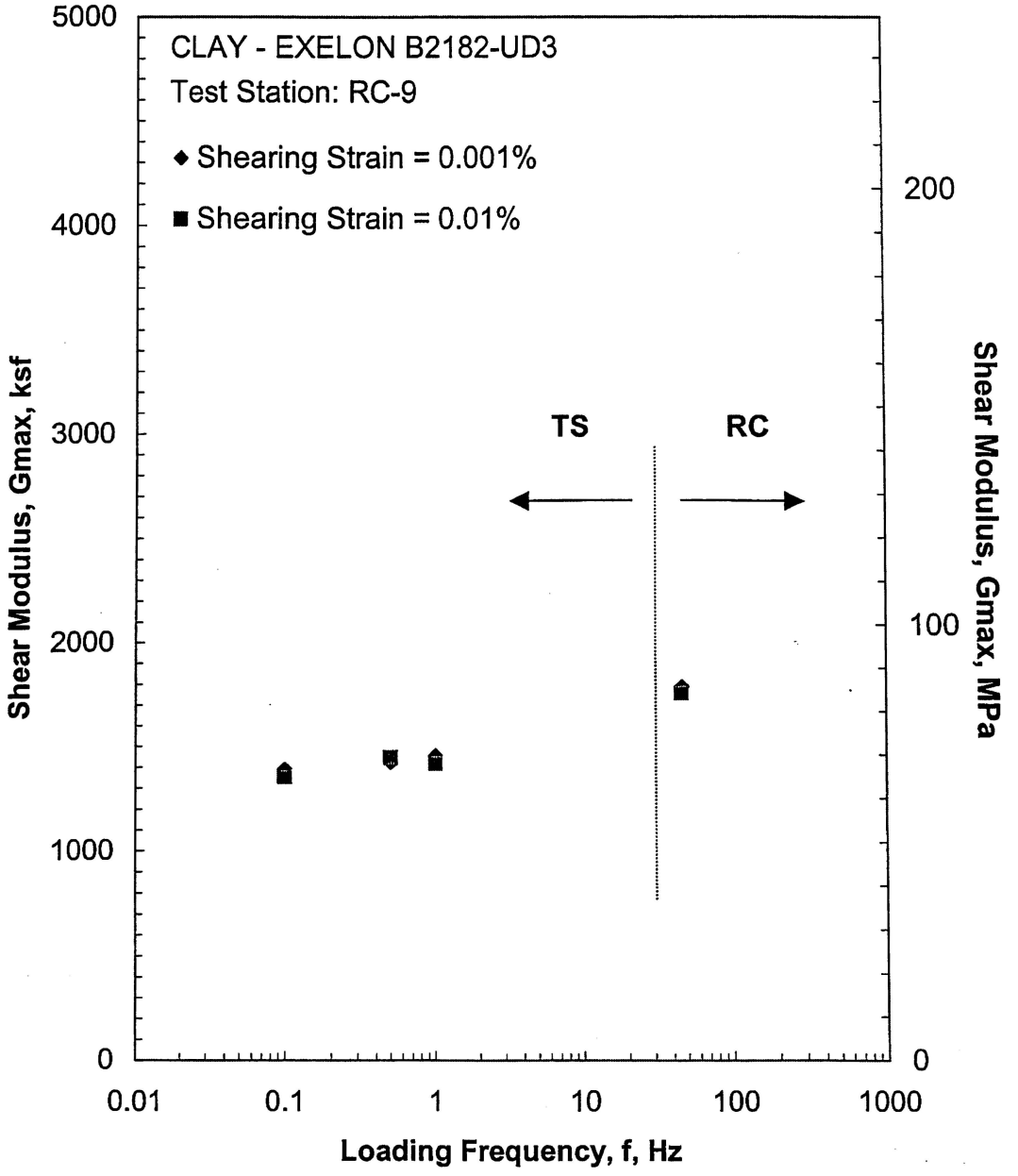

Figure B.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 9 psi from the Combined RCTS Tests

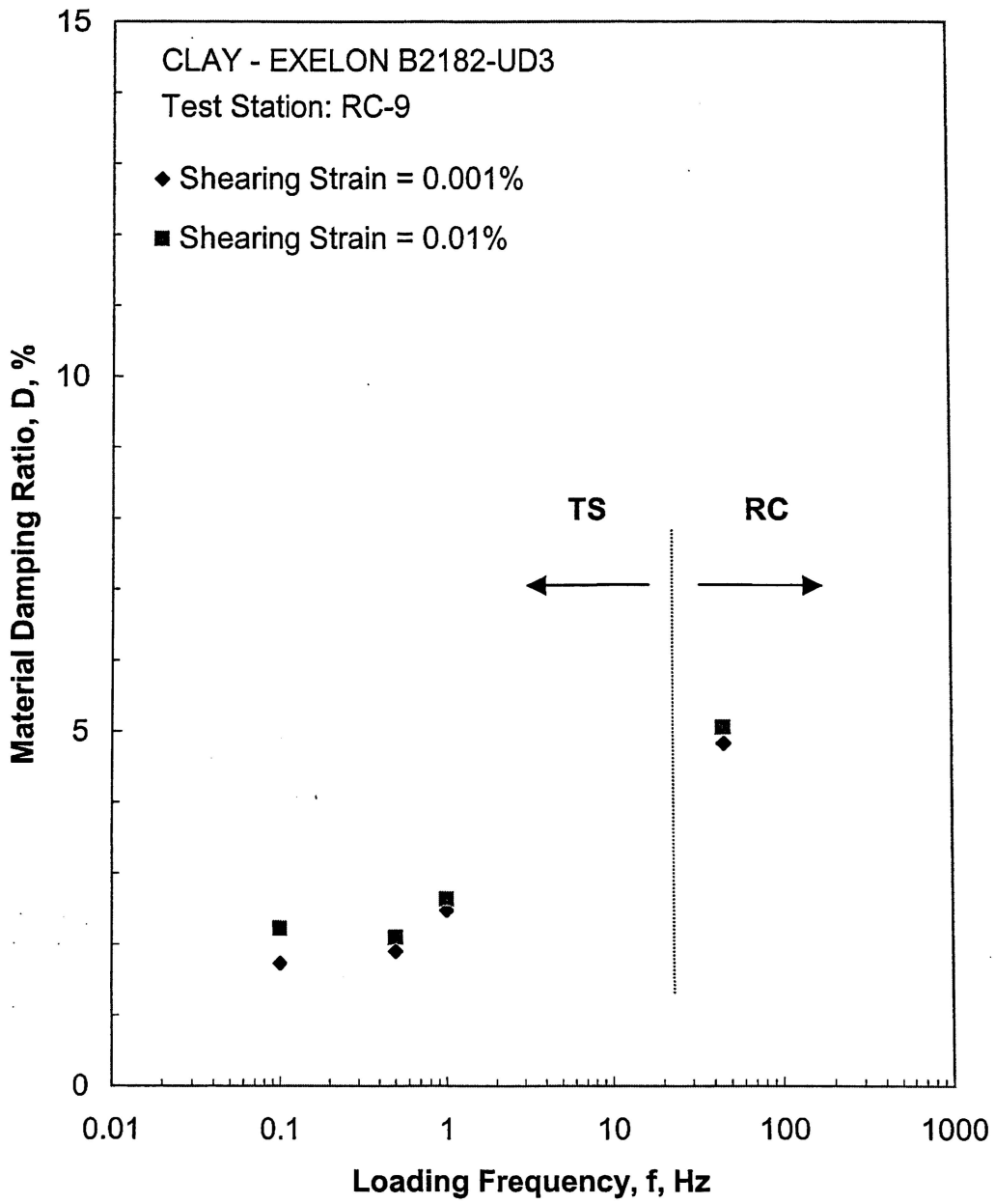

Figure B.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 9 psi from the Combined RCTS Tests

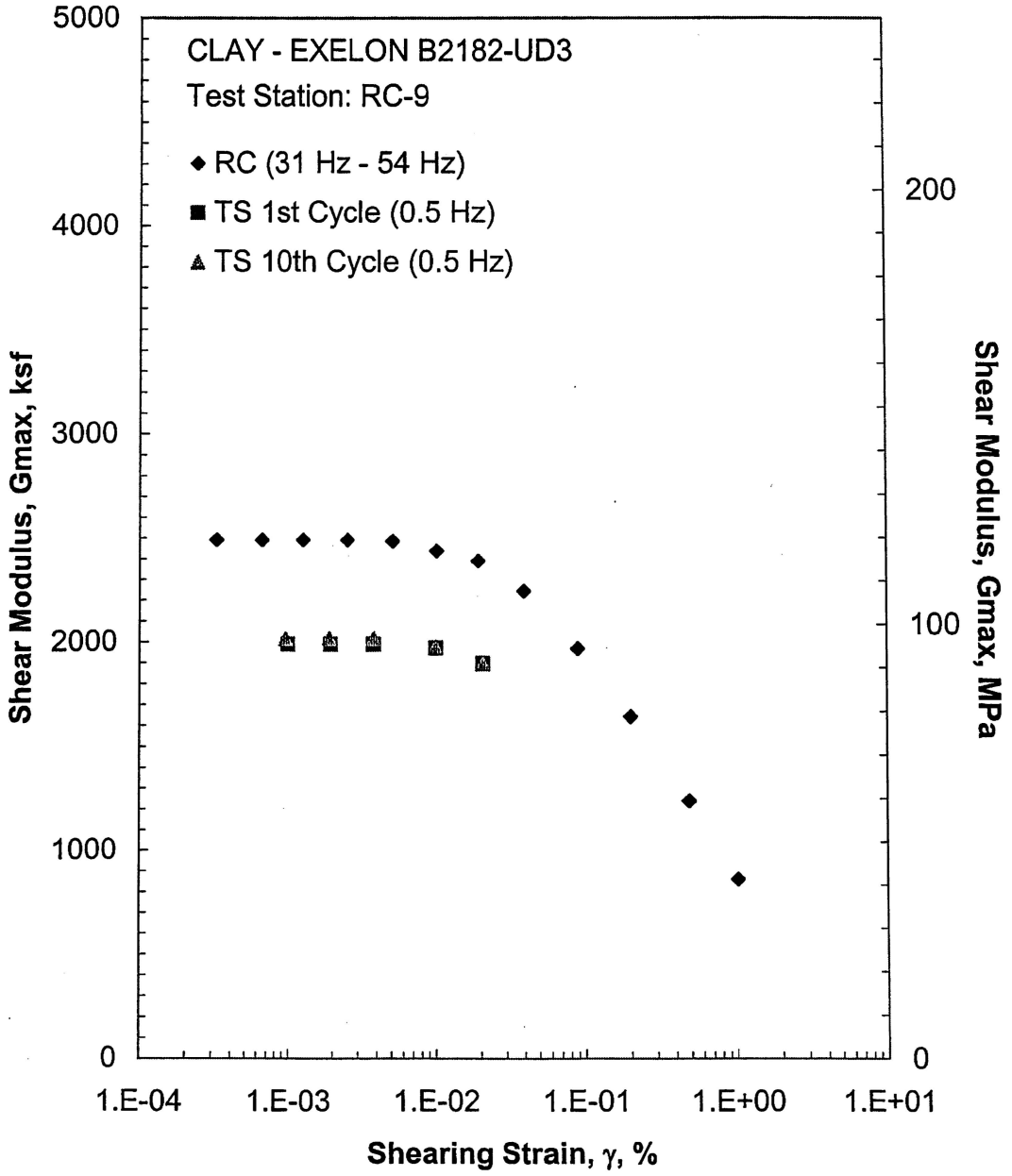

Figure B.16 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 37 psi from the Combined RCTS Tests

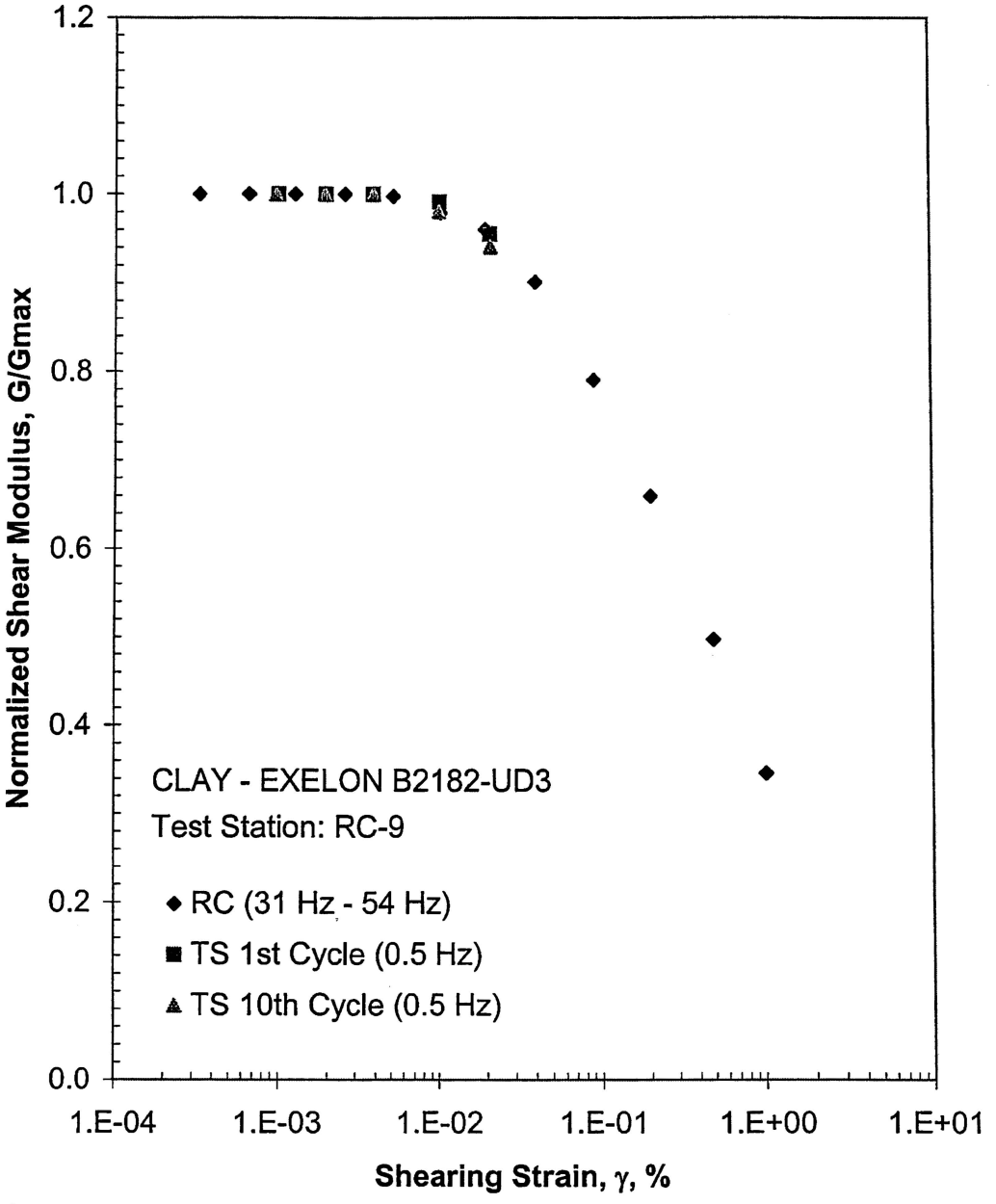

Figure B.17 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 37 psi from the Combined RCTS Tests

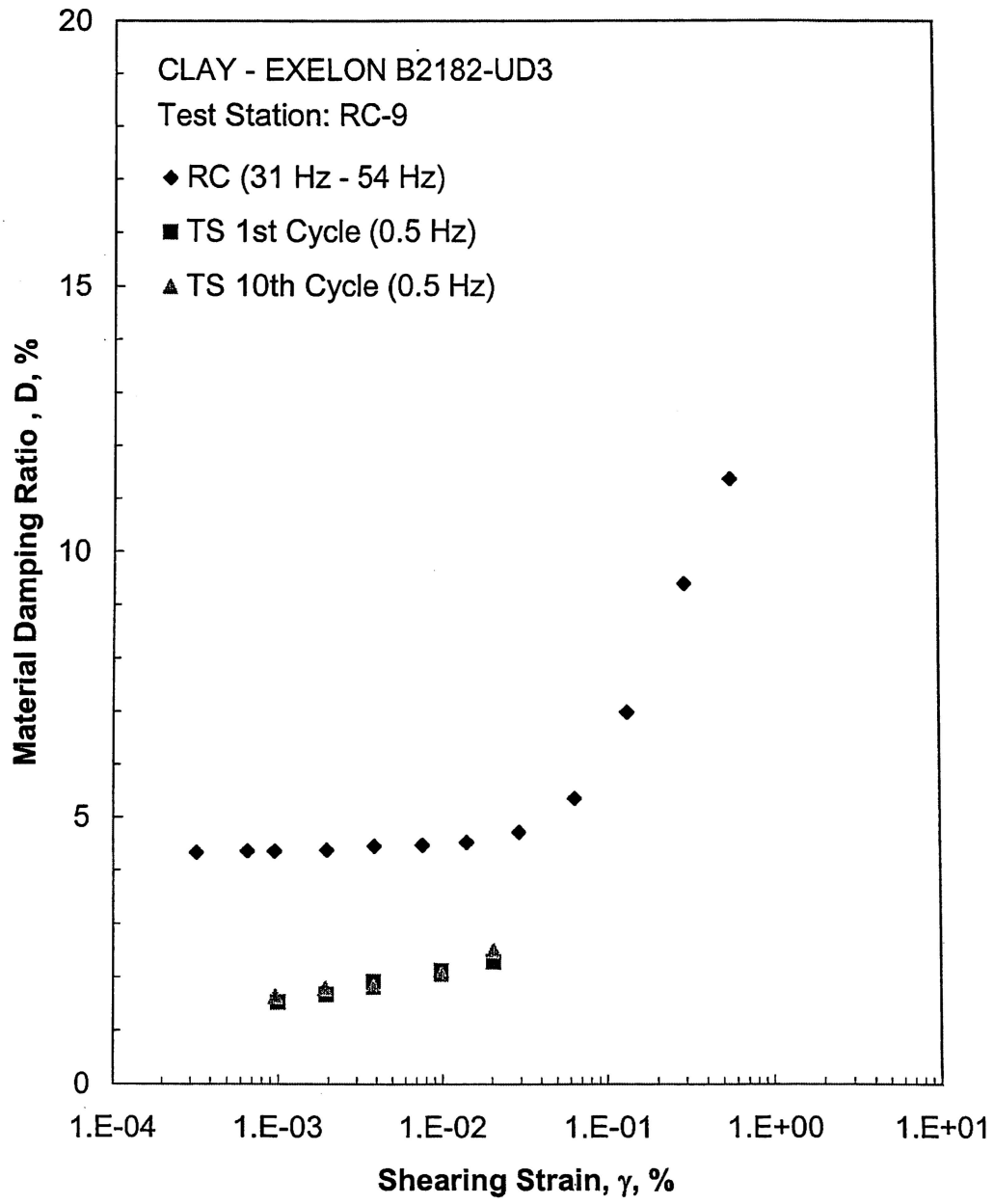

Figure B.18 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 37 psi from the Combined RCTS Tests

