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**PERMANENT DEFORMATION
OF SUBGRADE SOILS PHASE II:
REPEATED LOAD TESTING OF FOUR SOILS**

MBTC FR-1089

**Robert Elliott, Norman Dennis,
and Yanjun Qiu**

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13. ABSTRACT (Maximum 200 words) This reports the second phase of a three-phase project to study the permanent deformation behavior of subgrade soils. Four Arkansas soils were tested in this phase to develop data that can be used in Phase III. Phase III will examine the effect of factors such as deviator stress, moisture content, first cycle freeze-thaw, density load history, and soils type on subgrade permanent deformation. All the repeated load tests were conducted using the test protocol established during the first phase of the study. The test protocol consists of repeated load triaxial testing. The confining pressure of repeated load testing was set to a fixed value of 21 kPa (3psi). Load frequency was 1 Hz with a duration of 0.1 second followed by a rest period of 0.9 second. Deviator stresses were varied to determine their effect on the deformation accumulation. Moisture contents were set to three levels to simulate the service range of highway subgrades in Arkansas. The moisture contents were 105%, 110%, and 120% of the soils optimum moisture content. Some specimens were subjected to one cycle freeze-thaw to gain data on the effect of this parameter.				
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TABLE OF CONTENTS

LIST OF TABLES	iv
----------------	----

LIST OF FIGURES	v
-----------------	---

CHAPTER	PAGE
Introduction.....	1
Properties of Soils Tested	2
Test Program and Test Results	13
3-1 Test Results for Enders.....	13
3-2 Test Results for Gallion.....	16
3-3 Test Results for Houston	17
3-4 Test Results for Sacul	18
Reference	20
Appendix A Presentation of Test Results	21

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LIST OF TABLES

TABLE	PAGE
1. Summary of Soil Properties.....	2
2. Specifications Used for Conventional Soil Testing.....	3
3. Static Strength (in kPa) of Subgrade Soils	12
4. Summary of Data in Figure D-1 through D-28	15
A-1. Data for Figure A-1	A-29
A-2. Data for Figure A-2	A-30
A-3. Data for Figure A-3	A-31
A-4. Data for Figure A-4	A-32
A-5. Data For Figure A-5	A-33
A-6. Data for Figure A-6	A-34
A-7. Data for Figure A-7	A-35
A-8. Data for Figure A-8	A-36
A-9. Data for Figure A-9	A-37
A-10. Data for Figure A-10	A-38
A-11. Data for Figure A-11	A-39
A-12. Data for Figure A-12	A-40
A-13. Data for Figure A-13	A-41
A-14. Data for Figure A-14	A-42
A-15. Data for Figure A-15	A-43
A-16. Data for Figure A-16	A-44

A-17. Data for Figure A-17	A-45
A-18. Data for Figure A-18	A-46
A-19. Data for Figure A-19	A-47
A-20. Data for Figure A-20	A-48
A-21. Data for Figure A-21	A-49
A-22. Data for Figure A-22	A-50
A-23. Data for Figure A-23	A-51
A-24. Data for Figure A-24	A-52
A-25. Data for Figure A-25	A-53
A-26. Data for Figure A-26	A-54
A-27. Data for Figure A-27	A-55
A-28. Data for Figure A-28	A-56

LIST OF FIGURES

FIGURE	PAGE
1. Gradation Curves of Enders	4
2. Gradation Curves of Gallion.....	5
3. Gradation Curves of Houston	6
4. Gradation Curves of Sacul.....	7
5. Compaction Curve for Enders (AASHTO T-99)	8
6. Compaction Curve for Gallion (AASHTO T-99).....	9
7. Compaction Curve for Houston (AASHTO T-99)	10
8. Compaction Curve for Sacul (AASHTO T-99).....	11
A-1 Repeated Load Test Results for Enders (Moisture Content at 105% of OMC)	45
A-2 Repeated Load Test Results for Enders (Moisture Content at 110% of OMC)	46
A-3 Repeated Load Test Results for Enders (Moisture Content at 120% of OMC)	47
A-4 Effect of Density on Permanent Strain for Enders	48
A-5 Effect of Freeze-Thaw on Permanent Strain for Enders.....	49
A-6 Effect of Stress History on Permanent Strain for Enders (Ultimate Deviator Stress at 62 kPa)	50
A-7 Effect of Stress History on Permanent Strain for Enders (Ultimate Deviator Stress at 103 kPa)	51
A-8 Repeated Load Test Results for Gallion (Moisture Content at 105% of OMC) ...	52
A-9 Repeated Load Test Results for Gallion (Moisture Content at 110% of OMC) ...	53
A-10 Repeated Load Test Results for Gallion (Moisture Content at 120% of OMC) ...	54
A-11 Effect of Density on Permanent Strain for Gallion	55

A-12	Effect of Freeze-Thaw on Permanent Strain for Gallion.....	56
A-13	Effect of Stress History on Permanent Strain for Gallion (Ultimate Deviator Stress at 83 kPa).....	57
A-14	Effect of Stress History on Permanent Strain for Gallion (Ultimate Deviator Stress at 62 kPa).....	58
A-15	Repeated Load Test Results for Houston (Moisture Content at 105% of OMC)..	59
A-16	Repeated Load Test Results for Houston (Moisture Content at 110% of OMC)..	60
A-17	Repeated Load Test Results for Houston (Moisture Content at 120% of OMC)..	61
A-18	Effect of Density on Permanent Strain for Houston.....	62
A-19	Effect of Freeze-Thaw on Permanent Strain for Houston	63
A-20	Effect of Stress History on Permanent Strain for Houston (Moisture Content at 110% of OMC).....	64
A-21	Effect of Stress History on Permanent Strain for Houston (Moisture Content at 120% of OMC).....	65
A-22	Repeated Load Test Results for Sacul (Moisture Content at 105% of OMC)	66
A-23	Repeated Load Test Results for Sacul (Moisture Content at 110% of OMC)	67
A-24	Repeated Load Test Results for Sacul (Moisture Content at 120% of OMC)	68
A-25	Effect of Density on Permanent Strain for Sacul	69
A-26	Effect of Freeze-Thaw on Permanent Strain for Sacul.....	70
A-27	Effect of Stress History on Permanent Strain for Sacul (Ultimate Deviator Stress at 124 kPa).....	71
A-28	Effect of Stress History on Permanent Strain for Sacul (Ultimate Deviator Stress at 83 kPa).....	72

1. Introduction

Permanent deformation of subgrade soils was investigated through repeated load testing. Four subgrade soils of Arkansas subgrades were tested in this phase of research. The emphasis in the selection of subgrade soils was primarily based upon the coverage of predominant pedologic occurrence. Research report TRC-94 (Elliott et al. 1988) served as the main source in the selection of subgrades.

The major goal of this phase of research was to develop data that can be used in Phase III. Phase III will seek to verify the effect of factors such as deviator stress, moisture content, first cycle freeze-thaw, density, load history induced by sequential loading, and soils type on the permanent deformation of highway subgrades. Additional objectives are to verify the general deformation trend of subgrade soils that was found in the first phase of this research and to explore additional possible factors that affect testing results.

All the repeated load tests were conducted using the test protocol established during the first phase of this research. The main features of the test protocol are summarized here (Elliott et al. 1998). The confining pressure of repeated load testing was set to a fixed value of 21 kPa (3 psi). Load frequency should be set to 1 Hz (a load duration of 0.1 second followed by a rest period of 0.9 second). Deviator stresses were varied in the investigation to determine their effect on the deformation accumulation. Moisture contents were set to three levels to simulate the service range of highway subgrades in Arkansas, namely, 105%, 110%, and 120% of the optimum moisture content (OMC). Some specimens were subjected to one cycle of freeze-thaw to gain data on the effect of this parameter.

2. Properties of Soils Tested

Four representative Arkansas subgrade soils were selected for repeated load testing. The Planning and Research Section of Arkansas Highway and Transportation Department (AHTD) conducted all sampling work. Engineering properties for these four soils are listed in Table 1.

Table 1 Summary of Soil Properties

Soil	Enders	Gallion	Houston	Sacul
Coverage	10.8	N. A.	1.0	6.1
Sampling	Highway 162	Highway 365	Highway 19	Highway 71
Location	Crawford County	Faulkner County	Nevada County	Miller County
$M_R(\text{MPa})@ 28 \text{ kPa of } \sigma_d$	33	129	103	77
R-value	@ 240 psi: 20	@ 240 psi: 3	@ 240 psi: 6	@ 240 psi: 14
	@ 300 psi: 25	@ 300 psi: 4	@ 300 psi: 7	@ 300 psi: 18
LL	21	27	51	34
PL	17	17	26	16
PI	4	10	25	18
Specific Gravity	2.7154	2.6740	2.7056	2.6745
OMC	13.82	15	20.05	14
MDD (t/m^3)	1.880	1.822	1.637	1.824
% of Fines [†]	61	78	79	66
AASHTO Classification	A-4	A-4	A-7-5	A-6
Unified Classification	CL	CL	MH	CL

[†] particles with a diameter less than 0.075 mm (passing # 200 sieve)

Gradation curves for the soils tested are plotted in Figure 1 through Figure 4. Classification properties are included in Table 1. Compaction curves are presented in Figure 5 through Figure 8. All conventional soil tests were carried out in accordance with the corresponding specifications of AASHTO or ASTM as listed in Table 2.

Table 2. Specification Used for Conventional Soil Testing

Property	Specification
Liquid Limit	AASHTO T-265
Plastic Limit	AASHTO T-265
Optimum Moisture Content (%)	AASHTO T-99
Maximum Dry Density (kN/m^3)	AASHTO T-99
Specific Gravity	AASHTO T-100
% of Fines	AASHTO T-87, 88
% of Clay Particles	AASHTO T-87, 88
AASHTO Classification	AASHTO M-145
Unified Classification	ASTM D-2487

Static strength of soils were determined by triaxial testing with the confining pressure set at 21 kPa (3 psi). This is the same confining pressure as used in the repeated load testing. The triaxial strength test results are presented in Table 3.

