

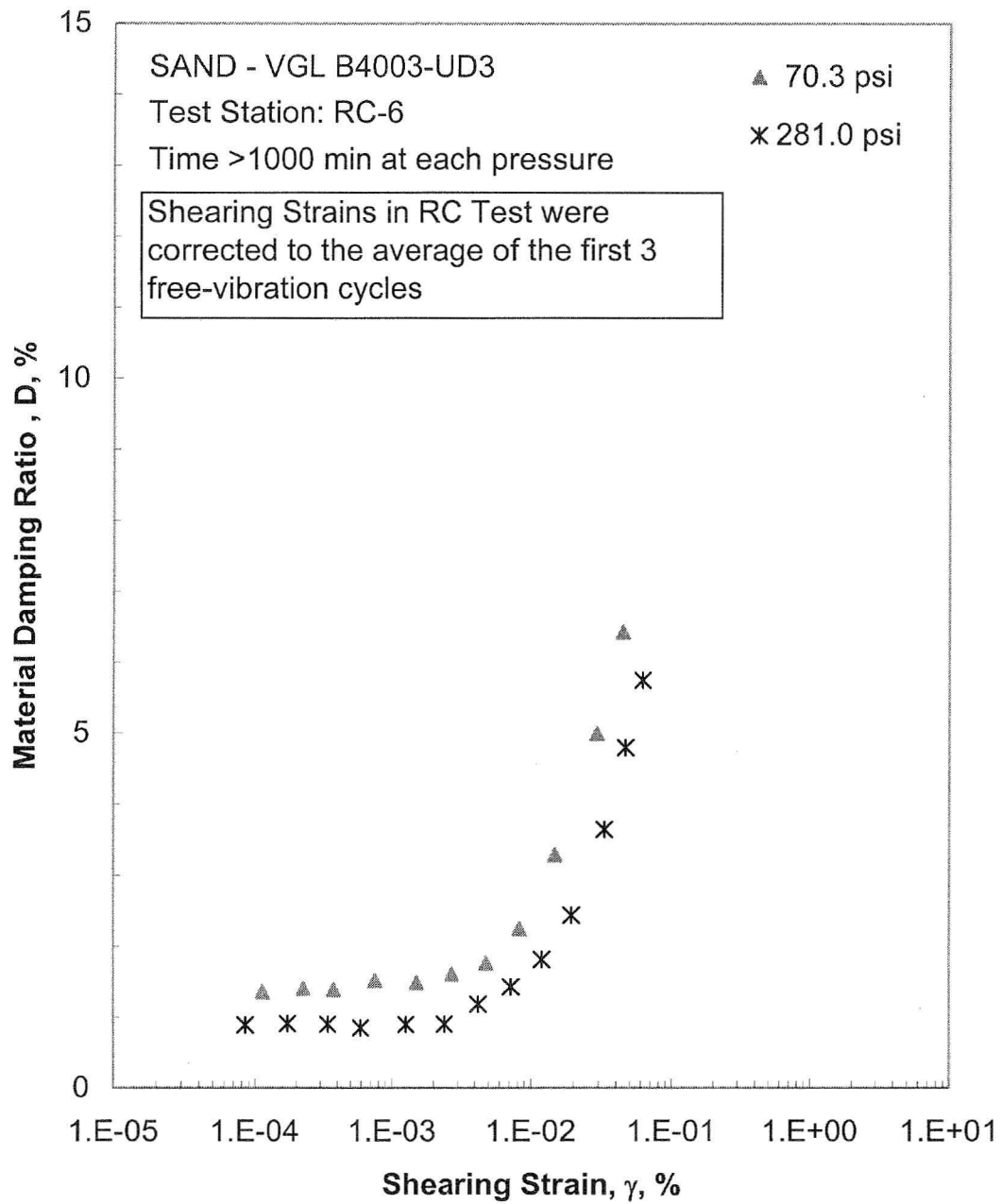


Figure D.10 Comparison of the Variation in Material Damping Ratio with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

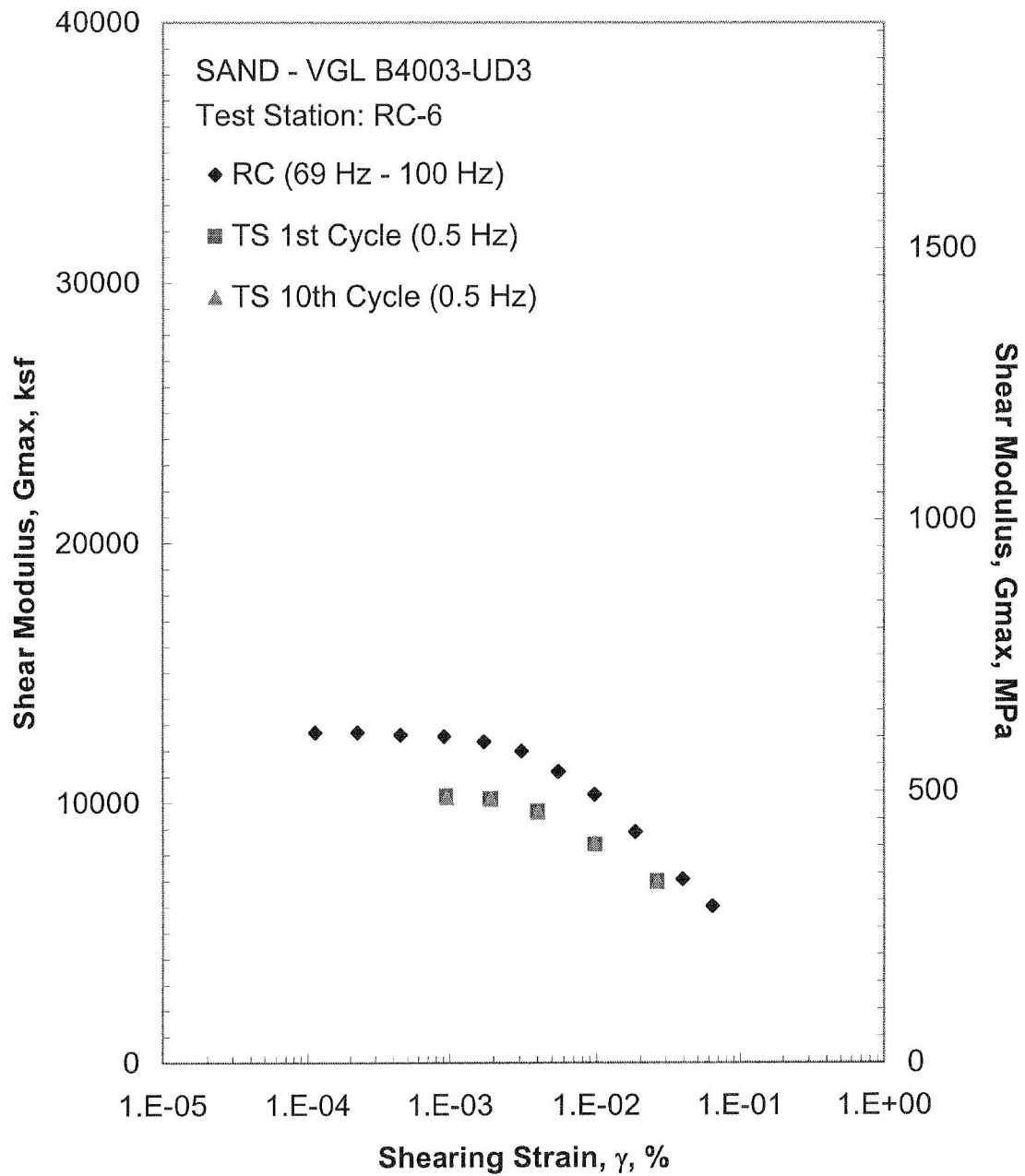


Figure D.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 70.3 psi from the Combined RCTS Tests

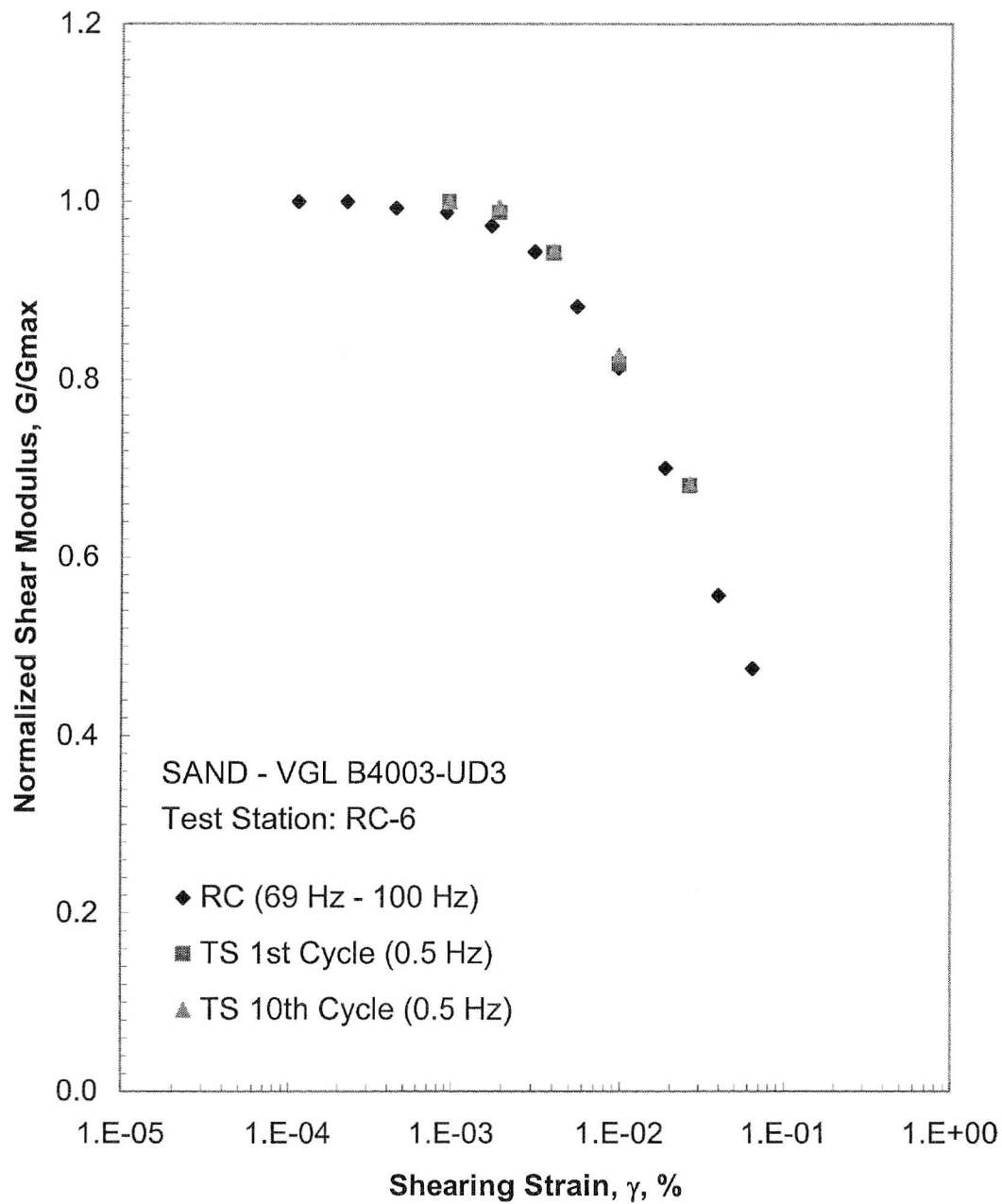


Figure D.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 70.3 psi from the Combined RCTS Tests

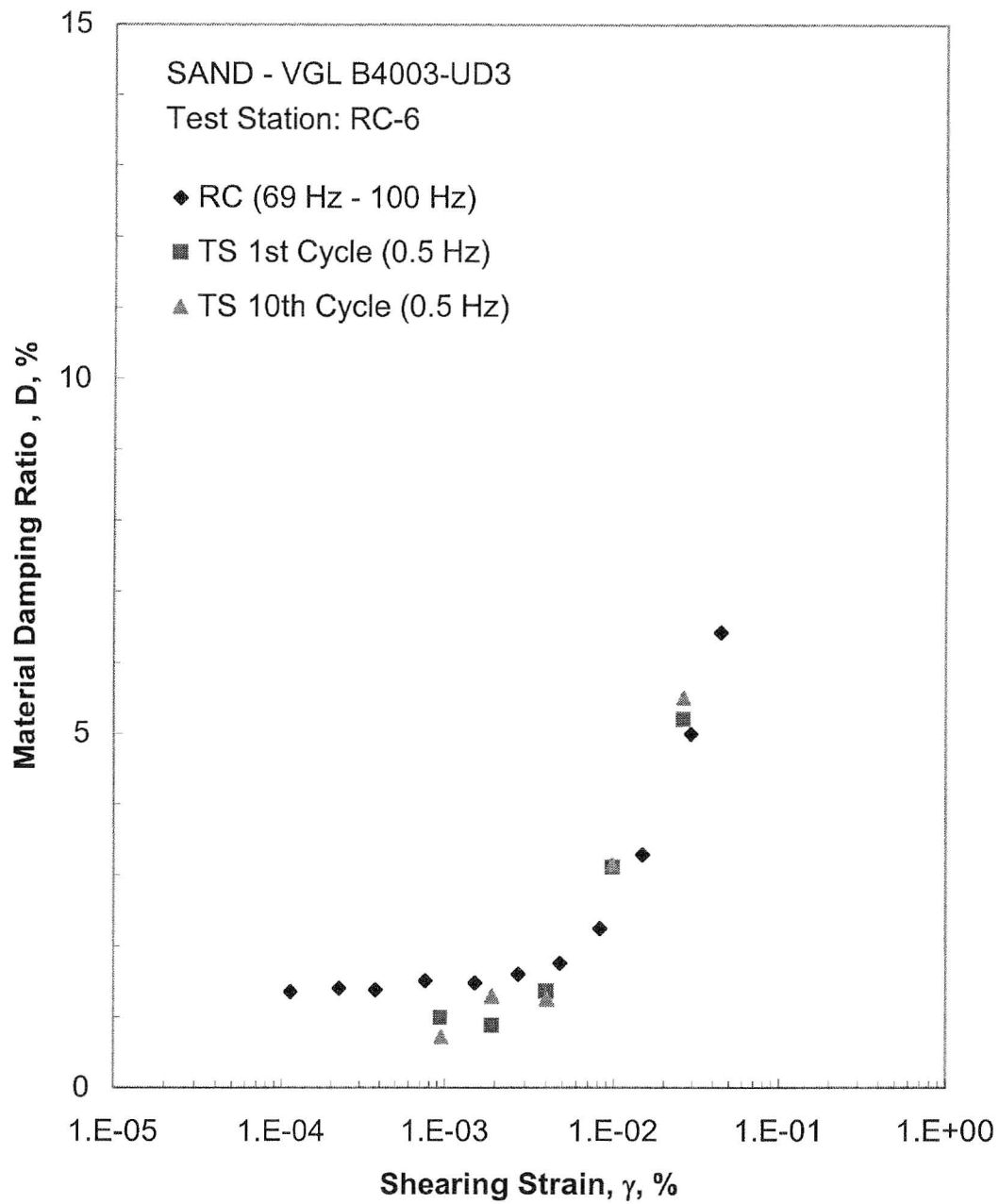


Figure D.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 70.3 psi from the Combined RCTS Tests

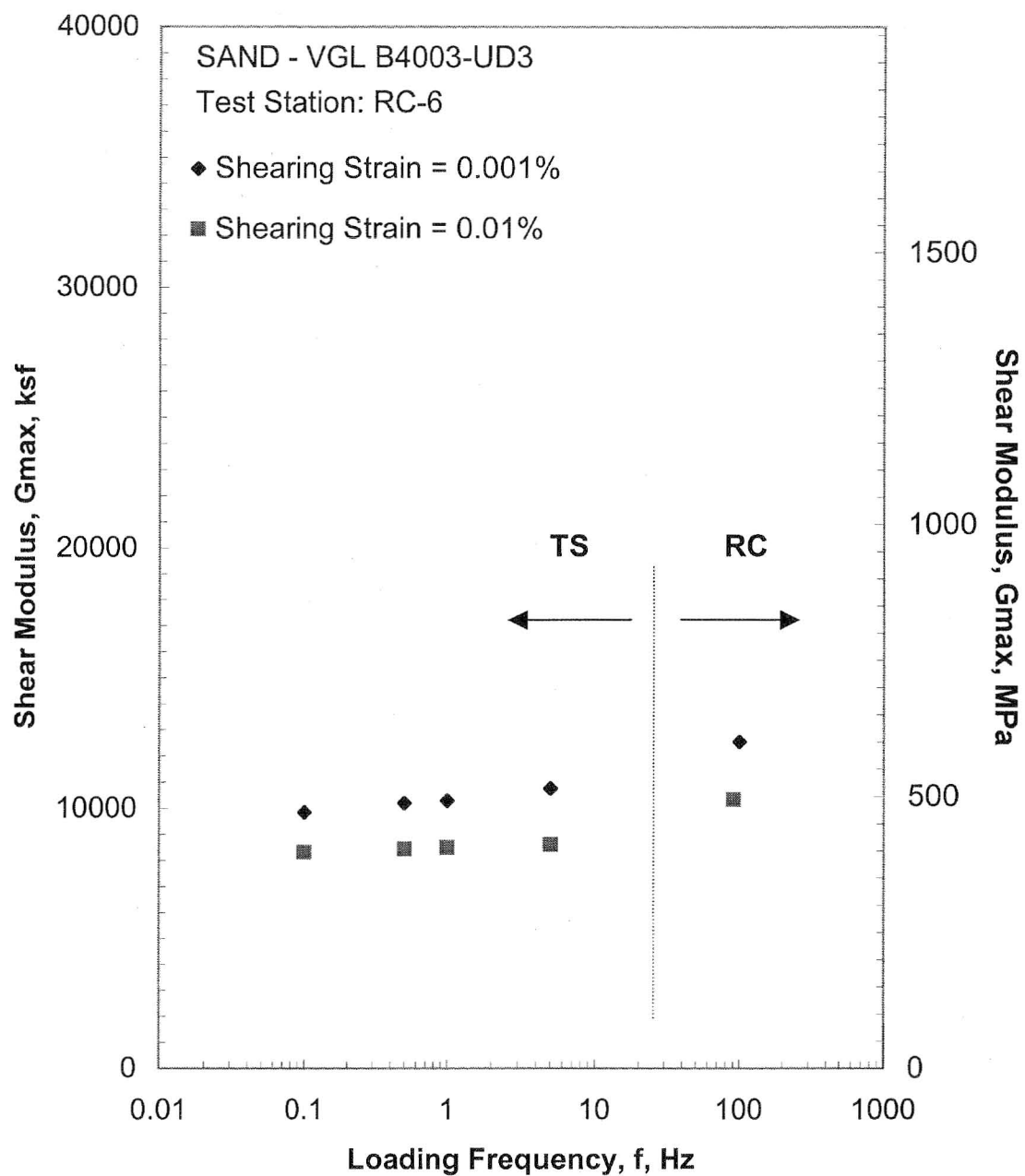


Figure D.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 70.3 psi from the Combined RCTS Tests

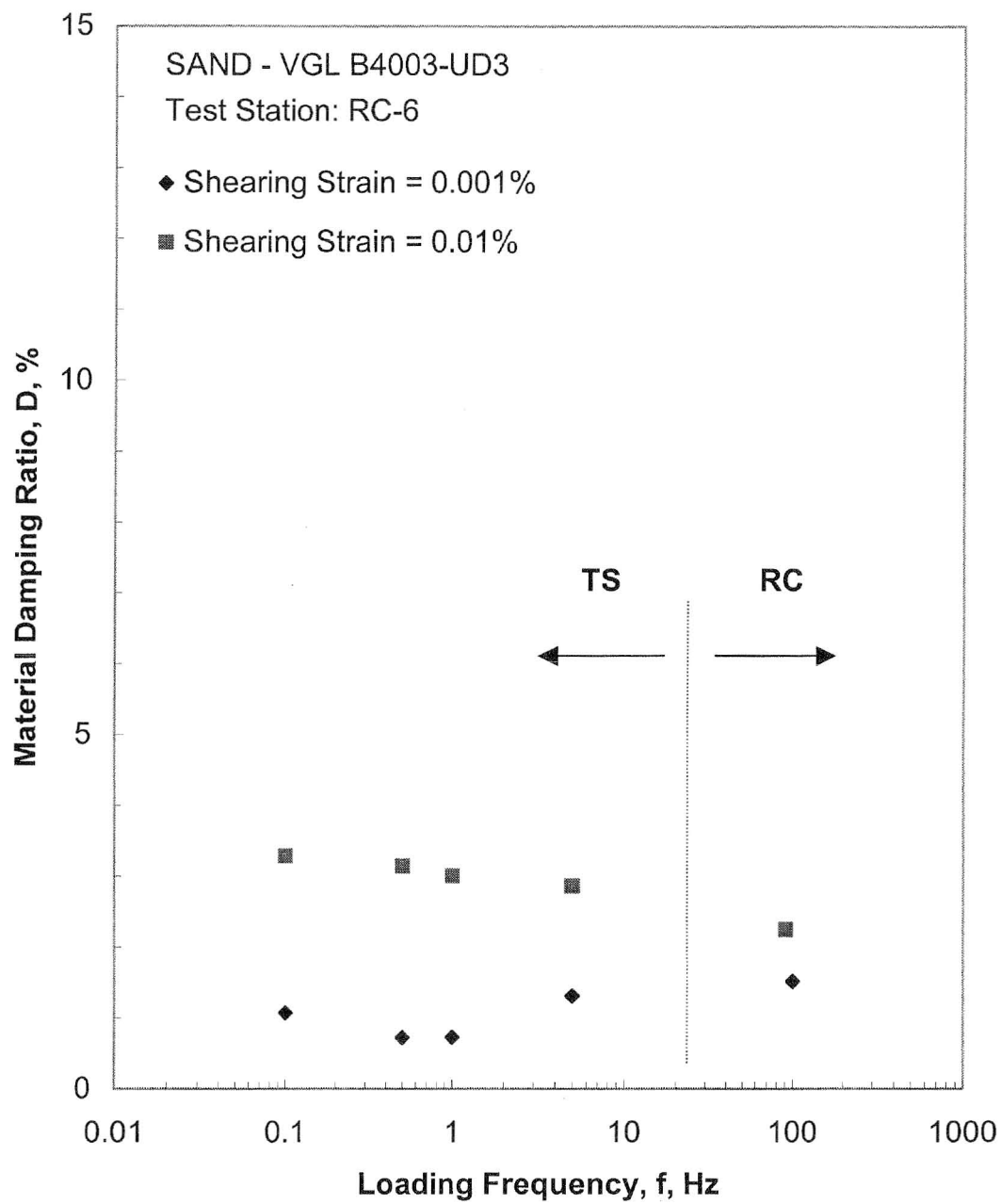


Figure D.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 70.3 psi from the Combined RCTS Tests

