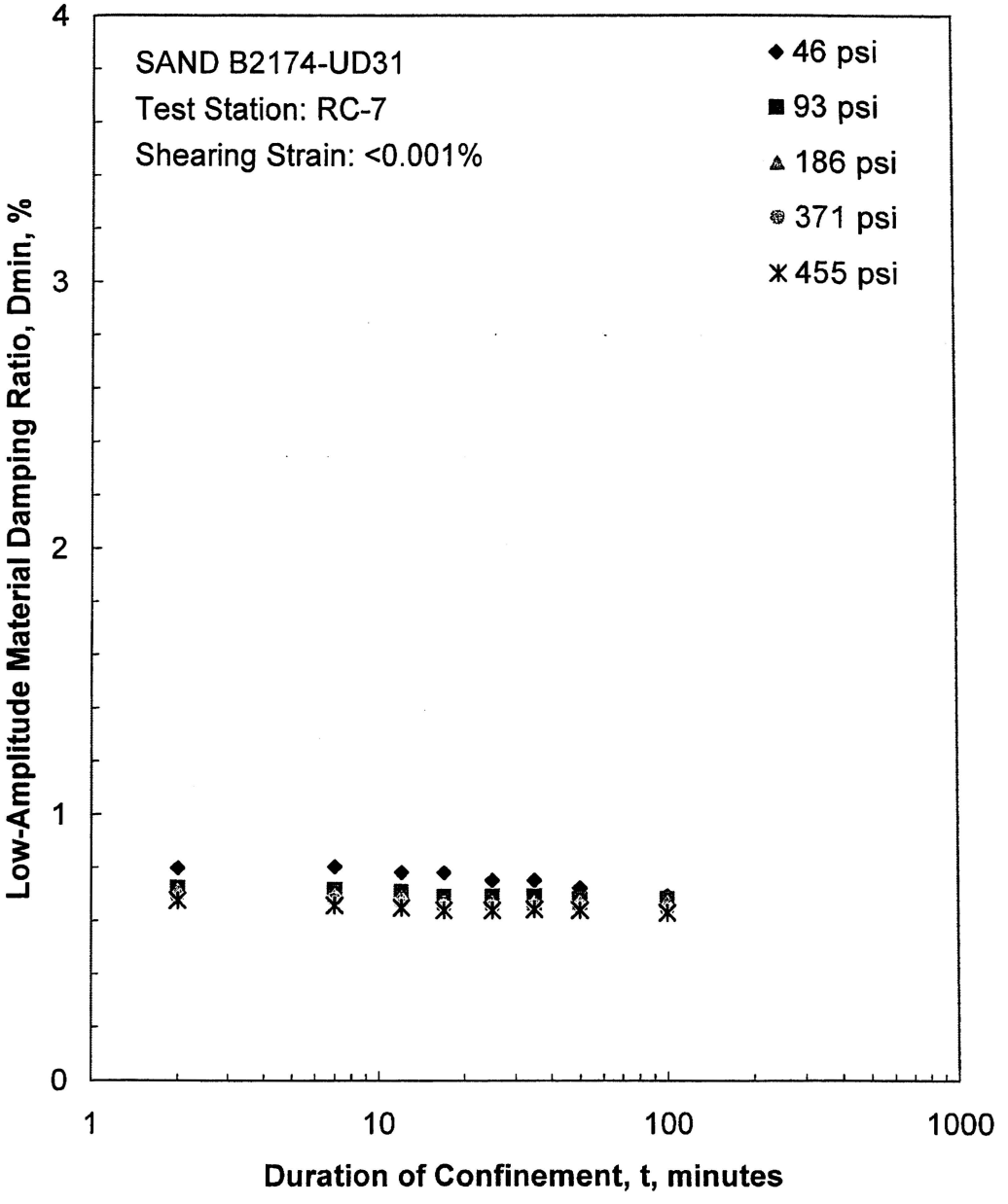

Figure L.2 Variation in Low-Amplitude Material Damping Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

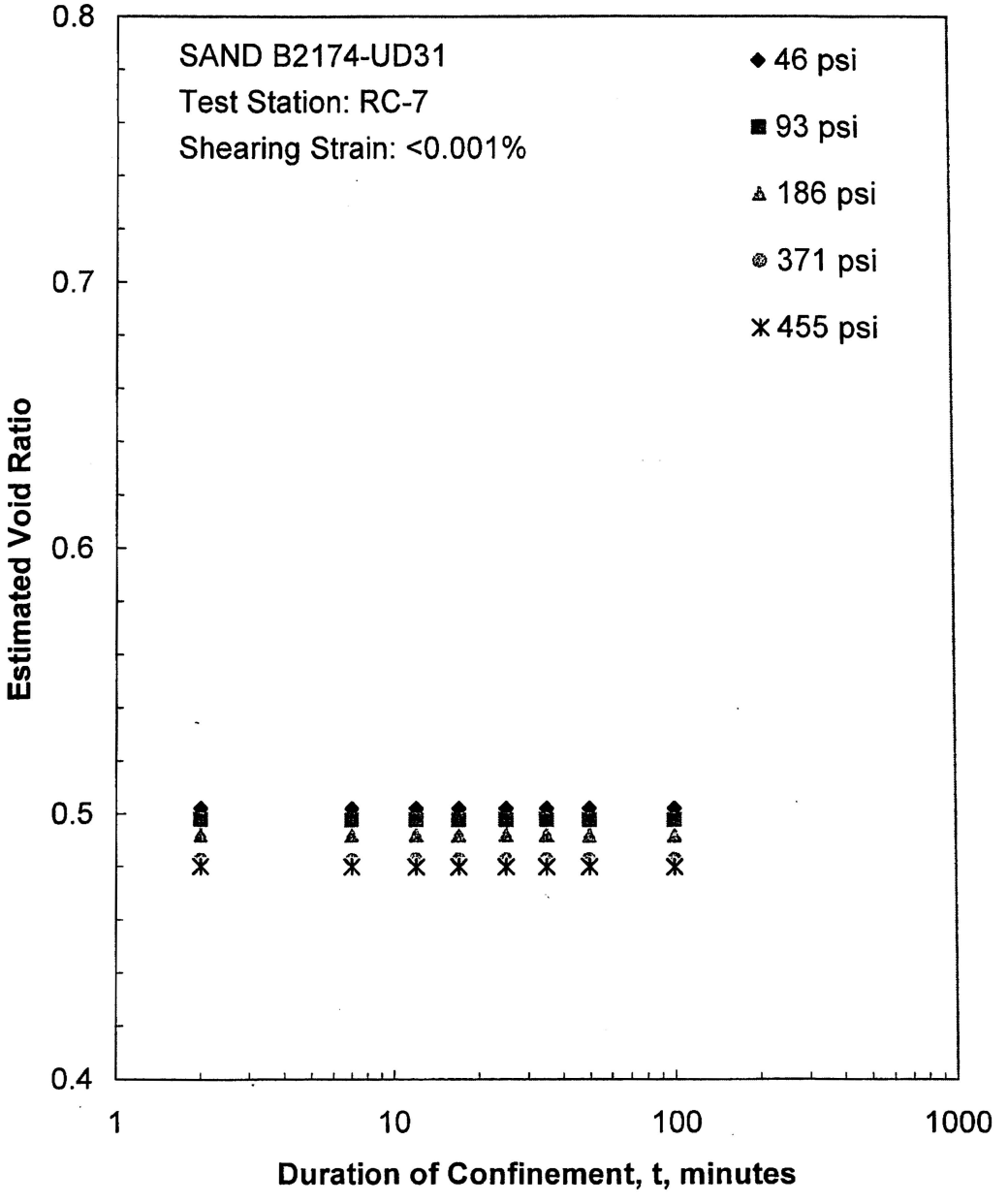

Figure L.3 Variation in Estimated Void Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

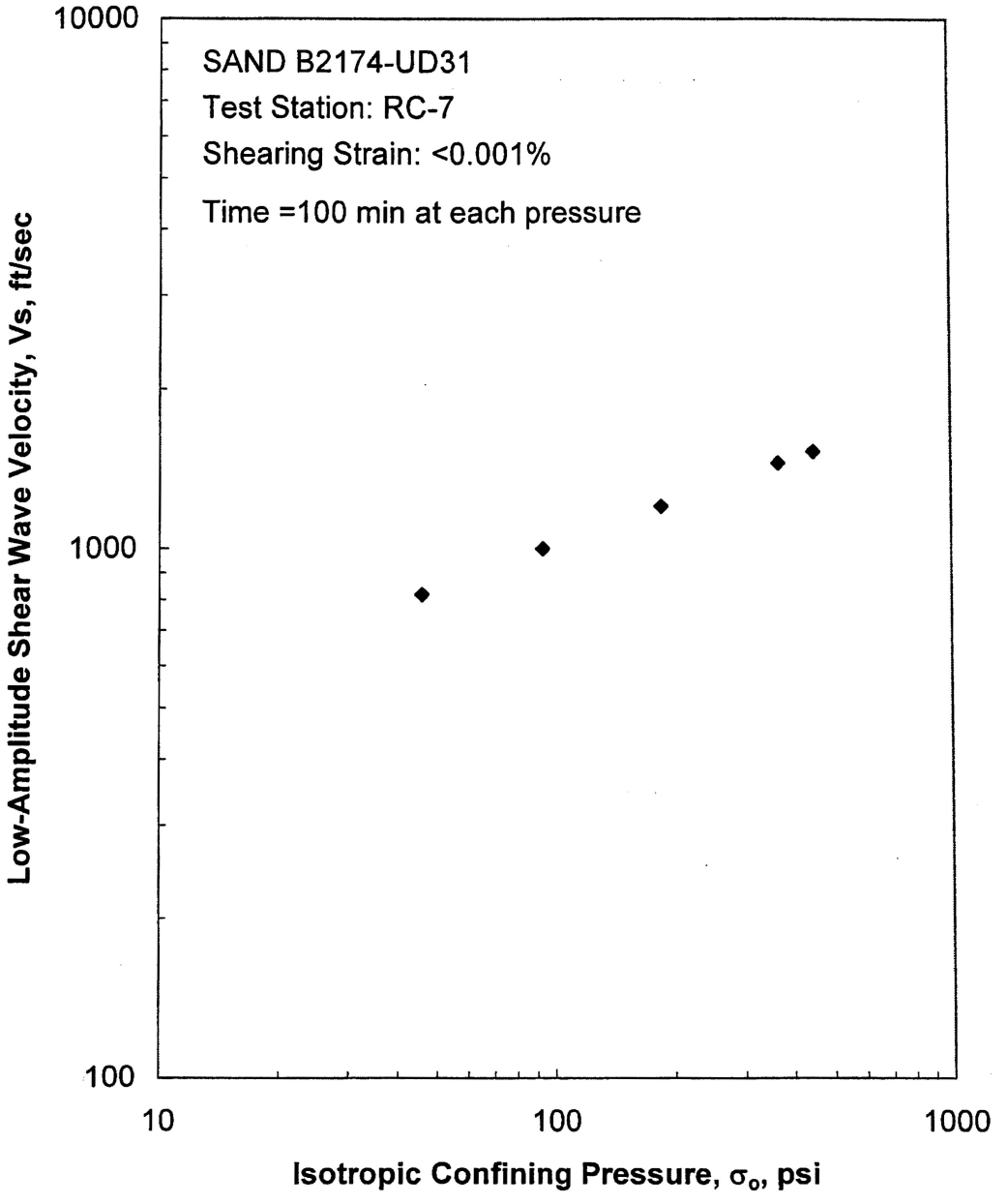

Figure L.4 Variation in Low-Amplitude Shear Wave Velocity with Isotropic Confining Pressure from Resonant Column Tests

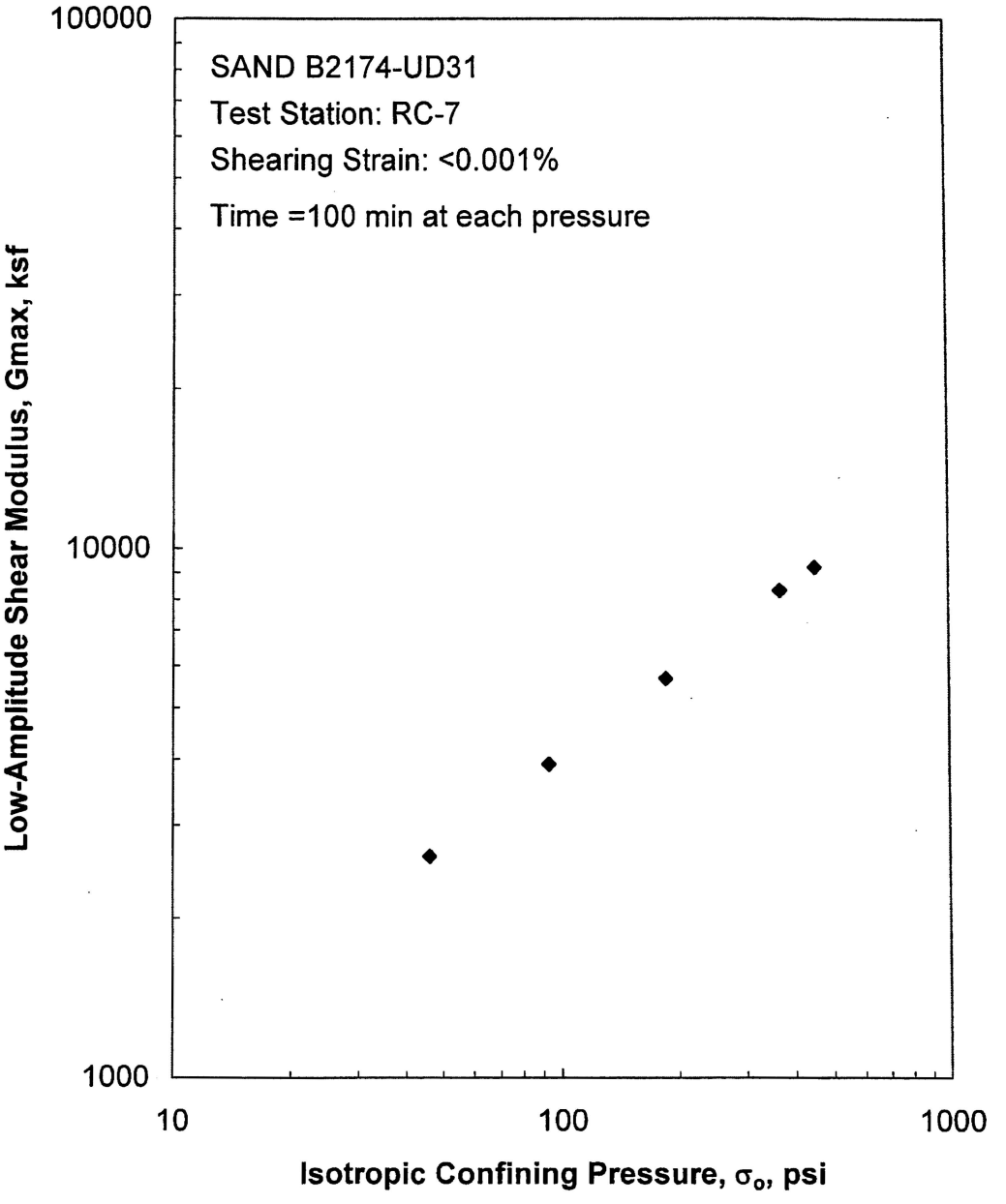

Figure L.5 Variation in Low-Amplitude Shear Modulus with Isotropic Confining Pressure from Resonant Column Tests

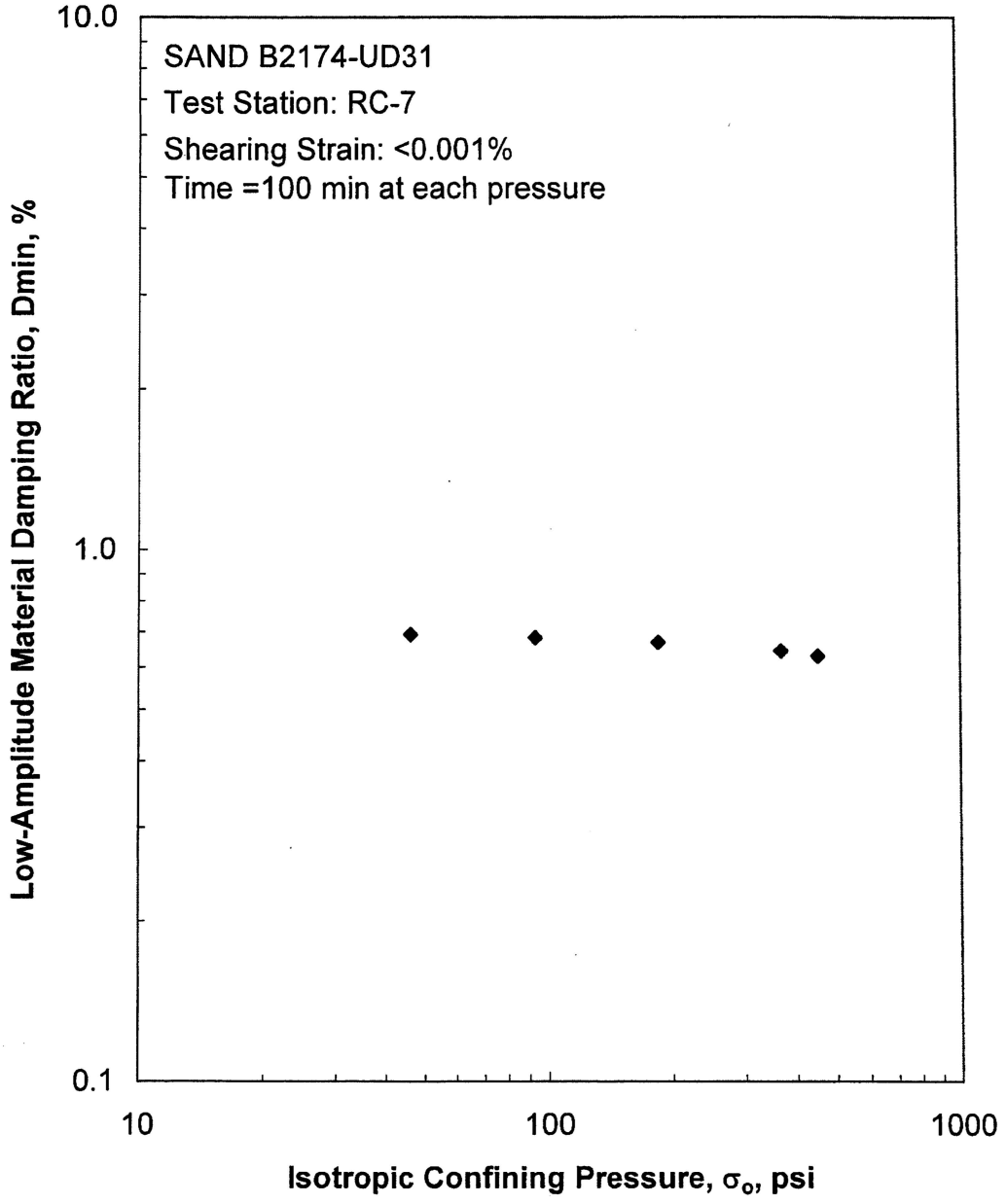

Figure L.6 Variation in Low-Amplitude Material Damping Ratio with Isotropic Confining Pressure from Resonant Column Tests