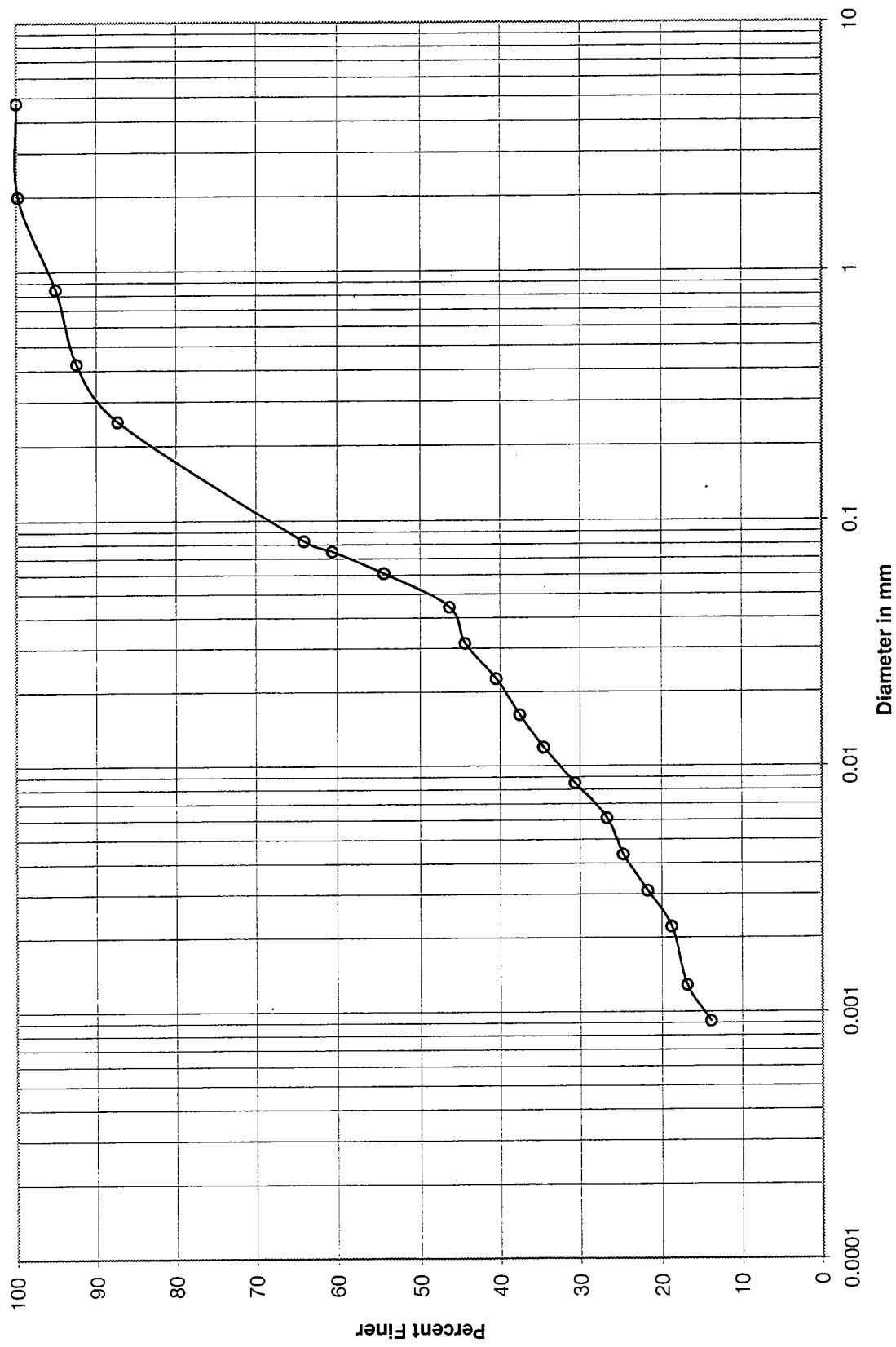


Figure 1 Gradation Curve of Enders Soil

Gallon

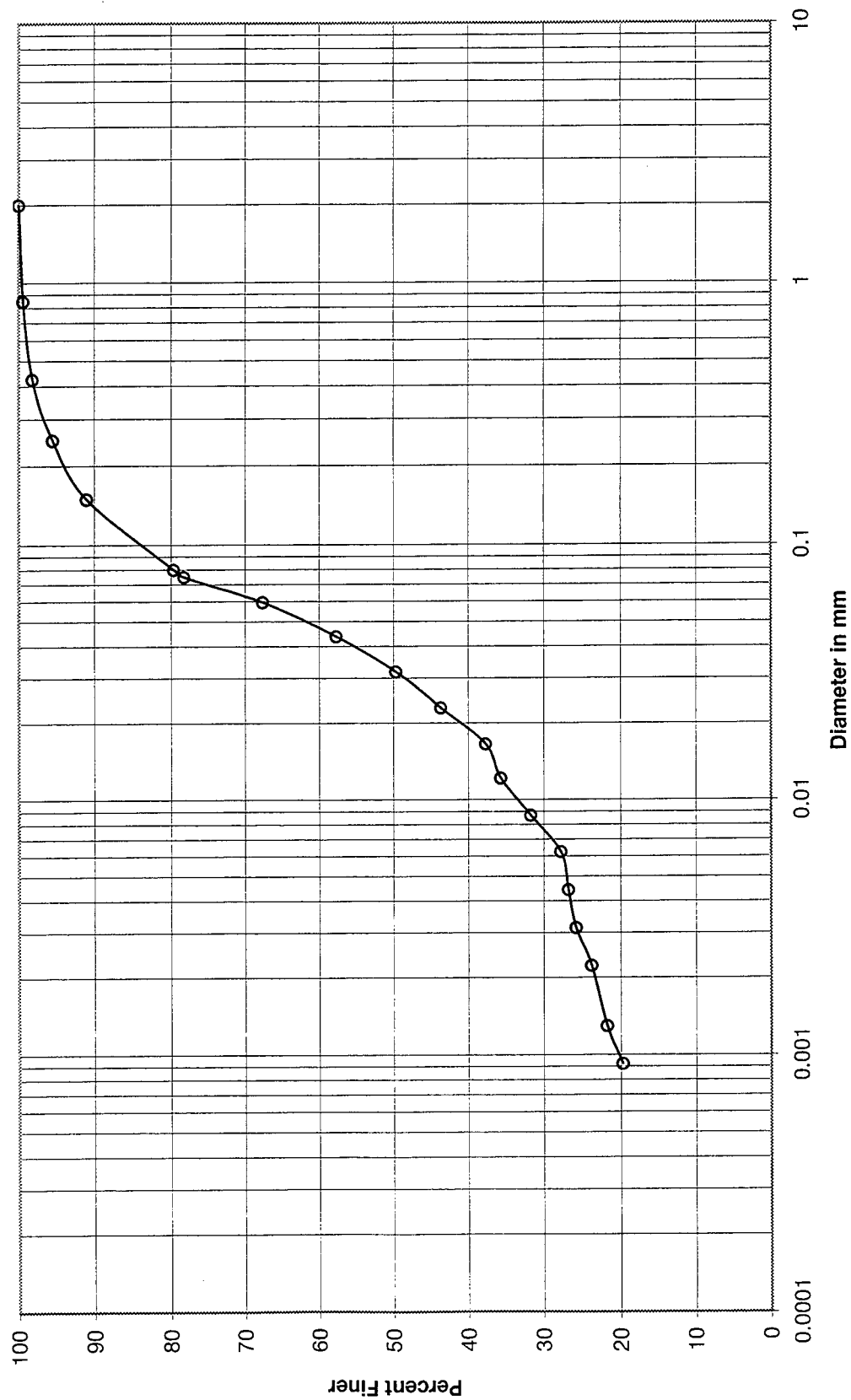


Figure 2 Gradation Curve of Gallion Soil

Houston

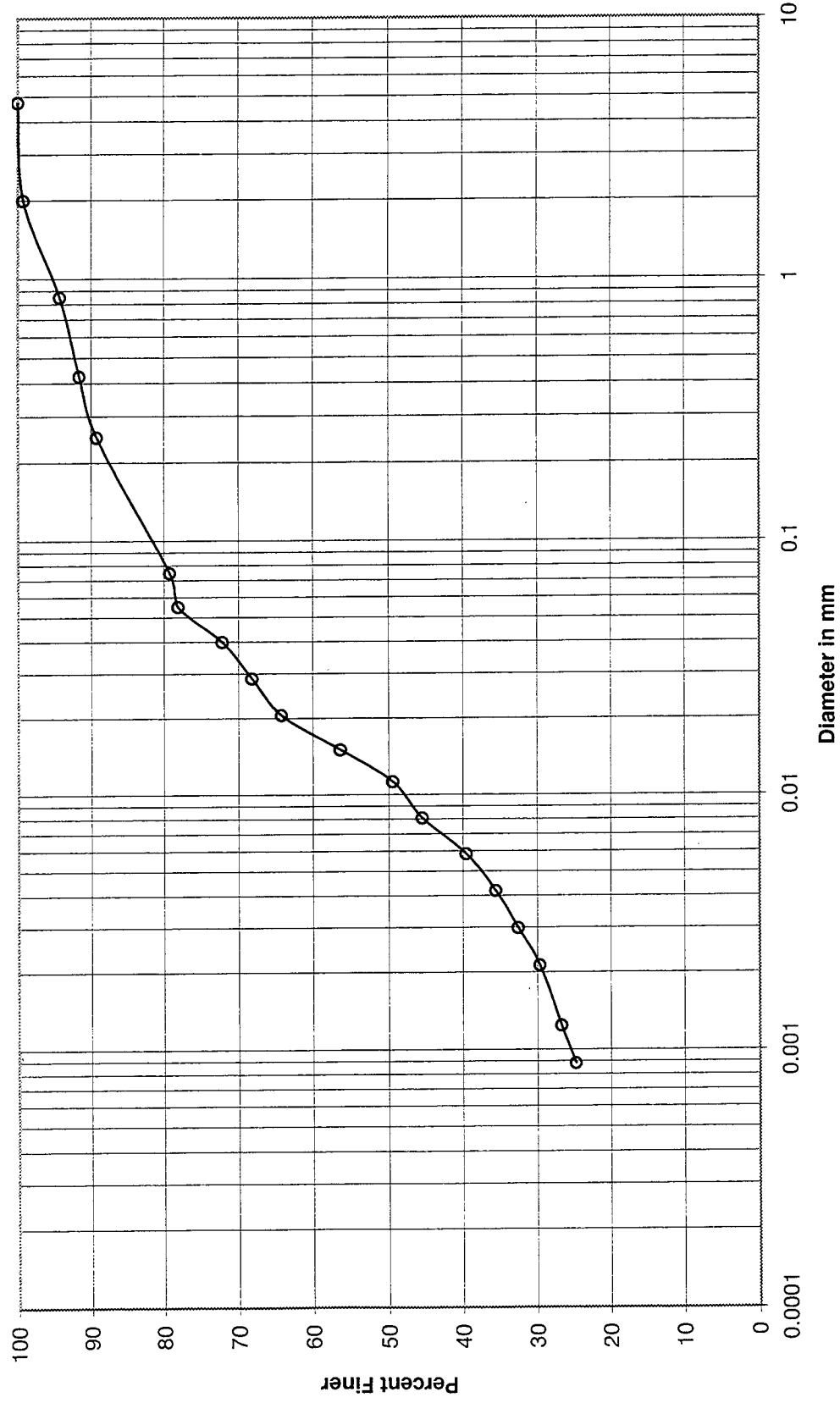


Figure 3 Gradation Curve of Houston Soil

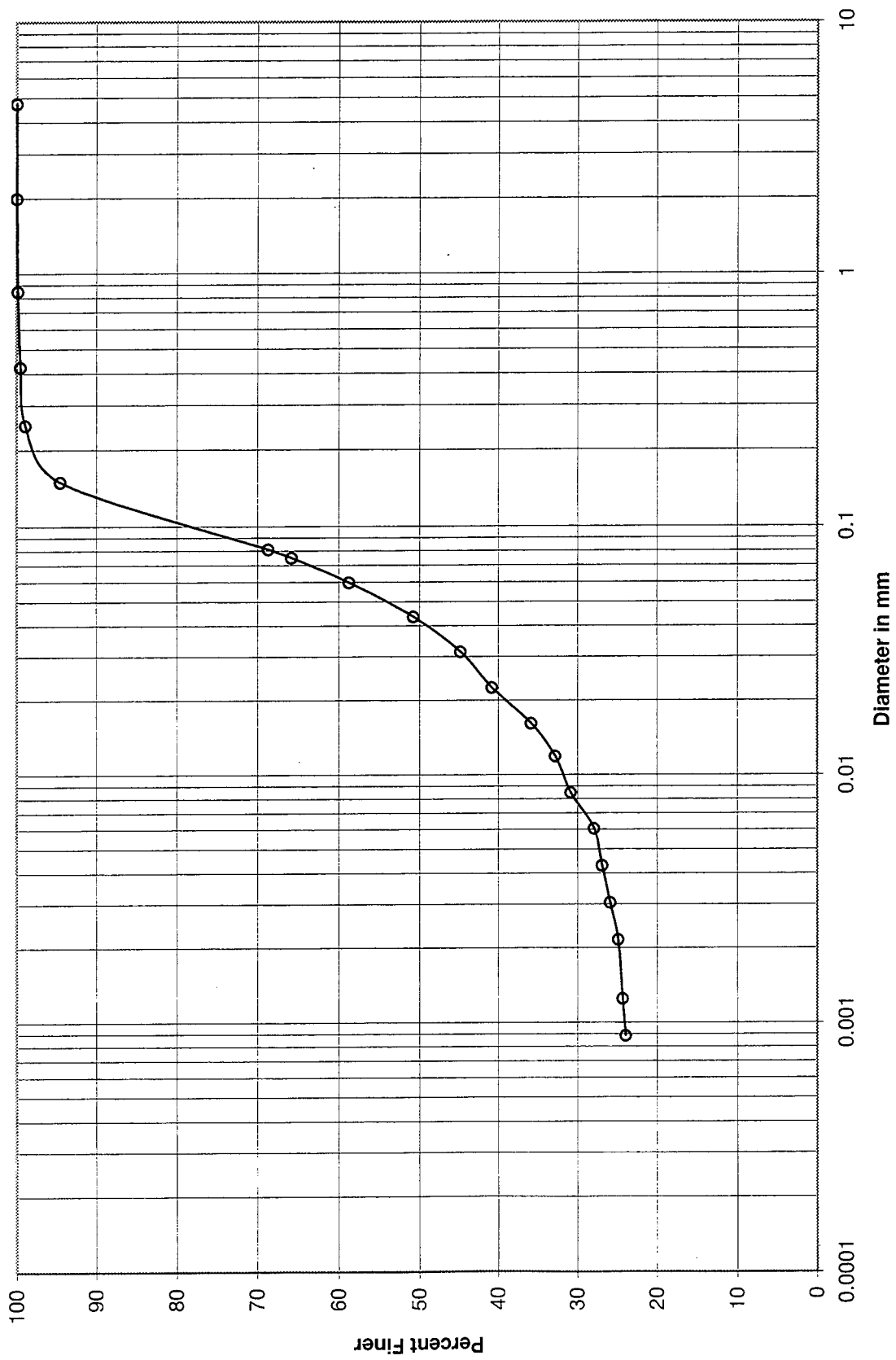


Figure 4 Gradation Curve of Sacul Soil

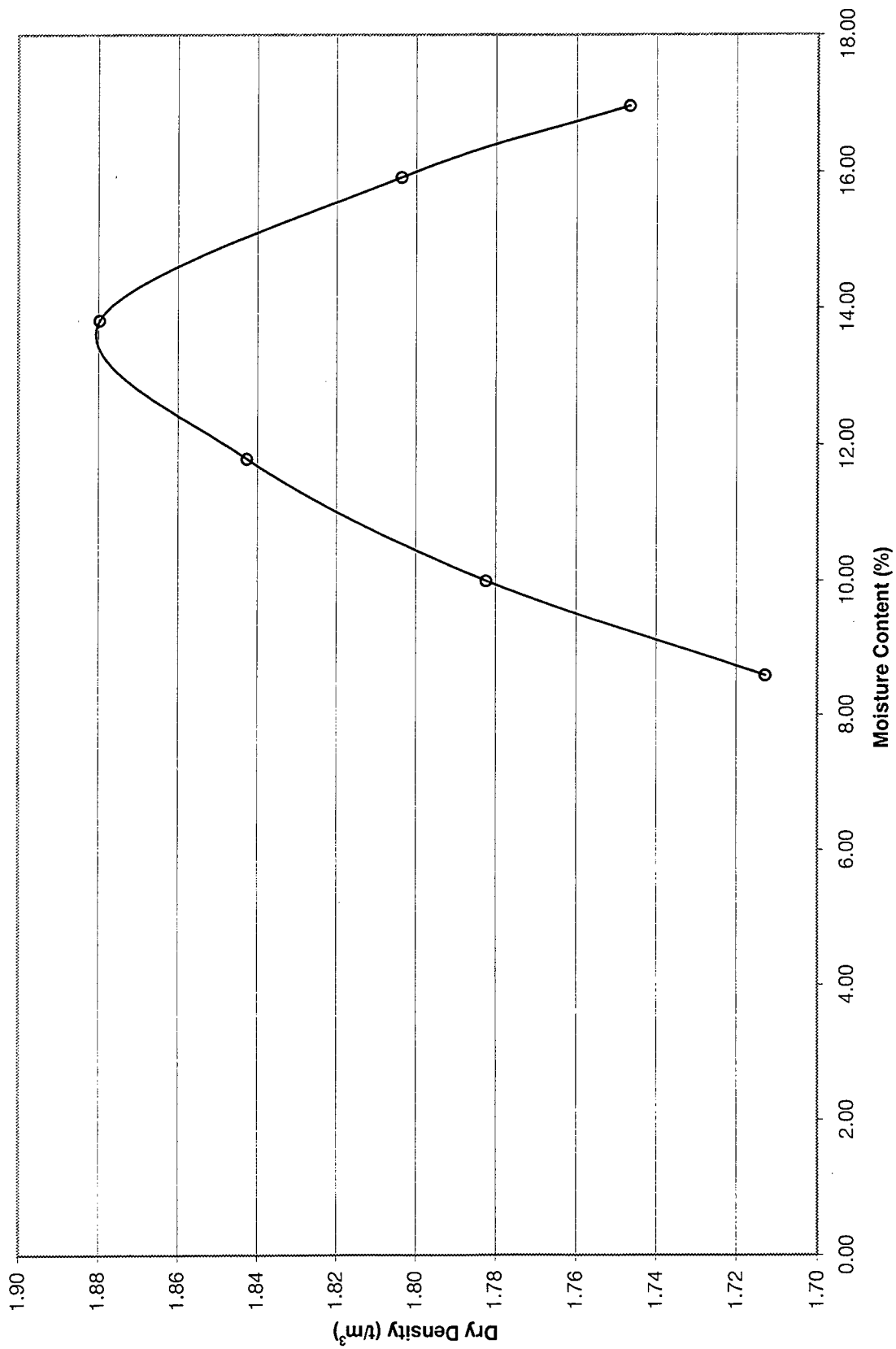


Figure 5 Compaction Curve for Enders Soil(AASHTO T-99)

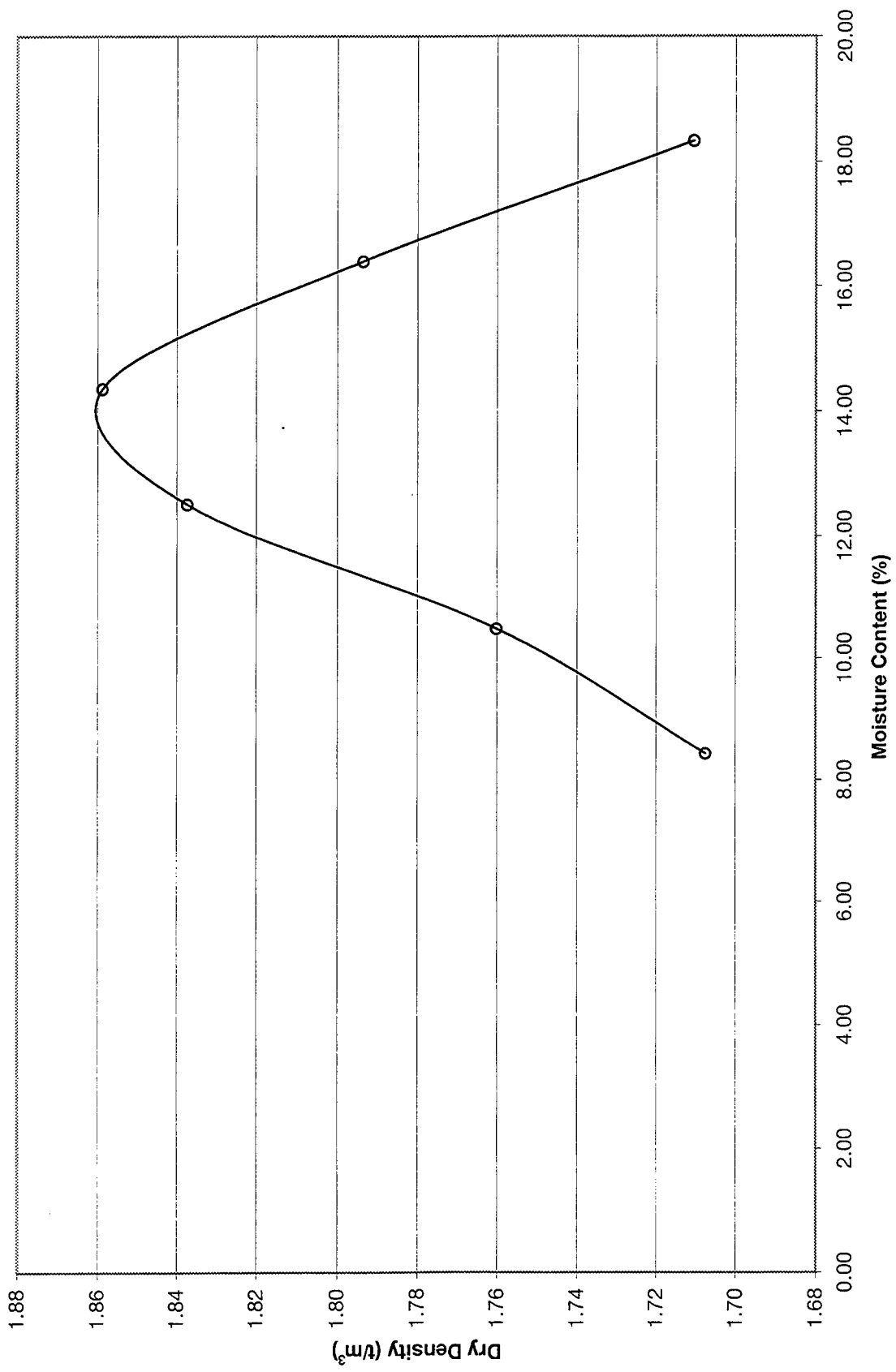


Figure 6 Compaction Curve for Gallion Soil (AASHTO T-99)

