	0.3943	0.3176	-4.0953	15	5.5317	1.1752	1.3810	0.9977	0.2124

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
50	1004	2	2	TP	BG56	0.5635	0.7474	-0.3827	15	44.2032	4.5135	20.3718	0.9987	0.1021
50	1681	1	1	BA*	BS**	1.2213	0.6279	-3.0230	15	20.1830	3.5260	12.4327	0.9984	0.1747
50	1681	1	2	TP	BS55	1.4159	0.3008	-2.1457	15	17.2902	7.9334	62.9395	0.9949	0.4588
50	1681	2	2	TP	BG56	0.6066	0.7146	-0.1734	15	51.2471	2.9838	8.9030	0.9995	0.0582
50	1682	1	1	BA*	BS**	1.0957	0.5284	-2.6105	15	16.5170	4.4261	19.5906	0.9972	0.2680
50	1682	1	2	BA*	BS**	1.1282	0.6013	-2.0879	15	18.1732	4.3784	19.1706	0.9979	0.2409
50	1682	2	2	BA*	BG**	0.6875	0.6992	-0.1642	15	56.1181	3.9118	15.3021	0.9994	0.0697
50	1683	2	1	BA1	BG02	0.8640	0.6675	-0.2055	14	65.0169	5.9241	35.0952	0.9989	0.0911
50	1683	2	2	TP	BG56	0.4986	0.7137	-0.0464	15	46.3476	2.9376	8.6295	0.9994	0.0634
51	0114	1	3	A2	TS03	0.5144	0.3259	-1.9594	15	5.7196	1.4357	2.0612	0.9988	0.2510
51	0115	1	3	B5	BS05	0.6203	0.3835	-2.0731	15	7.6737	2.3918	5.7206	0.9977	0.3117
51	0118	1	2	B6	BS06	0.5953	0.2372	-1.4975	15	5.4362	1.7564	3.0851	0.9988	0.3231
51	0118	1	3	A17	TS33	0.4442	0.4700	-1.3420	15	6.0616	1.8732	3.5087	0.9979	0.3090
51	0119	1	3	A9	TS17	0.3658	0.4482	-2.2999	15	5.2081	2.1489	4.6177	0.9945	0.4126
51	0120	1	3	A5	TS09	0.4780	0.4066	-1.5428	15	5.7628	1.7531	3.0733	0.9982	0.3042
51	0121	1	2	B1	BS01	0.6608	0.2973	-1.4822	15	6.6167	2.2443	5.0370	0.9985	0.3392
51	0122	1	2	B3	BS03	0.5062	0.4662	-1.5953	15	6.9680	2.4886	6.1930	0.9969	0.3571
51	0124	1	2	B4	BS04	0.5206	0.4808	-1.3342	15	7.3950	2.6712	7.1354	0.9969	0.3612
51	0124	1	3	A11	TS21	0.3912	0.4619	-1.9888	15	5.5015	2.1684	4.7021	0.9955	0.3942
51	1002	1	1	BA*	BS**	0.9203	0.5978	-2.4904	15	14.7400	3.6876	13.5984	0.9974	0.2502
51	1023	3	1	BA3	BG03	0.7583	0.6550	-0.0802	15	58.9732	5.5108	30.3684	0.9989	0.0934
51	1023	3	2	TP	BG55	0.7582	0.6091	0.0000	15	56.2160	6.1123	37.3603	0.9986	0.1087
51	1417	1	1	BA*	BS**	1.4674	0.2978	-0.6854	15	13.4313	3.7213	13.8477	0.9993	0.2771
51	1423	1	1	BA*	BS**	0.9465	0.3992	-1.7951	15	11.4842	3.5444	12.5626	0.9980	0.3086
51	1423	1	2	TP	BS55	0.9345	0.3388	-2.3778	15	11.4447	2.8925	8.3665	0.9984	0.2527
51	1464	1	1	BA*	BS**	0.7885	0.1180	0.0000	15	11.0324	10.4828	109.8897	0.9846	0.9502
51	1464	1	2	TP	BS55	0.8938	0.0218	-2.0860	15	9.8377	2.6124	6.8246	0.9986	0.2655
51	2004	1	1	BA*	BS**	0.5652	0.3826	-3.7069	15	8.3990	2.1311	4.5417	0.9966	0.2537
51	2021	2	1	BA*	BG**	0.9107	0.5696	-0.2606	15	48.4904	10.3851	107.8510	0.9961	0.2142
51	2021	2	2	TP	BG55	0.7662	0.6289	-0.0855	15	55.0742	8.6415	74.6758	0.9972	0.1569
51	2564	1	1	BA*	BS**	0.7350	0.6367	-0.4893	15	15.3849	2.2126	4.8956	0.9992	0.1438
51	2564	1	2	BA*	BS**	0.6886	0.5831	-0.3640	15	13.5671	1.7357	3.0127	0.9995	0.1279
51	5008	1	1	BA*	BS**	0.6460	0.4407	-0.0251	15	10.8417	3.2677	10.6778	0.9980	0.3014
51	5008	1	2	BA*	BS**	0.5809	0.5441	0.0000	15	11.9929	2.5340	6.4212	0.9986	0.2113
51	5009	1	1	BA*	BS**	0.9052	0.1870	-1.9295	15	9.5678	4.0459	16.3695	0.9969	0.4229
51	5009	1	2	BA*	BS**	1.0325	0.1803	0.0000	15	8.3449	4.8225	23.2565	0.9981	0.5779
53	1002	1	2	TP1	BS92	1.0332	0.2614	-0.6515	15	8.2445	1.8047	3.2571	0.9997	0.2189
53	1002	2	1	BA*	BG**	1.1580	0.2142	-0.0474	15	19.2927	2.3819	5.6735	0.9997	0.1235
53	1005	1	1	BA*	BS**	0.9097	0.2515	-0.3079	15	7.5763	2.0665	4.2702	0.9995	0.2728
53	1005	1	2	TP1	BS93	0.6142	0.4763	-1.7276	15	8.1492	1.6934	2.8676	0.9990	0.2078
53	1007	1	1	BA*	BS**	0.5906	0.3952	-1.6754	15	7.1094	2.2198	4.9276	0.9981	0.3122
53	1007	1	2	TP1	BS92	0.7145	0.3614	-1.6793	15	7.8891	1.8544	3.4389	0.9991	0.2351
53	1501	1	2	TP1	BS94	0.7335	0.3038	-1.1522	15	6.7167	1.2622	1.5933	0.9996	0.1879
53	1801	1	1	BA*	BS**	0.7999	0.1773	-0.5271	15	5.0029	2.4732	6.1169	0.9990	0.4944
53	3011	1	1	BA*	BS**	0.4274	0.7691	-1.1216	15	9.6249	1.2419	1.5424	0.9992	0.1290
53	3011	1	2	BA*	BS**	0.4703	0.6519	-1.0354	15	9.0069	1.5076	2.2727	0.9990	0.1674
53	3013	1	1	BA*	BS**	0.5114	0.4146	-0.9199	15	6.5647	2.4144	5.8295	0.9976	0.3678
53	3013	3	2	BA*	BG**	0.4448	0.6515	-0.1487	15	32.3363	2.1804	4.7541	0.9995	0.0674
53	3014	1	1	BA*	BS**	0.4594	0.7331	-1.5977	15	9.2464	2.0269	4.1083	0.9977	0.2192
53	3019	1	1	BA*	BS**	0.5597	0.4670	-1.6887	15	7.5258	2.2056	4.8646	0.9979	0.2931
53	3019	2	1	BA*	BG**	1.1767	0.2875	0.0000	15	30.6498	5.1271	26.2876	0.9991	0.1673
53	3812	1	1	BA*	BS**	0.5340	0.6305	-1.2078	15	9.6026	1.9926	3.9705	0.9985	0.2075
53	3813	1	1	BA*	BS**	0.3829	0.6385	-1.0895	15	7.1634	1.4574	2.1240	0.9985	0.2034
53	3813	1	2	BA*	BS**	0.4382	0.7987	-1.5788	15	9.4793	1.0563	1.1157	0.9994	0.1114
53	3813	3	1	BA*	BG**	1.1284	0.3111	-0.0801	15	29.9844	6.1666	38.0271	0.9985	0.2057
53	3813	3	2	BA*	BG**	1.0159	0.1915	-0.1497	15	12.4308	1.8367	3.3736	0.9998	0.1478

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
53	6020	1	1	BA*	BS**	0.7318	0.2985	-1.2997	15	7.0020	2.2530	5.0762	0.9988	0.3218
53	6020	1	2	TP1	BS93	0.8172	0.1737	-0.5986	15	5.0634	2.4790	6.1455	0.9990	0.4896
53	6048	1	1	BA*	BS**	0.4495	0.5742	-2.3301	15	7.1434	2.2914	5.2506	0.9960	0.3208
53	6048	1	2	TP1	BS93	0.2750	0.6909	-1.3540	15	5.4755	1.5383	2.3664	0.9966	0.2809
53	6056	1	1	BA*	BS**	0.5908	0.2718	-2.1214	15	6.4461	1.3607	1.8514	0.9991	0.2111
53	7322	1	1	A1	TS01	0.4421	0.3624	-3.0458	15	6.0222	1.4826	2.1981	0.9977	0.2462
53	7322	1	2	A2	TS03	0.6621	0.1988	-1.6438	15	5.8611	1.1943	1.4263	0.9995	0.2038
54	1640	1	2	TP	BS55	0.5410	0.0700	-4.9047	15	8.6932	4.1059	16.8585	0.9827	0.4723
54	1640	2	2	TP	BG55	0.9178	0.4477	-0.5587	15	27.5491	12.1551	147.7459	0.9908	0.4412
54	4003	1	1	BA*	BS**	1.0716	0.2435	-1.1424	15	10.0702	5.4886	30.1248	0.9968	0.5450
54	4003	1	2	BA*	BS**	0.8170	0.4793	-1.4548	15	11.5214	4.2115	17.7367	0.9967	0.3655
54	4004	1	2	BA*	BS**	1.4203	0.3066	-1.5908	15	14.7593	5.1961	26.9992	0.9982	0.3521
54	5007	1	1	BA*	BS**	1.1742	0.2740	-1.4721	15	10.8803	2.6045	6.7836	0.9993	0.2394
54	5007	1	2	BA*	BS**	0.9846	0.2224	-1.2891	15	8.8048	4.1543	17.2580	0.9977	0.4718
54	7008	1	1	BA*	BS**	1.0362	0.2487	-1.1386	15	9.8261	5.2988	28.0776	0.9968	0.5393
54	7008	1	2	BA*	BS**	0.8841	0.2236	-0.8756	15	7.8667	4.8688	23.7053	0.9966	0.6189
54	7008	2	1	BA*	BG**	0.9816	0.5243	-0.5753	14	34.2041	5.5294	30.5744	0.9986	0.1617
54	7008	2	2	BA*	BG**	1.1749	0.4853	-0.7702	15	32.2399	8.3627	69.9350	0.9971	0.2594
55	3008	1	1	A1	TS01	1.0364	0.2578	-3.0994	15	13.6887	1.6237	2.6364	0.9995	0.1186
55	3008	1	2	A2	TS03	1.5196	0.1800	-1.5251	15	12.4453	1.1405	1.3007	0.9999	0.0916
55	3008	2	1	BA*	BG**	0.8042	0.6120	0.0000	15	58.8891	7.7725	60.4117	0.9980	0.1320
55	3008	2	2	BA*	BG**	0.7533	0.6921	0.0000	15	67.7589	11.4098	130.1831	0.9960	0.1684
55	3009	1	1	A1	TS01	1.4634	0.1653	-1.8229	15	13.4996	0.9171	0.8411	0.9999	0.0679
55	3009	1	2	A2	TS03	1.2469	0.1538	-2.1802	15	13.2927	1.4383	2.0686	0.9998	0.1082
55	3009	2	1	BA*	BG**	0.5777	0.6857	0.0000	15	51.4322	13.4270	180.2853	0.9906	0.2611
55	3009	2	2	BA*	BG**	0.6681	0.6862	0.0000	15	58.9962	7.1587	51.2468	0.9980	0.1213
55	3010	1	1	BA*	BS**	1.2473	0.5325	-1.8301	15	17.8904	2.6231	6.8807	0.9994	0.1466
55	3010	1	2	BA*	BS**	1.5658	0.5045	-2.1686	15	21.7573	4.2054	17.6852	0.9989	0.1933
55	3010	2	1	BA*	BG**	0.6437	0.6906	-0.0160	14	52.1159	4.4055	19.4084	0.9991	0.0845
55	3010	2	2	BA*	BG**	0.8599	0.6231	-0.0681	15	61.9789	4.5754	20.9343	0.9994	0.0738
55	3012	1	2	BA*	BS**	0.8230	0.2729	-2.8097	15	10.3003	2.0583	4.2367	0.9988	0.1998
55	3012	2	2	BA*	BG**	0.6331	0.7364	-0.3018	15	51.1471	6.0547	36.6597	0.9982	0.1184
55	3014	2	1	BA*	BG**	0.7819	0.6045	-0.0046	15	55.9243	7.2832	53.0456	0.9981	0.1302
55	3014	2	2	BA*	BG**	0.7512	0.5633	0.0000	15	48.6824	8.6258	74.4042	0.9968	0.1772
55	3015	1	1	BA*	BS**	0.7631	0.7279	-0.9364	15	17.0665	4.5660	20.8484	0.9967	0.2675
55	3015	1	2	BA*	BS**	0.6826	0.7608	-0.7822	14	17.7151	6.2238	38.7362	0.9929	0.3513
55	3015	2	1	BA*	BG**	0.9702	0.5662	-0.1432	15	55.9959	8.9043	79.2863	0.9977	0.1590
55	3015	2	2	BA*	BG**	1.1878	0.4978	-0.0056	14	64.6290	6.6199	43.8224	0.9991	0.1024
55	3016	1	1	BA*	BS**	0.6840	0.7019	-0.8075	15	15.2628	4.1441	17.1737	0.9967	0.2715
55	3016	1	2	BA*	BS**	0.6764	0.7193	-0.7304	15	15.4155	2.8375	8.0514	0.9985	0.1841
55	3016	2	2	BA*	BG**	0.7246	0.6876	-0.1759	15	56.2122	8.0877	65.4113	0.9974	0.1439
55	3019	1	1	BA*	BS**	0.5193	0.8105	-1.2897	15	12.1459	2.5929	6.7230	0.9975	0.2135
55	3019	1	2	BA*	BS**	0.6382	0.7629	-1.0202	15	14.6164	2.3123	5.3466	0.9988	0.1582
55	3019	2	1	BA*	BG**	0.4696	0.8899	-0.2831	14	51.4534	3.3349	11.1218	0.9993	0.0648
55	3019	2	2	BA*	BG**	0.5305	0.8181	-0.3522	14	47.6593	4.0321	16.2575	0.9989	0.0846
55	5037	1	1	BA*	BS**	0.8135	0.7130	-0.9439	15	17.6856	3.9672	15.7389	0.9978	0.2243
55	5037	1	2	BA*	BS**	0.7853	0.7247	-0.7567	14	18.7183	4.5417	20.6273	0.9971	0.2426
55	5037	2	1	BA*	BG**	0.7356	0.6899	-0.1476	15	59.9553	5.0251	25.2513	0.9991	0.0838
55	5037	2	2	BA*	BG**	1.0646	0.4485	-0.0399	15	47.6517	8.7476	76.5197	0.9977	0.1836
55	5037	3	1	BA*	BG**	0.7199	0.6375	-0.1297	15	50.9659	8.0997	65.6049	0.9971	0.1589
55	5037	3	2	BA*	BG**	0.8673	0.6144	-0.0728	15	60.2130	9.7125	94.3333	0.9971	0.1613
55	5040	1	1	A1	TS01	0.7496	0.1026	-2.8290	15	9.5857	0.9551	0.9121	0.9997	0.0996
55	5040	1	2	A2	TS03	0.8517	0.2111	-1.7295	15	7.7257	0.8908	0.7935	0.9998	0.1153
55	5040	2	1	BA*	BG**	1.0359	0.5645	0.0000	15	66.9965	4.4413	19.7249	0.9995	0.0663
55	5040	2	2	BA*	BG**	1.1836	0.5859	-0.0435	14	73.1520	4.2972	18.4657	0.9997	0.0587
55	6351	1	1	BA*	BS**	1.0151	0.6627	-2.0042	15	17.6230	3.2109	10.3098	0.9987	0.1822

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
55	6351	1	2	BA*	BS**	1.2305	0.2870	-2.6085	15	14.8346	1.5503	2.4034	0.9997	0.1045
55	6351	2	1	BA*	BG**	0.6835	0.7305	0.0000	15	66.6113	9.1991	84.6238	0.9972	0.1381
55	6351	2	2	BA*	BG**	0.9798	0.5101	-0.0698	15	51.2385	9.9352	98.7080	0.9969	0.1939
55	6352	2	1	BA*	BG**	0.8347	0.5834	0.0000	15	56.4563	8.2268	67.6804	0.9977	0.1457
55	6352	2	2	BA*	BG**	0.9457	0.5664	-0.0925	15	56.7607	8.0662	65.0632	0.9981	0.1421
55	6352	3	2	BA*	BG**	1.1559	0.5722	-0.1505	15	67.3348	12.7446	162.4252	0.9967	0.1893
55	6353	2	1	BA*	BG**	0.9507	0.5942	0.0000	15	66.3937	5.2340	27.3943	0.9993	0.0788
55	6353	2	2	BA*	BG**	1.0573	0.5146	0.0000	15	59.2497	6.9840	48.7768	0.9988	0.1179
55	6353	3	1	BA*	BG**	0.8055	0.6693	-0.0362	14	61.0869	7.2402	52.4203	0.9983	0.1185
55	6353	3	2	BA*	BG**	1.1817	0.6066	-0.0133	15	84.8340	6.0394	36.4741	0.9994	0.0712
55	6354	2	1	BA*	BG**	1.0734	0.4901	-0.1456	15	49.3421	9.0026	81.0461	0.9976	0.1825
55	6354	2	2	BA*	BG**	0.7629	0.7229	-0.0283	15	72.0614	6.5750	43.2305	0.9988	0.0912
55	6354	3	1	BA*	BG**	0.7439	0.6535	0.0000	15	60.2026	8.2956	68.8174	0.9976	0.1378
55	6354	3	2	BA*	BG**	0.8589	0.6627	-0.0457	14	63.8479	5.7972	33.6070	0.9990	0.0908
55	6355	2	1	BA*	BG**	1.0170	0.5238	0.0000	15	58.5945	6.7882	46.0799	0.9988	0.1159
55	6355	3	1	BA*	BG**	1.0764	0.5262	0.0000	15	62.2665	11.2502	126.5672	0.9970	0.1807
55	6355	3	2	BA*	BG**	0.8631	0.6657	-0.2543	14	57.0610	8.0976	65.5706	0.9978	0.1419
56	1007	1	1	BA*	BS**	0.5267	0.6435	-1.6153	15	9.1626	1.9697	3.8797	0.9983	0.2150
56	1007	1	2	TP1	BS92	0.3757	0.6902	-1.1476	15	7.6799	2.2477	5.0520	0.9963	0.2927
56	2015	1	1	BA*	BS**	0.7355	0.2501	-0.7573	15	5.9785	2.4038	5.7781	0.9988	0.4021
56	2015	2	1	BA*	BS**	0.8038	0.3029	-0.2500	15	16.8254	5.2887	27.9698	0.9975	0.3143
56	2015	2	2	TP1	BS91	0.5109	0.6047	-0.3357	15	28.2256	5.2655	27.7260	0.9969	0.1866
56	2017	1	1	BA*	BS**	0.9145	0.1653	-0.6342	15	5.0124	1.4839	2.2019	0.9997	0.2960
56	2017	1	2	A2	TS03	0.8373	0.1439	-1.0321	15	5.2626	1.3780	1.8988	0.9997	0.2618
56	2017	1	2	TP1	BS91	0.9368	0.1288	-1.2572	15	6.6783	1.5417	2.3767	0.9996	0.2308
56	2018	1	1	BA*	BS**	0.6951	0.2164	-0.4344	15	5.0266	2.0530	4.2150	0.9991	0.4084
56	2018	1	2	A2	TS03	0.6300	0.3023	-2.6856	15	7.8510	1.5721	2.4716	0.9988	0.2002
56	2018	1	2	TP1	BS92	0.8120	0.1932	-1.5868	15	7.0122	1.1781	1.3879	0.9997	0.1680
56	2019	1	1	A1	TS01	0.5839	0.2582	-3.4133	15	8.0166	1.4579	2.1256	0.9986	0.1819
56	2019	1	1	BA*	BS**	0.8127	0.1588	-0.0702	15	4.7809	1.5786	2.4921	0.9997	0.3302
56	2019	3	1	BA*	BG**	0.7843	0.3780	-0.3117	15	20.9982	4.7261	22.3361	0.9981	0.2251
56	2019	3	2	TP1	BG91	0.4929	0.6218	-0.4144	15	26.9970	5.1264	26.2801	0.9967	0.1899
56	2020	1	1	BA*	BS**	0.9256	0.1478	0.0000	15	5.6044	2.5155	6.3276	0.9994	0.4488
56	2020	1	2	TP1	BS91	0.8684	0.1470	-1.0685	15	5.7998	1.9816	3.9266	0.9994	0.3417
56	2037	1	1	BA*	BS**	0.7543	0.1982	-1.1134	15	5.7998	2.3292	5.4254	0.9988	0.4016
56	2037	1	2	TP1	BS91	0.6440	0.3430	-2.1612	15	7.7016	2.3682	5.6084	0.9979	0.3075
56	6031	1	1	BA*	BS**	0.9141	0.1899	0.0000	15	8.5038	5.6761	32.2186	0.9967	0.6675
56	6031	1	2	TP1	BS91	0.9185	0.1802	0.0000	15	7.2493	3.9686	15.7501	0.9984	0.5475
56	7772	1	1	BA*	BS**	0.8610	0.1257	-0.5661	15	4.0708	1.8172	3.3022	0.9995	0.4464
56	7772	1	2	TP1	BS91	0.8466	0.1469	-0.5322	15	4.6823	2.5486	6.4954	0.9991	0.5443
56	7773	1	1	BA*	BS**	0.5958	0.5748	-1.2315	15	9.6870	2.0090	4.0363	0.9987	0.2074
56	7773	1	2	TP1	BS92	0.7844	0.2339	-0.5387	15	5.8538	1.9482	3.7953	0.9994	0.3328
56	7773	2	2	TP1	BG91	0.7720	0.4443	-0.2661	15	27.6469	4.2579	18.1297	0.9987	0.1540
56	7775	1	1	BA*	BS**	0.4821	0.4984	-1.8745	15	6.8917	2.2835	5.2143	0.9969	0.3313
56	7775	1	2	TP1	BS92	0.6113	0.4254	-1.7583	15	7.6295	2.0629	4.2556	0.9984	0.2704
72	1003	1	1	A1	TS01	0.7677	0.1314	-2.0330	15	8.1141	3.5550	12.6377	0.9966	0.4381
72	1003	2	2	BA*	BG**	0.7733	0.6425	-0.1222	15	56.5290	5.9619	35.5445	0.9987	0.1055
72	3008	2	1	BA*	BG**	1.0268	0.5676	-0.0038	15	67.1298	7.3403	53.8794	0.9988	0.1093
72	3008	2	2	BA*	BG**	0.5267	0.7757	0.0000	15	58.6135	12.4299	154.5012	0.9925	0.2121
72	4121	1	1	BA*	BS**	1.9106	0.5216	-2.5055	15	27.2654	4.8949	23.9605	0.9989	0.1795
72	4121	1	2	BA*	BS**	1.2027	0.4161	-0.8498	15	15.8685	6.5074	42.3464	0.9969	0.4101
72	4121	2	2	BA*	BG**	1.5485	0.5749	-0.5376	15	67.3378	12.7083	161.5020	0.9974	0.1887
72	4122	1	1	BA*	BS**	1.2098	0.2621	-0.4862	15	12.2397	7.2895	53.1373	0.9964	0.5956
72	4122	1	2	BA*	BS**	1.0992	0.3283	0.0000	15	19.1528	13.7886	190.1261	0.9872	0.7199
72	4122	2	1	BA*	BG**	1.1082	0.5559	-0.2774	15	55.8261	5.9029	34.8440	0.9991	0.1057
72	4122	2	2	BA*	BG**	1.4196	0.3703	0.0000	15	52.0171	16.3563	267.5274	0.9947	0.3144