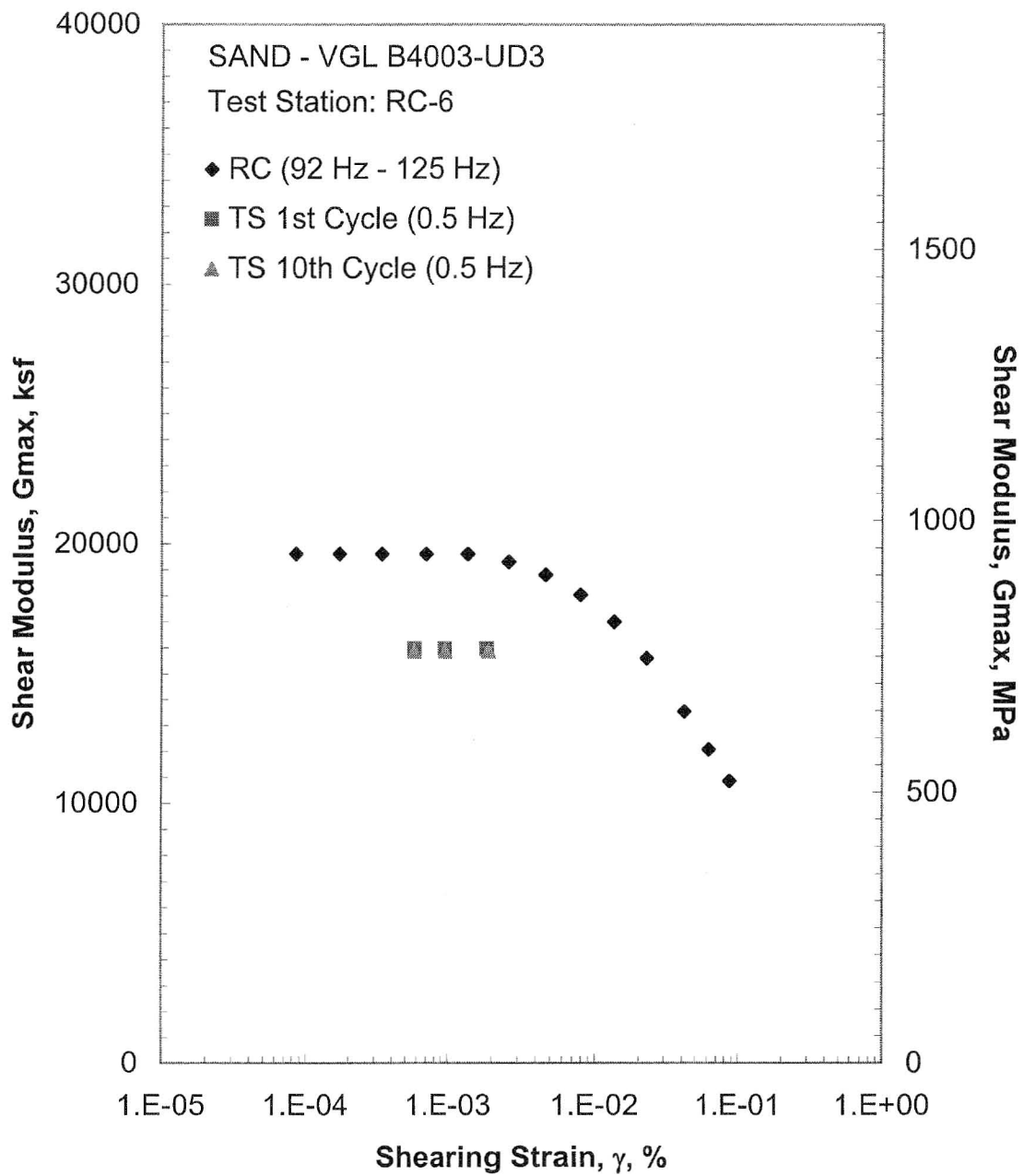


Figure D.16 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 281.0 psi from the Combined RCTS Tests

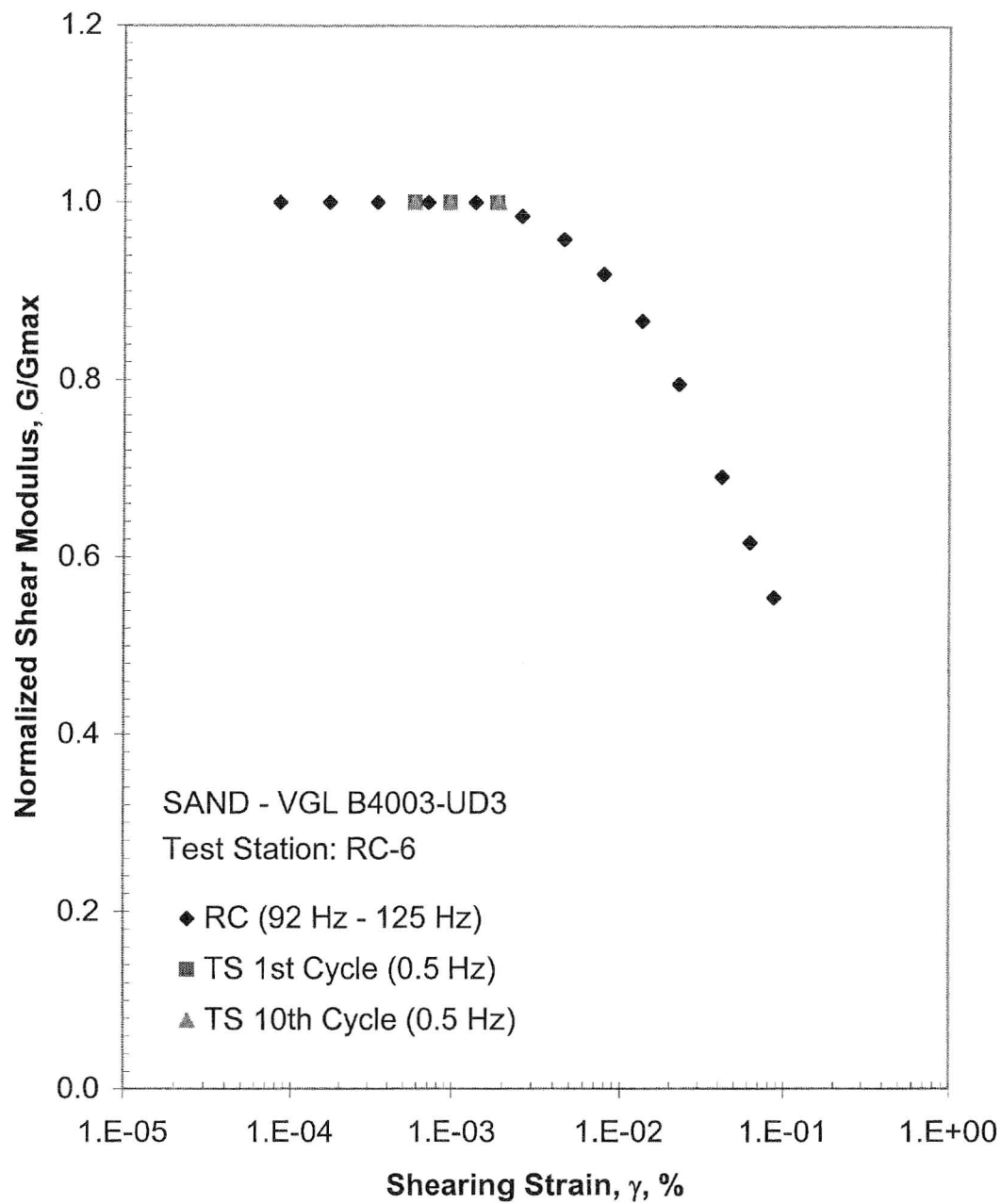


Figure D.17 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 281.0 psi from the Combined RCTS Tests

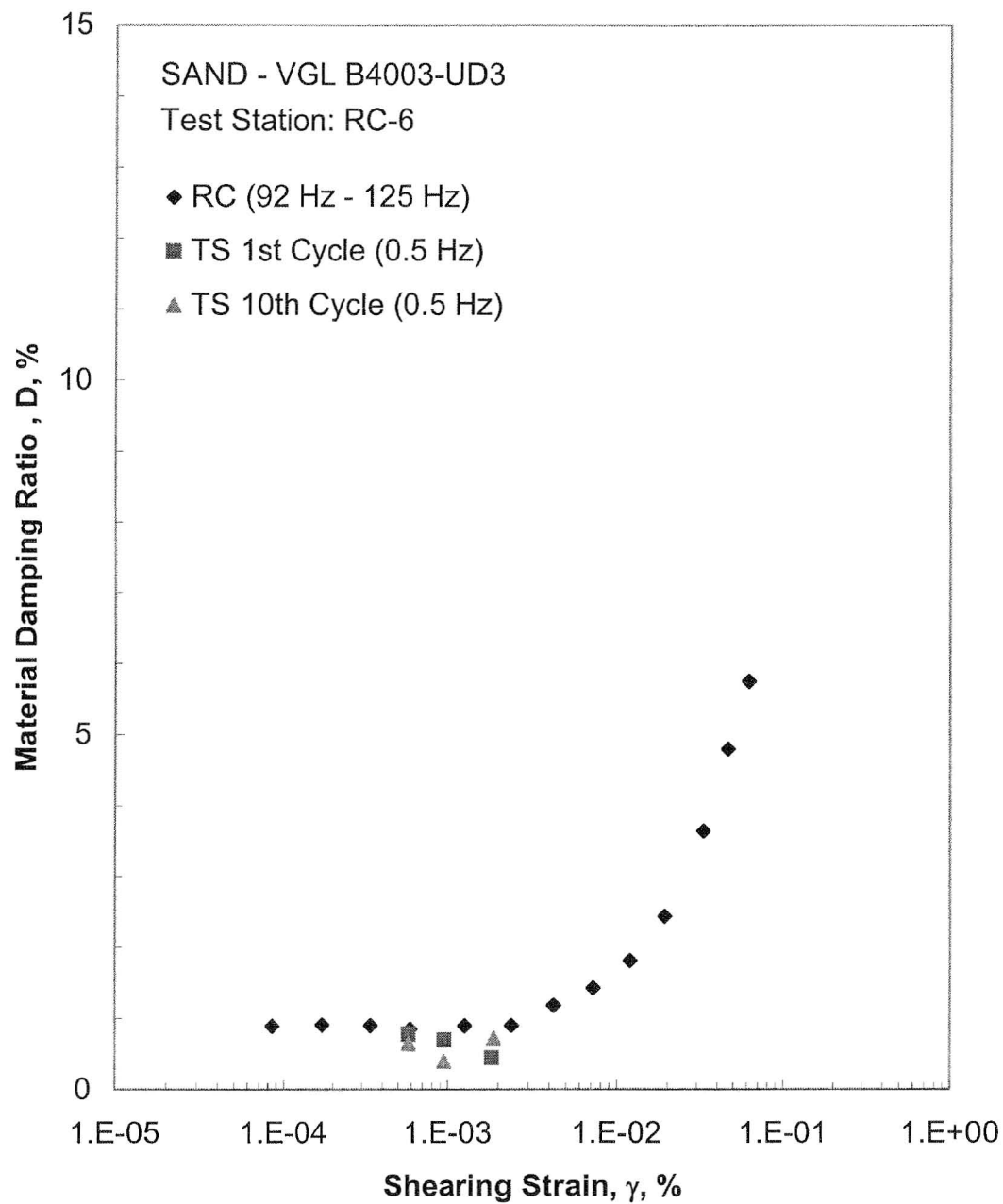


Figure D.18 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 281.0 psi from the Combined RCTS Tests

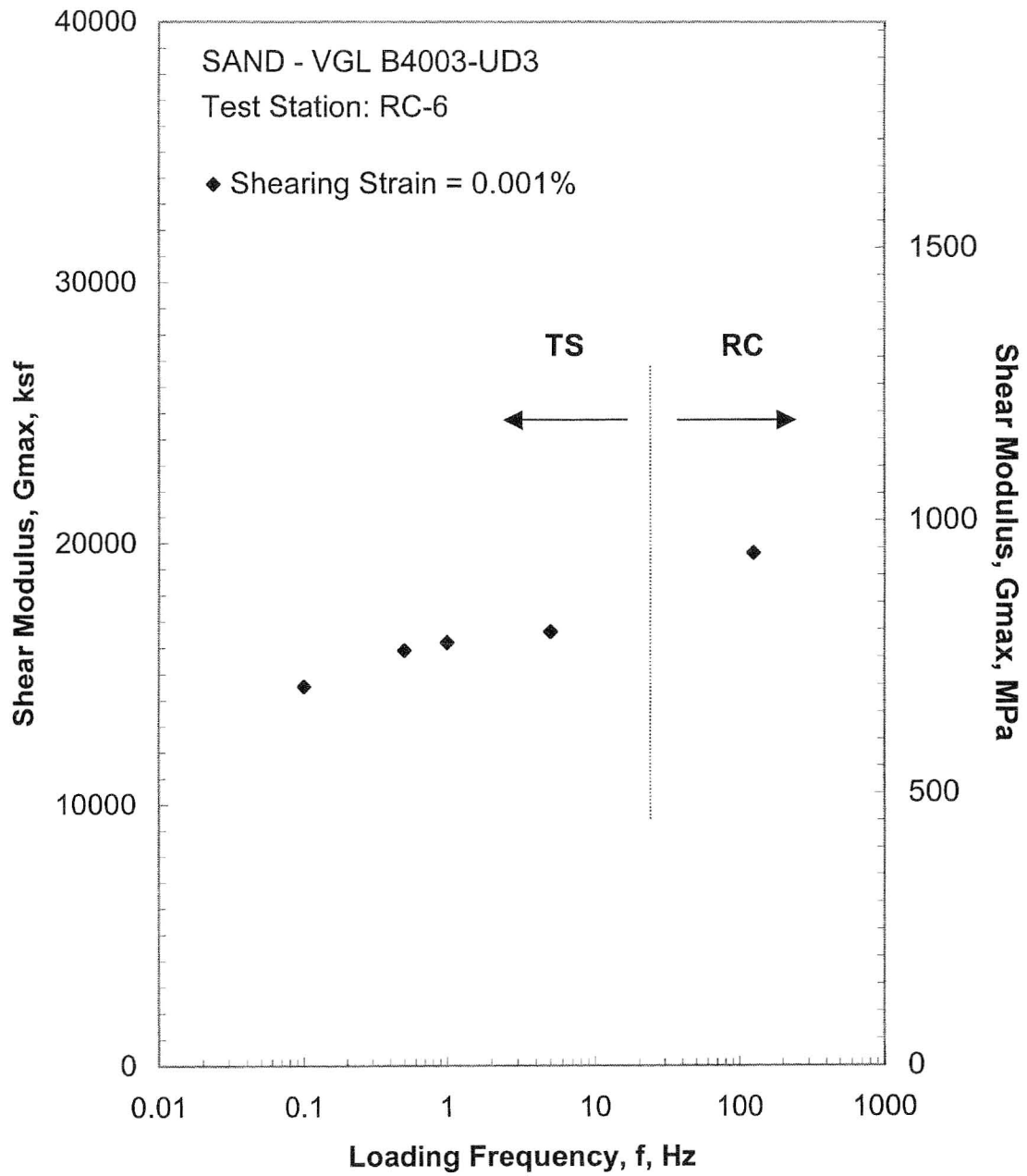


Figure D.19 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 281.0 psi from the Combined RCTS Tests

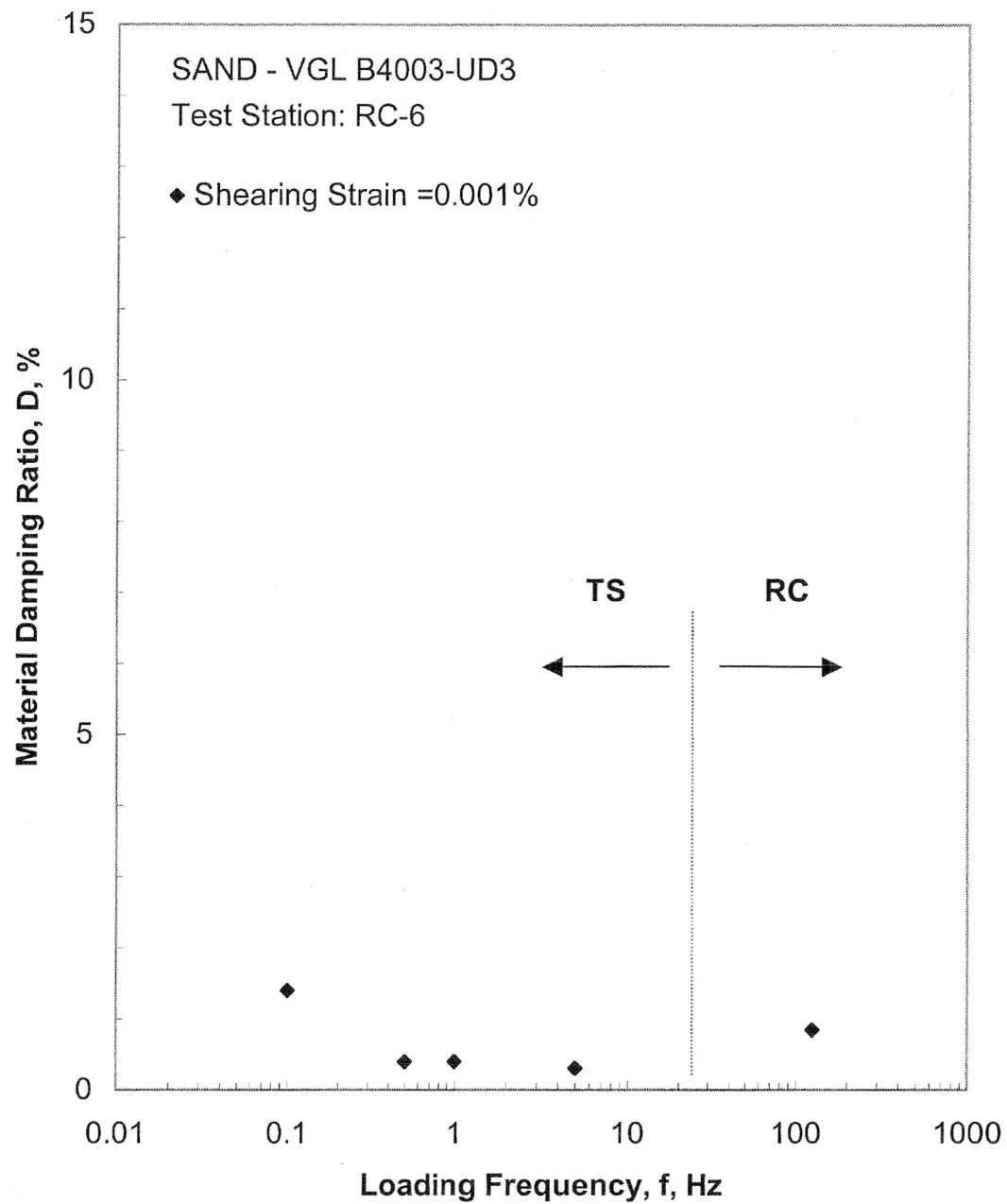


Figure D.20 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 281.0 psi from the Combined RCTS Tests

Table D.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 VGL B4003-UD3

Isotropic Confining Pressure, σ_o			Low-Amplitude Shear Modulus, G_{max}		Low-Amplitude Shear Wave Velocity, V_s	Low-Amplitude Material Damping Ratio, D_{min}	Estimated Void Ratio, e
(psi)	(psf)	(kPa)	(ksf)	(MPa)	(fps)	(%)	
17.6	2534	121	7410	356	1405	1.85	0.752
35.1	5054	242	9340	448	1575	1.67	0.748
70.3	10123	484	12606	605	1827	1.31	0.741
140.5	20232	968	16415	788	2079	0.96	0.733
281.0	40464	1936	19704	946	2270	0.77	0.720

Table D.2 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen VGL B4003-UD3; Isotropic Confining Pressure, $\sigma_o=70.3$ psi (10.1 ksf = 484 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average ⁺ Shearing Strain, %	Material Damping Ratio ^x , D, %
1.13E-04	12702	1.00	1.13E-04	1.36
2.25E-04	12702	1.00	2.25E-04	1.41
4.48E-04	12607	0.99	3.76E-04	1.39
9.12E-04	12544	0.99	7.57E-04	1.51
1.73E-03	12356	0.97	1.52E-03	1.48
3.10E-03	11985	0.94	2.73E-03	1.61
5.53E-03	11199	0.88	4.81E-03	1.76
9.71E-03	10326	0.81	8.25E-03	2.25
1.85E-02	8896	0.70	1.48E-02	3.28
3.93E-02	7076	0.56	2.91E-02	4.99
6.37E-02	6036	0.48	4.46E-02	6.42

⁺ 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 D.3 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen VGL B4003-UD3; Isotropic Confining Pressure, $\sigma_o = 70.3$ psi (10.1 ksf = 484 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, %
9.43E-04	10281	1.00	0.99	9.51E-04	10204	1.00	0.72
1.91E-03	10155	0.99	0.88	1.91E-03	10138	0.99	1.29
4.01E-03	9685	0.94	1.36	4.03E-03	9635	0.94	1.25
9.77E-03	8402	0.82	3.11	9.73E-03	8438	0.83	3.14
2.61E-02	6995	0.68	5.20	2.62E-02	6964	0.68	5.50

Table D.4 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen VGL B4003-UD3; Isotropic Confining Pressure, $\sigma_o = 281.0$ psi (40.5 ksf = 1936 kPa)

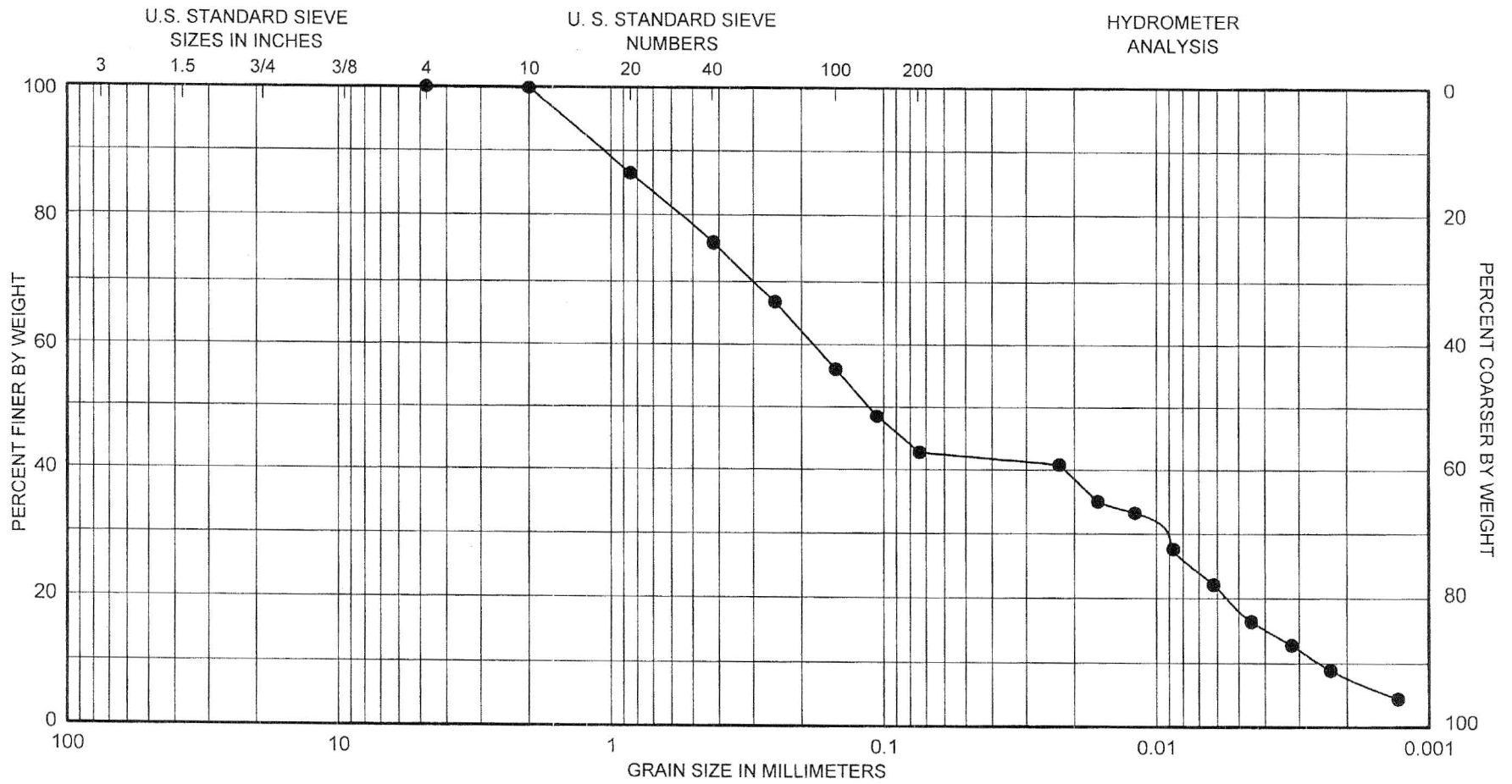
Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average ⁺ Shearing Strain, %	Material Damping Ratio ^x , D, %
8.50E-05	19613	1.00	8.50E-05	0.89
1.72E-04	19613	1.00	1.72E-04	0.91
3.40E-04	19613	1.00	3.40E-04	0.90
6.99E-04	19613	1.00	5.94E-04	0.85
1.37E-03	19613	1.00	1.27E-03	0.89
2.59E-03	19311	0.98	2.41E-03	0.90
4.61E-03	18803	0.96	4.24E-03	1.19
7.93E-03	18031	0.92	7.22E-03	1.43
1.35E-02	16997	0.87	1.20E-02	1.81
2.27E-02	15601	0.80	1.93E-02	2.44
4.17E-02	13546	0.69	3.29E-02	3.64
6.21E-02	12087	0.62	4.66E-02	4.79
8.70E-02	10876	0.55	6.18E-02	5.75

