

**ROCK MECHANICS TESTING AND ANALYSES  
ON SAMPLES FROM SOUTH FLORIDA  
FOR SOUTH FLORIDA WATER MANAGEMENT  
DISTRICT**

**TECHNICAL SERVICES REPORT HOU-040594  
ROCK MECHANICS LABORATORY**



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**PETROLEUM SERVICES**

**ROCK MECHANICS LABORATORY  
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**August 30, 2004**

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**Subject: Letter Report for South Florida Water Management (HOU-040594)**

This report reviews the results of unconfined compressive tests with concurrent acoustic velocity measurements for South Florida Water Management. A total of 6 samples of 1-inch in diameter from EXKR-1, EXPM-1, and EXBRY-1 wells were tested at fully saturated condition, using fresh water as the saturant.

The unconfined compressive tests were conducted by applying axial load to the sample at a constant rate under zero confining pressure until the sample fails. The unconfined compressive strengths of the samples ranged from 45-psi to 1,843-psi with static Young's modulus ranging from  $0.01 \times 10^6$  psi to  $1.48 \times 10^6$  psi and static Poisson's ratio ranging from 0.24 to 0.34. The results of the unconfined compressive tests, which include compressive strengths, static Young's modulus, and static Poisson's ratio are summarized in **Table 1**. Stress-strain curves for each test are shown in **Figures 1** through **6**, together with the sample dimensions and experimental conditions.

The acoustic velocities were measured during the unconfined compressive tests and corresponding dynamic elastic parameters were calculated. At the varying applied axial stresses ranging from 50-psi to 300-psi, the acoustic velocities of the samples ranged from 5,890 ft/sec to 11,270 ft/sec for the compressional waves and from 2,490 ft/sec to 6,020 ft/sec for the shear waves, with dynamic Young's modulus ranging from  $0.39 \times 10^6$  psi to  $2.90 \times 10^6$  psi and dynamic Poisson's ratio ranging from 0.29 to 0.39. The dynamic values of Young's modulus were higher than the static values. The acoustic velocities of the sample No. 2 were estimated because of unclear wave form data. The results of the acoustic velocities are summarized in **Table 2**.

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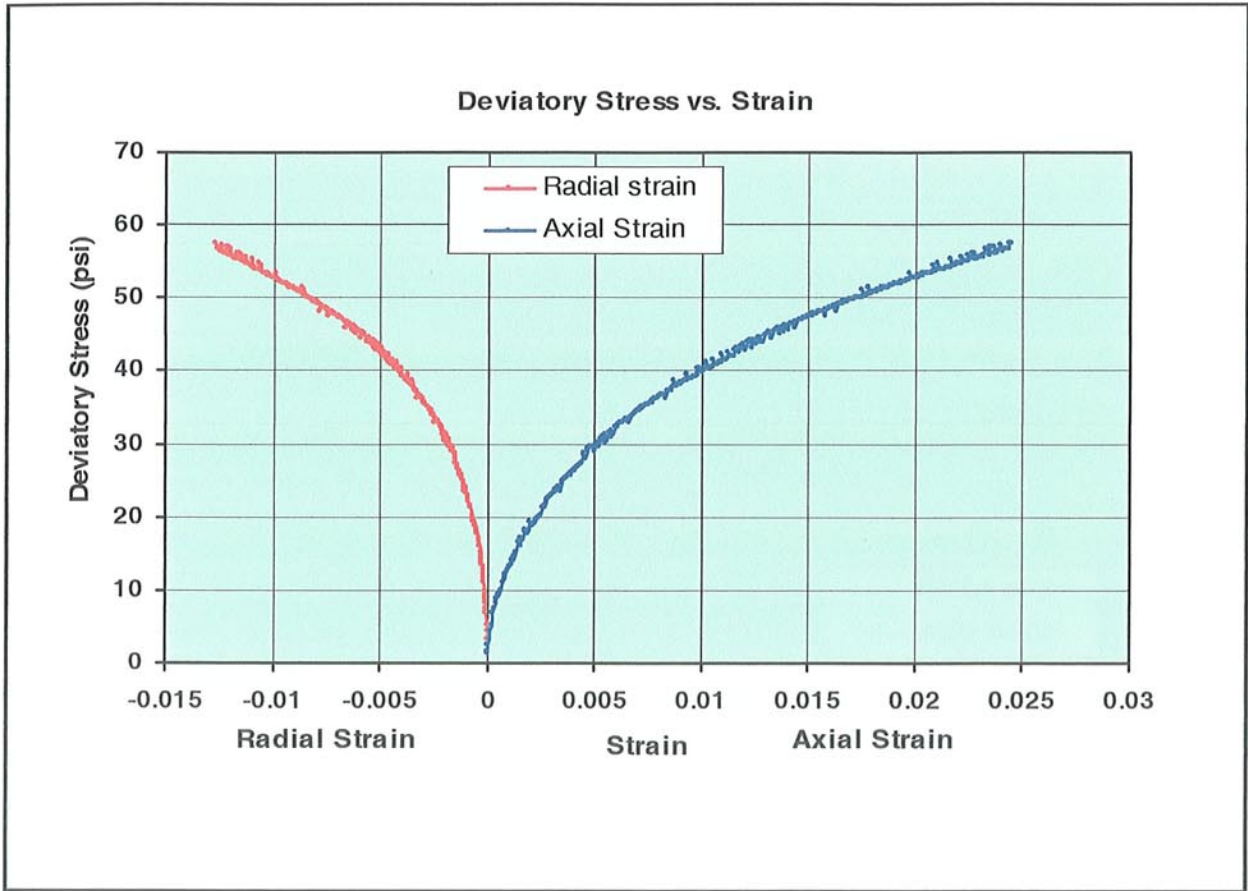
**Table 1. Results of unconfined compressive tests including compressive strength, static Young's modulus, and static Poisson's ratio are presented for samples from various wells in Florida.**