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
81	0502	1	1	B*	BS**	1.3128	0.2273	-1.4959	14	9.5791	1.4157	2.0043	0.9998	0.1478
81	0503	1	1	TP1	BS92	0.8891	0.2260	-2.2604	15	9.5907	1.2887	1.6609	0.9996	0.1344
81	1803	1	1	BA*	BS**	0.5780	0.6098	-1.0072	15	10.3845	1.7088	2.9199	0.9991	0.1645
81	1803	1	2	TP1	BS92	0.9559	0.1613	-0.6140	15	5.2327	1.8642	3.4754	0.9996	0.3563
81	1804	1	2	A2	TS01	0.7127	0.1848	-2.3735	15	7.8891	0.9652	0.9317	0.9997	0.1224
81	1805	1	1	BA*	BS**	0.8268	0.1422	-0.6674	15	4.4955	2.0442	4.1789	0.9993	0.4547
81	1805	1	2	A2	TS01	0.8676	0.1668	-1.4833	15	6.9864	1.3319	1.7740	0.9997	0.1906
81	2812	1	2	A2	TS01	0.6117	0.1241	-0.1113	15	3.6095	2.5915	6.7159	0.9984	0.7180
82	1005	1	2	TP1	BS93	0.4579	0.7072	-0.9901	15	9.6545	1.6413	2.6940	0.9988	0.1700
82	6006	1	1	BA*	BS**	0.4297	0.7591	-1.0445	15	9.6644	1.1709	1.3711	0.9993	0.1212
82	6006	2	2	TP1	BS91	0.3899	0.6125	-0.0975	15	26.6723	1.4002	1.9605	0.9997	0.0525
83	3802	3	1	TP*	BG**	0.6763	0.6963	0.0000	15	61.2728	4.4651	19.9374	0.9993	0.0729
83	3802	3	2	TP*	BG**	0.5925	0.7617	-0.0055	15	62.6748	4.6906	22.0020	0.9991	0.0748
83	6452	2	1	TP*	BG**	0.8337	0.6163	0.0000	15	61.4362	7.8370	61.4187	0.9981	0.1276
83	6452	2	2	TP*	BG**	0.8576	0.5819	0.0000	15	57.9362	7.7898	60.6808	0.9981	0.1345
84	1684	1	1	BA*	BS**	0.5179	0.5416	-0.7282	15	9.0528	2.5916	6.7165	0.9976	0.2863
84	1684	1	2	TP	BS55	0.7465	0.5157	-1.6855	15	11.0143	3.5974	12.9413	0.9970	0.3266
84	1684	2	1	BA*	BG**	0.4921	0.7761	-0.2031	14	48.7783	4.3794	19.1794	0.9987	0.0898
84	1802	1	1	BA*	BS**	0.9406	0.5042	-2.4537	15	13.8554	4.2982	18.4745	0.9965	0.3102
84	3803	1	1	BA*	BS**	1.0566	0.6190	-2.6651	15	17.7074	4.8586	23.6060	0.9964	0.2744
84	3803	1	2	BA*	BS**	1.5316	0.2817	-2.8357	15	19.1254	2.9740	8.8446	0.9993	0.1555
84	6804	1	1	BA*	BS**	2.3059	0.5146	-4.3315	15	38.5662	10.4900	110.0405	0.9943	0.2720
87	1620	1	1	BA*	BS**	1.0184	0.1279	-1.2565	15	8.3666	4.5074	20.3167	0.9975	0.5387
87	1622	1	1	BA*	BS**	1.0448	0.5029	-1.5132	15	14.4799	2.4721	6.1114	0.9993	0.1707
87	1622	1	2	TP	BS55	0.8343	0.3742	-0.9775	15	9.6323	3.4832	12.1327	0.9981	0.3616
87	1622	2	1	BA*	BG**	0.7437	0.6665	-0.3225	15	49.6466	3.0995	9.6069	0.9996	0.0624
87	1680	1	1	BA*	BS**	0.8394	0.6361	-1.4016	14	14.9122	2.4080	5.7984	0.9990	0.1615
87	1680	1	2	TP	BS55	1.0324	0.3501	-1.2024	15	11.0510	3.9020	15.2256	0.9983	0.3531
87	1680	2	2	TP	BG56	0.6671	0.7649	-0.2925	15	58.0769	4.8198	23.2306	0.9990	0.0830
87	1806	1	1	BA*	BS**	0.8891	0.6522	-1.8377	15	15.4689	3.0128	9.0770	0.9985	0.1948
87	2811	1	1	BA*	BS**	0.7644	0.0000	-1.2744	15	8.4420	6.0481	36.5792	0.9917	0.7164
87	2811	1	2	BA4	BS04	1.0321	0.2468	-3.7740	15	15.1510	3.7047	13.7249	0.9967	0.2445
87	2812	1	1	BA*	BS**	0.7722	0.3124	-5.6702	15	11.7951	2.4417	5.9619	0.9963	0.2070
87	2812	1	2	BA*	BS**	0.8875	0.2427	-5.1568	15	14.4166	1.7407	3.0301	0.9986	0.1207
88	1645	1	1	BA*	BS**	0.5575	0.5673	-1.8587	14	9.1378	3.0354	9.2136	0.9960	0.3322
88	1645	1	2	TP	BS55	1.0514	0.3470	-2.4734	15	13.5024	4.2005	17.6442	0.9972	0.3111
88	1646	1	1	BA*	BS**	0.8683	0.3856	-2.8835	15	12.1859	4.4038	19.3934	0.9950	0.3614
88	1646	1	2	TP	BS55	0.6209	0.4368	-1.5422	15	8.1105	2.9942	8.9652	0.9970	0.3692
88	1647	1	2	TP	BS55	0.9317	0.2328	-1.5853	15	9.1251	4.0036	16.0289	0.9974	0.4387
89	1021	1	1	BA*	BS**	0.8247	0.5784	-1.0241	15	13.8763	2.0789	4.3216	0.9993	0.1498
89	1021	1	2	TP	BS55	0.6993	0.5953	-0.7918	15	12.7025	1.9984	3.9934	0.9992	0.1573
89	1125	1	1	BA*	BS**	0.8009	0.7689	-1.3846	15	17.2552	2.4522	6.0135	0.9990	0.1421
89	1125	1	2	TP	BS55	0.6521	0.6448	-0.7963	15	12.8612	1.9143	3.6646	0.9992	0.1488
89	1125	2	1	BA*	BG**	0.6902	0.6806	-0.0818	15	57.3803	3.4760	12.0829	0.9995	0.0606
89	1125	2	2	TP	BG57	0.7417	0.6761	-0.2235	15	54.7011	2.9181	8.5151	0.9997	0.0533
89	1127	1	1	BA*	BS**	0.7183	0.5634	-0.9276	15	12.1000	2.8263	7.9878	0.9984	0.2336
89	1127	2	1	BA3	BG03	0.5767	0.7112	-0.3218	15	43.4476	2.6671	7.1134	0.9995	0.0614
89	1127	2	2	TP	BG56	0.5373	0.7512	-0.3205	15	44.5018	4.0575	16.4632	0.9989	0.0912
89	3001	1	1	BA*	BS**	0.5224	0.6329	-0.7970	15	10.2711	1.5581	2.4276	0.9992	0.1517
89	3001	1	2	BA*	BS**	0.6467	0.6037	-0.8812	15	11.7830	2.2201	4.9289	0.9988	0.1884
89	3001	2	2	BA*	BG**	0.5924	0.6600	-0.2148	15	42.3901	3.9292	15.4384	0.9990	0.0927
89	3002	1	1	BA*	BS**	0.8047	0.5151	-1.4386	15	12.1800	4.3839	19.2183	0.9964	0.3599
89	3015	1	1	BA*	BS**	0.6002	0.6961	-0.6166	15	13.5366	2.4707	6.1042	0.9986	0.1825
89	3015	1	2	BA*	BS**	0.8164	0.5880	-1.0565	15	14.0635	2.8041	7.8629	0.9988	0.1994
89	9018	1	1	BA*	BS**	0.7245	0.4851	-0.5827	15	11.1663	2.1725	4.7198	0.9992	0.1946
89	9018	1	2	BA*	BS**	0.7180	0.4582	-0.7045	15	10.6077	3.8728	14.9983	0.9972	0.3651

Table 16. k-values determined from nonlinear regression analyses of LTPP resilient modulus test of unbound materials (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	k1	k2	k3	No. Points	Std Dev(M_R)	RMSE	MSE	R^2	S_e/S_y
90	6400	1	1	TP*	BS**	0.9157	0.6394	-1.1130	15	16.6942	2.6427	6.9841	0.9991	0.1583
90	6400	1	2	TP*	BS**	0.8282	0.5789	-1.1381	15	13.6706	2.4851	6.1757	0.9990	0.1818
90	6405	3	1	TP*	BG**	0.7461	0.7024	-0.0178	15	68.1338	3.8397	14.7434	0.9995	0.0564
90	6405	3	2	TP*	BG**	1.4688	0.5246	-0.2743	15	68.1394	16.7181	279.4952	0.9955	0.2454
90	6801	1	1	TP*	BS**	1.5200	0.2122	-1.2996	15	11.7380	1.4006	1.9617	0.9999	0.1193
90	6801	1	2	TP*	BS**	0.9887	0.3140	0.0000	15	11.9575	3.6365	13.2241	0.9989	0.3041

* - Reference to LTPP Database Code List

** - Reference to LTPP Database Code List

APPENDIX B.

GRAPHICAL EXAMPLES OF THE DIFFERENT TYPES OF ANOMALIES IDENTIFIED IN THE RESILIENT MODULUS TEST DATA

Appendix B provides graphical examples of the different types of anomalies identified in the resilient modulus test data. The following gives a brief description of the graphical examples included in this appendix:

- Figures 34 through 37 show excess softening or potential disturbance of the test specimen for the higher vertical loads. These resilient modulus tests could be "good" data, but the universal constitutive equation does not fit the test data.

- Figures 38 through 41 provide graphical examples of the resilient modulus tests with a significant effect of the confining pressure that varies with the vertical loads used in the test program. These tests could be "good" data, but the universal constitutive equation does not represent a good fit to the test data.

- Figures 42 through 45 provide graphical examples of the resilient modulus tests with a sudden drop and then an increase in the resilient modulus measured at increasing vertical loads.

- Figures 46 through 49 provide graphical examples of the resilient modulus tests with relationships between resilient modulus and vertical loads for different confining pressures that intersect or have completely different stress sensitivity effects.

- Figures 50 through 53 provide graphical examples of the resilient modulus tests where the higher confining pressures result in a lower resilient modulus.

- Figures 54 through 57 provide graphical examples of the resilient modulus tests where the resilient modulus is independent of the confining pressure at the lowest vertical load used in the test program.

- Figures 58 through 61 provide graphical examples of the resilient modulus tests with possible data entry errors.

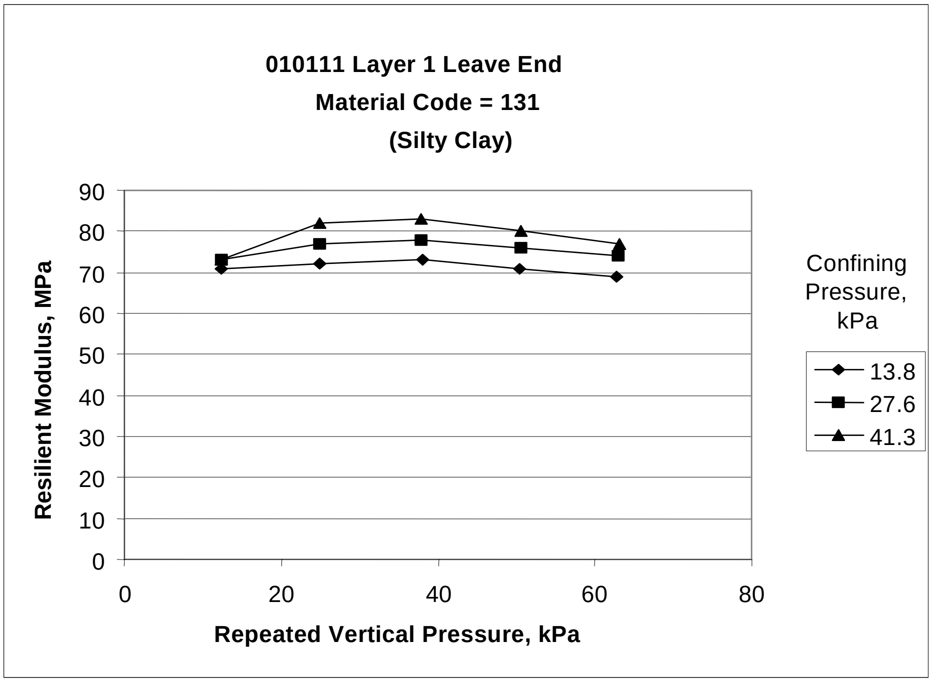

Figure 34. Sample from test section 010111, layer 1, at the leave end exhibits specimen distortion or excess softening.

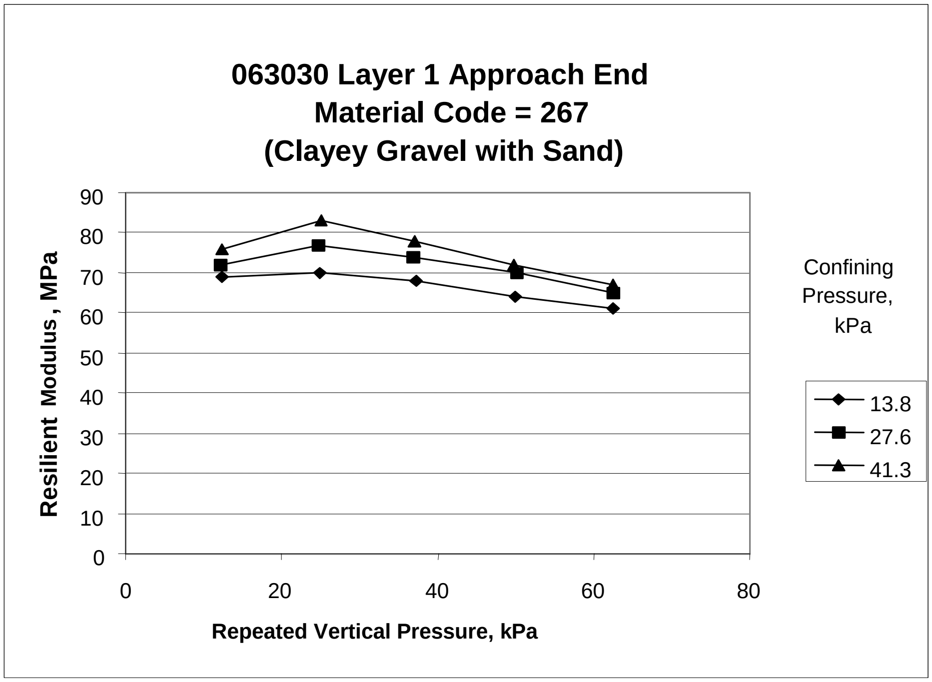

Figure 35. Sample from test section 063030, layer 1, at the approach end exhibits specimen distortion or excess softening.

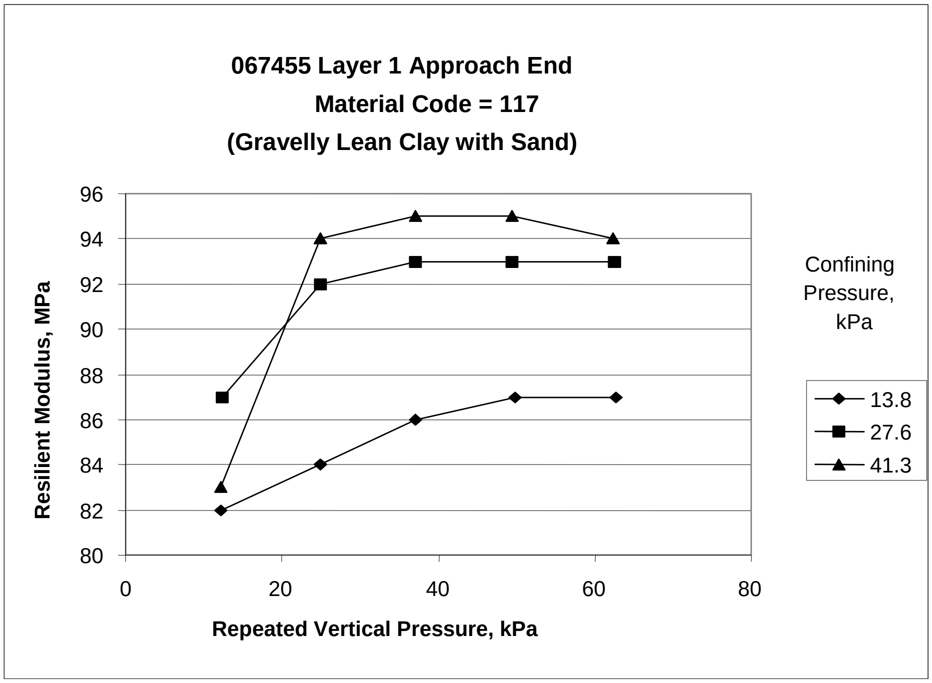

Figure 36. Sample from test section 067455, layer 1, at the approach end exhibits specimen distortion or excess softening.

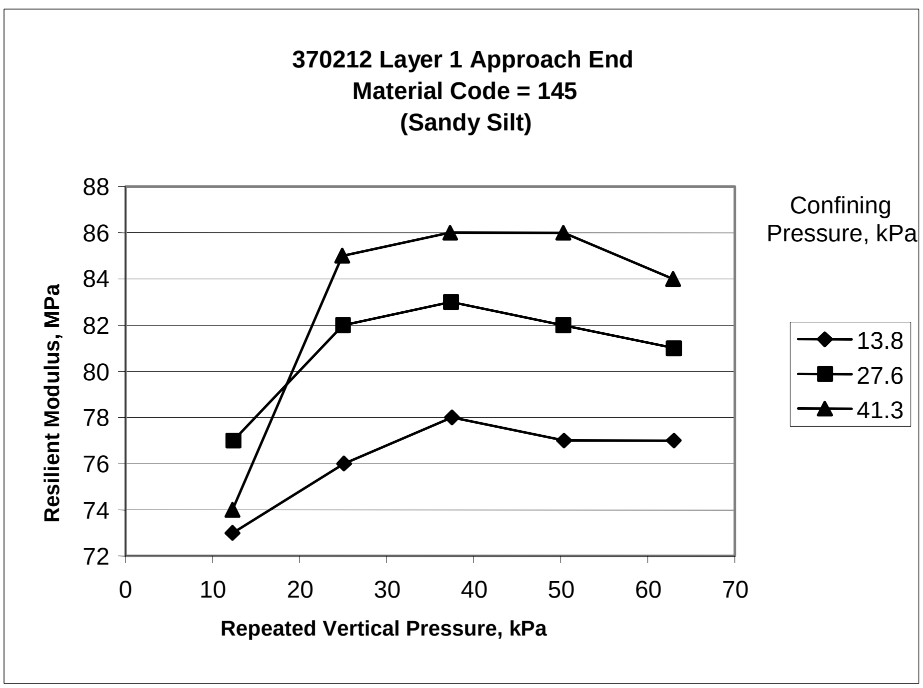

Figure 37. Sample from test section 370212, layer 1, at the approach end exhibits specimen distortion or excess softening.

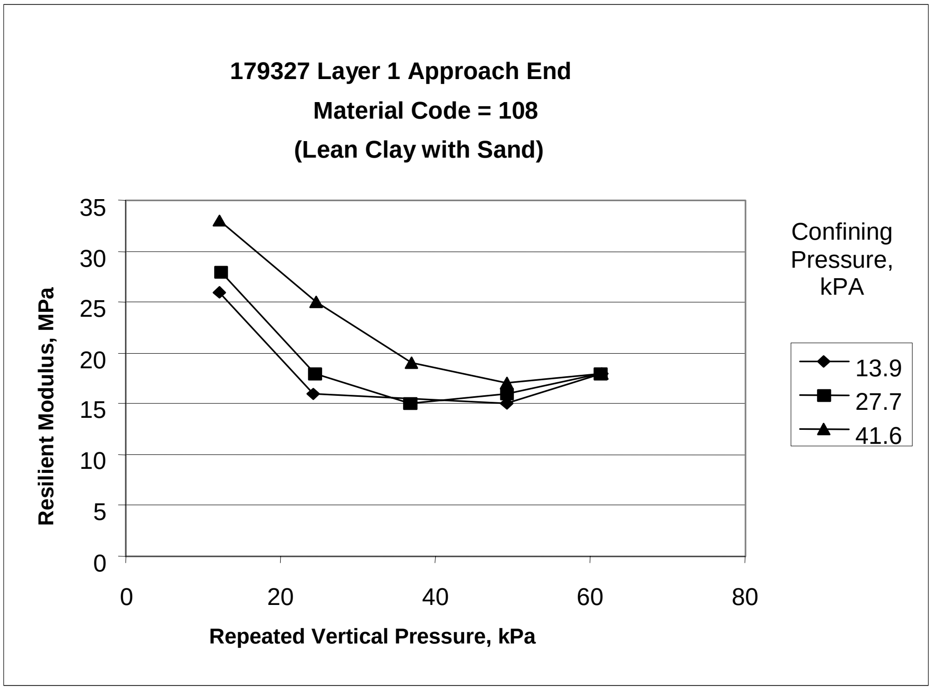

Figure 38. Sample from test section 179327, layer 1, at the approach end shows significant effect of confining pressure on resilient modulus.