⁺ 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 D.5 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen VGL B4003-UD3; Isotropic Confining Pressure, $\sigma_o=281.0$ psi (40.5 ksf = 1936 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, %
5.79E-04	15966	1.00	0.78	5.77E-04	15869	1.00	0.64
9.53E-04	15966	1.00	0.69	9.50E-04	15869	1.00	0.40
1.85E-03	15966	1.00	0.44	1.89E-03	15869	1.00	0.71



GRAVEL			SAND				SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine			
<u>SYMBOL</u>	<u>BORING</u>	<u>DEPTH, FT</u>	<u>C_c</u>	<u>C_u</u>	<u>D₅₀</u>	<u>D₉₀</u>	<u>CLASSIFICATION</u>
●	B-4003-UD3	159	0.22	71.51	0.1135	1.06	Sandy Clay, gray, with sandstone

GRAIN SIZE CURVE

APPENDIX E

Specimen VGL B3002-UD3
(LL=31, PI=7; Gs=2.69)

Borehole B3002
Sample UD3
Depth = 185.0 ft (56.4 m)
Total Unit Weight = 119.4 lb/ft³
Water Content = 26.9 %
Estimated In-Situ K_o = 0.44
Estimated In-Situ Mean Effective
Stress = 62.1 psi

FUGRO JOB #: 0401-1667
Testing Station: RC5



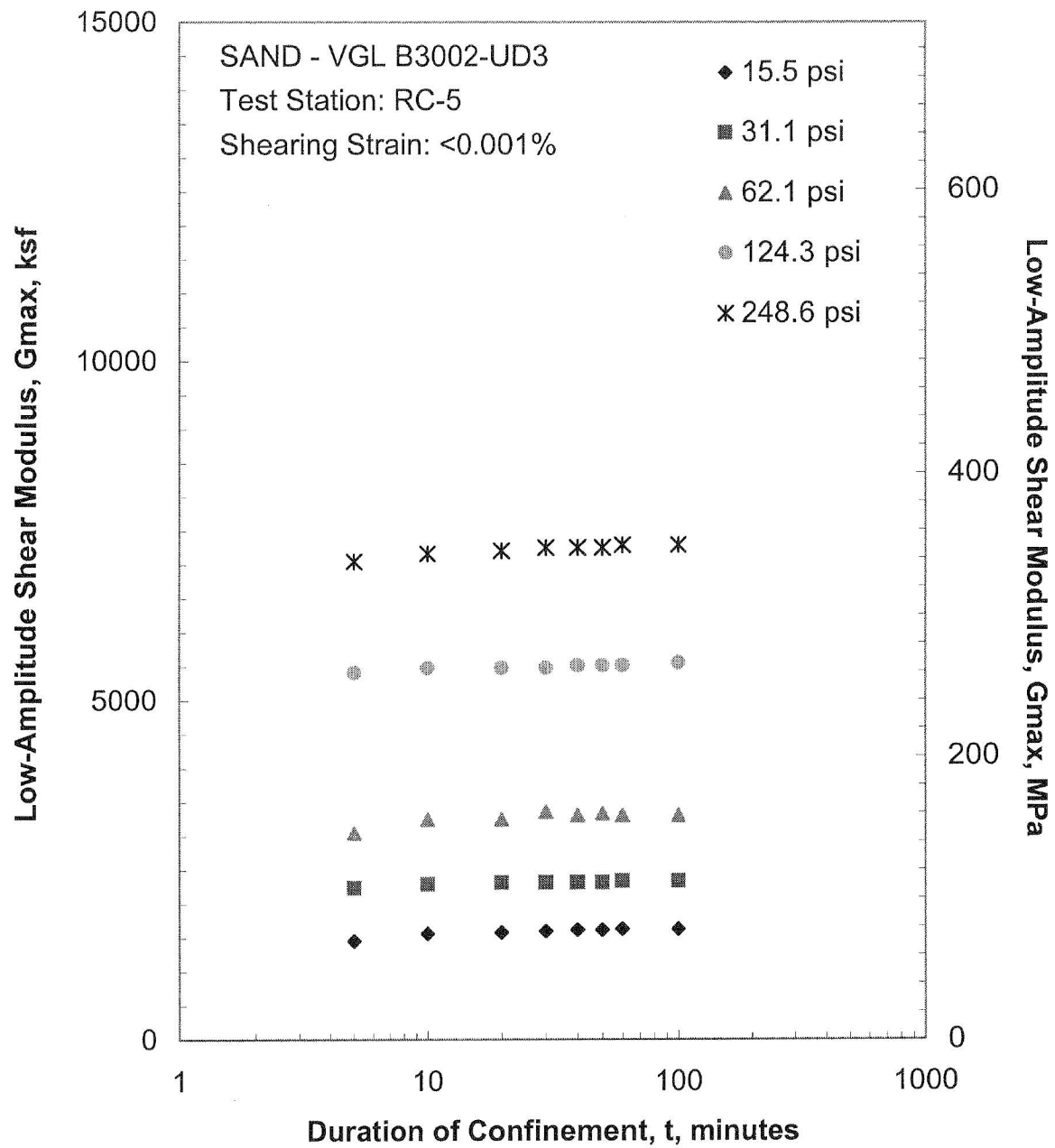


Figure E.1 Variation in Low-Amplitude Shear Modulus with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

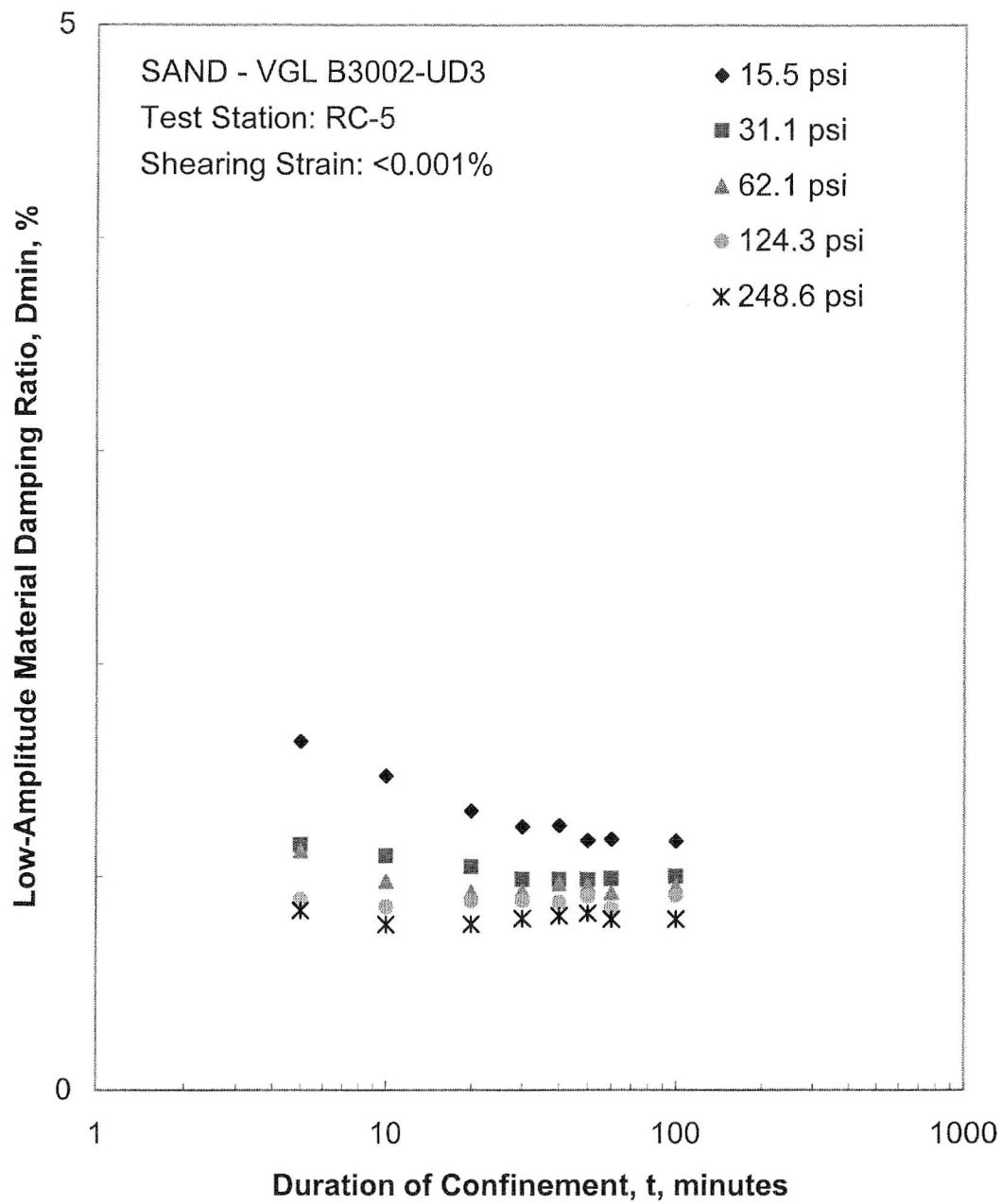


Figure E.2 Variation in Low-Amplitude Material Damping Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

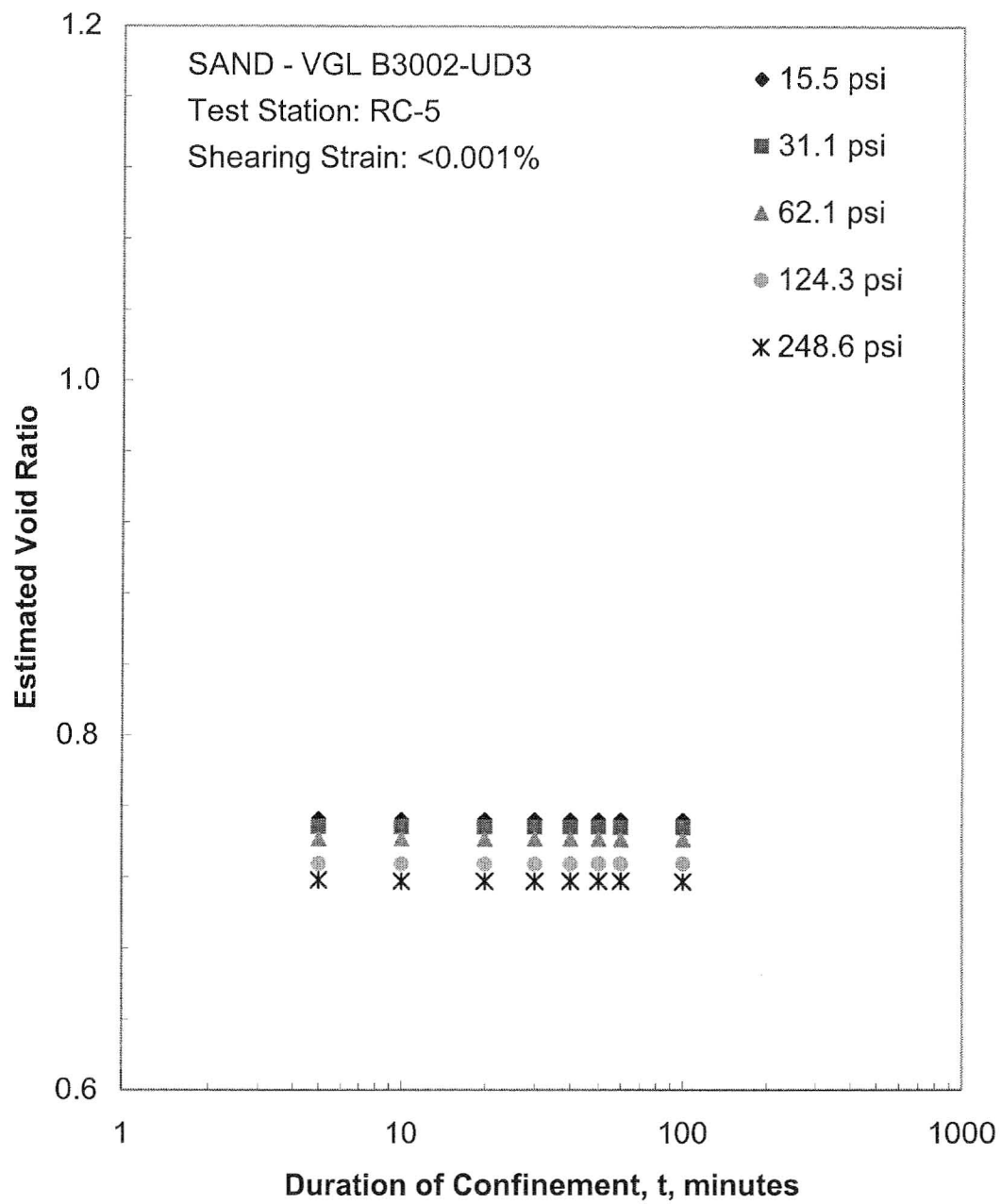


Figure E.3 Variation in Estimated Void Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

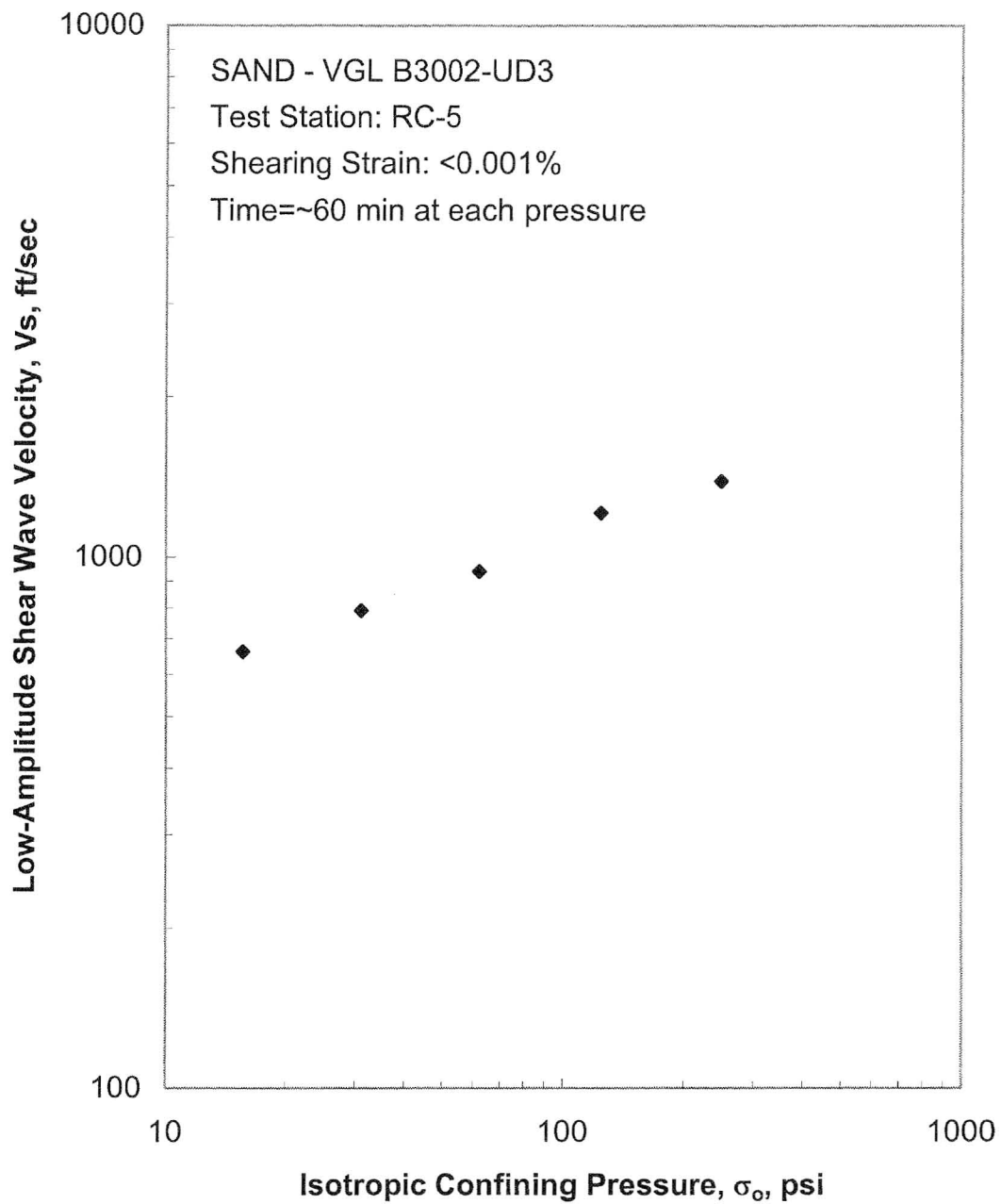


Figure E.4 Variation in Low-Amplitude Shear Wave Velocity with Isotropic Confining Pressure from Resonant Column Tests

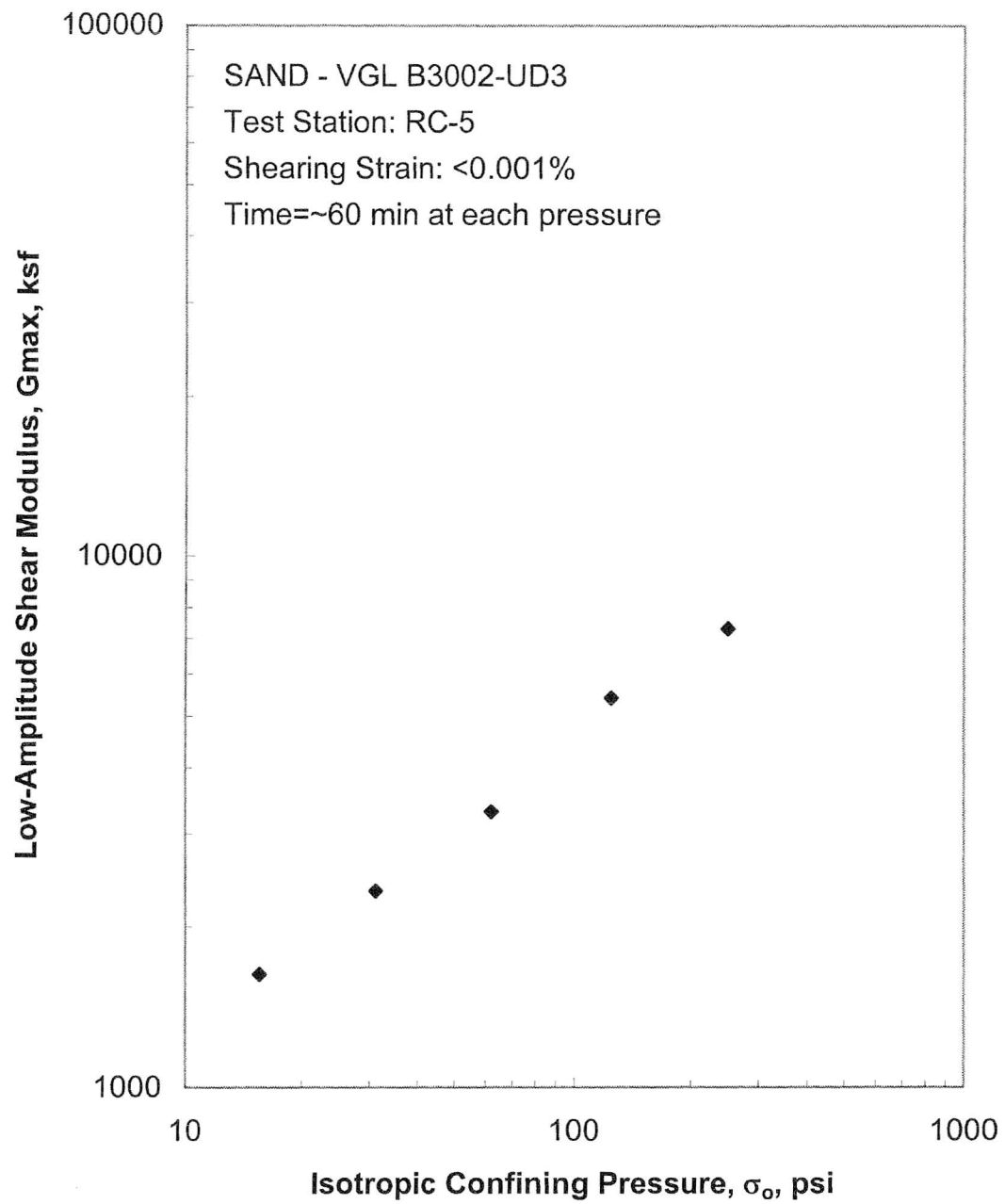


Figure E.5 Variation in Low-Amplitude Shear Modulus with Isotropic Confining Pressure from Resonant Column Tests

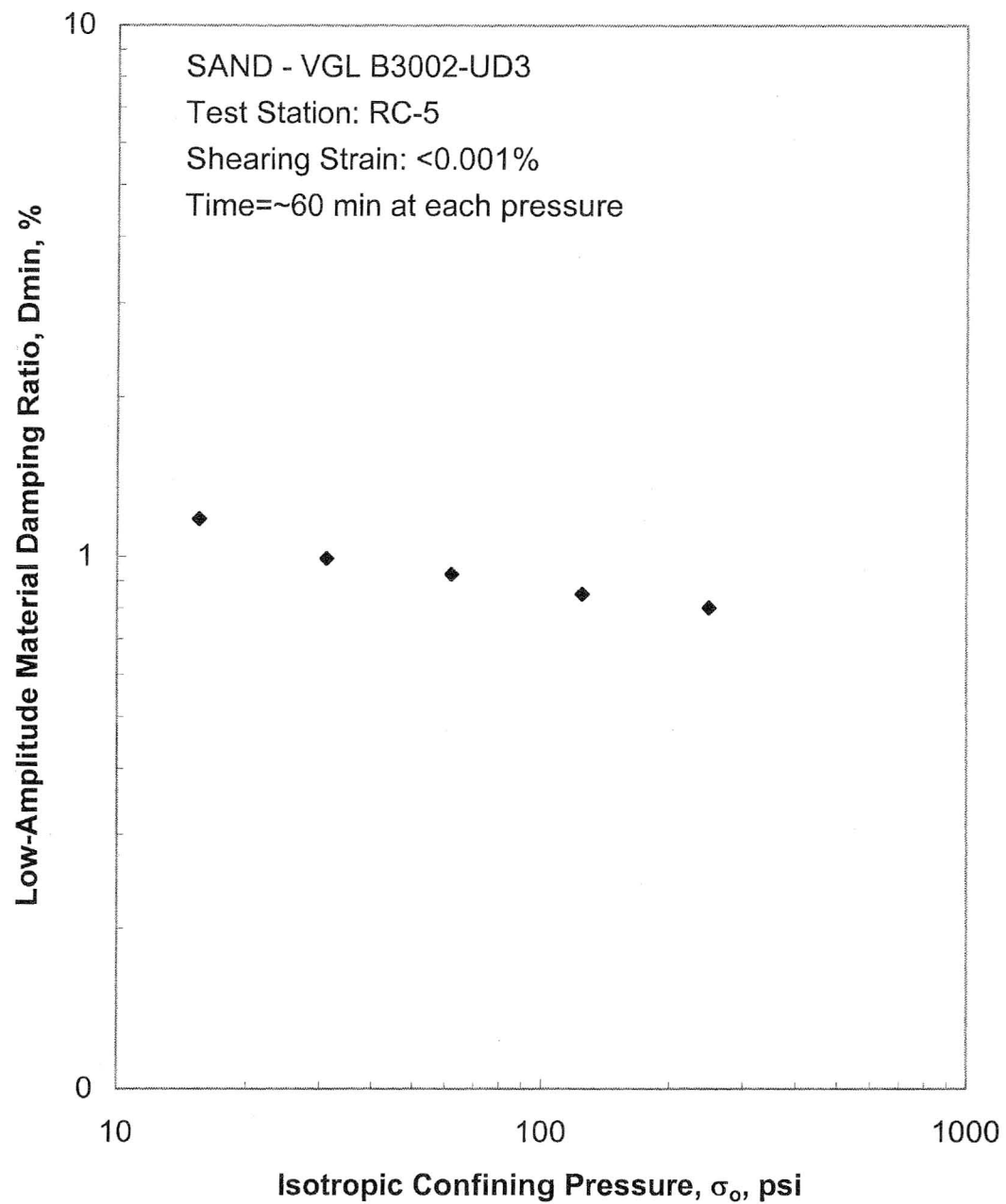


Figure E.6 Variation in Low-Amplitude Material Damping Ratio with Isotropic Confining Pressure from Resonant Column Tests