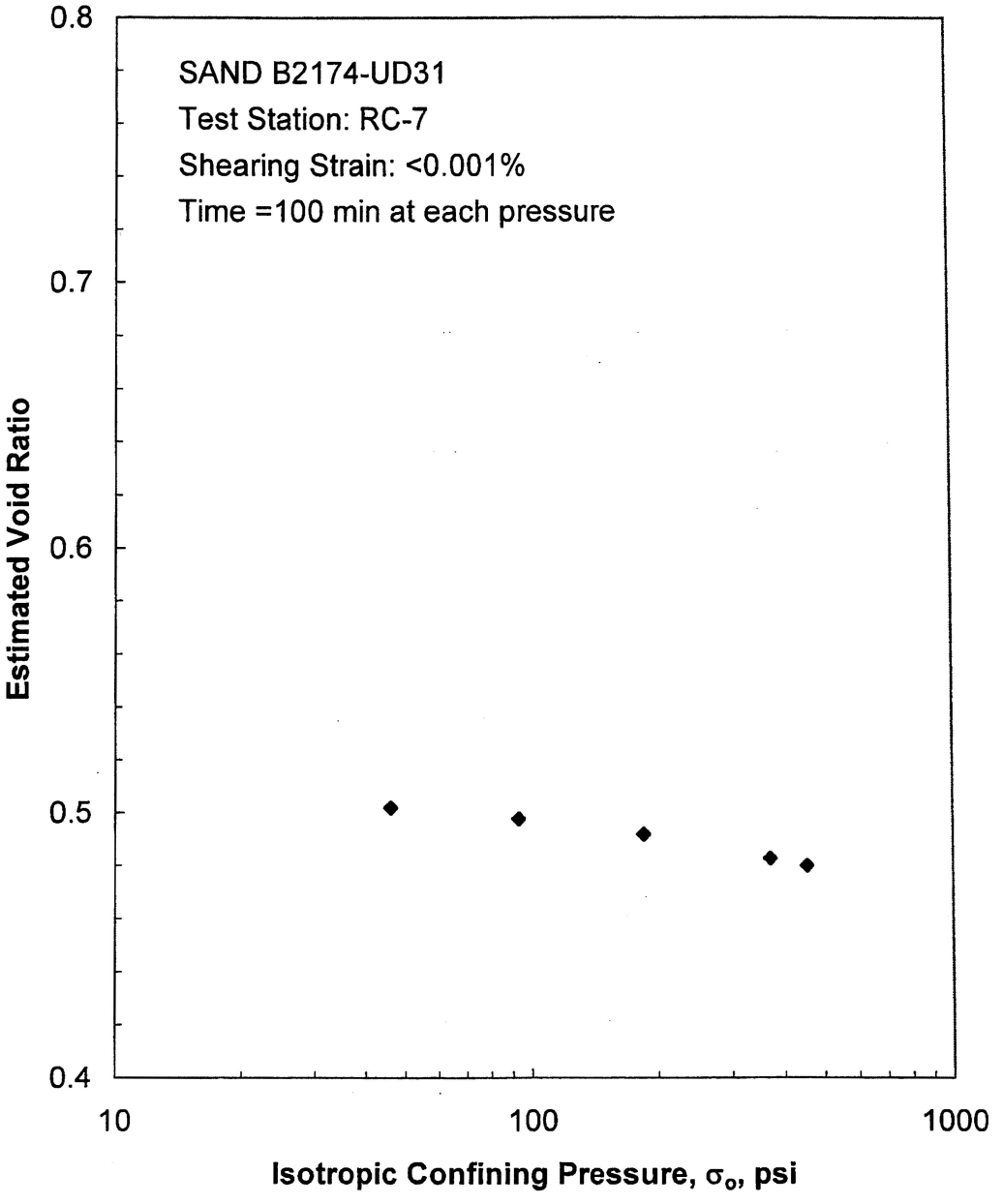

Figure L.7 Variation in Estimated Void Ratio with Isotropic Confining Pressure from Resonant Column Tests

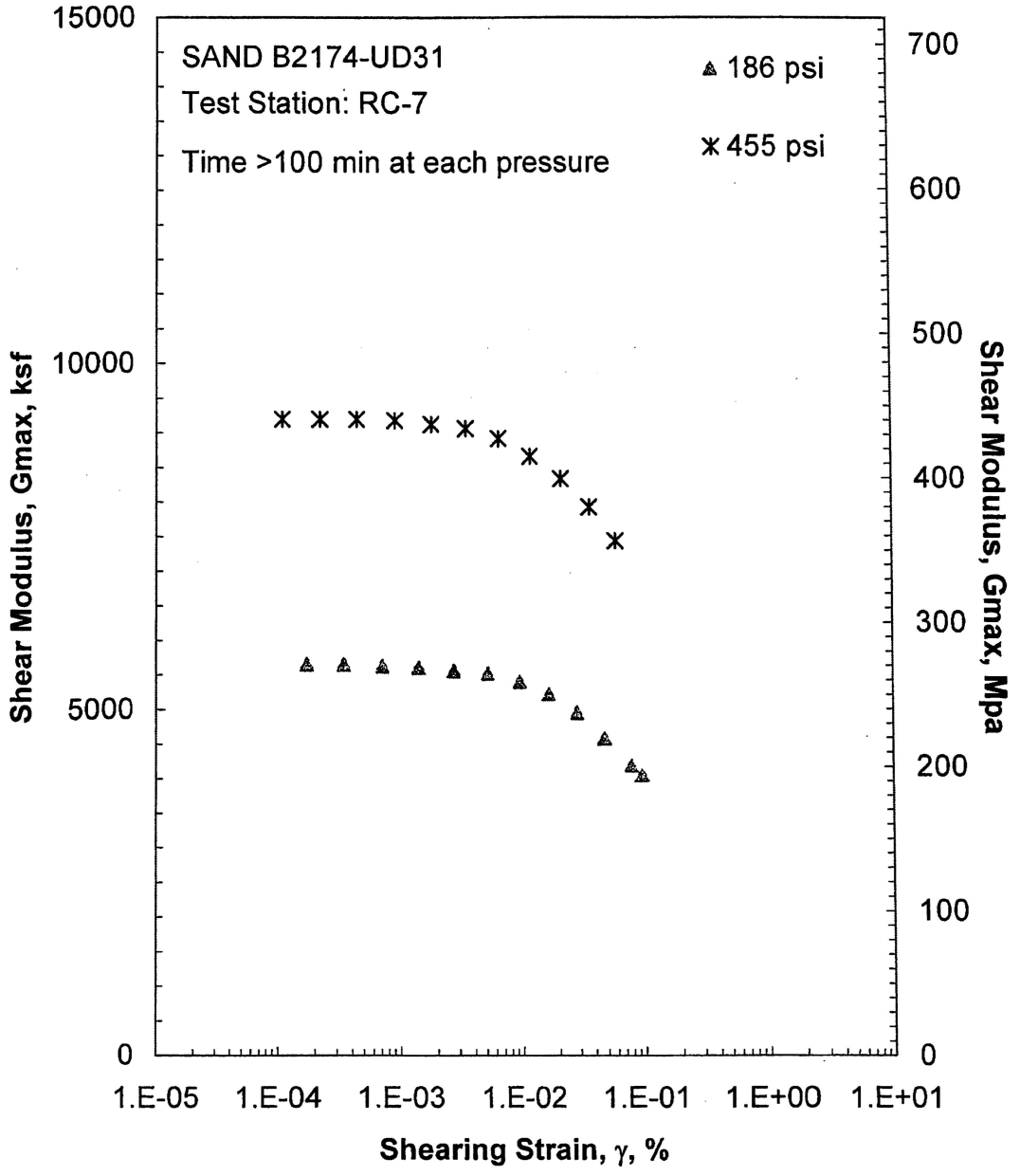

Figure L.8 Comparison of the Variation in Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

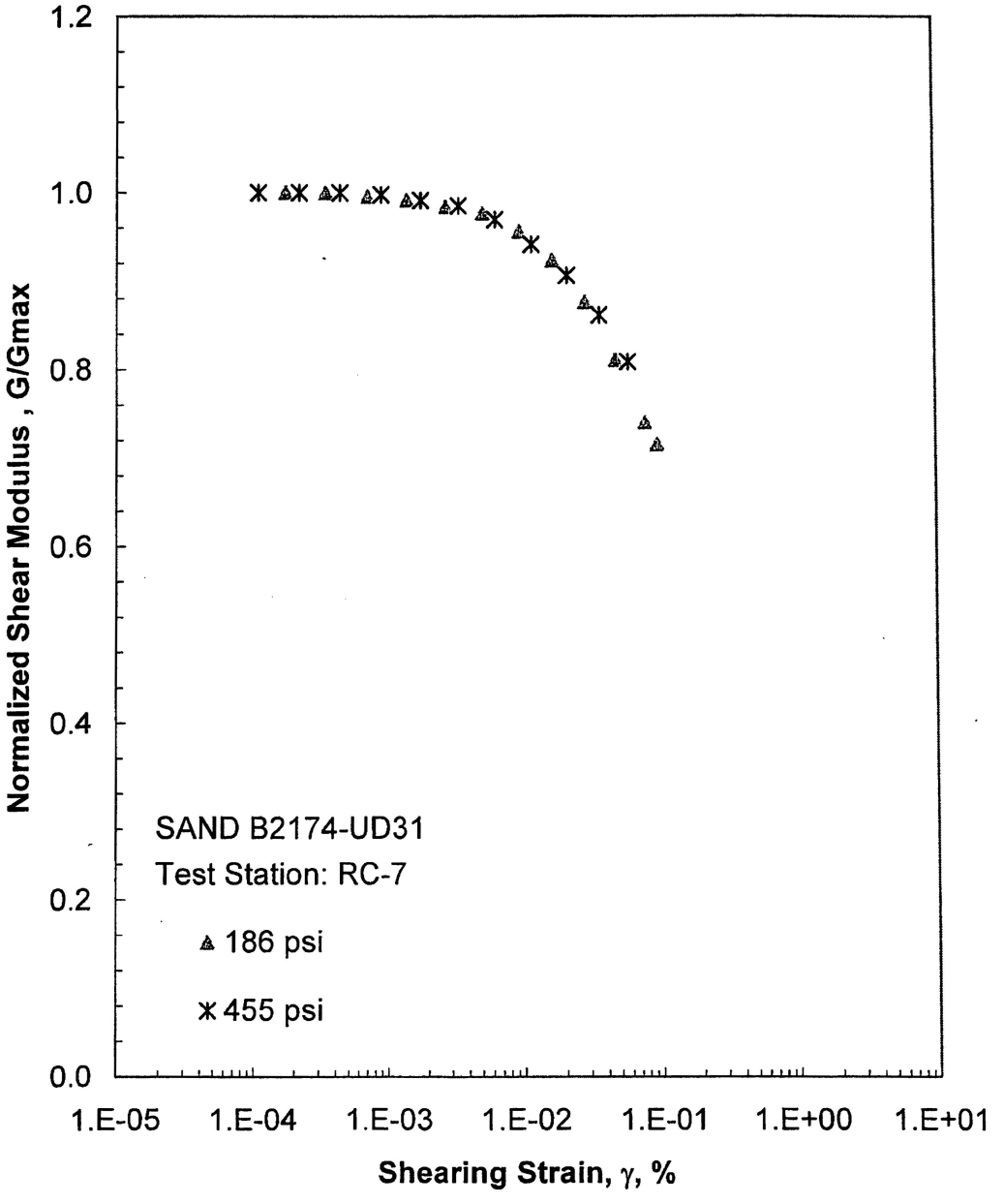

Figure L.9 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

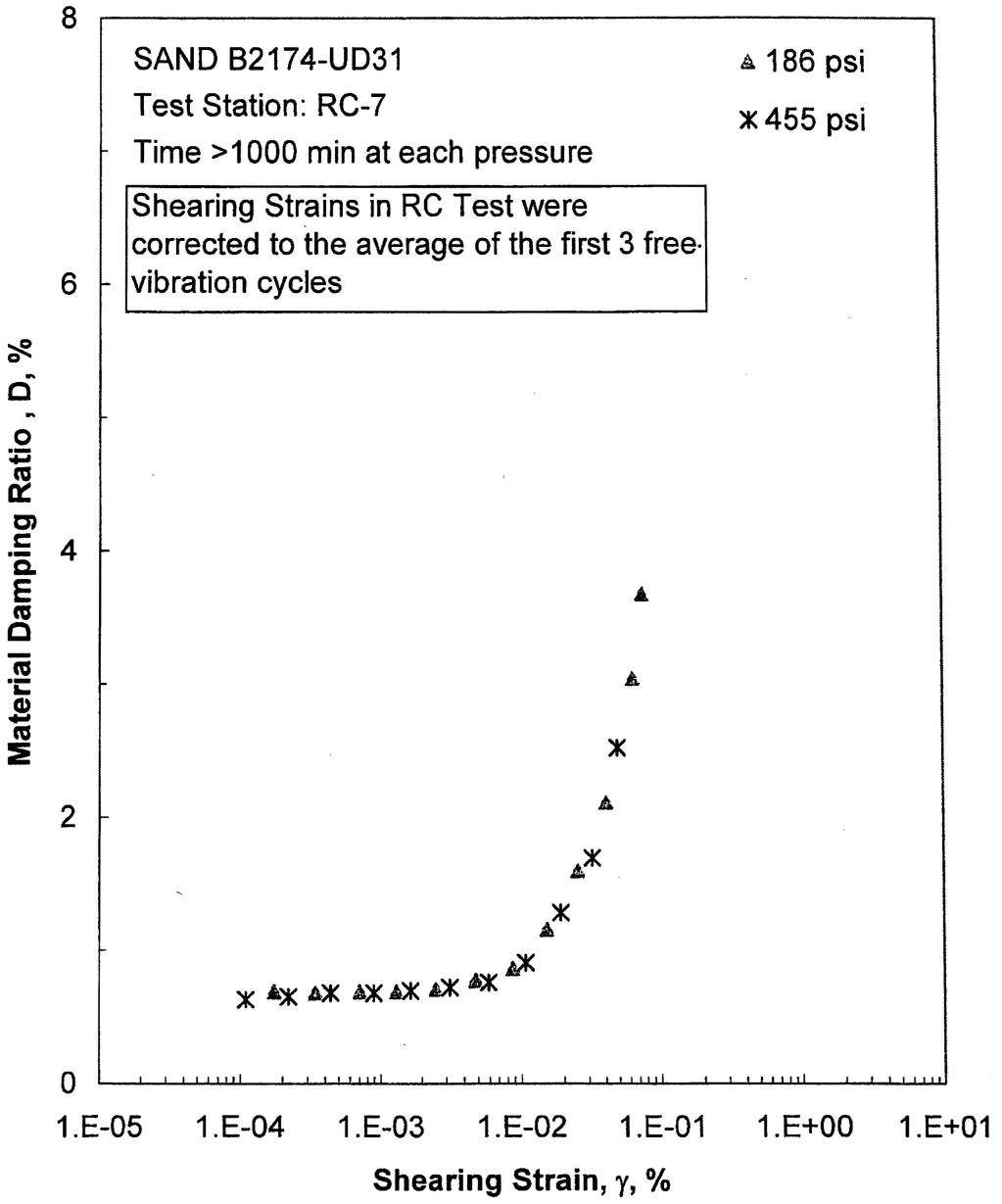

Figure L.10 Comparison of the Variation in Material Damping Ratio with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

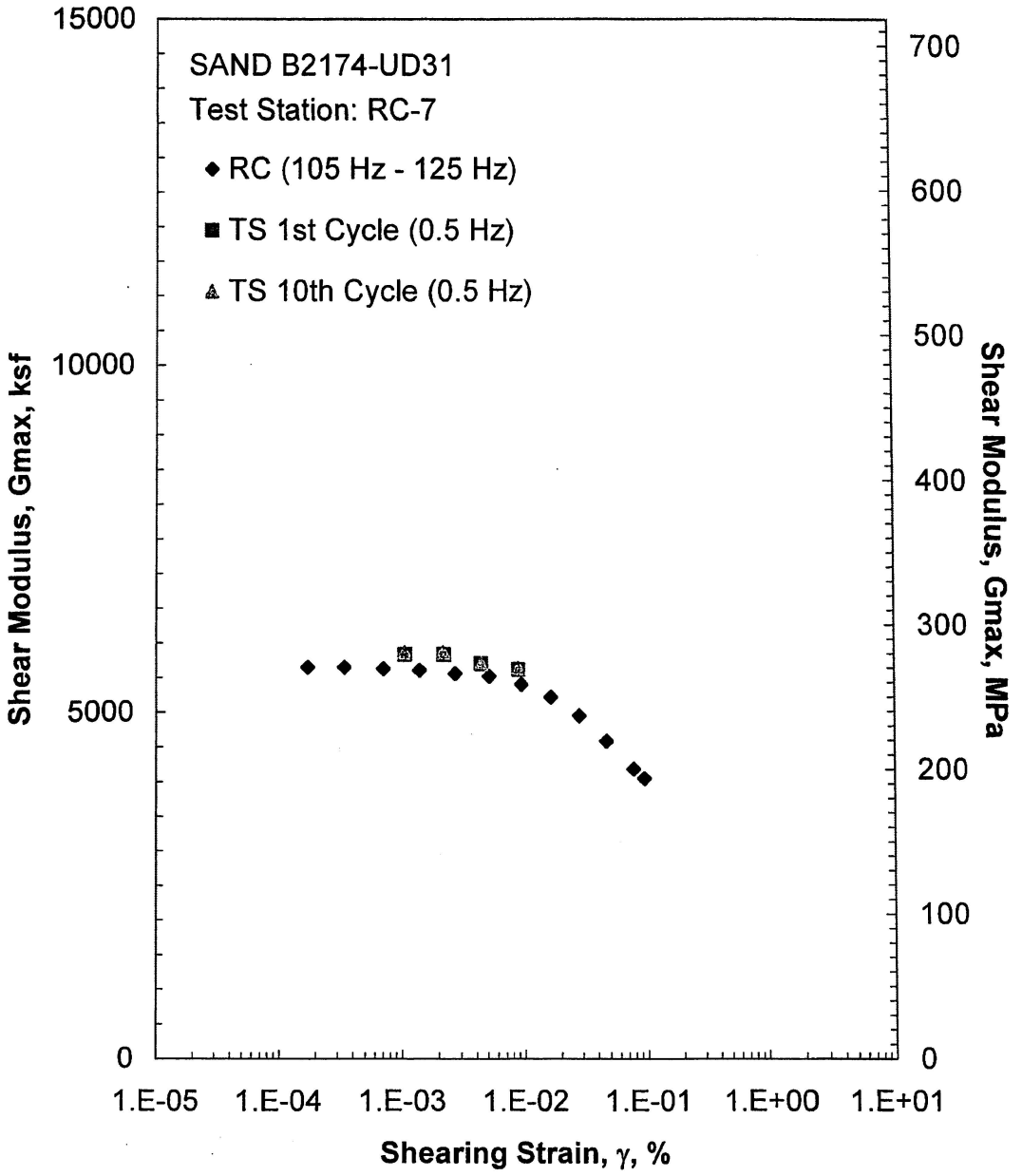

Figure L.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 186 psi from the Combined RCTS Tests