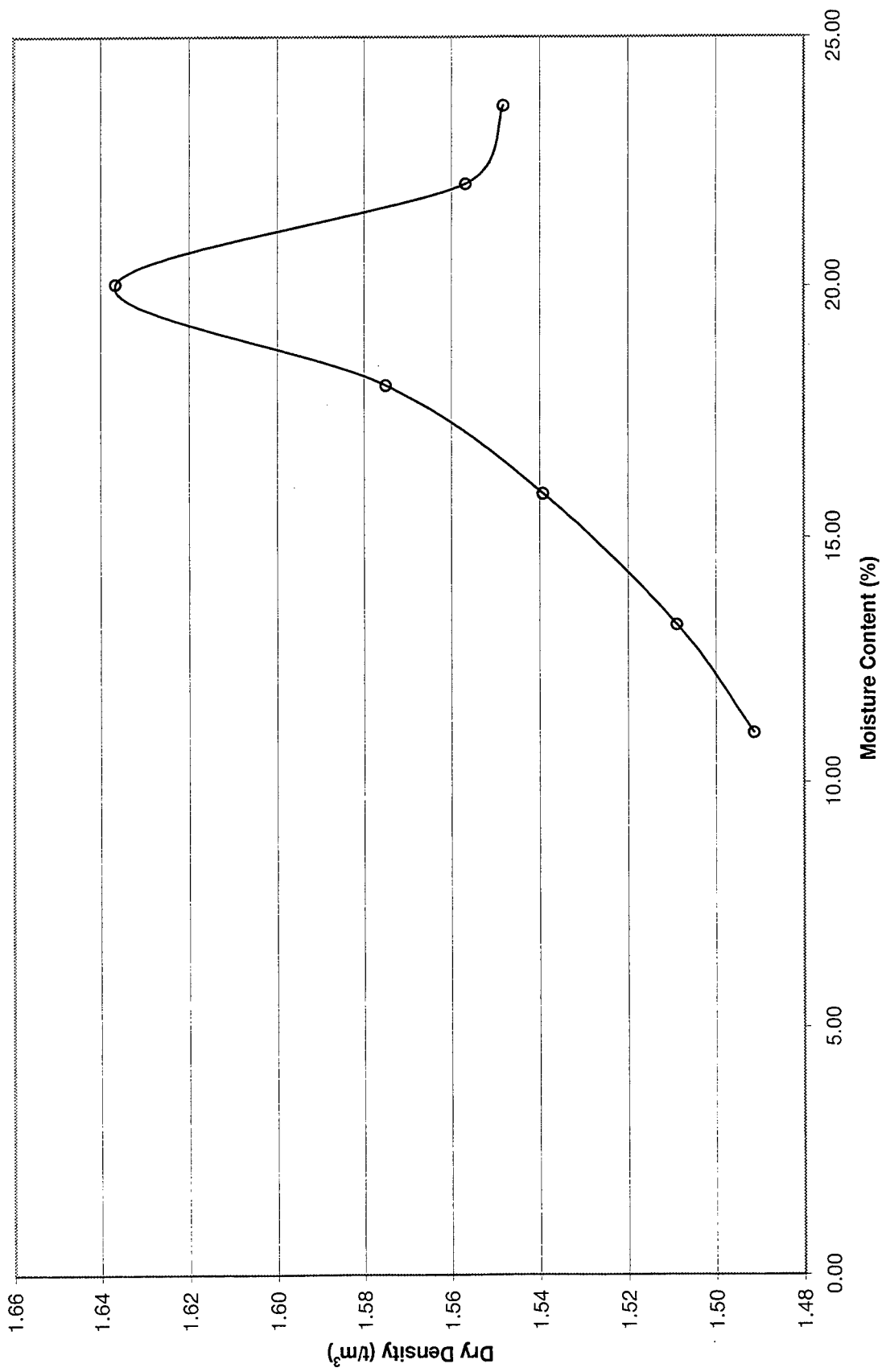


Figure 7 Compaction Curve for Gallion Soil (AASHTO T-99)

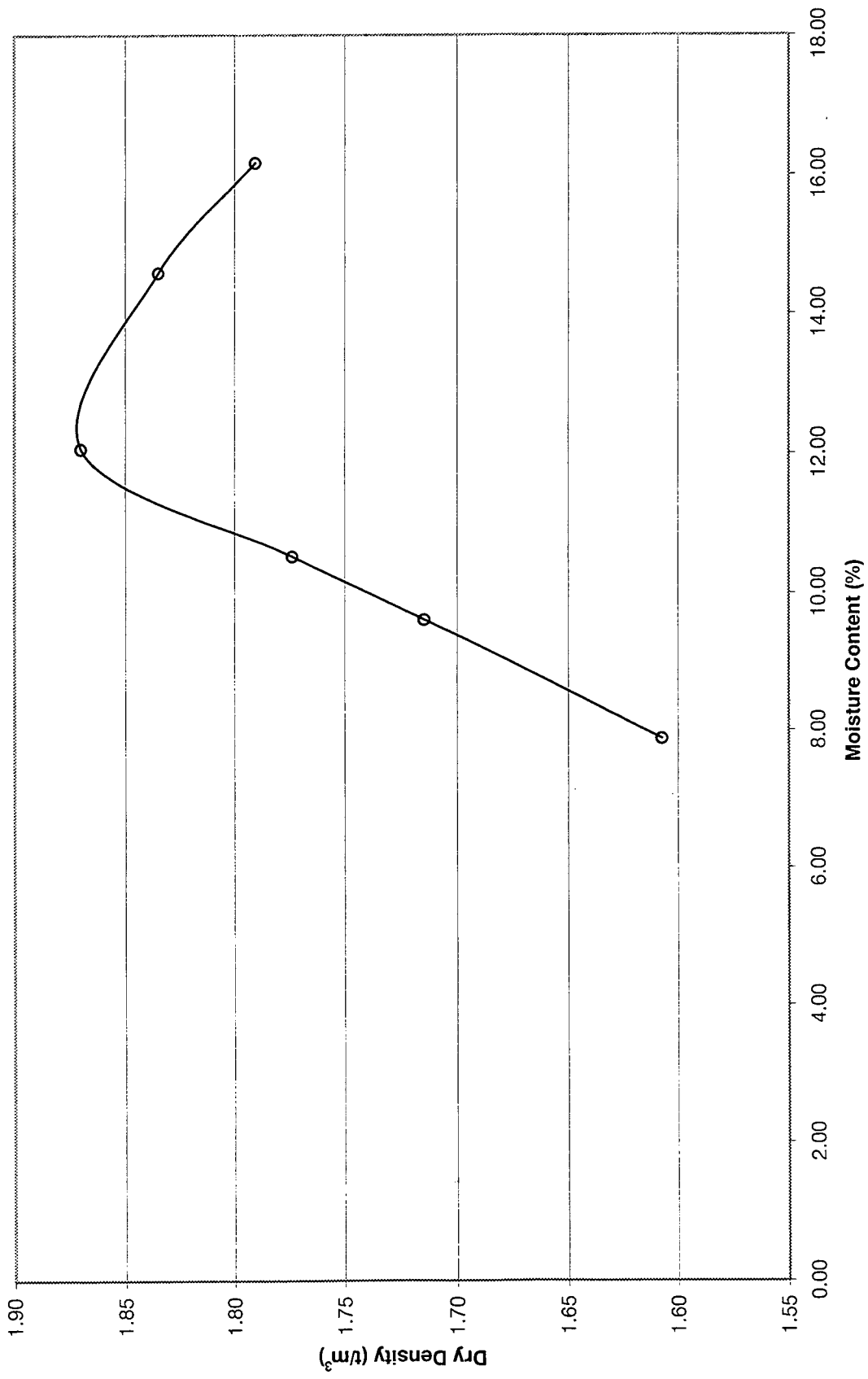


Figure 8 Compaction Curve for Sacul Soil (AASHTO T-99)

Table 3. Static Strength (in kPa) of Subgrade Soils

	105	110	120
	(% of OMC)	(% of OMC)	(% of OMC)
Enders	151 kPa	111 kPa	83 kPa
Gallion	242 kPa	174 kPa	111 kPa
Houston	345 kPa	276 kPa	138 kPa
Sacul	283 kPa	241 kPa	152 kPa

3. Test Program and Test Results

In order to investigate the effects of moisture content on the accumulation of permanent deformation, specimens were fabricated at three different moisture contents corresponding to 105%, 110%, 120% of optimum to simulate service conditions of pavement subgrades. Specimens with the same moisture content and density were subjected to various levels of deviator stress to explore the role of deviator stress in the development of subgrade deformation. The effect of limited variation in density on deformation behavior was also investigated. The first-cycle freeze-thaw was studied to estimate the impact of seasonal effects. Stress history induced from staged loading was studied to evaluate its effects on different soils.

The test protocol developed in the first phase of this research project (Elliott et al. 1998) was observed throughout all the tests. The confining pressure is set to a constant magnitude of 21 kPa (3 psi). The rest period was 0.9 second and the load duration was 0.1 second resulting in a load frequency of 1 Hz. Repeated load testing was concluded around 10,000 repetitions. Fresh specimens were used for each level of applied deviator stresses except for those specimens used to study the effects of staged loading.

All the test results of repeated load testing on the four selected soils are summarized in this section. Detailed presentation of the results in graphical and digital formats is included in Appendix A. Test results of specimens with the same moisture content are grouped together to better demonstrate the influence of deviator stress. Laboratory test results are summarized in Table 4 followed detailed description of every figure for all the four soils.

3-1 Test Results for Enders

Repeated load testing results for Enders are presented in Figure A-1 to A-7. Figure A-1 illustrates test results for specimens with moisture contents corresponding to 105% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 28 kPa (4 psi) to 103 kPa (15 psi). Figure A-2 presents test results with moisture contents corresponding to 110% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 28 kPa (4 psi) to 83 kPa (12 psi). Figure A-3 illustrates test results with moisture contents corresponding to 120% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 28 kPa (4 psi) to 41 kPa (6 psi).

Figure A-4 demonstrates the effect of dry density on the accumulation of permanent strain. Specimens are fabricated to a moisture content at 110% of optimum. Dry density ranges from 91.7% to 97.9% of maximum. The effect of the first cycle of freeze-thaw is presented in Figure A-5. The moisture contents of the specimens in these tests are 105% of optimum and the dry densities are 95%.

The effect of stress history induced from staged loading is shown in Figure A-6 and Figure A-7. In Figure A-6, one specimen was subjected to a deviator stress of 28 kPa (4 psi) for about 10,000 load repetitions and subsequently the deviator stress was increased to 62 kPa (9 psi) for repeated loading. The effect of staged load was compared to a virgin specimen subjected to 62 kPa (9 psi). In Figure A-7, one specimen was subjected to a deviator stress of 62 kPa (9 psi) for about 10,000 load repetitions and subsequently the deviator stress was increased to 103 kPa (15 psi) for repeated loading. The effect of staged load was compared to a virgin specimen subjected to 103 kPa (15 psi).

Table 4. Summary of Data in Figures A-1 through A-28

No. of Figures	Soil	Effect Tested
A-1	Enders	deviator stress @ 105% of OMC & 95% of MDD
A-2	Enders	deviator stress @ 110% of OMC & 95% of MDD
A-3	Enders	deviator stress @ 120% of OMC & 95% of MDD
A-4	Enders	density @ 110% of OMC
A-5	Enders	freeze-thaw at 105% of OMC & 95% of MDD
A-6	Enders	stress history @ ultimate $\sigma_d = 62$ kPa
A-7	Enders	stress history @ ultimate $\sigma_d = 103$ kPa
A-8	Gallion	deviator stress @ 105% of OMC & 95% of MDD
A-9	Gallion	deviator stress @ 110% of OMC & 95% of MDD
A-10	Gallion	deviator stress @ 120% of OMC & 95% of MDD
A-11	Gallion	density @ 110% of OMC
A-12	Gallion	freeze-thaw at 105% of OMC & 95% of MDD
A-13	Gallion	stress history @ ultimate $\sigma_d = 83$ kPa
A-14	Gallion	stress history @ ultimate $\sigma_d = 62$ kPa
A-15	Houston	deviator stress @ 105% of OMC & 95% of MDD
A-16	Houston	deviator stress @ 110% of OMC & 95% of MDD
A-17	Houston	deviator stress @ 120% of OMC & 95% of MDD
A-18	Houston	density @ 110% of OMC
A-19	Houston	freeze-thaw at 105% of OMC & 95% of MDD
A-20	Houston	stress history @ ultimate $\sigma_d = 83$ kPa & 110% of OMC
A-21	Houston	stress history @ ultimate $\sigma_d = 83$ kPa & 120% of OMC

A-22	Sacul	deviator stress @ 105% of OMC & 95% of MDD
A-23	Sacul	deviator stress @ 110% of OMC & 95% of MDD
A-24	Sacul	deviator stress @ 120% of OMC & 95% of MDD
A-25	Sacul	density @ 110% of OMC
A-26	Sacul	freeze-thaw at 105% of OMC & 95% of MDD
A-27	Sacul	stress history @ ultimate $\sigma_d = 124$ kPa
A-28	Sacul	stress history @ ultimate $\sigma_d = 83$ kPa

3-2 Test Results for Gallion

Repeated load testing results for Gallion are presented in Figure A-8 to A-14. Figure A-8 illustrates test results for specimens with moisture contents corresponding to 105% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 28 kPa (4 psi) to 103 kPa (15 psi). Figure A-9 presents test results with moisture contents corresponding to 110% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 28 kPa (4 psi) to 83 kPa (12 psi). Figure A-10 illustrates test results with moisture contents corresponding to 120% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 28 kPa (4 psi) to 62 kPa (9 psi).

Figure A-11 demonstrates the effect of dry density on the accumulation of permanent strain. Specimens are fabricated to a moisture content at 110% of optimum. Dry density ranges from 93.5% to 98.1% of maximum. The effect of the first cycle of freeze-thaw is presented in Figure A-12. The moisture contents of the specimens in these tests are 105% of optimum and the dry densities are 95% of maximum. The applied deviator stress is 28 kPa (4 psi).

The effect of stress history induced from staged load is shown in Figure A-13 and Figure A-14. In Figure A-13, one specimen was subjected to a deviator stress of 28 kPa (4 psi) for about 10,000 load repetitions and subsequently the deviator stress was increased to 83 kPa (12 psi) for repeated loading. The effect of staged load was compared to a virgin specimen subjected to 83 kPa (12 psi). In Figure A-14, one specimen was subjected to a deviator stress of 21 kPa (3 psi) for about 10,000 load repetitions and the deviator stress was subsequently increased to 41 kPa (6 psi) for another 10,000 load applications. After the specimen had been subjected to around 20,000 repetitions of these two levels of deviator stress, an even higher deviator stress, 62 kPa (9 psi) was applied and the result was compared to a virgin specimen subjected to 62 kPa (9 psi).

3-3 Test Results for Houston

Repeated load testing results for Houston are presented in Figure A-15 to A-21. Figure A-15 illustrates test results for specimens with moisture contents corresponding to 105% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 41 kPa (4 psi) to 207 kPa (30 psi). Figure A-16 presents test results with moisture contents corresponding to 110% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 41 kPa (6 psi) to 165 kPa (24 psi). Figure A-17 illustrates test results with moisture contents corresponding to 120% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 41 kPa (6 psi) to 124 kPa (18 psi).

Figure A-18 demonstrates the effect of dry density on the accumulation of permanent strain. Specimens are fabricated to a moisture content at 110% of optimum. Dry density ranges from 91.8% to 97.8% of maximum. The effect of the first cycle of freeze-

thaw is presented in Figure A-19. The moisture contents of the specimens in these tests are 105% of optimum and the dry densities are 95%.

The effect of stress history induced from staged load is shown in Figure A-20 and Figure A-21. In Figure A-20, one specimen was subjected to a deviator stress of 28 kPa (4 psi) for about 10,000 load repetitions and subsequently the deviator stress was increased to 83 kPa (12 psi) for repeated loading. The effect of staged load was compared to a virgin specimen subjected to 83 kPa (12 psi). Moisture contents for these specimens are 110 % of optimum. Figure A-21 illustrates the similar stress scenario as Figure A-20 except that the specimens in these figures have a higher moisture content corresponding to 120% of OMC.

3-4 Test Results for Sacul

Repeated load testing results for Enders are presented in Figure A-22 to A-28. Figure A-22 illustrates test results for specimens with moisture contents corresponding to 105% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 41 kPa (6 psi) to 207 kPa (30 psi). Figure A-23 presents test results with moisture contents corresponding to 110% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 41 kPa (6 psi) to 165 kPa (24 psi). Figure A-24 illustrates test results with moisture contents corresponding to 120% of optimum and dry densities corresponding to 95% of maximum. Deviator stress ranges from 41 kPa (6 psi) to 124 kPa (18 psi).