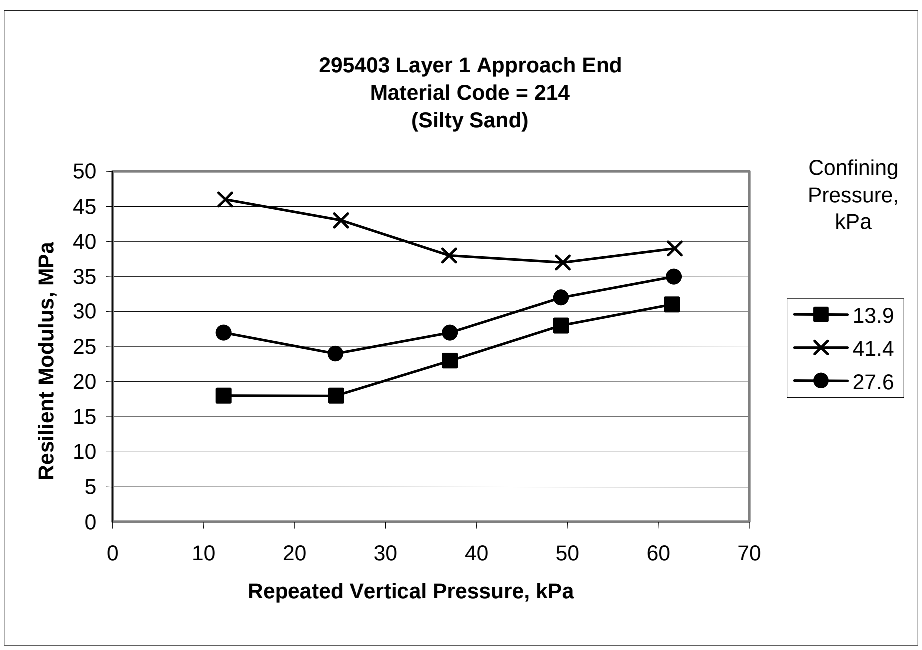

Figure 39. Sample from test section 295403, layer 1, at the approach end shows significant effect of confining pressure on resilient modulus.

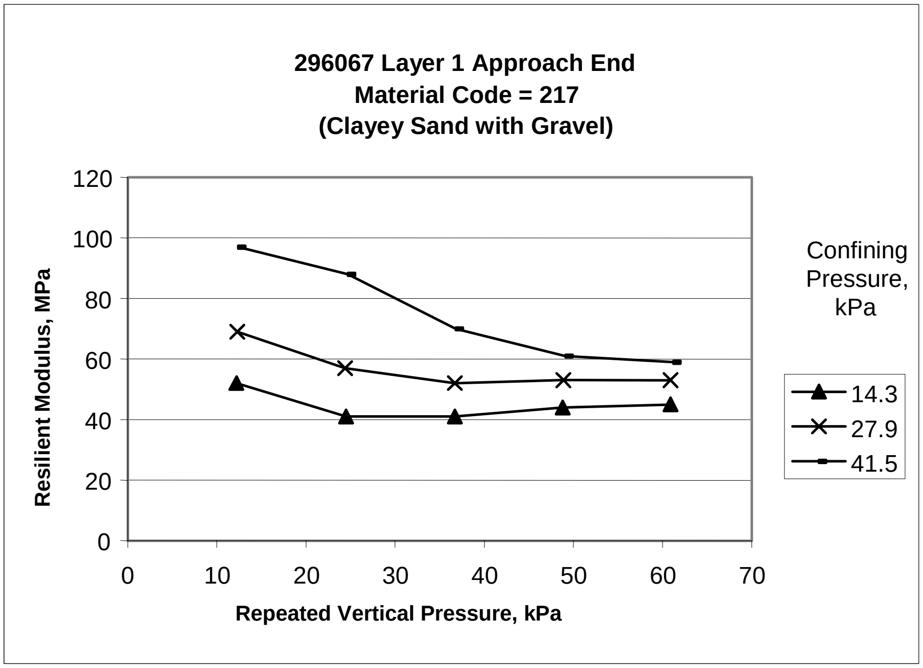

Figure 40. Sample from test section 296067, layer 1, at the approach end shows significant effect of confining pressure on resilient modulus.

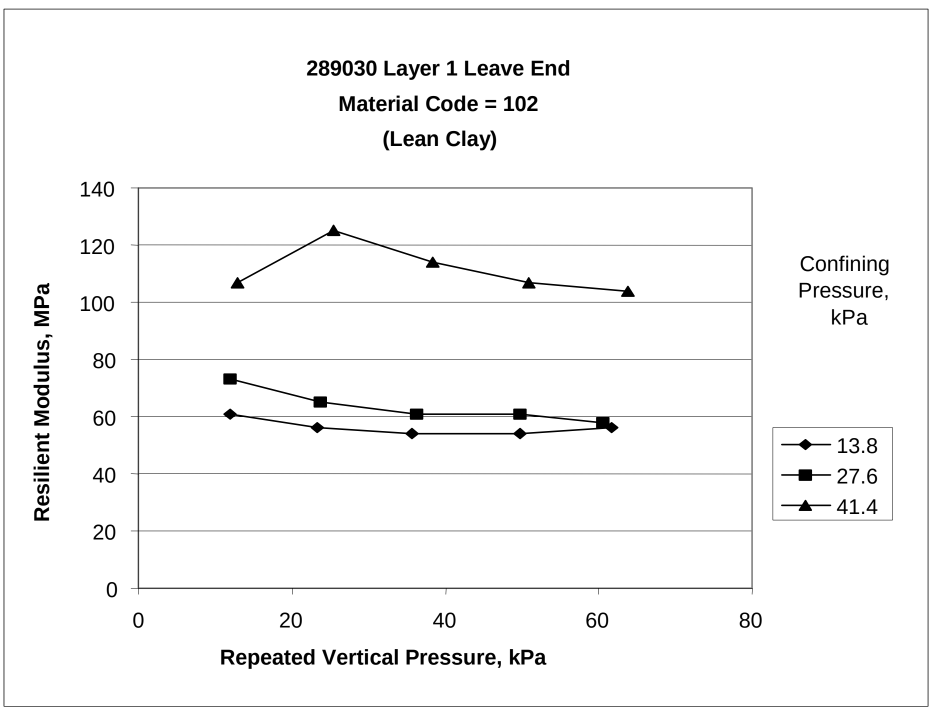

Figure 41. Sample from test section 289030, layer 1, at the leave end shows significant effect of confining pressure on resilient modulus.

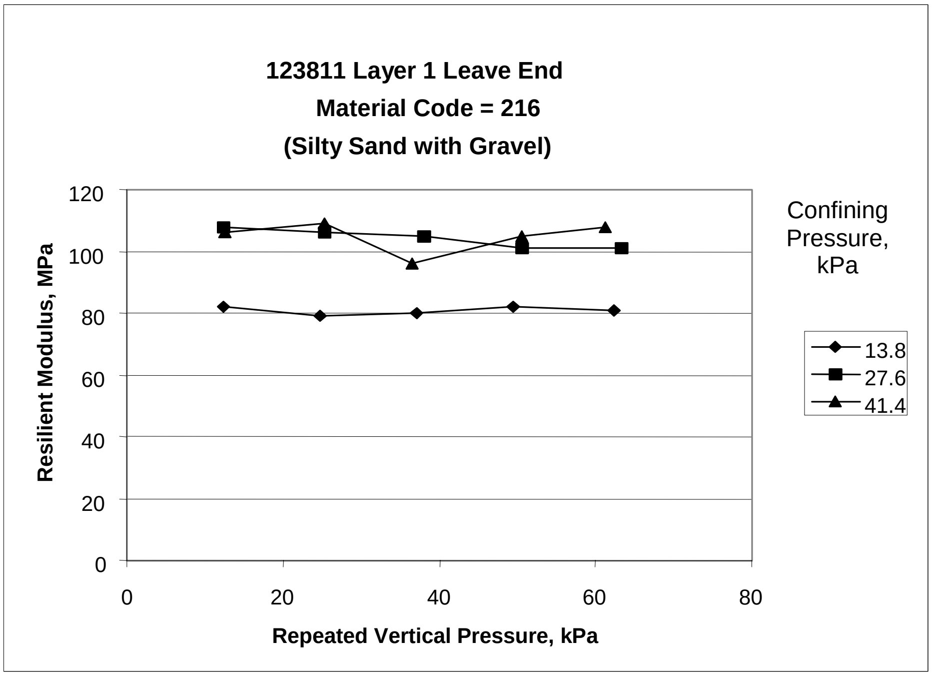

Figure 42. Sample from test section 123811, layer 1, at the leave end shows sudden drop and then increase in resilient modulus.

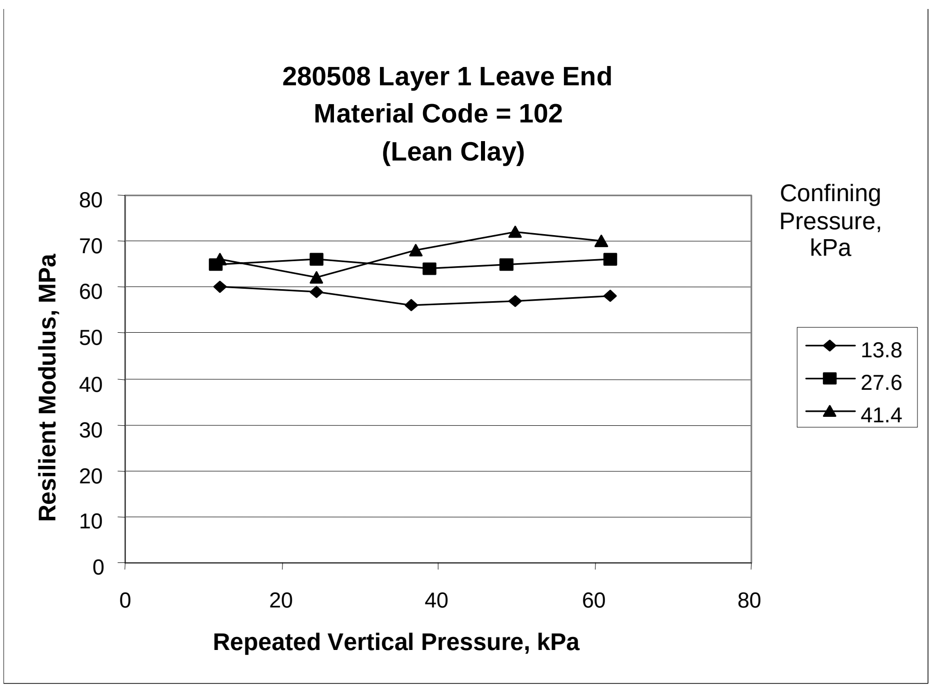

Figure 43. Sample from test section 280508, layer 1, at the leave end shows sudden drop and then increase in resilient modulus.

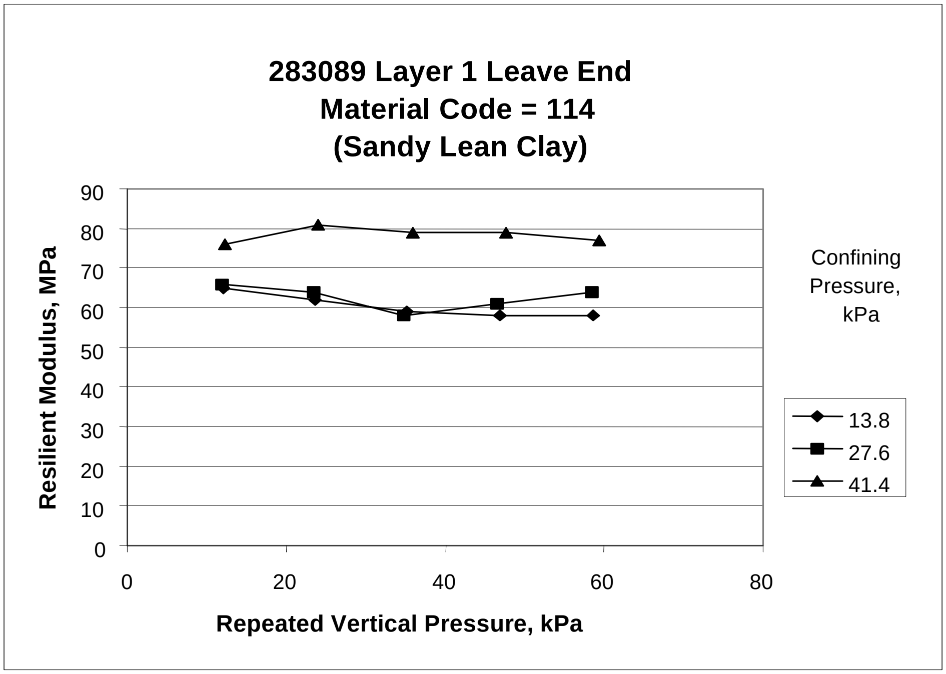

Figure 44. Sample from test section 283089, layer 1, at the leave end shows sudden drop and then increase in resilient modulus.

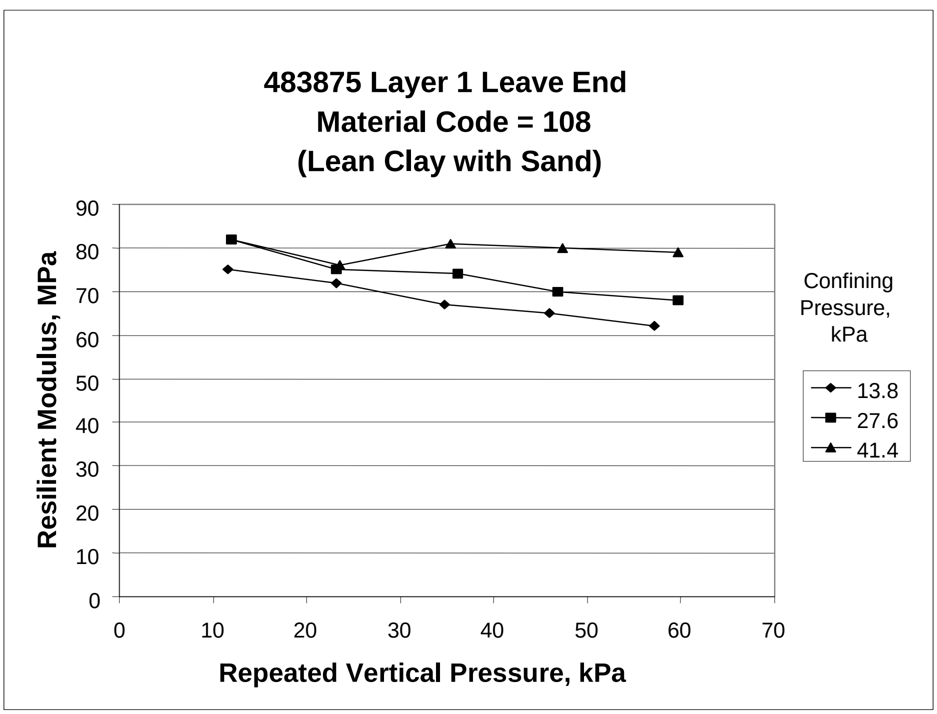

Figure 45. Sample from test section 483875, layer 1, at the leave end shows sudden drop and then increase in resilient modulus.

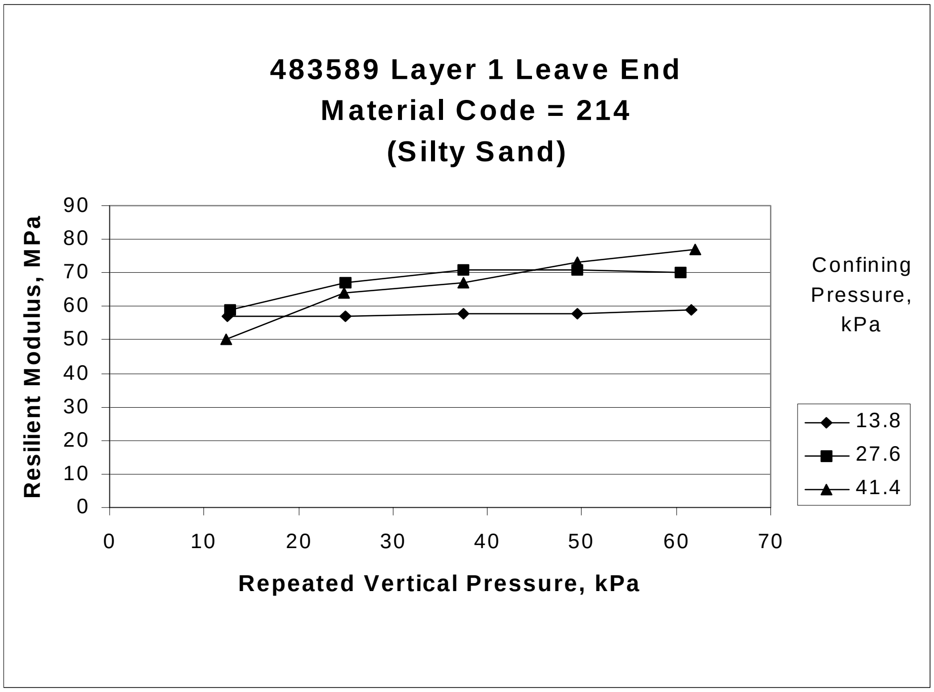

Figure 46. Sample from test section 483589, layer 1, at the leave end exhibiting localized softening or disturbance of the specimen during the test or LVDT movement.

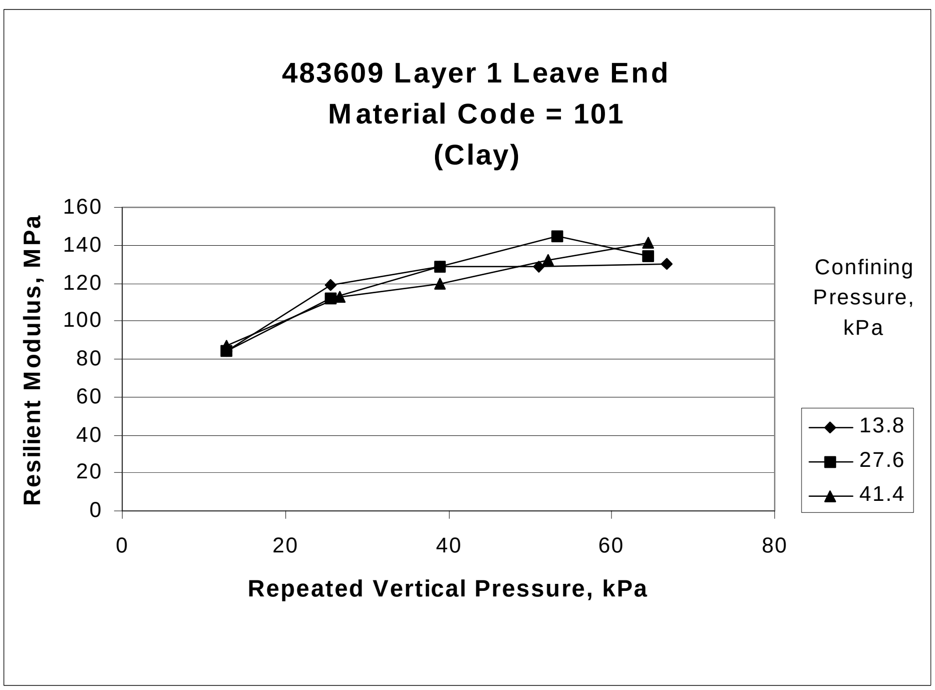

Figure 47. Sample from test section 483609, layer 1, at the leave end exhibiting localized softening or disturbance of the specimen during the test or LVDT movement.

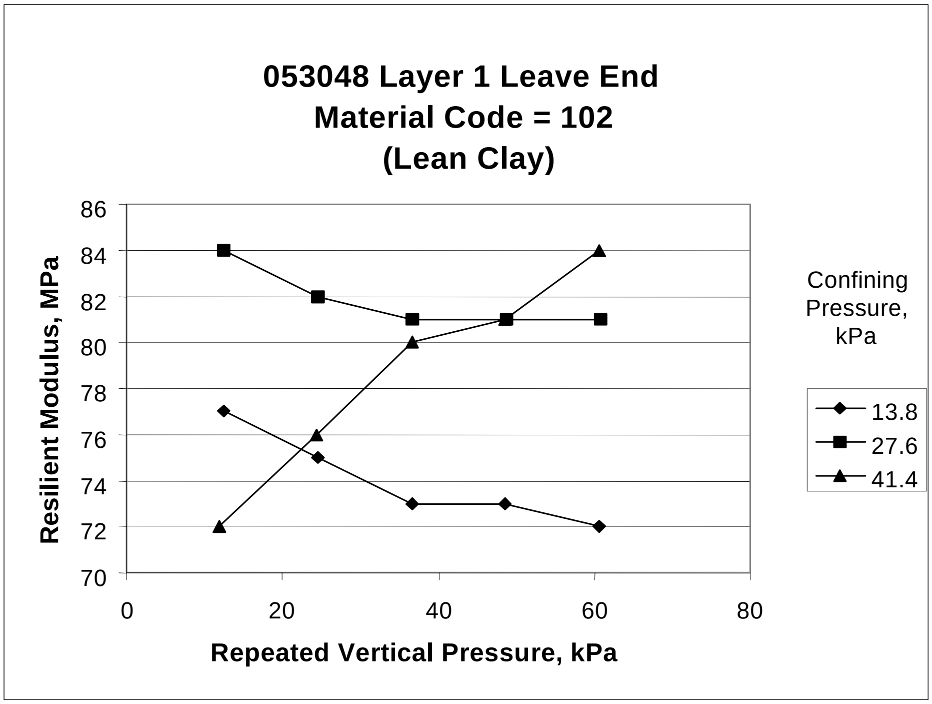

Figure 48. Sample from test section 053048, layer 1, at the leave end exhibiting localized softening or disturbance of the specimen during the test or LVDT movement.

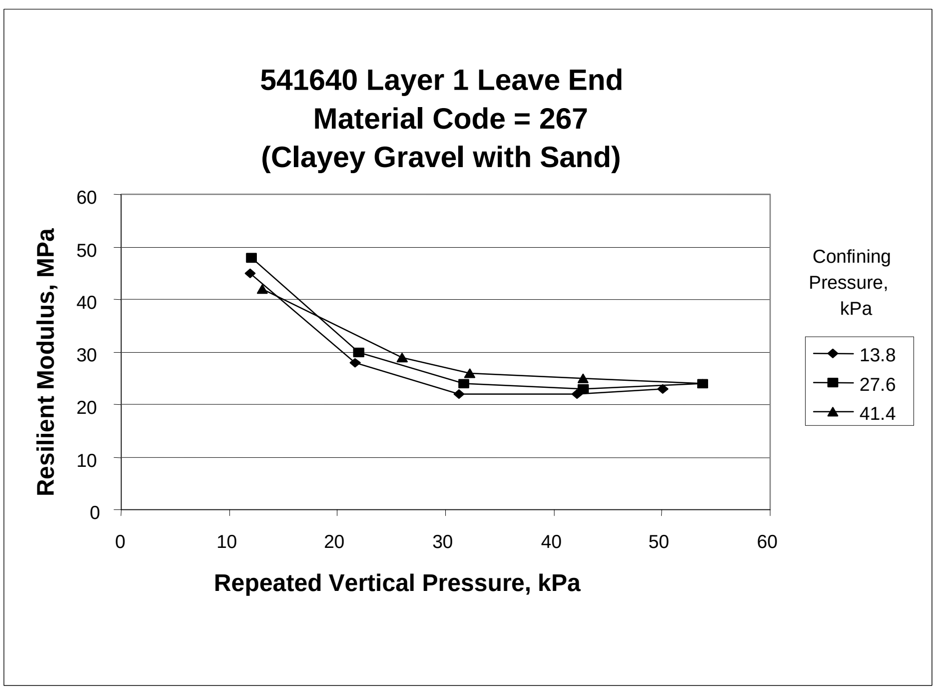

Figure 49. Sample from test section 541640, layer 1, at the leave end exhibiting localized softening or disturbance of the specimen during the test or LVDT movement.