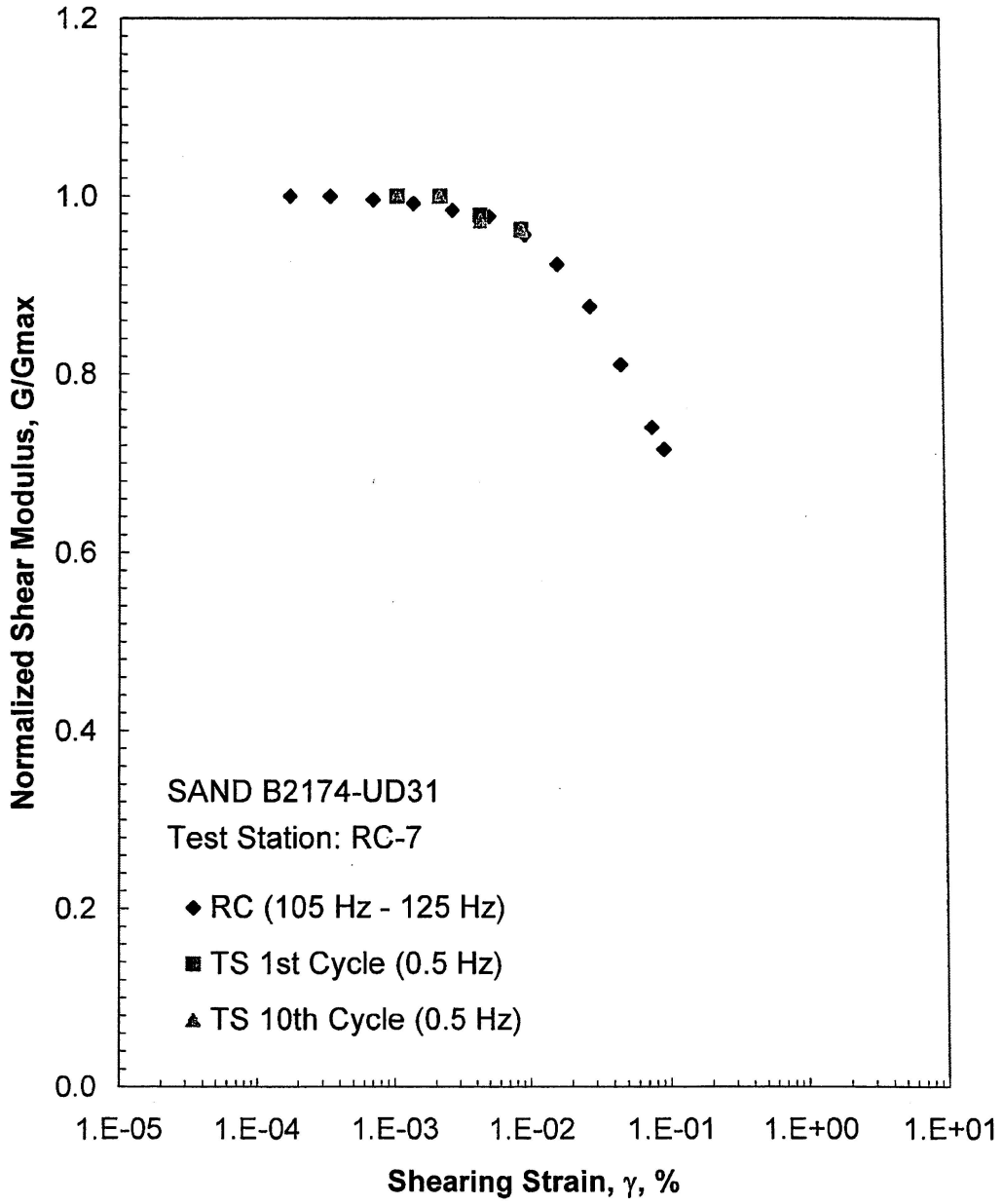

Figure L.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 186 psi from the Combined RCTS Tests

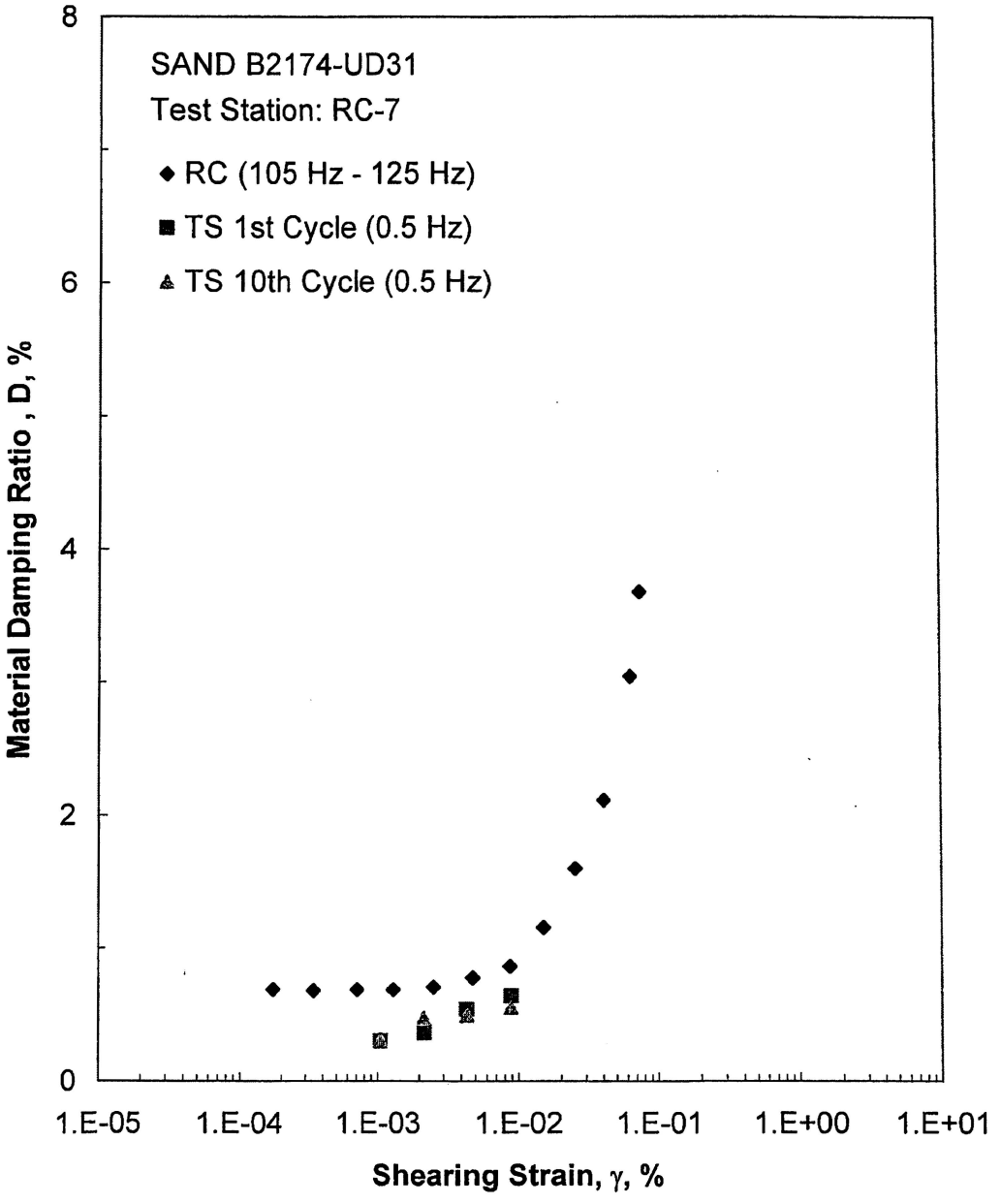

Figure L.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 186 psi from the Combined RCTS Tests

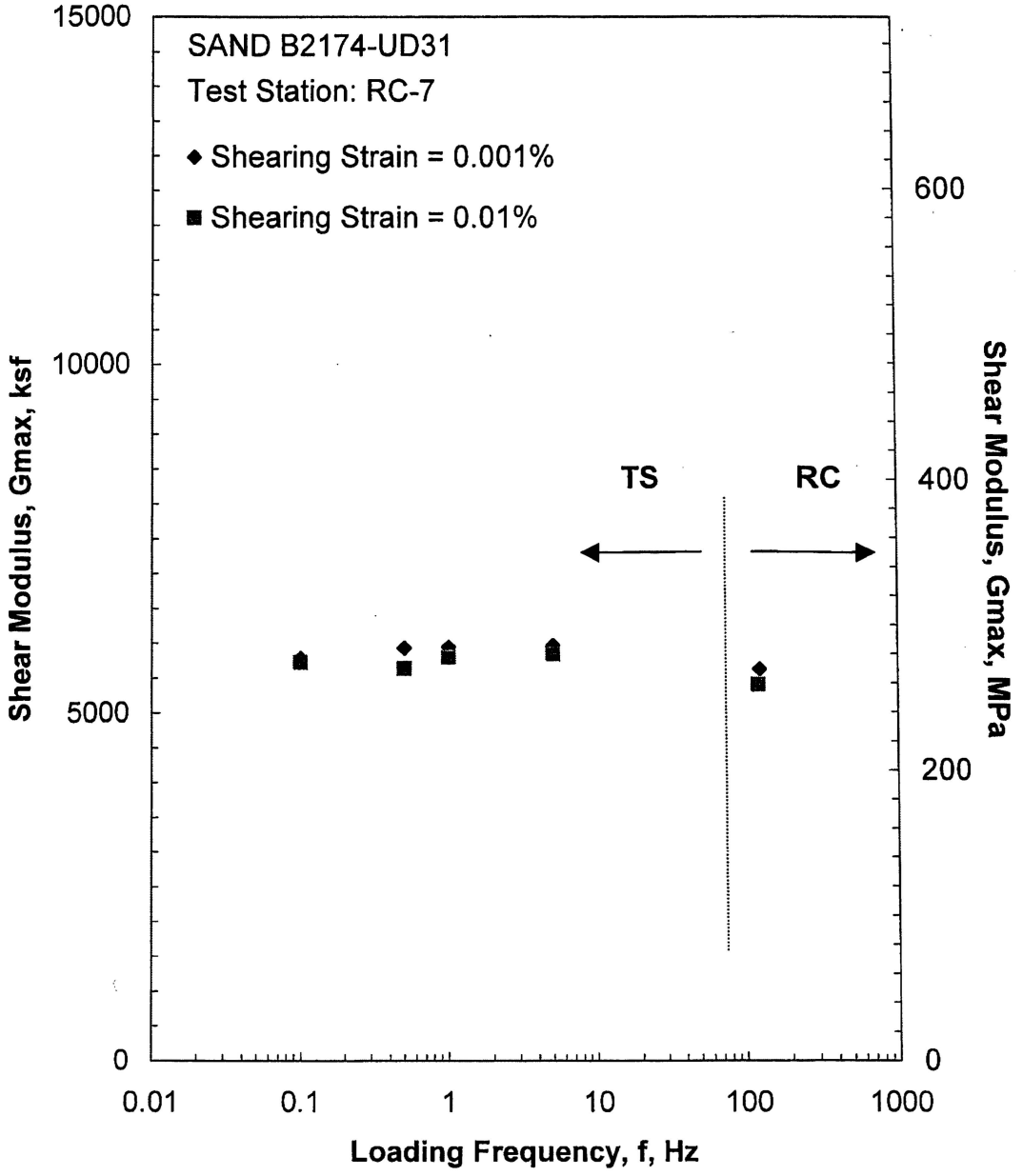

Figure L.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 186 psi from the Combined RCTS Tests

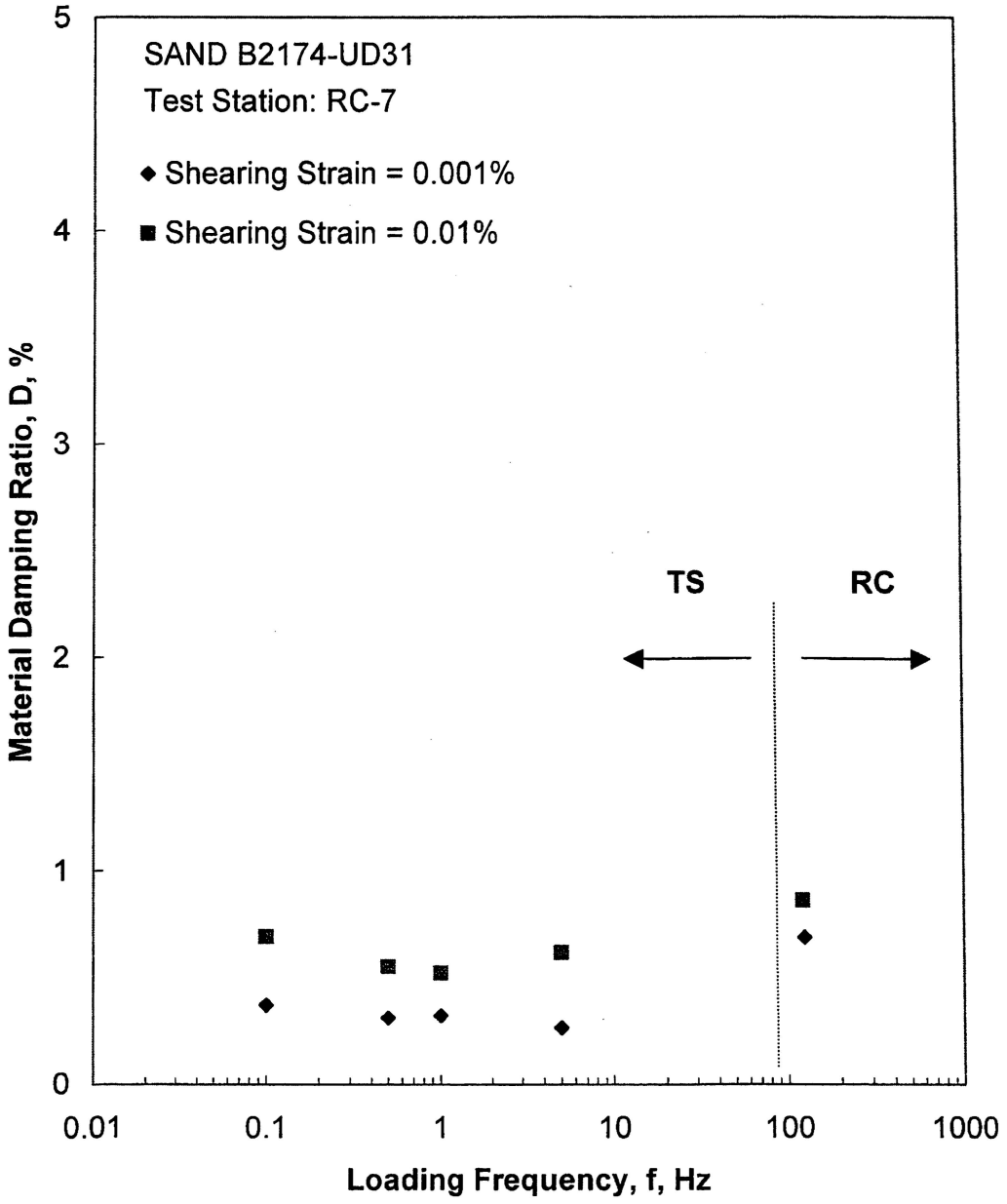

Figure L.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 186 psi from the Combined RCTS Tests