Figure A-25 demonstrates the effect of dry density on the accumulation of permanent strain. Specimens are fabricated to a moisture content at 110% of optimum. Dry density ranges from 93.8% to 96.3% of maximum. The effect of the first cycle of freeze-thaw is presented in Figure A-26. The moisture contents of the specimens in these tests are

105% of optimum and the dry densities are 95%.

The effect of stress history induced from staged load is shown in Figure A-27 and Figure A-28. In Figure A-27, one specimen was subjected to a deviator stress of 83 kPa (12 psi) for about 10,000 load repetitions and subsequently the deviator stress was increased to 124 kPa (18 psi) for repeated loading. The effect of staged load was compared to a virgin specimen subjected to 124 kPa (18 psi). In Figure A-28, one specimen was subjected to a deviator stress of 41 kPa (6 psi) for about 10,000 load repetitions and subsequently the deviator stress was increased to 83 kPa (12 psi) for repeated loading. The effect of staged load was compared to a virgin specimen subjected to 83 kPa (12 psi).

4. Reference

- Elliott, R. P., and Dennis, N. D., and Qiu, Y. (1998). *Permanent deformation of Subgrade Soils, Phase I: A Test Protocol*, MBTC FR-1069, Department of Civil Engineering, University of Arkansas.
- Elliott, R. P., Thornton, S. I., Foo, K. Y., Siew, K. W., and Woodbridge, R. (1988). *Final Report TRC-94, Resilient Properties of Arkansas Subgrades*, FHWA/AR-89/004.

APPENDIX

RESULTS OF REPEATED LOAD TESTING

Figure A-1 Repeated Load Test Results for Enders
(Moisture Content at 105% of OMC)

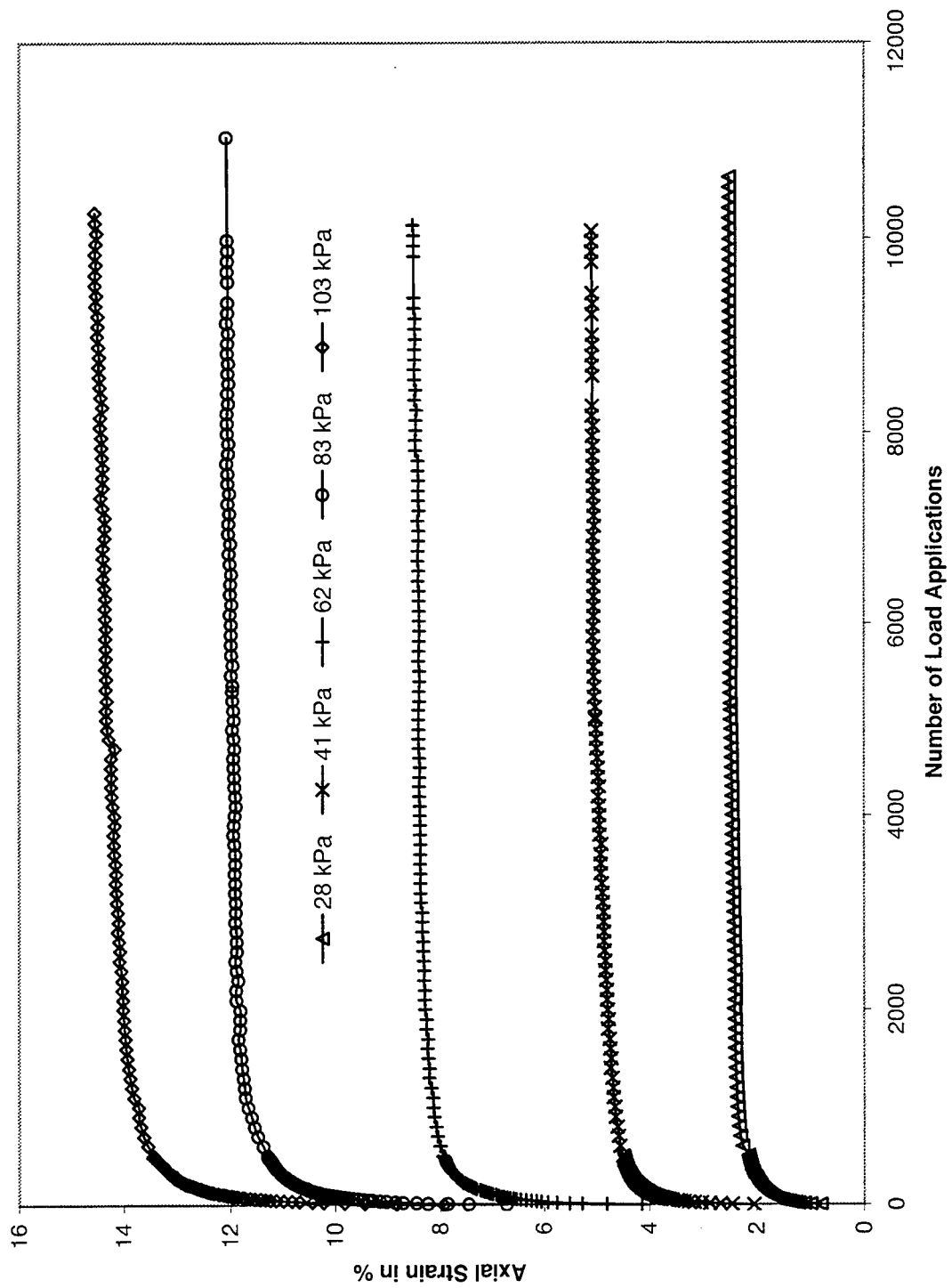


Figure A-2 Repeated Load Test Results for Enders
(Moisture Content at 110% of OMC)

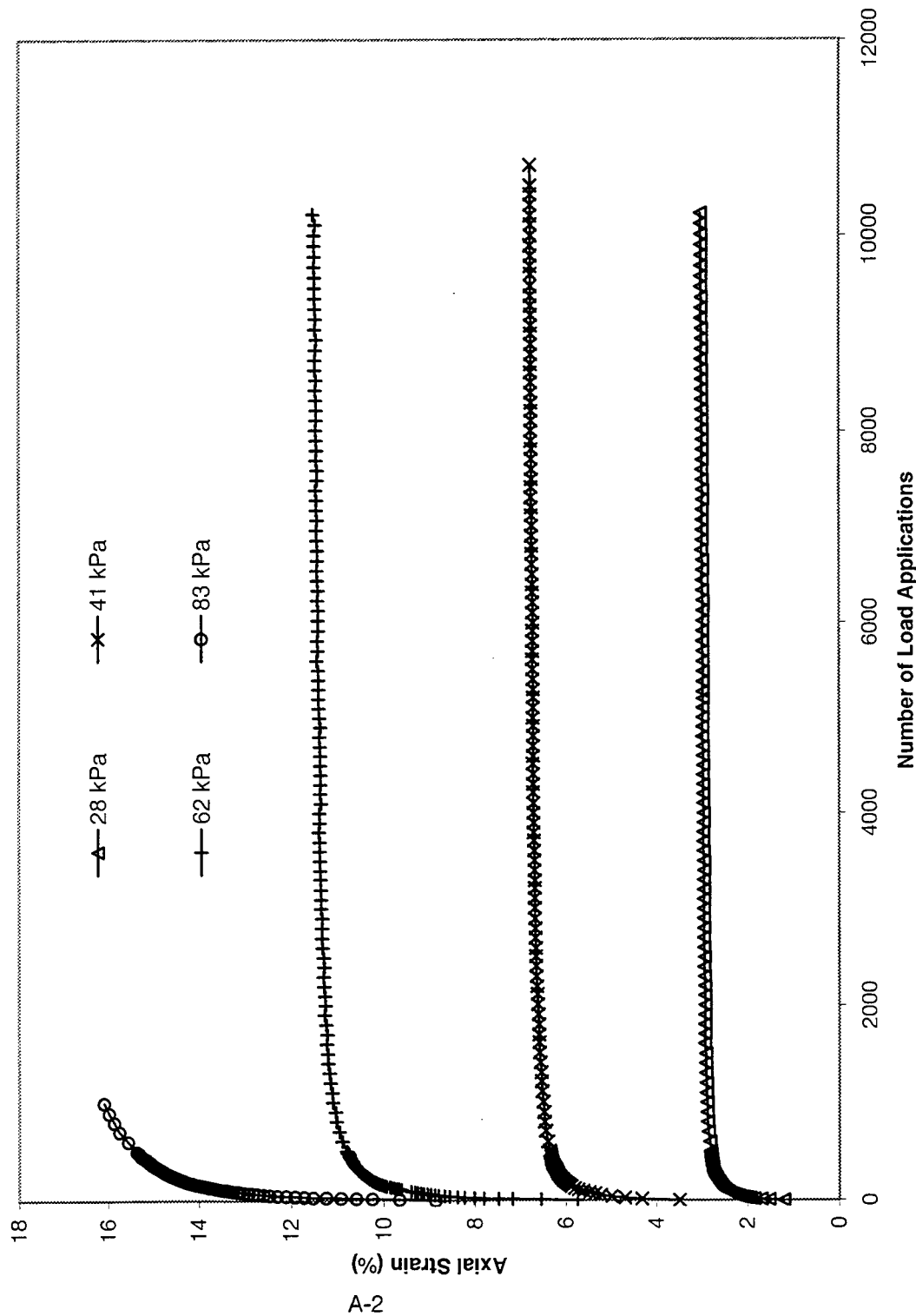


Figure A-3 Repeated Load Test Results for Enders
(Moisture Content at 120% of OMC)