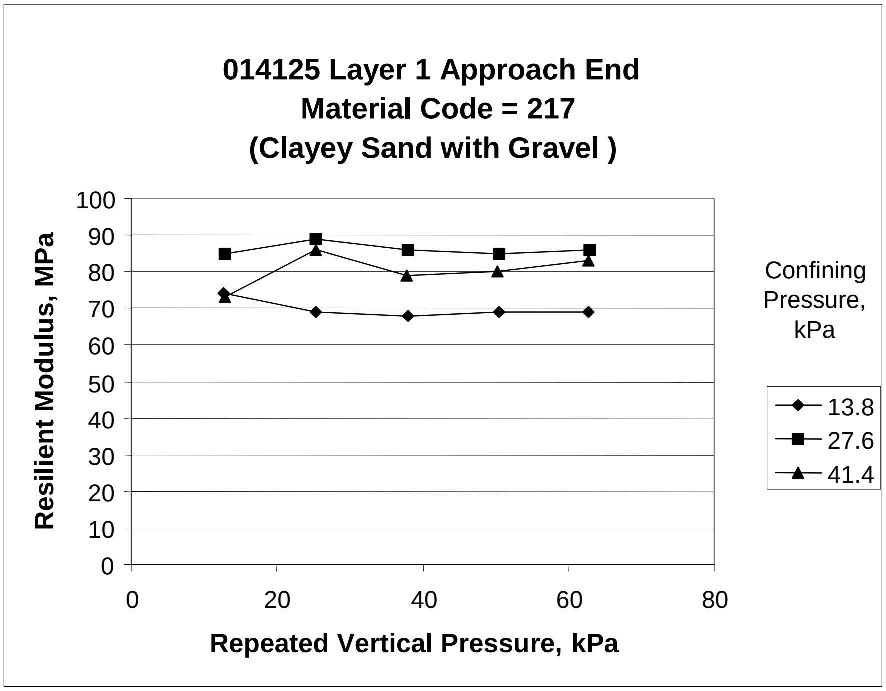

Figure 50. Sample from test section 014125, layer 1, at the approach end shows higher confining pressures result in lower resilient modulus.

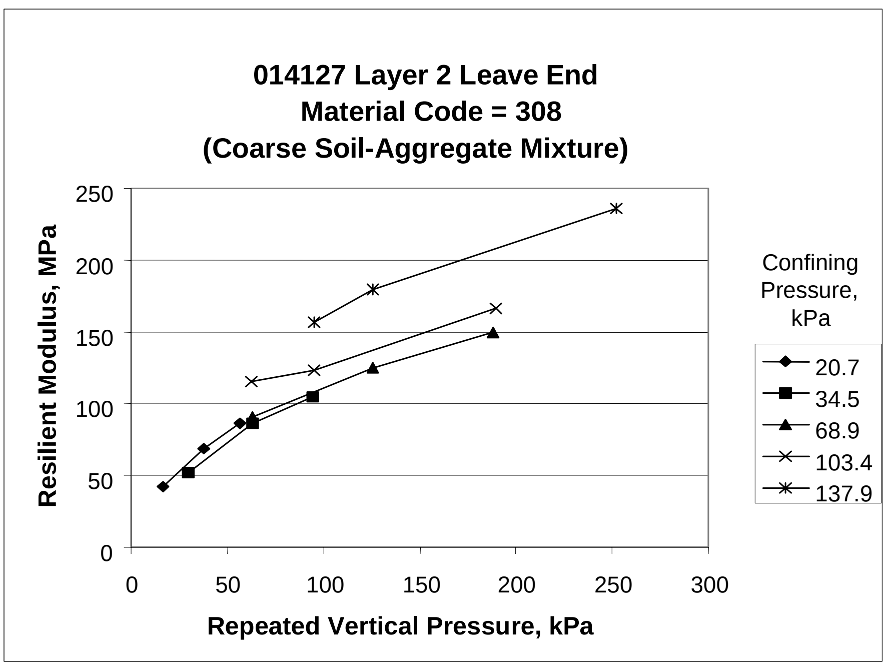

Figure 51. Sample from test section 014127, layer 1, at the leave end shows higher confining pressures result in lower resilient modulus.

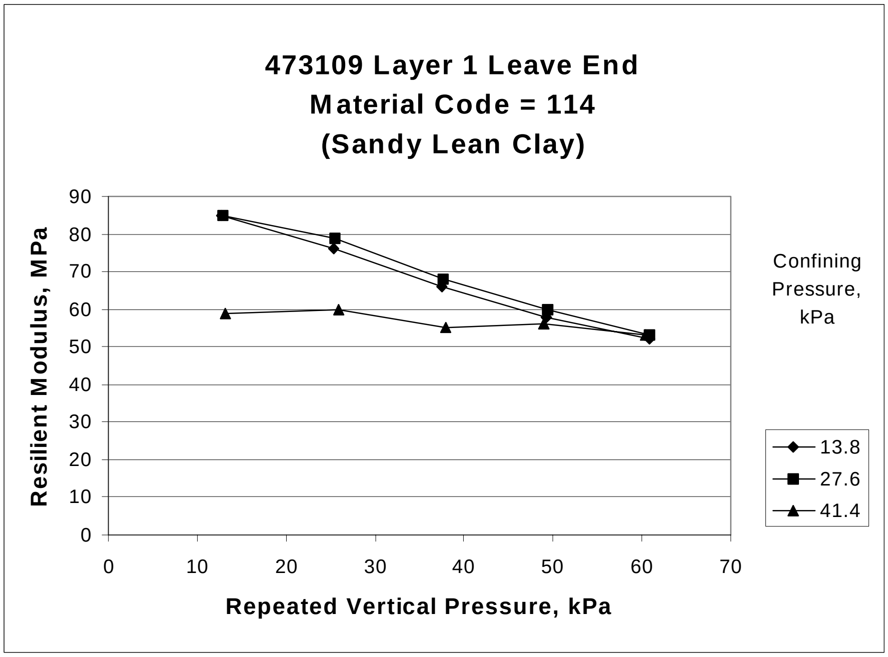

Figure 52. Sample from test section 473109, layer 1, at the leave end shows higher confining pressures result in lower resilient modulus.

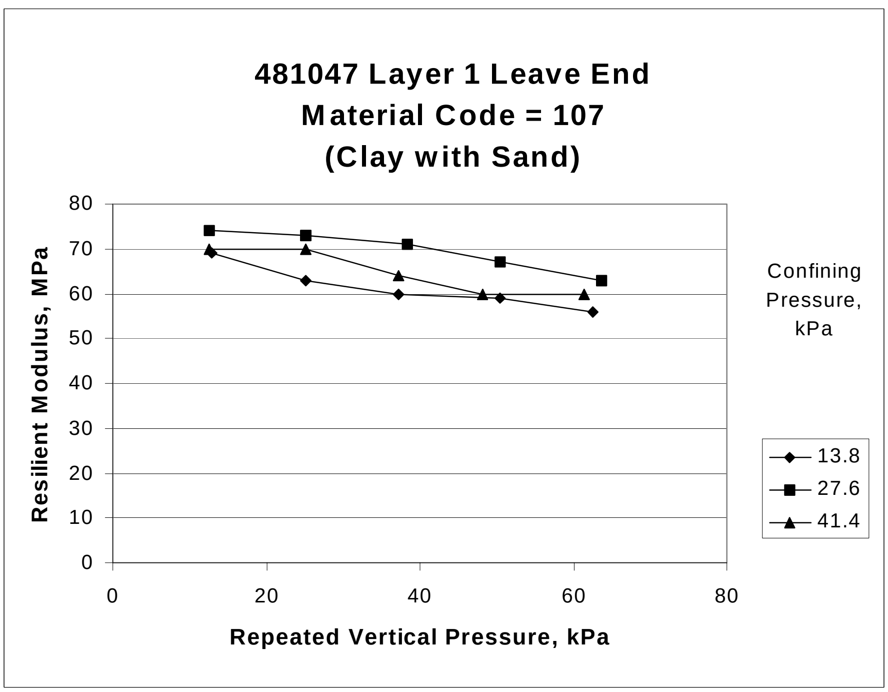

Figure 53. Sample from test section 481047, layer 1, at the leave end shows higher confining pressures result in lower resilient modulus.

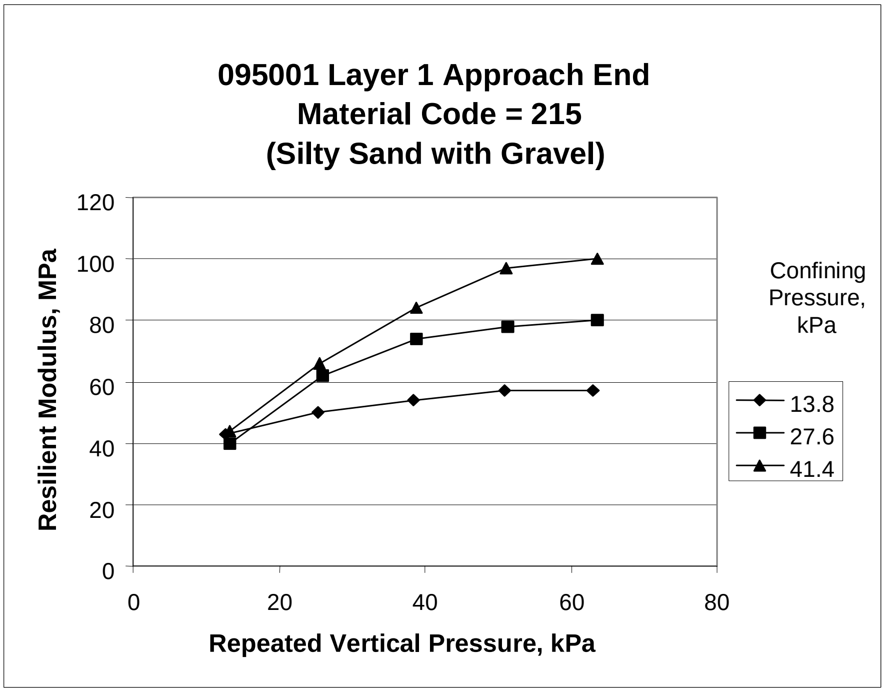

Figure 54. Sample from test section 095001, layer 1, at the approach end shows that resilient modulus is independent of confining pressure at the lowest vertical stress.

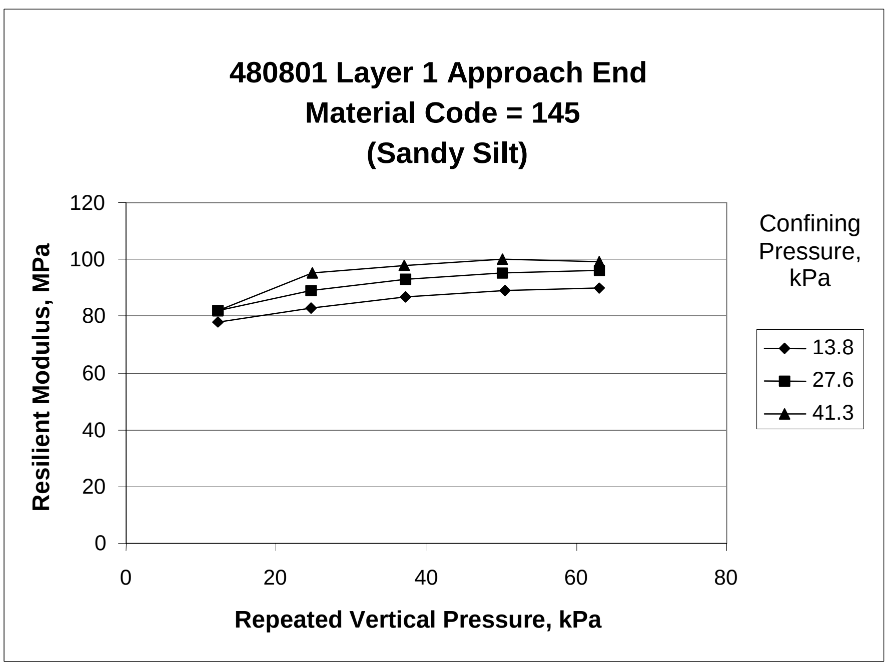

Figure 55. Sample from test section 480801, layer 1, at the approach end shows that resilient modulus is independent of confining pressure at the lowest vertical stress.

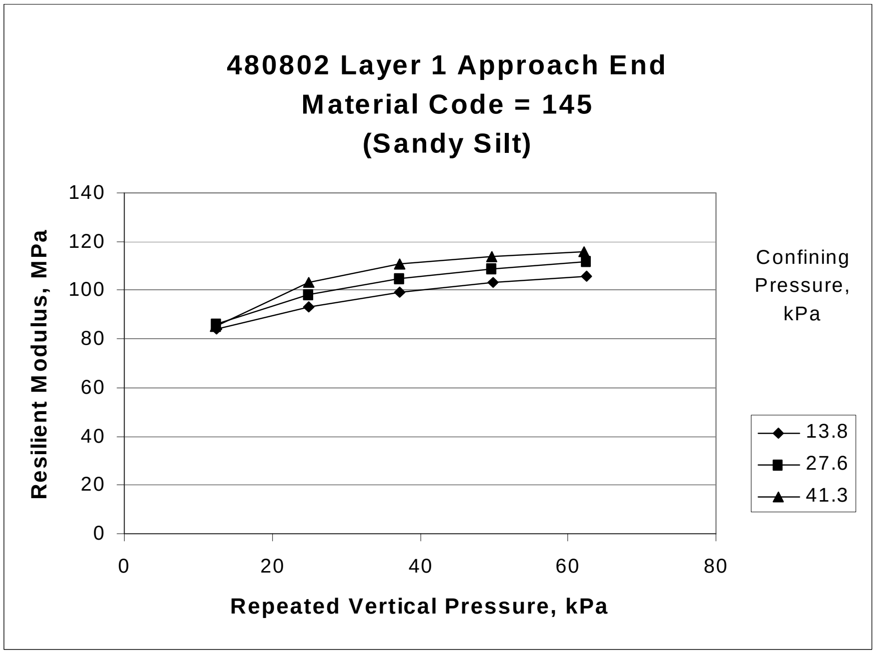

Figure 56. Sample from test section 480802, layer 1, at the approach end shows that resilient modulus is independent of confining pressure at the lowest vertical stress.

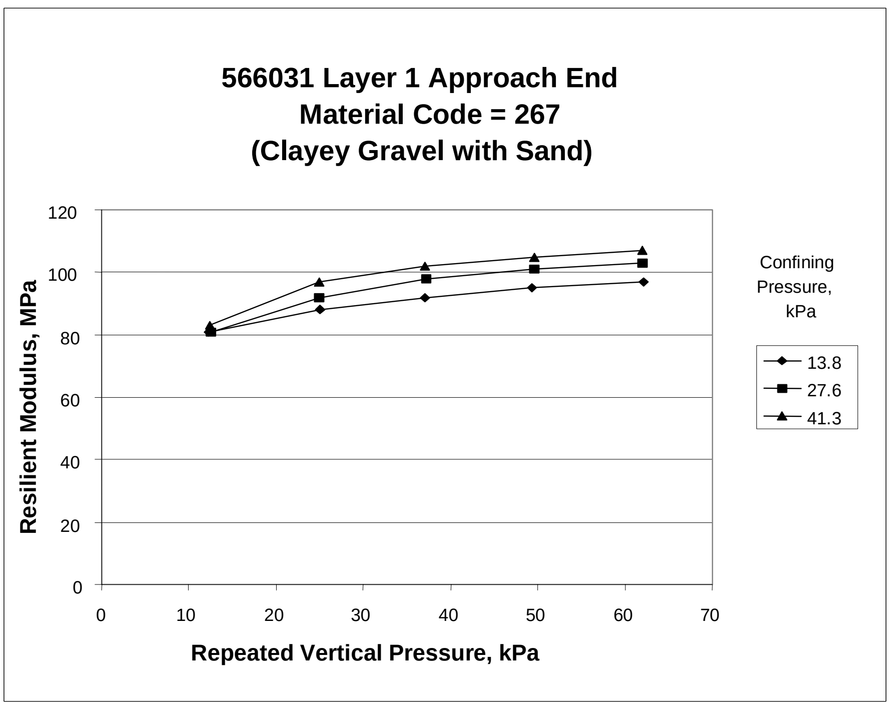

Figure 57. Sample from test section 566031, layer 1, at the approach end shows that resilient modulus is independent of confining pressure at the lowest vertical stress.

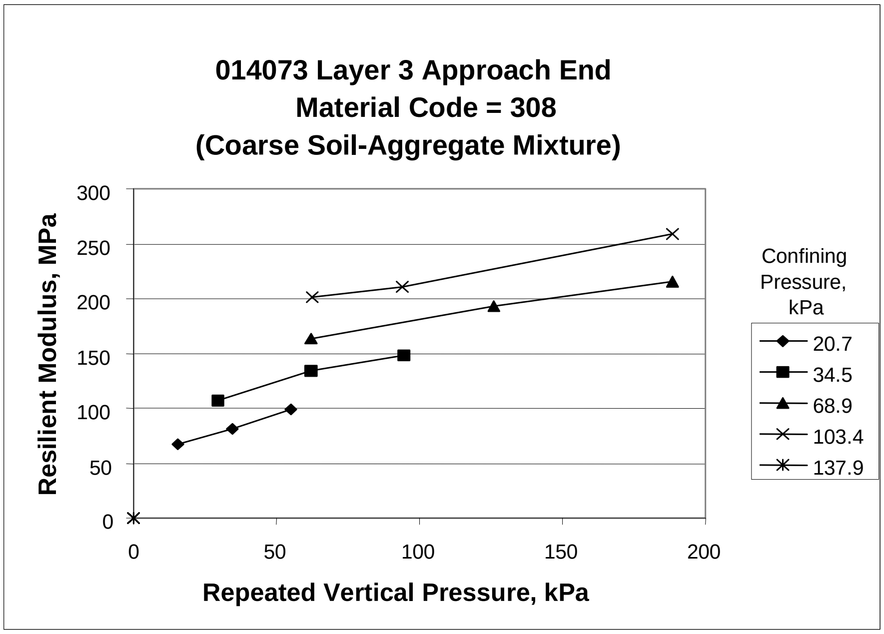

Figure 58. Sample from test section 014073, layer 3, at the approach end shows possible data entry error.

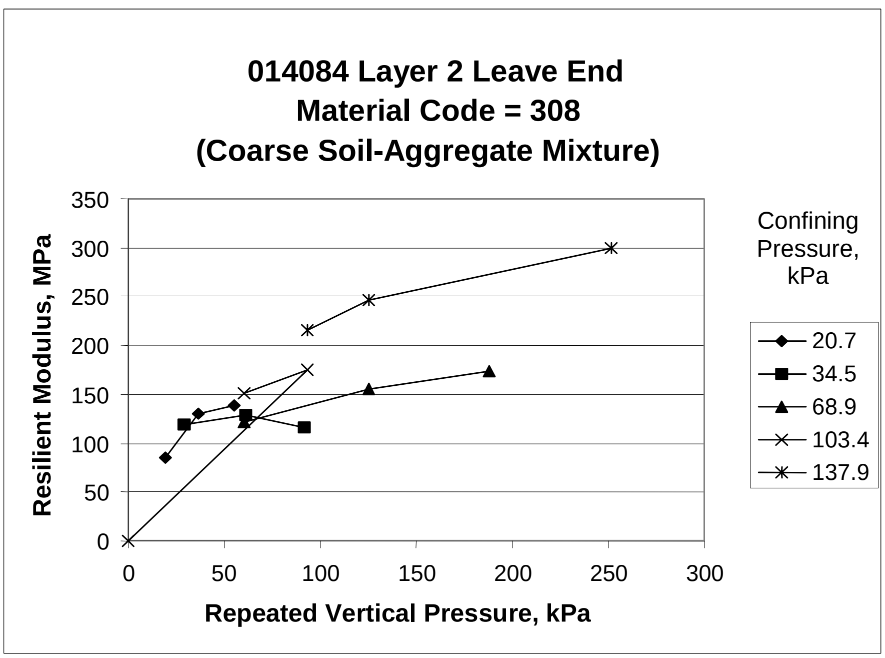

Figure 59. Sample from test section 014084, layer 2, at the leave end shows possible data entry error.

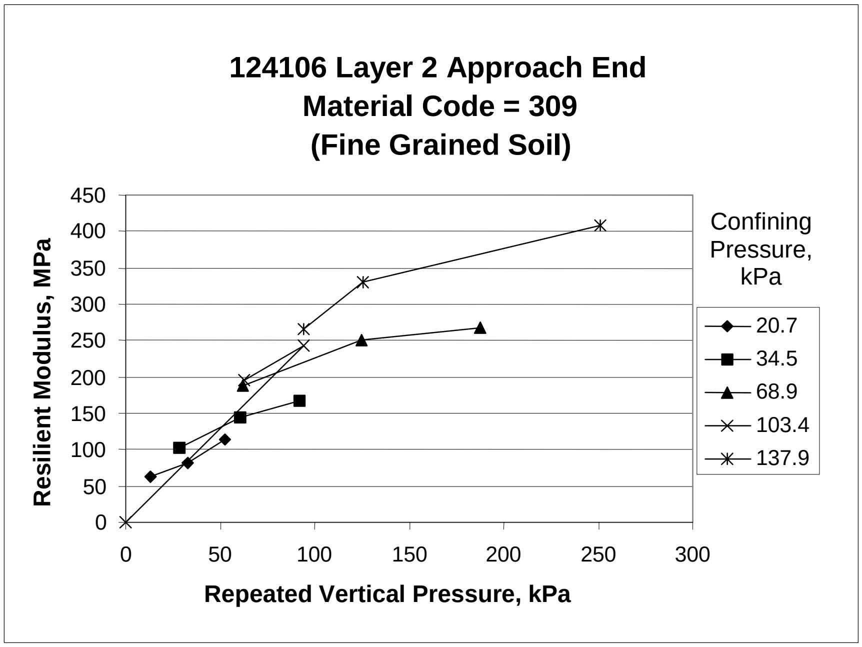

Figure 60. Sample from test section 124106, layer 2, at the approach end shows possible data entry error.