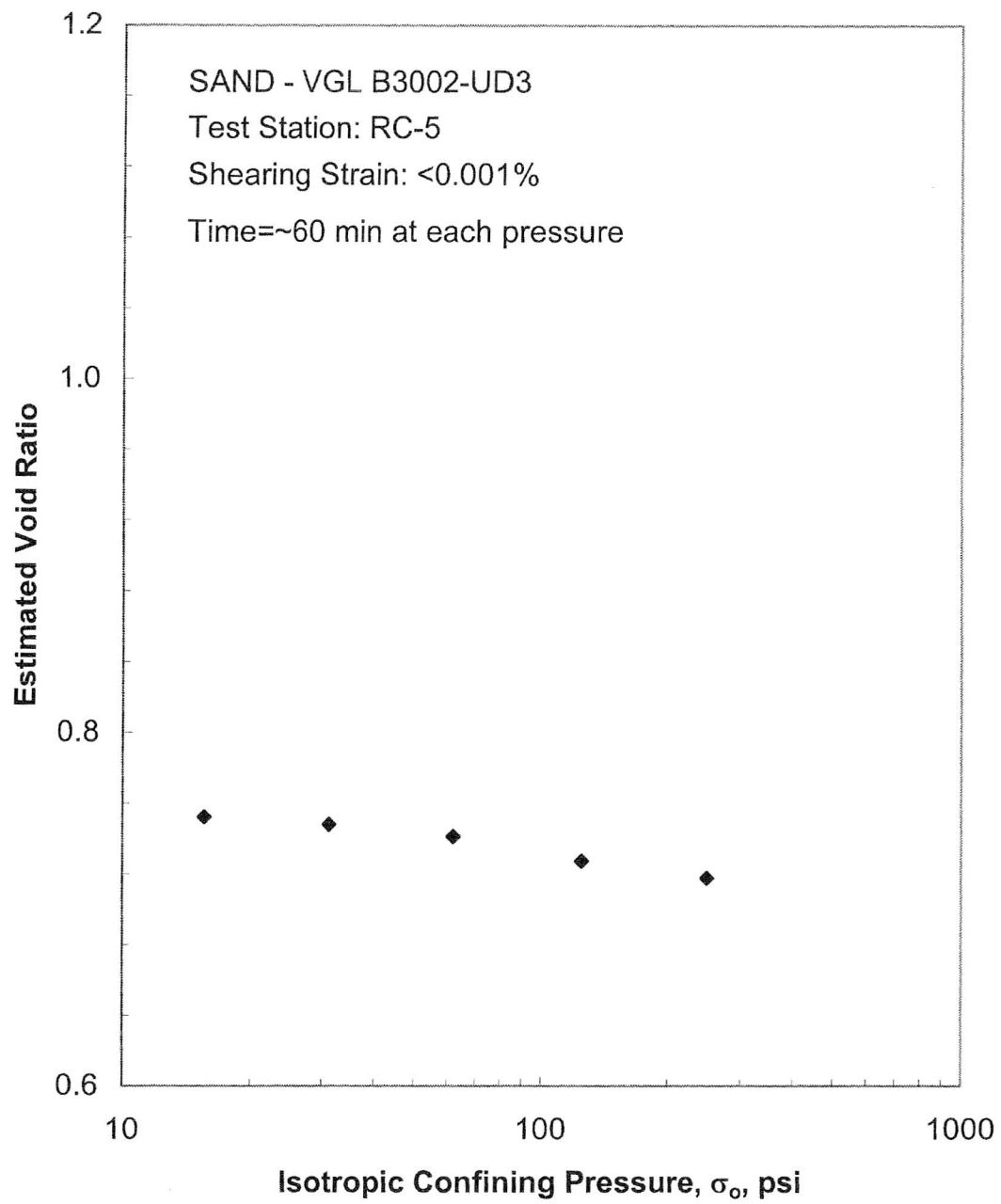


Figure E.7 Variation in Estimated Void Ratio with Isotropic Confining Pressure from Resonant Column Tests

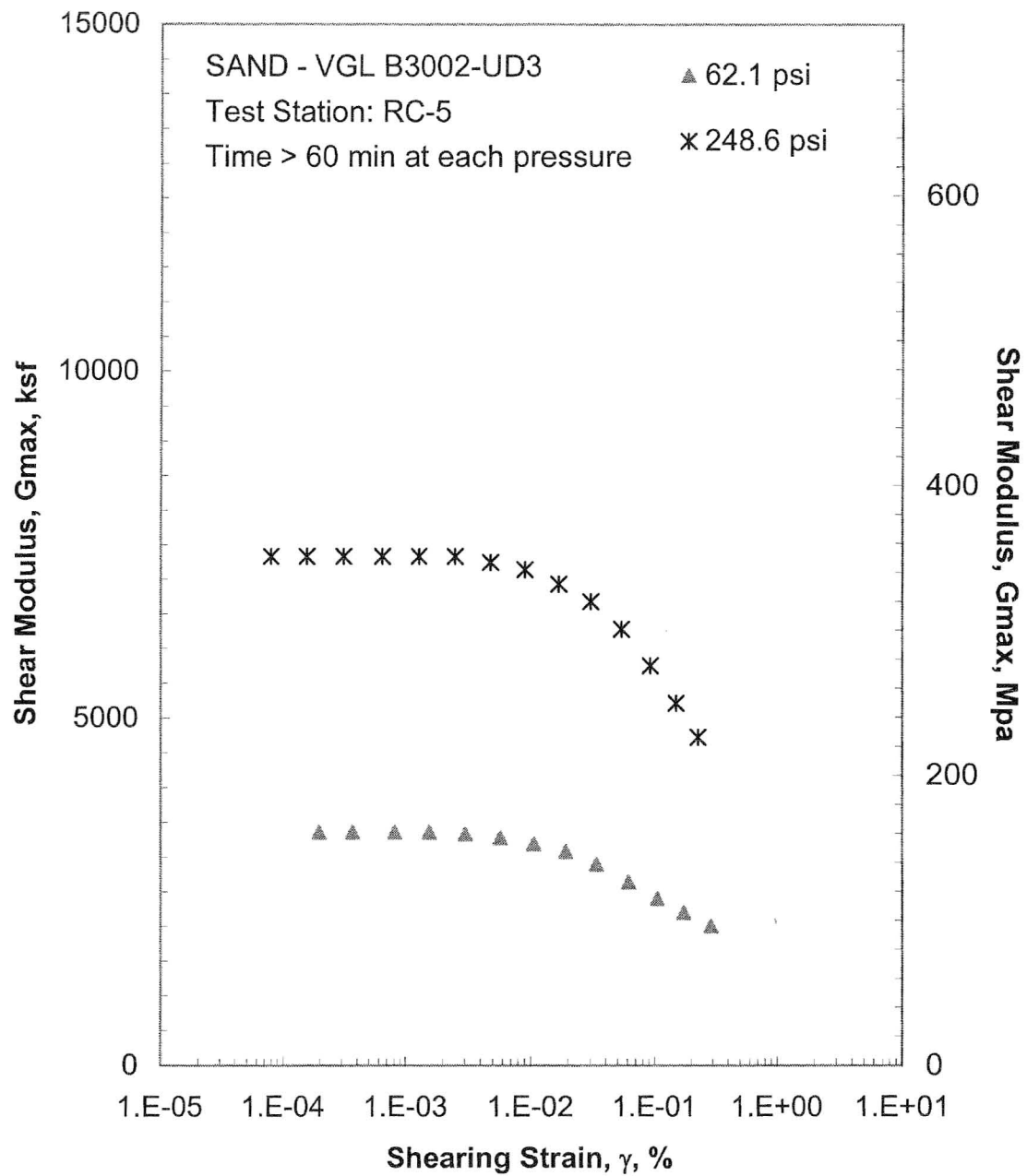


Figure E.8 Comparison of the Variation in Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

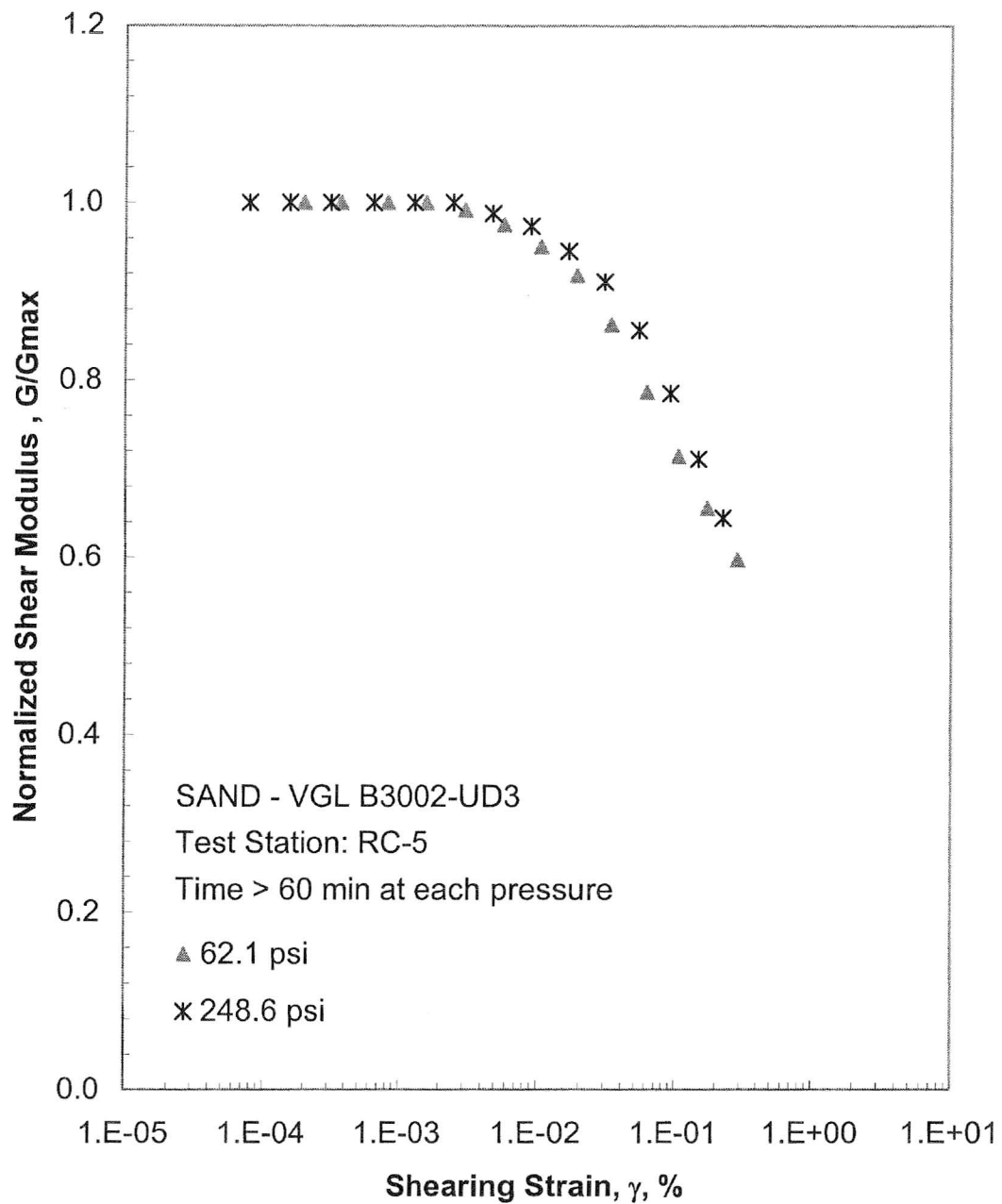


Figure E.9 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

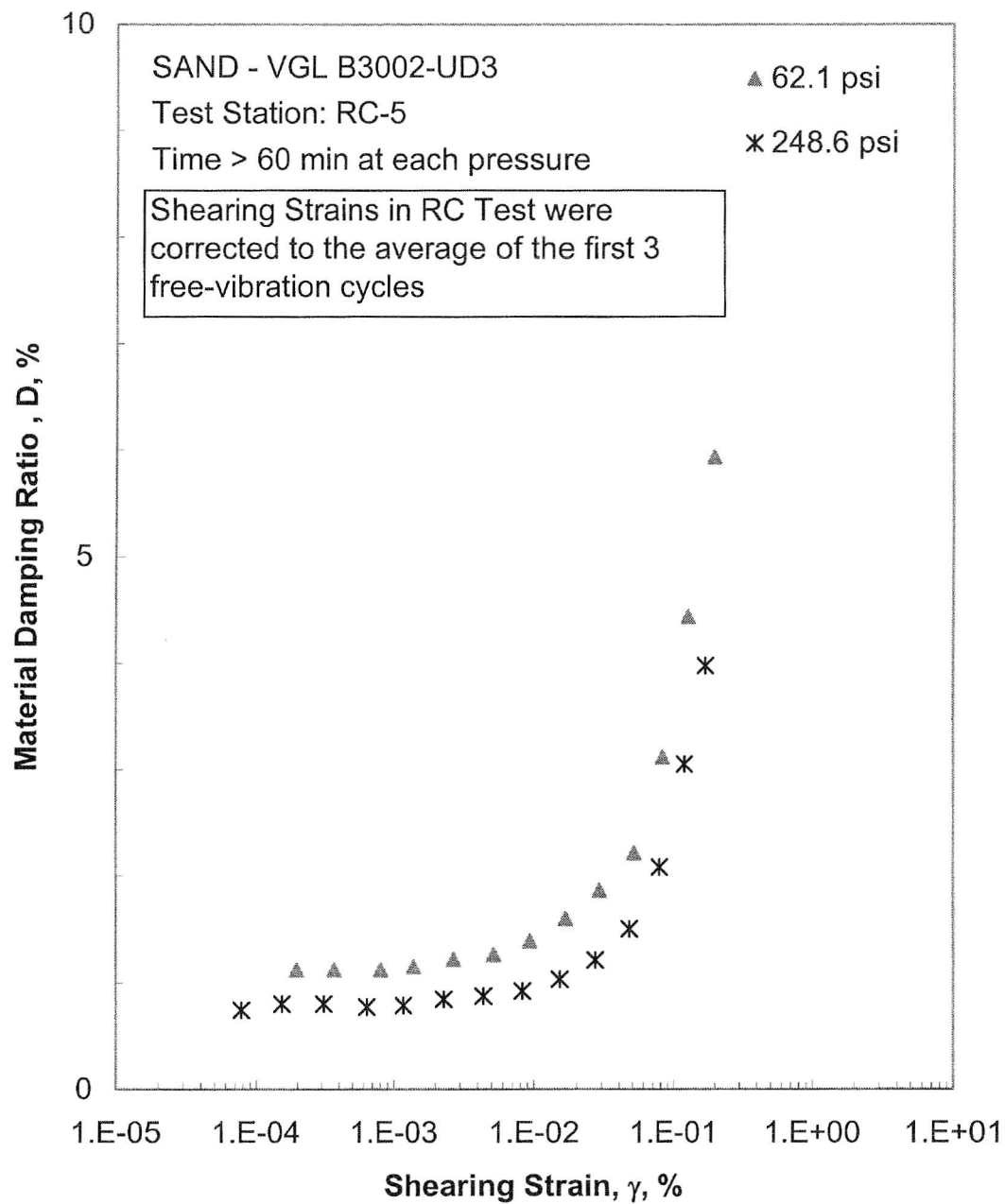


Figure E.10 Comparison of the Variation in Material Damping Ratio with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

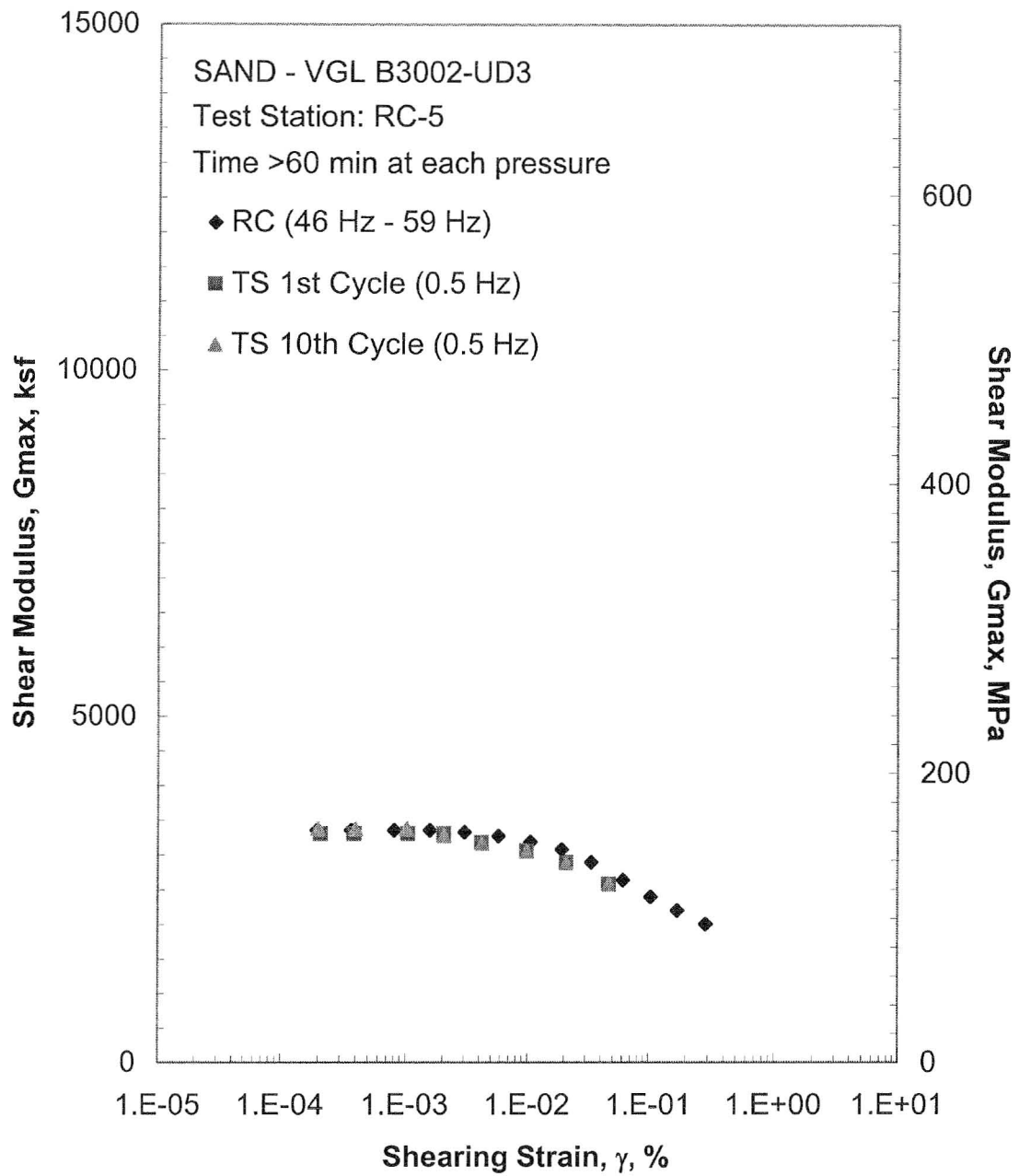


Figure E.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 62.1 psi from the Combined RCTS Tests

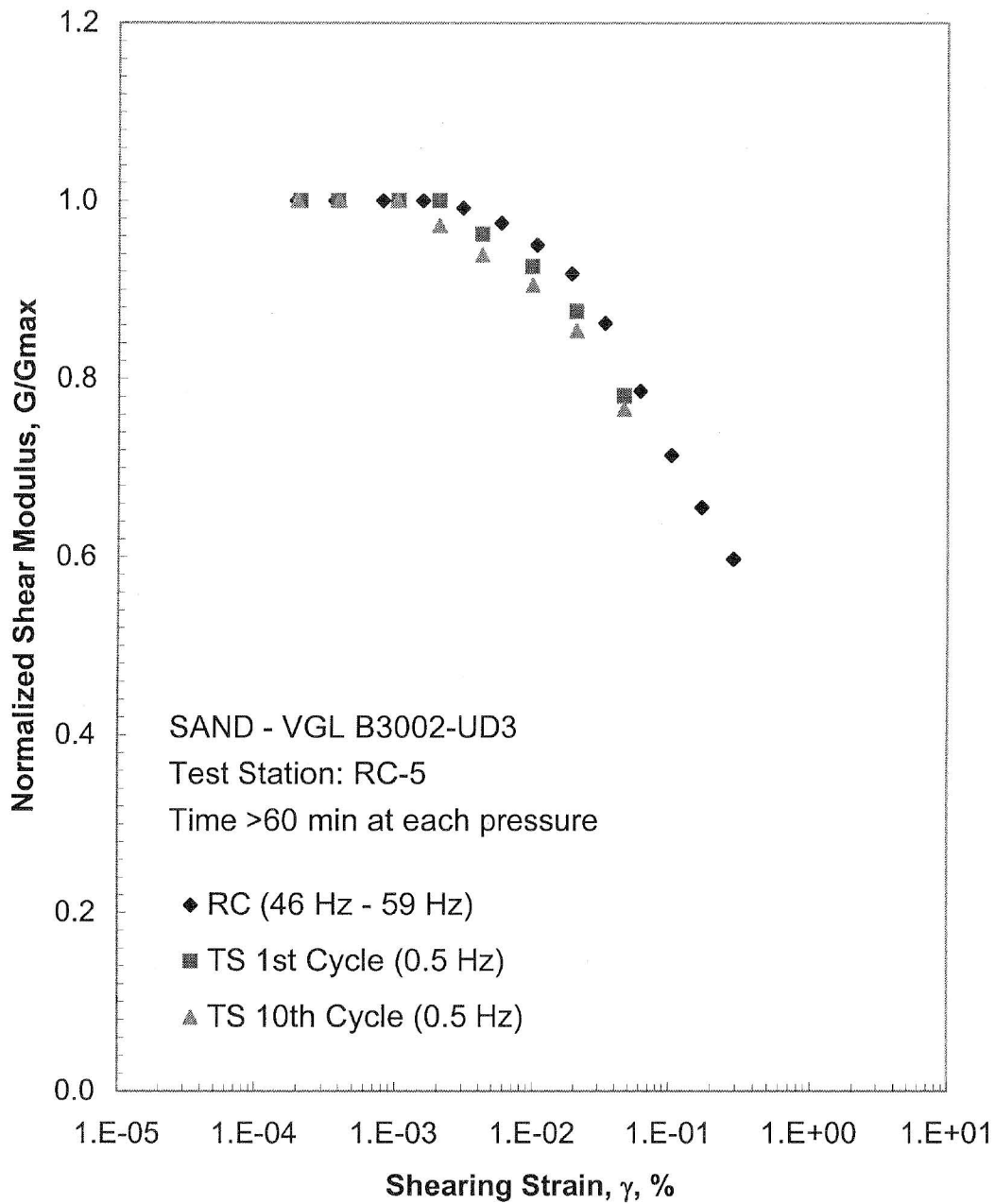


Figure E.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 62.1 psi from the Combined RCTS Tests