Sample No.	Depth (ft)	Well	Confining Pressure (psi)	Bulk Density (g/cc)	Compressive Strength (psi)	Static Young's Modulus ( $\times 10^6$ psi)	Static Poisson's Ratio
2	304.8	EXKR-1	0	1.92	45	0.01	0.34
7	932.2	EXPM-1	0	1.91	311	0.27	0.26
10	1057.6	EXPM-1	0	1.85	321	0.16	0.24
13	1305.0	EXBRY-1	0	2.30	1301	0.63	0.27
14	1322.0	EXBRY-1	0	2.28	651	0.42	0.27
16	1324.4	EXBRY-1	0	2.28	1843	1.48	0.26

**Table 2. Results of measured acoustic velocities and calculated dynamic elastic parameters are provided for the unconfined compressive strength test samples.**

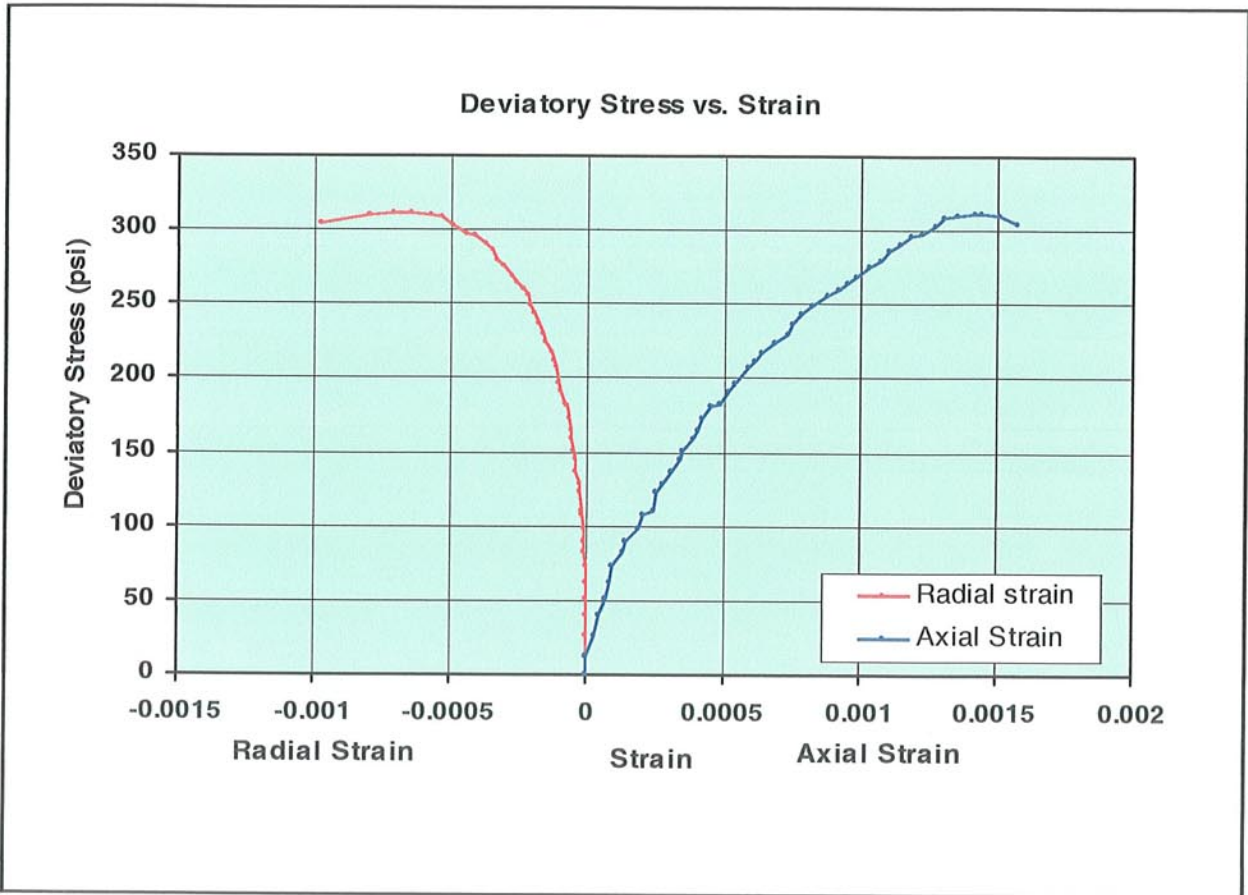
Sample No.	Depth (ft)	Confining Pressure (psi)	Axial Stress (psi)	Bulk Density (g/cc)	Acoustic Velocity				Dynamic Elastic Parameters			
					Compressional		Shear		Bulk Modulus ( $\times 10^6$ psi)	Young's Modulus ( $\times 10^6$ psi)	Shear Modulus ( $\times 10^6$ psi)	Poisson's Ratio
					ft/sec	$\mu$ s/ft	ft/sec	$\mu$ s/ft				
2	304.8	0	50	1.92	5890	169.78	2490	401.61	0.59	0.39	0.14	0.39
7	932.2	0	100	1.91	9590	104.28	5140	194.55	1.43	1.73	0.67	0.30
10	1057.6	0	100	1.85	9510	105.15	5200	192.31	1.37	1.75	0.68	0.29
13	1305.0	0	300	2.30	11010	90.83	5700	175.44	2.42	2.65	1.01	0.32
14	1322.0	0	300	2.28	9710	102.99	5220	191.57	1.78	2.17	0.84	0.30
16	1324.4	0	300	2.28	11270	88.73	6020	166.11	2.42	2.90	1.11	0.30

Values in red are estimated due to unclear wave forms.