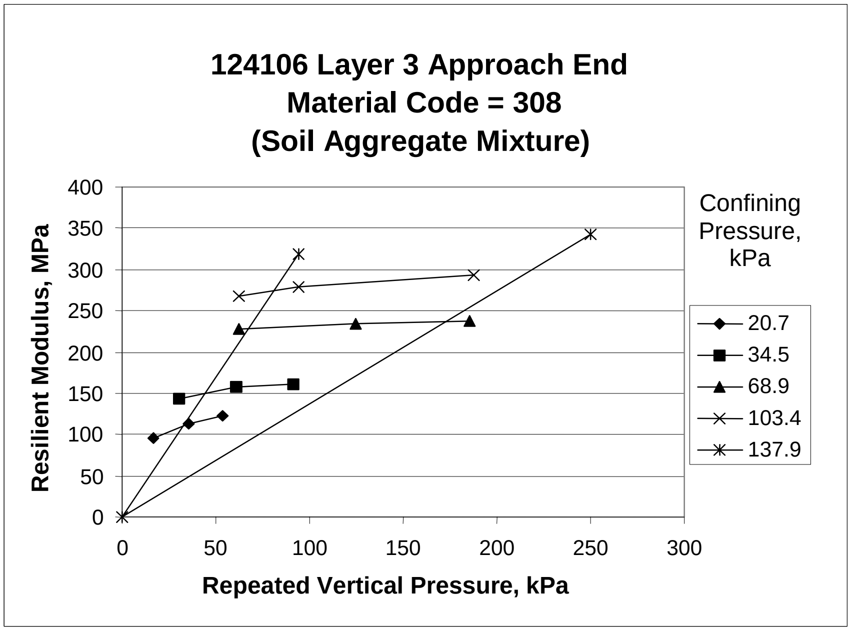

Figure 61. Sample from test section 124106, layer 3, at the approach end shows possible data entry error.

APPENDIX C.

SUMMARY OF THE FLAGGED RESILIENT MODULUS TESTS BY ANOMALY TYPE

Appendix C, tables 17 through 23, provides listings of all the resilient modulus tests that were flagged with the potential anomalies graphically presented in appendix B.

Table 17. Resilient modulus tests showing characteristics of exhibiting test specimen distortion or excessive softening.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
1	0102	1	2	B7	BS07	0.9990	0.5558	131	15	0.6274	-0.1670	1	Failure
1	0111	1	2	B3	BS03	0.9988	0.6470	131	15	0.7076	0.0259	1	Failure
1	4073	1	1	BA*	BS**	0.9968	0.8106	215	15	0.5578	0.0058	1	Failure
1	4155	1	1	BA*	BS**	0.9799	0.5513	214	15	0.8244	0.1524	1	Lowest confining pressure curve behaves (concaves up) totally different from the other two (concave down).
6	6044	1	1	BA*	BS**	0.9990	0.5689	145	15	0.8265	0.5620	1	Failure
6	7455	1	1	BA1	BS01	0.9991	0.5840	117	15	0.8015	0.5104	1	Failure
10	0103	1	1	B3	BS03	0.9991	0.6256	202	15	0.7127	-0.0037	1	Failure, first point of highest and mid confinement coincide.
30	8129	1	1	BA*	BS**	0.9991	0.5361	117	15	0.8556	0.6380	1	Failure at confining pressure of 41.4 kPa.
37	0212	1	1	B5	BS05	0.9989	0.6214	145	15	0.7859	0.4244	1	Failure
42	1606	1	1	BA2	BS02	0.9951	0.9337	117	15	0.3327	0.0507	1	Failure with interweaving pattern.
42	1618	1	1	BA*	BS**	0.9710	0.9836	120	15	0.2168	0.6799	1	Failure with interweaving pattern. Possible seating problem at initial stages for 41.4-kPa and 27.6-kPa confining pressure.
51	1464	1	1	BA*	BS**	0.9846	0.9502	135	15	0.2958	0.5469	1	Failure, first point on the 41.4-kPa curve lies below the other two curves. This could be due to a seating problem with the sample at 41.4 kPa.
81	2812	1	2	A2	TS01	0.9984	0.7180	108	15	0.7314	0.1891	1	Failure

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 18. Resilient modulus tests showing significant effect of confining pressure.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
17	1003	1	2	TP*	BS**	0.9872	0.3804	102	15	0.3379	-0.5564	2	All seem to merge at end.
17	9327	1	1	BA*	BS**	0.9787	0.5676	108	14	-0.0863	-0.6986	2	All merged at end.
18	3003	1	1	BA*	BS**	0.9807	0.5508	216	15	0.7481	0.1058	2	
18	5528	1	1	BA*	BS**	0.9792	0.3648	217	15	0.5770	-0.2747	2	
27	4082	1	2	TP*	BS**	0.9814	0.5051	217	14	0.7976	0.0651	2	Highest confining pressure curve/shape is a mirror image of the other two confining pressures.
28	9030	1	2	A2	TS03	0.9807	0.4484	102	15	0.7436	-0.0835	2	Highest confining pressure shows failure, big gap between it and the other two curves.
29	5403	1	1	BA*	BS**	0.9867	0.4476	214	15	0.8494	0.2330	2	Failure at highest confining pressure (41.4 kPa).
29	5413	1	1	BA*	BS**	0.9506	0.7765	145	14	0.6310	0.9024	2	Points on 27.6 kPa and 41.4 kPa seem to merge at the end.
29	6067	1	1	BA*	BS**	0.9942	0.2934	217	15	0.4942	-0.4435	2	
36	1011	1	2	TP	BS55	0.9828	0.9800	265	14	0.0196	-0.1406	2	All merged at end.
39	3013	1	1	A1	TS02	0.9876	0.4303	108	15	0.0386	-0.7283	2	Highest and mid confining pressure merged at end.
48	1047	1	1	A1	TS01	0.9855	0.5817	107	15	0.7413	0.1683	2	Weaving of 13.8-kPa and 27.6-kPa confining pressure curves.
48	1056	2	2	TP1	BG56	0.9890	0.4795	308	15	0.8462	0.4455	2	Highest confining pressure concave down and all others concave up.
48	3559	1	1	BA*	BS**	0.9941	0.5077	214	15	0.7649	-0.0547	2	Big gap between highest confining pressure (concave down) and the other two (concave up).
48	5284	1	1	BA*	BS**	0.9928	0.5328	216	15	0.4744	-0.3790	2	First and last points of curves 13.8 kPa and 27.6 kPa coincide.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 19. Resilient modulus tests with a sudden drop and then an increase in resilient modulus.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
1	4129	1	2	TP1	BS55	0.9951	0.7299	215	15	0.2770	-0.4128	3	Leak in membrane suspected for highest confining pressure.
12	3811	1	2	A2	TS03	0.9964	0.5001	216	15	0.7180	-0.0632	3	Highest confining pressure went down and up, the other two not very stress-sensitive.
28	0508	1	2	A9	TS03	0.9983	0.5757	102	15	0.8119	0.1305	3	2nd point of highest confining pressure plot below mid confining pressure.
28	3089	1	2	A2	TS03	0.9950	0.5721	114	15	0.7298	-0.1215	3	Mid confining pressure very close to lowest confining pressure; 3rd point actually went below.
45	1024	1	1	A1	TS01	0.9966	0.3753	217	15	0.4722	-0.4943	3	There is a sudden dip in the data at 41.4-kPa confining pressure after which the curve becomes normal; also there might be some initial seating problem at a confining pressure of 41.4 kPa.
48	1056	1	1	A1	TS02	0.9990	0.6303	108	15	0.3895	-0.4717	3	Curve 41.4 kPa dips suddenly and also has an initial seating problem.
48	1056	2	2	TP1	BG55	0.9863	0.4299	308	15	0.8215	0.6161	3	Curve 137.9 kPa suddenly dips, probably due to membrane rupture.
48	1061	1	2	A2	TS04	0.9981	0.5205	108	15	0.4530	-0.4930	3	1st two points of highest confining pressure coincide with the mid confining pressure.
48	1069	1	2	A2	TS03	0.9983	0.6191	103	15	0.7259	0.0983	3	Highest confining pressure very close to mid confining pressure; 2nd point actually went below.
48	3875	1	2	A2	TS04	0.9981	0.5205	108	15	0.4530	-0.4930	3	Highest confining pressure has a sudden dip in the middle; probably due to defective sample (air voids ?).

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R- Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
01	3028	1	1	BA*	BS**	0.9750	0.8727	216	15	0.4830	0.8360	4	Highest confining pressure test plot below other two tests at beginning, possible problem with seating of specimen; all show failure at end.
01	4073	1	2	A2	TS03	0.9618	0.9473	215	15	0.3334	0.9081	4	Higher confining pressure test plot below lower confining pressure test at beginning, possible problem with seating of specimen.
01	4084	1	1	A1	TS01	0.9991	0.5145	216	15	0.7123	-0.1511	4	Lowest and highest confining pressure show failure, mid confining pressure not sensitive to stress.
01	4126	1	1	A1	TS01	0.9951	0.5137	214	15	0.4255	-0.4975	4	Highest confining pressure test plot below mid confining pressure test at beginning, possible problem with seating of specimen.
04	1015	1	2	TP1	BS92	0.9981	0.6582	267	15	0.7576	0.7586	4	First point of highest confining pressure plot below lowest confining pressure, seating problem suspected for specimen.
04	1017	1	1	BA*	BS**	0.9945	0.8660	267	15	0.5015	0.9538	4	Highest confining pressure test plot below other two tests at beginning, possible problem with seating of specimen.
05	3011	1	2	A2	TS03	0.9972	0.6716	133	15	0.4038	-0.4237	4	Failure at highest confining pressure.
05	3048	1	2	A2	TS03	0.9977	0.8997	102	15	0.4530	0.1170	4	1st point of highest confining pressure plot below lowest confining pressure test.
05	3073	1	1	BA*	BS**	0.9945	0.7465	265	15	0.2842	-0.4630	4	Highest confining pressure test went wild!
05	4021	1	1	A1	TS01	0.9841	0.9319	265	15	-0.1699	-0.3471	4	Highest confining pressure test went wild!
05	5803	1	1	BA*	BS**	0.9964	0.7366	217	15	0.7201	0.4326	4	Each confining test weaves in and out with the others.
05	5805	1	2	BA*	BS**	0.9958	0.6178	282	15	0.7947	0.5935	4	Mid confining pressure behaves (concaves down) totally different from the other two (concave up).
08	7783	1	2	TP1	BS93	0.9876	0.5139	216	15	-0.2180	-0.7920	4	Three confining pressures close to each other.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R- Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
12	4000	1	1	A1	TS01	0.9723	0.9658	214	15	0.1921	0.4881	4	Leak in membrane for highest confining pressure, it almost coincides with the lowest confining pressure.
12	4059	1	2	BA*	BS**	0.9948	0.5249	202	15	0.8610	0.2460	4	Mid confining pressure behaves differently from the other two, possible rupture of membrane in the middle of the test.
12	4102	1	1	A1	TS02	0.9713	0.7394	204	15	0.6884	0.8606	4	Beginning of highest confining pressure plot below the other two, Seating problem?
12	4103	1	1	BA*	BS**	0.8766	0.8768	214	15	0.4853	0.9543	4	Each confining test weaves in and out with the others.
15	1003	1	1	BA*	BS**	0.9964	0.5461	145	15	0.8346	0.8442	4	1st point of highest confining pressure plot below mid confining pressure test.
16	6027	1	2	TP1	BS93	0.9937	0.7566	255	15	0.6592	0.9273	4	1st point of all confining pressures are out of order, possible problem with seating of sample.
17	5854	1	1	BA*	BS**	0.9856	0.6732	108	15	-0.2648	-0.6812	4	All merged at end.
21	6040	1	1	BA*	BS**	0.9957	0.7271	108	15	0.6858	0.9062	4	1st half of highest confining pressure plot below mid confining pressure.
22	0118	1	2	B4	BS04	0.9978	0.5966	101	15	0.7986	0.8203	4	1st point of highest confining pressure plot below mid confining pressure test.
28	1016	1	1	A1	TS01	0.9887	0.3869	214	15	0.8582	0.1640	4	1st point of highest confining pressure plot below mid confining pressure, big gap between the lowest and the other two curves.
28	3018	1	2	A2	TS03	0.9959	0.5013	214	15	0.1695	-0.6590	4	Highest confining pressure below mid confining pressure except last point.
28	3081	1	1	A1	TS01	0.9931	0.7821	216	15	0.1502	-0.4899	4	Highest confining pressure crossing the other two curves.
28	3090	1	1	A1	TS01	0.9885	0.6523	143	15	0.2925	-0.5250	4	1st point of highest confining pressure plot below lowest confining pressure test.
28	3097	1	1	A1	TS01	0.9693	1.0000	141	15	-0.2393	-0.0113	4	Highest confining pressure crossing the other two curves.
28	3099	1	1	A1	TS01	0.9960	0.8400	103	15	0.4192	-0.1249	4	Highest confining pressure crossing the other two curves.

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
34	1033	1	2	TP	BS55	0.9965	0.5103	267	15	0.5167	-0.4152	4	1st point of highest confining pressure plot below mid confining pressure test.
35	1022	1	1	A1	TS01	0.9943	0.4376	204	15	0.4313	-0.4923	4	1st point of highest confining pressure plot below mid confining pressure test.
35	2118	1	1	A1	TS01	0.9944	0.8583	214	15	0.4930	0.7739	4	Data points at different confining pressures form a weaving pattern.
35	3010	1	1	A1	TS01	0.9907	0.5846	202	15	0.8301	0.6993	4	1st point of highest confining pressure plots below mid & lowest confining pressure test.
37	1024	1	2	TP	BS55	0.9874	0.5150	214	14	0.0140	-0.7077	4	Data points of confining pressures 13.8 kPa and 27.6 kPa form a weaving pattern.
37	1352	1	2	TP	BS55	0.9927	1.0000	141	15	0.0570	0.0980	4	Data points at different confining pressures form a weaving pattern.
37	1803	1	2	TP	BS55	0.9960	0.5124	144	15	0.4728	-0.4673	4	1st point of highest confining pressure plot below mid confining pressure test.
37	1992	1	1	BA*	BS**	0.9981	0.5061	215	15	0.5541	-0.3762	4	Data points of confining pressures 41.4 kPa and 27.6 kPa form a weaving pattern.
37	2825	1	2	TP	BS55	0.9964	0.8159	204	15	0.5545	-0.0093	4	Data points of confining pressures 41.4 kPa and 27.6 kPa form a weaving pattern.
37	3011	1	1	BA*	BS**	0.9962	0.6789	216	15	0.6536	-0.0090	4	Data points of confining pressures 41.4 kPa and 27.6 kPa form a weaving pattern.
37	5037	1	1	BA*	BS**	0.9865	0.6047	215	15	0.2836	-0.5465	4	1st point of highest confining pressure plot below mid confining pressure test.
40	0116	1	2	B2	BS02	0.9987	0.5134	113	15	0.8543	0.6704	4	1st point of highest confining pressure plot below mid confining pressure test.
40	4087	1	2	BA*	BS**	0.9319	0.9479	108	15	0.3259	0.9272	4	Weaving pattern seen.
40	4161	1	1	A1	TS01	0.9814	0.9226	214	15	0.4172	0.8217	4	Weaving pattern seen.
40	4161	1	2	A2	TS03	0.9833	0.8917	214	15	0.4912	0.1678	4	Weaving pattern seen and soil seems to be stress-insensitive.
40	4166	1	1	BA*	BS**	0.9917	0.8673	114	15	0.5024	0.8040	4	Data at confining pressure of 41.4 kPa weaves through the data at the other two confining pressures.
40	5021	1	2	A2	TS01	0.9848	0.9433	265	15	-0.3253	-0.3316	4	Data at confining pressure of 41.4 kPa weaves through the data at the other two confining pressures.

* - Reference to LTPP Database Code List

** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
40	6010	1	2	BA*	BS**	0.9971	0.5426	217	15	0.7421	-0.0317	4	Data points at confining pressure of 41.4 kPa weave through the data points at a confining pressure of 27.6 kPa.
40	7024	1	2	A2	TS03	0.9897	0.7258	214	15	0.1761	-0.5484	4	First point of highest confining pressure plot below lowest confining pressure, seating problem suspected for specimen.
42	1597	1	2	TP	BS55	0.9797	0.8934	111	15	0.4510	0.8784	4	Curves 41.4 kPa and 27.6 kPa lower than the curve at 13.8 kPa during initial stages of the test. Could be a seating problem or leak in pressure during the initial stages of the test.
42	1598	1	2	BA6	BS06	0.9162	0.9553	217	15	0.3077	0.9222	4	Curves 41.4 kPa and 27.6 kPa lower than the curve at 13.8 kPa during initial stages of the test. Could be a seating problem or leak in pressure during the initial stages of the test.
42	1605	1	2	TP	BS55	0.9889	0.4388	267	14	-0.1774	-0.8089	4	First point on the 41.4-kPa curve which is slightly below the first point on the 27.6 kPa curve. Initial seating problem for 41.4 kPa?
42	1690	1	1	BA*	BS**	0.9944	0.6388	146	15	0.8085	0.3473	4	Weaving pattern, with seating problem for a pressure of 27.6 kPa. Also the soil seems to stress-insensitive.
42	7037	1	2	BA*	BS**	0.9977	0.5600	267	15	0.5678	-0.3326	4	Weaving pattern, with seating problem for a pressure of 41.1. Also, the soil seems stress-insensitive.
42	9027	1	2	BA*	BS**	0.9980	0.6105	267	15	0.5527	-0.3264	4	Weaving pattern, with seating problem for a pressure of 27.6 kPa. Also, the soil seems stress-insensitive.
45	1008	1	2	A2	TS03	0.9829	0.8335	214	15	0.5816	0.6383	4	Weaving pattern, with seating problem for a pressure of 41.4 kPa. Also, the soil seems stress-insensitive during the latter part of the test.
45	1011	2	1	BA*	BG**	0.9862	0.3155	308	15	0.9521	0.8993	4	Weaving pattern. The first point at every pressure is below the curve at an immediately lower pressure. Probably seating problems at the initial stages of the test.
47	1029	1	2	TP1	BS55	0.9953	0.6113	217	15	0.3157	-0.5409	4	Seating problem with 41.4 kPa.
47	2008	1	2	A2	TS03	0.9924	0.7033	131	15	0.1024	-0.6179	4	Seating problem with 41.4 kPa.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
47	3101	1	1	A1	TS01	0.9803	0.9283	109	15	0.3780	0.5898	4	Weaving pattern with the 41.4-kPa curve lower than that of 27.6 kPa. Probable initial seating problems and also a leak in pressure at 41.4 kPa.
47	6022	1	1	A1	TS01	0.9959	0.4761	114	15	0.4705	-0.4557	4	Curves at pressure 41.4 kPa and 27.6 kPa weave through each other. Leak in pressure at level 41.4 kPa?
48	0801	1	3	A5	TS09	0.9983	0.6001	145	15	0.7146	-0.0544	4	Failure with seating problem at 41.4 kPa?
48	1046	2	1	BA*	BG**	0.9832	0.3962	309	13	0.9336	0.8257	4	Seating problem with 34.5 and 68.9 kPa?
48	1069	1	1	BA*	BS**	0.9993	0.7093	103	15	0.7223	0.3748	4	1st point of highest and lowest confining pressure coincide.
48	1092	1	1	BA*	BS**	0.9909	1.0000	143	15	-0.1710	0.1423	4	All three curves cross each other.
48	1094	1	2	TP1	BS55	0.9929	0.5702	217	15	0.8159	0.7139	4	Mid confining pressure crosses the other two curves.
48	1111	1	2	A2	TS03	0.9837	0.9019	216	15	0.4419	0.8732	4	All three curves cross each other.
48	1111	1	1	A1	TS01	0.9910	0.9958	216	15	0.0569	-0.0743	4	Highest confining pressure crosses the other two curves.
48	1113	1	2	A2	TS03	0.9513	0.9895	114	15	0.1790	0.7852	4	All three curves cross each other.
48	1116	1	1	A1	TS01	0.9957	0.9128	114	15	0.4004	0.2941	4	All three curves cross each other.
48	1130	1	2	A2	TS03	0.9798	0.9423	109	15	0.3352	0.9155	4	Highest confining pressure below mid confining pressure and crosses the lowest confining pressure curve.
48	1181	1	2	BA*	BS**	0.9829	0.7838	114	15	0.6034	0.7567	4	Mid confining pressure crosses the other two curves.
48	1183	1	2	A2	TS03	0.9940	0.8556	114	15	0.3563	-0.1881	4	Highest confining pressure below mid confining pressure and crosses the lowest confining pressure curve.
48	3003	1	1	A1	TS01	0.9959	0.9410	103	15	0.4018	0.5168	4	All three curves cross each other.
48	3010	1	2	BA*	BS**	0.9988	0.7834	102	15	-0.0756	-0.5581	4	All three curves are very close and cross each other.
48	3579	1	1	A1	TS01	0.9985	0.5796	114	15	0.7667	0.2049	4	Highest confining pressure crosses mid confining pressure.
48	3589	1	2	A2	TS03	0.9927	0.7455	214	15	0.6881	0.6033	4	Highest confining pressure crosses the other two curves.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
48	3609	1	1	A1	TS01	0.9981	0.5103	101	15	0.1417	-0.6404	4	Highest confining pressure crosses the other two curves.
48	3609	1	2	A2	TS03	0.9797	0.8954	101	15	0.4350	0.8887	4	All three curves are very close and cross each other.
48	3689	1	2	A2	TS03	0.9766	0.8534	113	15	0.5666	0.7254	4	Lowest confining pressure crosses the other two curves and data entry error for mid confining pressure.
48	3729	1	1	A1	TS01	0.9941	0.6437	102	15	0.6323	-0.1869	4	Highest confining pressure (concave down) crossed the other two (concave up).
48	3749	1	1	A1	TS02	0.9973	0.8904	216	15	0.4979	0.5238	4	All three curves cross each other.
48	3749	1	2	A2	TS03	0.9890	1.0000	216	15	-0.0034	0.1366	4	Highest confining pressure (concave down) crossed the other two (concave up).
48	3769	1	1	BA*	BS**	0.9975	0.6711	215	15	0.6232	-0.1880	4	Highest confining pressure (concave down) crossed the other two (concave up).
48	3779	1	1	A1	TS01	0.9931	0.5885	109	15	-0.1265	-0.7517	4	Lowest confining pressure crosses mid confining pressure.
48	4142	1	1	A1	TS01	0.9943	0.7639	216	15	0.6560	0.5129	4	First point of highest confining pressure plot below lowest confining pressure, seating problem suspected for specimen.
48	5026	1	1	A1	TS01	0.9959	1.0000	103	15	-0.1073	0.3915	4	All three curves cross each other.
48	5154	1	1	A1	TS02	0.9800	1.0000	216	15	-0.3015	0.2044	4	Leak in pressure for the highest confining pressure, hence it crosses the other two curves.
48	5278	1	1	BA*	BS**	0.9963	0.6317	217	15	0.6168	-0.0005	4	Leak in pressure for 41.4-kPa sample, hence it falls below the 27.6-kPa curve. Could be due to rupture in membrane.
48	5310	1	2	BA*	BS**	0.9888	0.6436	214	15	0.7688	0.8089	4	First point of 27.6 kPa falls below that of 13.8 kPa. This could be due to a seating problem for the sample at 27.6 kPa.
48	5323	1	2	A2	TS03	0.9688	0.9522	108	15	0.3180	0.8322	4	Curves 27.6 kPa and 41.4 kPa fall below curve 13.8 kPa for the first half of the test and during the second half, curve 41.4 kPa is below curve 27.6 kPa. This could be due to seating problems or leak in pressure.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
48	5334	1	2	A2	TS03	0.9940	0.5232	114	15	0.2214	-0.6071	4	First point of 27.6 kPa falls below that of 13.8 kPa. This could be due to a seating problem for the sample at 27.6 kPa. Also, the last points on the 13.8-kPa and 27.6-kPa curves coincide.
48	5335	1	2	BA*	BS**	0.9733	0.9192	108	15	0.3890	0.7325	4	Curves 27.6 kPa and 41.4 kPa fall below curve 13.8 kPa for the first half of the test and during the second half, curve 41.4 kPa is below curve 27.6 kPa. This could be due to seating problems or leak in pressure.
48	5336	1	2	A2	TS03	0.9708	0.9971	108	15	0.1334	0.4812	4	All three curves cross each other. The material is also stress-insensitive.
48	6179	1	1	A1	TS01	0.9913	0.7866	216	15	0.3214	-0.3123	4	Curve 27.6 kPa falls below curve 13.8 kPa during the latter part of the test. This could be due to membrane rupture or leak in pressure.
48	9005	1	2	A2	TS02	0.9968	0.8181	118	15	0.6201	0.6909	4	Seating problems with samples at 27.6 kPa and 41.4 kPa.
49	1008	1	2	TP1	BS92	0.9892	0.9980	114	15	0.1121	0.0801	4	Curves 27.6 kPa and 13.8 kPa seem to be almost the same. All the curves cross each other.
51	5009	1	2	BA*	BS**	0.9981	0.5779	267	15	0.8143	0.7293	4	Highest confining pressure crosses mid confining pressure.
54	1640	1	2	TP	BS55	0.9827	0.4723	267	15	-0.2536	-0.8097	4	First point on curve 41.4 kPa lies below the other two curves. This is probably due to a seating problem. The last points on the middle and high confining pressures coincide with each other.
54	4003	1	1	BA*	BS**	0.9968	0.5450	265	15	0.5032	-0.4247	4	First point on the highest confinement curve is below that on the mid confining pressure curve. Due to a seating problem? Soil is stress insensitive.
54	7008	1	2	BA*	BS**	0.9966	0.6189	108	15	0.5514	-0.3145	4	First point on the highest confinement curve is below that on the mid confining pressure curve. Due to a seating problem? Soil is stress insensitive.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 20. Resilient modulus tests exhibiting localized softening or disturbance of the specimen during the test or LVDT movement (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
54	7008	1	1	BA*	BS**	0.9968	0.5393	108	15	0.5152	-0.4178	4	First point on the highest confinement curve is below that on the mid confining pressure curve. Due to a seating problem Soil is stress insensitive.
72	4122	1	1	BA*	BS**	0.9964	0.5956	267	15	0.7028	0.0797	4	The 41.4-kPa curve falls below the 27.6-kPa curve during the second half of the test. Could be due to membrane rupture.
87	1620	1	1	BA*	BS**	0.9975	0.5387	102	15	0.0715	-0.7134	4	First point on the highest confinement curve is below that on the mid & low confining pressure curves. Due to a seating problem?
87	2811	1	1	BA*	BS**	0.9917	0.7164	131	15	-0.4051	-0.7092	4	First point on the highest confinement curve is below that on the mid & low confining pressure curves. Due to a seating problem?