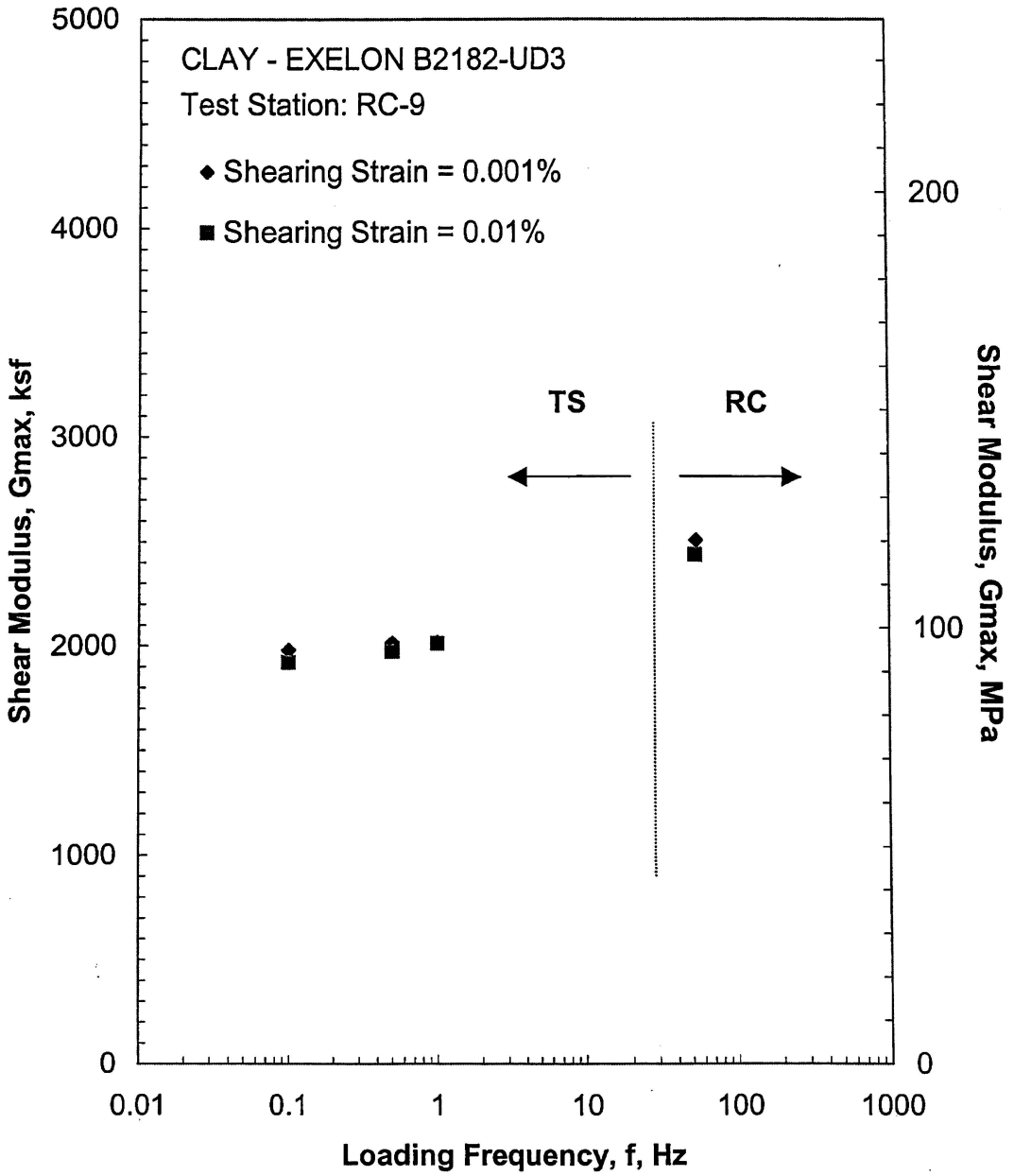

Figure B.19 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 37 psi from the Combined RCTS Tests

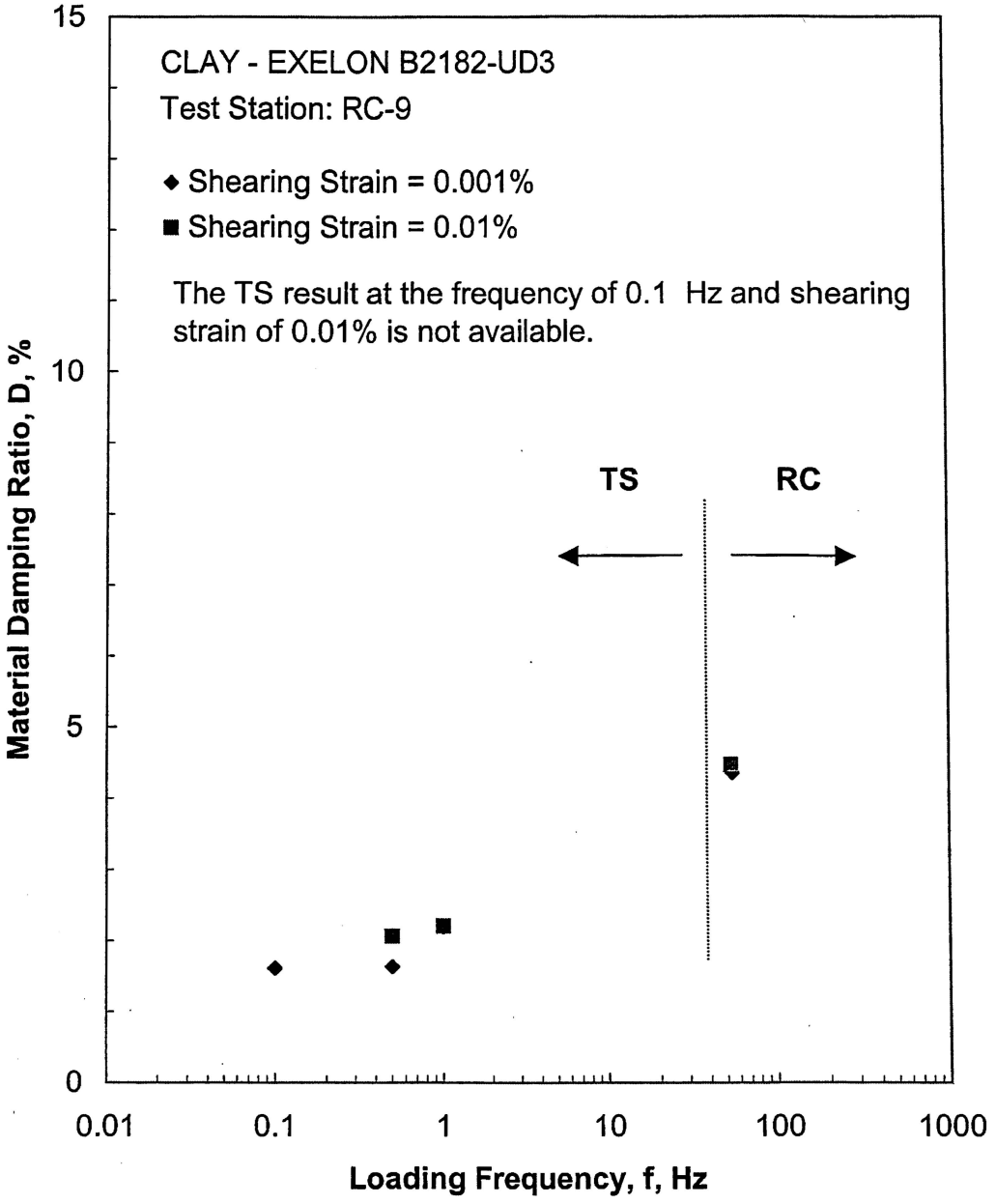

Figure B.20 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 37 psi from the Combined RCTS Tests

Table B.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 EXELON B2182-UD3

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)	(%)	
2	288	14	1311	63	579	5.55	0.52
5	720	34	1502	72	618	5.18	0.51
9	1296	62	1730	83	663	4.90	0.51
19	2736	131	2040	98	718	4.60	0.50
37	5328	255	2479	119	789	4.38	0.49

Table B.2 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen EXELON B2182-UD3; Isoptropic Confining Pressure, σ_o=9 psi (1.3 ksf = 62 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
3.47E-04	1823	1.00	3.47E-04	4.84
7.29E-04	1823	1.00	7.29E-04	4.83
1.43E-03	1823	1.00	1.07E-03	4.83
2.84E-03	1810	0.99	2.10E-03	4.88
5.76E-03	1771	0.97	4.26E-03	5.00
1.15E-02	1759	0.96	8.40E-03	5.07
2.22E-02	1682	0.92	1.62E-02	5.23
4.24E-02	1608	0.88	3.01E-02	5.39
1.04E-01	1418	0.78	7.14E-02	6.14
2.32E-01	1120	0.61	1.46E-01	8.18

[+] 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 B.3 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen EXELON B2182-UD3; Isotropic Confining Pressure, σ_o= 9 psi (1.3 ksf =62 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, %
9.42E-04	1429	1.00	2.10	9.56E-04	1418	1.00	1.90
1.89E-03	1429	1.00	1.98	1.90E-03	1418	1.00	2.09
3.89E-03	1403	0.98	1.96	3.92E-03	1391	0.98	2.06
9.60E-03	1395	0.98	2.21	9.61E-03	1393	0.98	2.21
2.00E-02	1336	0.93	2.74	2.01E-02	1330	0.94	2.76

Table B.4 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen EXELON B2182-UD3; Isoptropic Confining Pressure, σ_o= 37 psi (5.3 ksf = 255 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
3.26E-04	2492	1.00	3.26E-04	4.34
6.60E-04	2492	1.00	6.60E-04	4.37
1.27E-03	2492	1.00	9.53E-04	4.36
2.55E-03	2492	1.00	1.96E-03	4.38
5.10E-03	2486	1.00	3.87E-03	4.46
1.00E-02	2440	0.98	7.61E-03	4.48
1.91E-02	2392	0.96	1.41E-02	4.53
3.91E-02	2246	0.90	2.93E-02	4.73
8.87E-02	1969	0.79	6.39E-02	5.36
1.99E-01	1643	0.66	1.33E-01	6.99
4.90E-01	1239	0.50	2.99E-01	9.40
1.01E+00	862	0.35	5.68E-01	11.37

[+] 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 B.5 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen EXELON B2182-UD3; Isotropic Confining Pressure, σ_o=37 psi (5.3 ksf = 255 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, %
1.00E-03	1989	1.00	1.53	9.68E-04	2015	1.00	1.63
1.95E-03	1989	1.00	1.67	1.92E-03	2015	1.00	1.79
3.83E-03	1989	1.00	1.91	3.83E-03	2015	1.00	1.82
9.89E-03	1972	0.99	2.11	9.87E-03	1976	0.98	2.06
2.05E-02	1900	0.95	2.29	2.06E-02	1896	0.94	2.49

APPENDIX C

Specimen B2182-UD32
(Index Properties Not Available)

Borehole B2182
Sample UD32
Depth = 352.7 ft (107.5 m)
Total Unit Weight = 126.8 lb/ft^3
Water Content = 21.1 %
Estimated In-Situ Ko = 0.5
Estimated In-Situ Mean Effective
Stress = 116 psi

FUGRO JOB #: 0401-1686
Testing Station: RC7

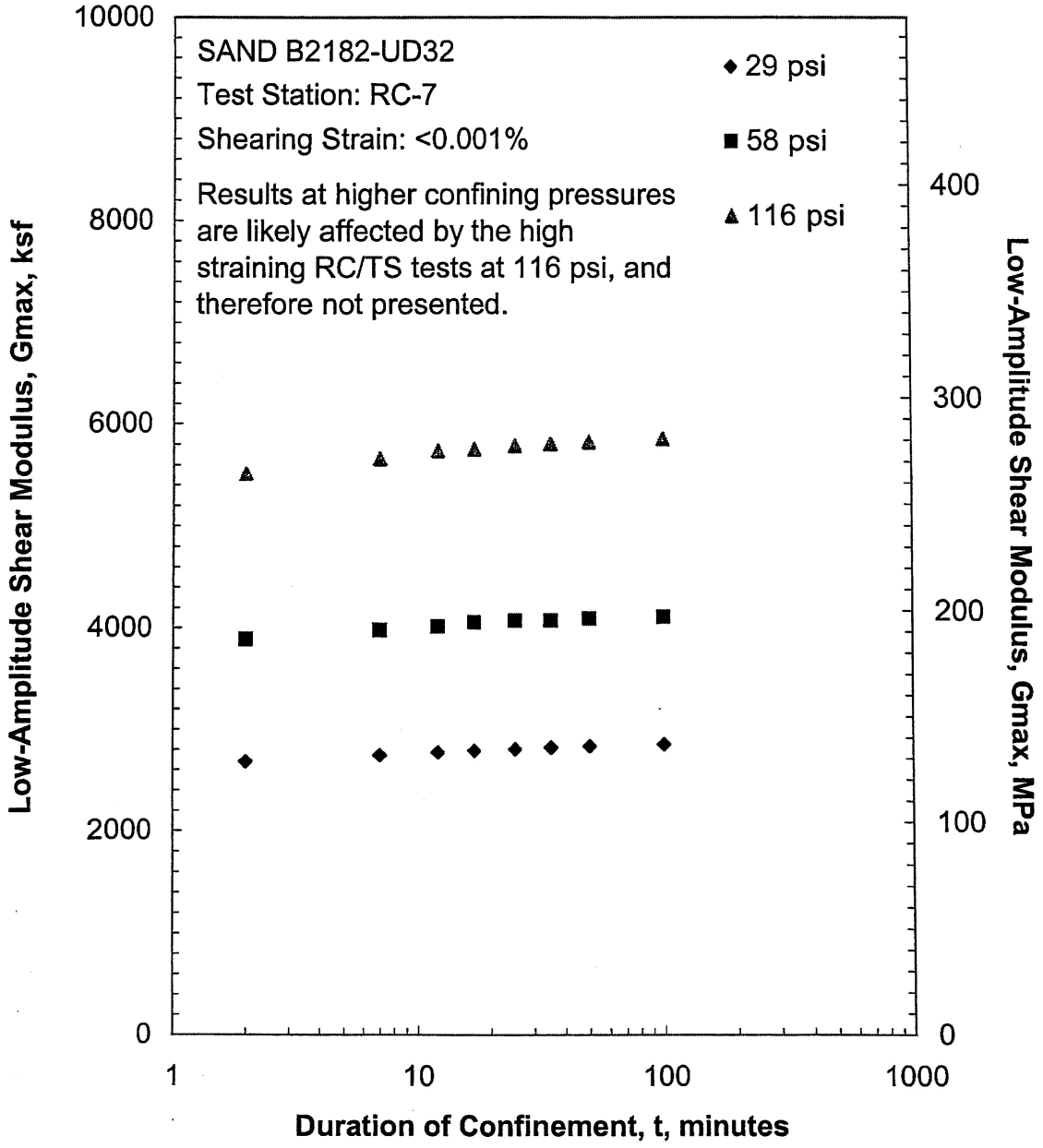

Figure C.1 Variation in Low-Amplitude Shear Modulus with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

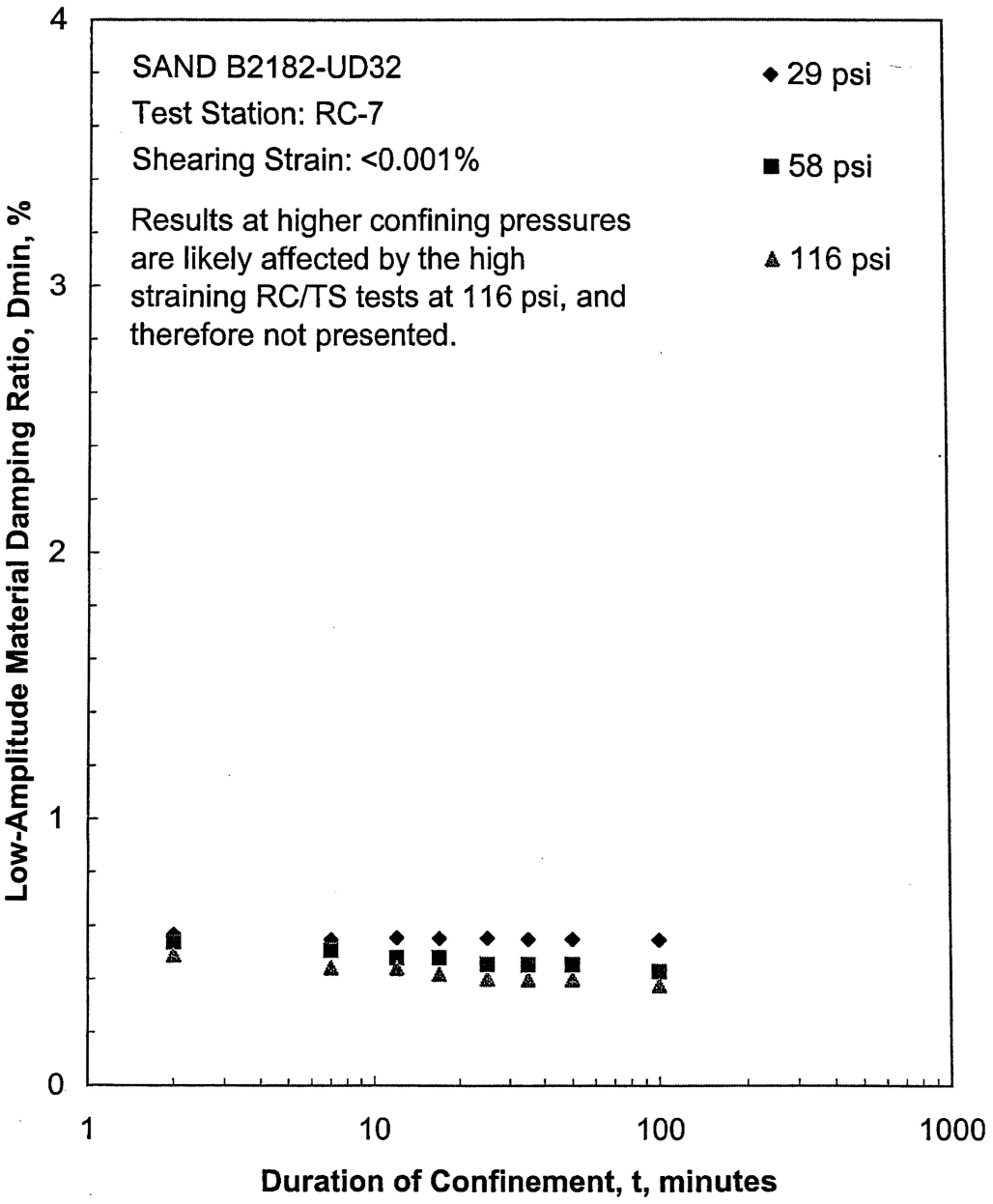

Figure C.2 Variation in Low-Amplitude Material Damping Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