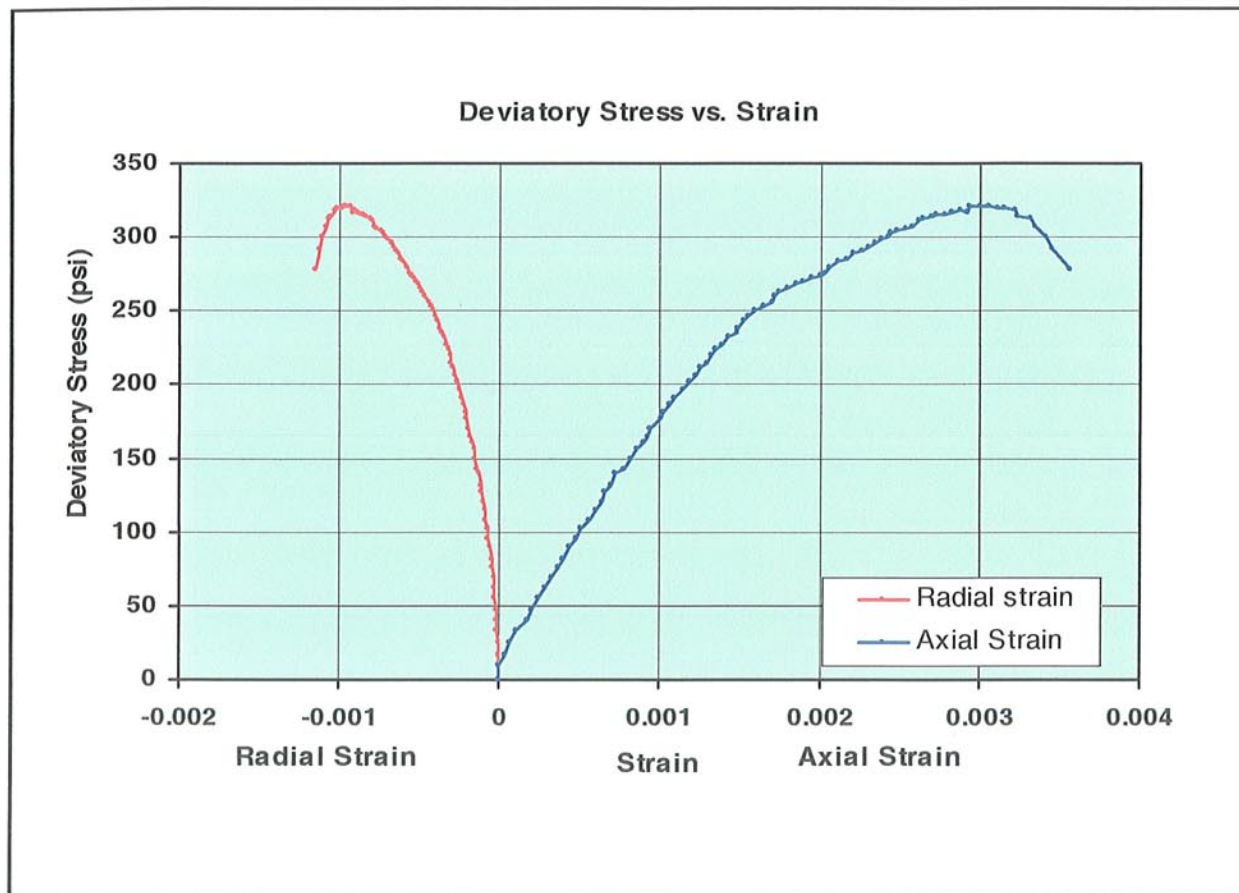
Sample	2
Depth (ft)	304.8
Diameter (in)	0.9757
Length (in)	1.4508
Mass (g)	34.07
Saturation Fluid	Fresh Water
Bulk Density (g/cc)	1.92
Confining Pressure (psi)	0
Pore Pressure (psi)	0
Static Young's Modulus ( $\times 10^6$ psi)	0.01
Static Poisson's Ratio	0.34
Compressive Strength (psi)	45

Figure 1. Stress-strain curves measured for sample No. 2 from EXKR-1 well.



Sample	7
Depth (ft)	932.2
Diameter (in)	0.9892
Length (in)	2.0265
Mass (g)	48.63
Saturation Fluid	Fresh Water
Bulk Density (g/cc)	1.91
Confining Pressure (psi)	0
Pore Pressure (psi)	0
Static Young's Modulus ( $\times 10^6$ psi)	0.27
Static Poisson's Ratio	0.26
Compressive Strength (psi)	311

Figure 2. Stress-strain curves measured for sample No. 7 from EXPM-1 well.



Sample	10
Depth (ft)	1057.6
Diameter (in)	0.9733
Length (in)	2.0645
Mass (g)	46.52
Saturation Fluid	Fresh Water
Bulk Density (g/cc)	1.85
Confining Pressure (psi)	0
Pore Pressure (psi)	0
Static Young's Modulus (X10 <sup>6</sup> psi)	0.16
Static Poisson's Ratio	0.24
Compressive Strength (psi)	321