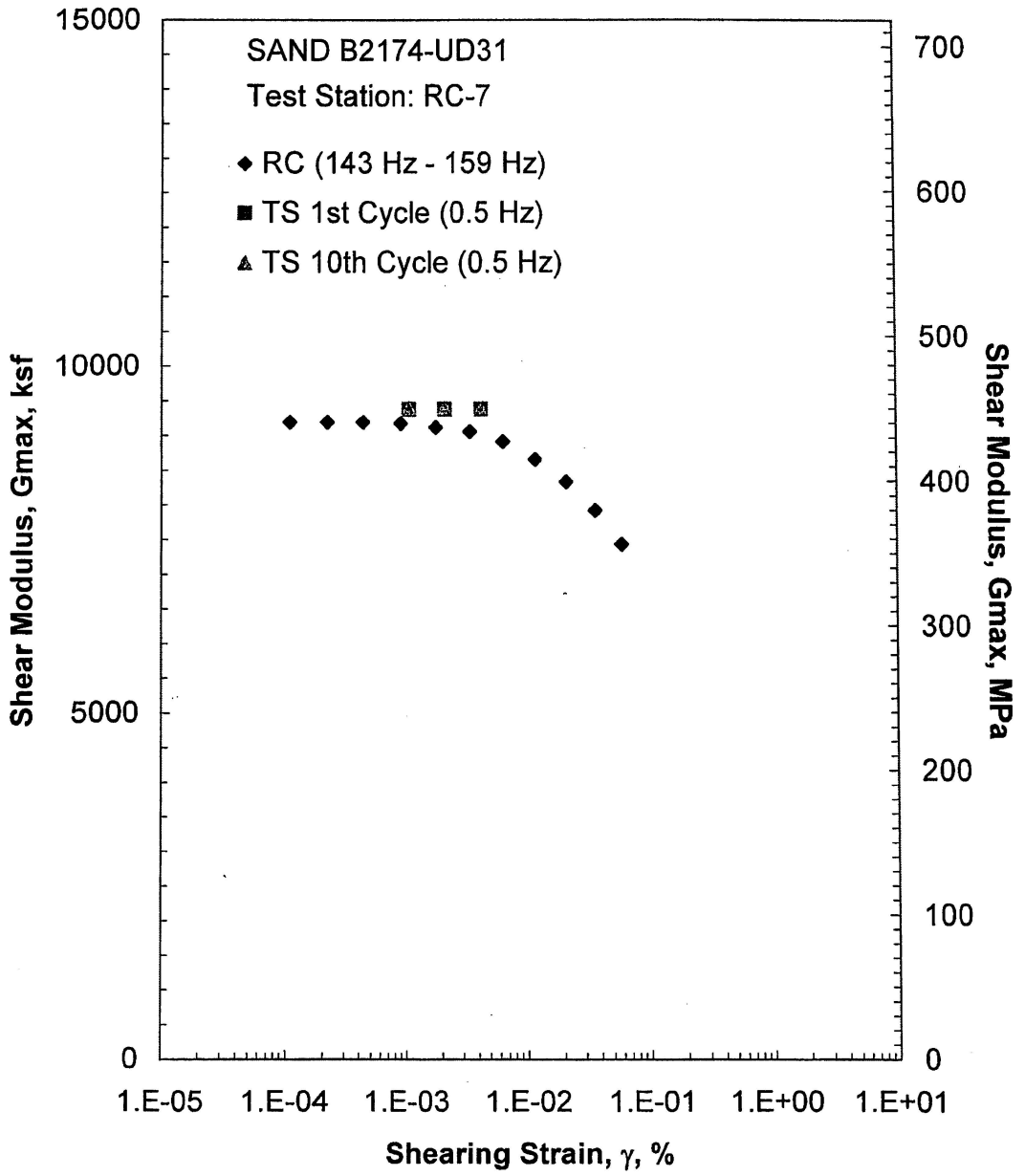

Figure L.16 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

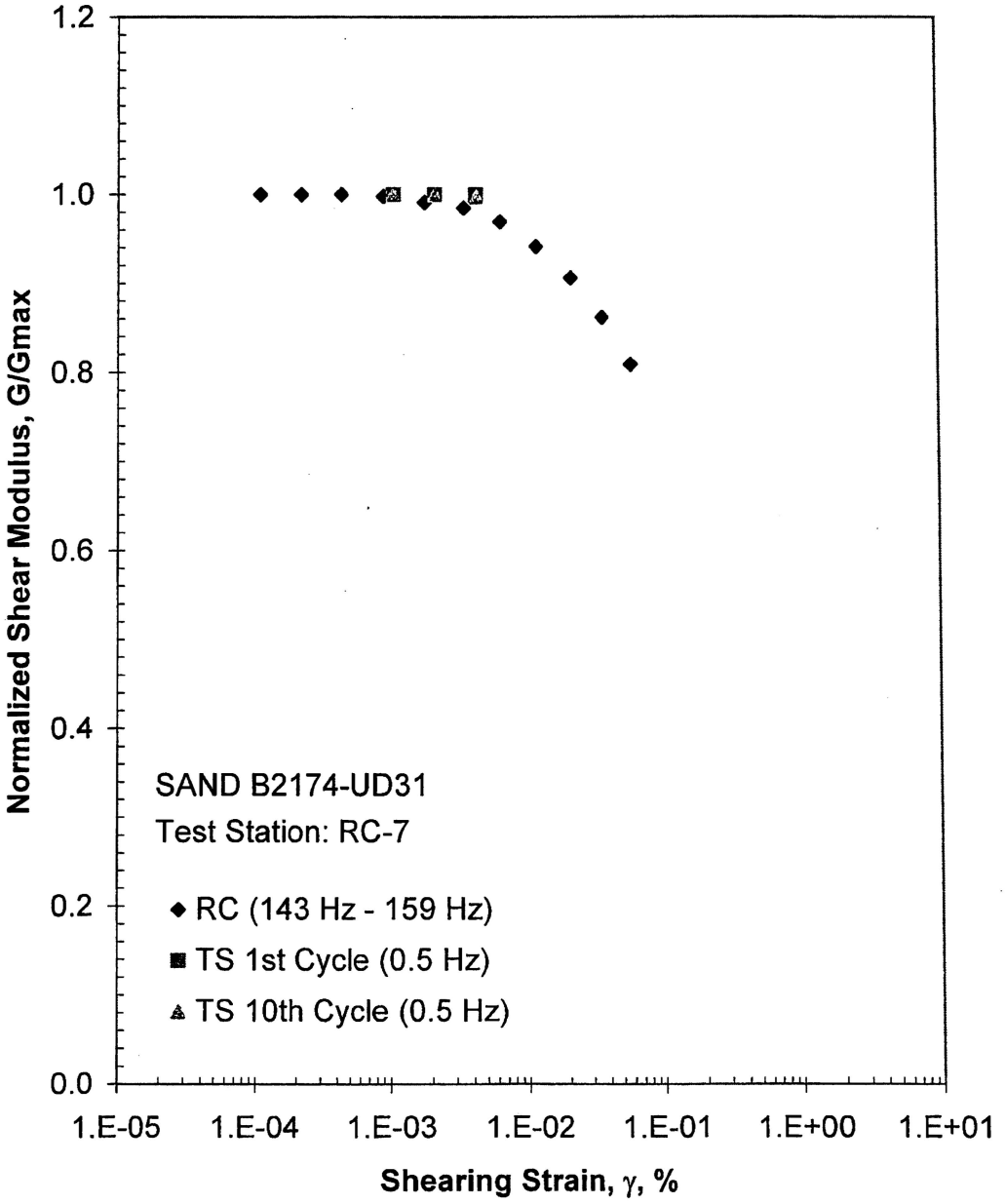

Figure L.17 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

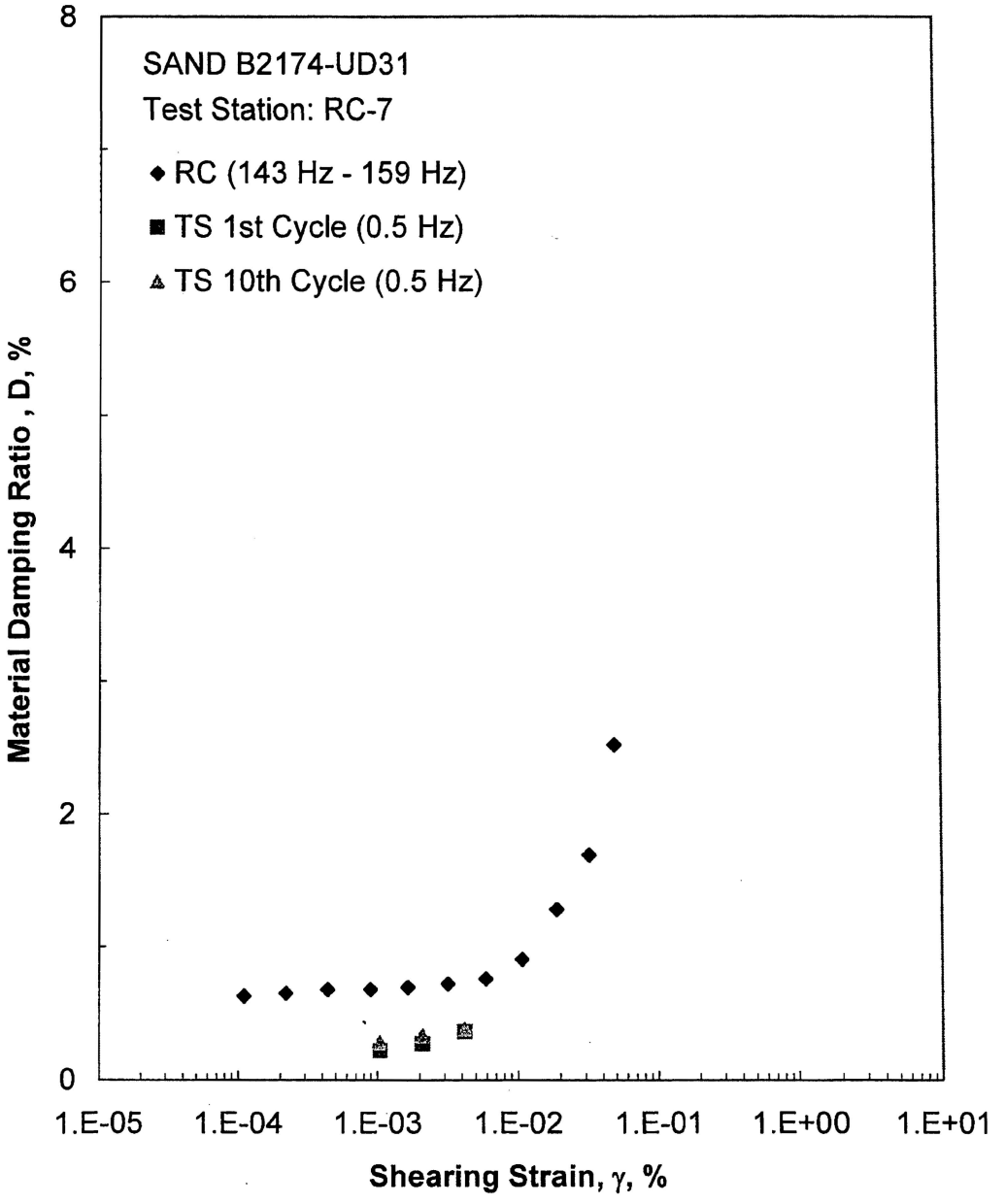

Figure L.18 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

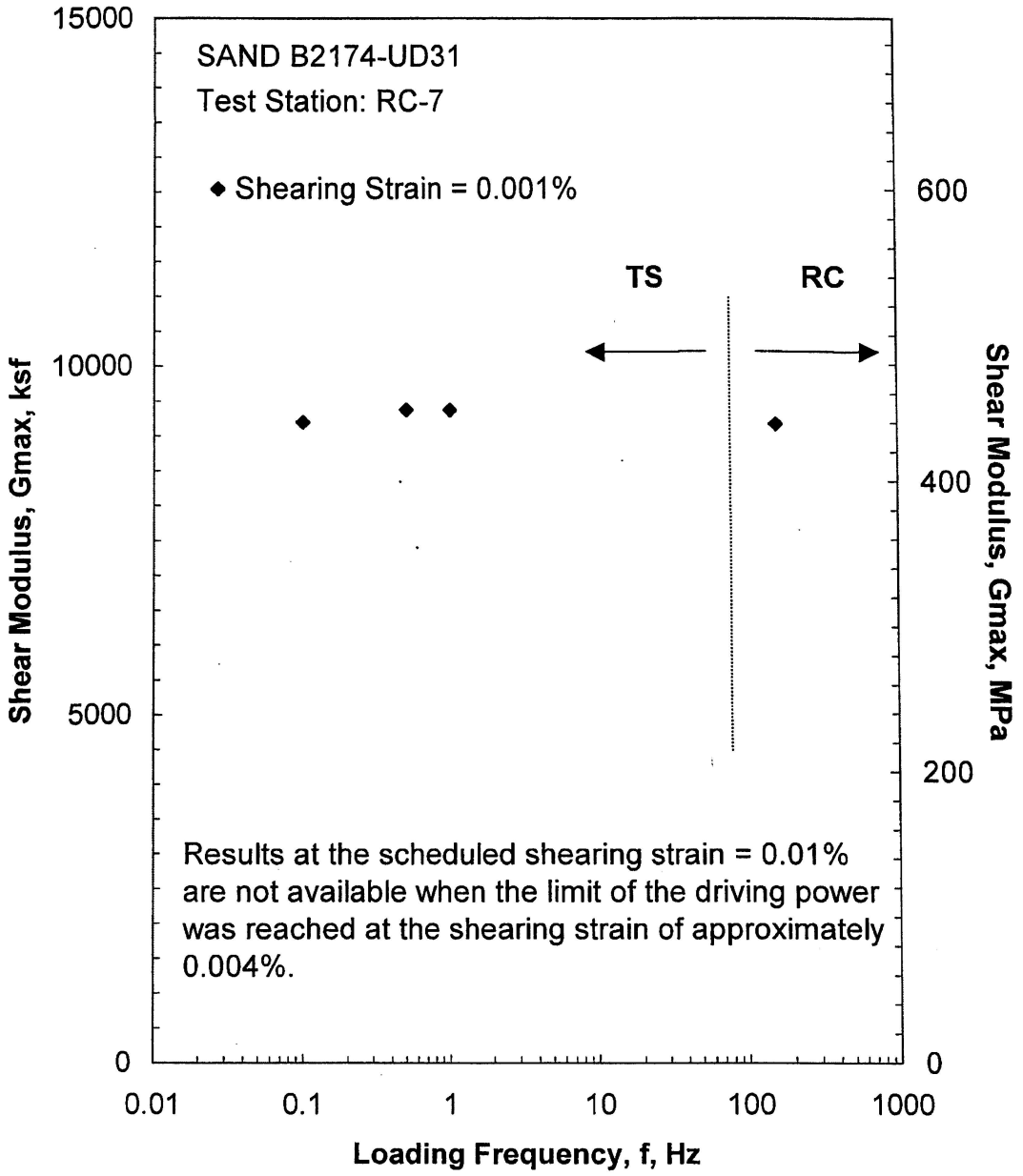

Figure L.19 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

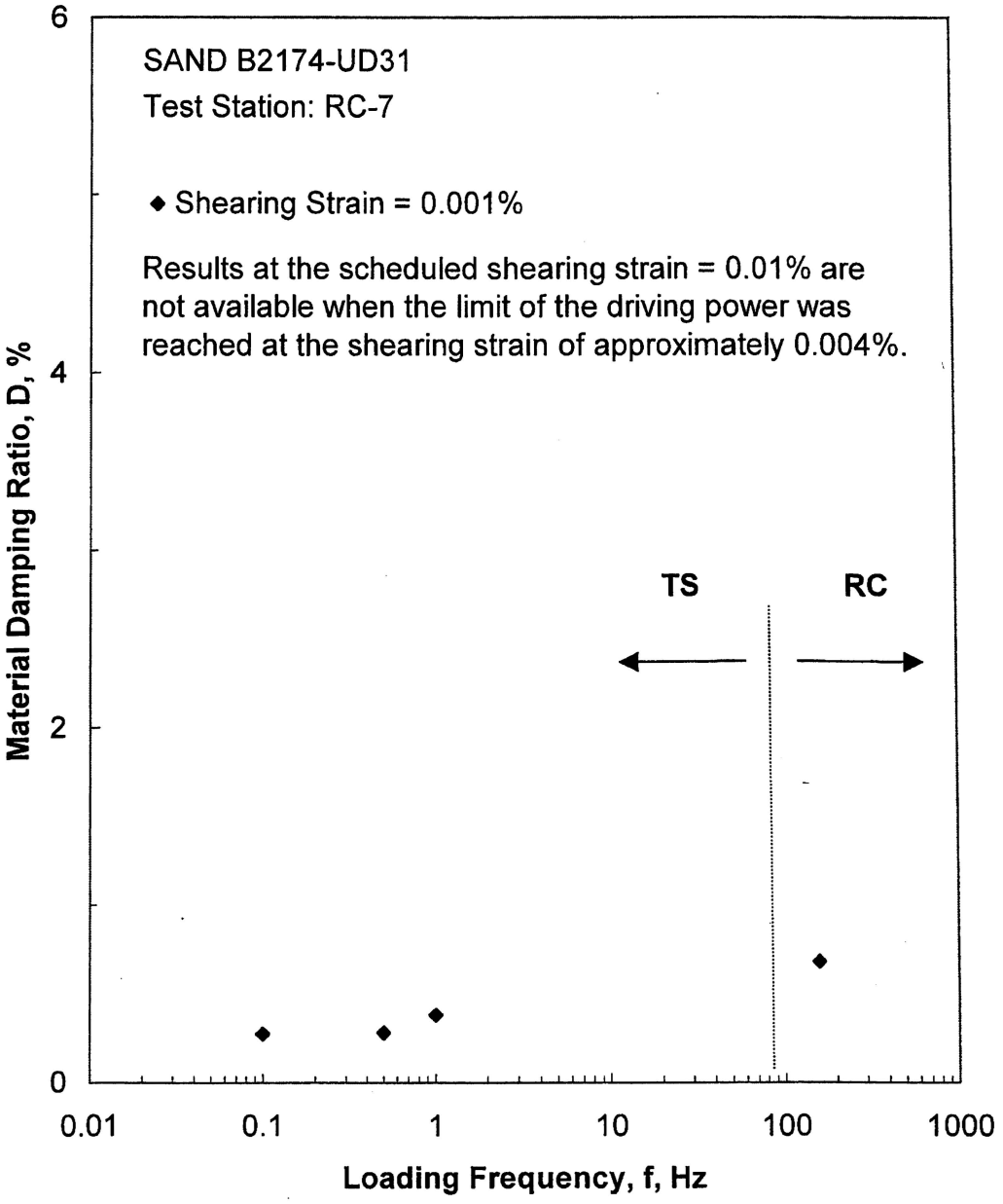

Figure L.20 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

Table L.1 Variation in Low-Amplitude Shear Wave Velocity, Low-Amplitude Shear Modulus, Low-Amplitude Material Damping Ratio and Estimated Void Ratio with Isotropic Confining Pressure from RC Tests of Specimen B2174-UD31

Isotropic Confining Pressure, σ_o			Low-Amplitude Shear Modulus, G_{max}		Low-Amplitude Shear Wave Velocity, Vs	Low-Amplitude Material Damping Ratio, Dmin	Estimated Void Ratio, e
(psi)	(psf)	(kPa)	(ksf)	(MPa)	(fps)	(%)	
46	6624	317	2620	126	819	0.69	0.50
93	13392	641	3910	188	999	0.68	0.50
186	26784	1282	5670	272	1201	0.67	0.49
371	53424	2556	8316	399	1449	0.64	0.48
455	65520	3135	9207	442	1524	0.63	0.48

Table L.2 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen B2174-UD31; Isoptropic Confining Pressure, σ_o= 186 psi (26.8 ksf = 1282 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
1.74E-04	5651	1.00	1.74E-04	0.69
3.43E-04	5651	1.00	3.43E-04	0.68
7.08E-04	5628	1.00	7.08E-04	0.69
1.39E-03	5605	0.99	1.30E-03	0.69
2.69E-03	5560	0.98	2.53E-03	0.71
5.11E-03	5518	0.98	4.80E-03	0.77
9.41E-03	5402	0.96	8.75E-03	0.86
1.65E-02	5217	0.92	1.51E-02	1.15
2.83E-02	4948	0.88	2.52E-02	1.59
4.73E-02	4580	0.81	4.06E-02	2.11
7.80E-02	4183	0.74	6.39E-02	3.04
9.51E-02	4042	0.72	7.52E-02	3.67

[+] Average Shearing Strain from the First Three Cycles of the Free Vibration Decay Curve

[x] Average Damping Ratio from the First Three Cycles of the Free Vibration Decay Curve

Table L.3 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen B2174-UD31; Isotropic Confining Pressure, σ_o= 186 psi (26.8 ksf =1282 kPa)

First Cycle				Tenth Cycle			
Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %	Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %
1.06E-03	5833	1.00	0.30	1.05E-03	5864	1.00	0.31
2.18E-03	5833	1.00	0.36	2.16E-03	5864	1.00	0.47
4.39E-03	5706	0.98	0.54	4.39E-03	5698	0.97	0.49
8.92E-03	5614	0.96	0.64	8.89E-03	5638	0.96	0.55

Table L.4 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen B2174-UD31; Isoptropic Confining Pressure, σ_o= 455 psi (65.5 ksf = 3135 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
1.10E-04	9195	1.00	1.10E-04	0.63
2.20E-04	9195	1.00	2.20E-04	0.65
4.37E-04	9195	1.00	4.37E-04	0.68
8.96E-04	9176	1.00	8.96E-04	0.68
1.76E-03	9117	0.99	1.66E-03	0.69
3.39E-03	9059	0.99	3.18E-03	0.72
6.30E-03	8914	0.97	5.92E-03	0.76
1.16E-02	8658	0.94	1.08E-02	0.90
2.09E-02	8333	0.91	1.90E-02	1.28
3.61E-02	7922	0.86	3.22E-02	1.69
5.87E-02	7436	0.81	4.93E-02	2.52

[+] Average Shearing Strain from the First Three Cycles of the Free Vibration Decay Curve

[x] Average Damping Ratio from the First Three Cycles of the Free Vibration Decay Curve

Table L.5 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen B2174-UD31; Isotropic Confining Pressure, σ_o=455 psi (65.5 ksf = 3135 kPa)

First Cycle				Tenth Cycle			
Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %	Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %
1.05E-03	9382	1.00	0.22	1.05E-03	9400	1.00	0.28
2.09E-03	9382	1.00	0.27	2.09E-03	9400	1.00	0.33
4.18E-03	9382	1.00	0.36	4.20E-03	9382	1.00	0.38

APPENDIX M

Specimen B2174-UD30
(Index properties not available)

Borehole B2174
Sample UD30
Depth = 571.6 ft (174.2 m)
Total Unit Weight = 126.4 lb/ft^3
Water Content = 23.1 %
Estimated In-Situ Ko = 0.5
Estimated In-Situ Mean Effective
Stress = 180 psi