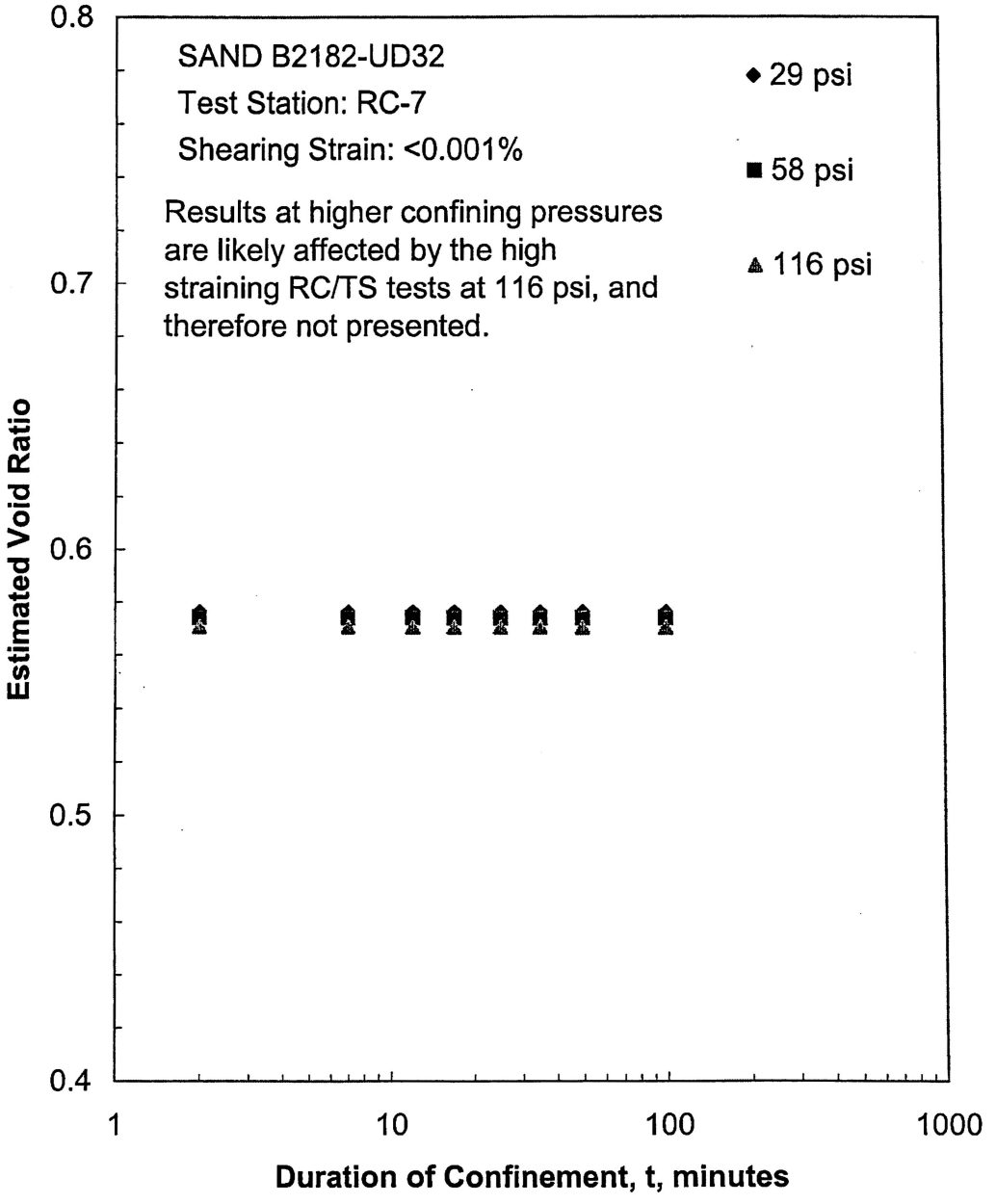

Figure C.3 Variation in Estimated Void Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

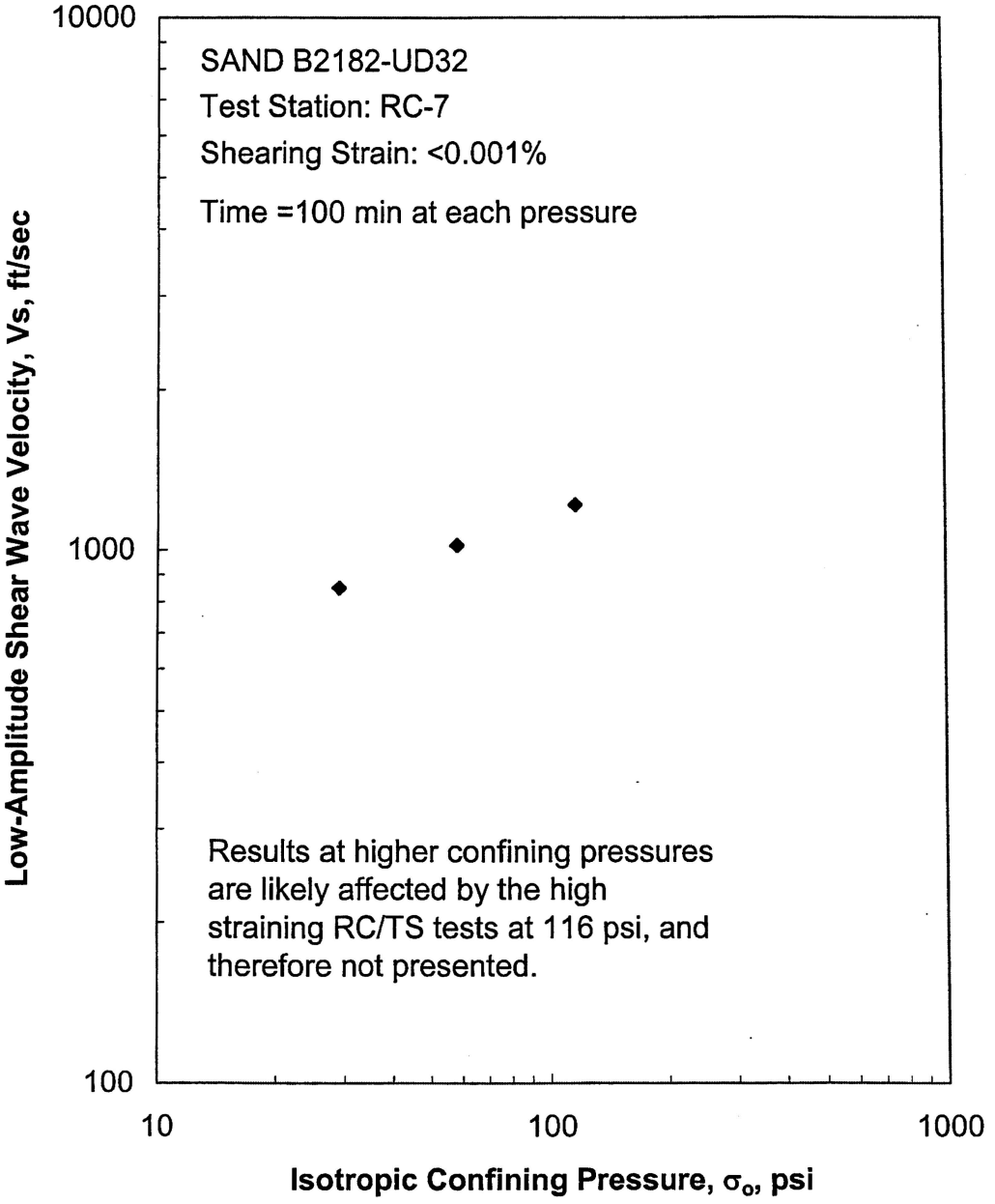

Figure C.4 Variation in Low-Amplitude Shear Wave Velocity with Isotropic Confining Pressure from Resonant Column Tests

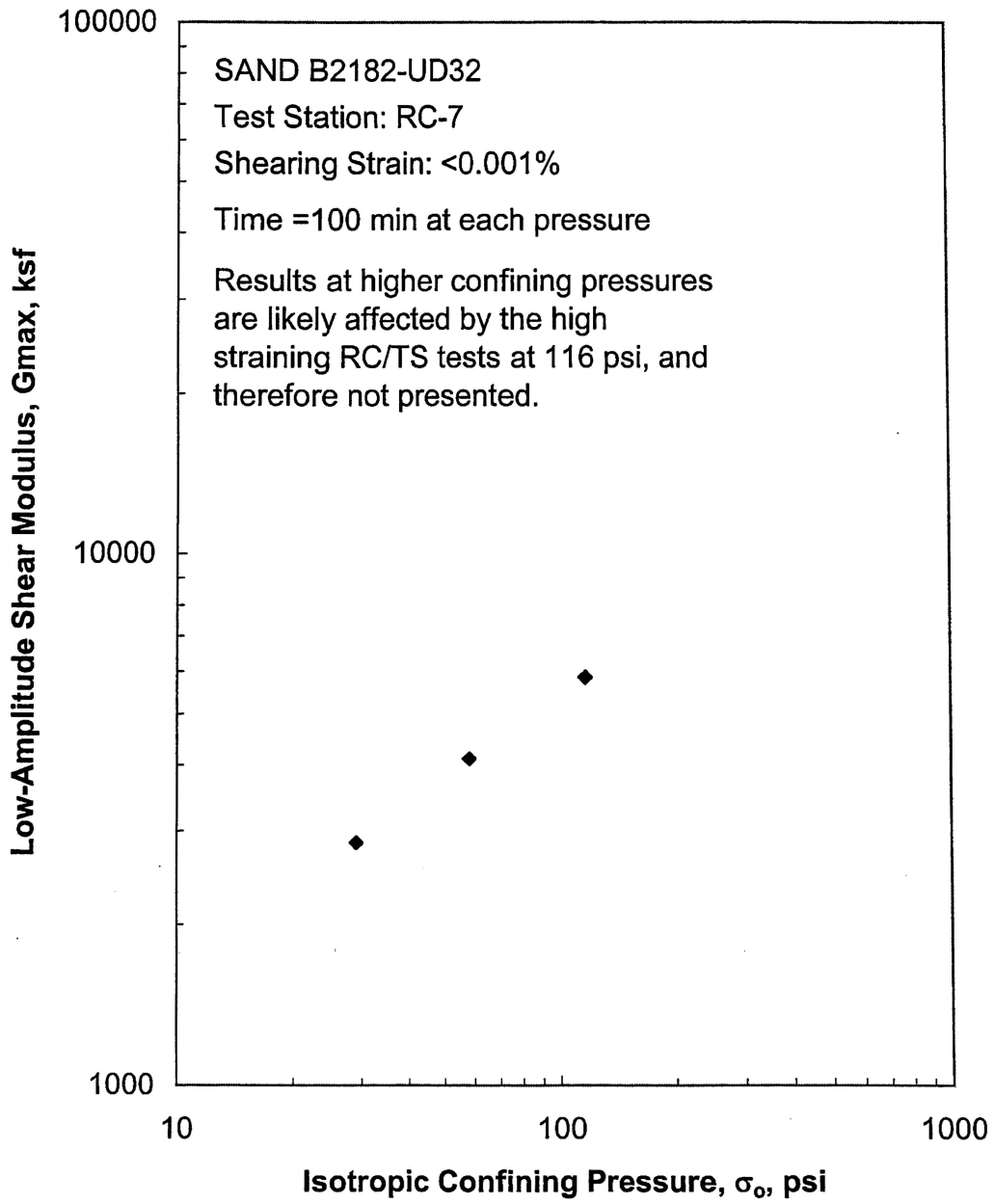

Figure C.5 Variation in Low-Amplitude Shear Modulus with Isotropic Confining Pressure from Resonant Column Tests

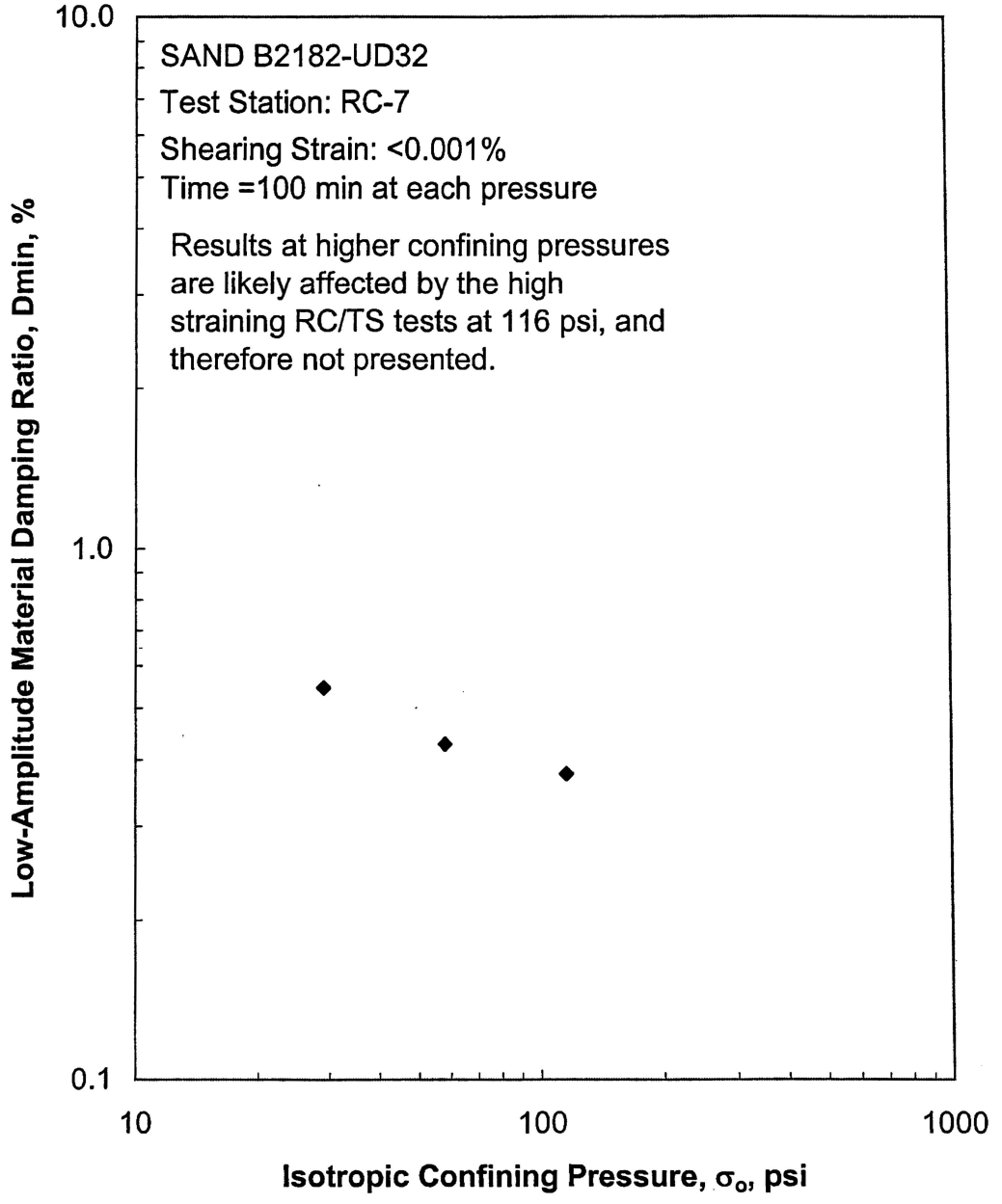

Figure C.6 Variation in Low-Amplitude Material Damping Ratio with Isotropic Confining Pressure from Resonant Column Tests

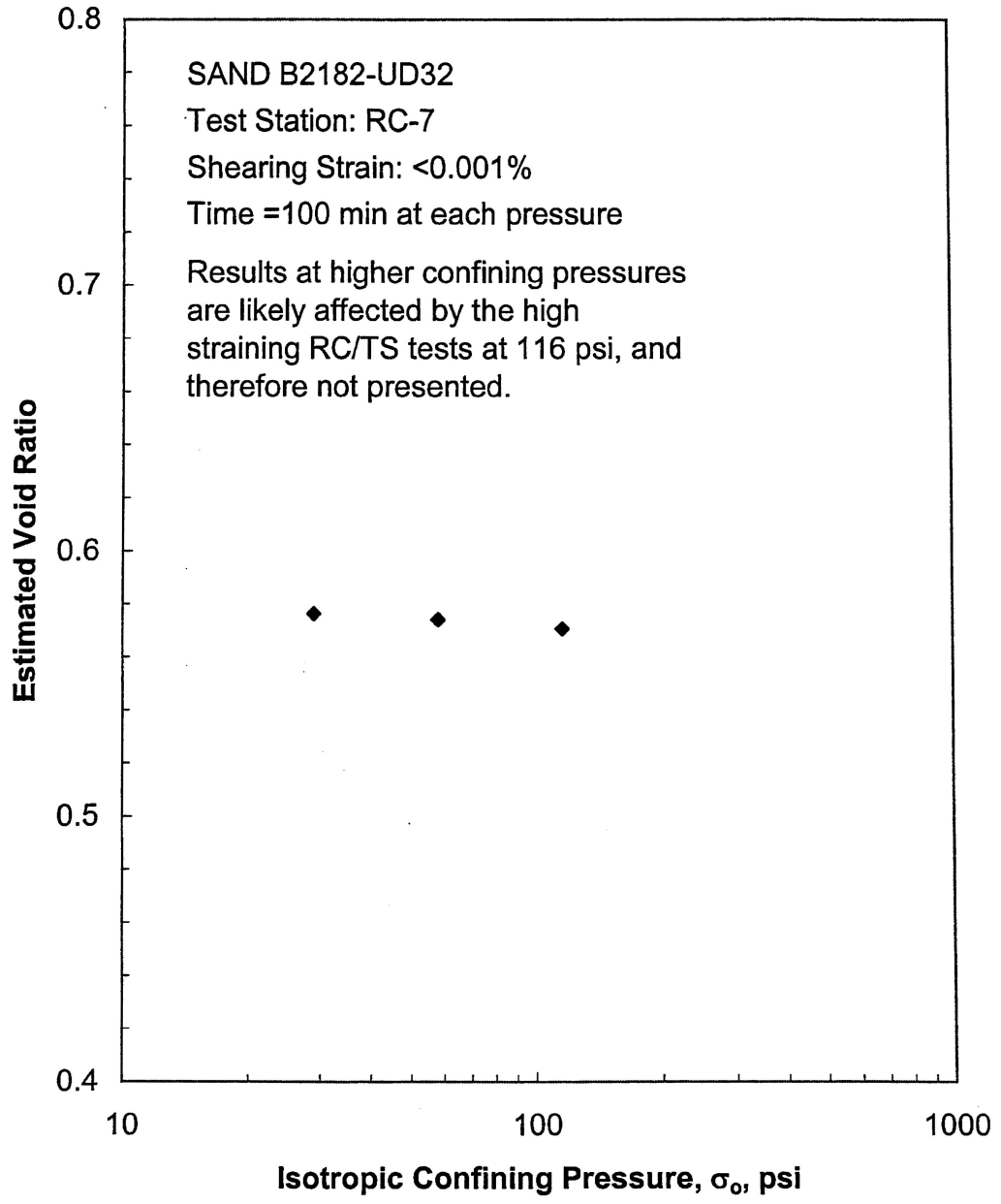

Figure C.7 Variation in Estimated Void Ratio with Isotropic Confining Pressure from Resonant Column Tests