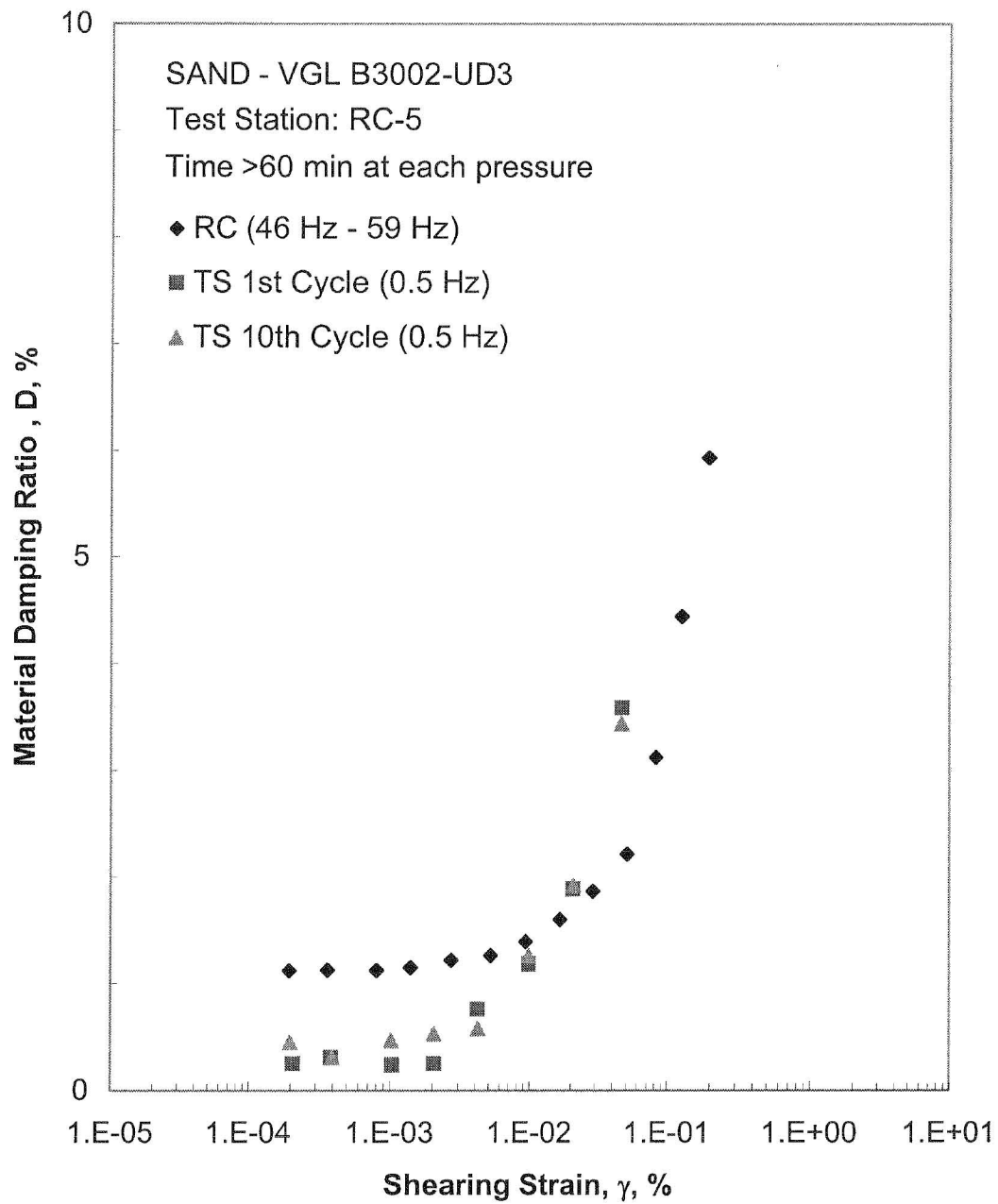


Figure E.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 62.1 psi from the Combined RCTS Tests

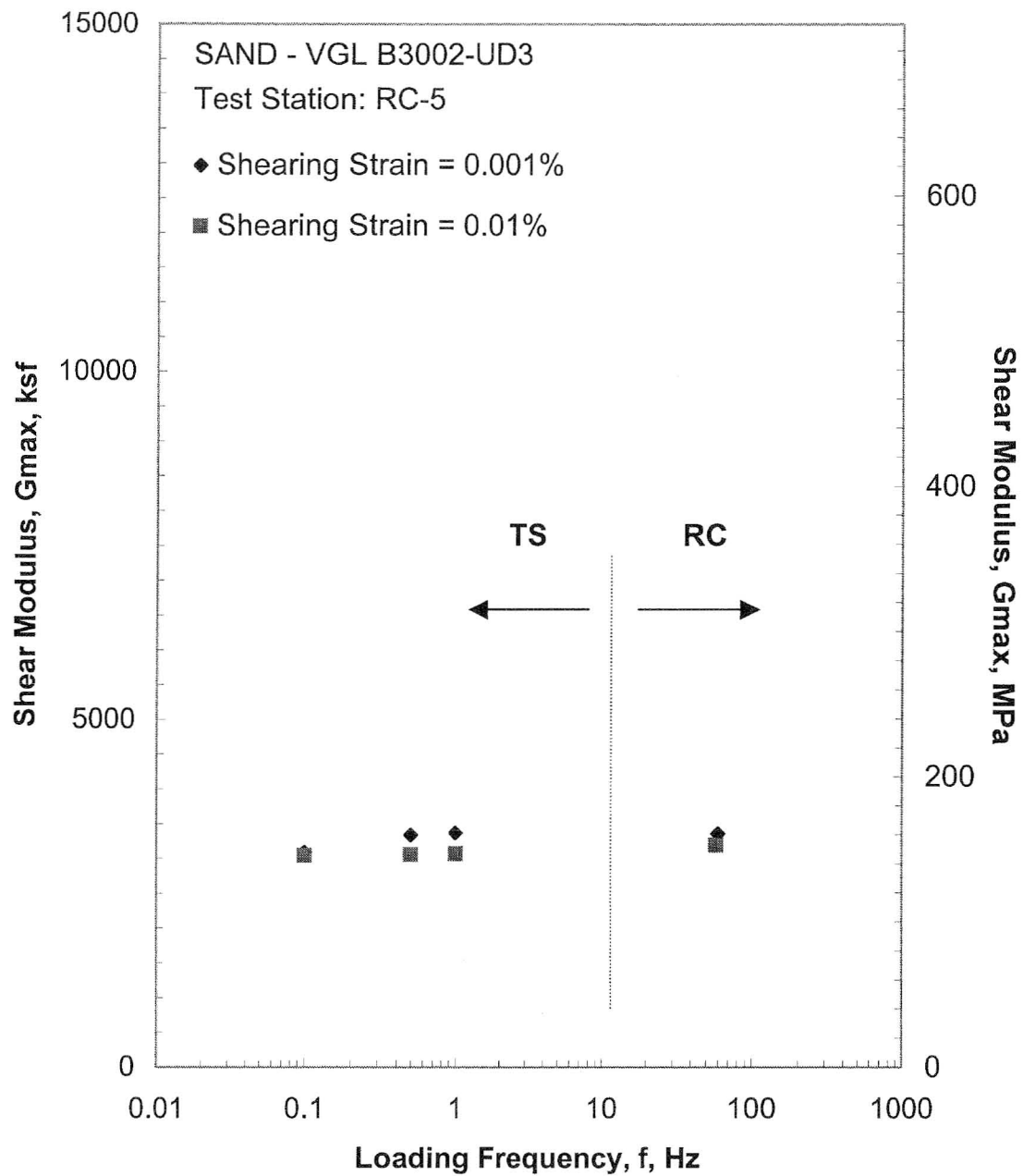


Figure E.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 62.1 psi from the Combined RCTS Tests

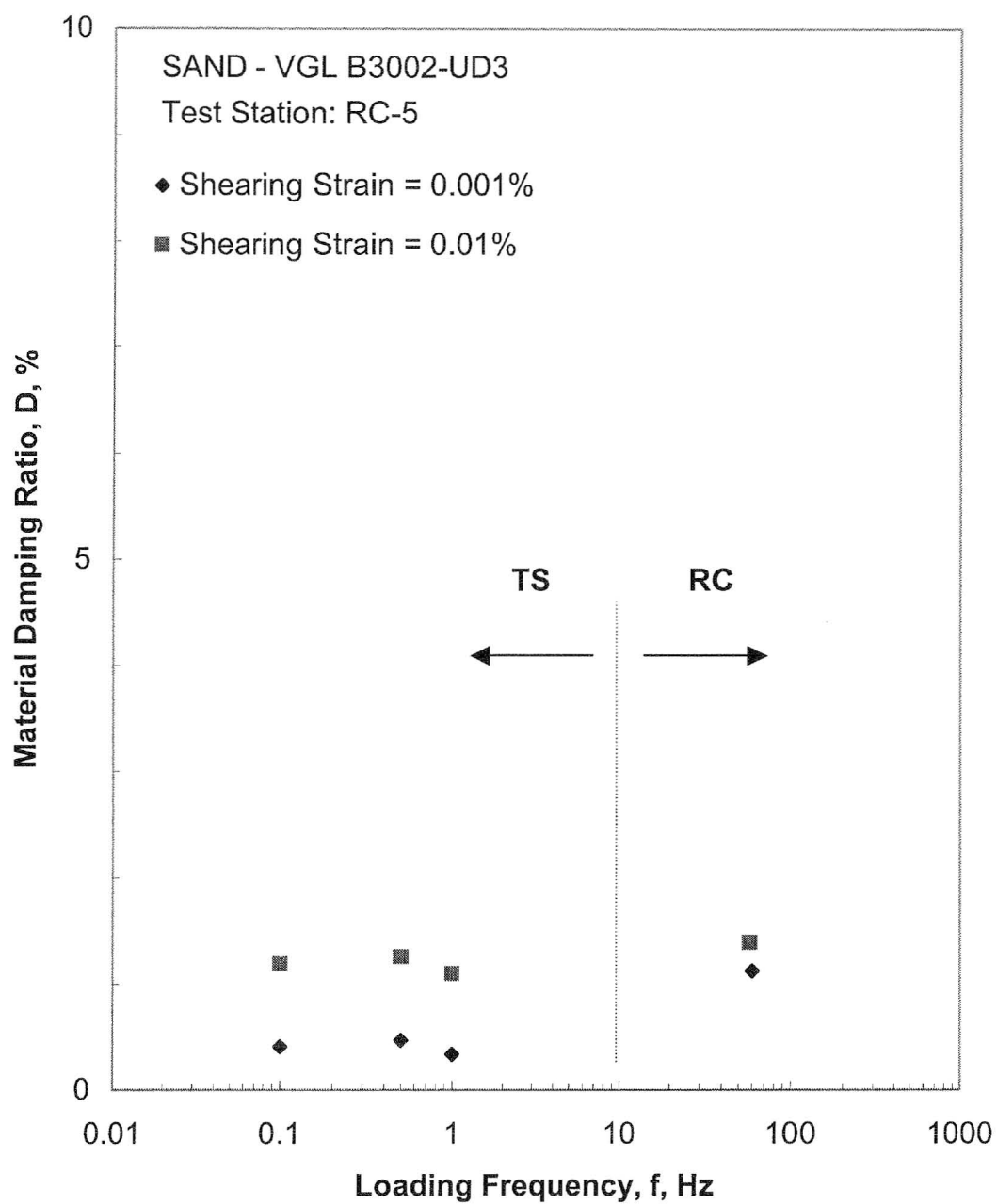


Figure E.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 62.1 psi from the Combined RCTS Tests

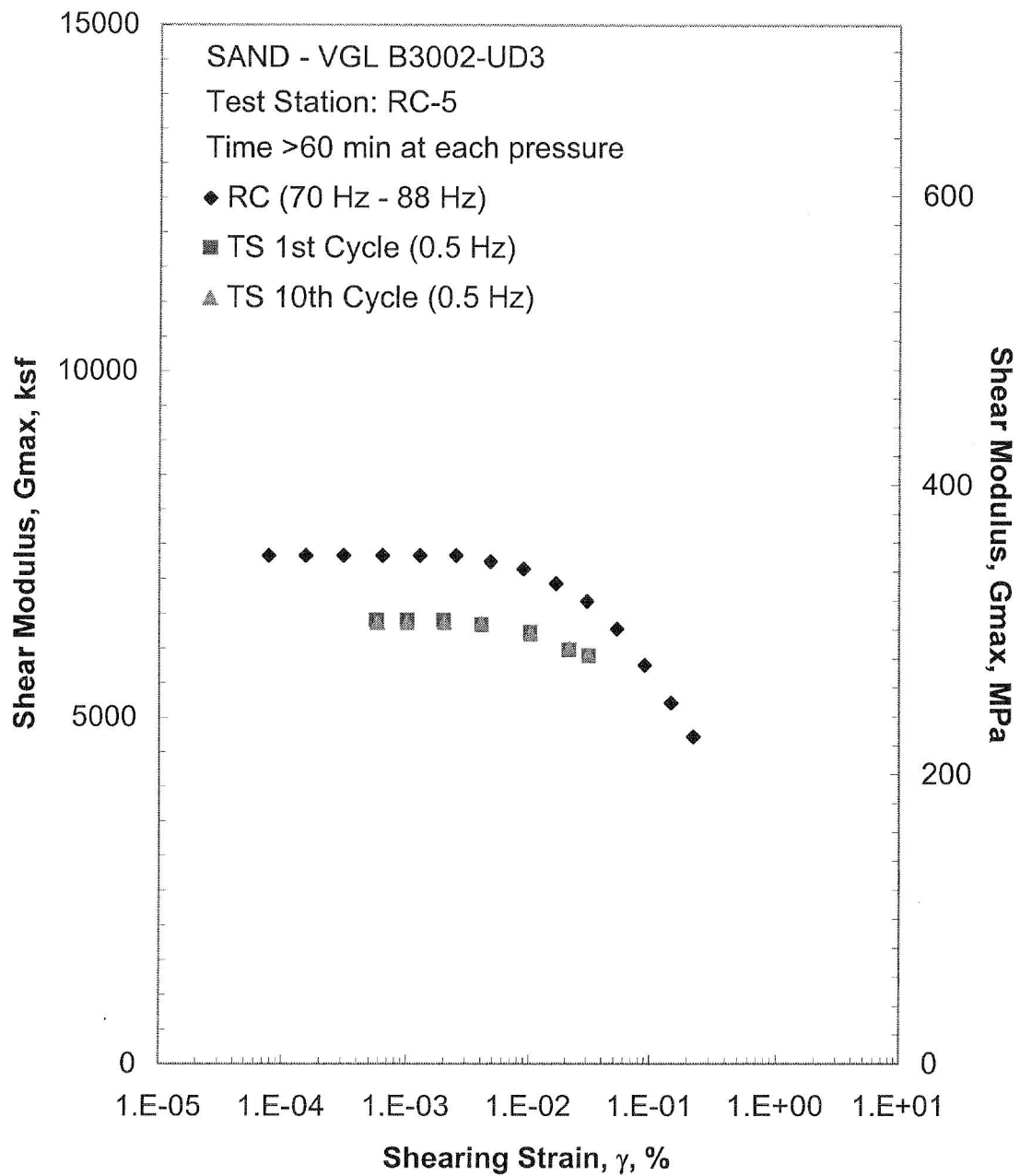


Figure E.16 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 248.6 psi from the Combined RCTS Tests

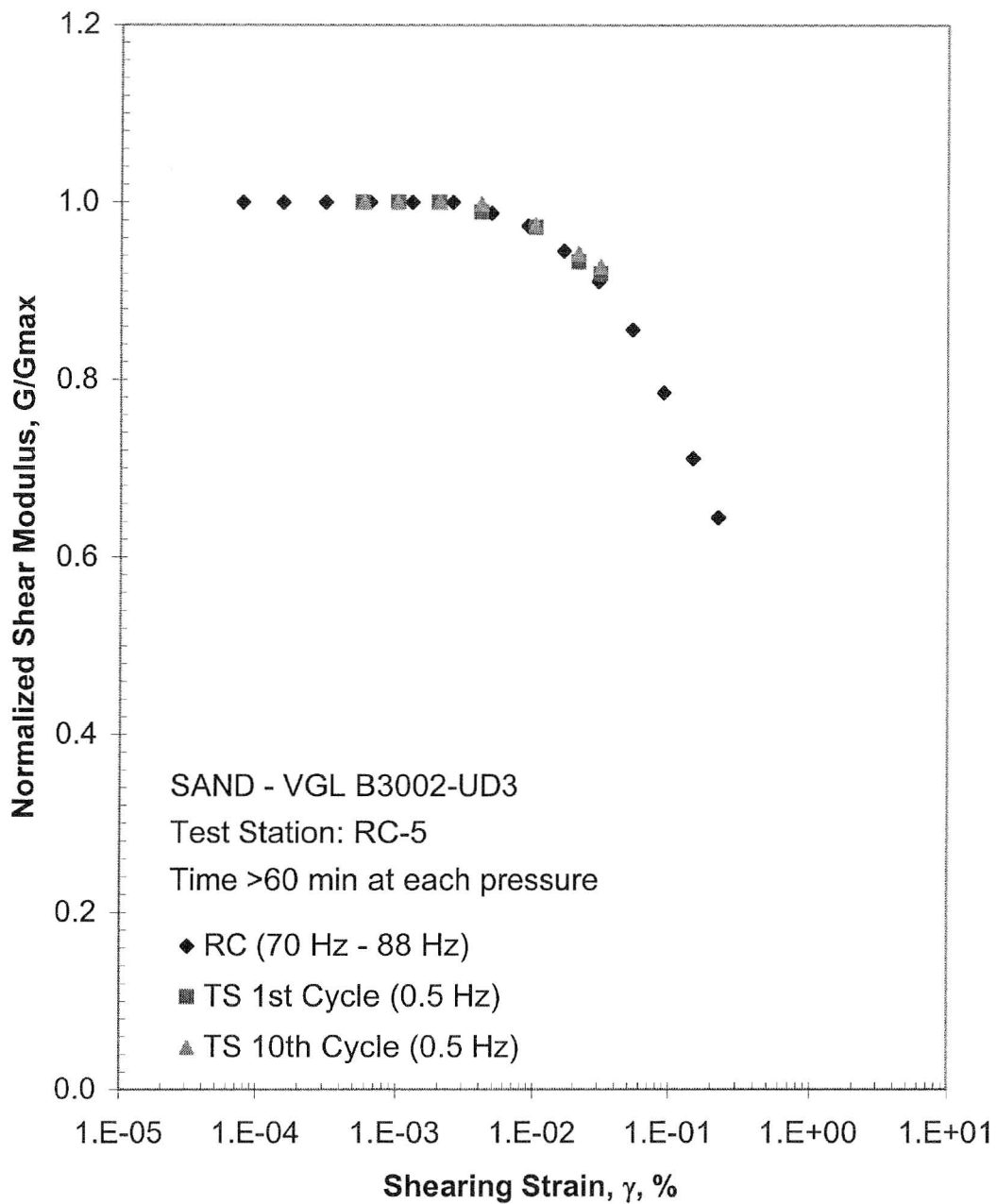


Figure E.17 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 248.6 psi from the Combined RCTS Tests

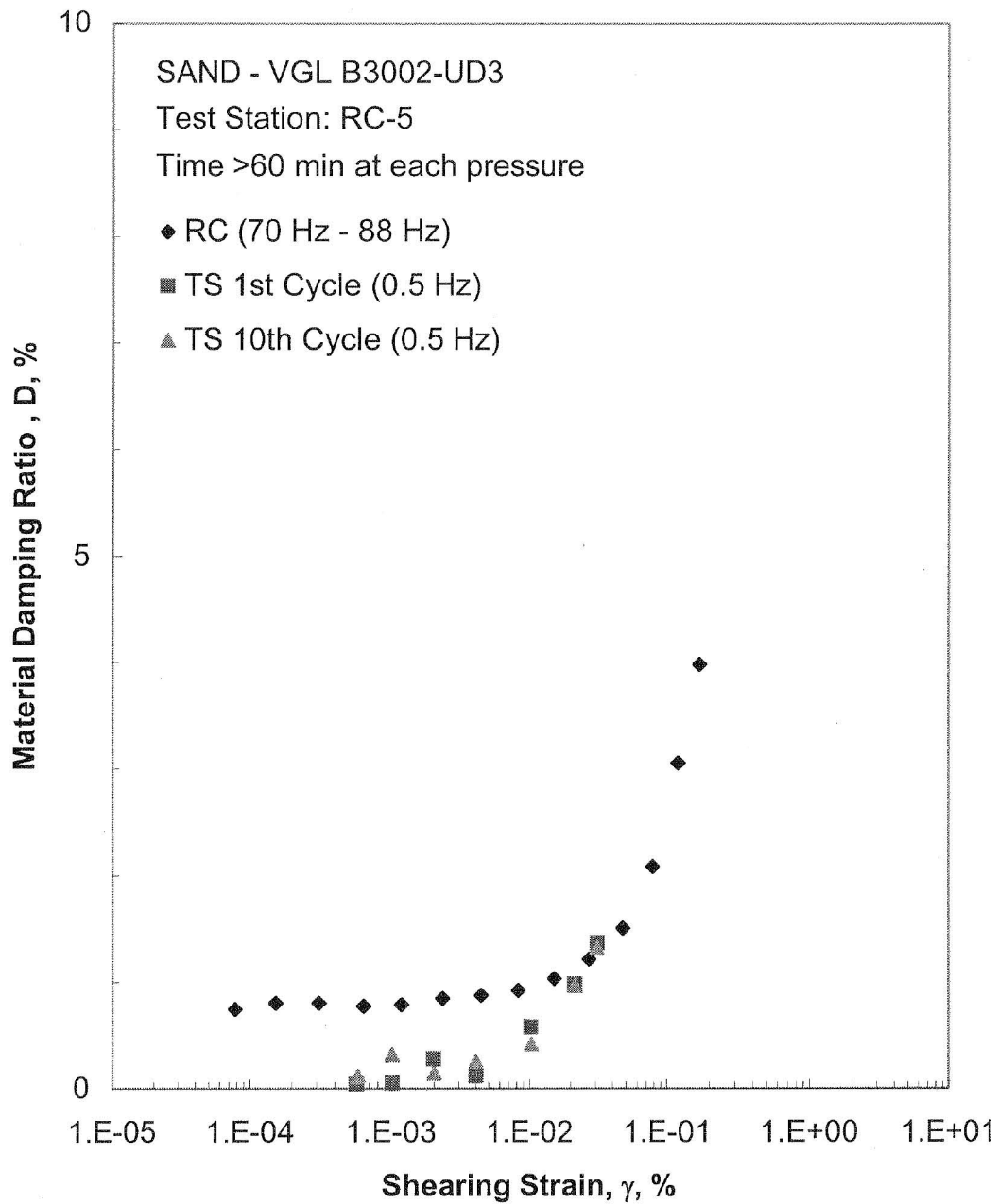


Figure E.18 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 248.6 psi from the Combined RCTS Tests