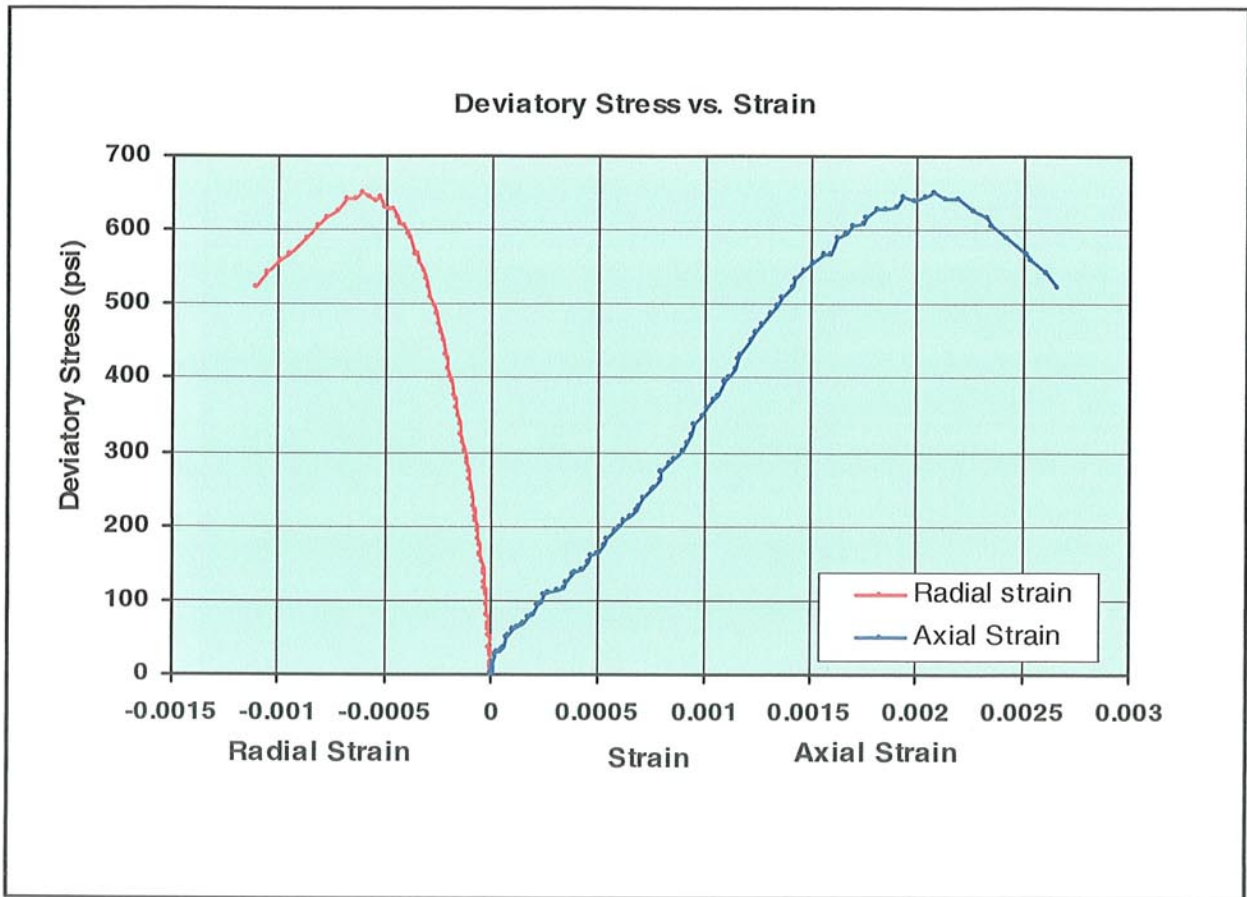
**Figure 3. Stress-strain curves measured for sample No. 10 from EXPM-1 well.**



Sample	13
Depth (ft)	1305.0
Diameter (in)	0.9983
Length (in)	1.9712
Mass (g)	58.14
Saturation Fluid	Fresh Water
Bulk Density (g/cc)	2.3
Confining Pressure (psi)	0
Pore Pressure (psi)	0
Static Young's Modulus ( $\times 10^6$ psi)	0.63
Static Poisson's Ratio	0.27
Compressive Strength (psi)	1301