FUGRO JOB #: 0411-08-1686
Testing Station: RC9

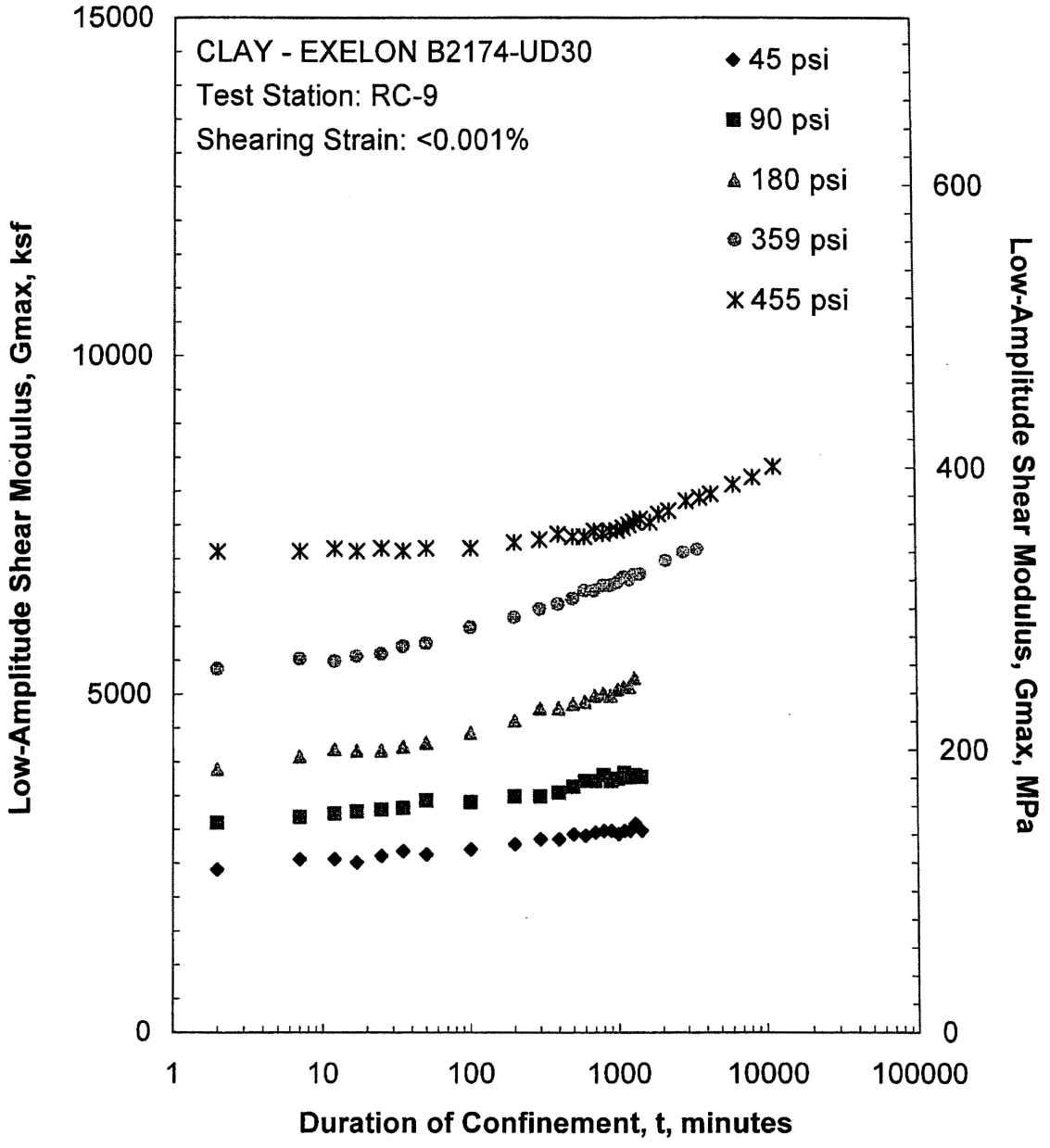

Figure M.1 Variation in Low-Amplitude Shear Modulus with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

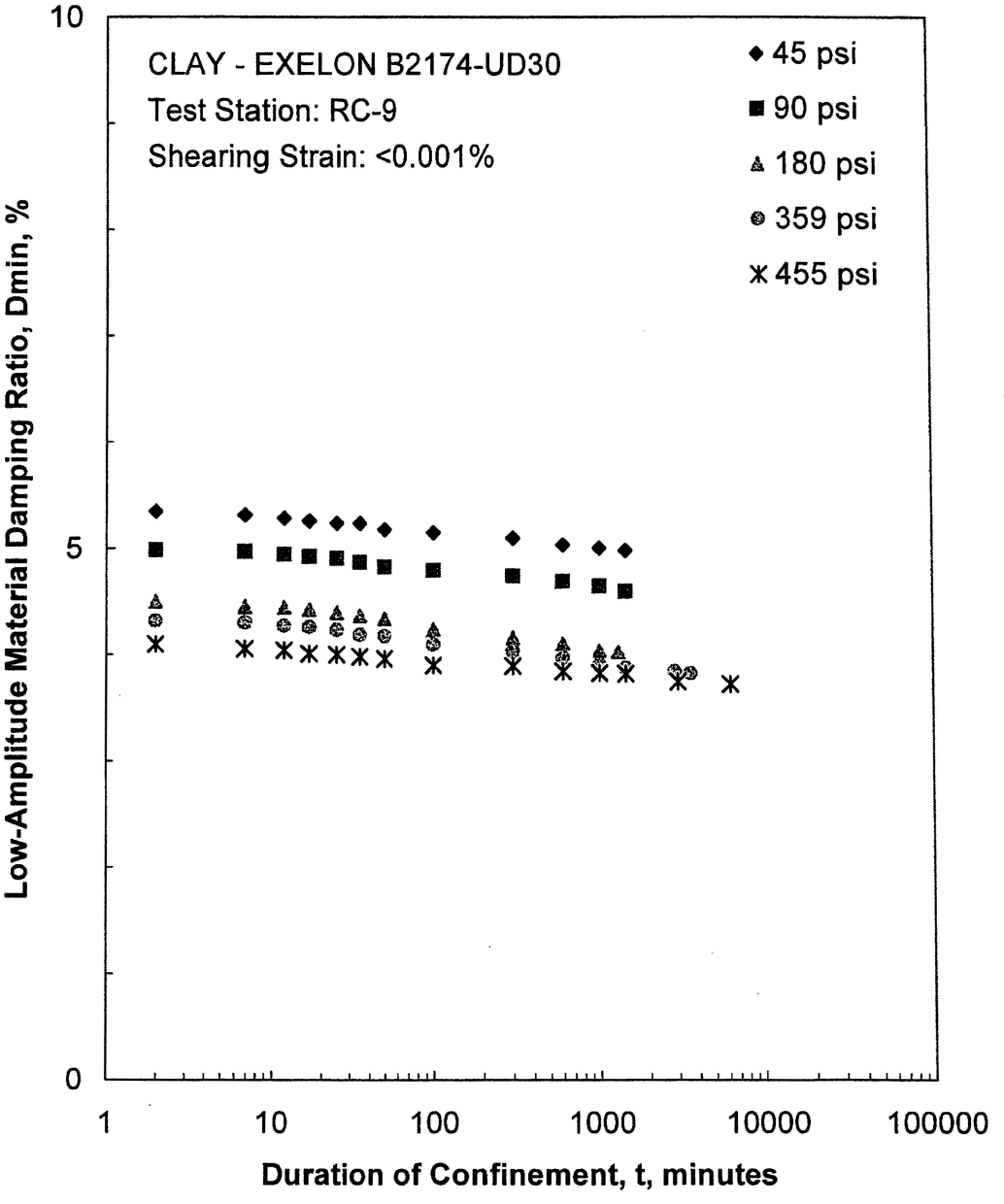

Figure M.2 Variation in Low-Amplitude Material Damping Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

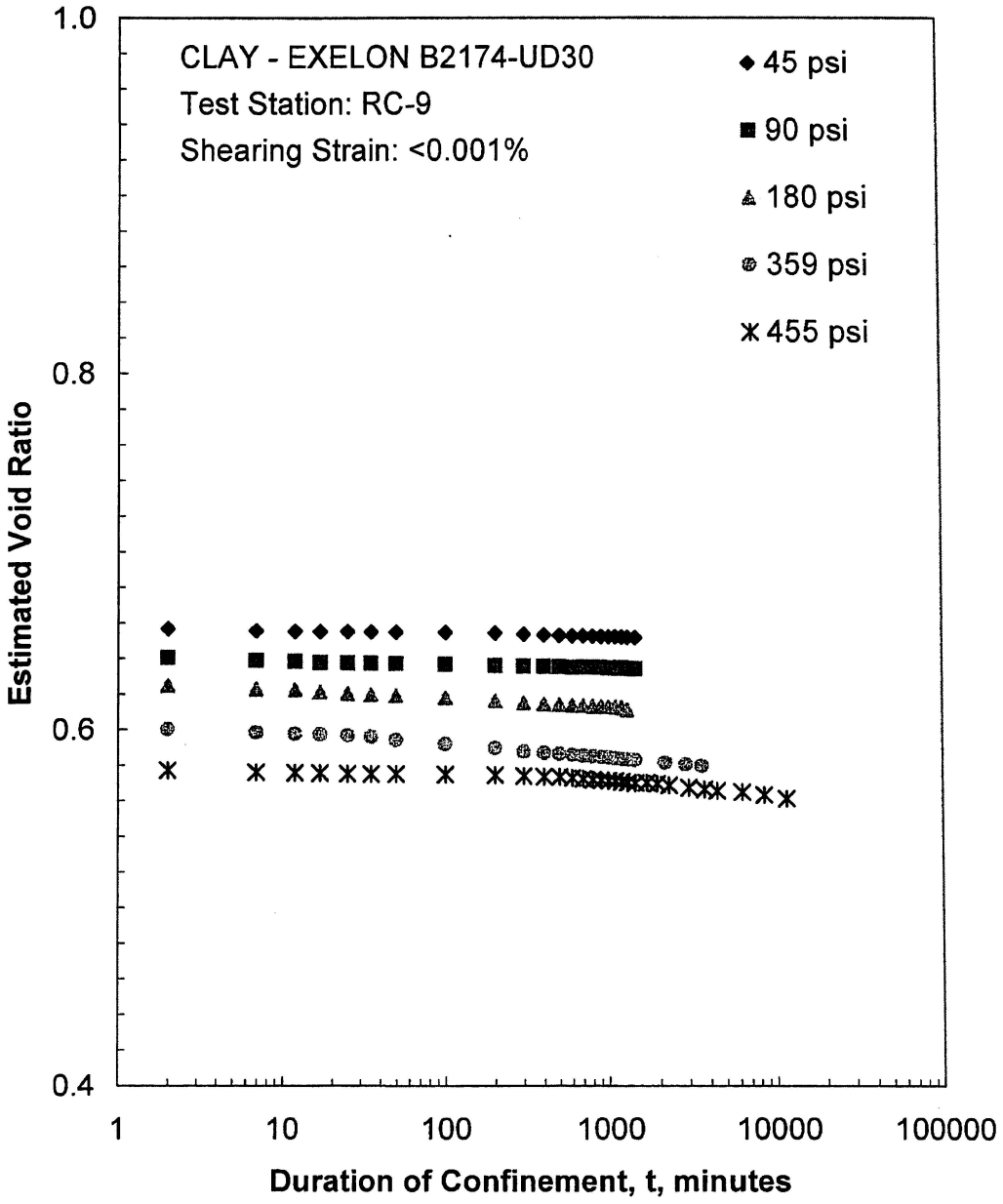

Figure M.3 Variation in Estimated Void Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

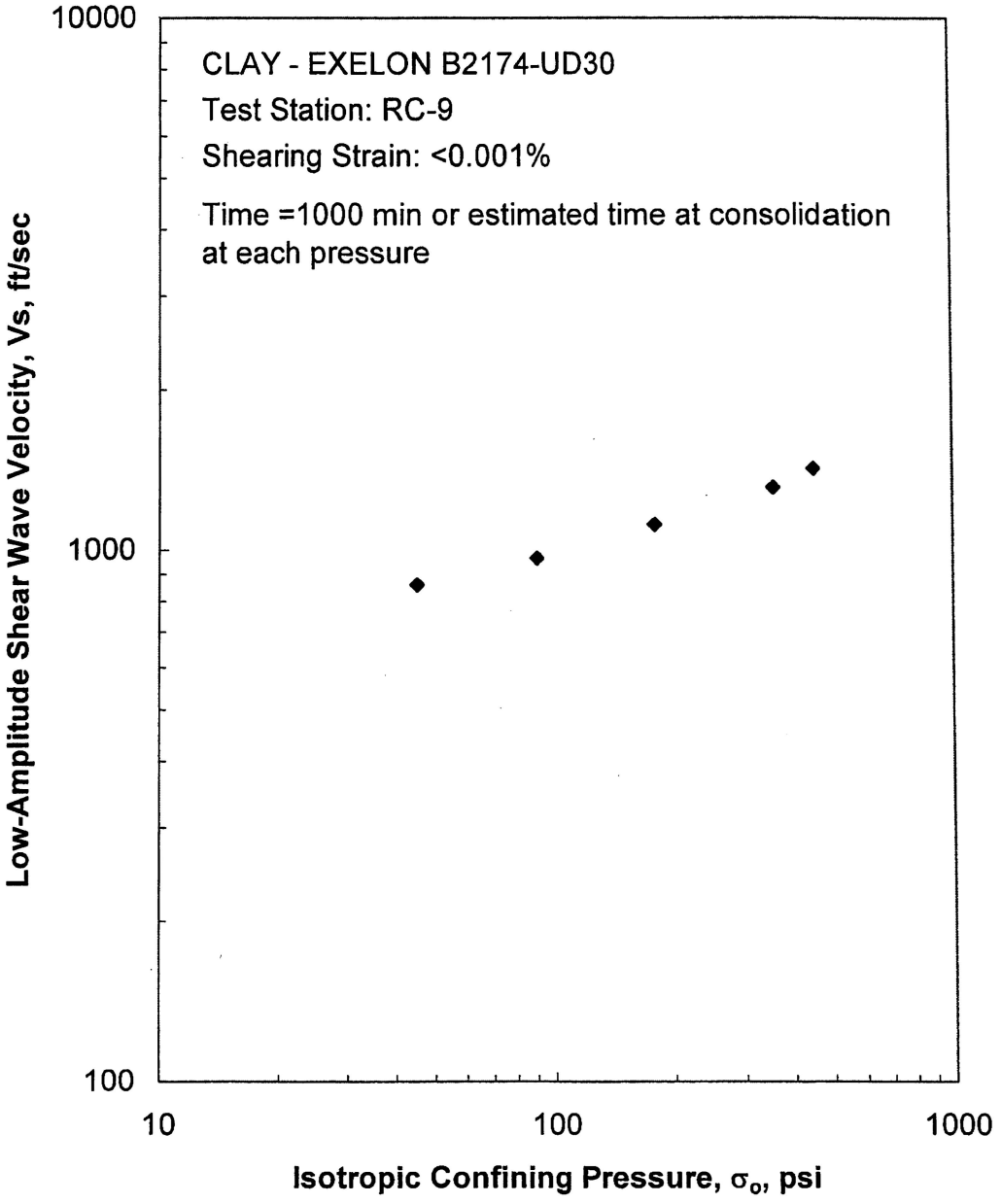

Figure M.4 Variation in Low-Amplitude Shear Wave Velocity with Isotropic Confining Pressure from Resonant Column Tests

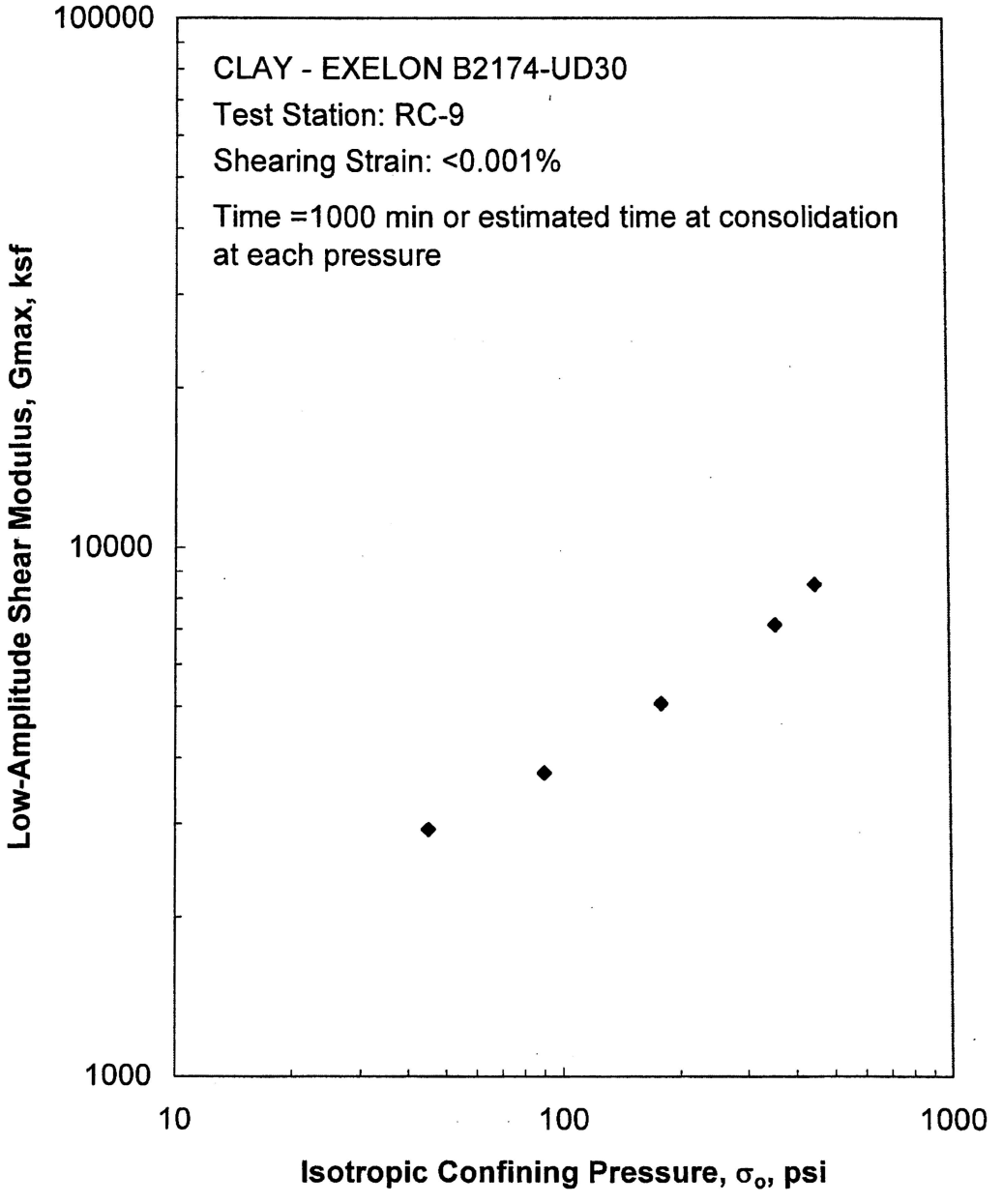

Figure M.5 Variation in Low-Amplitude Shear Modulus with Isotropic Confining Pressure from Resonant Column Tests

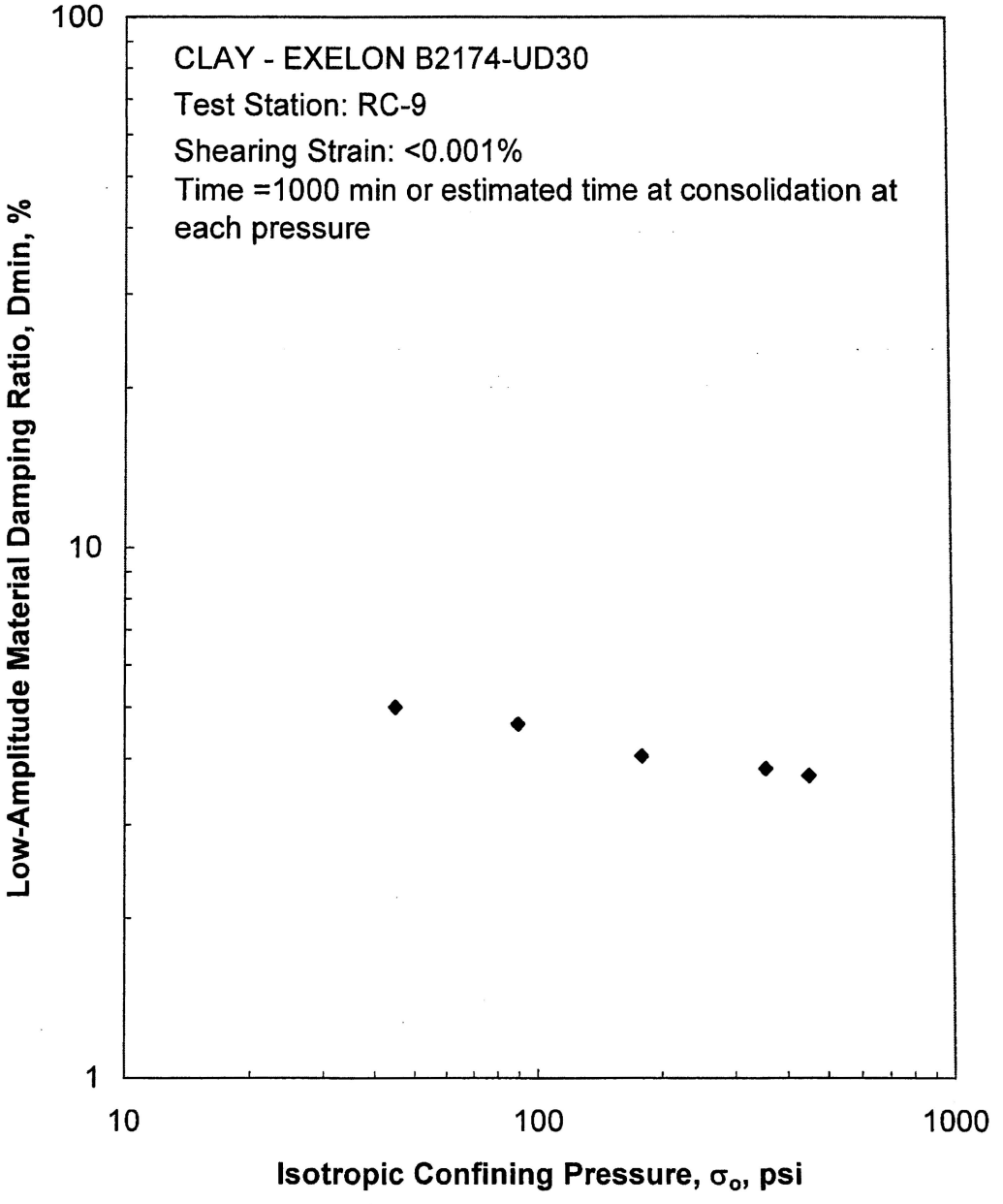

Figure M.6 Variation in Low-Amplitude Material Damping Ratio with Isotropic Confining Pressure from Resonant Column Tests