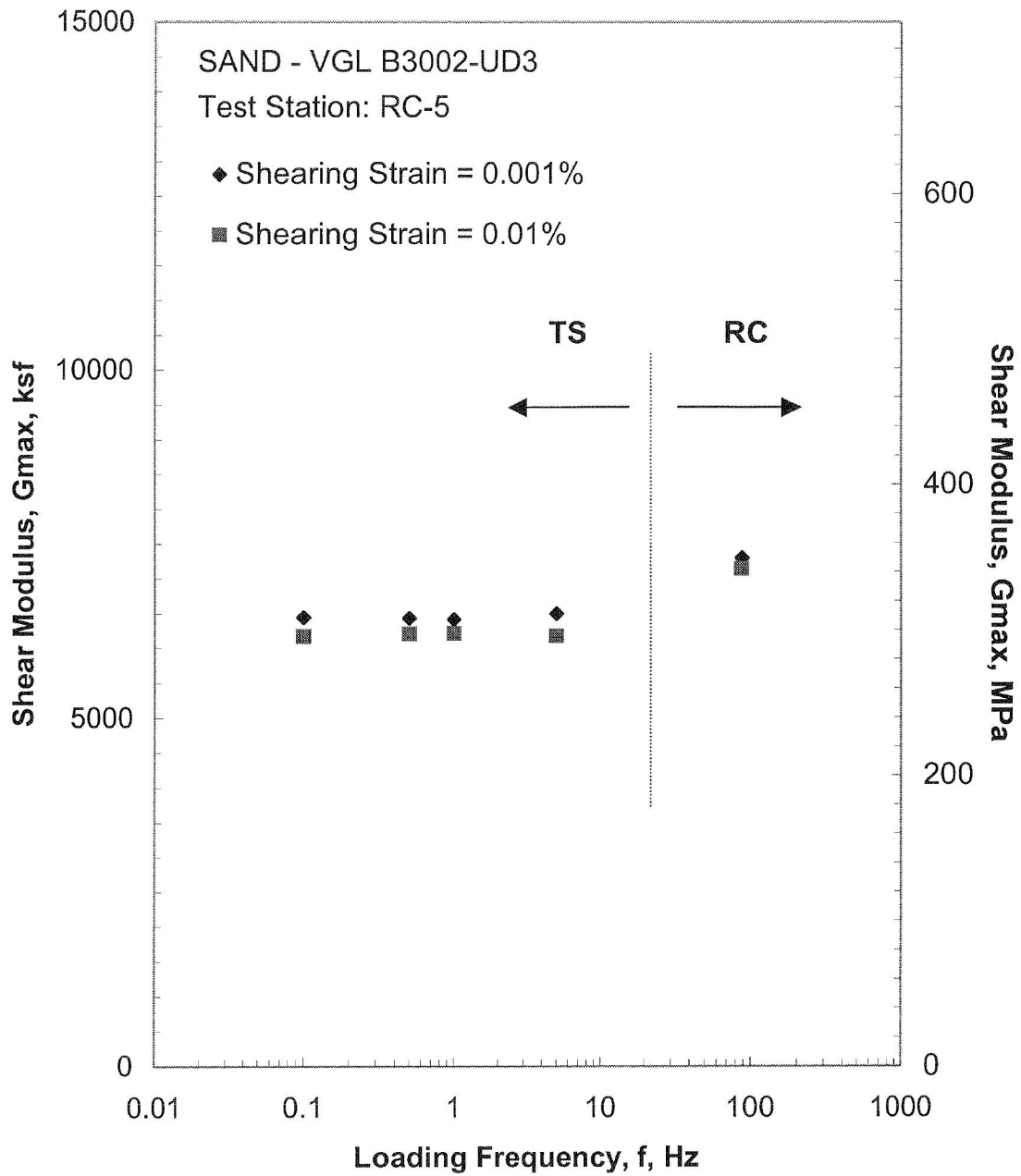


Figure E.19 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 248.6 psi from the Combined RCTS Tests

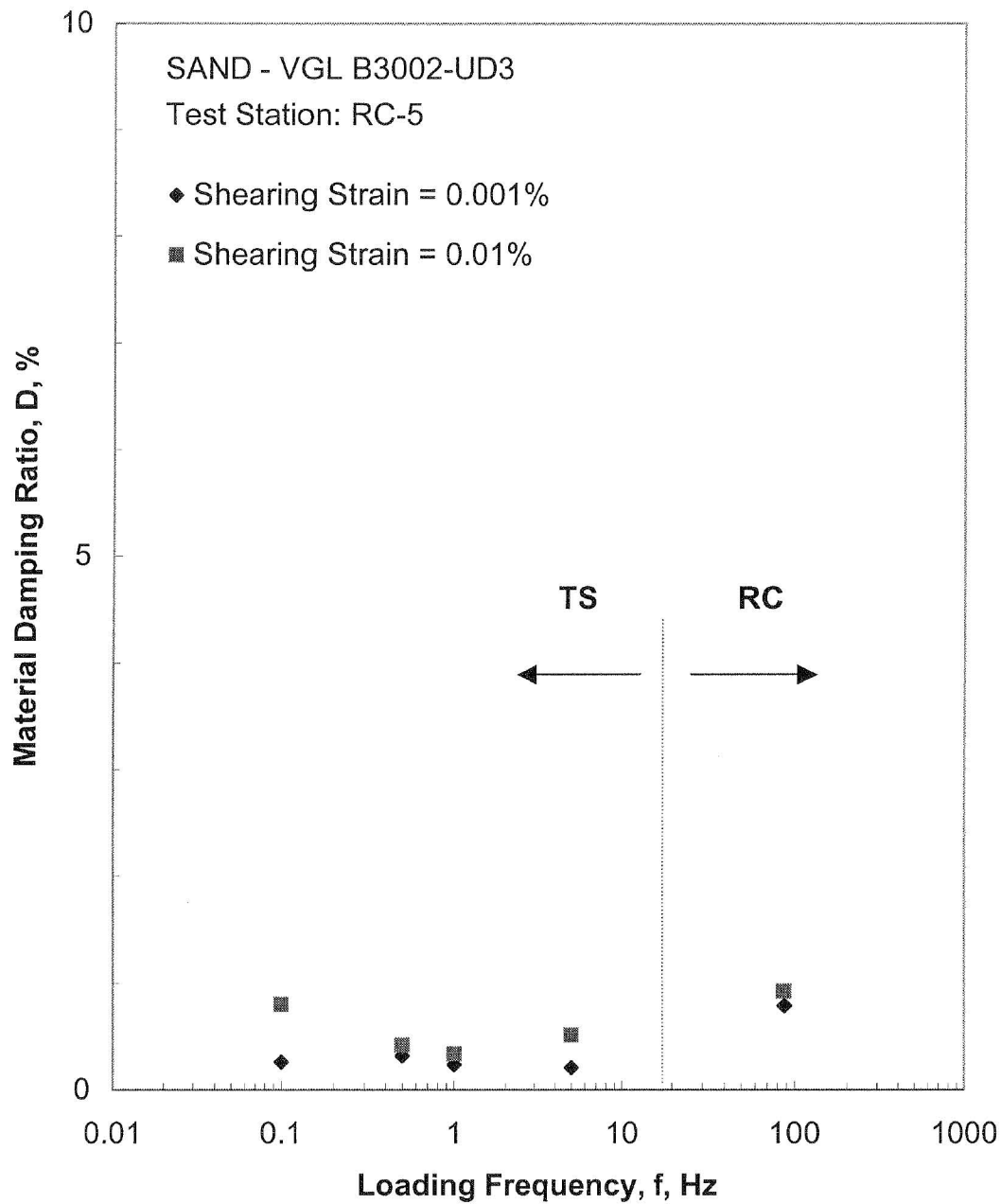


Figure E.20 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 248.6 psi from the Combined RCTS Tests

Table E.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 VGL B3002-UD3

Isotropic Confining Pressure, σ_o			Low-Amplitude Shear Modulus, G_{max}		Low-Amplitude Shear Wave Velocity, V_s	Low-Amplitude Material Damping Ratio, D_{min}	Estimated Void Ratio, e
(psi)	(psf)	(kPa)	(ksf)	(MPa)	(fps)	(%)	
15.5	2232	107	1631	78	662	1.18	0.752
31.1	4478	214	2339	112	792	0.99	0.748
62.1	8942	428	3302	158	939	0.93	0.741
124.3	17899	856	5407	260	1209	0.85	0.727
248.6	35798	1713	7293	350	1386	0.80	0.718

Table E.2 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen VGL B3002-UD3; Isotropic Confining Pressure, $\sigma_o=62.1$ psi (8.9 ksf = 428 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average ⁺ Shearing Strain, %	Material Damping Ratio ^x , D, %
1.96E-04	3358	1.00	1.96E-04	1.12
3.66E-04	3358	1.00	3.66E-04	1.12
8.05E-04	3358	1.00	8.05E-04	1.12
1.56E-03	3358	1.00	1.39E-03	1.15
3.03E-03	3330	0.99	2.69E-03	1.22
5.75E-03	3274	0.97	5.18E-03	1.26
1.06E-02	3191	0.95	9.36E-03	1.39
1.91E-02	3081	0.92	1.66E-02	1.60
3.36E-02	2895	0.86	2.89E-02	1.86
6.10E-02	2640	0.79	5.12E-02	2.21
1.05E-01	2397	0.71	8.26E-02	3.12
1.72E-01	2200	0.66	1.27E-01	4.44
2.88E-01	2005	0.60	1.96E-01	5.93

⁺ 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 E.3 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen VGL B3002-UD3; Isotropic Confining Pressure, $\sigma_o = 62.1$ psi (8.9 ksf = 428 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, %
2.08E-04	3304	1.00	0.25	1.99E-04	3376	1.00	0.45
3.86E-04	3304	1.00	0.31	3.94E-04	3376	1.00	0.31
1.04E-03	3304	1.00	0.24	1.02E-03	3376	1.00	0.47
2.05E-03	3304	1.00	0.25	2.04E-03	3280	0.97	0.53
4.18E-03	3178	0.96	0.76	4.19E-03	3169	0.94	0.58
9.83E-03	3058	0.93	1.18	9.85E-03	3054	0.90	1.26
2.08E-02	2892	0.88	1.88	2.08E-02	2882	0.85	1.92
4.66E-02	2579	0.78	3.58	4.64E-02	2587	0.77	3.44

Table E.4 Variation in Shear Modulus and Material Damping Ratio with Shearing Strain from RC Tests of Specimen VGL B3002-UD3; Isotropic Confining Pressure, $\sigma_o = 248.6$ psi (35.8 ksf = 1713 kPa)

Peak Shearing Strain, %	Shear Modulus, G, ksf	Normalized Shear Modulus, G/G_{max}	Average ⁺ Shearing Strain, %	Material Damping Ratio ^x , D, %
7.80E-05	7332	1.00	7.80E-05	0.74
1.54E-04	7332	1.00	1.54E-04	0.80
3.09E-04	7332	1.00	3.09E-04	0.80
6.37E-04	7332	1.00	6.37E-04	0.77
1.28E-03	7332	1.00	1.17E-03	0.79
2.50E-03	7332	1.00	2.30E-03	0.85
4.79E-03	7244	0.99	4.41E-03	0.88
9.00E-03	7139	0.97	8.28E-03	0.92
1.67E-02	6932	0.95	1.52E-02	1.03
3.01E-02	6677	0.91	2.71E-02	1.21
5.33E-02	6279	0.86	4.74E-02	1.51
9.11E-02	5754	0.78	7.83E-02	2.08
1.48E-01	5211	0.71	1.20E-01	3.05
2.24E-01	4725	0.64	1.71E-01	3.98

⁺ 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 E.5 Variation in Shear Modulus, Normalized Shear Modulus and Material Damping Ratio with Shearing Strain from TS Tests of Specimen VGL B3002-UD3; Isotropic Confining Pressure, $\sigma_o=248.6$ psi (35.8 ksf = 1713 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, %
5.70E-04	6406	1.00	0.04	5.81E-04	6366	1.00	0.12
1.01E-03	6406	1.00	0.05	1.01E-03	6366	1.00	0.32
1.99E-03	6406	1.00	0.28	2.01E-03	6366	1.00	0.15
4.05E-03	6334	0.99	0.12	4.04E-03	6354	1.00	0.26
1.03E-02	6226	0.97	0.58	1.03E-02	6206	0.97	0.42
2.14E-02	5973	0.93	0.98	2.13E-02	5998	0.94	0.97
3.11E-02	5889	0.92	1.37	3.10E-02	5906	0.93	1.32

GRAVEL			SAND			SILT or CLAY	
Coarse	Fine	Coarse	Medium	Fine			
<u>SYMBOL</u>	<u>BORING</u>	<u>DEPTH, FT</u>	<u>C_c</u>	<u>C_u</u>	<u>D₅₀</u>	<u>D₉₀</u>	<u>CLASSIFICATION</u>
●	B-3002-UD3	185	1.46	3.41	0.1619	0.35	Silty Sand, dark gray

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APPENDIX F

Specimen VGL B3003-UD7
(LL=46, PI=21; Gs=2.66)

Borehole B3003

Sample UD7

Depth = 215.5 ft (65.7 m)

Total Unit Weight = 127.0 lb/ft³

Water Content = 21.1 %

Estimated In-Situ K_o = 0.44

Estimated In-Situ Mean Effective
Stress = 70.2 psi

FUGRO JOB #: 0401-1667

Testing Station: RC5



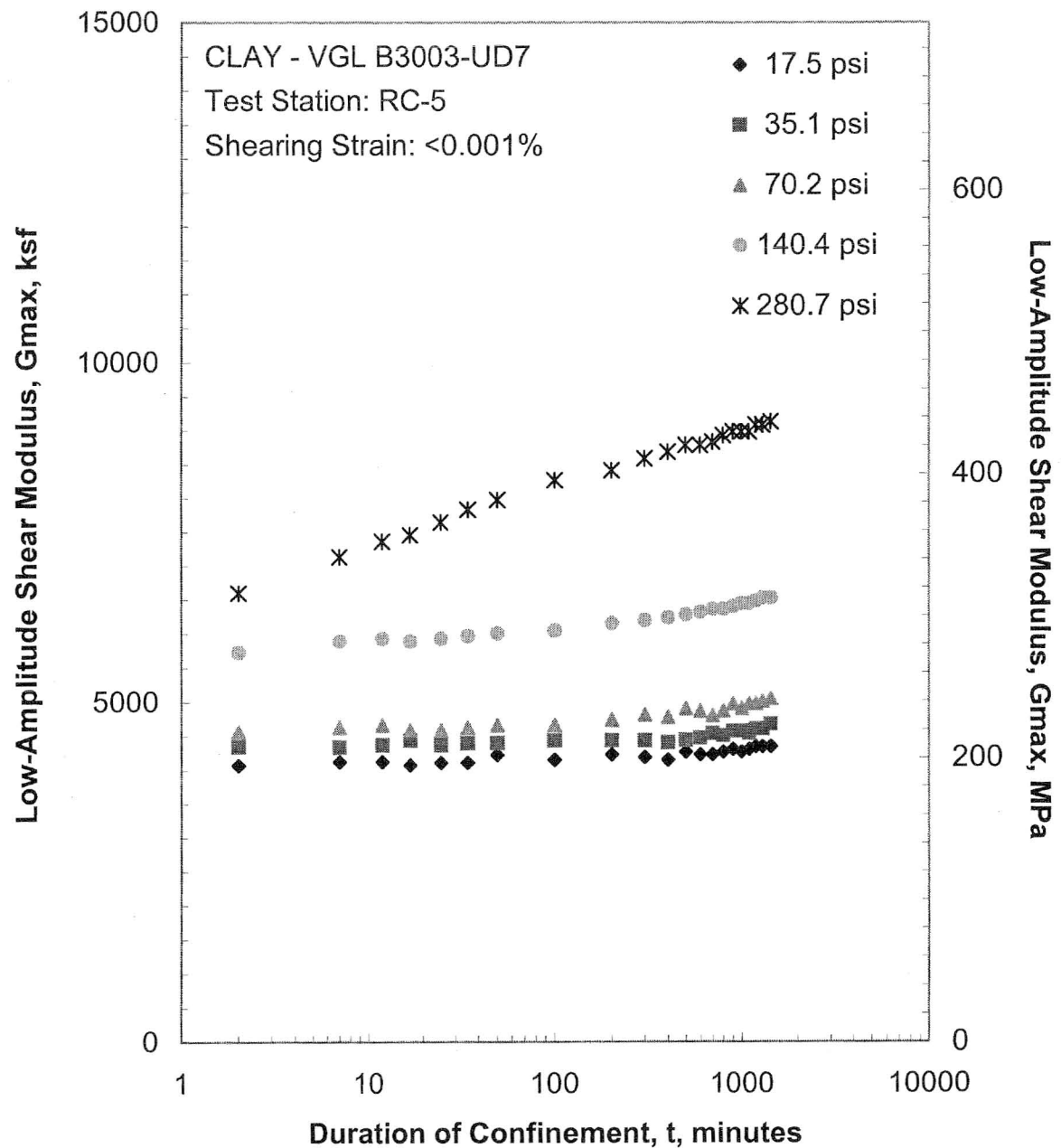


Figure F.1 Variation in Low-Amplitude Shear Modulus with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

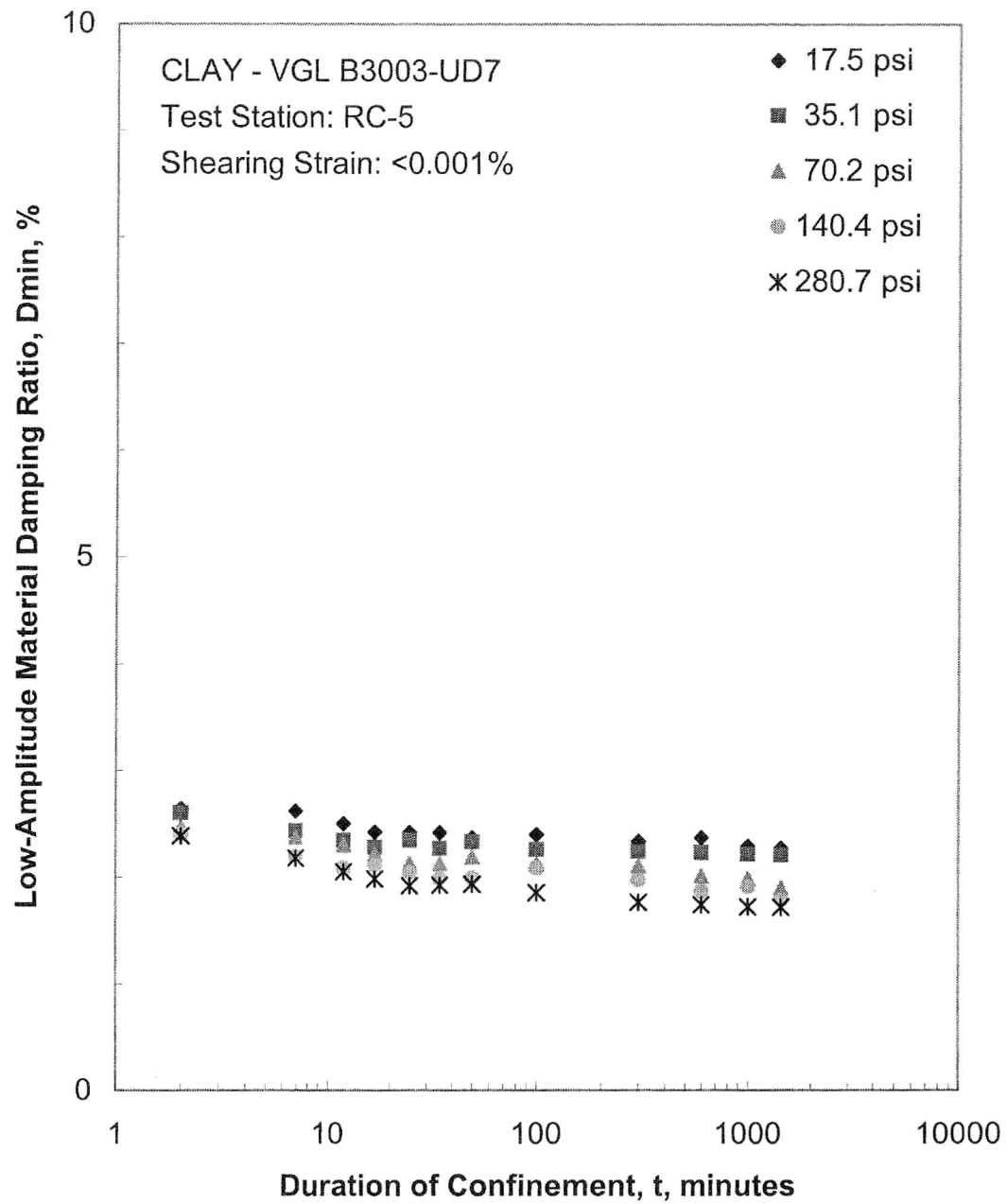


Figure F.2 Variation in Low-Amplitude Material Damping Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

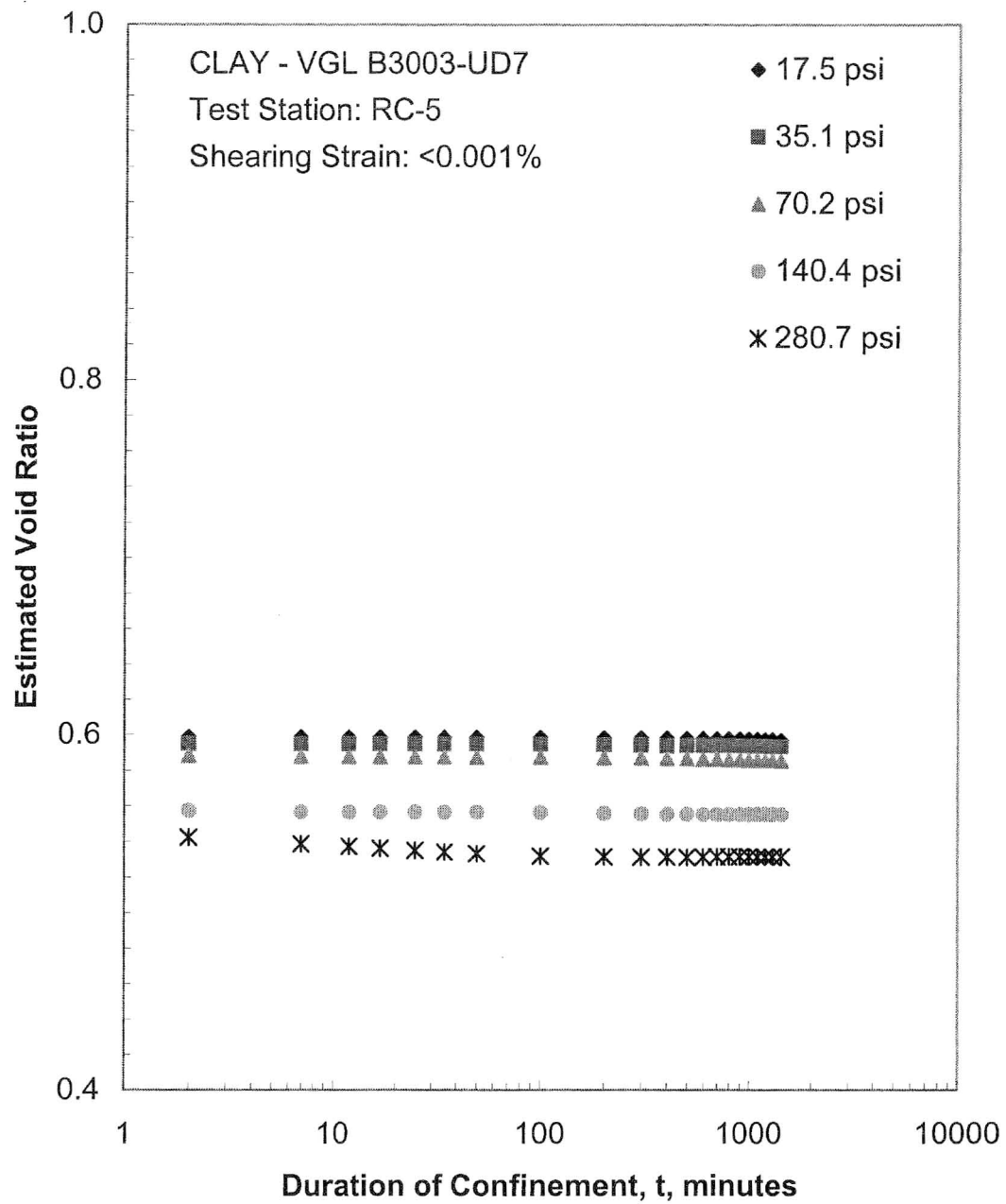


Figure F.3 Variation in Estimated Void Ratio with Magnitude and Duration of Isotropic Confining Pressure from Resonant Column Tests