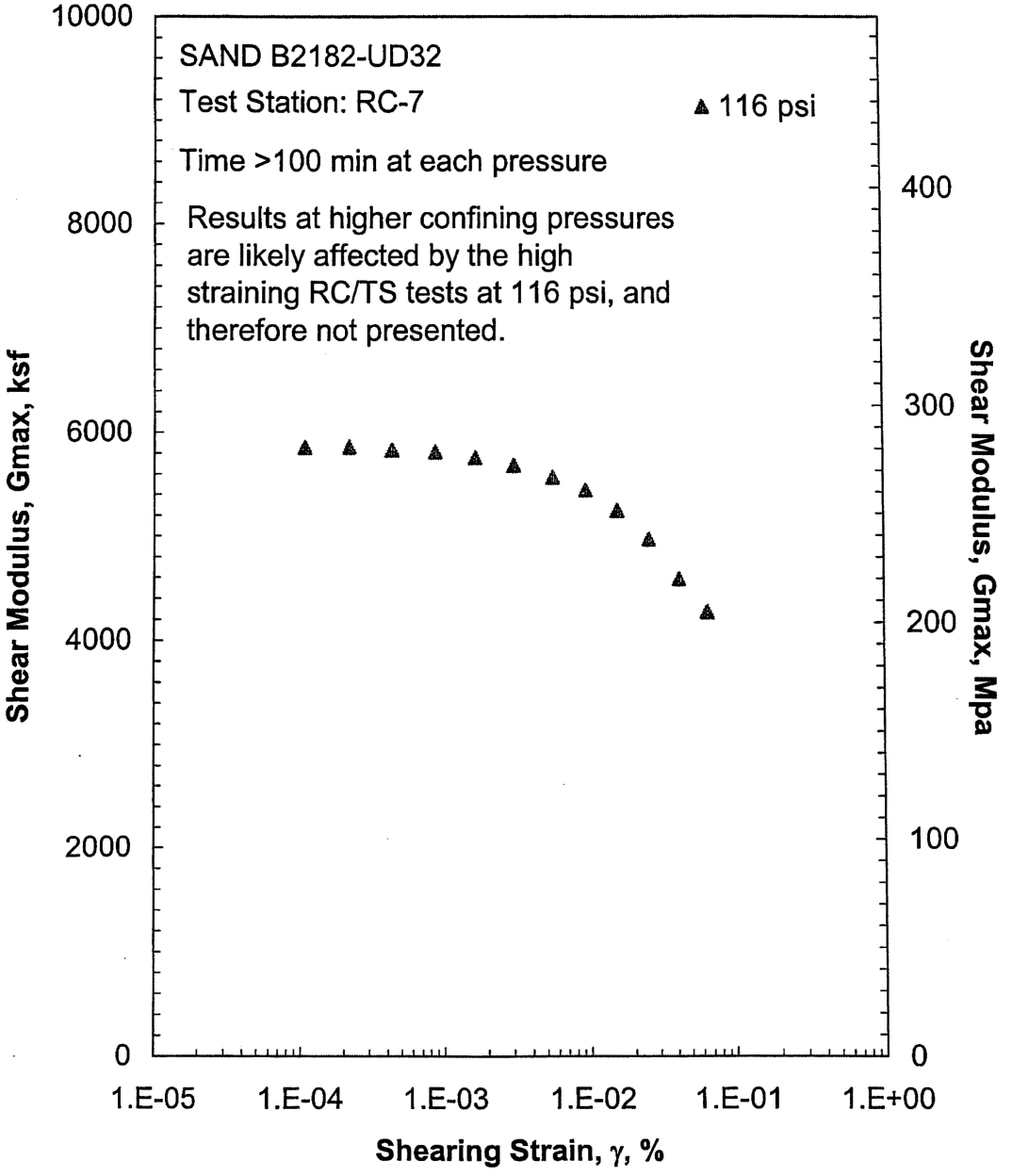

Figure C.8 Variation in Shear Modulus with Shearing Strain at An Isotropic Confining Pressure of 116 psi from the Resonant Column Tests

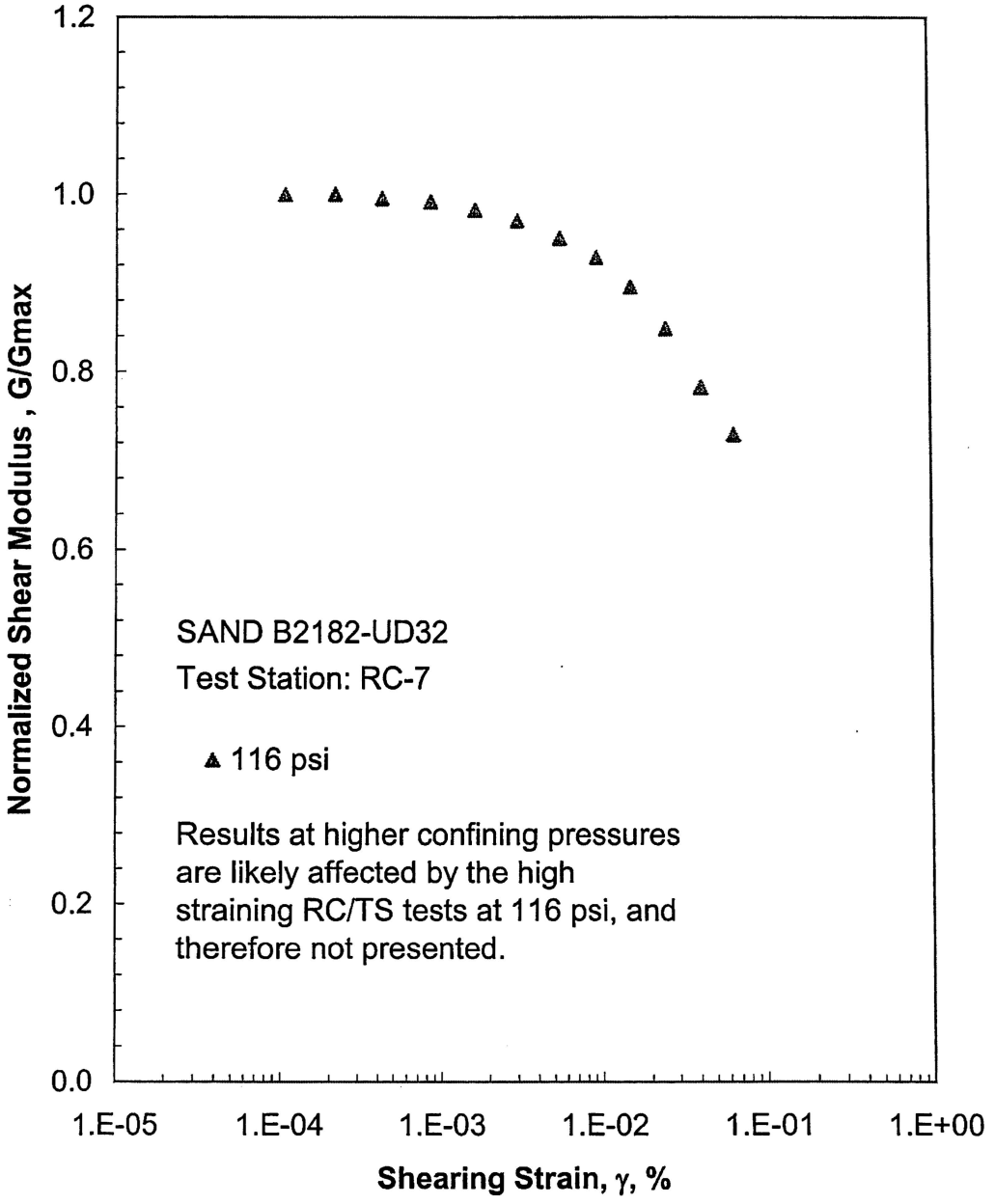

Figure C.9 Variation in Normalized Shear Modulus with Shearing Strain at An Isotropic Confining Pressure of 116 psi from the Resonant Column Tests

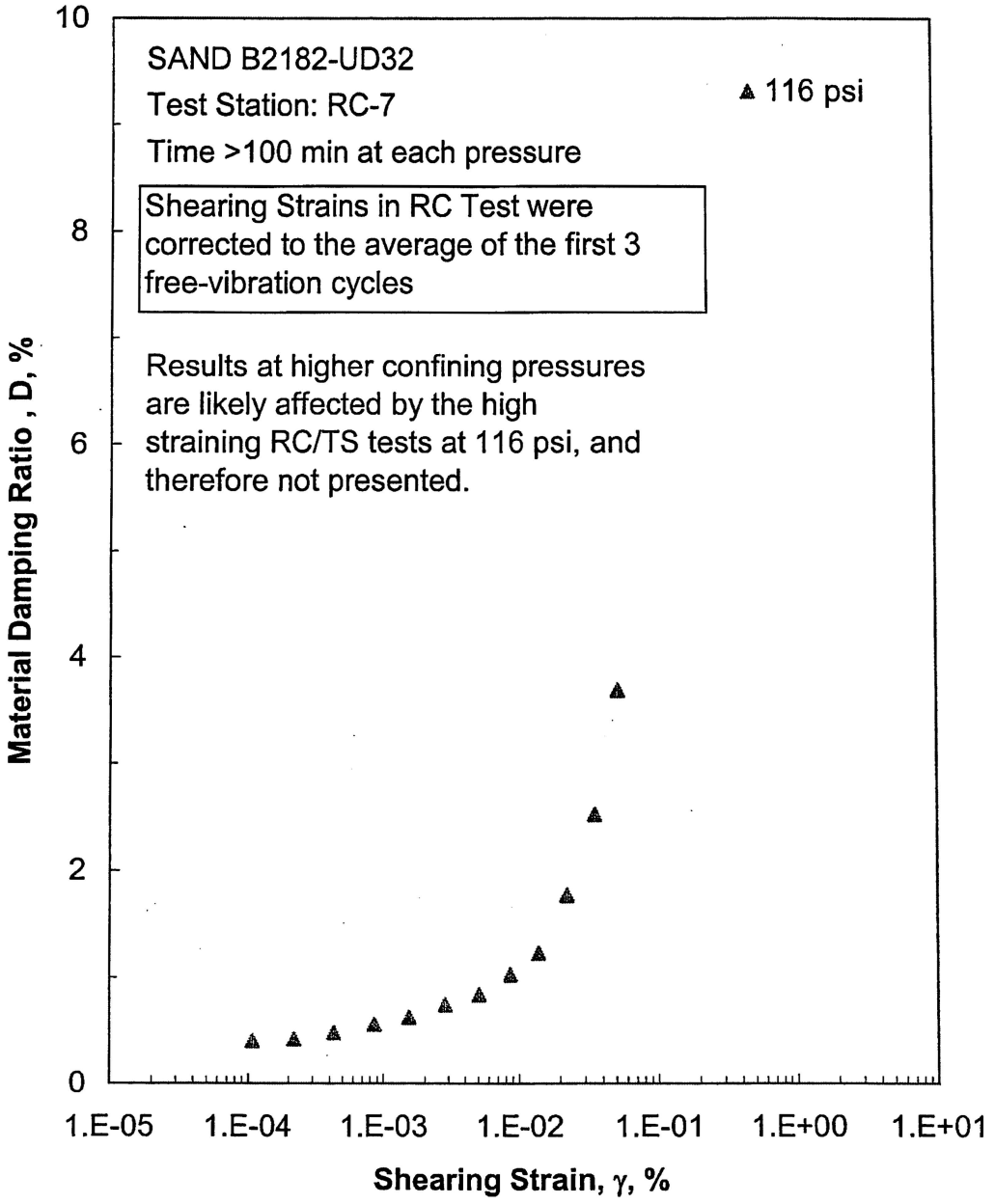

Figure C.10 Variation in Material Damping Ratio with Shearing Strain at An Isotropic Confining Pressure of 116 psi from the Resonant Column Tests

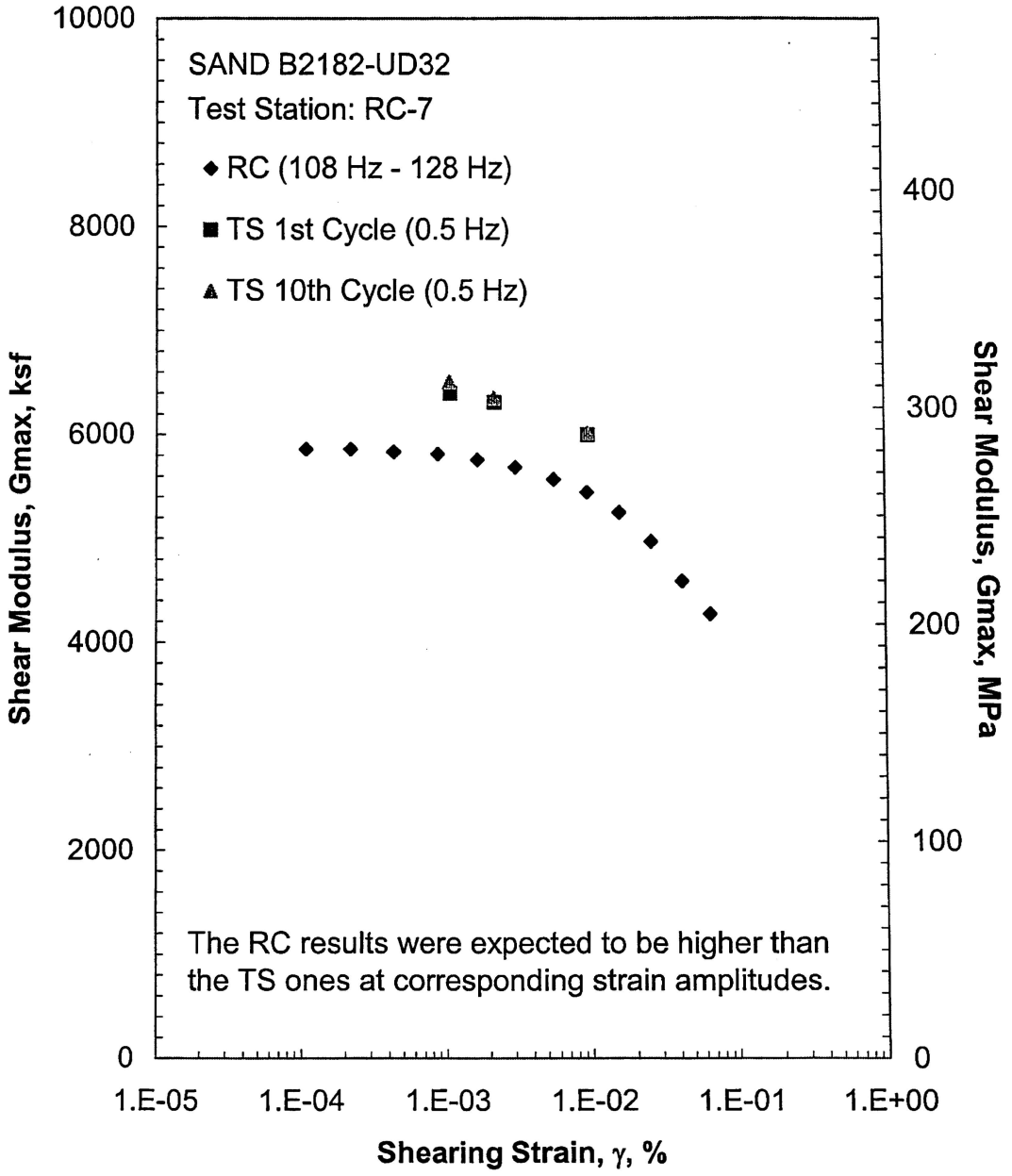

Figure C.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 116 psi from the Combined RCTS Tests