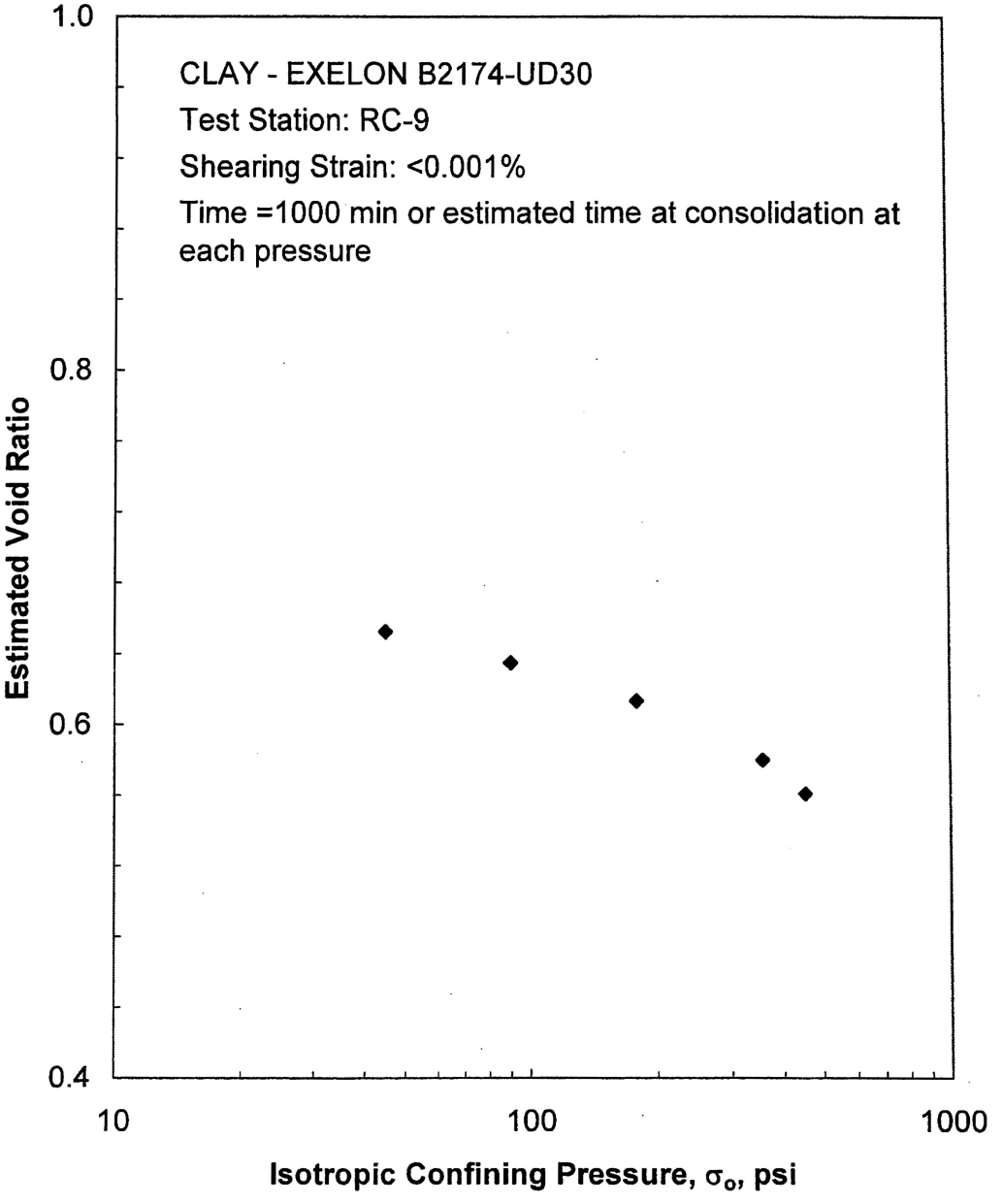

Figure M.7 Variation in Estimated Void Ratio with Isotropic Confining Pressure from Resonant Column Tests

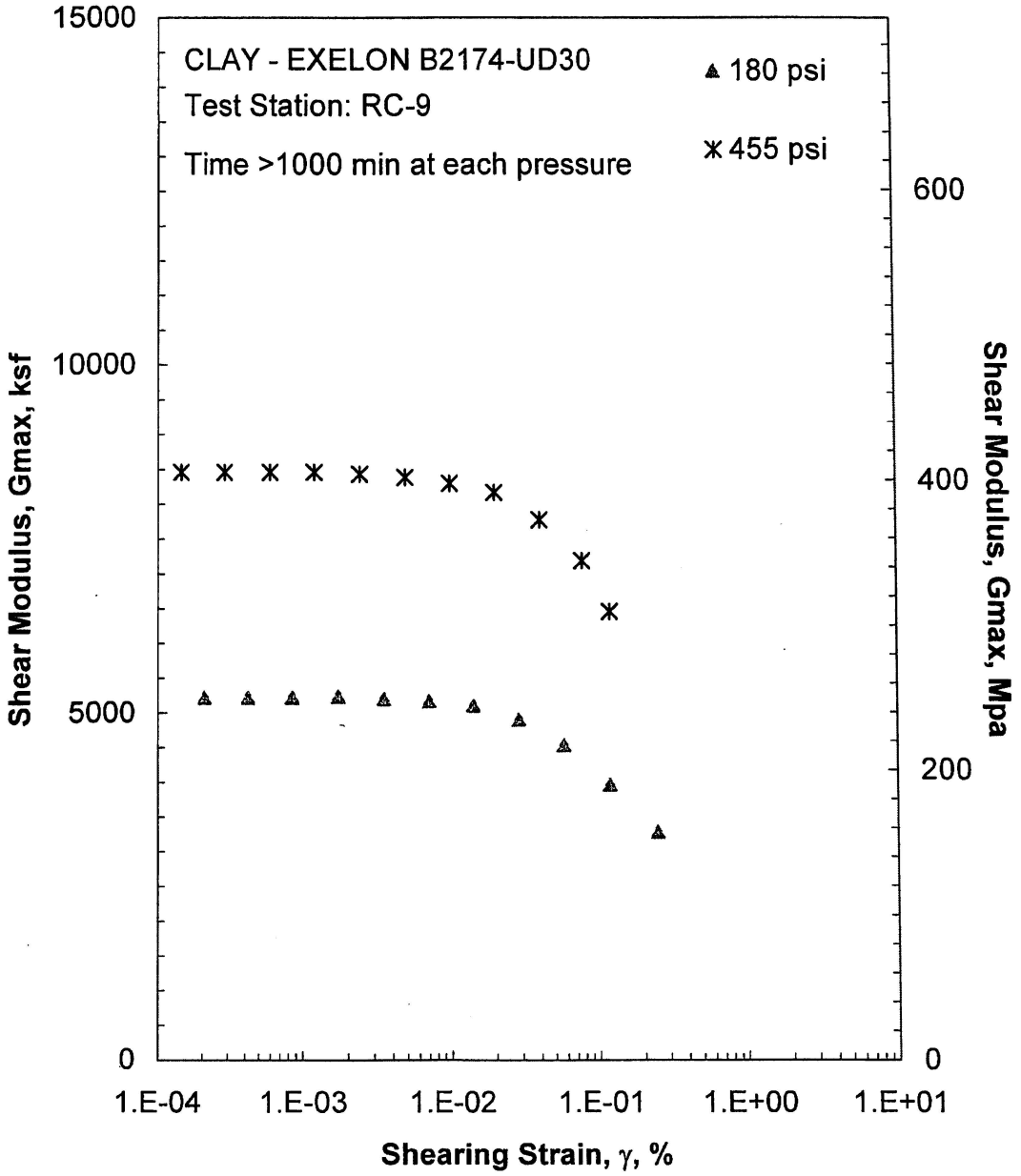

Figure M.8 Comparison of the Variation in Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

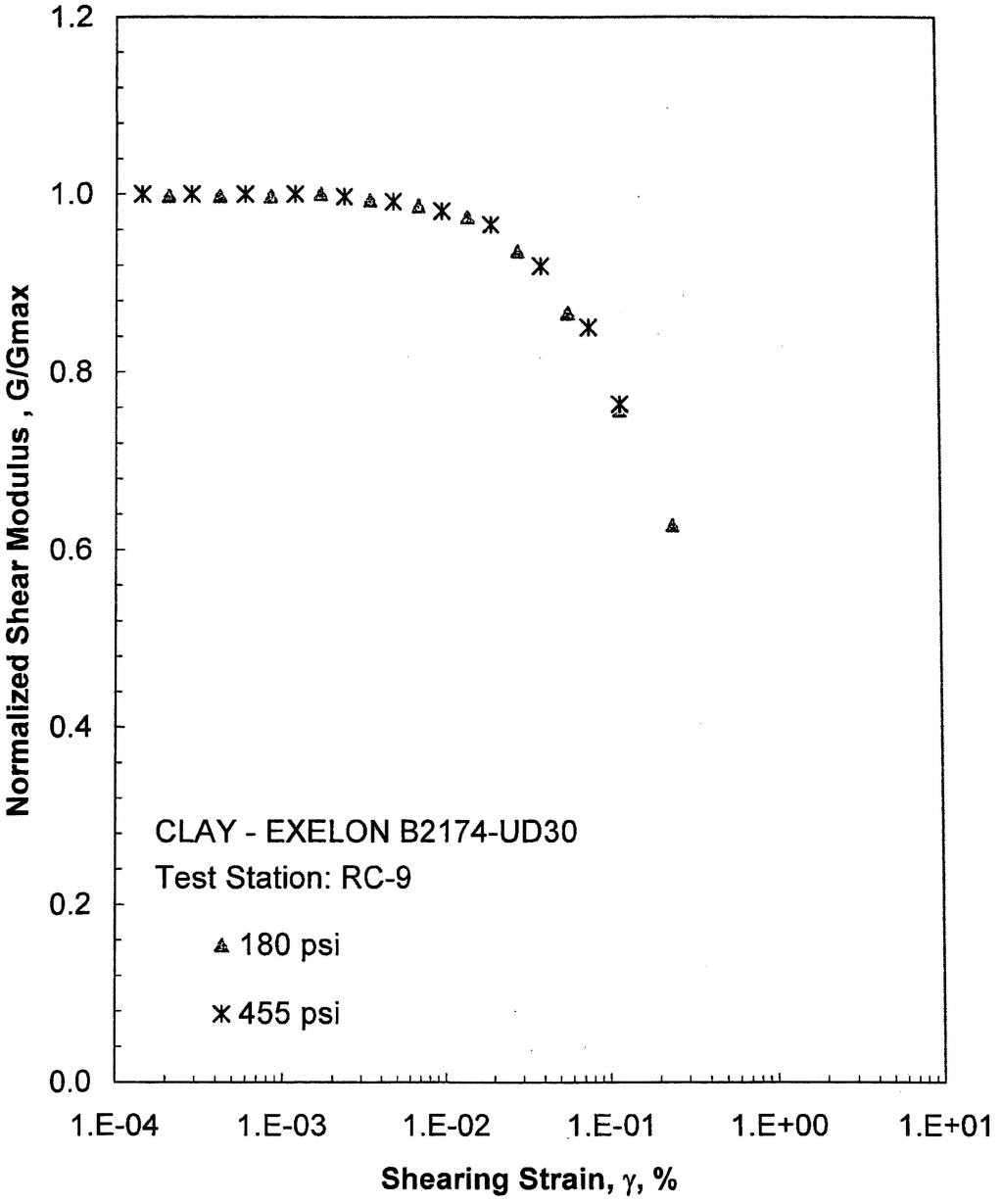

Figure M.9 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

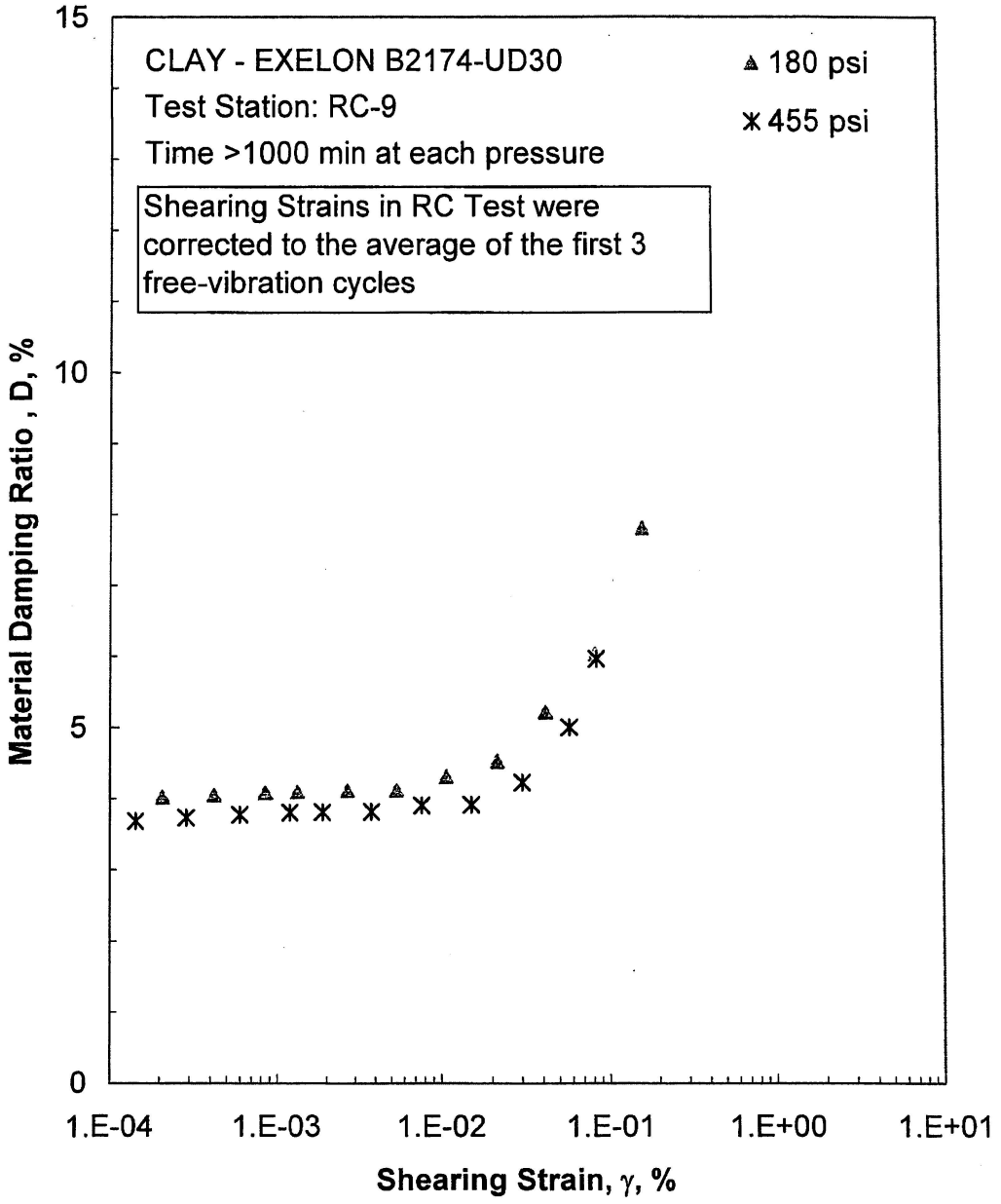

Figure M.10 Comparison of the Variation in Material Damping Ratio with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

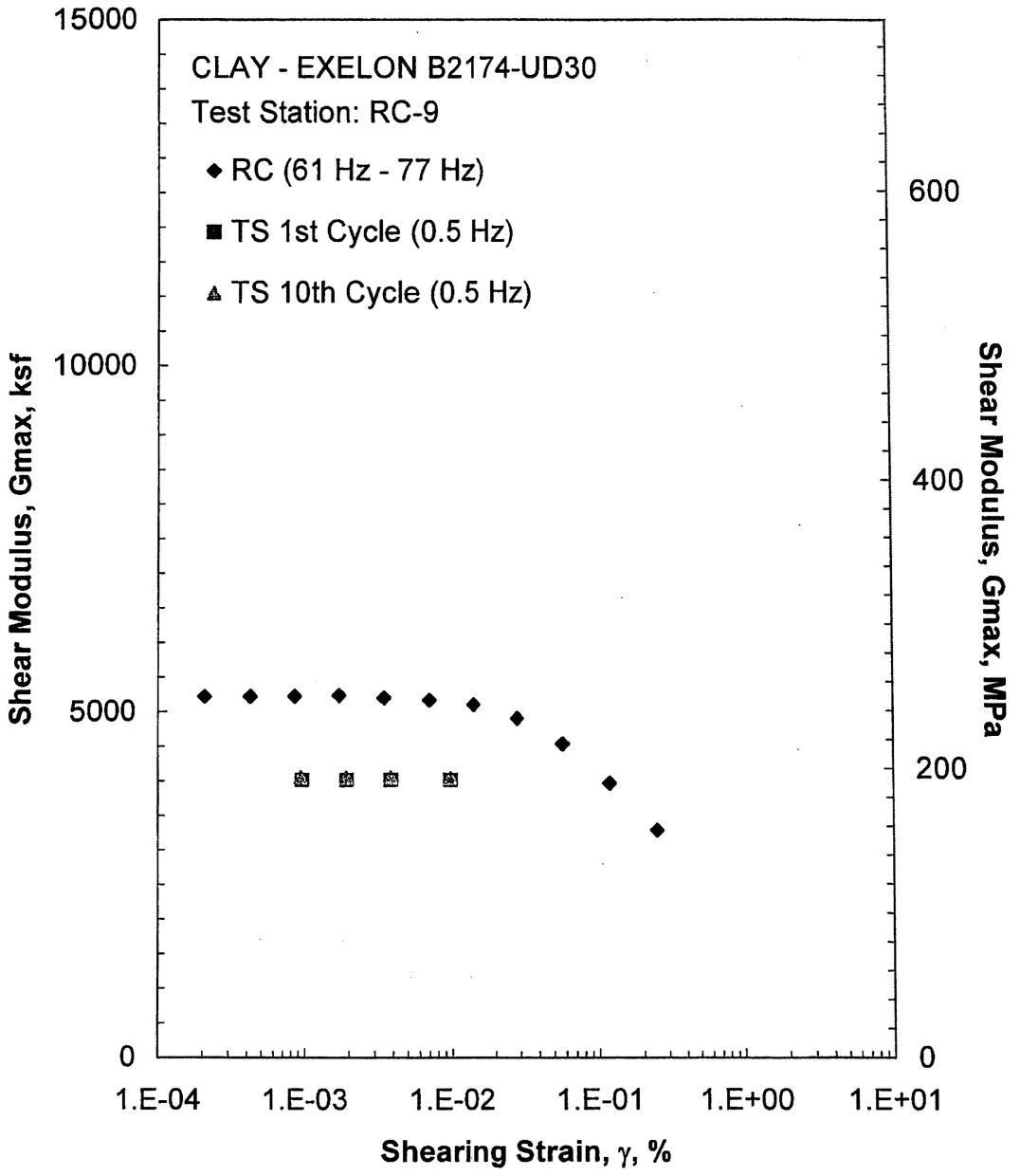

Figure M.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 180 psi from the Combined RCTS Tests