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 21. Resilient modulus tests that result in lower resilient moduli for the higher confining pressures.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
1	4125	1	1	BA*	BS**	0.9944	0.8035	217	15	0.5165	0.0141	5	Leak in membrane suspected for highest confining pressure, not sensitive to stress for the other two.
1	4127	2	2	BA*	BG**	0.9845	0.3184	308	15	0.9579	0.9118	5	Leak in membrane suspected for 34.5-kPa and 68.9-kPa confining pressure.
12	3995	3	1	BA*	BG**	0.9800	0.3448	308	15	0.9551	0.8834	5	20.7-kPa confining pressure above 34.5-kPa confining pressure and behaves differently from all confining pressures.
28	1016	1	2	A2	TS03	0.9887	0.5853	214	15	0.4356	-0.4020	5	Highest confining pressure below mid confining pressure.
28	4024	1	1	BA*	BS**	0.9904	0.8564	108	15	0.5351	0.7370	5	Highest confining pressure below mid confining pressure, 2nd point of all three curves coincide.
40	3018	1	2	A2	TS03	0.9928	0.5490	102	15	-0.5167	-0.7962	5	Out of order and some weaving seen.
47	3108	1	2	TP1	BS55	0.9899	0.4136	114	15	-0.6332	-0.8891	5	Curve at pressure of 41.4 kPa is lower than the curve at 13.8 kPa.
47	3109	1	2	TP1	BS55	0.9880	0.6362	114	15	-0.6952	-0.7730	5	Curve at pressure of 41.4 kPa is lower than the curve at 13.8 kPa. Also the last points of all curves merge at one single point.
48	0802	3	2	B4	BG01	0.9924	1.0000	302	15	-0.4163	0.0445	5	Curve at pressure 41.4 kPa is lower than the curves at 13.8 kPa and 27.6 kPa. The soil is stress-insensitive.
48	1047	1	2	A2	TS03	0.9975	0.6008	107	15	-0.1202	-0.7463	5	Curve 41.4 kPa below curve 26.7 kPa
48	9005	1	1	A1	TS01	0.9939	0.9218	118	15	-0.6583	-0.3640	5	Curve 41.4 kPa is below the curves at 13.8 kPa and 27.6 kPa. Also, the curves at 13.8 kPa and 27.6 kPa cross each other, which may be due to seating problems with the sample at 27.6 kPa.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 22. Resilient modulus tests showing resilient modulus is independent of confining pressure at the lowest vertical stress.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
6	1253	1	1	BA*	BS**	0.9972	0.6037	267	15	0.8209	0.7423	6	1st points of all confining pressures are about the same.
9	5001	1	1	BA2	BS02	0.9767	0.5652	215	15	0.8353	0.7068	6	1st points of all confining pressures are about the same.
12	3811	1	1	BA*	BS**	0.9937	0.6869	216	15	0.7299	0.7225	6	1st points of all confining pressures are about the same.
22	0113	1	1	B6	BS06	0.9966	0.6632	101	15	0.7409	0.8622	6	1st points of highest confining pressure plot coincide with mid confining pressure test.
22	0117	1	2	B5	BS05	0.9991	0.5231	101	15	0.8566	0.5662	6	1st points of highest confining pressure plot coincide with mid confining pressure test.
22	0124	1	1	B3	BS03	0.9988	0.6005	101	15	0.7928	0.8236	6	1st points of highest confining pressure plot coincide with mid confining pressure test.
35	0101	1	2	B1	BS01	0.9958	0.7379	114	15	0.6699	0.8883	6	1st points of highest confining pressure plot below mid & lowest confining pressure test.
35	0105	1	2	B3	BS03	0.9965	0.7091	103	15	0.7000	0.8837	6	1st points of highest confining pressure plot below mid confining pressure test (the first points at all confining pressures. Start at almost the same point).
40	0117	1	2	B3	BS03	0.9964	0.6047	113	15	0.7927	0.8499	6	1st points of highest and mid confining pressure test coincide.
40	0120	1	2	B5	BS05	0.9971	0.5888	113	15	0.8066	0.7704	6	1st points of highest and mid confining pressure test coincide.
40	0123	1	2	B6	BS06	0.9926	0.7377	113	15	0.6792	0.9140	6	The first points at all confining pressure start at almost the same point.
48	0801	1	1	B2	BS02	0.9985	0.5336	145	15	0.8479	0.7235	6	First and the last points of confining pressures 27.6 kPa and 41.3 kPa coincide.
48	0802	1	1	B1	BS01	0.9951	0.7011	145	15	0.7176	0.8737	6	Initial point is the same for all three curves.

Table 22. Resilient modulus tests showing resilient modulus is independent of confining pressure at the lowest vertical stress (continued).

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
48	2133	1	1	A1	TS01	0.9984	0.5330	103	15	0.7112	-0.1237	6	1st points of highest and mid confining pressure coincide.
49	1006	1	2	TP1	BS92	0.9978	0.5413	267	15	0.8344	0.6160	6	Initial points on curves 13.8 kPa and 27.6 kPa coincide. Also, the second point on the 41.4-kPa curve looks like a data entry error.
56	6031	1	1	BA*	BS**	0.9967	0.6675	267	15	0.7533	0.8494	6	First point on all three curves coincide.
56	6031	1	1	BA*	BS**	0.9967	0.6675	267	15	0.7533	0.8494	6	First point on all three curves coincide.
56	6031	1	2	TP1	BS91	0.9984	0.5475	267	15	0.8397	0.7415	6	First points on the mid and high confining pressures coincide.
56	7772	1	2	TP1	BS91	0.9991	0.5443	267	15	0.6069	-0.2731	6	First points on the mid and high confining pressures coincide. First point on the low curve does not exactly coincide with the other two, but is very close.
72	4122	1	2	BA*	BS**	0.9872	0.7199	267	15	0.6964	0.8196	6	First point on all three curves coincide.
81	1805	1	1	BA*	BS**	0.9993	0.4547	137	15	0.4926	-0.4517	6	First points on the mid and high confining pressures coincide. Failure?

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

Table 23. Resilient modulus tests with potential data entry error.

State Code	SHRP ID	Layer No.	Test No.	Loc. No.	Sample No.	R-Squared	S_E/S_Y	Matl Code	No. of Cycles	Correlations with M_R		Flag	Comment
										θ	τ_{oct}		
1	4073	3	1	BA*	BG**	0.7186	0.9743	308	15	0.2039	0.8829	7	Both *Mr* and stress at zero for highest confining pressure, data entry error?! But it's at Level E!!??
1	4084	2	2	BA*	BG**	0.9121	0.7272	308	15	0.7395	0.8240	7	Leak in membrane suspected for 34.5-kPa and 68.9-kPa confining pressure, zero data point for 103.4-kPa confining pressure.
12	3997	3	1	BA*	BG**	0.9313	0.6430	308	15	0.7856	0.7503	7	Zero data point for 103.4-kPa confining pressure.
12	4106	3	1	BA*	BG**	0.9070	0.7260	308	15	0.6918	0.7711	7	Zero data point for 137.9-kPa confining pressure.
12	4106	2	1	BA*	BG**	0.9310	0.5385	309	15	0.8489	0.9126	7	Zero data point for 103.4-kPa confining pressure.
28	3090	3	2	BA*	BG**	0.9075	0.6885	308	15	0.7319	0.8265	7	Zero point for highest confining pressure.
47	3104	2	1	BA*	BG**	0.9052	0.6603	303	15	0.7507	0.8214	7	Zero point for a pressure of 137.9 kPa.
48	3865	1	1	BA*	BS**	0.9695	0.6396	114	15	0.7238	0.5862	7	Zero point for lowest confining pressure.
48	9167	3	2	BA4	BG04	0.9032	0.6839	308	15	0.7396	0.9023	7	Initial zero point for curve 137.9 kPa.

* - Reference to LTPP Database Code List
** - Reference to LTPP Database Code List

APPENDIX D.

PARAMETERS AND THEIR VALUES INCLUDED IN THE NONLINEAR REGRESSION RELATING RESILIENT MODULUS TO PHYSICAL PROPERTIES

Appendix D, tables 24 through 39, provides a summary of the minimum, maximum, mean, and median values for each parameter included in the nonlinear optimization regression study to determine the relationship and effect between resilient modulus and physical properties. Tables 24 through 31 include the data sets for the base and subbase materials, while tables 31 through 36 include the data sets for the subgrade soils. The following defines the parameters used in these tables.

$P_{3/8}$	–	Percent passing the 3/8-in [9.5-mm] sieve.
$P_{No.\ 4}$	–	Percent passing the No. 4 sieve.
$P_{No.\ 40}$	–	Percent passing the No. 40 sieve.
$P_{No.\ 200}$	–	Percent passing the No. 200 sieve.
LL	–	Liquid limit.
PI	–	Plasticity index.
W_{opt}	–	Optimum water content of material.
$\delta_{d,opt}$	–	Maximum dry unit weight of material.
W_s	–	Water content of test specimen.
δ_s	–	Dry unit weight of test specimen.
%Silt	–	Percent by weight of silt in the material.
%Clay	–	Percent by weight of clay in the material.

Table 24. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for all granular base and subbase material data set.

LTPP BASE MATL. CODE: All Granular Base & Subbase Materials
No. of Resilient Modulus Tests: 423

Parameters	Min	Max	Median	Mean
$P_{3/8''}$	39.0	100.0	79.0	78.9
$P_{No.\ 4}$	21.0	100.0	65.0	67.6
$P_{No.\ 40}$	8.0	98.0	38.0	42.4
$P_{No.\ 200}$	1.7	96.1	14.1	17.5
LL	0.0	60.0	0.0	7.5
PI	0.0	37.0	0.0	1.9
w_{opt}%	4.0	19.0	8.0	8.2
$\gamma_{d,\ opt}$ (kg/m^3)	1666.1	2467.1	2114.6	2097.0
w_s%	3.1	20.5	7.6	8.0
γ_s (kg/m^3)	1557.0	2391.6	2000.0	1978.8
$\gamma_s/\gamma_{d,opt}$	0.80	1.06	0.95	0.94
w_s/w_{opt}	0.36	1.46	0.98	0.98
$(\gamma_{d,opt})^2/P_{No.\ 40}$	30172.0	665211.9	117421.0	140388.9

Table 25. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 302 data set – uncrushed gravel.

LTPP BASE MATL. CODE: 302 – Uncrushed Gravel
No. of Resilient Modulus Tests: 31

Parameters	Min	Max	Median	Mean
$P_{3/8''}$	60.0	90.0	76.0	76.6
$P_{No.\ 4}$	32.0	81.0	59.0	61.2
$P_{No.\ 40}$	9.0	45.0	25.0	25.6
$P_{No.\ 200}$	3.5	18.1	6.9	8.5
LL	0.0	23.0	0.0	3.0
PI	0.0	8.0	0.0	0.7
w_{opt}%	5.0	10.0	6.0	6.7
$\gamma_{d,\ opt}$ (kg/m^3)	2018.5	2371.0	2194.7	2190.1
w_s%	3.7	13.8	6.0	6.4
γ_s (kg/m^3)	1882.1	2215.5	2057.0	2049.9
$\gamma_s/\gamma_{d,opt}$	0.89	1.00	0.94	0.94
w_s/w_{opt}	0.62	1.38	0.98	0.95
$(\gamma_{d,opt})^2/P_{No.\ 40}$	93439.9	535209.3	193843.1	215727.5

Table 26. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 303 data set – crushed stone.

LTPP BASE MATL. CODE: 303 – Crushed Stone
No. of Resilient Modulus Tests: 57

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	39.0	90.0	64.0	63.5
$P_{No. 4}$	21.0	77.0	49.0	46.9
$P_{No. 40}$	8.0	47.0	25.0	25.6
$P_{No. 200}$	3.0	32.4	12.2	13.4
LL	0.0	27.0	0.0	6.1
PI	0.0	8.0	0.0	1.3
w_{opt}%	4.0	11.0	6.0	6.4
$\gamma_{d, opt}$ (kg/m^3)	1874.3	2354.9	2242.8	2218.6
w_s%	3.1	12.9	6.3	6.6
γ_s (kg/m^3)	1723.6	2236.2	2095.2	2082.3
$\gamma_s/\gamma_{d,opt}$	0.80	1.00	0.94	0.94
w_s/w_{opt}	0.52	1.42	1.00	1.03
$(\gamma_{d,opt})^2/P_{No. 40}$	74747.9	665211.9	198342.0	220732.2

Table 27. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 304 data set – crushed gravel.

LTPP BASE MATL. CODE: 304 – Crushed Gravel
No. of Resilient Modulus Tests: 27

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	49.0	98.0	69.0	69.5
$P_{No. 4}$	30.0	91.0	53.0	53.7
$P_{No. 40}$	8.0	69.0	28.0	28.2
$P_{No. 200}$	3.5	59.9	12.3	16.3
LL	0.0	33.0	0.0	9.7
PI	0.0	16.0	0.0	2.1
w_{opt}%	5.0	11.0	6.0	7.2
$\gamma_{d, opt}$ (kg/m^3)	1986.5	2419.0	2194.7	2195.3
w_s%	4.3	11.3	5.9	6.9
γ_s (kg/m^3)	1875.8	2285.8	2061.6	2072.8
$\gamma_s/\gamma_{d,opt}$	0.92	0.96	0.94	0.94
w_s/w_{opt}	0.69	1.30	0.95	0.96
$(\gamma_{d,opt})^2/P_{No. 40}$	57189.9	584658.9	172031.6	210196.2

Table 28. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 306 data set – sand.

LTPP BASE MATL. CODE: 306 – Sand
No. of Resilient Modulus Tests: 35

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	80.0	100.0	98.0	94.6
$P_{No. 4}$	69.0	100.0	95.0	91.1
$P_{No. 40}$	28.0	97.0	59.0	60.9
$P_{No. 200}$	1.7	32.3	9.4	10.5
LL	0.0	26.0	0.0	2.0
PI	0.0	4.0	0.0	0.1
w_{opt}%	5.0	16.0	10.0	9.5
$\gamma_{d, opt}$ (kg/m^3)	1666.1	2226.8	1906.4	1943.0
w_s%	5.0	14.7	9.1	8.9
γ_s (kg/m^3)	1574.6	2108.9	1797.3	1831.5
$\gamma_s/\gamma_{d,opt}$	0.90	0.97	0.95	0.94
w_s/w_{opt}	0.55	1.21	0.96	0.95
$(\gamma_{d,opt})^2/P_{No. 40}$	30172.0	151323.7	64972.0	78238.9

Table 29. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 307 data set – fine-grained soil-aggregate mixture.

LTPP BASE MATL. CODE: 307 – Fine-Grained Soil-Aggregate Mixture
No. of Resilient Modulus Tests: 26

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	59.0	100.0	92.0	89.0
$P_{No. 4}$	47.0	99.0	85.5	83.0
$P_{No. 40}$	32.0	80.0	50.5	51.4
$P_{No. 200}$	7.2	64.8	32.5	29.3
LL	0.0	60.0	0.0	12.8
PI	0.0	37.0	0.0	4.5
w_{opt}%	4.0	17.0	8.0	8.5
$\gamma_{d, opt}$ (kg/m^3)	1794.2	2226.8	2082.6	2065.3
w_s%	3.7	16.6	7.7	8.1
γ_s (kg/m^3)	1726.4	2096.8	1968.7	1962.3
$\gamma_s/\gamma_{d,opt}$	0.92	0.97	0.96	0.95
w_s/w_{opt}	0.87	1.10	0.94	0.95
$(\gamma_{d,opt})^2/P_{No. 40}$	43914.4	139740.7	84267.3	87798.8

Table 30. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 308 data set – coarse-grained soil-aggregate mixture.

LTPP BASE MATL. CODE: 308 – Coarse-Grained Soil-Aggregate Mixture
No. of Resilient Modulus Tests: 155

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	45.0	100.0	75.0	75.3
$P_{No.\ 4}$	34.0	99.0	61.0	62.1
$P_{No.\ 40}$	13.0	90.0	36.0	37.3
$P_{No.\ 200}$	1.9	37.0	15.9	17.4
LL	0.0	44.0	0.0	10.4
PI	0.0	18.0	0.0	2.7
w_{opt}%	4.0	19.0	8.0	8.5
$\gamma_{d,\ opt}$ (kg/m^3)	1682.1	2451.1	2114.6	2099.8
w_s%	3.5	20.5	7.9	8.5
γ_s (kg/m^3)	1557.0	2332.0	2005.5	1985.3
$\gamma_s/\gamma_{d,opt}$	0.85	1.06	0.95	0.95
w_s/w_{opt}	0.36	1.46	0.99	1.01
$(\gamma_{d,opt})^2/P_{No.\ 40}$	37058.9	412457.8	117658.0	141567.2

Table 31. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for LTPP base and subbase material code 309 data set – fine-grained soil.

LTPP BASE MATL. CODE: 309 – Fine-Grained Soil
No. of Resilient Modulus Tests: 72

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	58.0	100.0	94.5	92.3
$P_{No.\ 4}$	36.0	100.0	89.5	87.4
$P_{No.\ 40}$	20.0	98.0	66.0	67.2
$P_{No.\ 200}$	4.1	96.1	18.0	23.9
LL	0.0	30.0	0.0	5.4
PI	0.0	12.0	0.0	1.6
w_{opt}%	5.0	13.0	9.0	9.0
$\gamma_{d,\ opt}$ (kg/m^3)	1746.2	2467.1	1986.5	2001.8
w_s%	4.7	14.2	8.3	8.5
γ_s (kg/m^3)	1608.3	2391.6	1871.0	1889.8
$\gamma_s/\gamma_{d,opt}$	0.86	1.01	0.94	0.94
w_s/w_{opt}	0.45	1.29	0.96	0.95
$(\gamma_{d,opt})^2/P_{No.\ 40}$	33188.6	304324.2	58296.3	69574.2

Table 32. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for all subgrade soils data set.

SOIL TYPE: All Subgrade Soils
No. of Resilient Modulus Tests: 404

Parameters	Min	Max	Median	Mean
$P_{3/8''}$	53.0	100.0	96.0	92.3
$P_{No. 4}$	30.0	100.0	92.0	87.4
$P_{No. 40}$	18.0	99.0	71.0	69.3
$P_{No. 200}$	1.0	99.0	35.0	40.2
% Silt	0.0	92.7	23.2	26.6
% Clay	0.0	75.5	10.3	13.5
LL	0.0	73.0	22.0	19.7
PI	0.0	46.0	5.0	7.9
w_{opt}%	6.0	95.0	12.0	13.2
$\gamma_{d, opt}$ (kg/m^3)	352.4	2226.8	1890.4	1865.5
w_s%	3.0	33.2	11.6	12.7
γ_s (kg/m^3)	1215.8	2160.0	1804.5	1790.3
$\gamma_s/\gamma_{d,opt}$	0.816	4.231	0.957	0.966
w_s/w_{opt}	0.239	1.357	0.973	0.964
$(\gamma_{d,opt})^2/P_{No. 40}$	1380.2	275475.0	49524.3	58883.4

Table 33. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for the gravel subgrade soils data set.