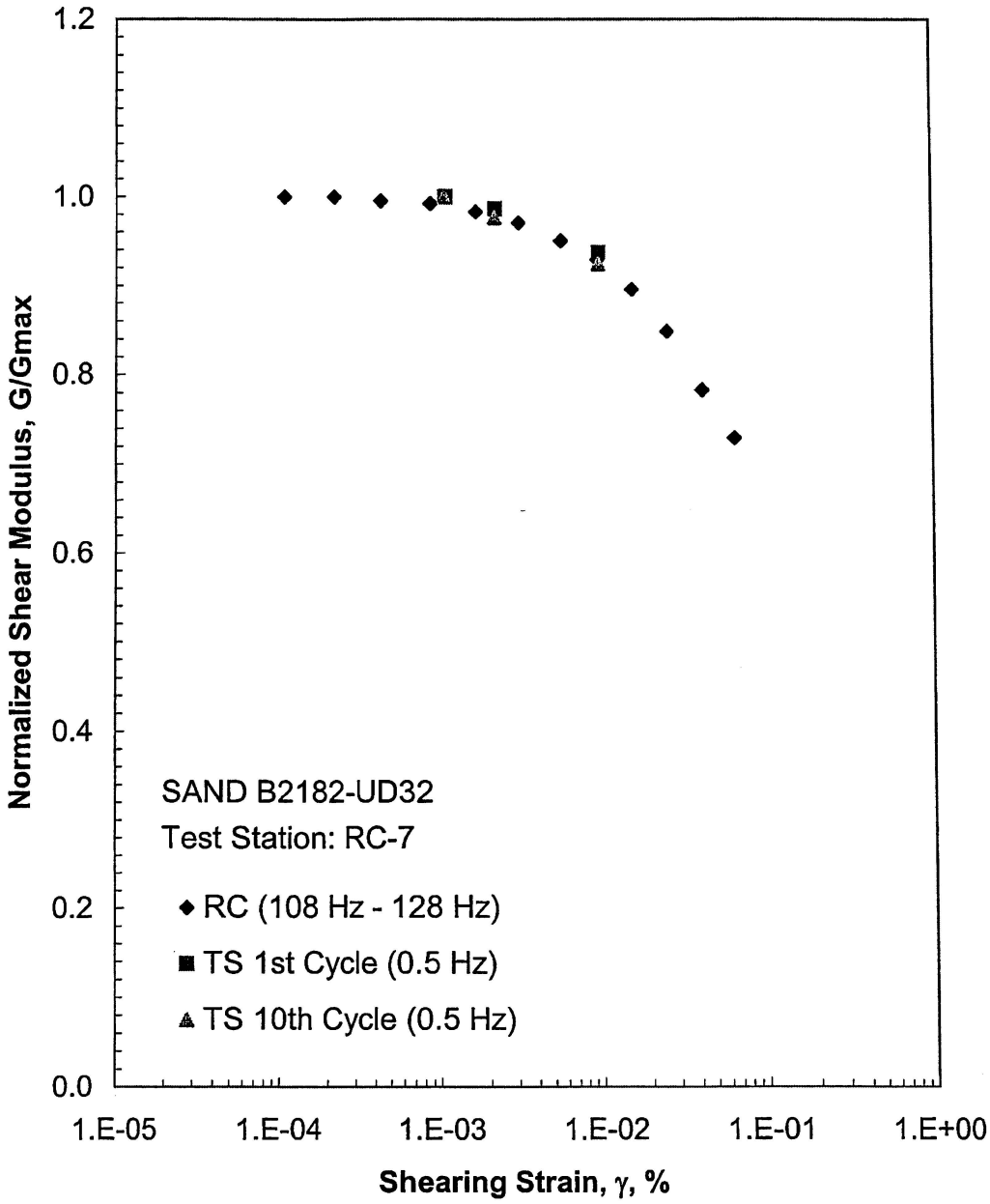

Figure C.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 116 psi from the Combined RCTS Tests

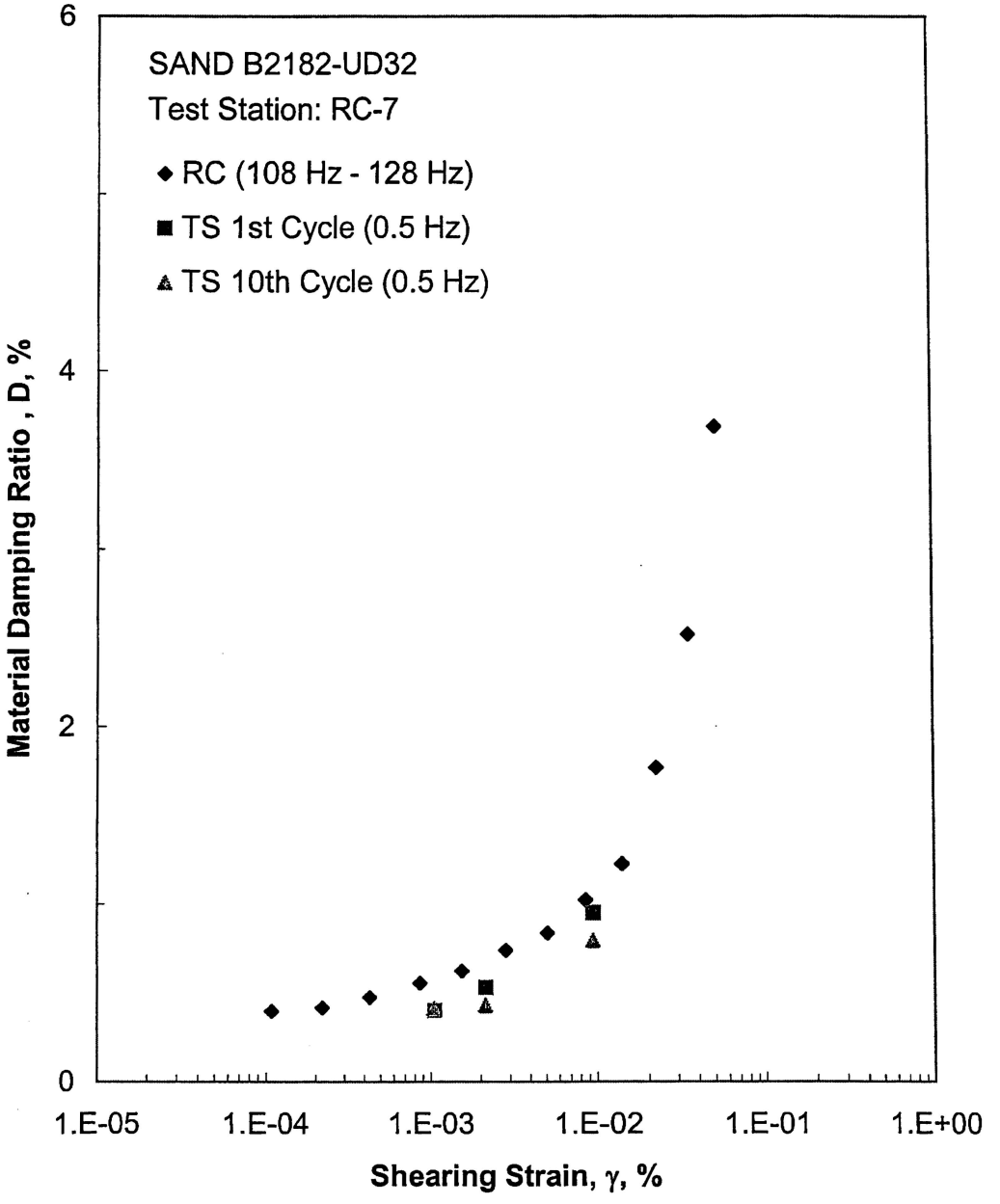

Figure C.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 116 psi from the Combined RCTS Tests

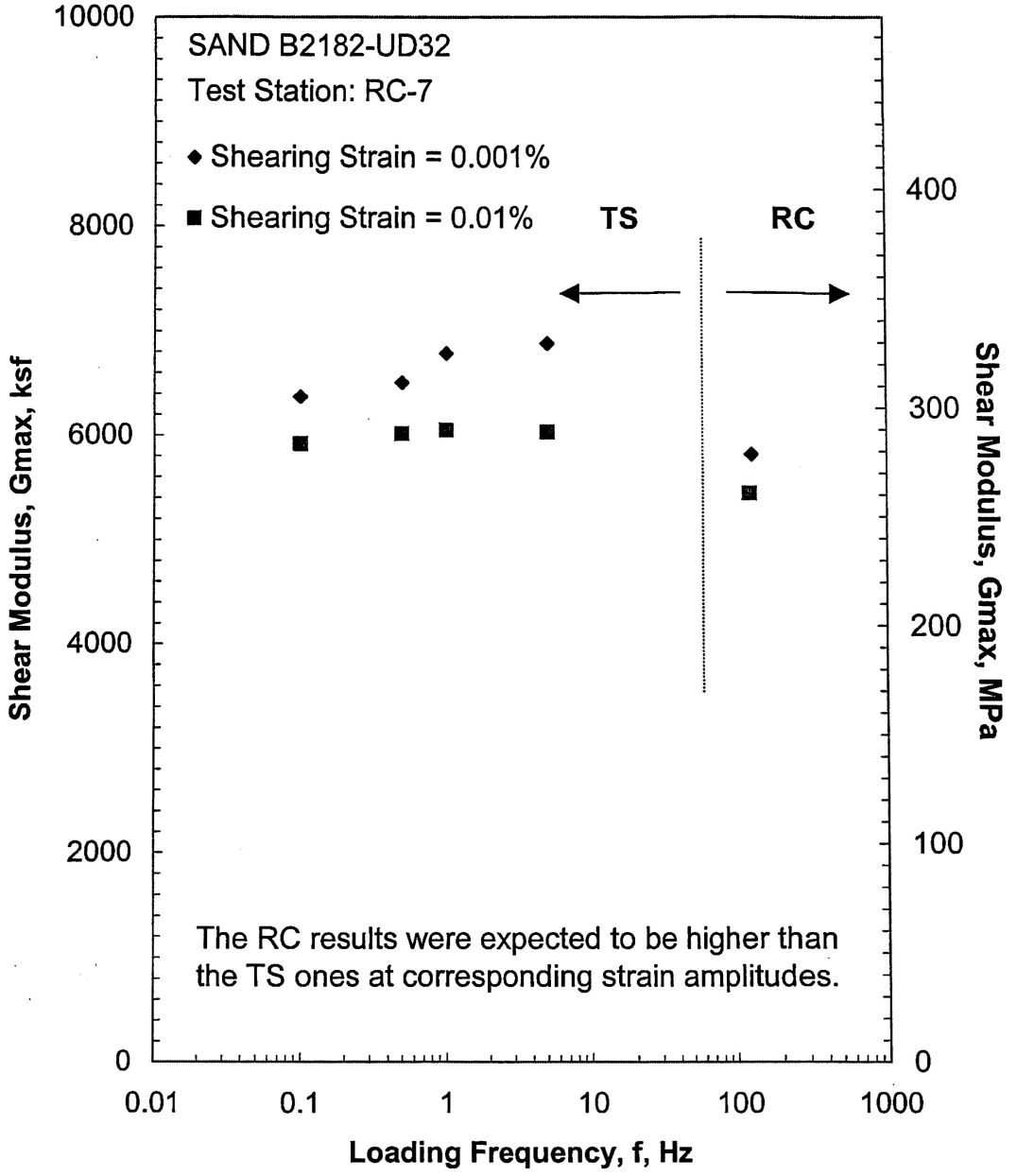

Figure C.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 116 psi from the Combined RCTS Tests

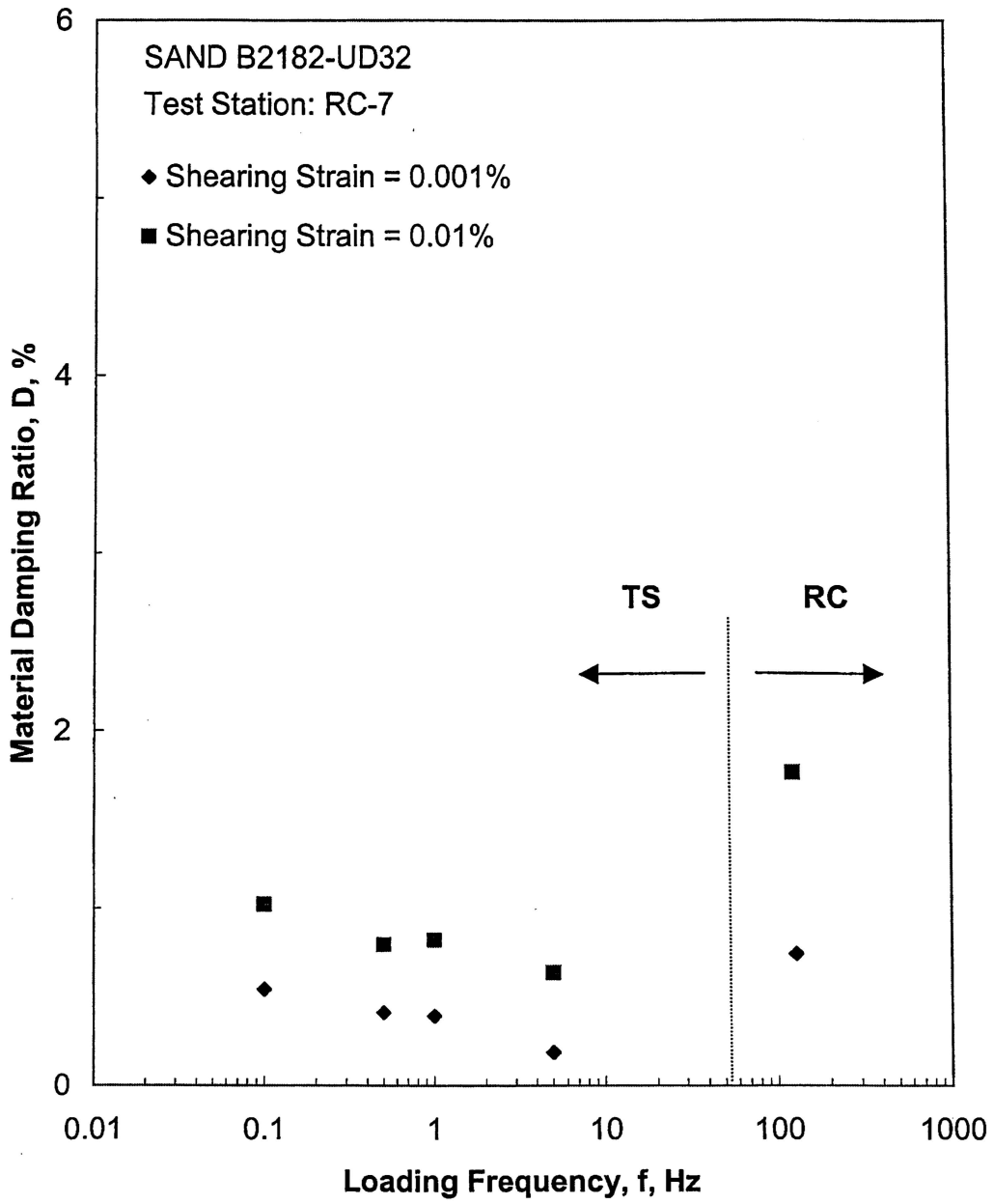

Figure C.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 116 psi from the Combined RCTS Tests

NOTE: Figures C.16 through C.20 are NOT presented due to the influence of strain hardening during testing. See relevant note on figures (Figures C.1 through C.10).

Table C.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 B2182-UD32

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)	(%)	
29	4176	200	2853	137	850	0.55	0.58
58	8352	400	4112	197	1020	0.43	0.57
116	16704	799	5856	281	1215	0.38	0.57

Note: Results at higher confining pressures are likely affected by the high straining RC/TS tests at 116 psi, and therefore not presented.

Table C.2 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen EXELON B2182-UD3; Isoptropic Confining Pressure, σ_o=116 psi (16.7 ksf = 799 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average[+] Shearing Strain, %	Material Damping Ratio[x], D, %
1.08E-04	5858	1.00	1.08E-04	0.40
2.19E-04	5858	1.00	2.19E-04	0.42
4.31E-04	5830	1.00	4.31E-04	0.48
8.63E-04	5812	0.99	8.63E-04	0.56
1.64E-03	5757	0.98	1.54E-03	0.62
3.02E-03	5684	0.97	2.84E-03	0.74
5.52E-03	5566	0.95	5.08E-03	0.84
9.32E-03	5440	0.93	8.58E-03	1.02
1.54E-02	5245	0.90	1.40E-02	1.23
2.54E-02	4969	0.85	2.24E-02	1.77
4.20E-02	4584	0.78	3.53E-02	2.52
6.55E-02	4270	0.73	5.18E-02	3.69

[+] 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 C.3 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen B2182-UD32; Isotropic Confining Pressure, σ_o= 116 psi (16.7 ksf =799 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	6398	1.00	0.40	1.04E-03	6506	1.00	0.41
2.15E-03	6309	0.99	0.53	2.13E-03	6351	0.98	0.43
9.50E-03	5993	0.94	0.95	9.47E-03	6012	0.92	0.80

Table C.4 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen B2182-UD32; 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, %
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[+] 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

* Results at higher confining pressures are likely affected by the high straining RC/TS tests at 116 psi, and therefore not presented.

Table C.5 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen B2182-UD32; 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, %
---*	---*	---*	---*	---*	---*	---*	---*

* Results at higher confining pressures are likely affected by the high straining RC/TS tests at 116 psi, and therefore not presented.