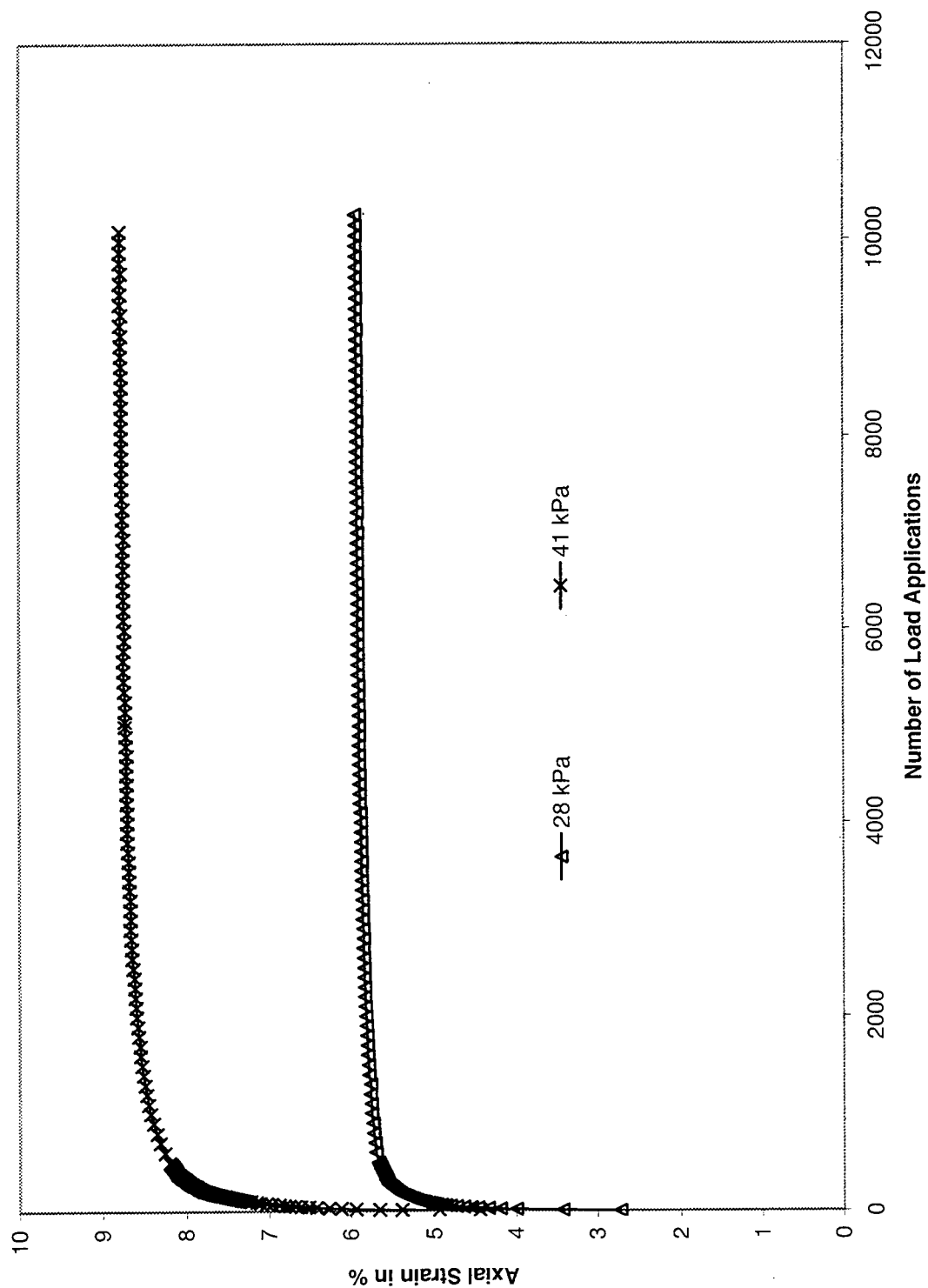


Figure A-4 Effect of Density on Permanent Strain for Enders

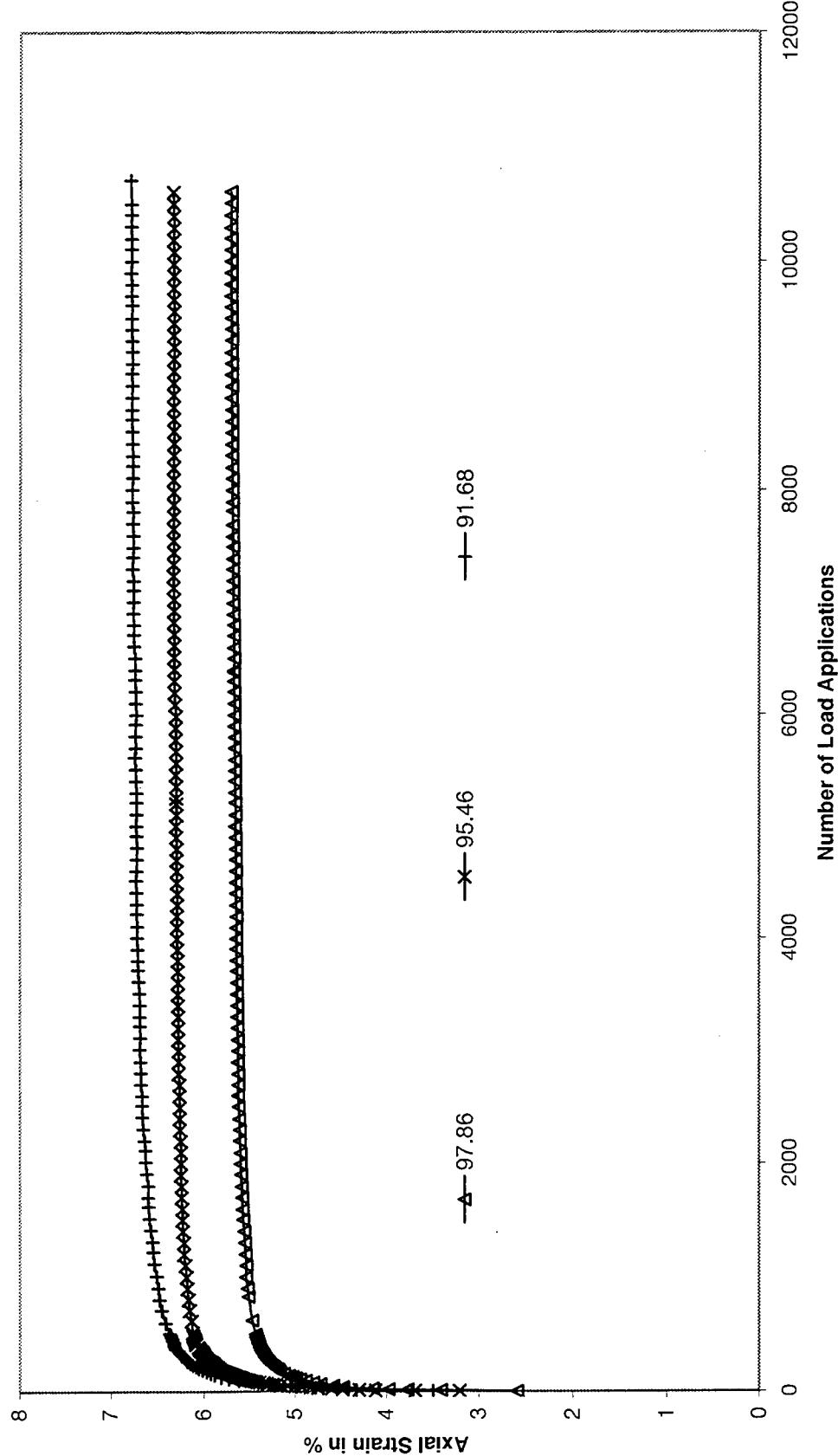


Figure A-5 Effect of Freeze on Permanent Strain for Enders

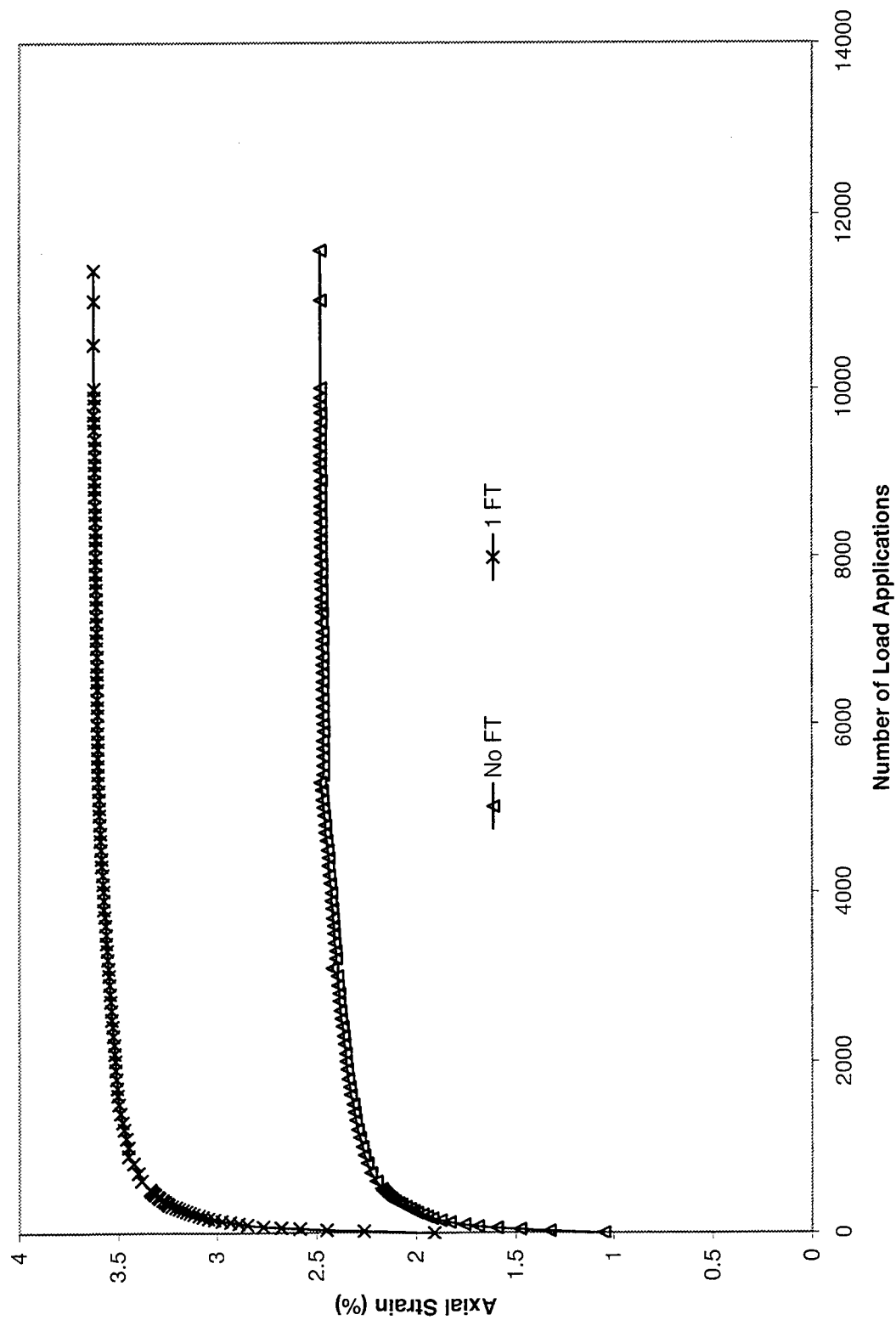
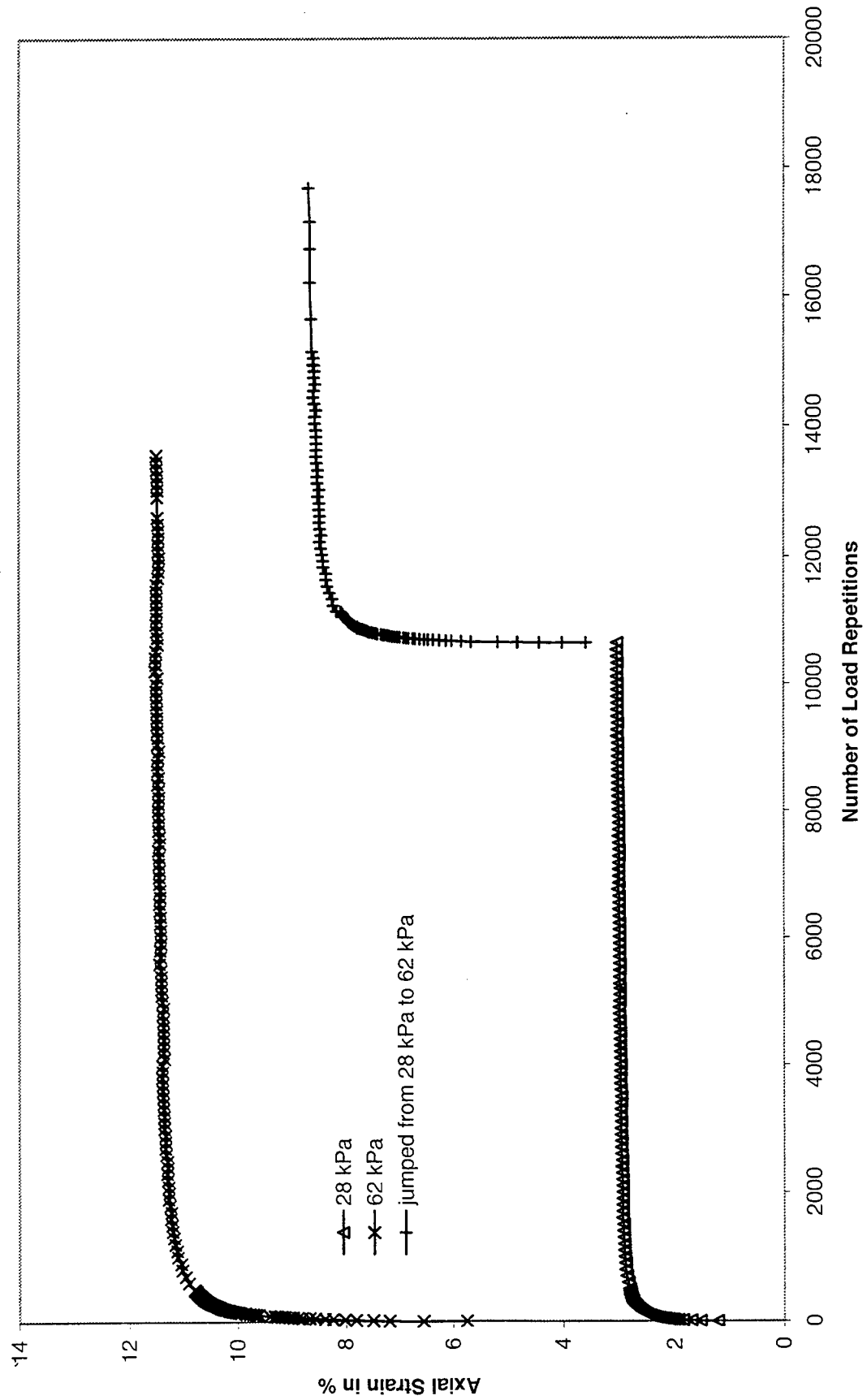


Figure A-6 Effect of Stress History on Permanent Strain for Enders
(Ultimate Deviator Stress at 62 kPa)



**Figure A-7 Effect of Stress History on Permanent Strain for Enders
(Ultimate Deviator Stress at 103 kPa)**

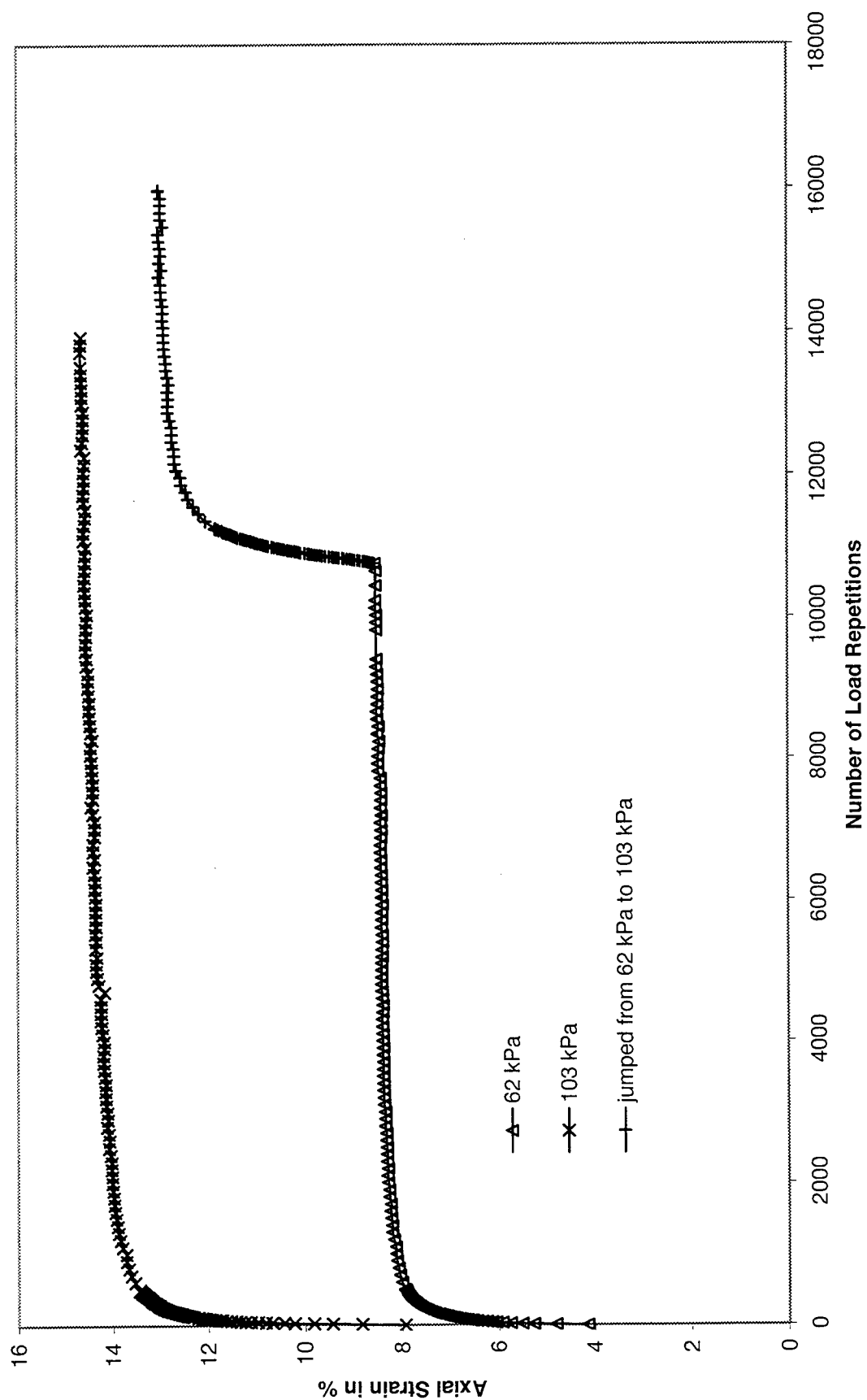


Figure A-8 Repeated Load Test Results for Gallion
(Moisture Content at 105% of OMC)

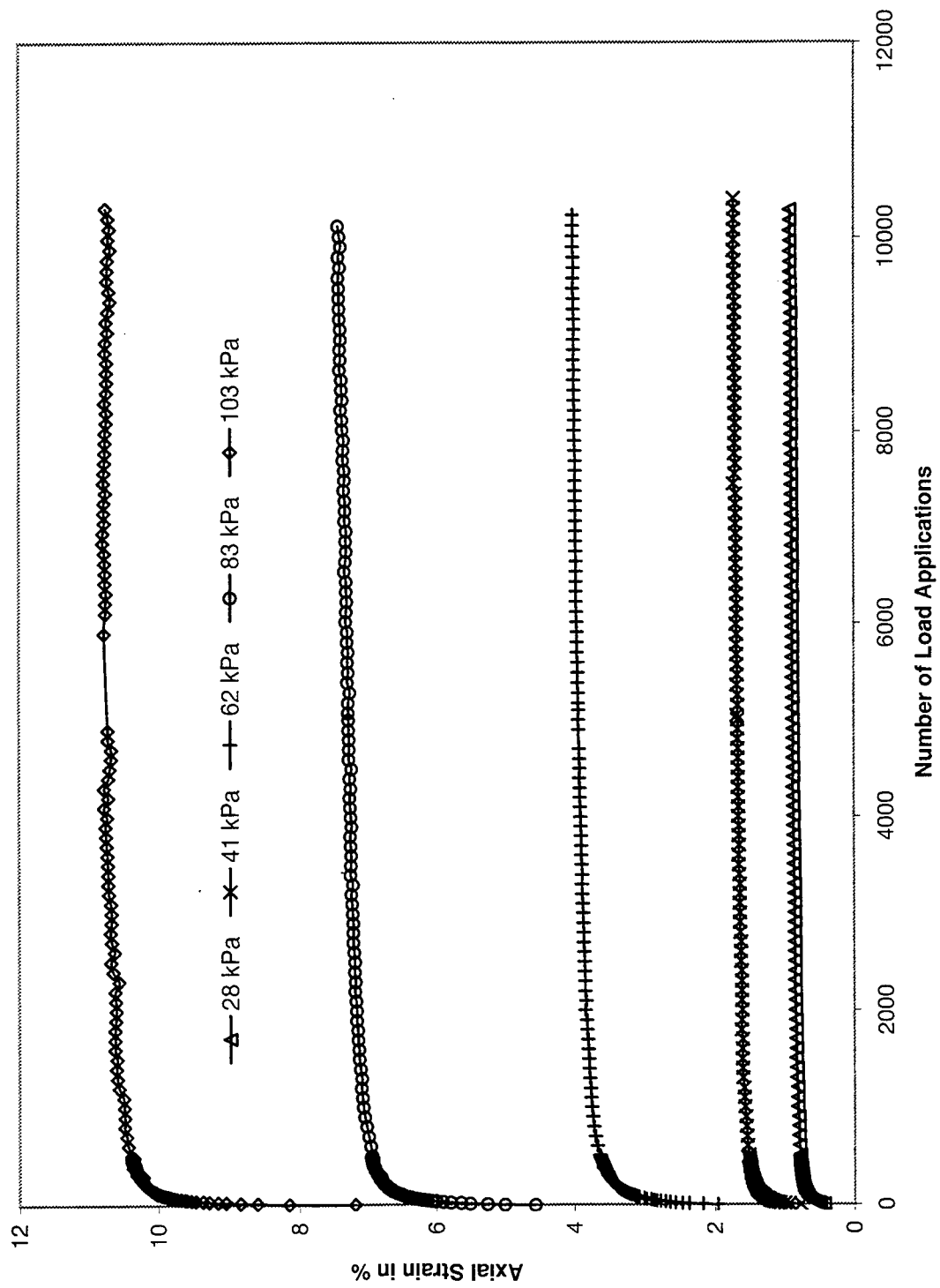
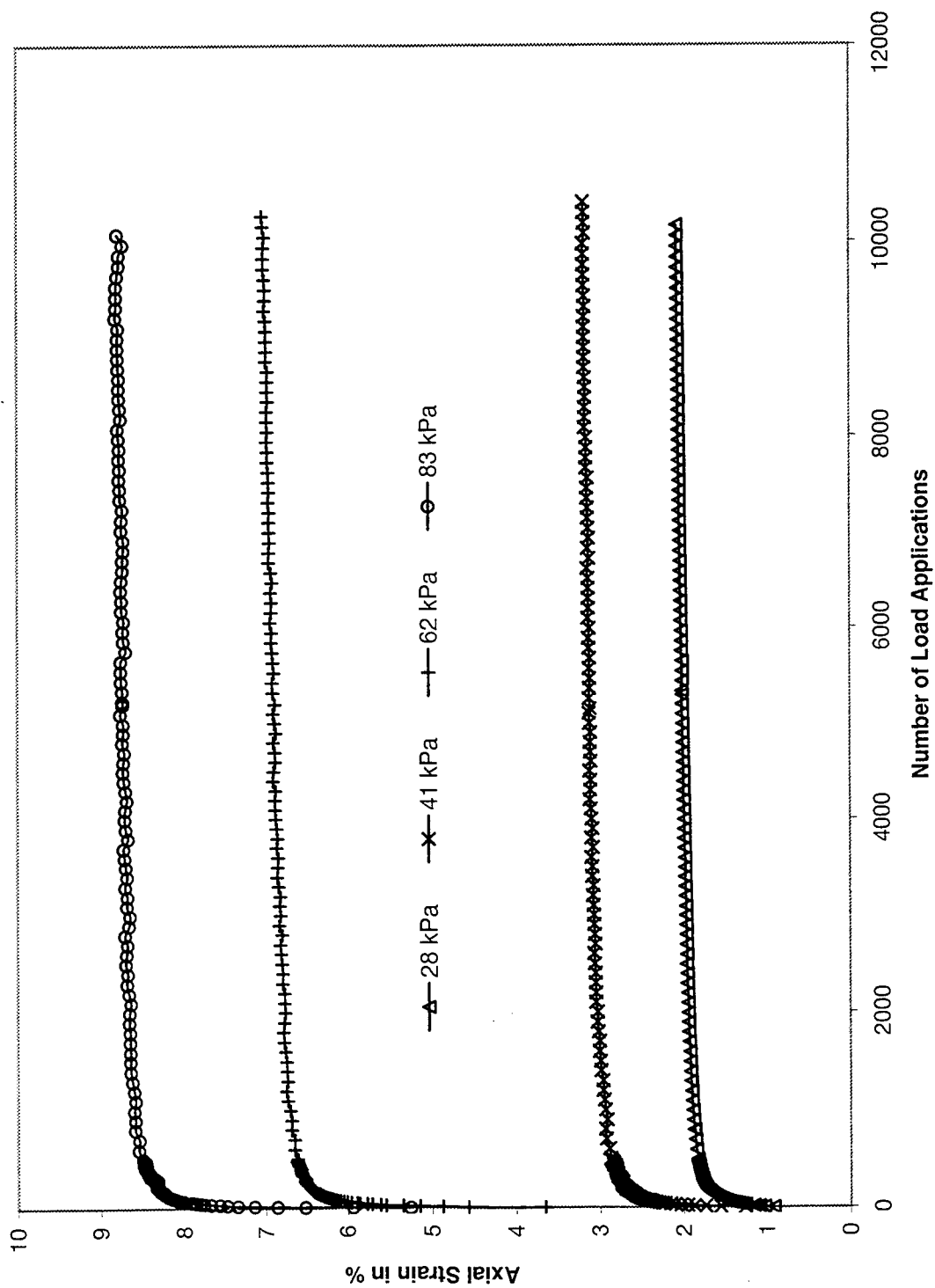