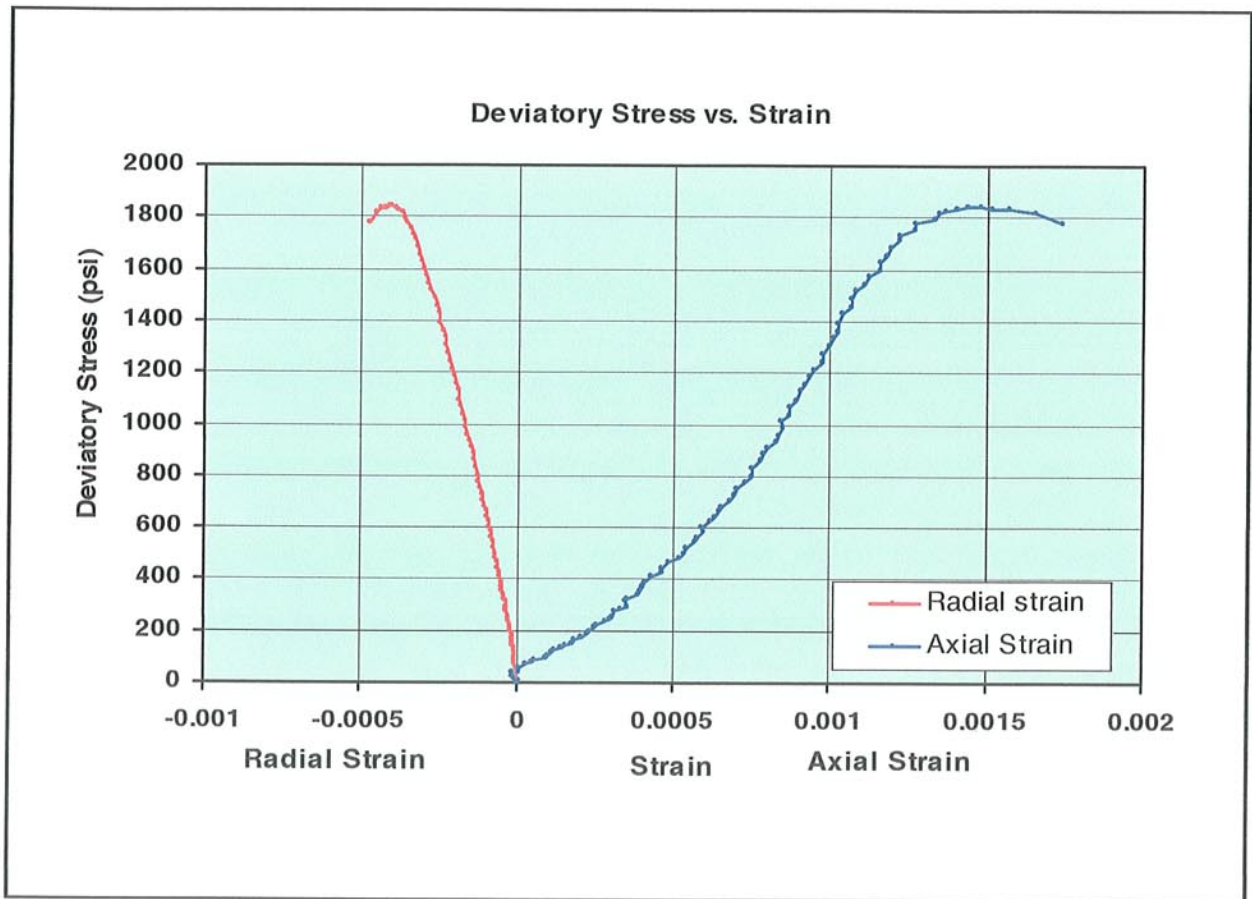
Figure 4. Stress-strain curves measured for sample No. 13 from EXBRY-1 well.





Sample	14
Depth (ft)	1322.0
Diameter (in)	0.9963
Length (in)	1.8787
Mass (g)	54.78
Saturation Fluid	Fresh Water
Bulk Density (g/cc)	2.28
Confining Pressure (psi)	0
Pore Pressure (psi)	0
Static Young's Modulus ( $\times 10^6$ psi)	0.42
Static Poisson's Ratio	0.27
Compressive Strength (psi)	651

Figure 5. Stress-strain curves measured for sample No. 14 from EXBRY-1 well.



Sample	16
Depth (ft)	1324.4
Diameter (in)	0.9975
Length (in)	1.9637
Mass (g)	57.28
Saturation Fluid	Fresh Water
Bulk Density (g/cc)	2.28
Confining Pressure (psi)	0
Pore Pressure (psi)	0
Static Young's Modulus ( $\times 10^6$ psi)	1.48
Static Poisson's Ratio	0.26
Compressive Strength (psi)	1843

Figure 6. Stress-strain curves measured for sample No. 16 from EXBRY-1 well.