APPENDIX D

Specimen EXELON B2182-UD18
(Index Properties Not Available)

Borehole B2182
Sample UD18
Depth = 220.5 ft (67.2 m)
Total Unit Weight = 115.1 lb/ft^3
Water Content = 35.2 %
Estimated In-Situ Ko = 0.5
Estimated In-Situ Mean Effective
Stress = 78 psi

FUGRO JOB #: 0401-1686
Testing Station: RC6

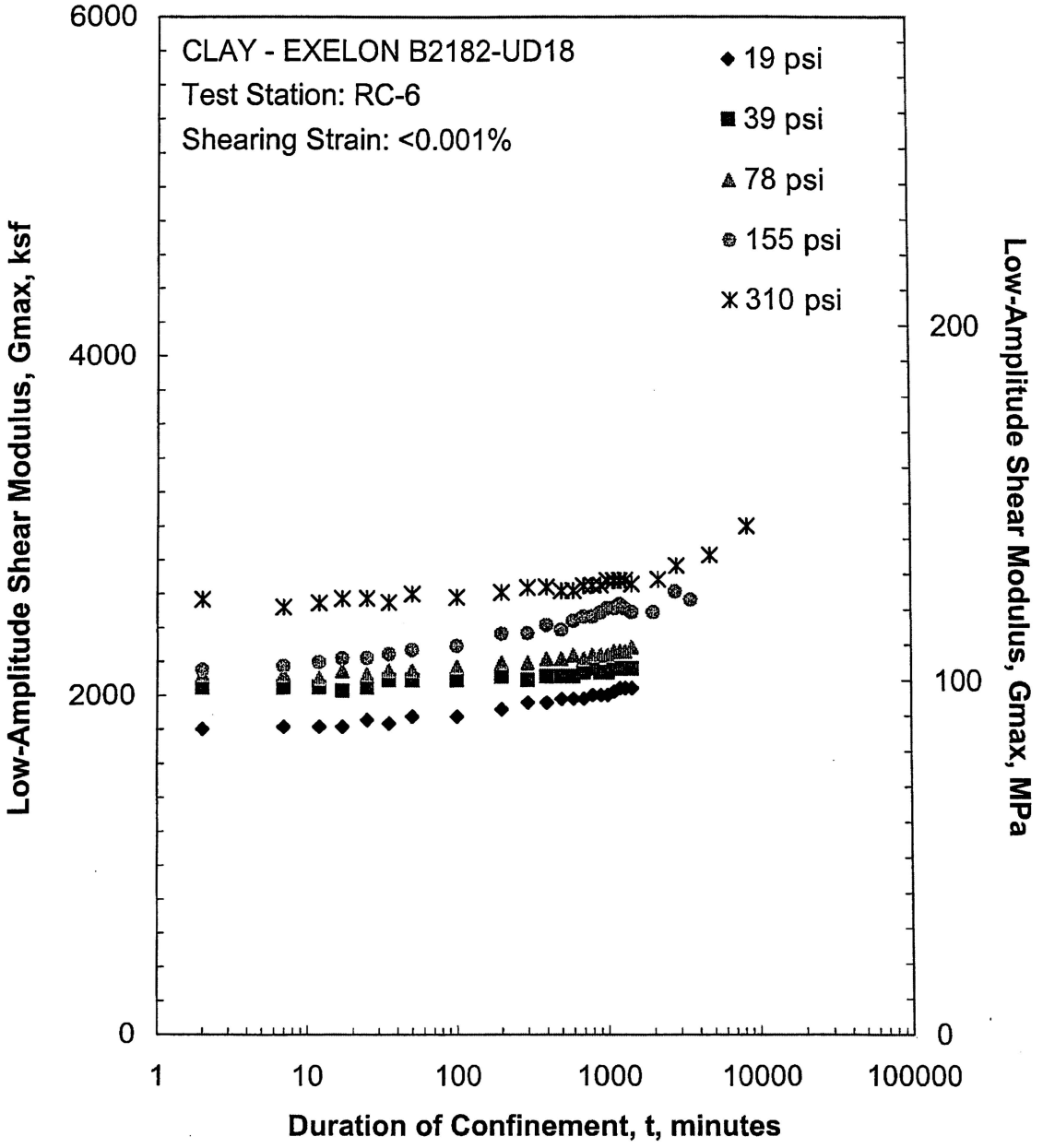

Figure D.1 Variation in Low-Amplitude Shear Modulus with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

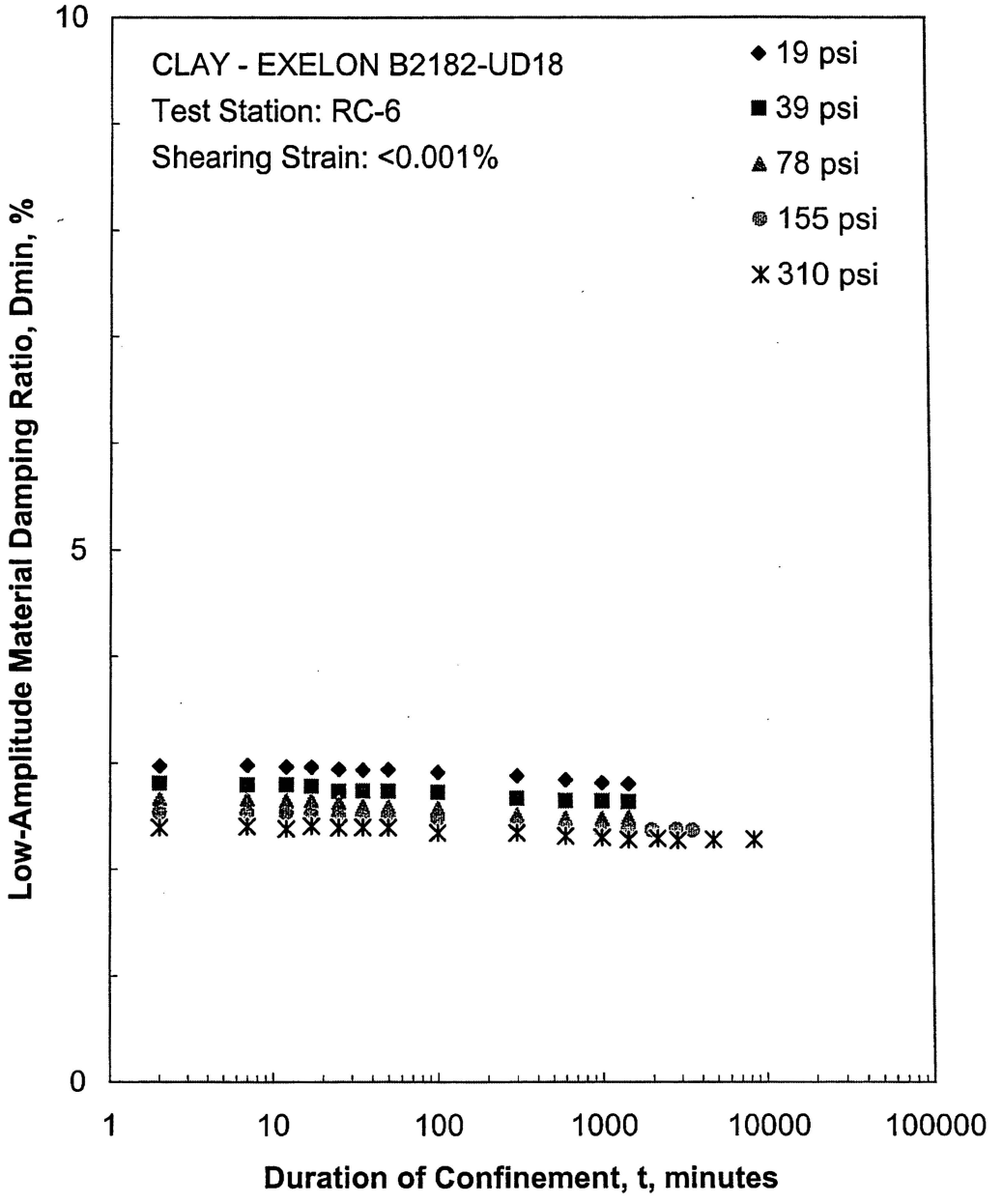

Figure D.2 Variation in Low-Amplitude Material Damping Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

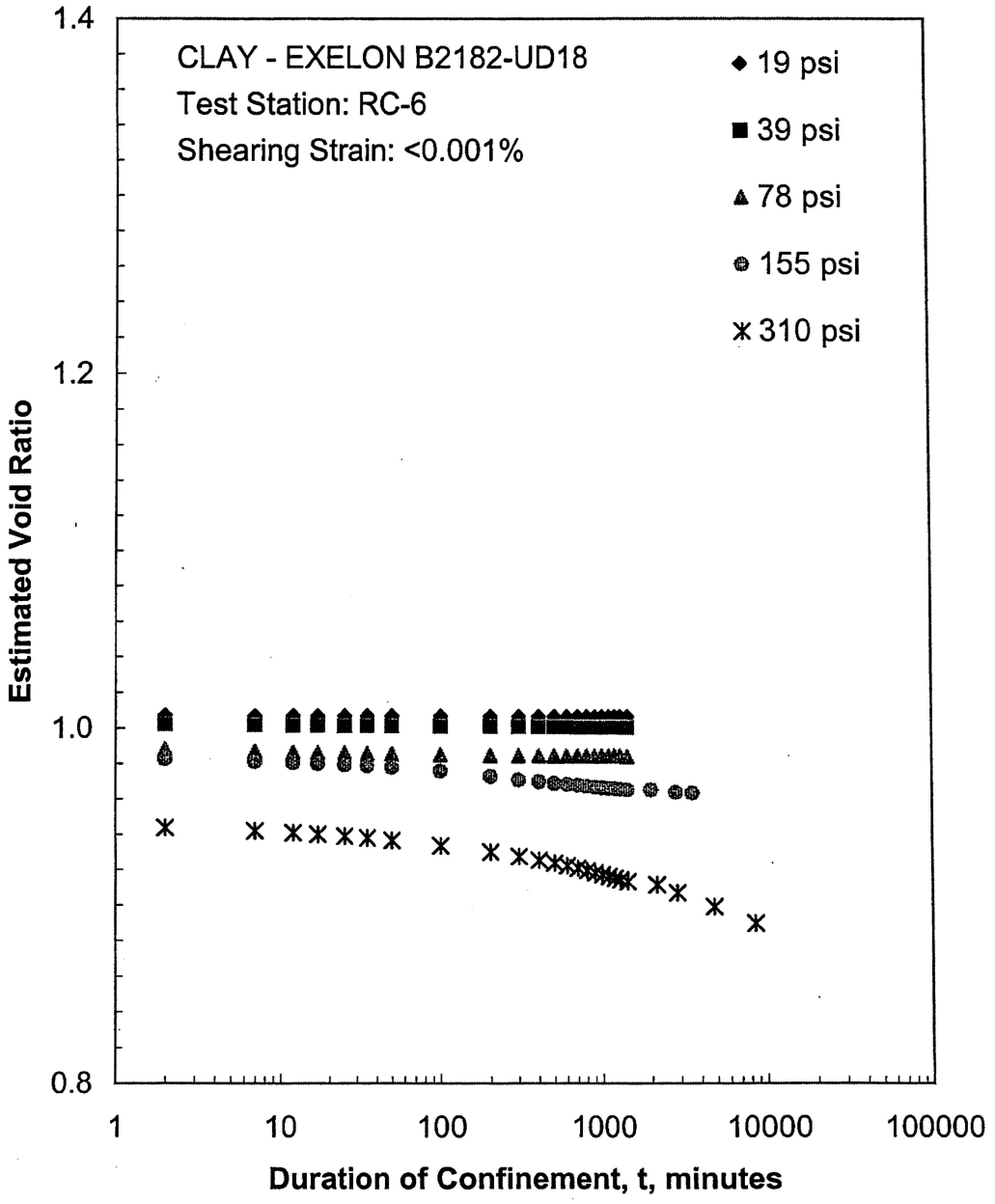

Figure D.3 Variation in Estimated Void Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

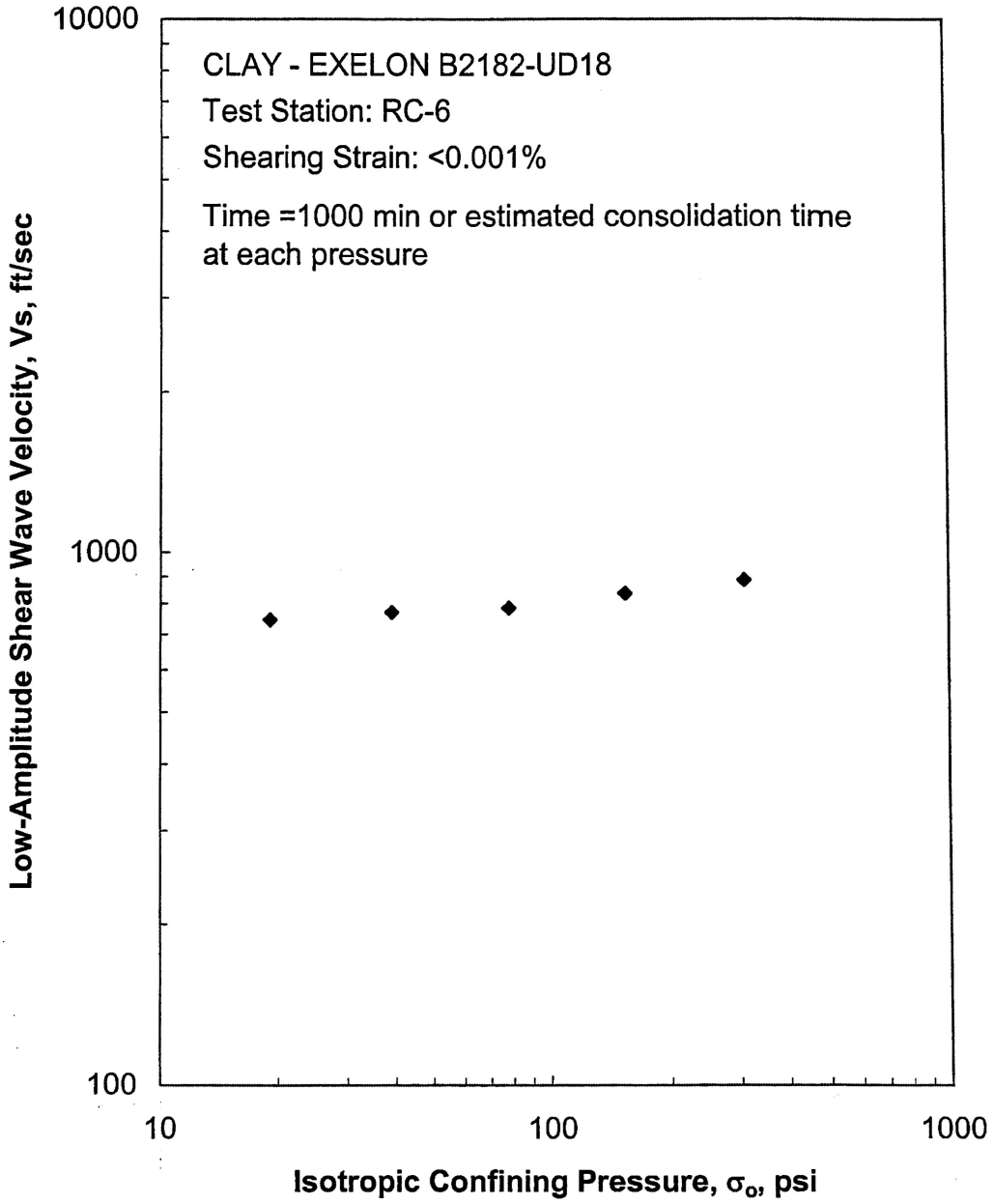

Figure D.4 Variation in Low-Amplitude Shear Wave Velocity with Isotropic Confining Pressure from Resonant Column Tests

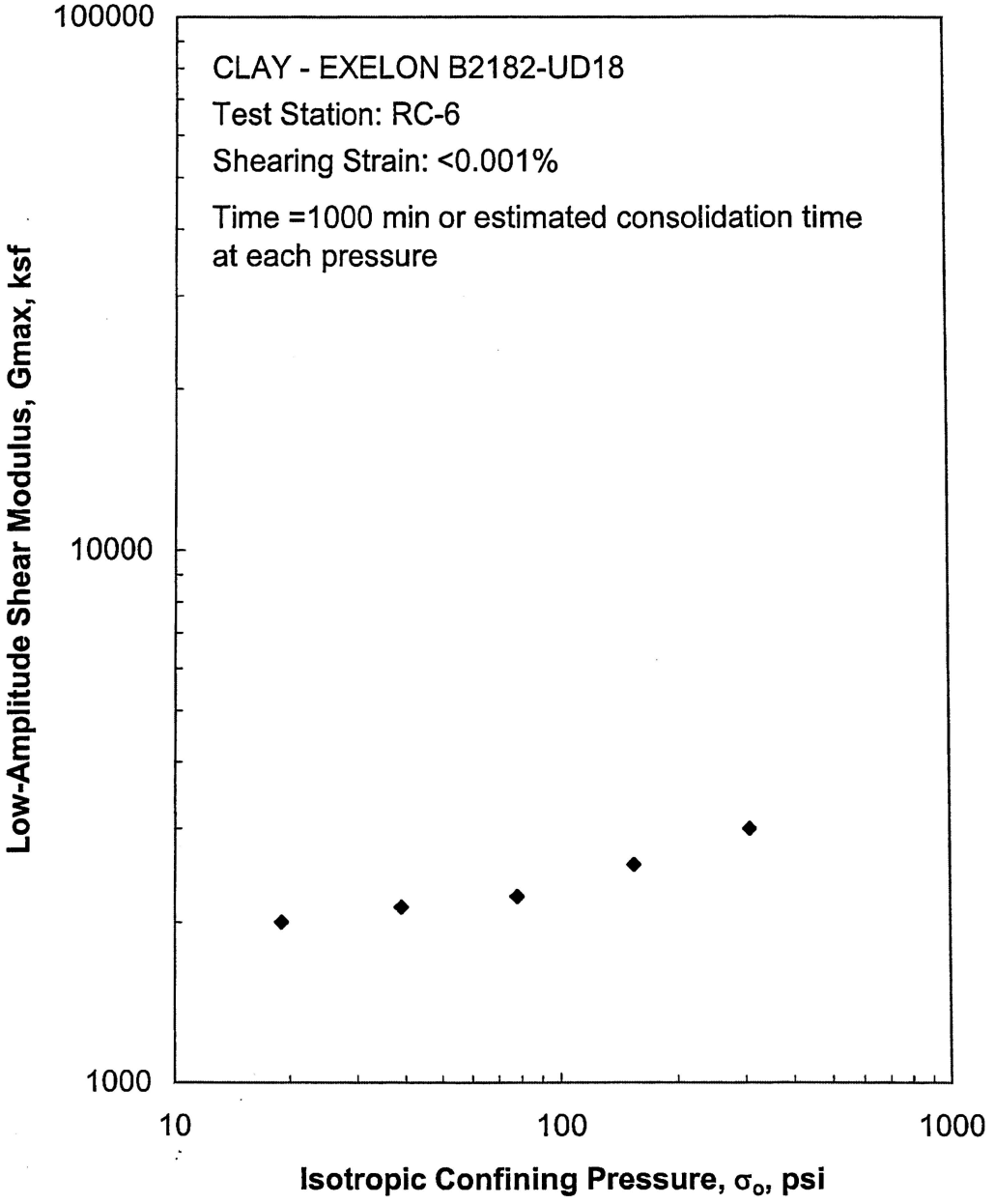

Figure D.5 Variation in Low-Amplitude Shear Modulus with Isotropic Confining Pressure from Resonant Column Tests