Figure A-9 Repeated Load Test Results for Gallion
(Moisture Content at 110% of OMC)



**Figure A-10 Repeated Load Test Results for Gallion
(Moisture Content at 120% of OMC))**

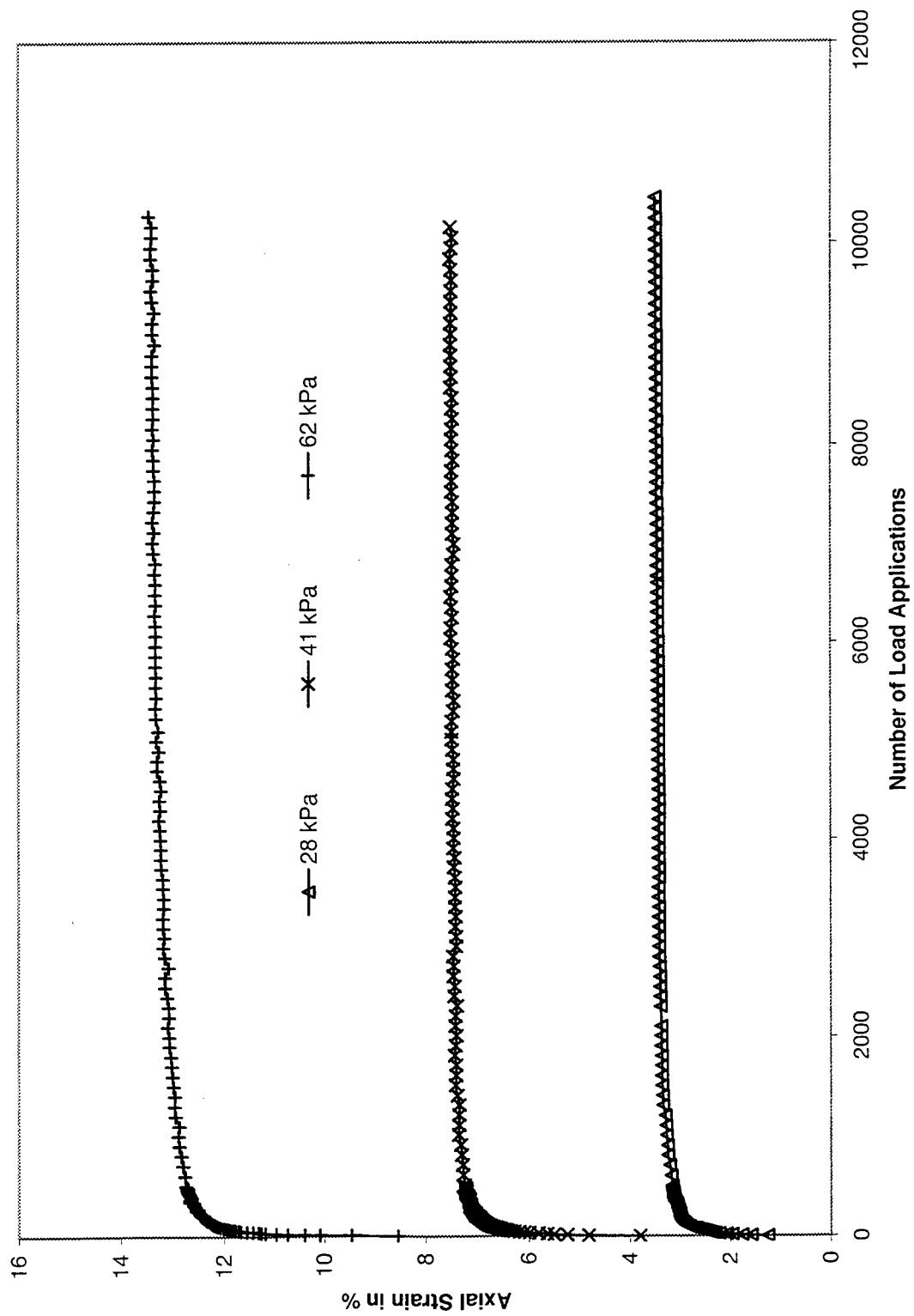


Figure A-11 Effect of Density on Permanent Strain for Gallion

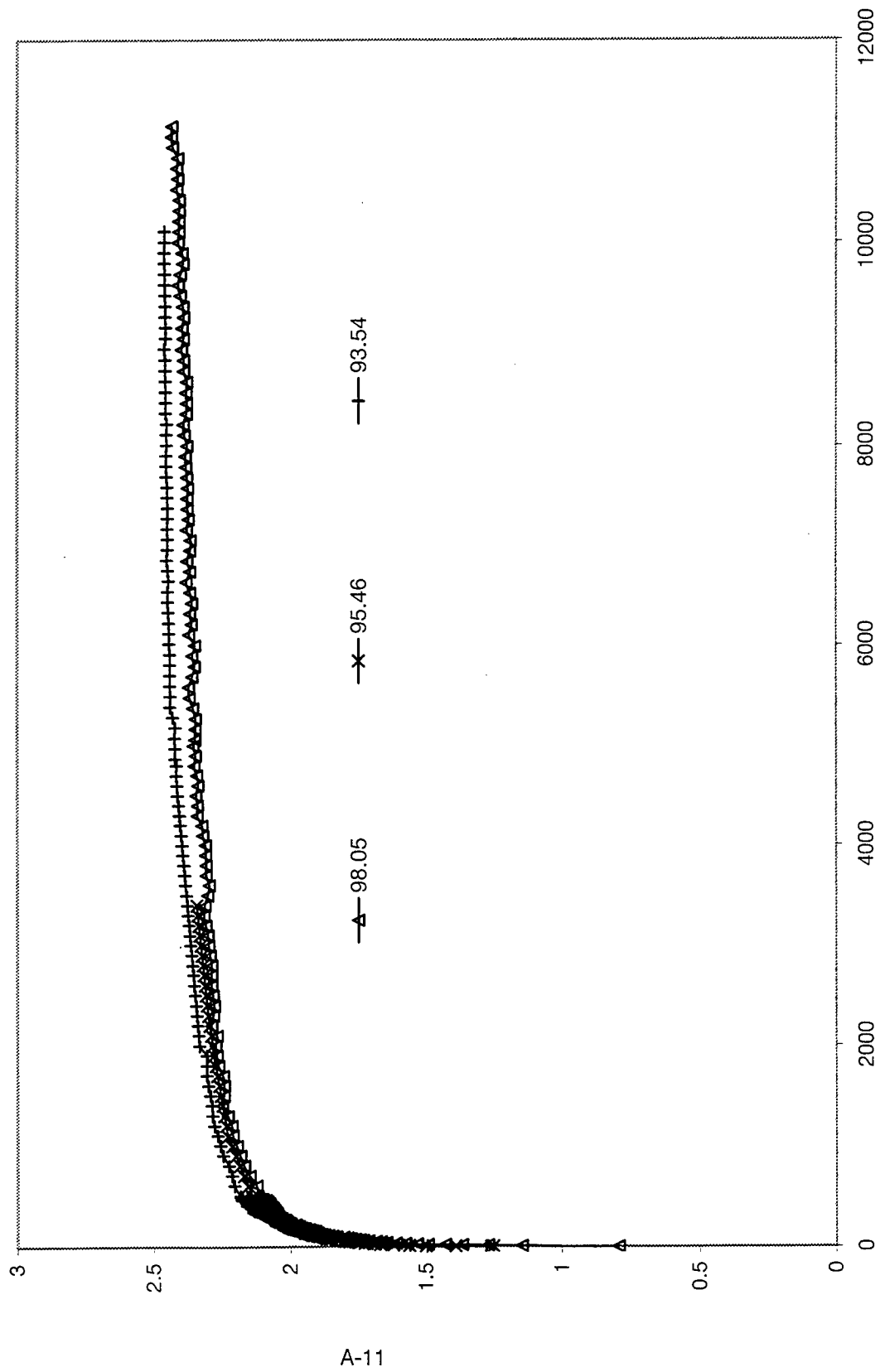


Figure A-12 Effect of Freeze-Thaw on Permanent Strain for Gallion

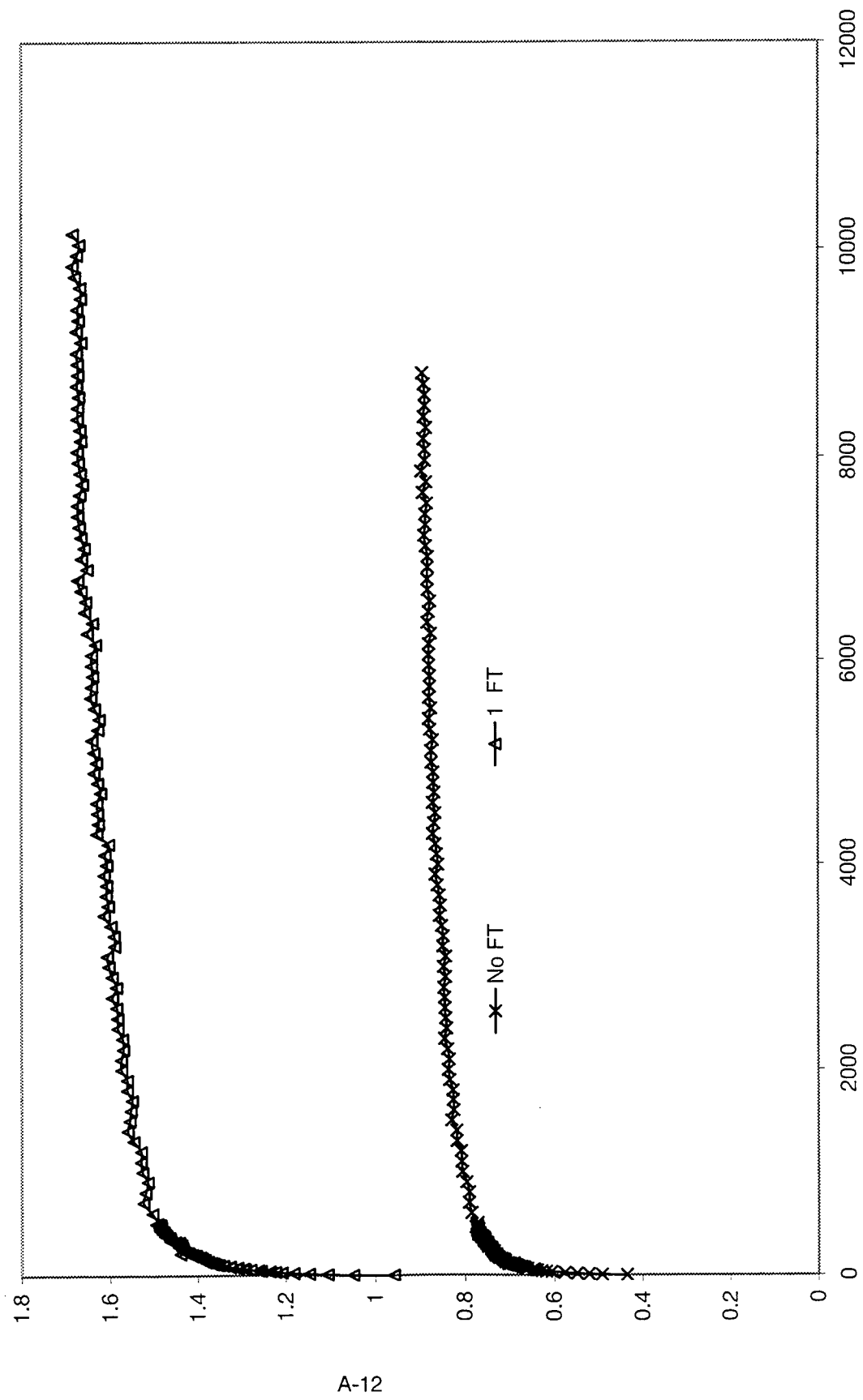


Figure A-13 Effect of Stress History on Permanent Strain for Gallion
(Ultimate Deviator Stress at 83 kPa)