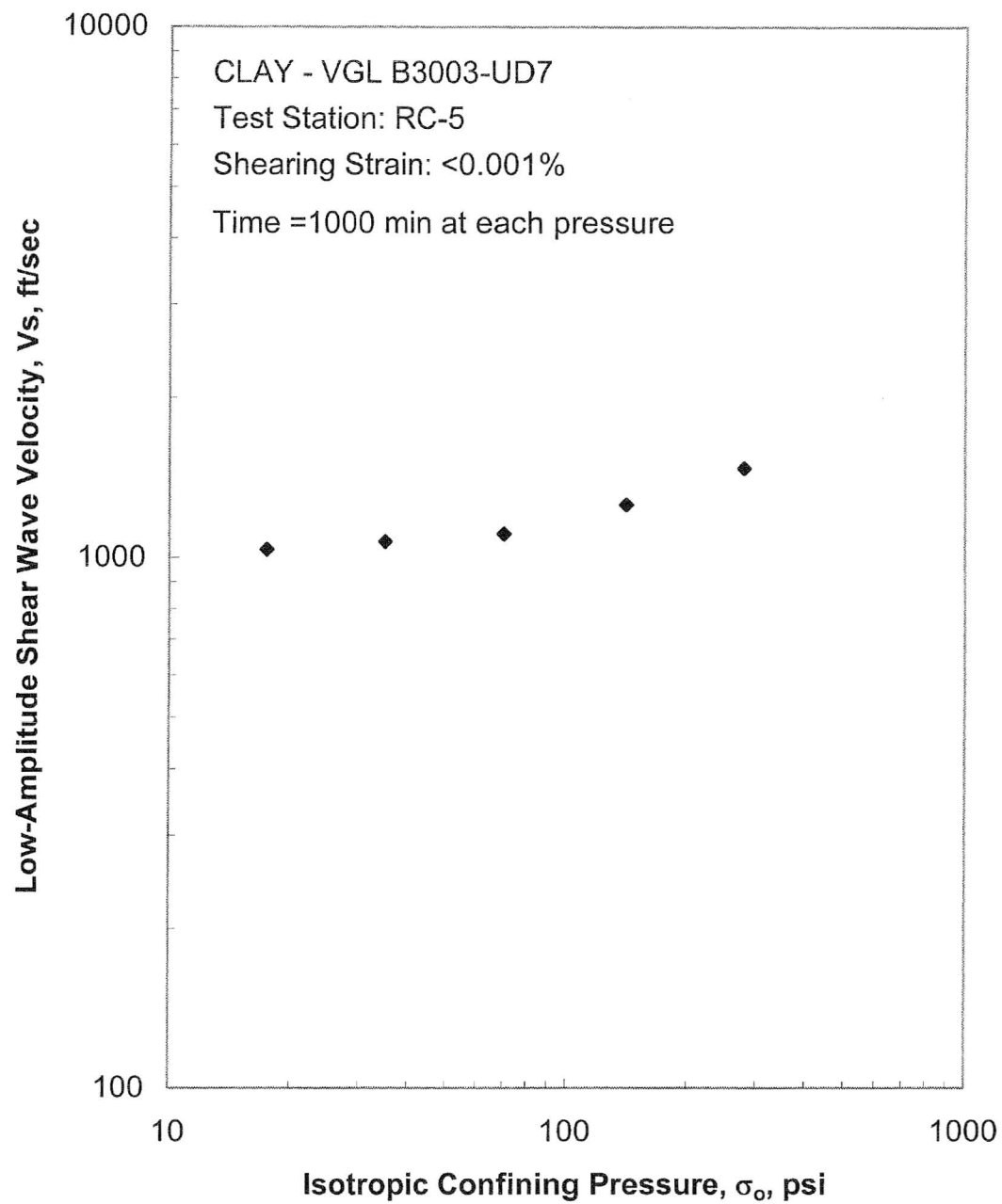


Figure F.4 Variation in Low-Amplitude Shear Wave Velocity with Isotropic Confining Pressure from Resonant Column Tests

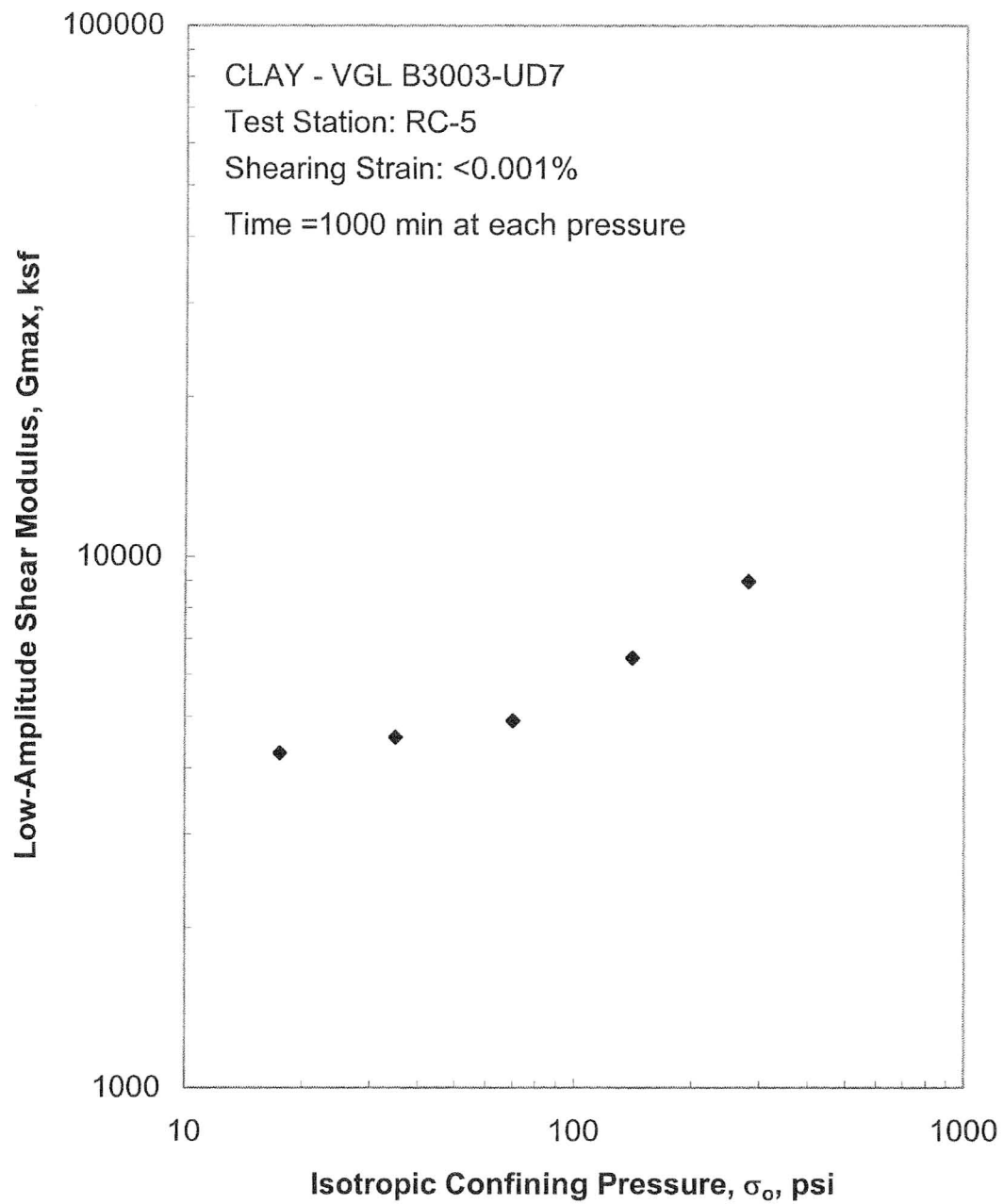


Figure F.5 Variation in Low-Amplitude Shear Modulus with Isotropic Confining Pressure from Resonant Column Tests

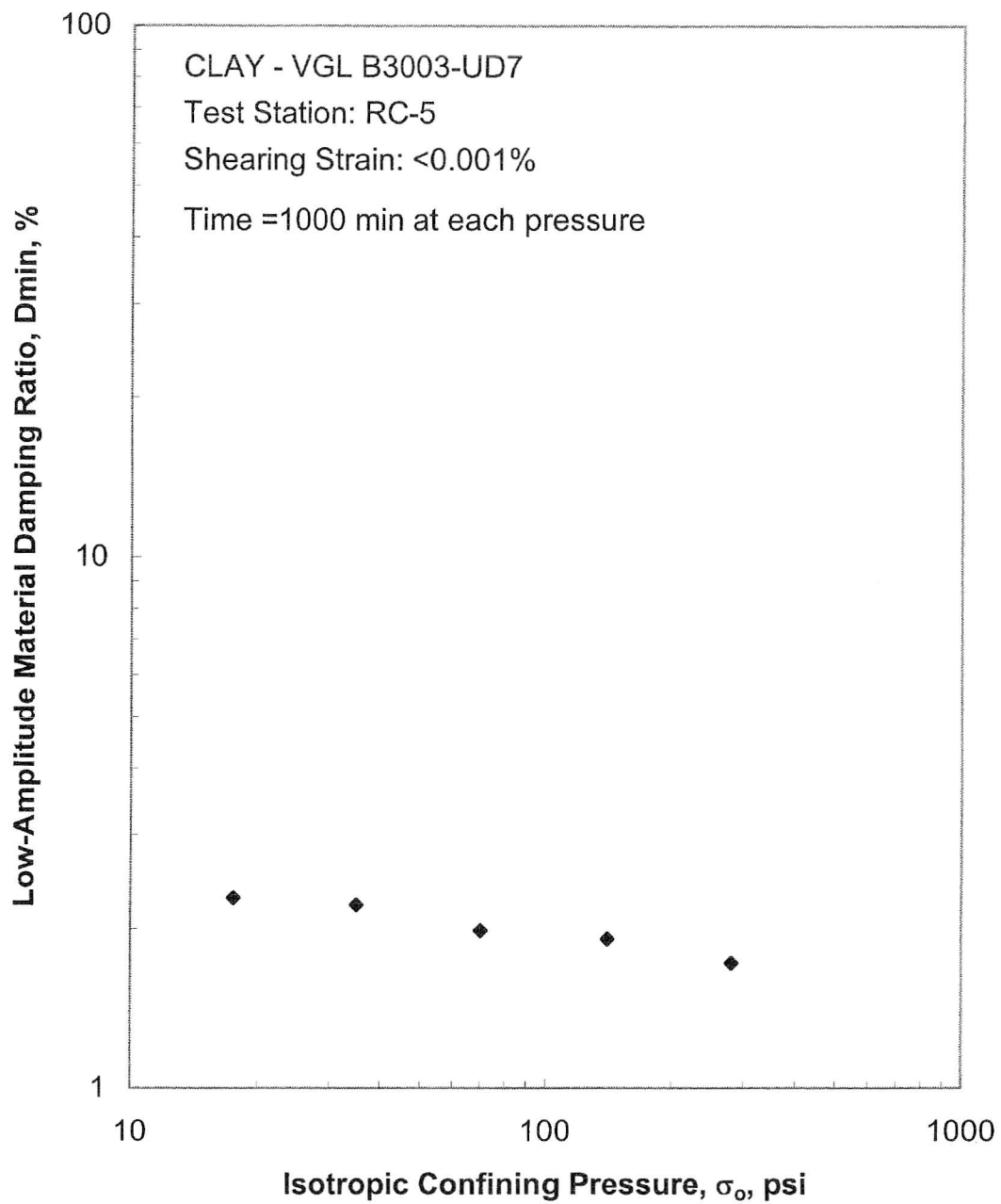


Figure F.6 Variation in Low-Amplitude Material Damping Ratio with Isotropic Confining Pressure from Resonant Column Tests

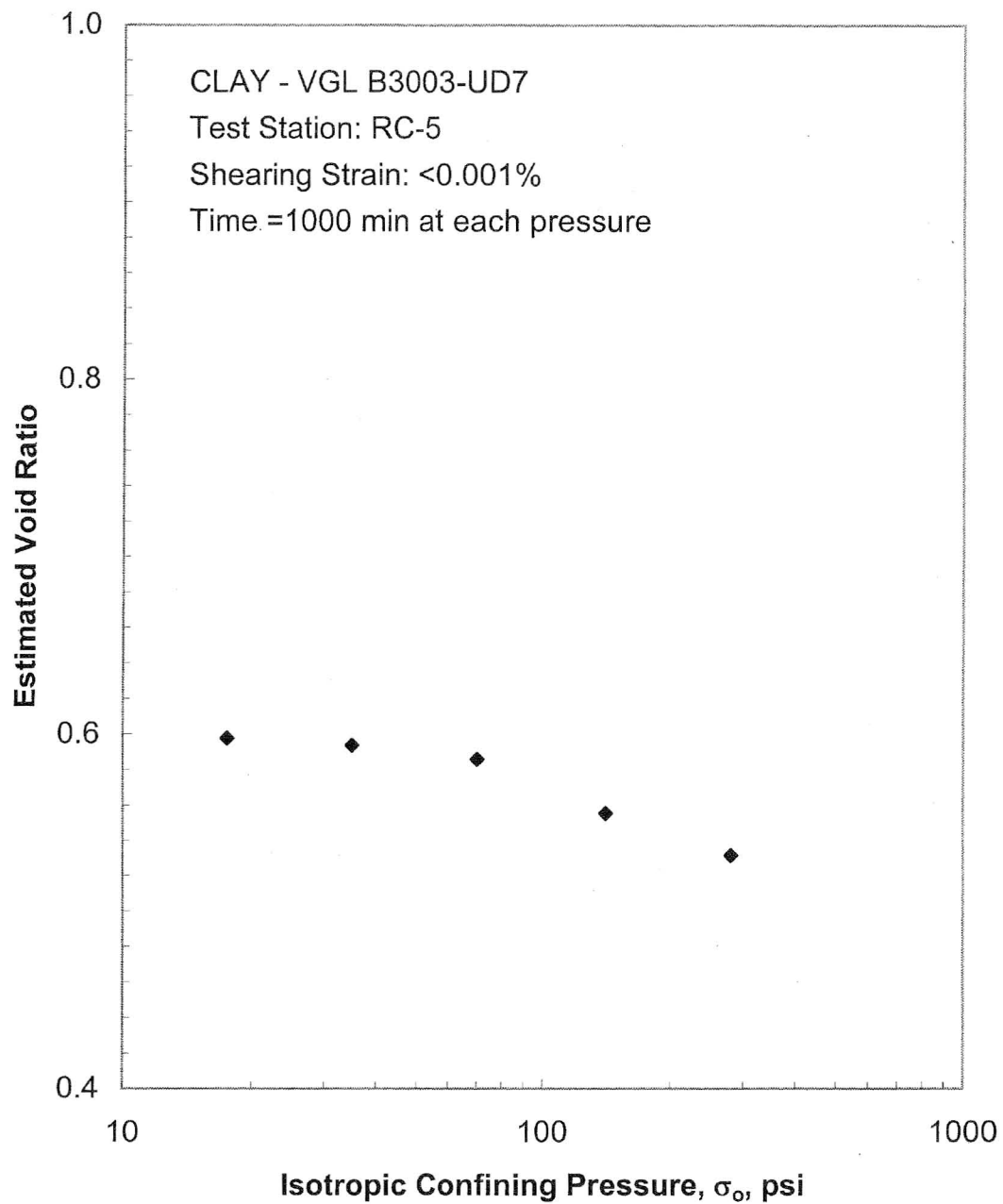


Figure F.7 Variation in Estimated Void Ratio with Isotropic Confining Pressure from Resonant Column Tests

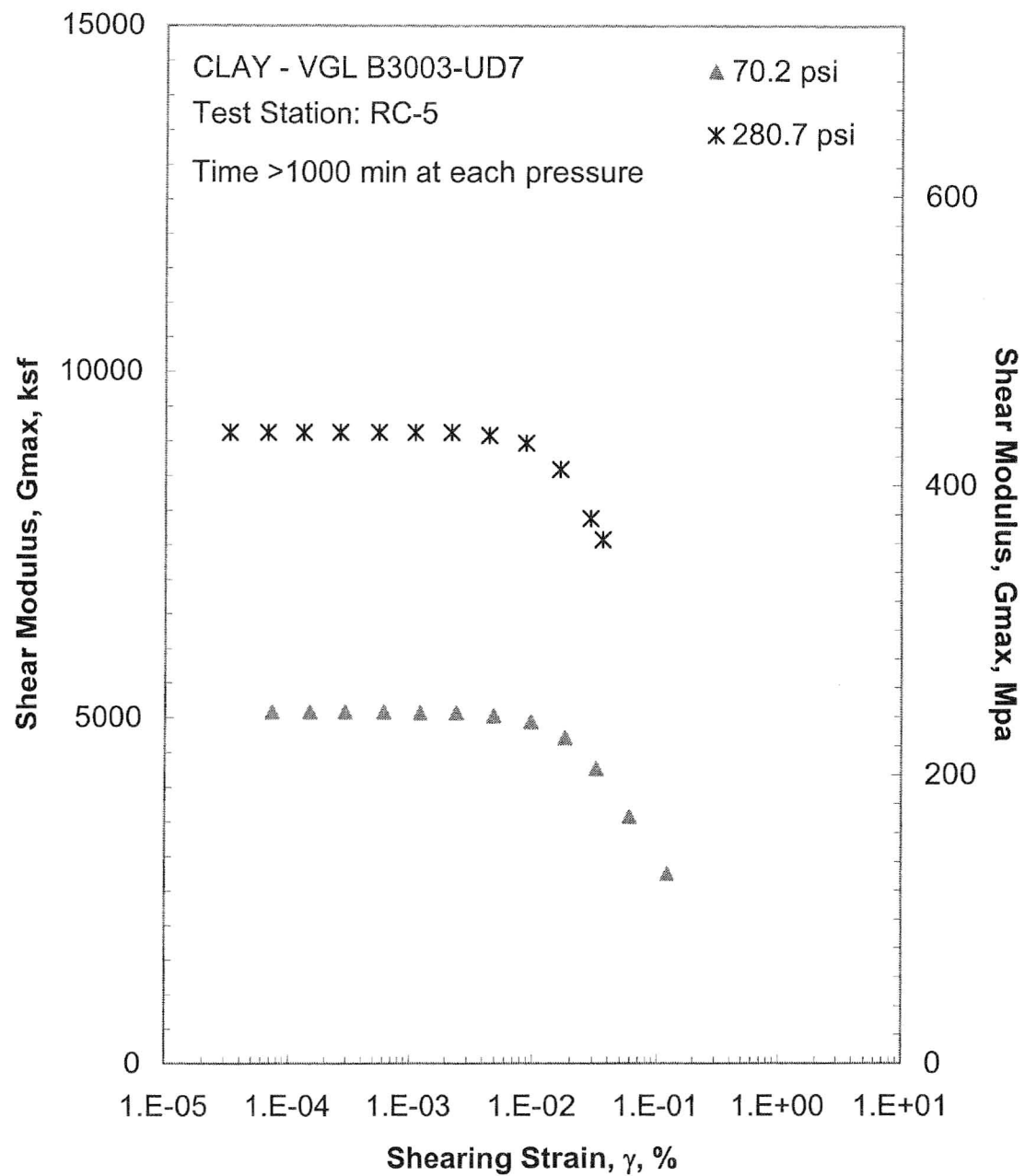


Figure F.8 Comparison of the Variation in Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