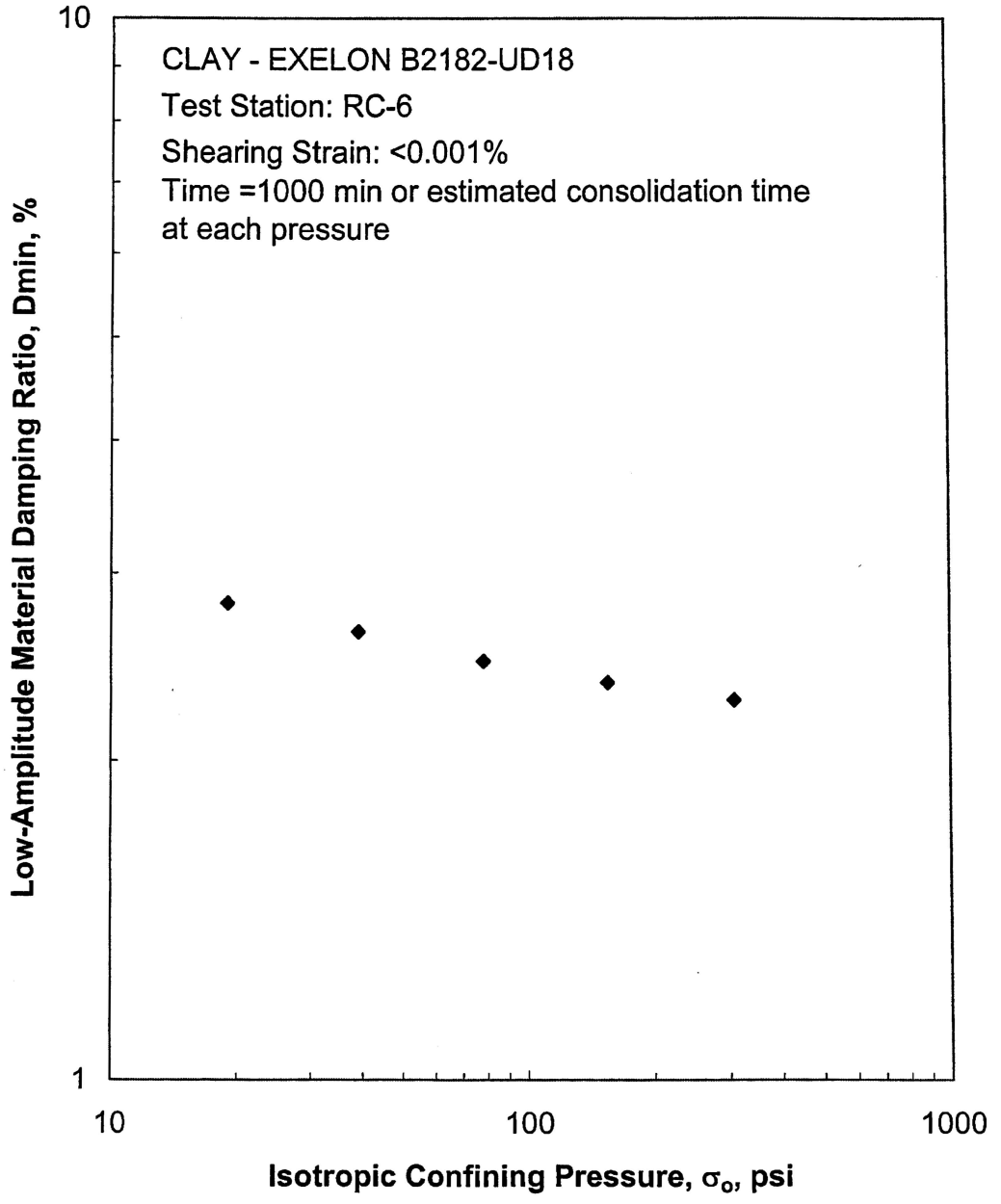

Figure D.6 Variation in Low-Amplitude Material Damping Ratio with Isotropic Confining Pressure from Resonant Column Tests

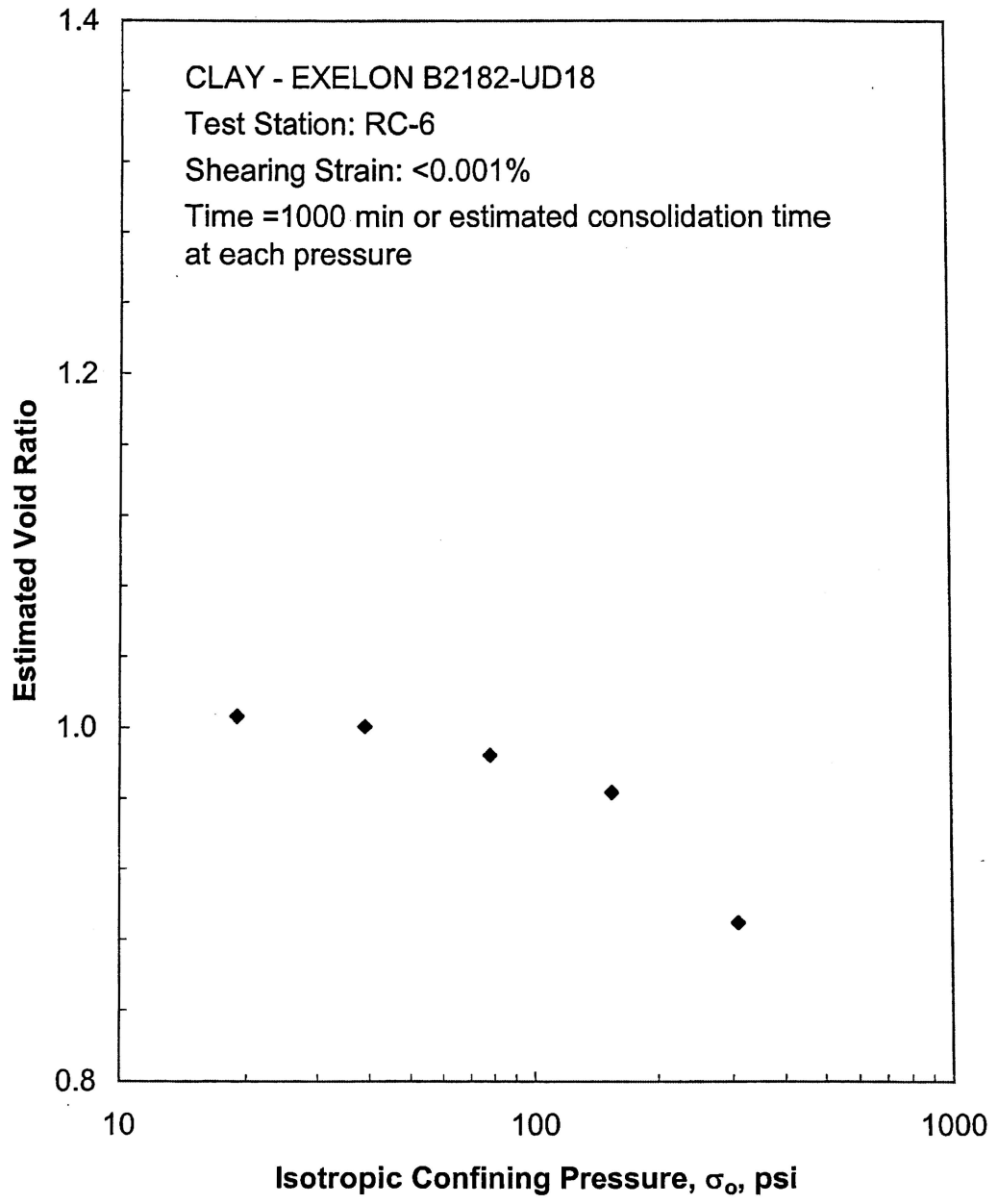

Figure D.7 Variation in Estimated Void Ratio with Isotropic Confining Pressure from Resonant Column Tests

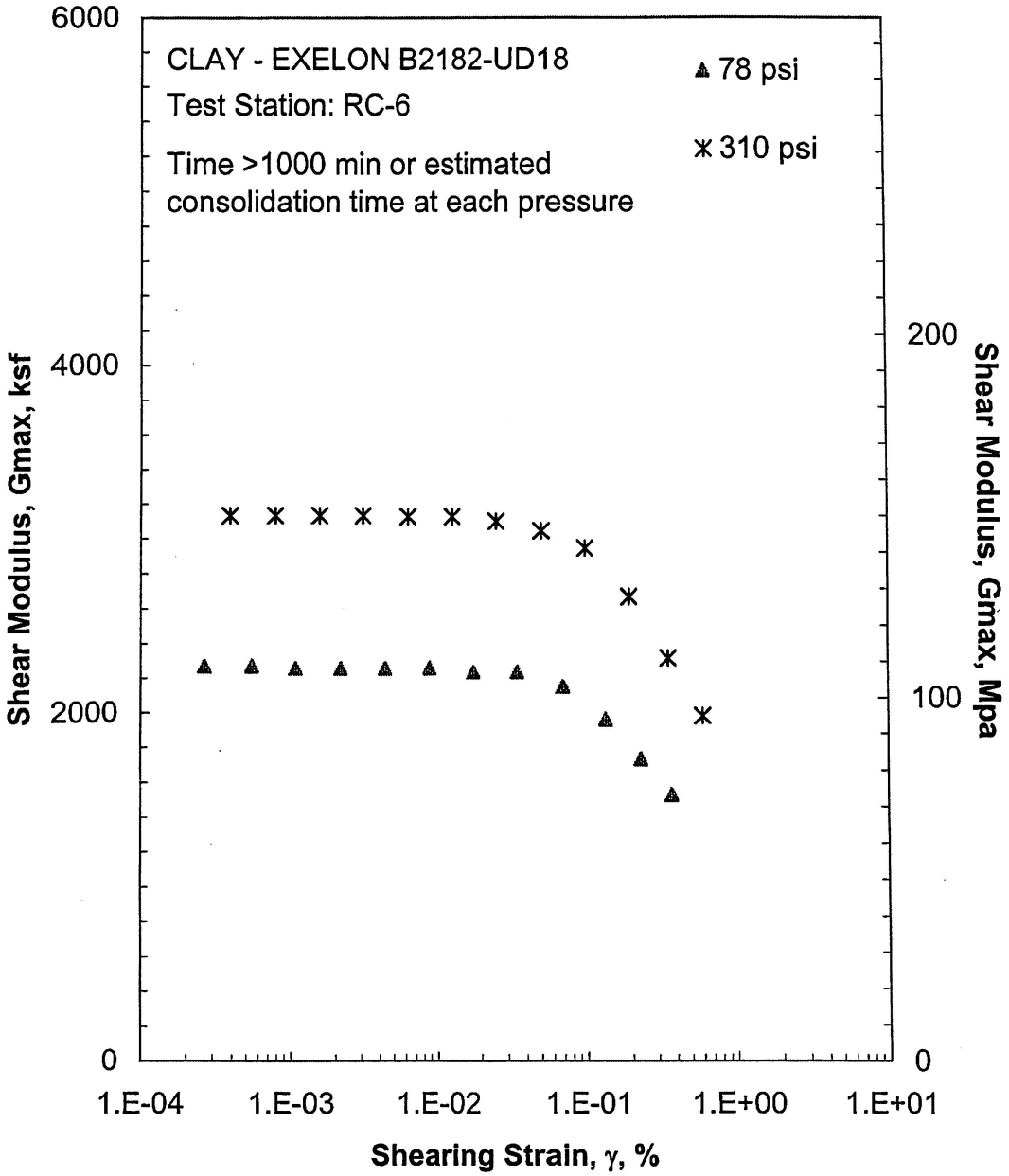

Figure D.8 Comparison of the Variation in Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

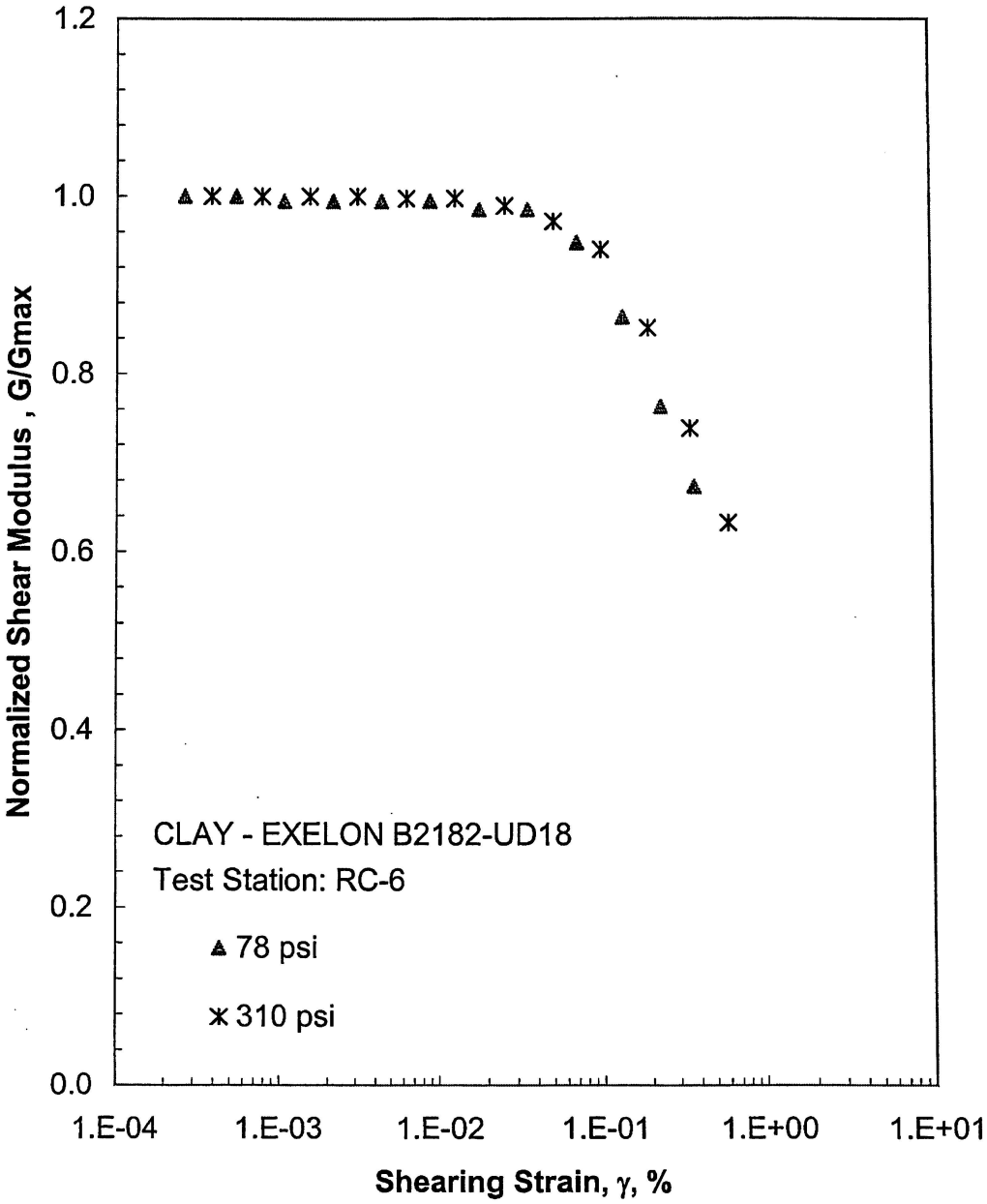

Figure D.9 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

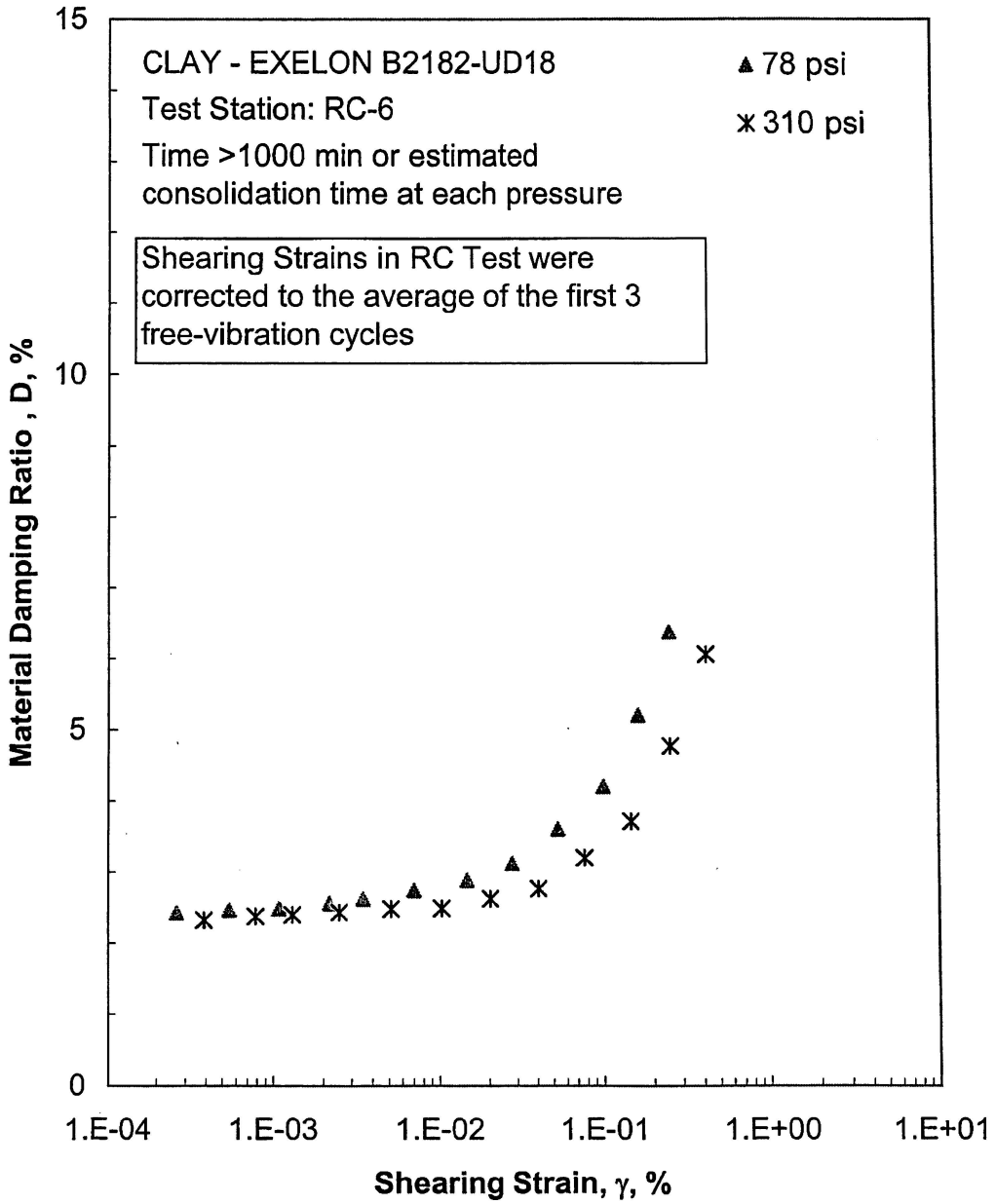

Figure D.10 Comparison of the Variation in Material Damping Ratio with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