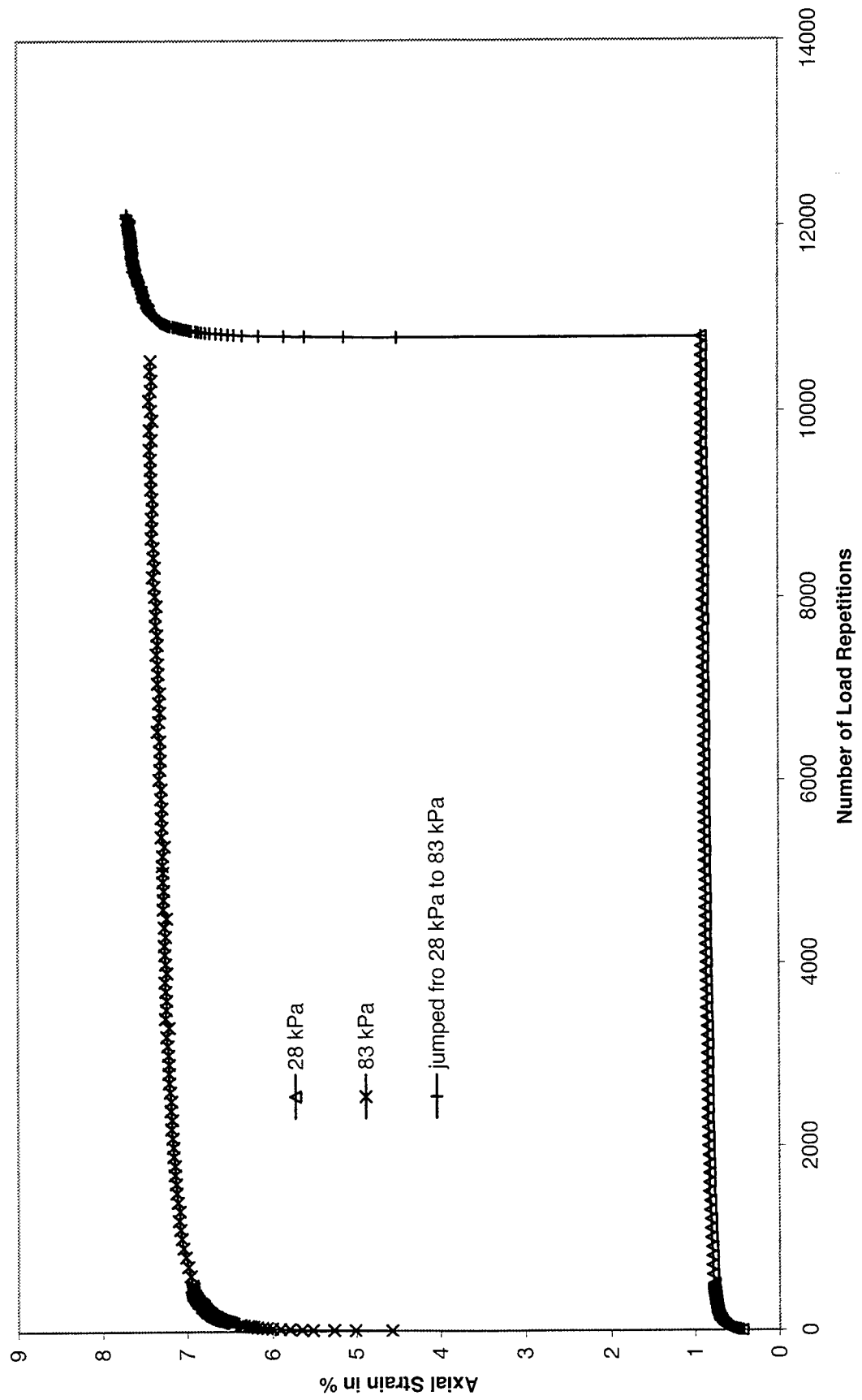


Figure A-14 Effect of Stress History on Permanent Strain for Gallion
(Ultimated deciator Stress at 62 kPa)

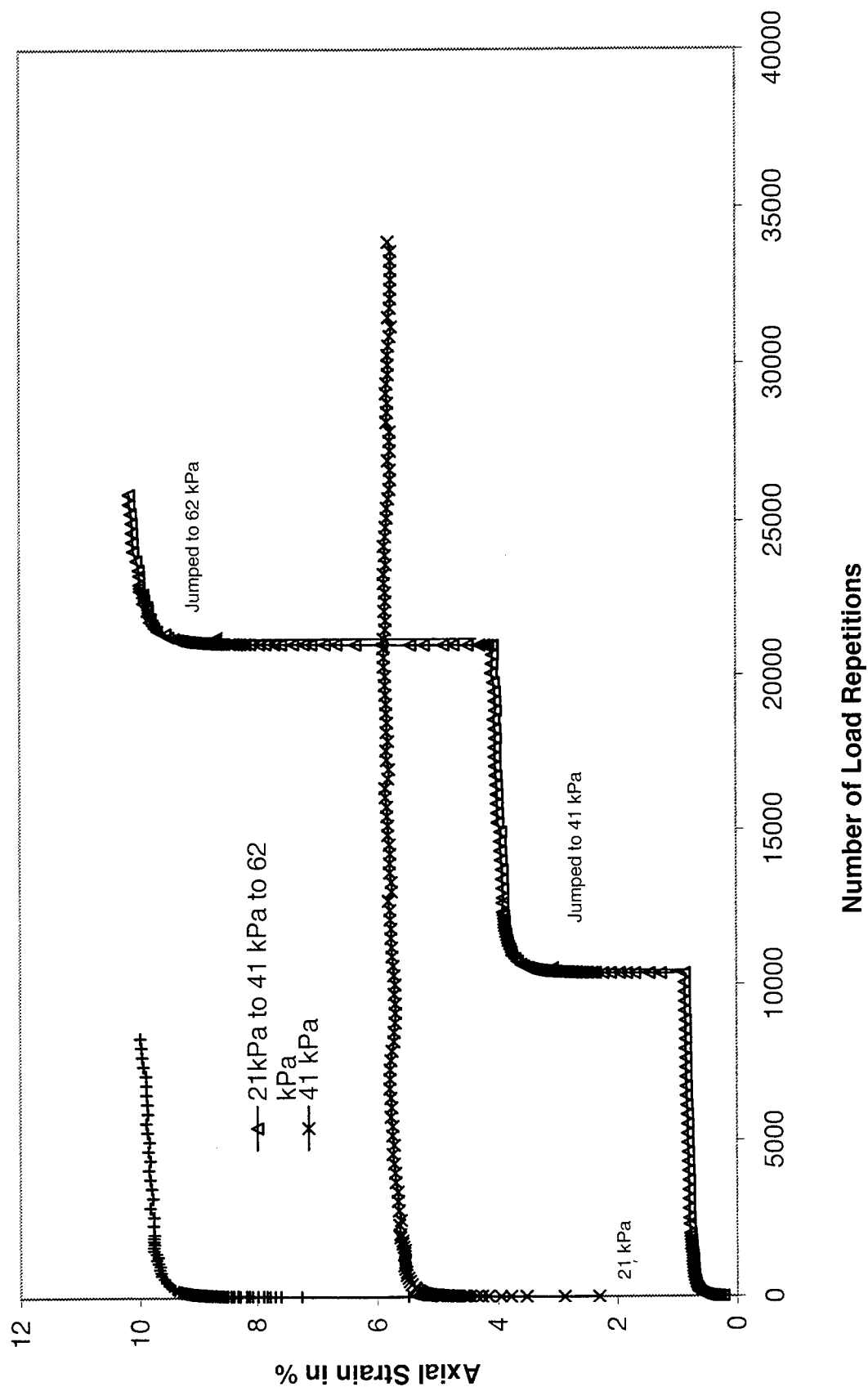


Figure A-15 Repeated Load Test Result for Houston
(Moisture Content at 105% of OMC)

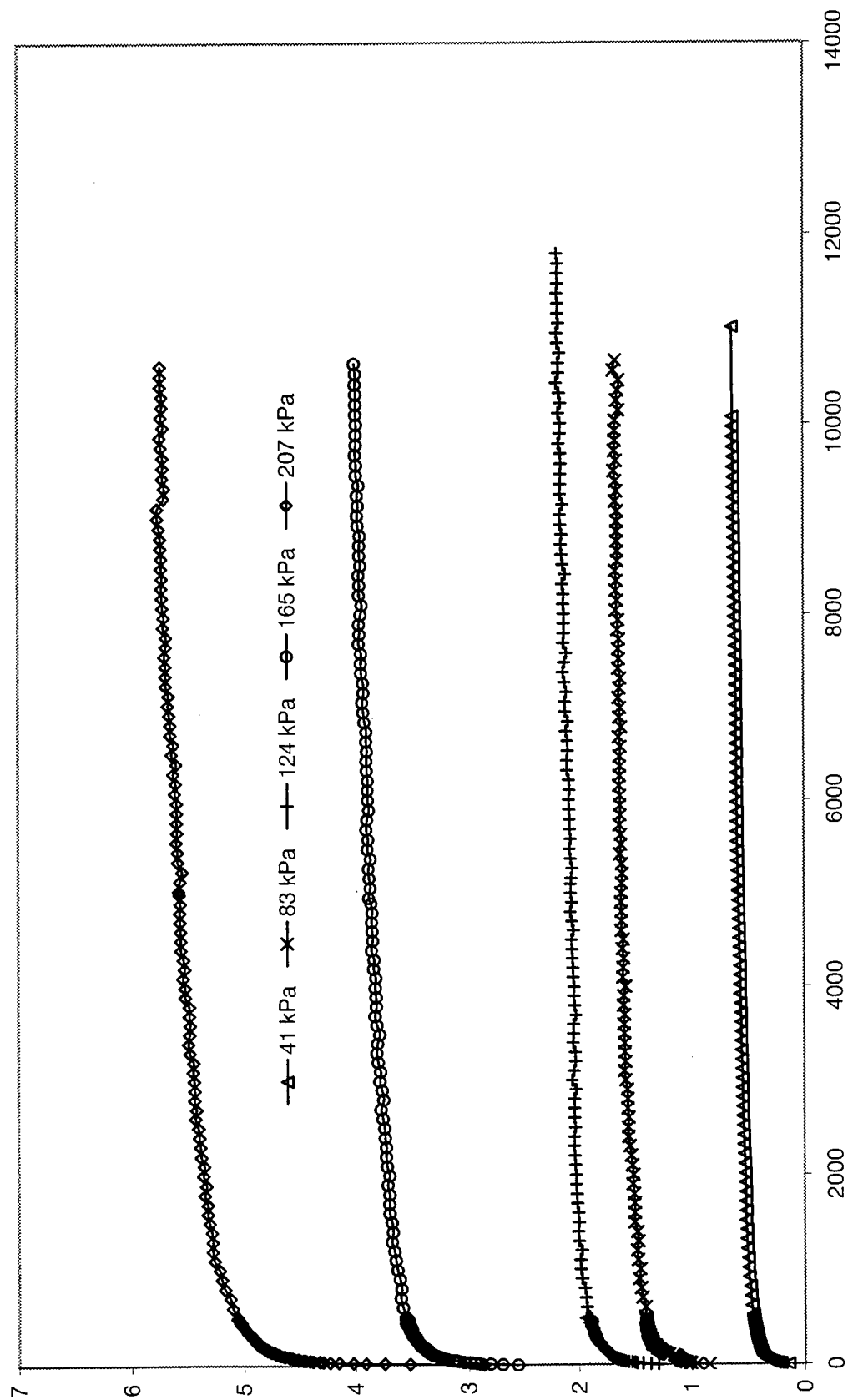


Figure A-16 Repeated Load Test Results for Houston
(Moisture Content at 110%)

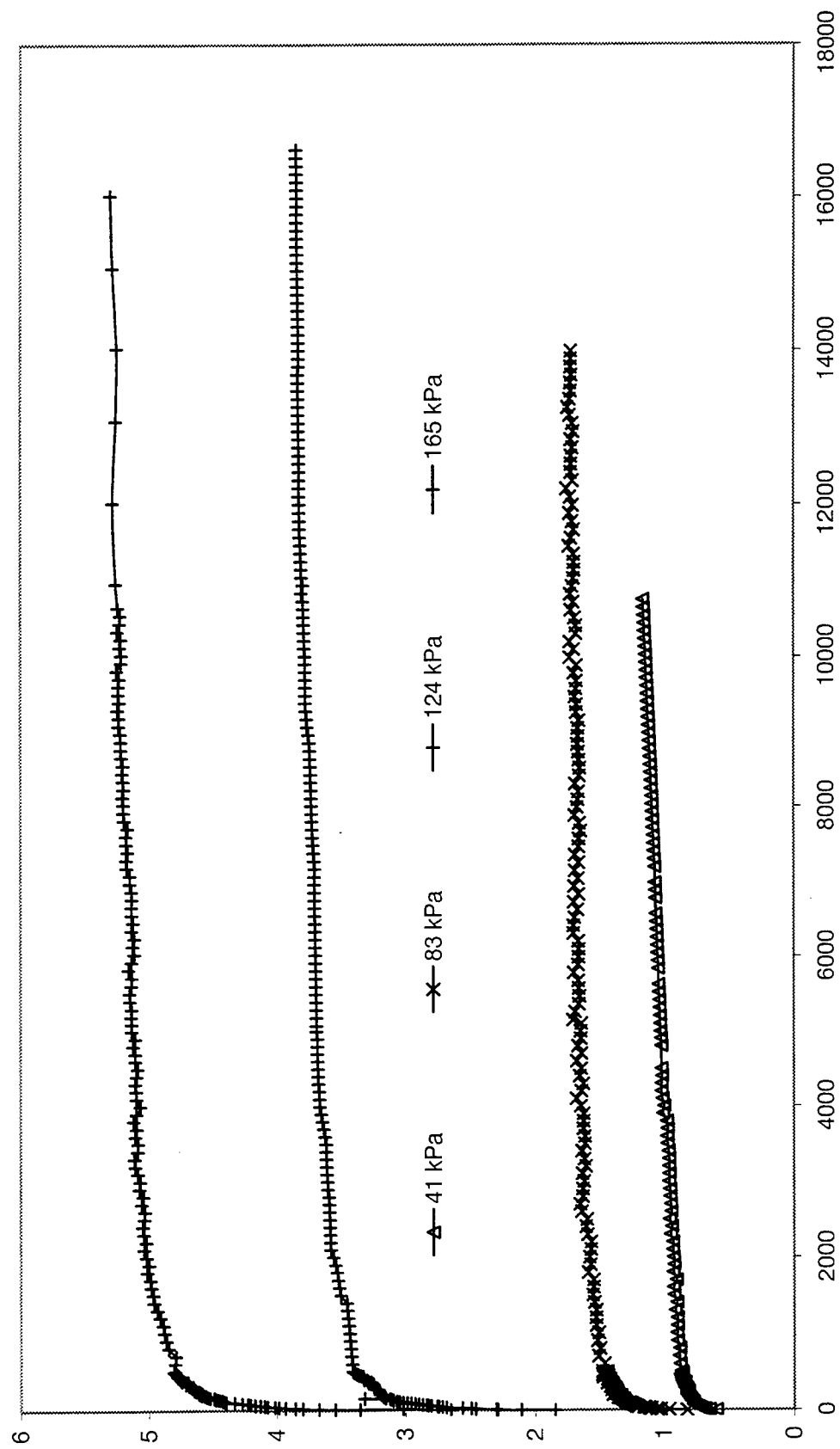


Figure A-17 Repeated Load Test Results for Houston
(Moisture Content at 120%)