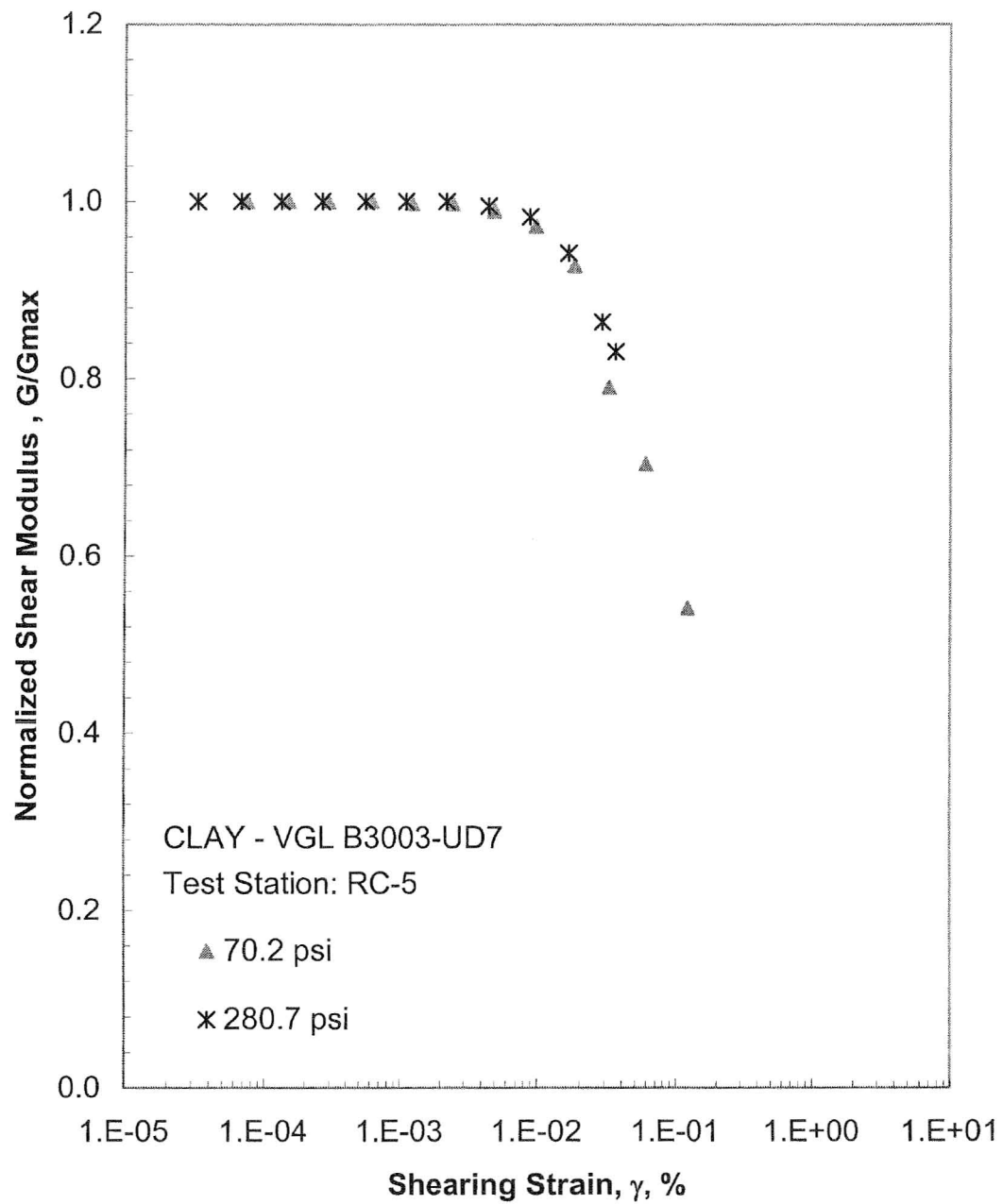


Figure F.9 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

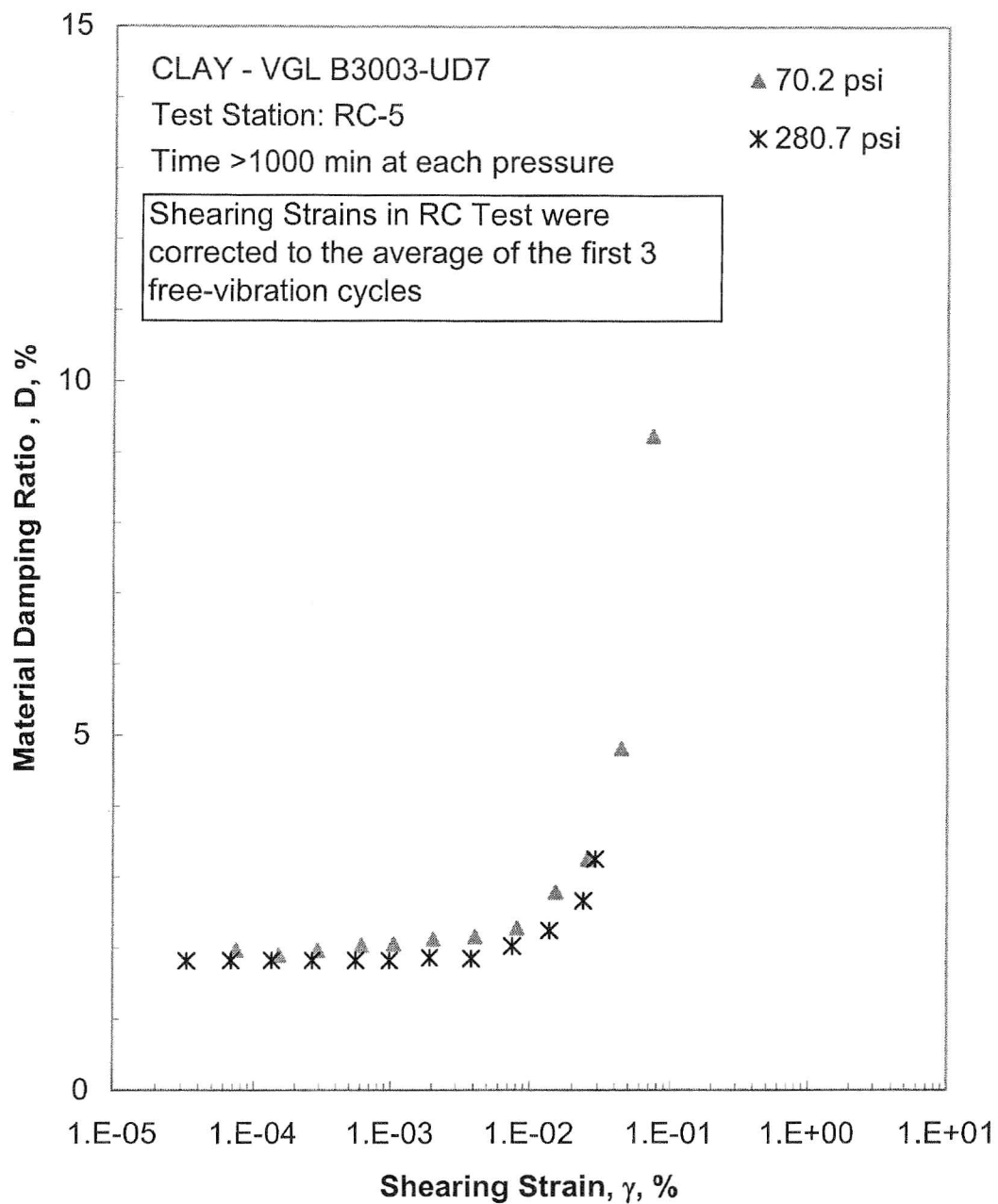


Figure F.10 Comparison of the Variation in Material Damping Ratio with Shearing Strain and Isotropic Confining Pressure from the Resonant Column Tests

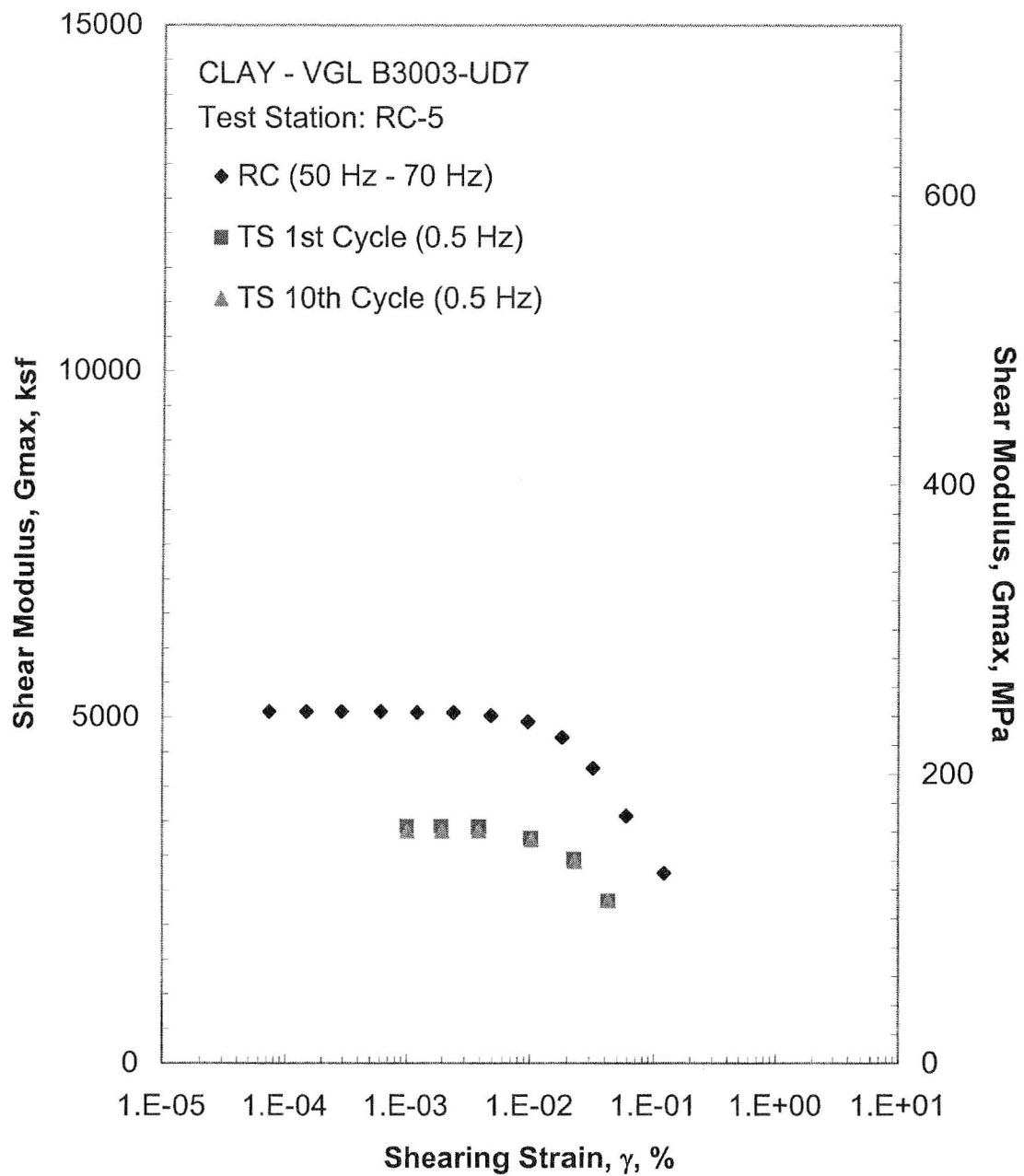


Figure F.11 Comparison of the Variation in Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 70.2 psi from the Combined RCTS Tests

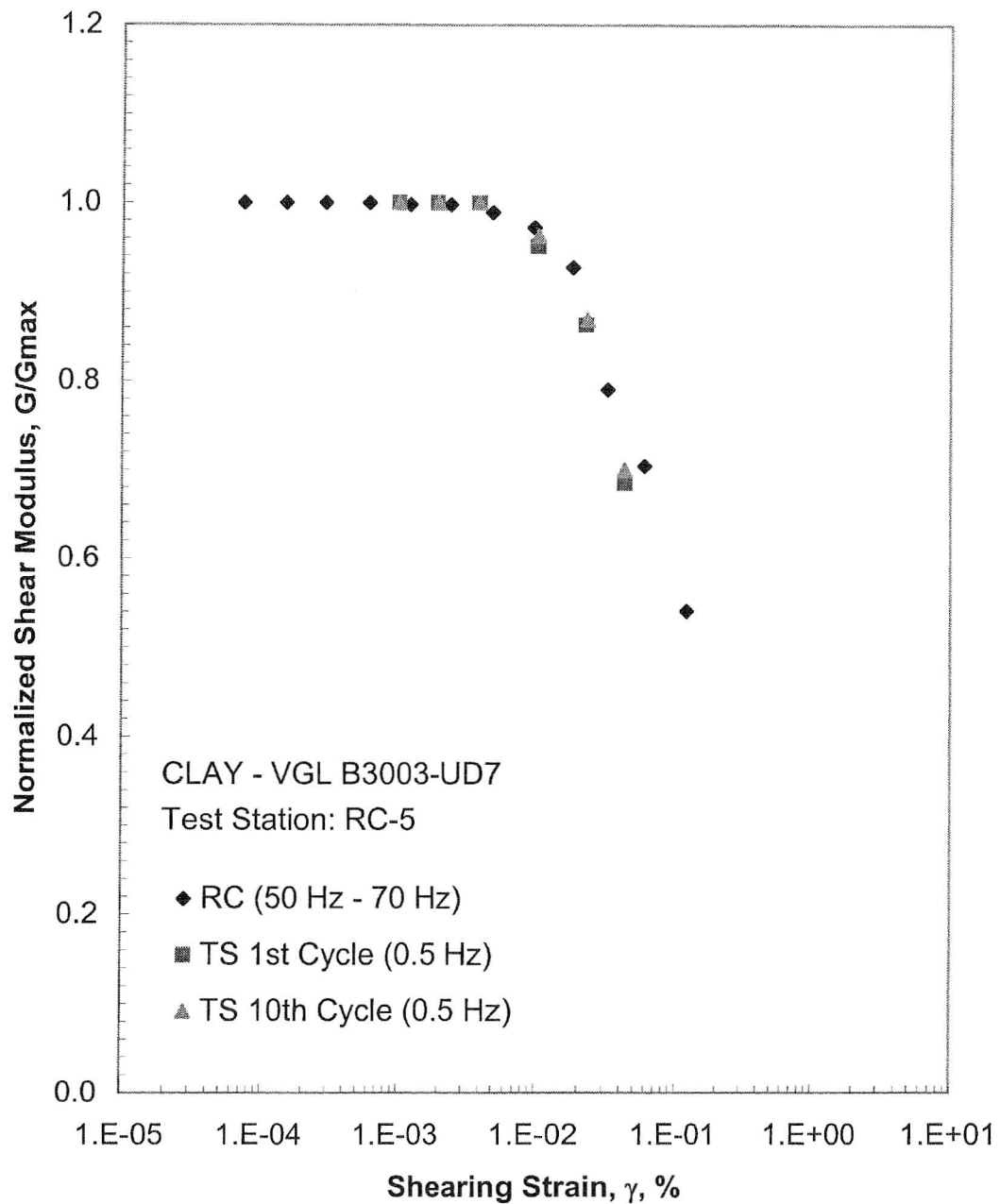


Figure F.12 Comparison of the Variation in Normalized Shear Modulus with Shearing Strain at an Isotropic Confining Pressure of 70.2 psi from the Combined RCTS Tests

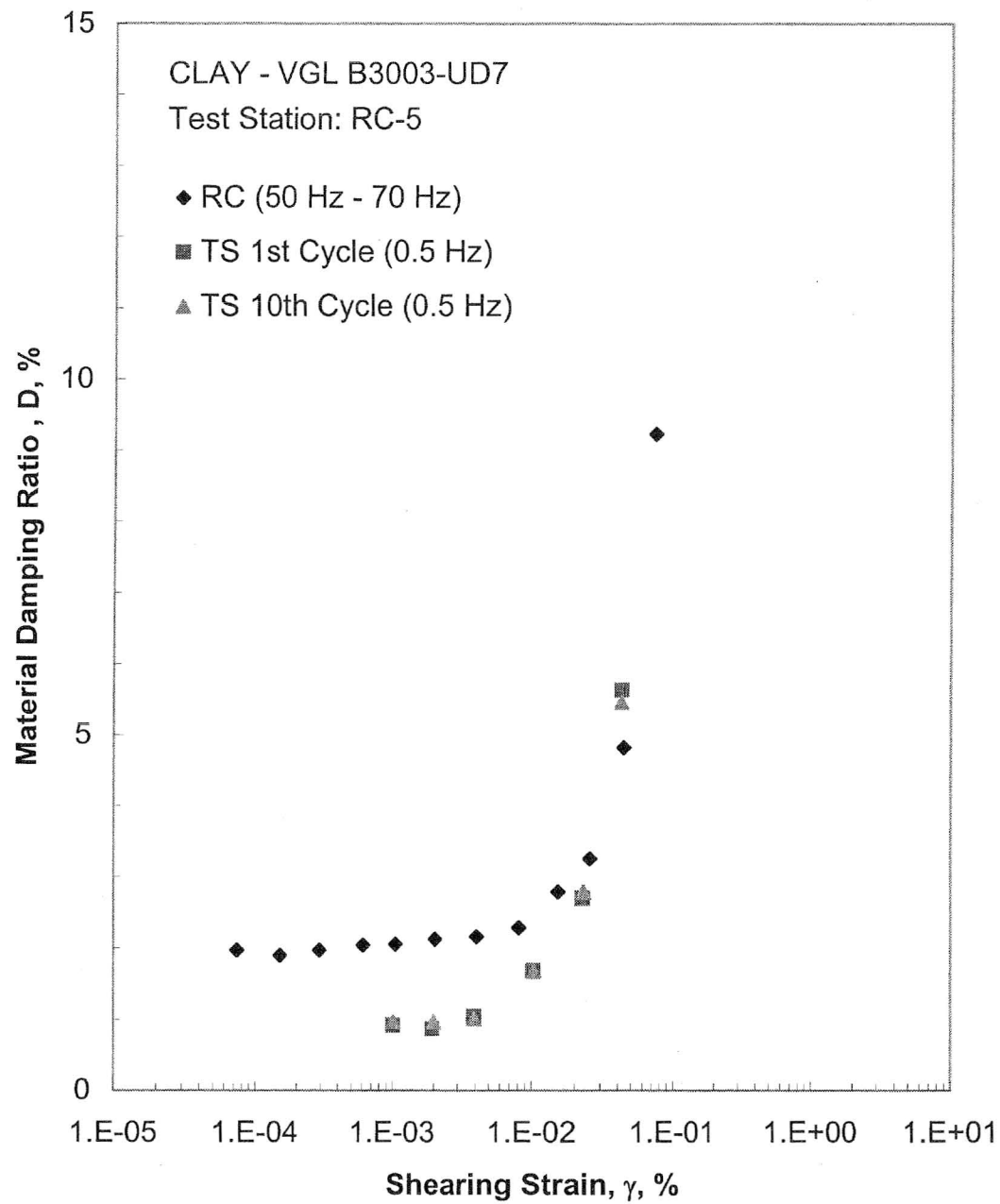


Figure F.13 Comparison of the Variation in Material Damping Ratio with Shearing Strain at an Isotropic Confining Pressure of 70.2 psi from the Combined RCTS Tests

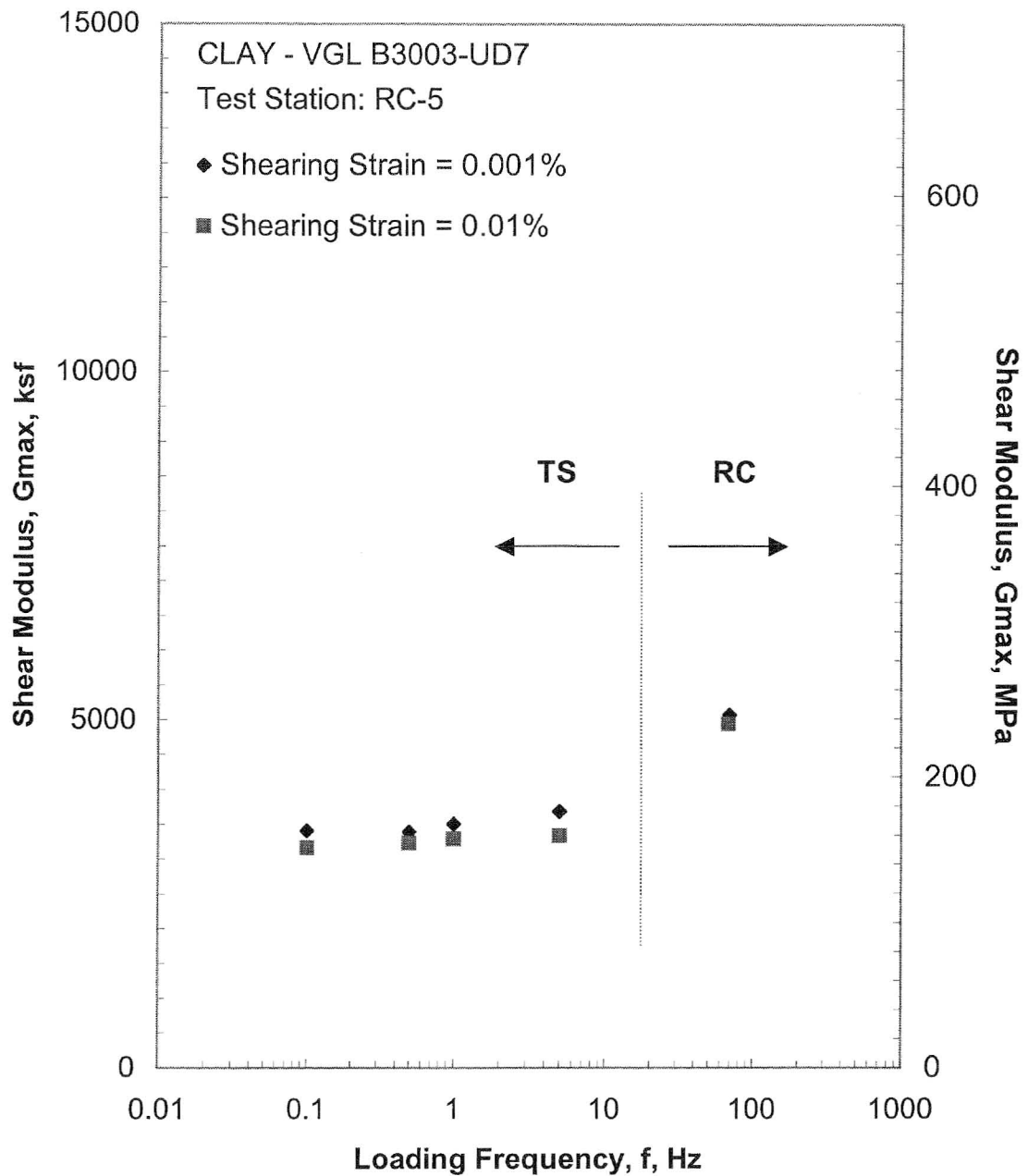


Figure F.14 Comparison of the Variation in Shear Modulus with Loading Frequency at an Isotropic Confining Pressure of 70.2 psi from the Combined RCTS Tests

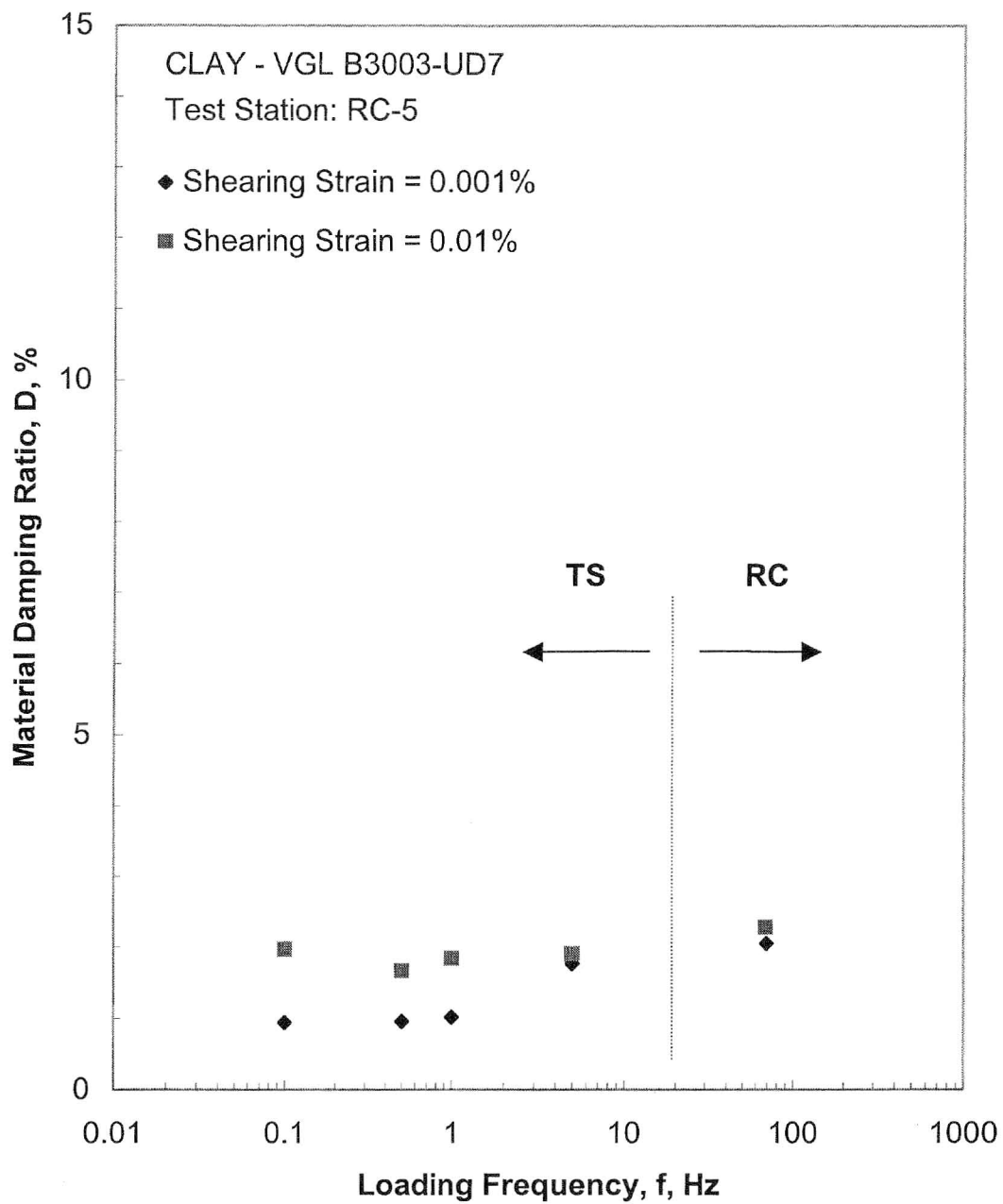


Figure F.15 Comparison of the Variation in Material Damping Ratio with Loading Frequency at an Isotropic Confining Pressure of 70.2 psi from the Combined RCTS Tests