SOIL TYPE: Gravel
No. of Resilient Modulus Tests: 64

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	53.0	99.0	79.0	78.7
$P_{No. 4}$	30.0	99.0	65.0	66.5
$P_{No. 40}$	18.0	97.0	47.0	48.3
$P_{No. 200}$	9.5	61.1	29.4	31.8
% Silt	4.1	55.5	20.9	22.2
% Clay	0.7	32.8	8.7	9.8
LL	0.0	50.0	26.0	23.7
PI	0.0	27.0	7.0	8.2
w_{opt}%	7.0	26.0	11.0	12.6
$\gamma_{d, opt}$ (kg/m^3)	1457.8	2226.8	1978.5	1921.9
w_s%	6.8	25.5	11.4	12.3
γ_s (kg/m^3)	1377.6	2160.0	1869.6	1838.3
$\gamma_s/\gamma_{d,opt}$	0.864	1.030	0.958	0.957
w_s/w_{opt}	0.746	1.244	0.971	0.977
$(\gamma_{d,opt})^2/P_{No. 40}$	36839.8	275475.0	76995.7	89477.2

Table 34. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for the sand subgrade soils data set.

SOIL TYPE: Sand
No. of Resilient Modulus Tests: 209

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	65.0	100.0	96.0	93.7
$P_{No. 4}$	45.0	100.0	92.0	89.4
$P_{No. 40}$	26.0	99.0	65.0	66.0
$P_{No. 200}$	1.0	74.0	24.3	25.4
% Silt	0.0	55.0	15.9	17.1
% Clay	0.0	28.0	7.1	8.3
LL	0.0	65.0	0.0	10.7
PI	0.0	26.0	0.0	3.4
w_{opt}%	6.0	33.0	11.0	11.3
$\gamma_{d, opt}$ (kg/m^3)	1361.7	2194.7	1922.4	1913.3
w_s%	3.0	33.2	10.4	10.6
γ_s (kg/m^3)	1249.4	2141.4	1839.5	1831.9
$\gamma_s/\gamma_{d,opt}$	0.865	1.056	0.957	0.957
w_s/w_{opt}	0.250	1.167	0.960	0.938
$(\gamma_{d,opt})^2/P_{No. 40}$	22074.1	151773.2	57600.0	62402.6

Table 35. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for the silt subgrade soils data set.

SOIL TYPE: Silt
No. of Resilient Modulus Tests: 31

Parameters	Min	Max	Median	Mean
$P_{3/8"}$	85.0	100.0	97.0	94.6
$P_{No. 4}$	64.0	100.0	94.0	90.8
$P_{No. 40}$	50.0	99.0	82.0	81.5
$P_{No. 200}$	34.7	99.0	61.2	65.6
% Silt	28.0	92.7	48.9	55.6
% Clay	2.8	19.0	8.8	9.8
LL	0.0	52.0	18.0	15.3
PI	0.0	15.0	0.0	2.6
w_{opt}%	7.0	32.0	13.0	14.1
$\gamma_{d, opt}$ (kg/m^3)	1409.8	2210.8	1842.3	1845.2
w_s%	6.6	33.1	12.3	14.0
γ_s (kg/m^3)	1366.5	2098.3	1778.1	1775.0
$\gamma_s/\gamma_{d,opt}$	0.926	1.048	0.953	0.962
w_s/w_{opt}	0.771	1.182	0.985	0.983
$(\gamma_{d,opt})^2/P_{No. 40}$	22165.4	70263.0	40329.2	43567.6

Table 36. Summary of the LTPP data used in the nonlinear regression study of resilient modulus for the clay subgrade soils data set.

SOIL TYPE: Clay

No. of Resilient Modulus Tests: 100

Parameters	Min	Max	Median	Mean
$P_{3/8''}$	74.0	100.0	99.0	97.5
$P_{No.\ 4}$	54.0	100.0	98.0	95.3
$P_{No.\ 40}$	38.0	99.0	88.0	85.9
$P_{No.\ 200}$	7.0	98.4	66.6	68.5
% Silt	3.3	71.2	39.4	40.1
% Clay	3.1	75.5	26.0	28.0
LL	0.0	73.0	35.0	37.1
PI	0.0	46.0	15.5	18.7
w_{opt}%	8.0	95.0	16.0	17.5
$\gamma_{d,\ opt}$ (kg/m^3)	352.4	2114.6	1730.2	1735.7
w_s%	7.9	28.7	16.8	16.9
γ_s (kg/m^3)	1215.8	2027.9	1666.7	1677.3
$\gamma_s/\gamma_{d,opt}$	0.816	4.231	0.957	0.993
w_s/w_{opt}	0.239	1.357	1.000	1.003
$(\gamma_{d,opt})^2/P_{No.\ 40}$	1380.2	63686.0	35848.6	36696.0

APPENDIX E.

RESULTS FROM NONLINEAR OPTIMIZATION REGRESSION STUDY RELATING RESILIENT MODULUS TO PHYSICAL PROPERTIES

Appendix E provides a summary from the nonlinear regression study that was used to identify the relationship or effect of physical properties of the materials on the resilient modulus by material type. Tables 37 through 49 identify the physical properties considered to be important and list the coefficients for each parameter, along with resulting statistics from the regression study for each base material and soil type.

Figures 62 through 74 provide a graphical comparison of the residuals (M_R[Predicted]-M_R[Observed]) by base material and soil type. As shown by the models, there is a modulus-dependent bias. Determining the cause of the bias was beyond the scope of work for this study. Thus, the residuals and their resilient modulus dependence are presented for the consideration of future users of the LTPP resilient modulus database and computed parameters from this study.

Table 37. Results from the nonlinear optimization regression study for all base and subbase material types combined.

Material		All Base and Subbase Materials Combined		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	12.8140	-8.9652	-2.7735
	$P_{3/8"}$	0.0083	--	--
	$P_{No. 4}$	-0.0139	0.0023	0.0007
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	0.0036	-0.0019	-0.0054
	% Silt	--	--	--
	% Clay	--	--	--
	LL	-0.0055	0.0041	0.0007
	PI	0.0206	-0.0168	--
	w_{opt}%	--	--	--
	$\gamma_{d, opt}$ (kg/m^3)	-0.0056	0.0042	0.0010
	w_s%	-0.0431	--	--
	γ_s (kg/m^3)	0.0054	-0.0045	-0.0005
	$\gamma_s/\gamma_{d,opt}$	-10.9427	9.7625	1.7644
	w_s/w_{opt}	0.1150	0.1251	-0.0969
	$(\gamma_{d,opt})^2/P_{No. 40}$	-8.14E-07	4.29E-07	--
Statistics	MSE	1871.79		
	s_e	43.264		
	s_y	75.312		
	s_e/s_y	0.5745		
	R^2	--		
	No. of Points	6329		

Table 38. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 302 – uncrushed gravel.

Material		LTPP Base and Subbase Material Code 302: Uncrushed Gravel		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	-1.8961	0.4960	-0.5979
	$P_{3/8"}$	--	--	--
	$P_{No. 4}$	--	--	--
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	--	-0.0074	--
	% Silt	--	--	--
	% Clay	--	--	--
	LL	--	--	--
	PI	--	--	--
	w_{opt}%	--	--	0.0349
	$\gamma_{d, opt}$ (kg/m^3)	--	--	0.0004
	w_s%	--	--	--
	γ_s (kg/m^3)	0.0014	-0.0007	--
	$\gamma_s/\gamma_{d,opt}$	--	1.6972	--
	w_s/w_{opt}	-0.1184	0.1199	-0.5166
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	--
Statistics	MSE	475.85		
	s_e	21.814		
	s_y	63.045		
	s_e/s_y	0.346		
	R^2	--		
	No. of Points	461		

Table 39. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 303 – crushed stone.

Material		LTPP Base and Subbase Material Code 303: Crushed Stone		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	0.7632	2.2159	-1.1720
	$P_{3/8"}$	0.0084	-0.0016	--
	$P_{No.\ 4}$	--	--	--
	$P_{No.\ 40}$	--	--	--
	$P_{No.\ 200}$	--	--	--
	% Silt	--	--	--
	% Clay	--	--	--
	LL	0.0088	0.0008	-0.0082
	PI	--	--	--
	w_{opt}%	-0.0371	-0.0380	-0.0014
	$\gamma_{d,\ opt}$ (kg/m^3)	-0.0001	-0.0006	0.0005
	w_s%	--	--	--
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No.\ 40}$	--	2.4E-07	--
Statistics	MSE	1699.64		
	s_e	41.227		
	s_y	87.416		
	s_e/s_y	0.4716		
	R^2	--		
	No. of Points	853		

Table 40. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 304 – crushed gravel.

Material		LTPP Base and Subbase Material Code 304: Crushed Gravel		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	-0.8292	4.9555	-3.5141
	$P_{3/8"}$	-0.0065	--	--
	$P_{No. 4}$	--	--	--
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	--	--	--
	% Silt	--	--	--
	% Clay	--	--	--
	LL	0.0114	-0.0057	--
	PI	0.0004	-0.0075	--
	w_{opt}%	-0.0187	--	--
	$\gamma_{d, opt}$ (kg/m^3)	--	--	--
	w_s%	0.0036	-0.0470	--
	γ_s (kg/m^3)	0.0013	-0.0022	0.0016
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No. 40}$	-2.6E-06	2.8E-06	--
Statistics	MSE	854.398		
	s_e	29.230		
	s_y	66.743		
	s_e/s_y	0.4380		
	R^2	--		
	No. of Points	404		

Table 41. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 306 – sand.

Material		LTPP Base and Subbase Material Code 306: Sand		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	-0.2786	1.1148	-0.4508
	$P_{3/8"}$	0.0097	-0.0053	0.0029
	$P_{No. 4}$	--	--	--
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	--	--	--
	% Silt	--	--	--
	% Clay	--	--	--
	LL	0.0219	-0.0095	-0.0185
	PI	-0.0737	0.0325	0.0798
	w_{opt}%	--	--	--
	$\gamma_{d, opt}$ (kg/m^3)	--	--	--
	w_s%	--	--	--
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No. 40}$	1.8E-07	7.2E-07	--
Statistics	MSE	512.674		
	s_e	22.642		
	s_y	51.605		
	s_e/s_y	0.4388		
	R^2	--		
	No. of Points	519		

Table 42. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 307 – fine-grained soil-aggregate mixture.

Material		LTPP Base and Subbase Material Code 307: Fine-Grained Soil-Aggregate Mix		
		Recalibrated Coefficient with M_r Equation		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	-0.7668	0.4951	0.9303
	$P_{3/8"}$	--	--	0.0293
	$P_{No.\ 4}$	0.0051	-0.0141	--
	$P_{No.\ 40}$	--	--	--
	$P_{No.\ 200}$	0.0128	-0.0061	--
	% Silt	--	--	--
	% Clay	--	--	--
	LL	0.0030	--	0.0036
	PI	--	--	--
	w_{opt}%	-0.0510	--	--
	$\gamma_{d,\ opt}$ (kg/m^3)	--	--	--
	w_s%	--	--	--
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	1.1729	1.3941	-3.8903
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No.\ 40}$	--	--	--
Statistics	MSE	588.20		
	s_e	24.253		
	s_y	49.371		
	s_e/s_y	0.4912		
	R^2	--		
	No. of Points	390		

Table 43. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 308 – coarse-grained soil-aggregate mixture.

Material		Base and Subbase Material 308: Coarse-Grained Soil-Aggregate Mixture		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	-0.5856	0.7833	-0.1906
	$P_{3/8"}$	0.0130	---	--
	$P_{No. 4}$	-0.0174	---	--
	$P_{No. 40}$	---	---	--
	$P_{No. 200}$	0.0027	-0.0060	-0.0026
	% Silt	---	---	--
	% Clay	---	---	--
	LL	---	---	--
	PI	0.0149	-0.0081	--
	w_{opt}%	---	---	--
	$\gamma_{d, opt}$ (kg/m^3)	1.6E-06	0.0001	--
	w_s%	-0.0426	---	--
	γ_s (kg/m^3)	---	---	--
	$\gamma_s/\gamma_{d,opt}$	1.6456	---	--
	w_s/w_{opt}	0.3932	-0.1483	--
	$(\gamma_{d,opt})^2/P_{No. 40}$	-8.2E-07	-2.7E-07	8.1E-07
Statistics	MSE	1883.89		
	s_e	43.404		
	s_y	80.186		
	s_e/s_y	0.5413		
	R^2	--		
	No. of Points	2323		

Table 44. Results from the nonlinear optimization regression study for the LTPP base and subbase material code data set 309 – fine-grained soil.

Material		LTPP Base and Subbase Material Code 309: Fine-Grained Soil		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	0.8409	0.6668	-0.1667
	$P_{3/8"}$	--	--	--
	$P_{No. 4}$	--	--	--
	$P_{No. 40}$	0.0004	-0.0007	--
	$P_{No. 200}$	--	--	--
	% Silt	--	--	--
	% Clay	--	--	--
	LL	--	--	--
	PI	0.0161	-0.0139	-0.0207
	w_{opt}%	--	--	--
	$\gamma_{d, opt}$ (kg/m^3)	--	--	--
	w_s%	--	--	--
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	--
Statistics	MSE	1167.03		
	s_e	34.162		
	s_y	62.8		
	s_e/s_y	0.5440		
	R^2	--		
	No. of Points	1079		

Table 45. Results from the nonlinear optimization regression study for the combined subgrade soil data set.

Material		All Subgrade Soils Combined		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	0.9848	0.4808	9.6691
	$P_{3/8"}$	-0.0050	-0.0037	-0.0302
	$P_{No. 4}$	--	0.0062	0.0065
	$P_{No. 40}$	0.0011	-0.0016	0.0192
	$P_{No. 200}$	--	-0.0008	-0.0115
	% Silt	--	--	--
	% Clay	0.0085	-0.0018	0.0040
	LL	0.0089	-0.0078	0.0075
	PI	-0.0094	0.0019	0.0401
	w_{opt}%	--	--	0.0020
	$\gamma_{d, opt}$ (kg/m^3)	--	--	-0.0039
	w_s%	-0.0235	0.0111	-0.2750
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	--	-0.1232	-0.7177
	w_s/w_{opt}	0.3290	-0.0009	1.0262
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	5.28E-06
Statistics	MSE	449.184		
	s_e	21.194		
	s_y	26.574		
	s_e/s_y	0.7975		
	R^2	--		
	No. of Points	6022		

Table 46. Results from the nonlinear optimization regression study for the LTPP gravel subgrade soil data set.

Material		Gravel Subgrade Soils		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	1.3429	0.3311	1.5167
	$P_{3/8"}$	-0.0051	0.0010	-0.0302
	$P_{No. 4}$	--	--	--
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	--	--	--
	% Silt	--	--	--
	% Clay	0.0124	-0.0019	0.0435
	LL	0.0053	-0.0050	0.0626
	PI	--	-0.0072	0.0377
	w_{opt}%	--	--	--
	$\gamma_{d, opt}$ (kg/m^3)	--	--	--
	w_s%	-0.0231	0.0093	-0.2353
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	--
Statistics	MSE	301.322		
	s_e	17.359		
	s_y	26.812		
	s_e/s_y	0.6474		
	R^2	--		
	No. of Points	957		

Table 47. Results from the nonlinear optimization regression study for the LTPP sand subgrade soil data set.

Material		Sand Subgrade Soils		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	3.2868	0.5670	-3.5677
	$P_{3/8''}$	-0.0412	0.0045	0.1142
	$P_{No. 4}$	0.0267	-2.98E-05	-0.0839
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	--	--	-0.1249
	% Silt	--	-0.0043	0.1030
	% Clay	0.0137	-0.0102	0.1191
	LL	0.0083	-0.0041	-0.0069
	PI	--	--	--
	w_{opt}%	-0.0379	0.0014	-0.0103
	$\gamma_{d, opt}$ (kg/m^3)	--	--	--
	w_s%	--	--	--
	γ_s (kg/m^3)	-0.0004	-3.41E-05	-0.0017
	$\gamma_s/\gamma_{d,opt}$	--	-0.4582	4.3177
	w_s/w_{opt}	--	0.1779	-1.1095
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	--
Statistics	MSE	357.7155648		
	s_e	18.91337		
	s_y	24.787		
	s_e/s_y	0.7630		
	R^2	--		
	No. of Points	3117		

Table 48. Results from the nonlinear optimization regression study for the LTPP silt subgrade soil data set.

Material		Silt Subgrade Soils		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	1.0480	0.5097	-0.2218
	$P_{3/8"}$	--	--	--
	$P_{No. 4}$	--	--	--
	$P_{No. 40}$	--	--	--
	$P_{No. 200}$	--	--	--
	% Silt	--	--	0.0047
	% Clay	0.0177	--	--
	LL	--	--	--
	PI	0.0279	-0.0286	0.0849
	w_{opt}%	--	--	--
	$\gamma_{d, opt}$ (kg/m^3)	--	--	--
	w_s%	-0.0370	--	-0.1399
	γ_s (kg/m^3)	--	--	--
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	--
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	--
Statistics	MSE	193.03		
	s_e	13.894		
	s_y	24.714		
	s_e/s_y	0.5622		
	R^2	--		
	No. of Points	464		

Table 49. Results from the nonlinear optimization regression study for the LTPP clay subgrade soil data set.

Material		Clay Subgrade Soils		
Model		Coefficient	θ Exponent	τ_{oct} Exponent
Model Parameters	Intercept	1.3577	0.5193	1.4258
	$P_{3/8"}$	--	--	--
	$P_{No. 4}$	--	-0.0073	-0.0288
	$P_{No. 40}$	--	0.0095	0.0303
	$P_{No. 200}$	--	-0.0027	-0.0521
	% Silt	--	--	0.0251
	% Clay	0.0106	--	--
	LL	--	-0.0030	0.0535
	PI	--	--	--
	w_{opt}%	--	-0.0049	-0.0672
	$\gamma_{d, opt}$ (kg/m^3)	--	--	-0.0026
	w_s%	-0.0437	--	--
	γ_s (kg/m^3)	--	--	0.0025
	$\gamma_s/\gamma_{d,opt}$	--	--	--
	w_s/w_{opt}	--	--	-0.6055
	$(\gamma_{d,opt})^2/P_{No. 40}$	--	--	--
Statistics	MSE	557.918		
	s_e	23.620		
	s_y	29.224		
	s_e/s_y	0.8082		
	R^2	--		
	No. of Points	1484		

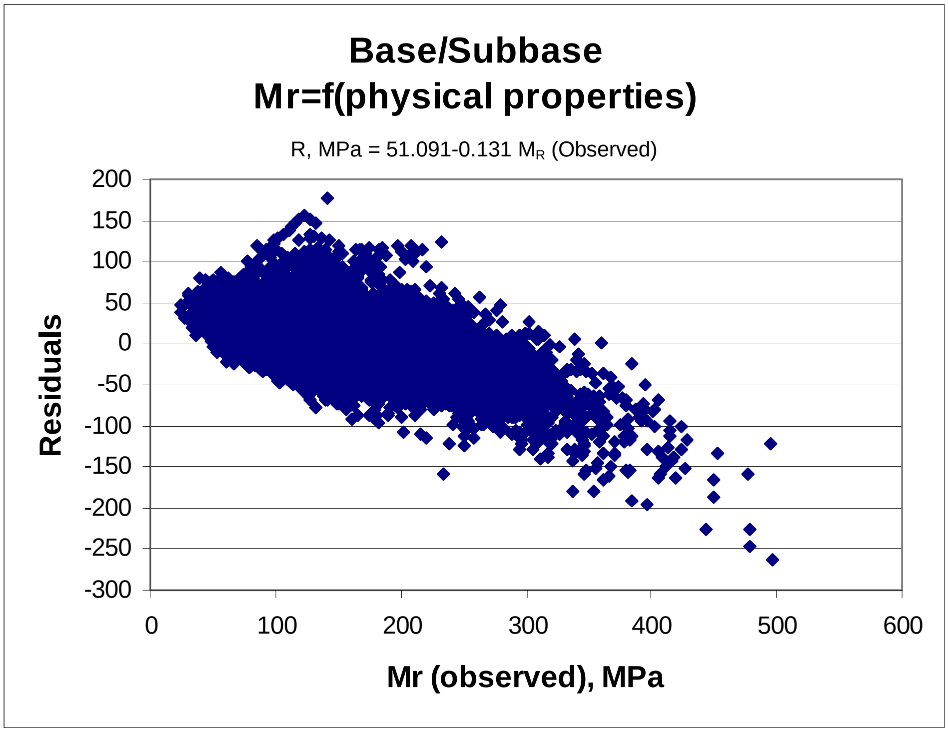

Figure 62. Residuals, *R*, for the combined resilient modulus prediction equation for all base and subbase materials.

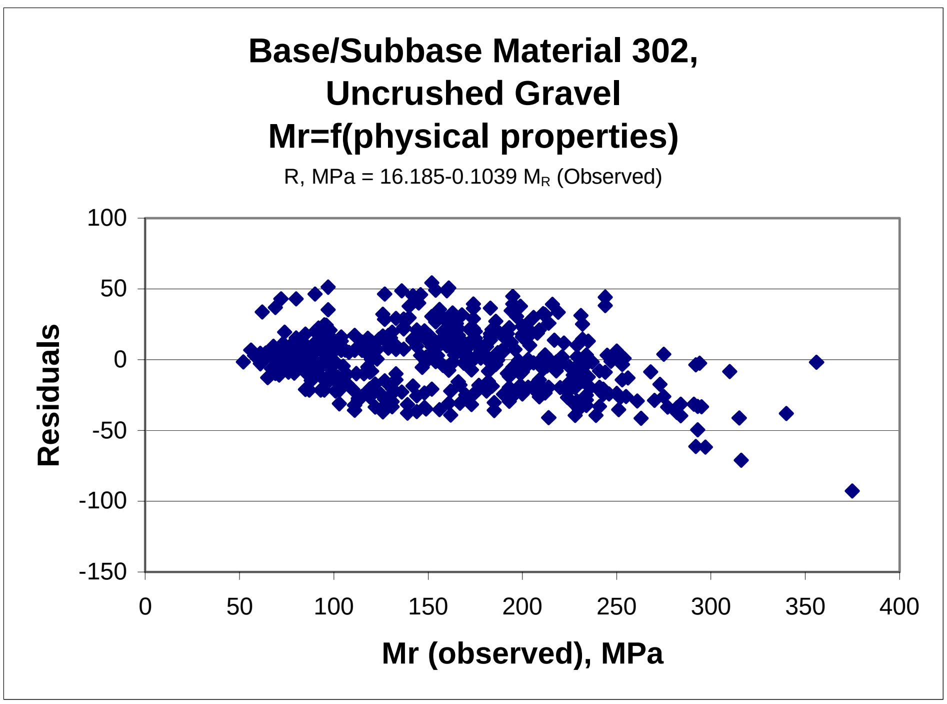

Figure 63. Residuals, *R*, for the uncrushed gravel (LTPP material code 302) resilient modulus prediction equation.