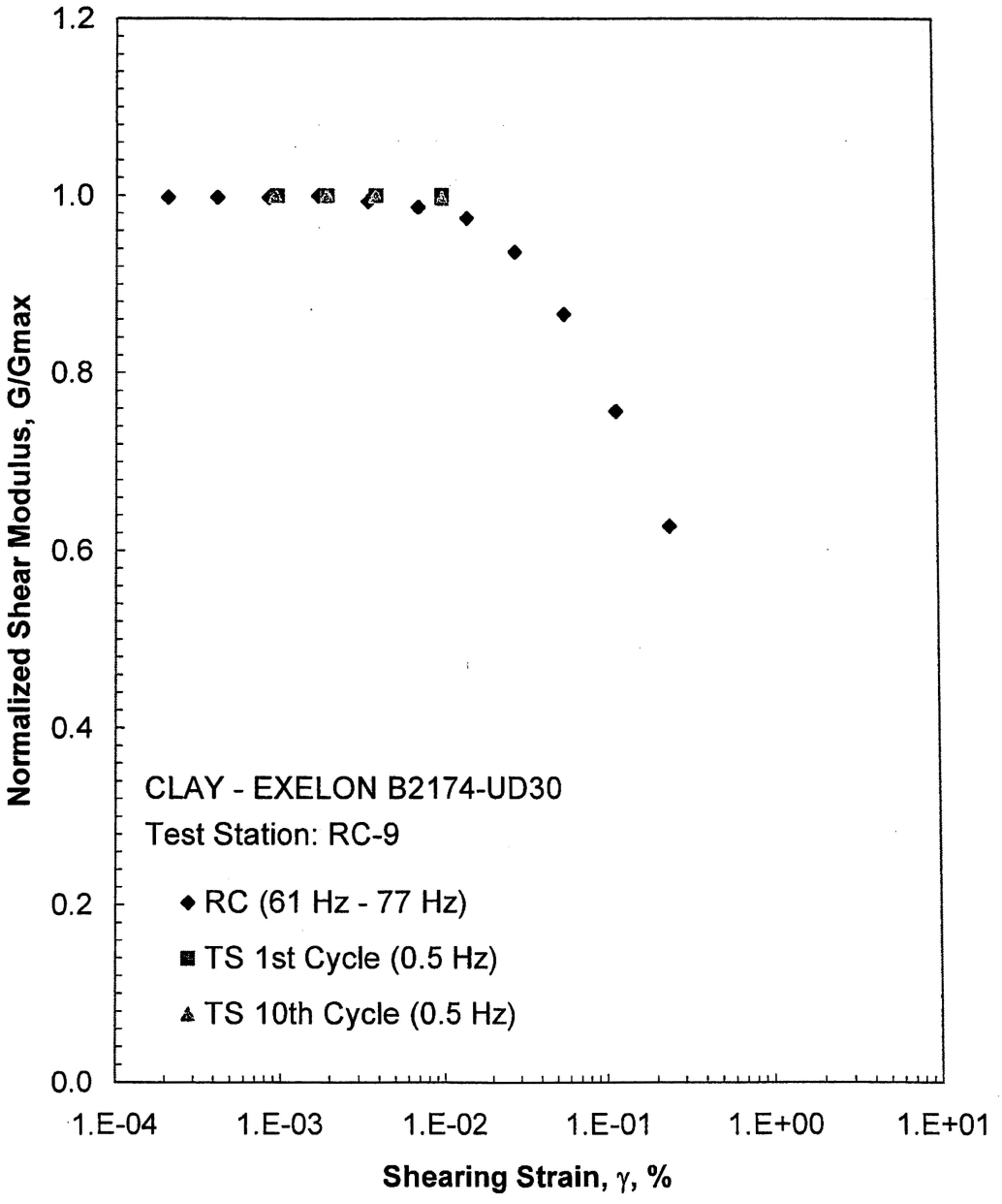

Figure M.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 180 psi from the Combined RCTS Tests

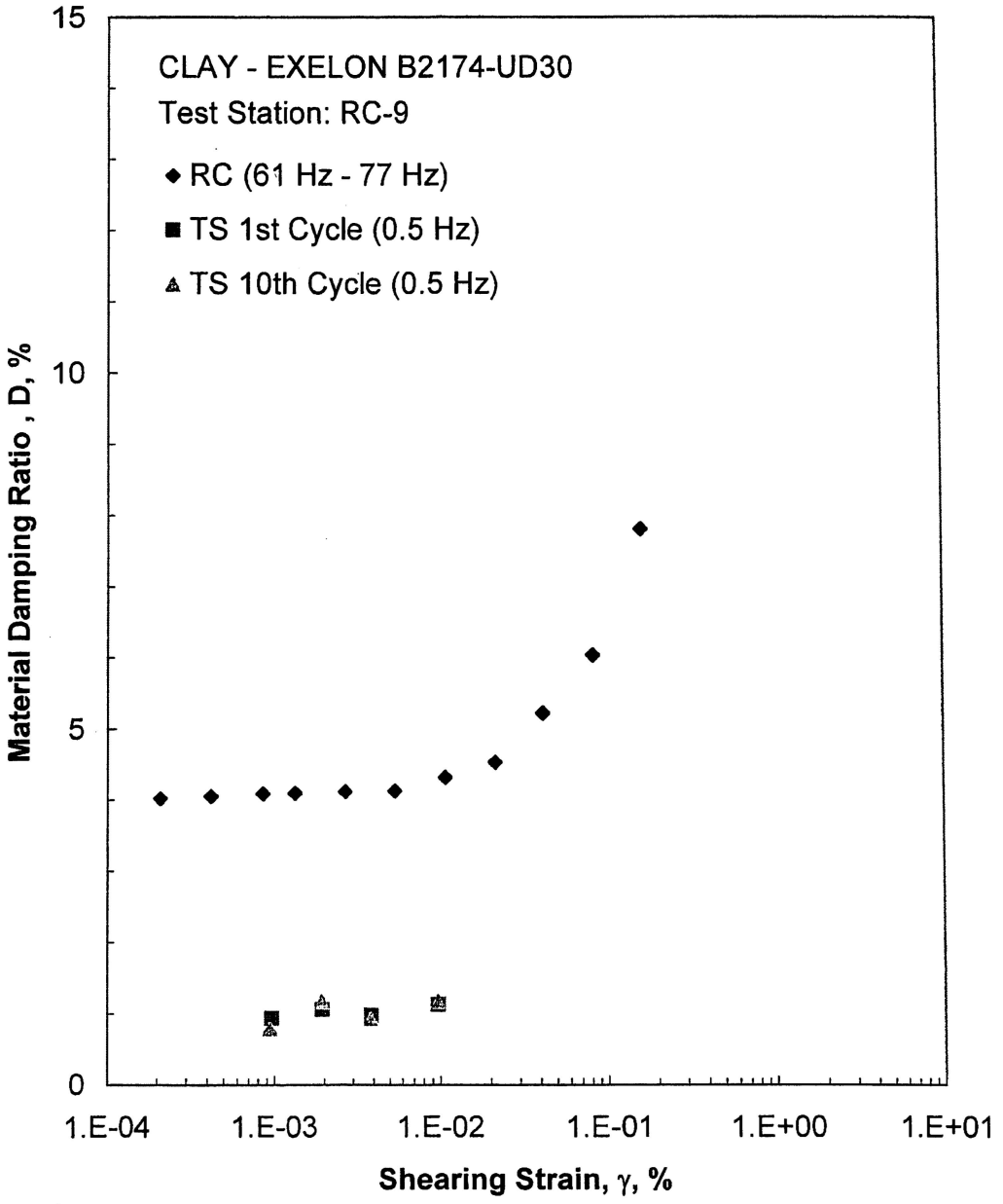

Figure M.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 180 psi from the Combined RCTS Tests

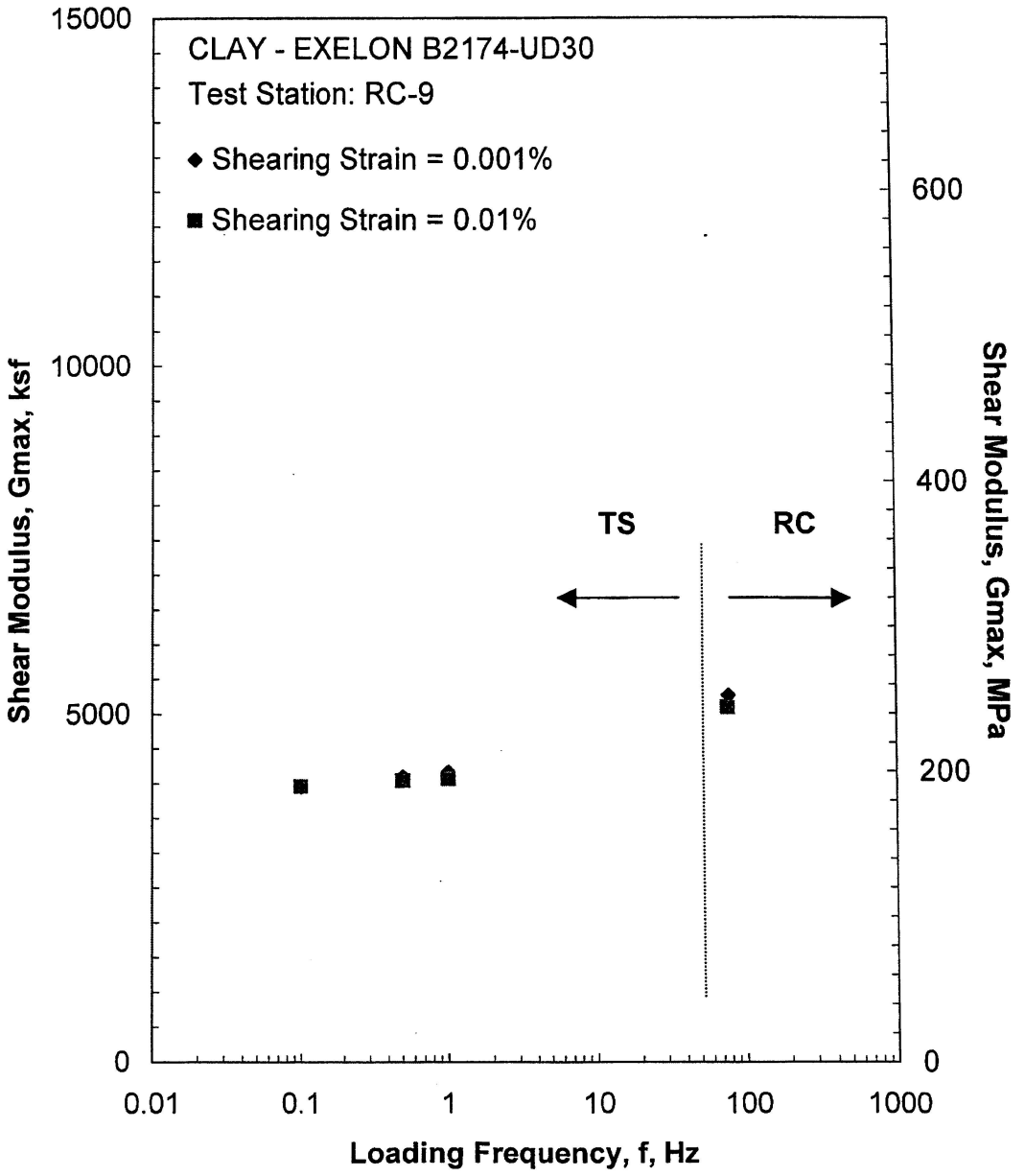

Figure M.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 180 psi from the Combined RCTS Tests

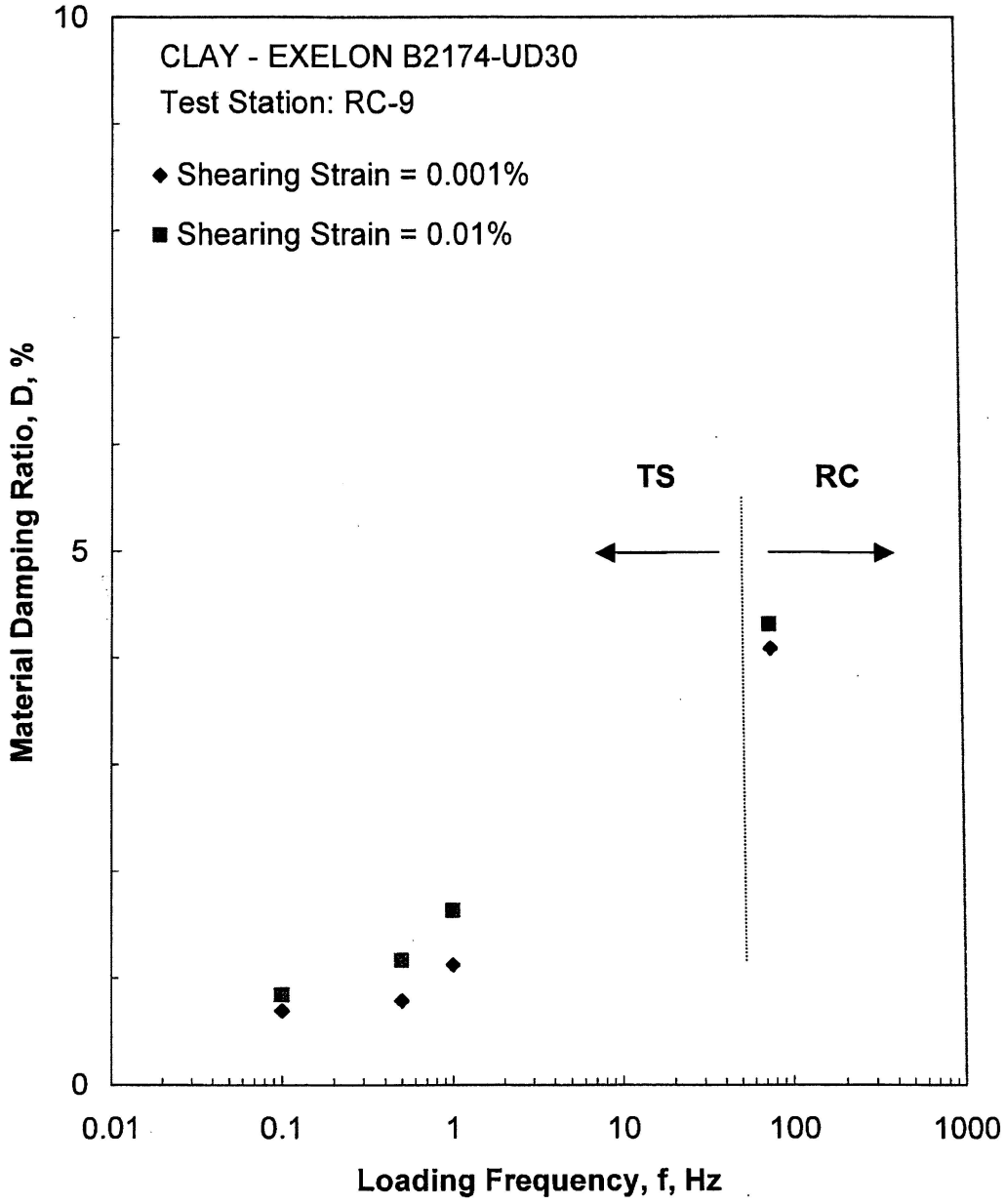

Figure M.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 180 psi from the Combined RCTS Tests