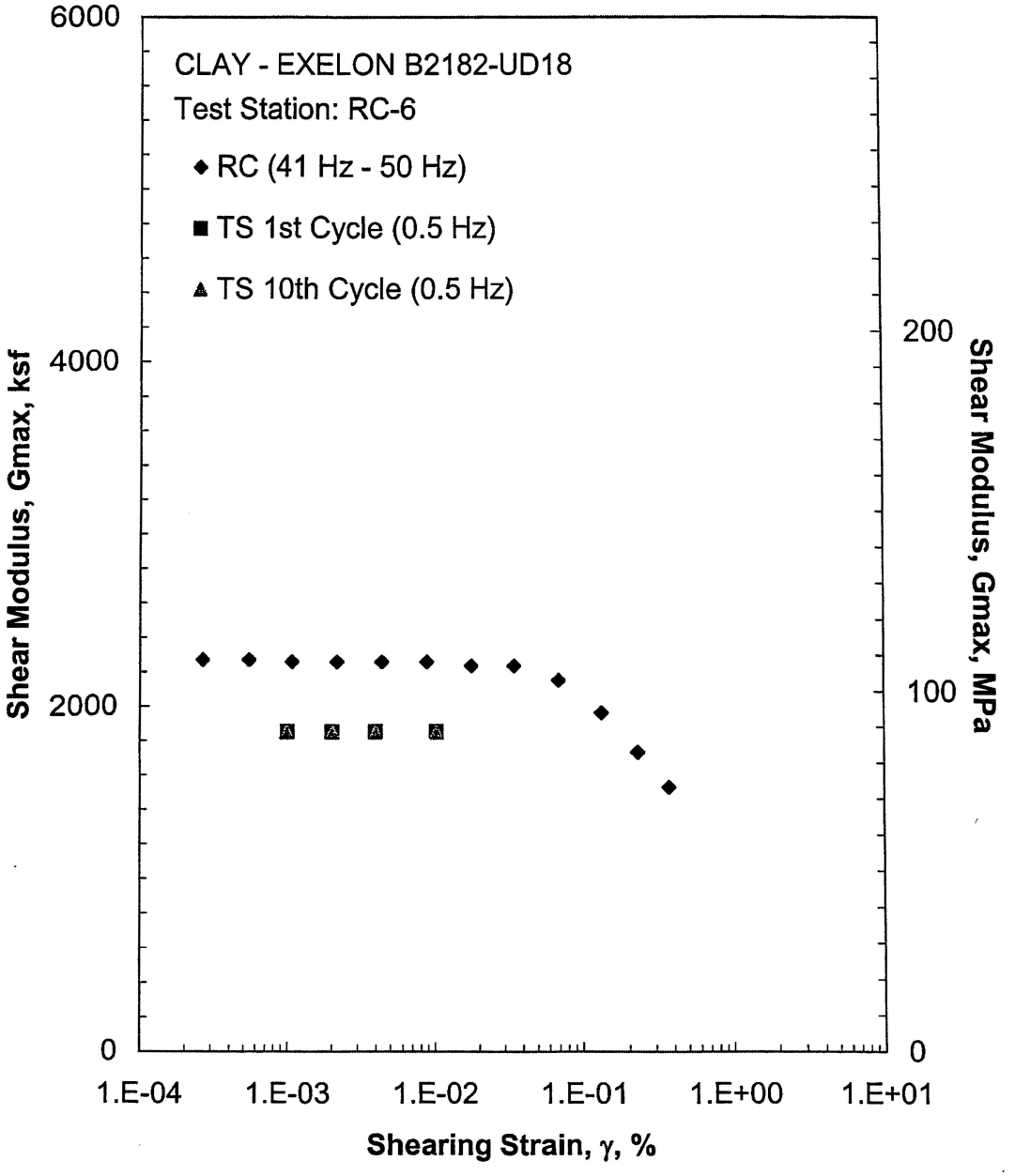

Figure D.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 78 psi from the Combined RCTS Tests

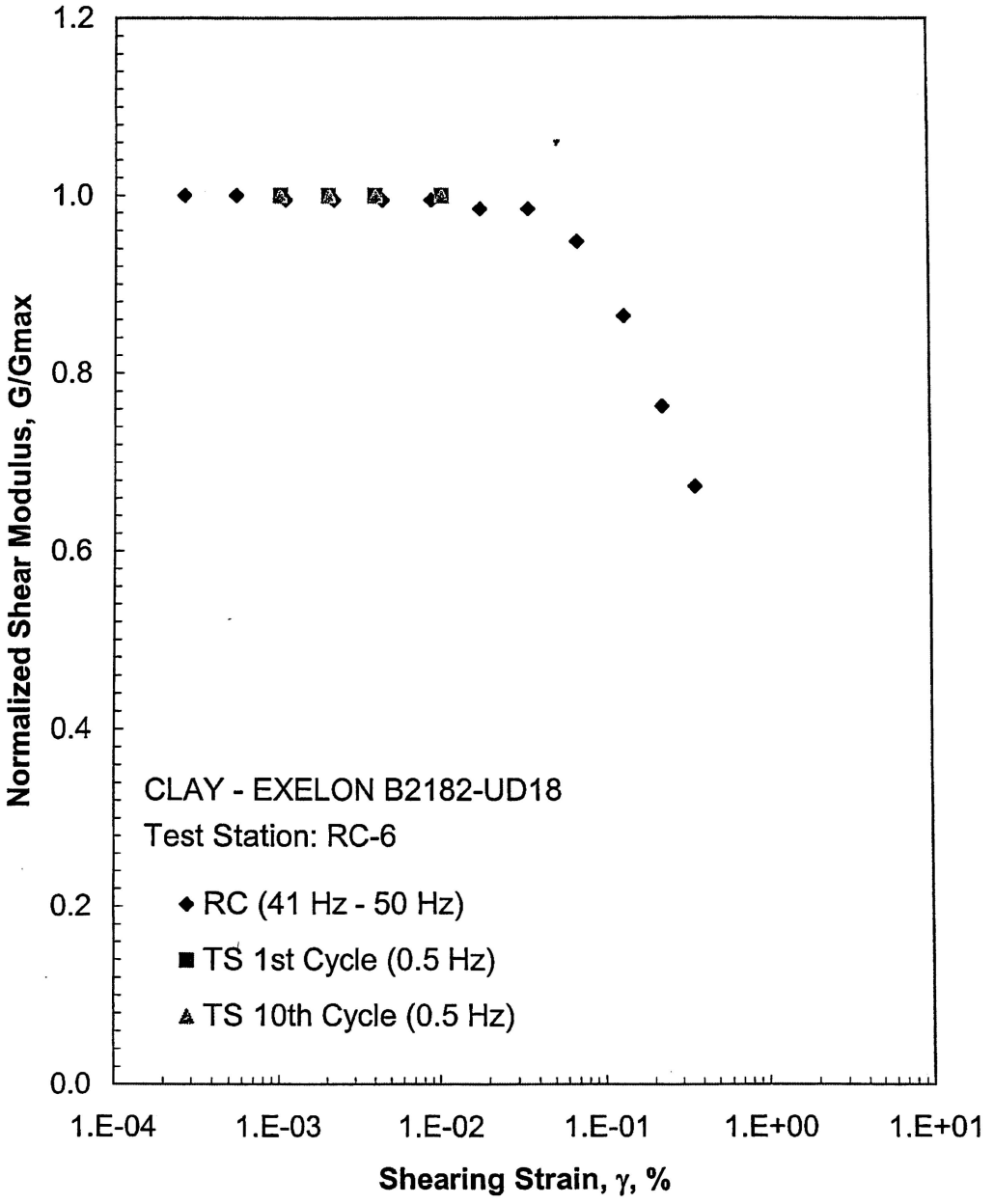

Figure D.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 78 psi from the Combined RCTS Tests

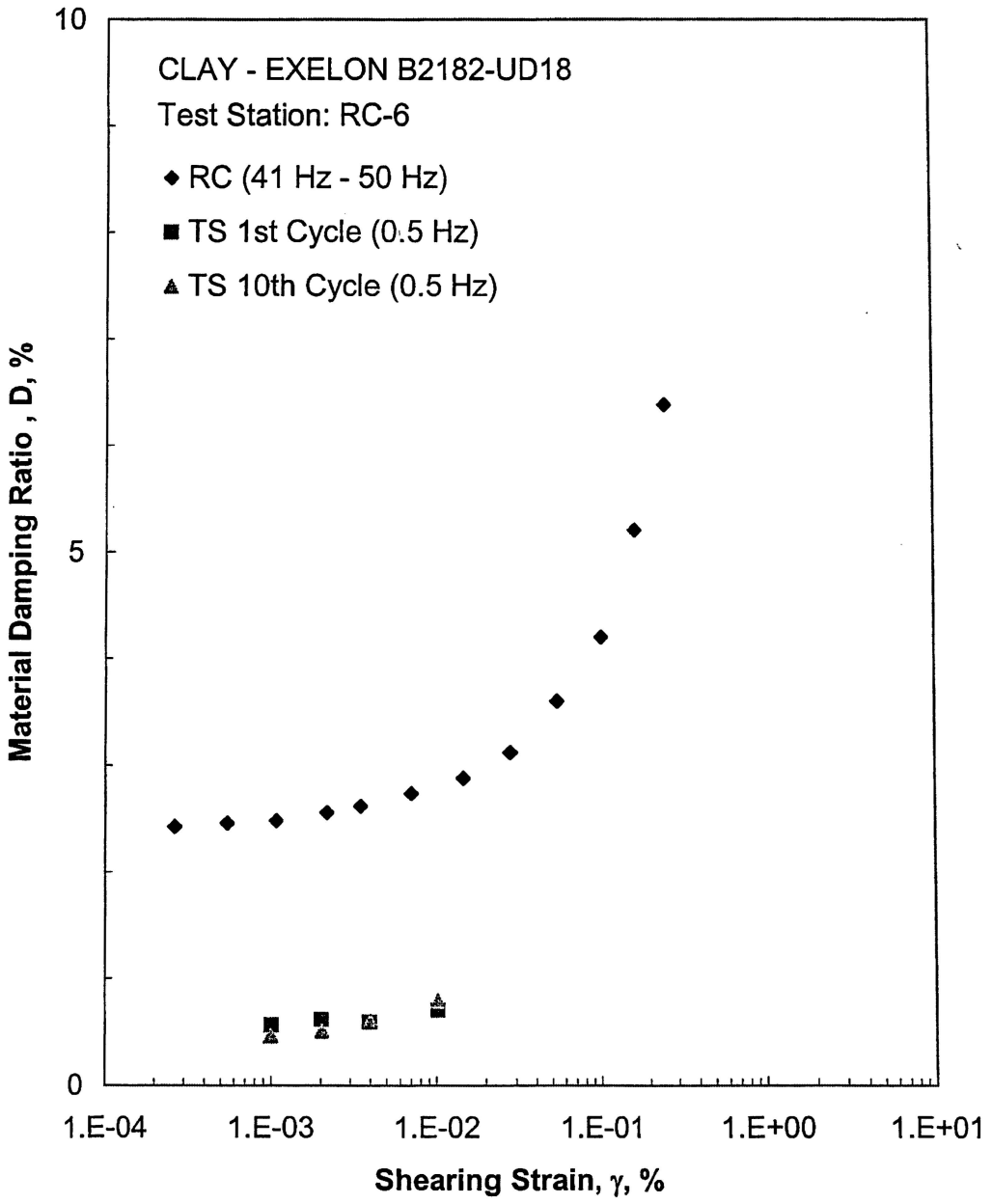

Figure D.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 78 psi from the Combined RCTS Tests

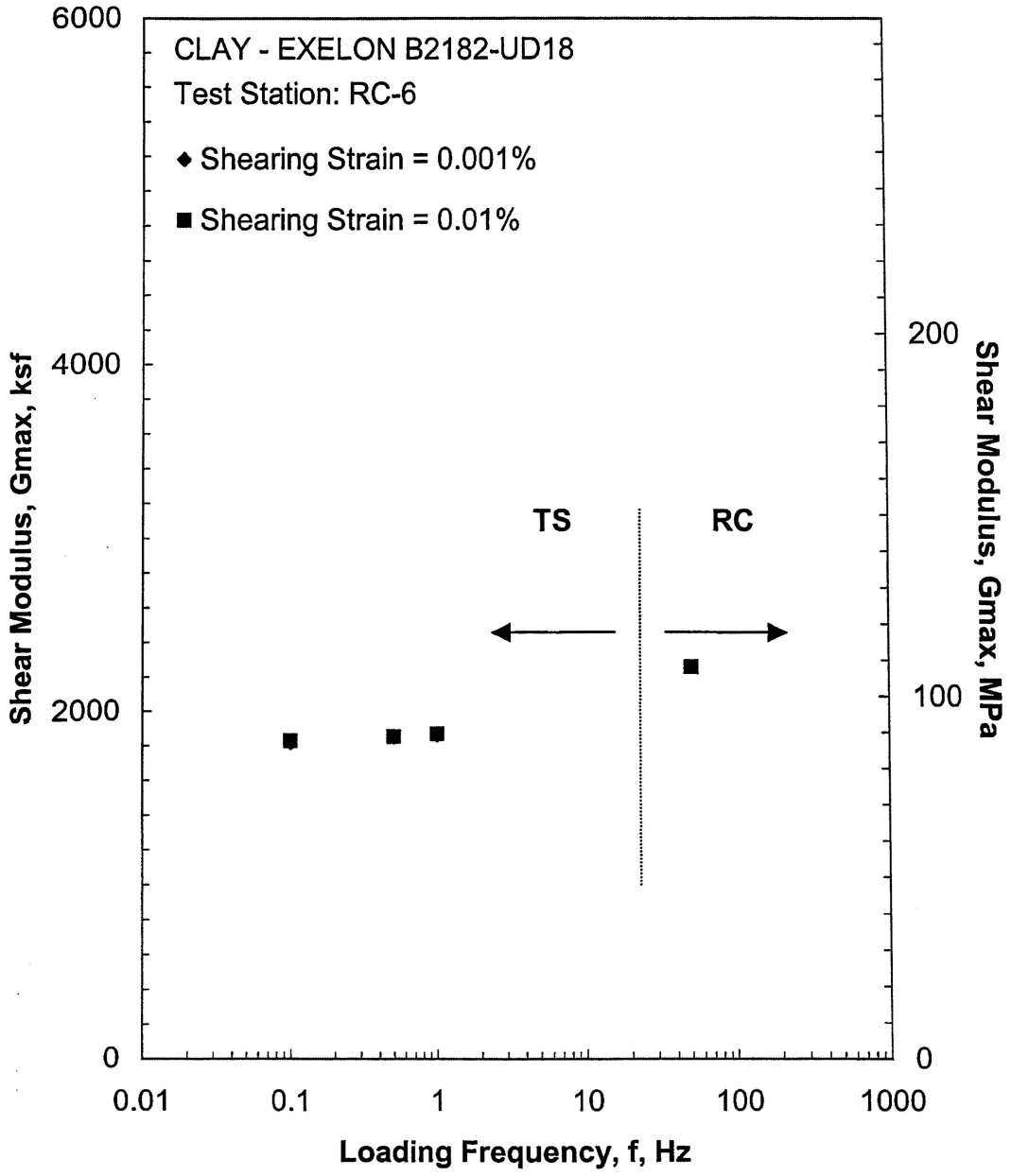

Figure D.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 78 psi from the Combined RCTS Tests

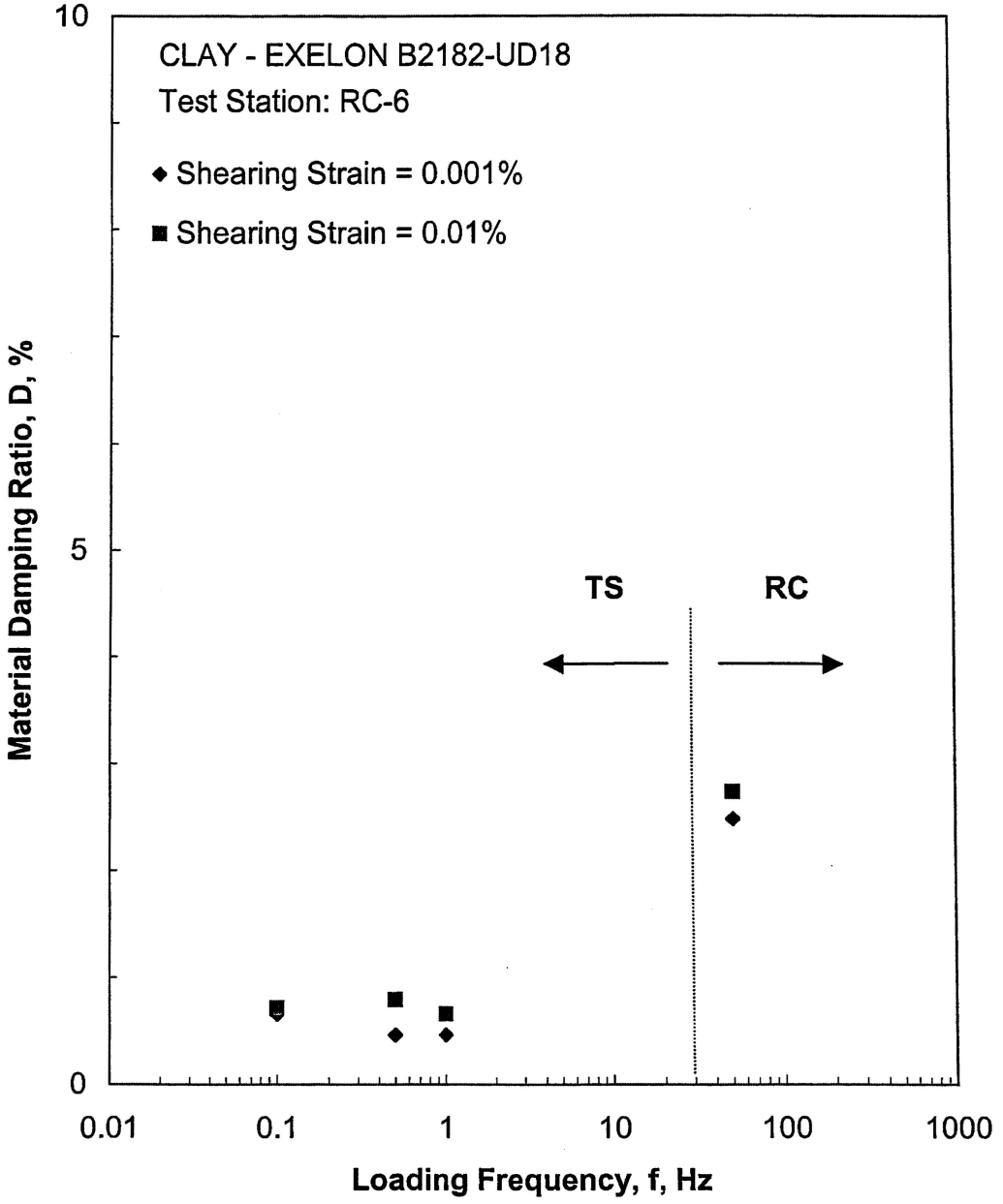

Figure D.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 78 psi from the Combined RCTS Tests