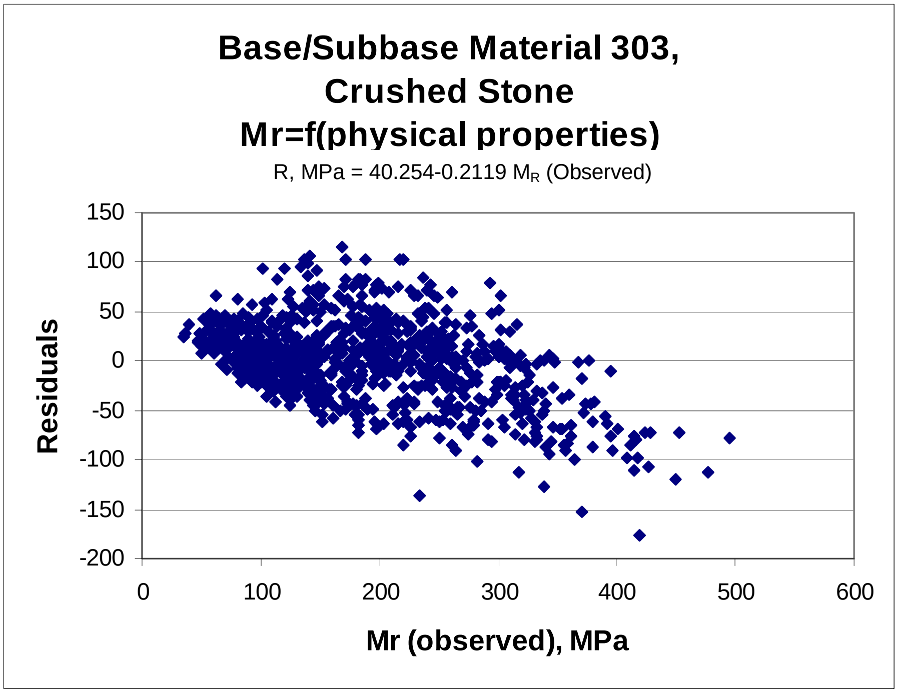

Figure 64. Residuals, *R*, for the crushed stone (LTPP material code 303) resilient modulus prediction equation.

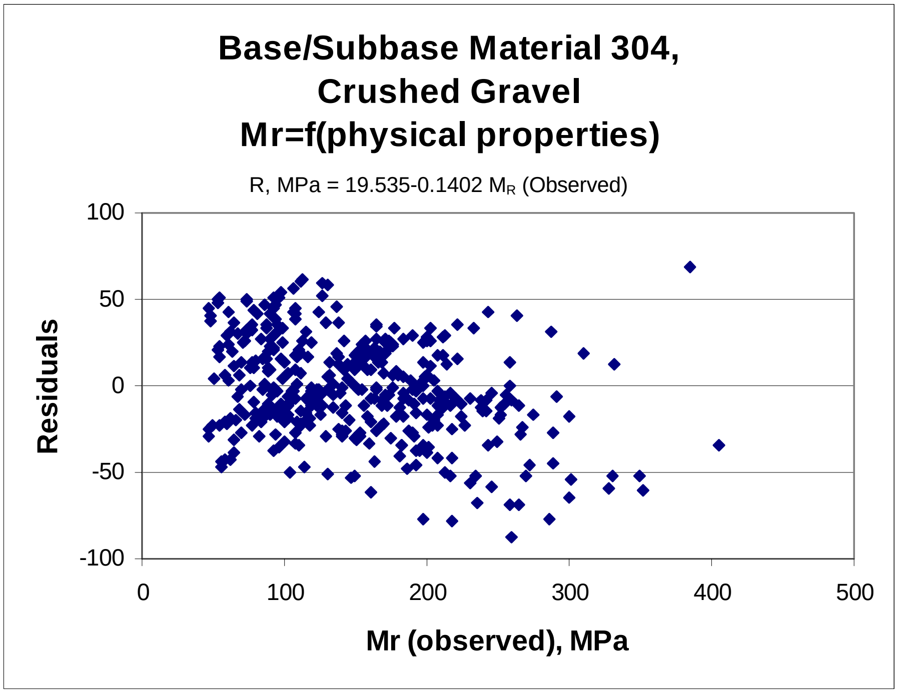

Figure 65. Residuals, *R*, for the crushed gravel (LTPP material code 304) resilient modulus prediction equation.

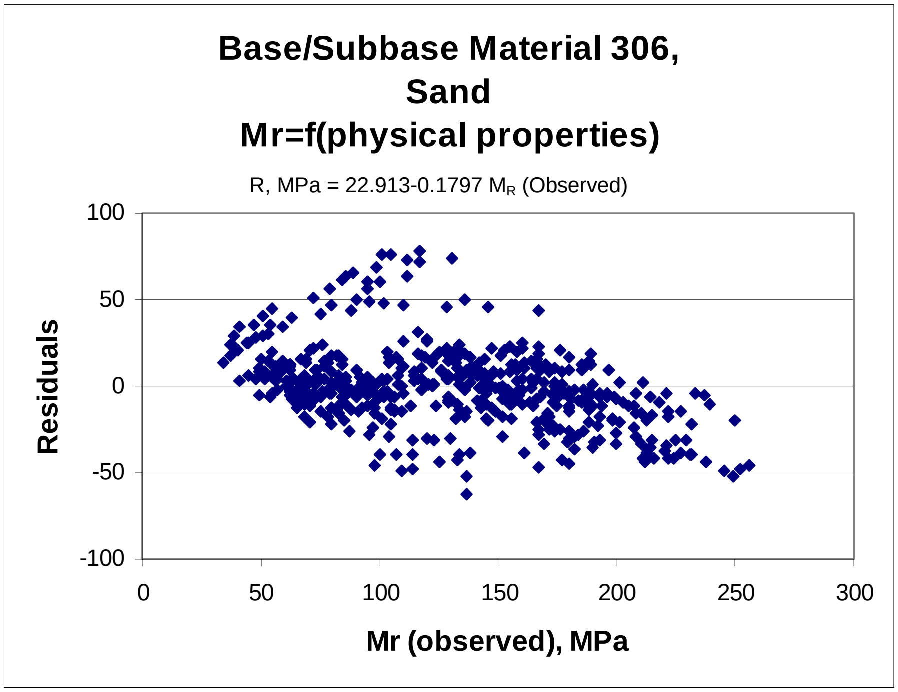

Figure 66. Residuals, *R*, for the sand (LTPP material code 306) resilient modulus prediction equation.

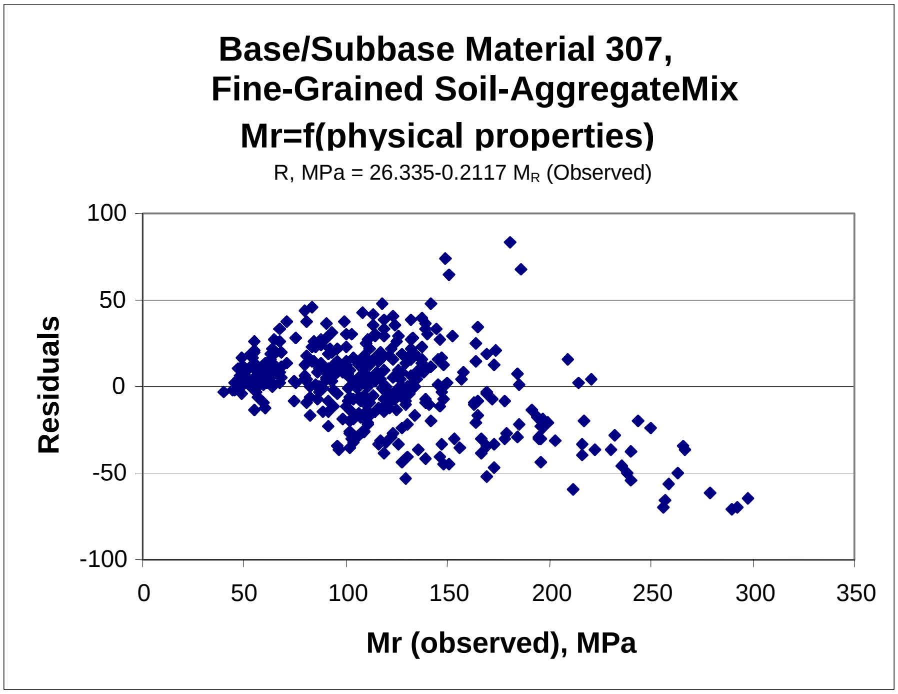

Figure 67. Residuals, *R*, for the fine-grained soil-aggregate mixture (LTPP material code 307) resilient modulus prediction equation.

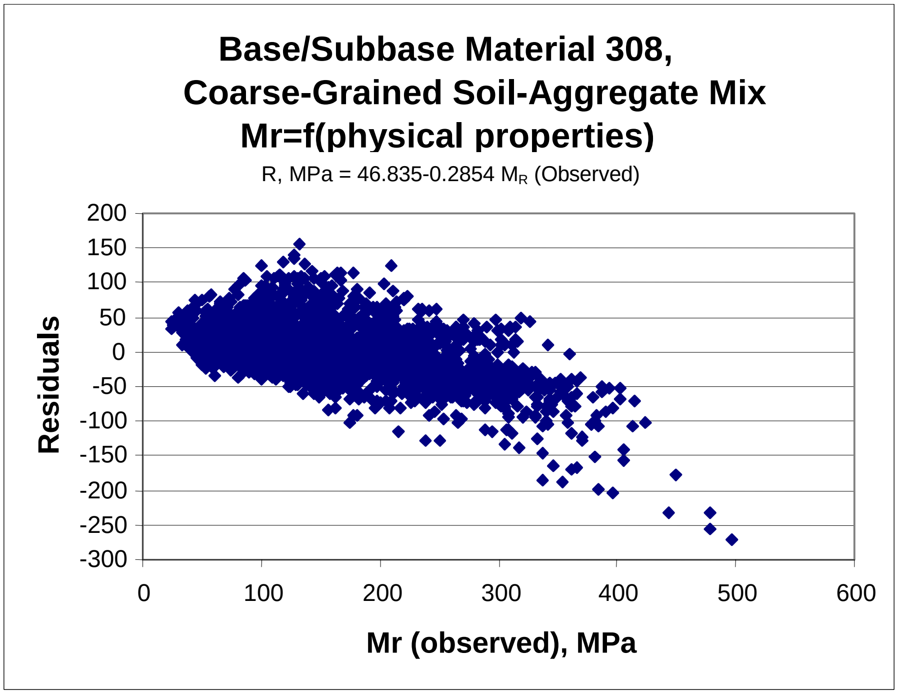

Figure 68. Residuals, *R*, for the coarse-grained soil-aggregate mixture (LTPP material, code 308) resilient modulus prediction equation.

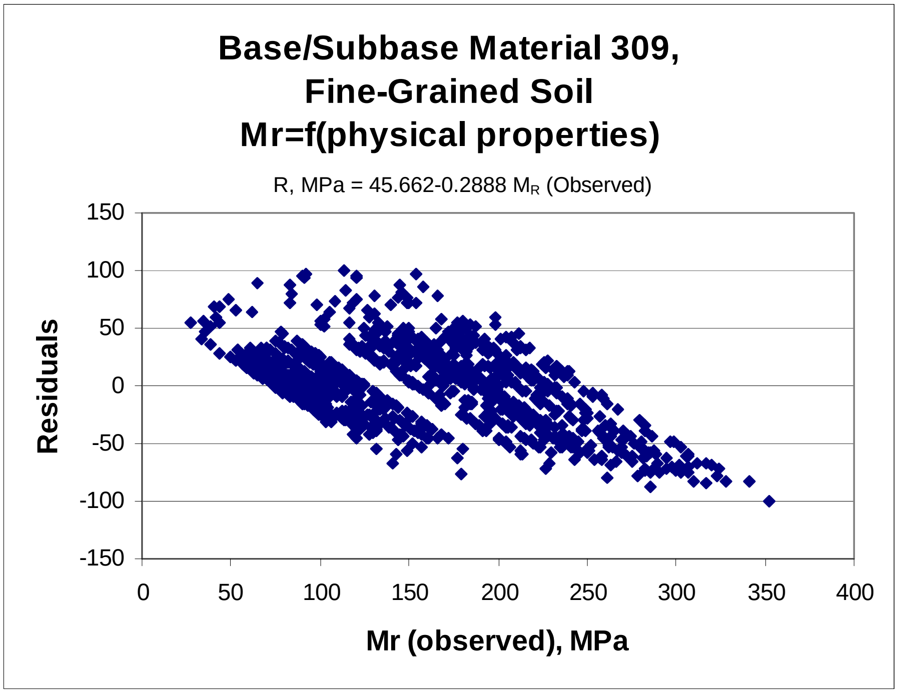

Figure 69. Residuals, *R*, for the fine-grained soil (LTPP material code 309) resilient modulus prediction equation.

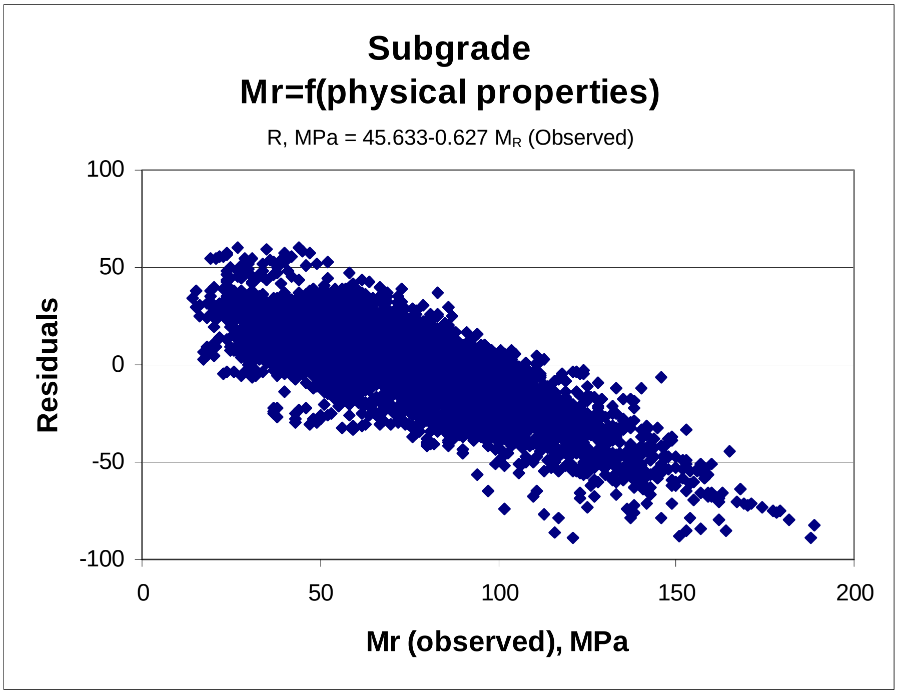

Figure 70. Residuals, *R*, for the resilient modulus prediction equation for all subgrade soils.

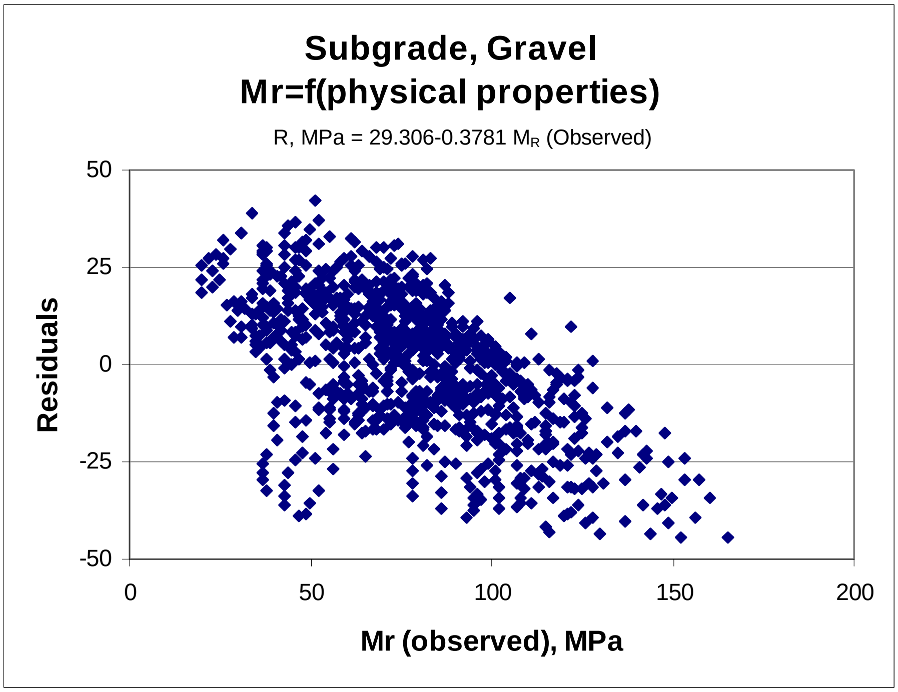

Figure 71. Residuals, *R*, for the gravel soils resilient modulus prediction equation.

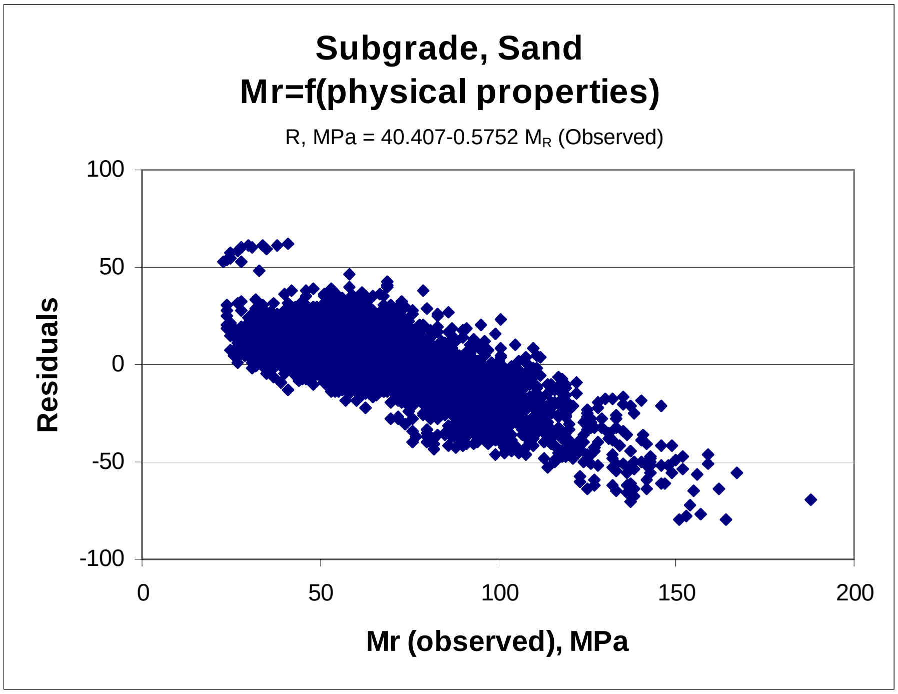

Figure 72. Residuals, *R*, for the sand soils resilient modulus prediction equation.

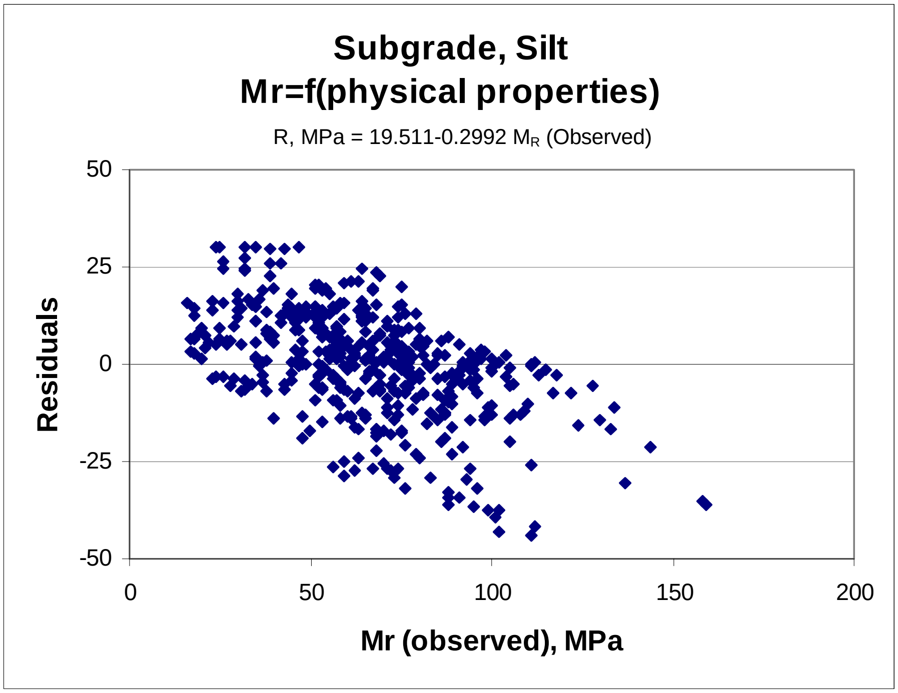

Figure 73. Residuals, *R*, for the silt soils resilient modulus prediction equation.

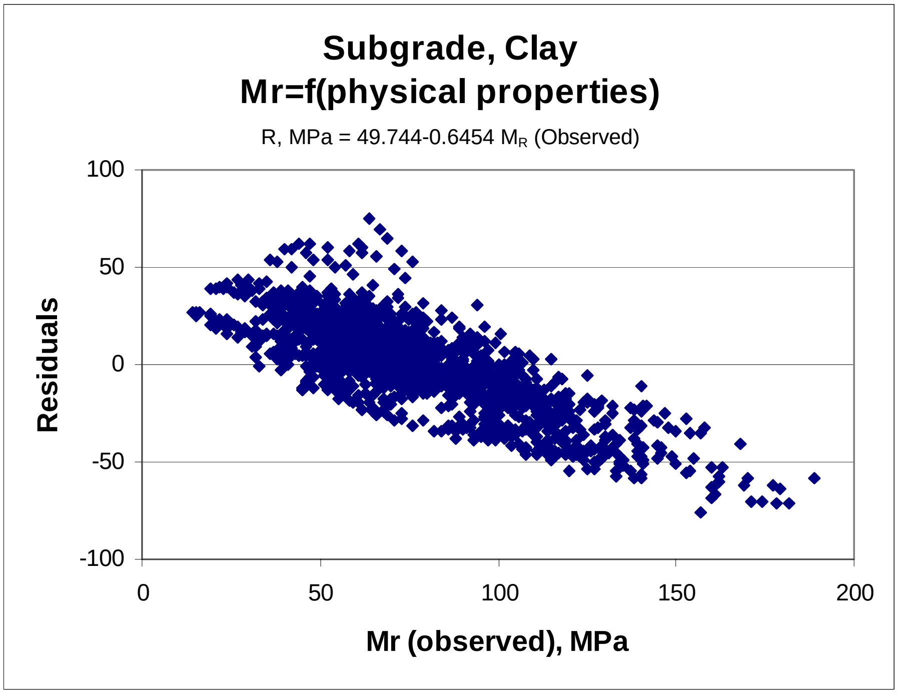

Figure 74. Residuals, *R*, for the clay soils resilient modulus prediction equation.

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