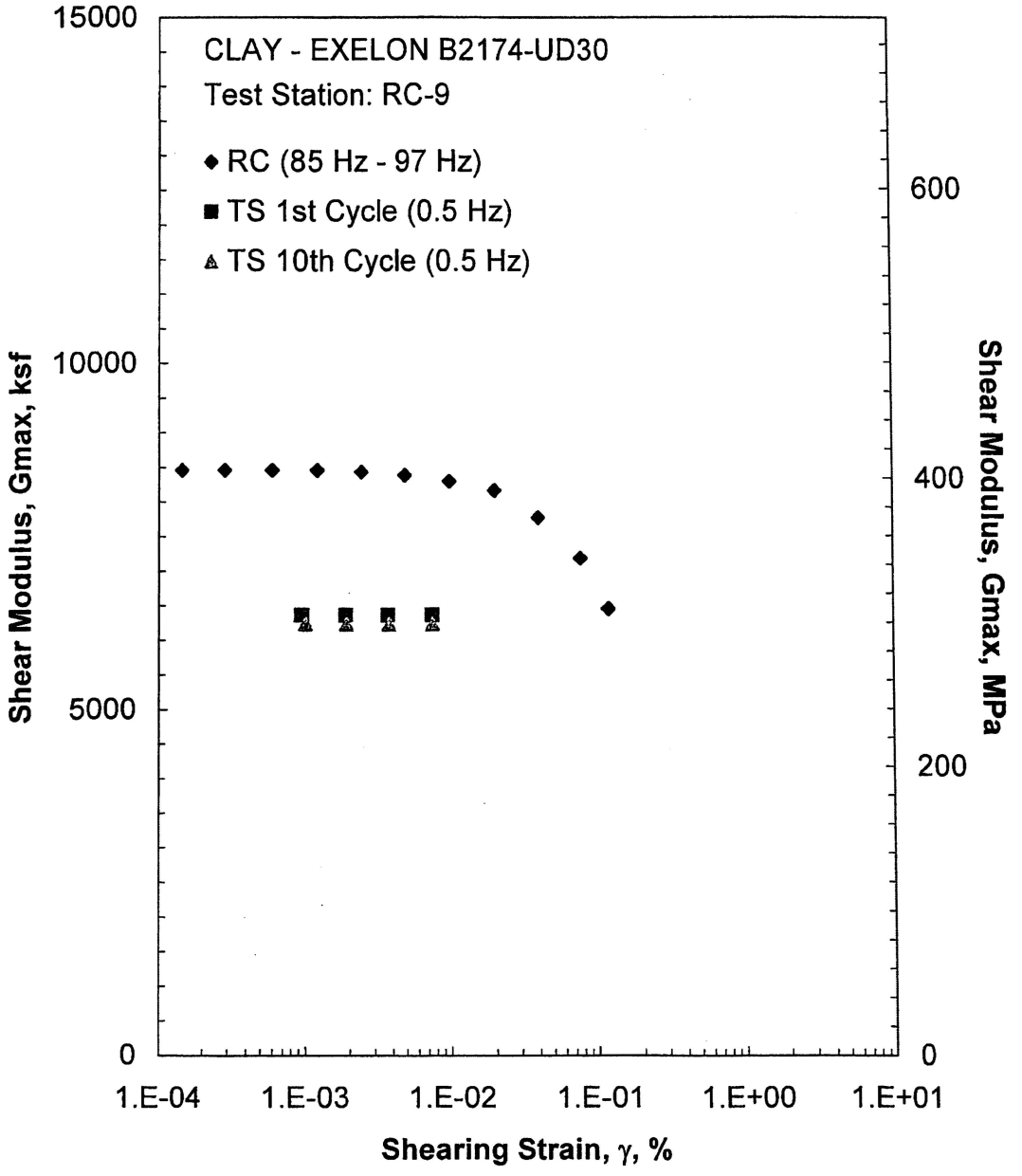

Figure M.16 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

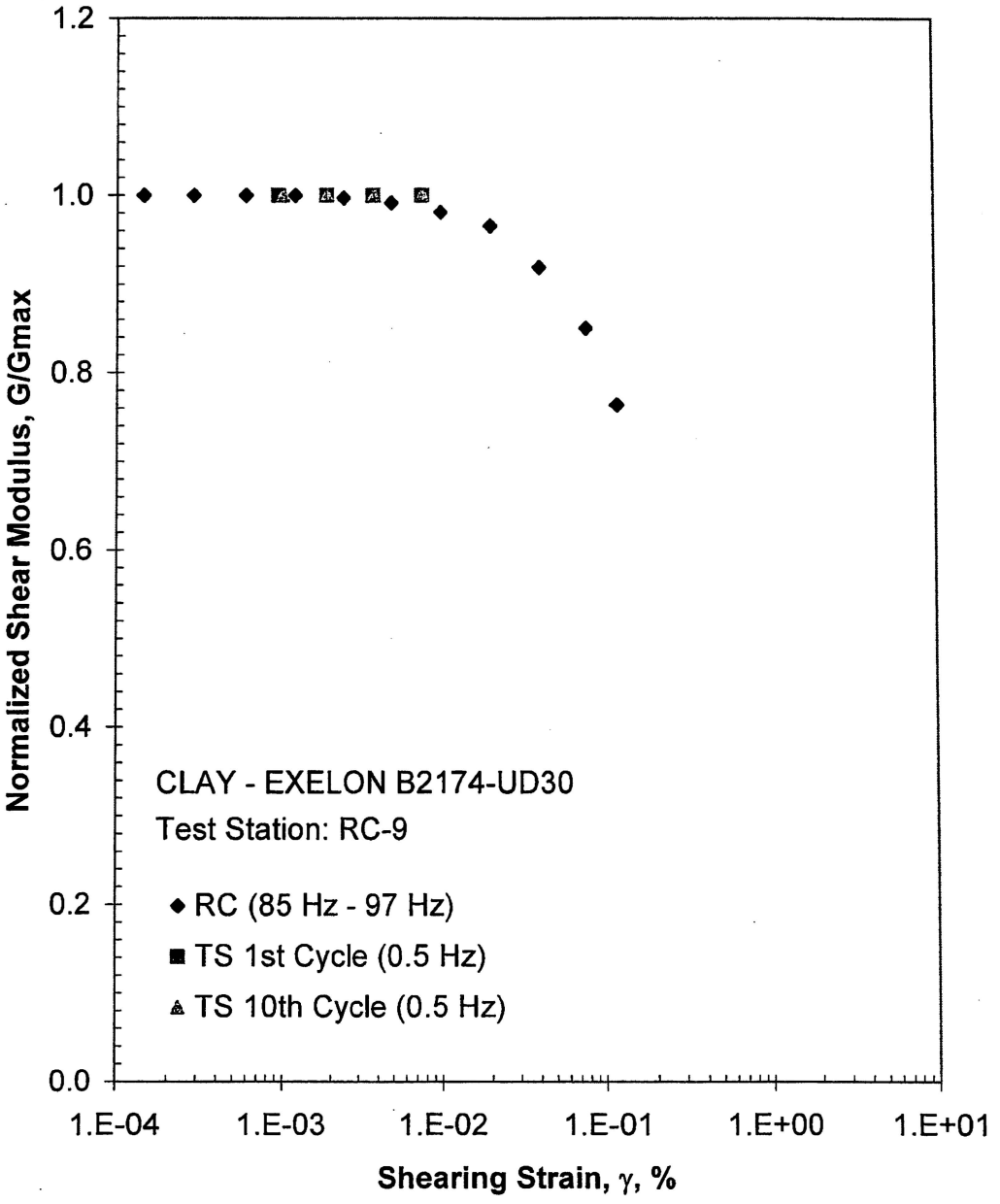

Figure M.17 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

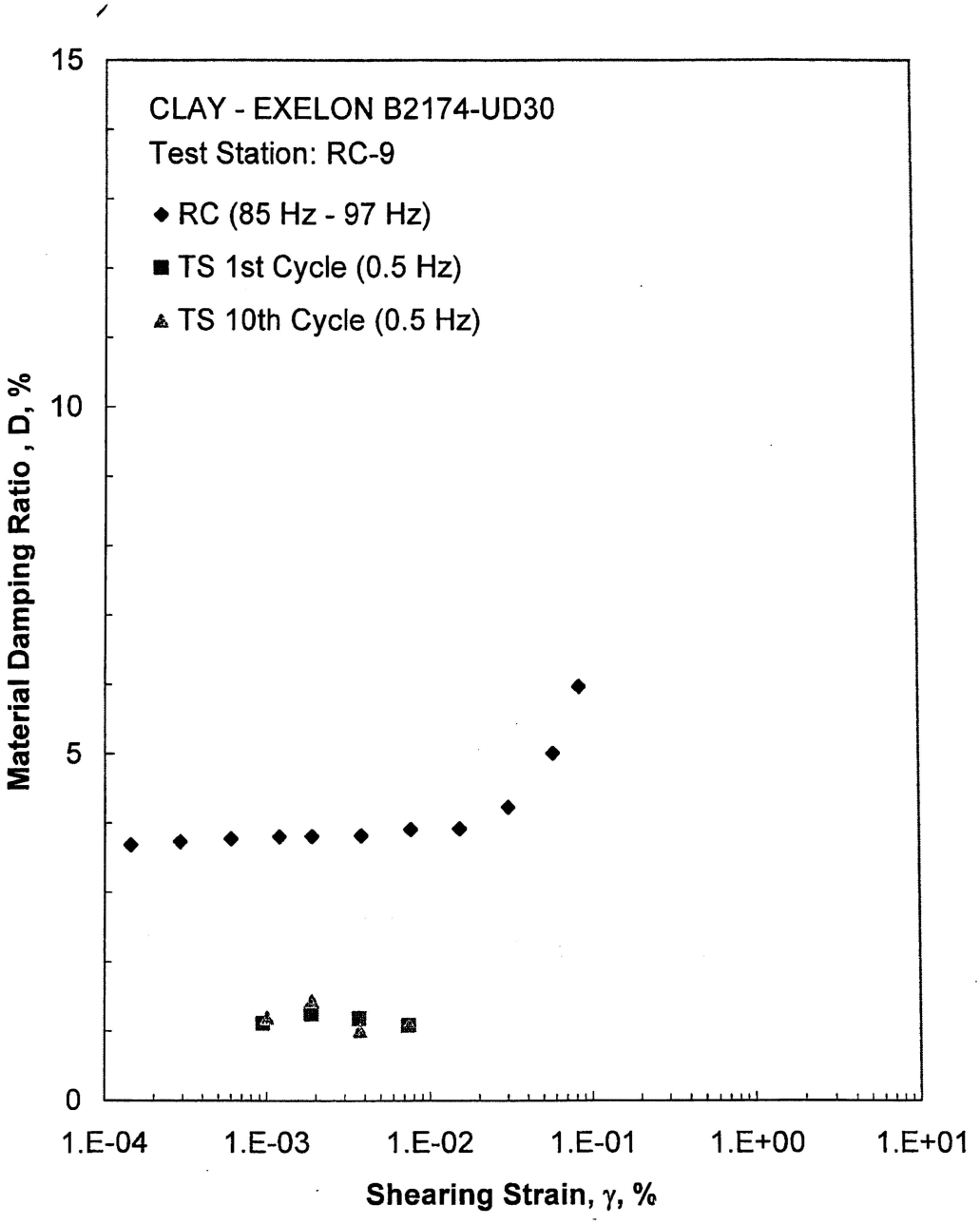

Figure M.18 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

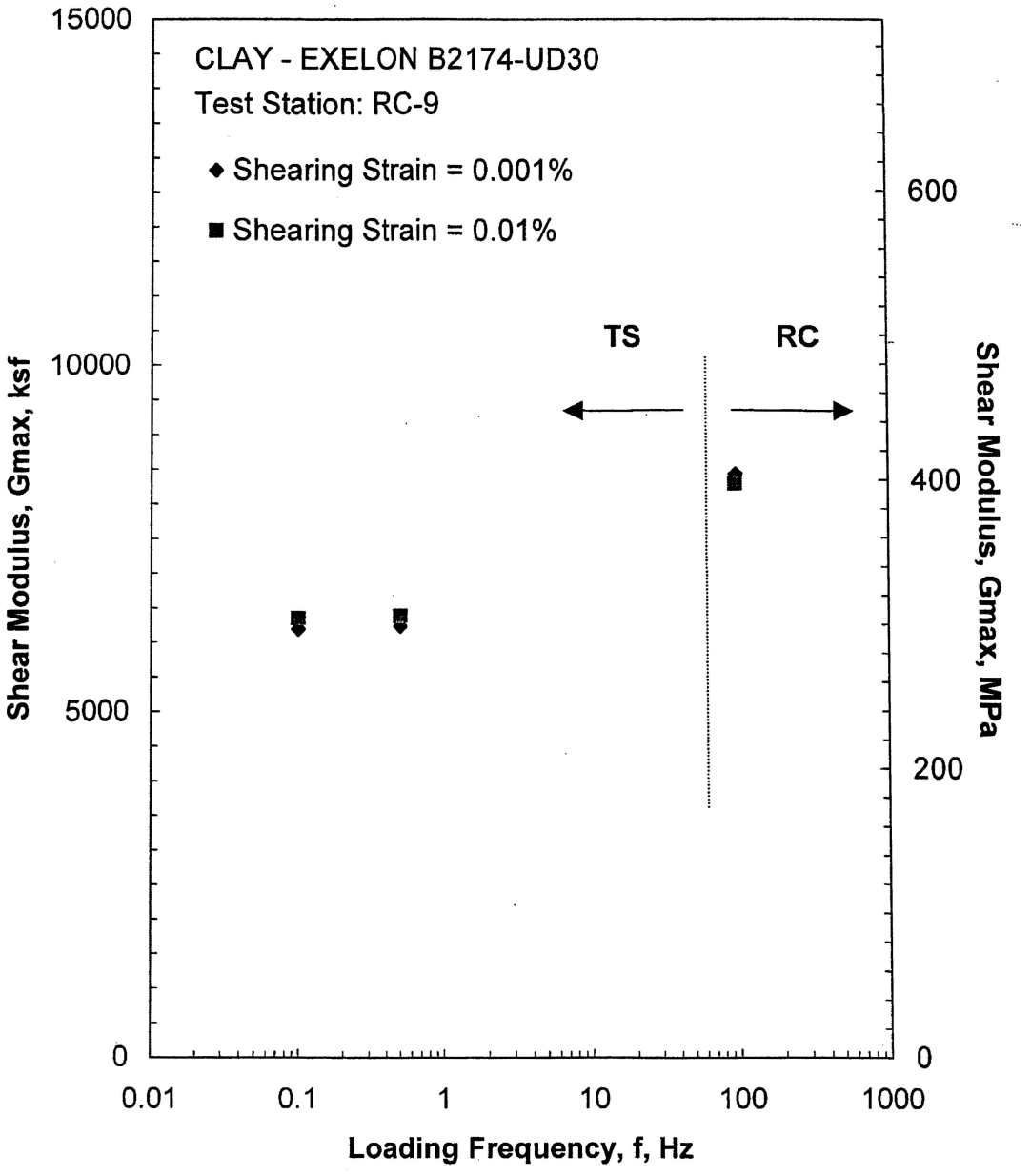

Figure M.19 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

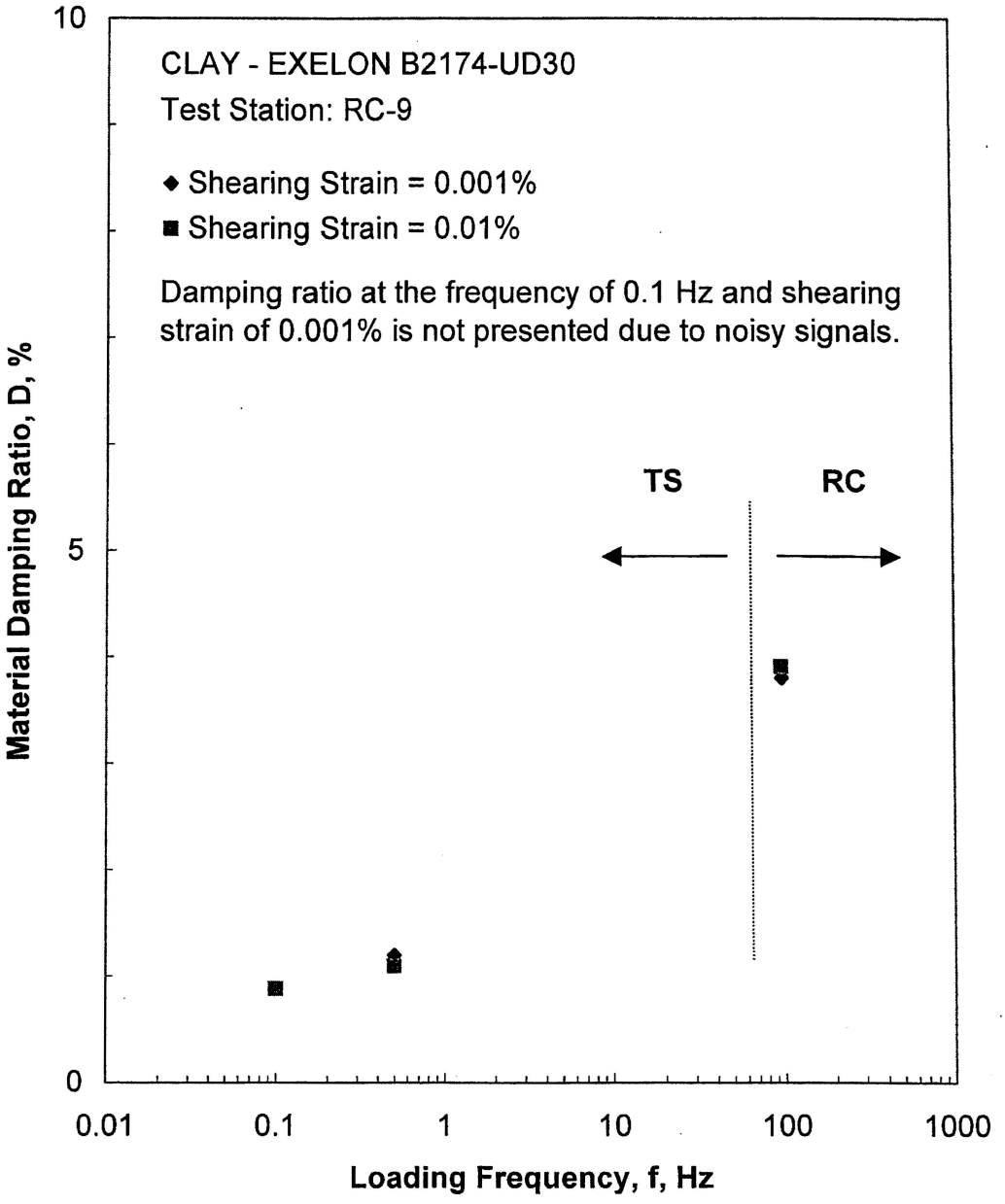

Figure M.20 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 455 psi from the Combined RCTS Tests

Table M.1 Variation in Low-Amplitude Shear Wave Velocity, Low-Amplitude Shear Modulus, Low-Amplitude Material Damping Ratio and Estimated Void Ratio with Isotropic Confining Pressure from RC Tests of Specimen B2174-UD30

Isotropic Confining Pressure, σ_o			Low-Amplitude Shear Modulus, G_{max}		Low-Amplitude Shear Wave Velocity, Vs	Low-Amplitude Material Damping Ratio, Dmin	Estimated Void Ratio, e
(psi)	(psf)	(kPa)	(ksf)	(MPa)	(fps)	(%)	
45	6480	310	2930	141	858	5.00	0.65
90	12960	620	3744	180	965	4.64	0.63
180	25920	1240	5066	243	1115	4.04	0.61
359	51696	2474	7137	343	1310	3.82	0.58
455	65520	3135	8508	408	1422	3.72	0.56

Table M.2 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen B2174-UD30; Isoptropic Confining Pressure, σ_o=180 psi (25.9 ksf = 1240 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
2.09E-04	5223	1.00	2.09E-04	4.02
4.23E-04	5223	1.00	4.23E-04	4.05
8.54E-04	5223	1.00	8.54E-04	4.09
1.72E-03	5234	1.00	1.34E-03	4.10
3.46E-03	5200	0.99	2.70E-03	4.12
6.94E-03	5166	0.99	5.41E-03	4.13
1.40E-02	5098	0.97	1.08E-02	4.31
2.84E-02	4898	0.94	2.16E-02	4.53
5.73E-02	4531	0.87	4.18E-02	5.22
1.18E-01	3959	0.76	8.27E-02	6.03
2.48E-01	3283	0.63	1.61E-01	7.80

[+] Average Shearing Strain from the First Three Cycles of the Free Vibration Decay Curve

[x] Average Damping Ratio from the First Three Cycles of the Free Vibration Decay Curve

Table M.3 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen B2174-UD30; Isotropic Confining Pressure, σ_o= 180 psi (25.9 ksf =1240 kPa)

First Cycle				Tenth Cycle			
Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %	Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %
9.62E-04	4010	1.00	0.93	9.38E-04	4052	1.00	0.78
1.95E-03	4010	1.00	1.05	1.94E-03	4052	1.00	1.16
3.87E-03	4010	1.00	0.97	3.85E-03	4052	1.00	0.92
9.72E-03	4010	1.00	1.12	9.69E-03	4039	1.00	1.16

Table M.4 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen B2174-UD30; Isoptropic Confining Pressure, σ_o= 455 psi (65.5 ksf = 3135 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
1.44E-04	8457	1.00	1.44E-04	3.69
2.88E-04	8457	1.00	2.88E-04	3.74
6.00E-04	8457	1.00	6.00E-04	3.77
1.20E-03	8457	1.00	1.20E-03	3.80
2.40E-03	8433	1.00	1.89E-03	3.81
4.81E-03	8386	0.99	3.80E-03	3.82
9.69E-03	8295	0.98	7.66E-03	3.91
1.95E-02	8166	0.97	1.52E-02	3.91
3.93E-02	7774	0.92	3.03E-02	4.23
7.68E-02	7187	0.85	5.76E-02	5.01
1.18E-01	6456	0.76	8.41E-02	5.97

[+] Average Shearing Strain from the First Three Cycles of the Free Vibration Decay Curve

[x] Average Damping Ratio from the First Three Cycles of the Free Vibration Decay Curve

Table M.5 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen B2174-UD30; Isotropic Confining Pressure, σ_o=455 psi (65.5 ksf = 3135 kPa)

First Cycle				Tenth Cycle			
Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %	Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Material Damping Ratio, D, %
9.48E-04	6366	1.00	1.11	1.01E-03	6234	1.00	1.19
1.88E-03	6366	1.00	1.24	1.89E-03	6234	1.00	1.43
3.69E-03	6366	1.00	1.18	3.74E-03	6234	1.00	1.00
7.43E-03	6366	1.00	1.08	7.46E-03	6234	1.00	1.09