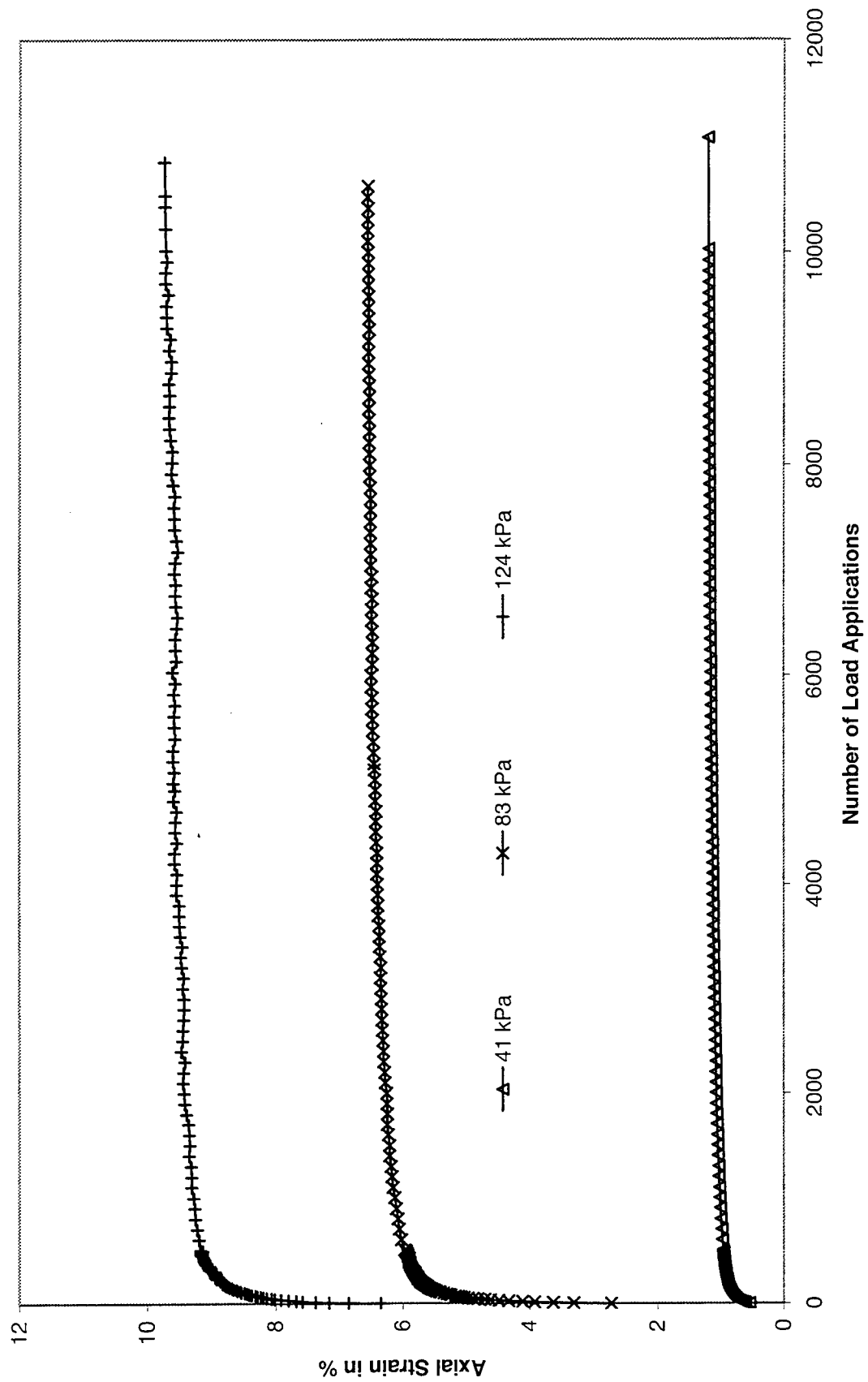


Figure A-18 Effect of Density on Permanent Strain for Houston

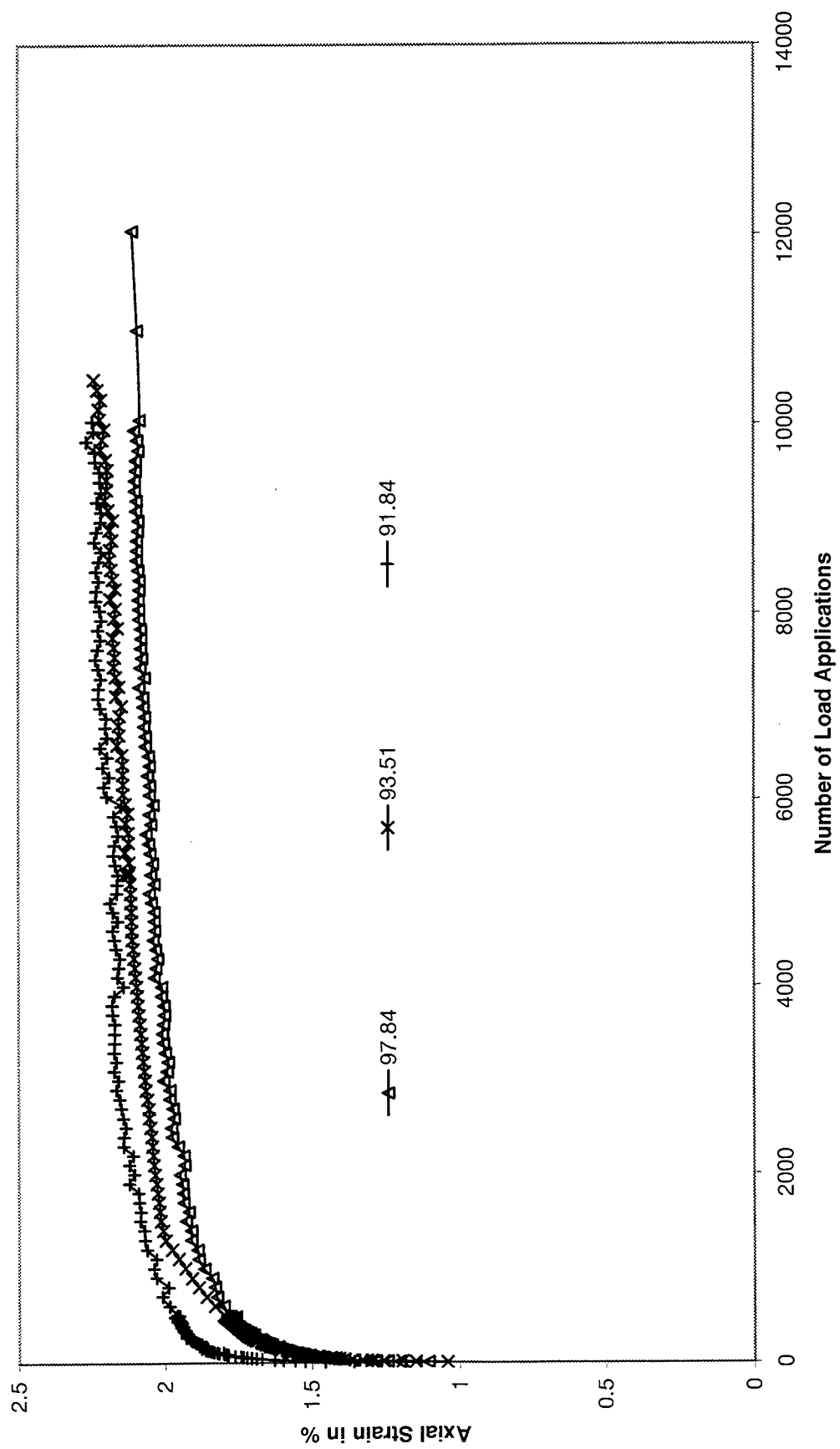
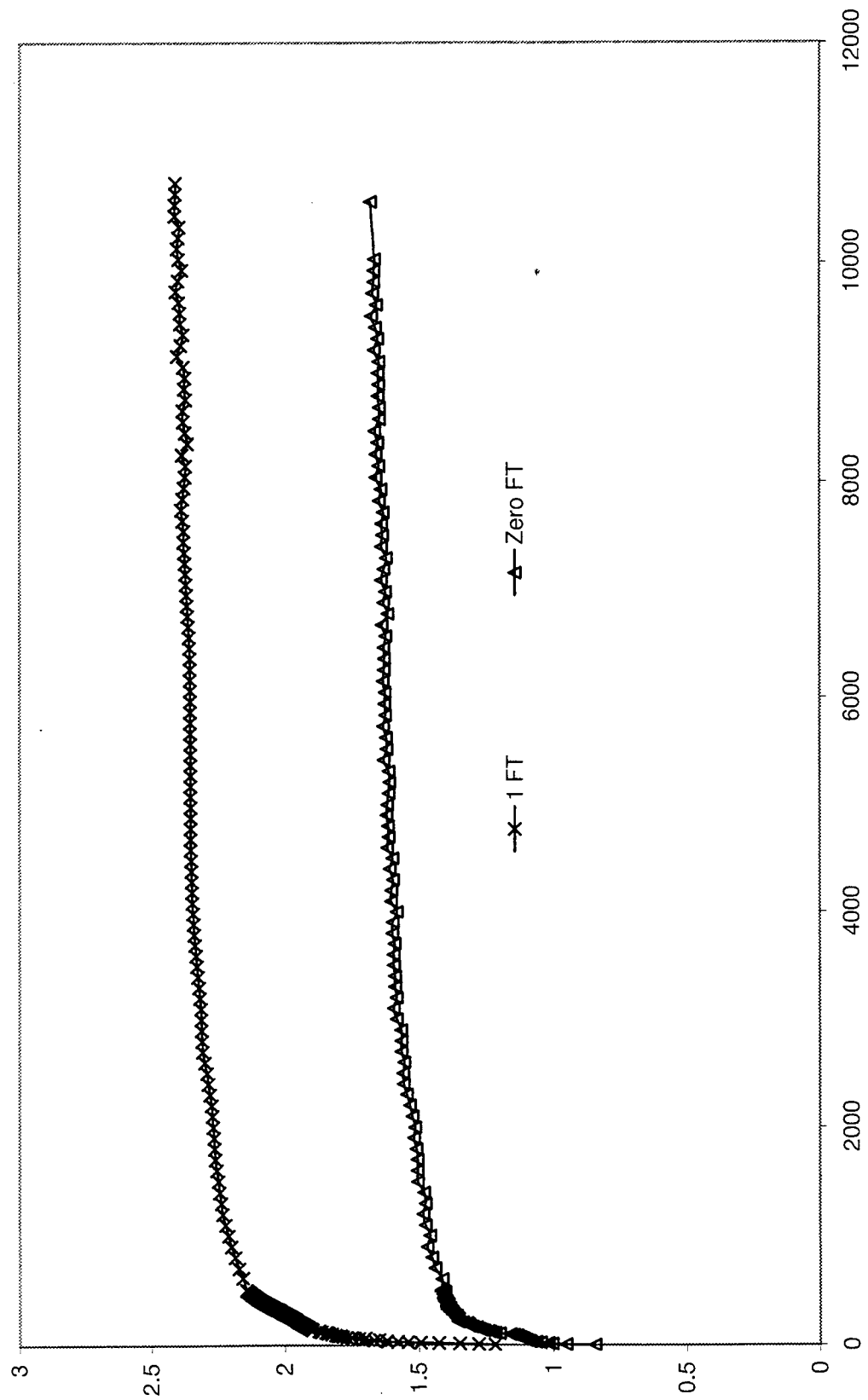


Figure A-19 Effect of Freeze-Thaw on Permanent Strain for Houston



**Figure A-20 Effect of Stress History on Permanent Strain for Houston
(Moisture content at 110% of OMC)**

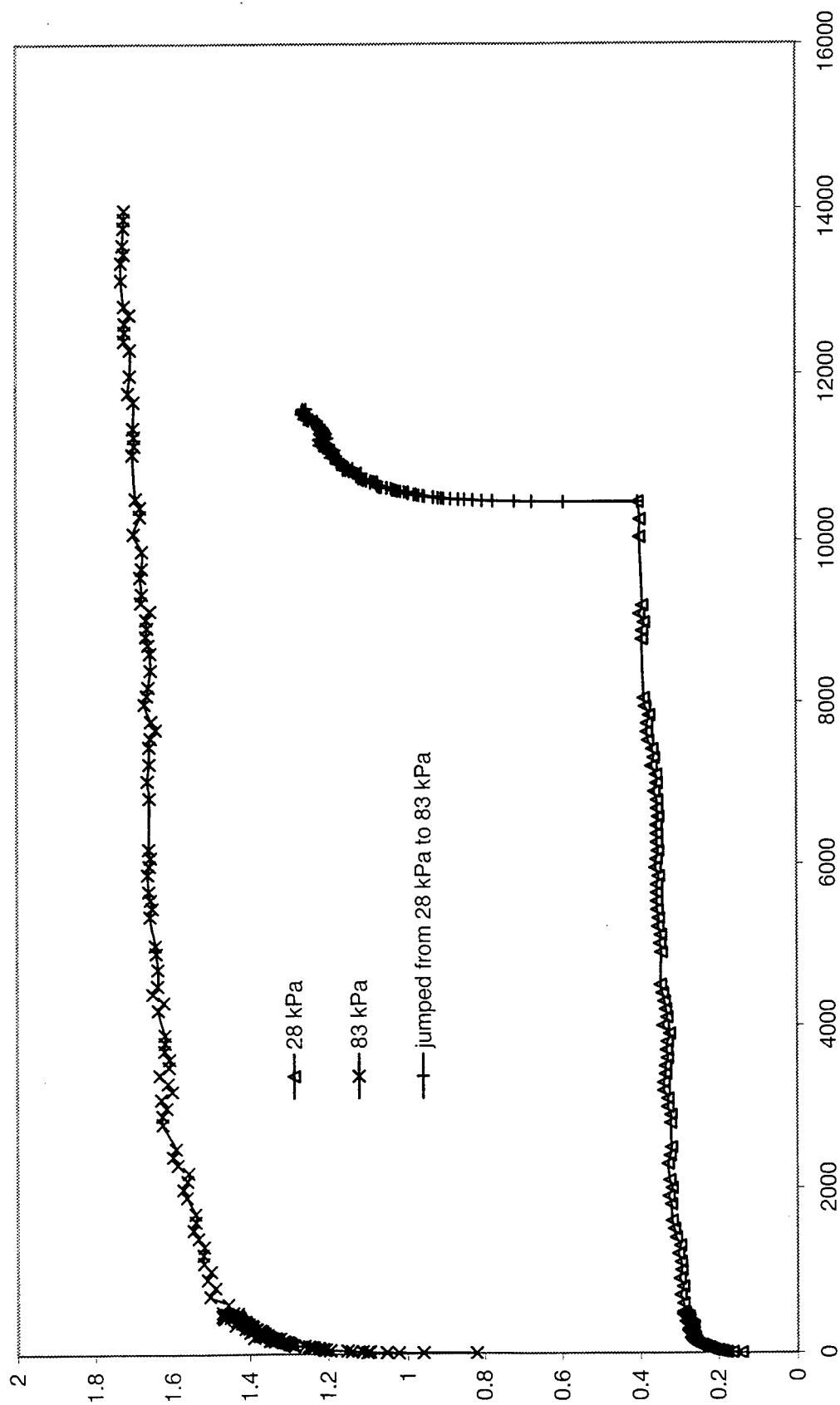


Figure A-21 Effect of Stress History on Permanent Strain for houston
(Moisture Content at 120% of OMC)

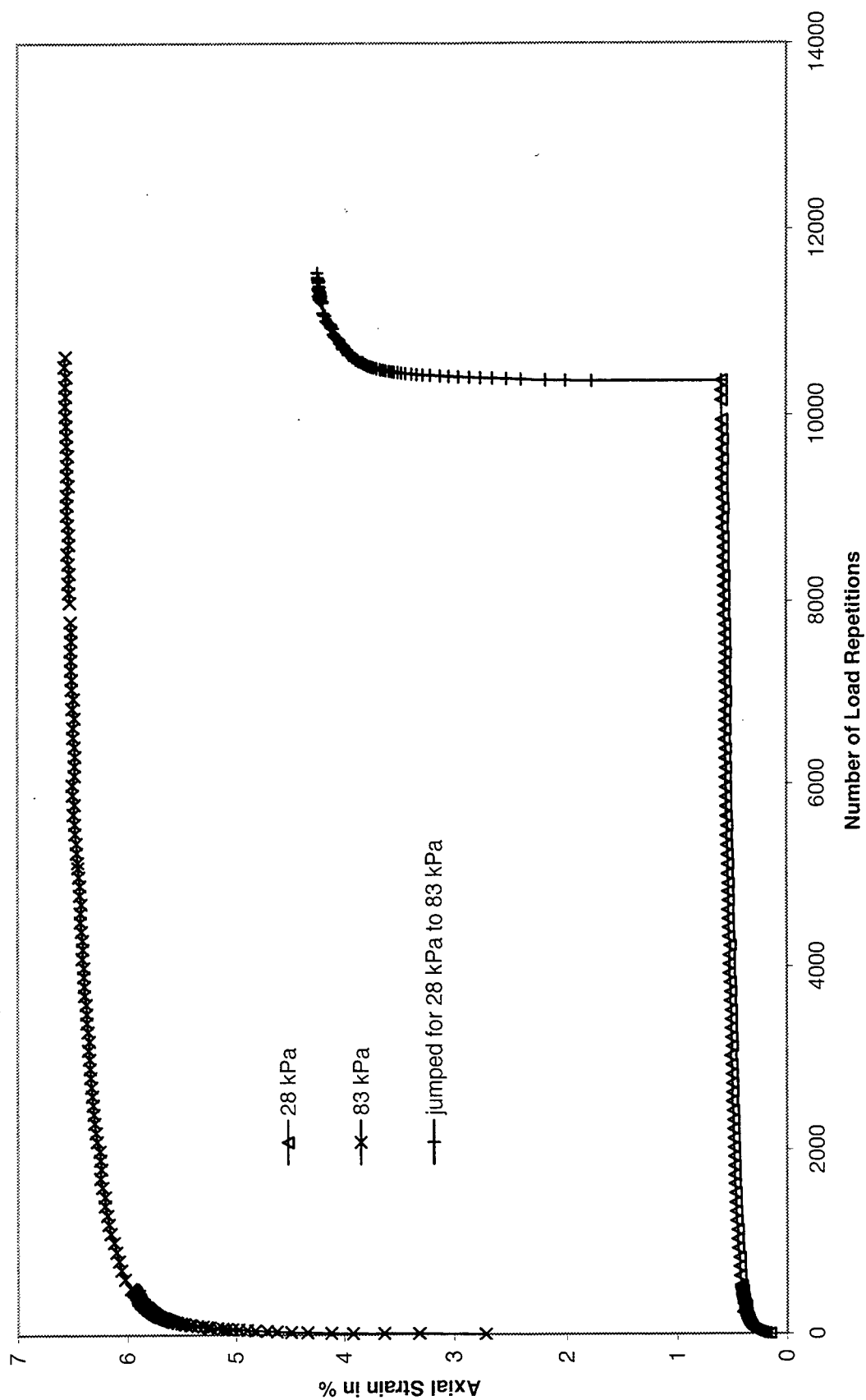
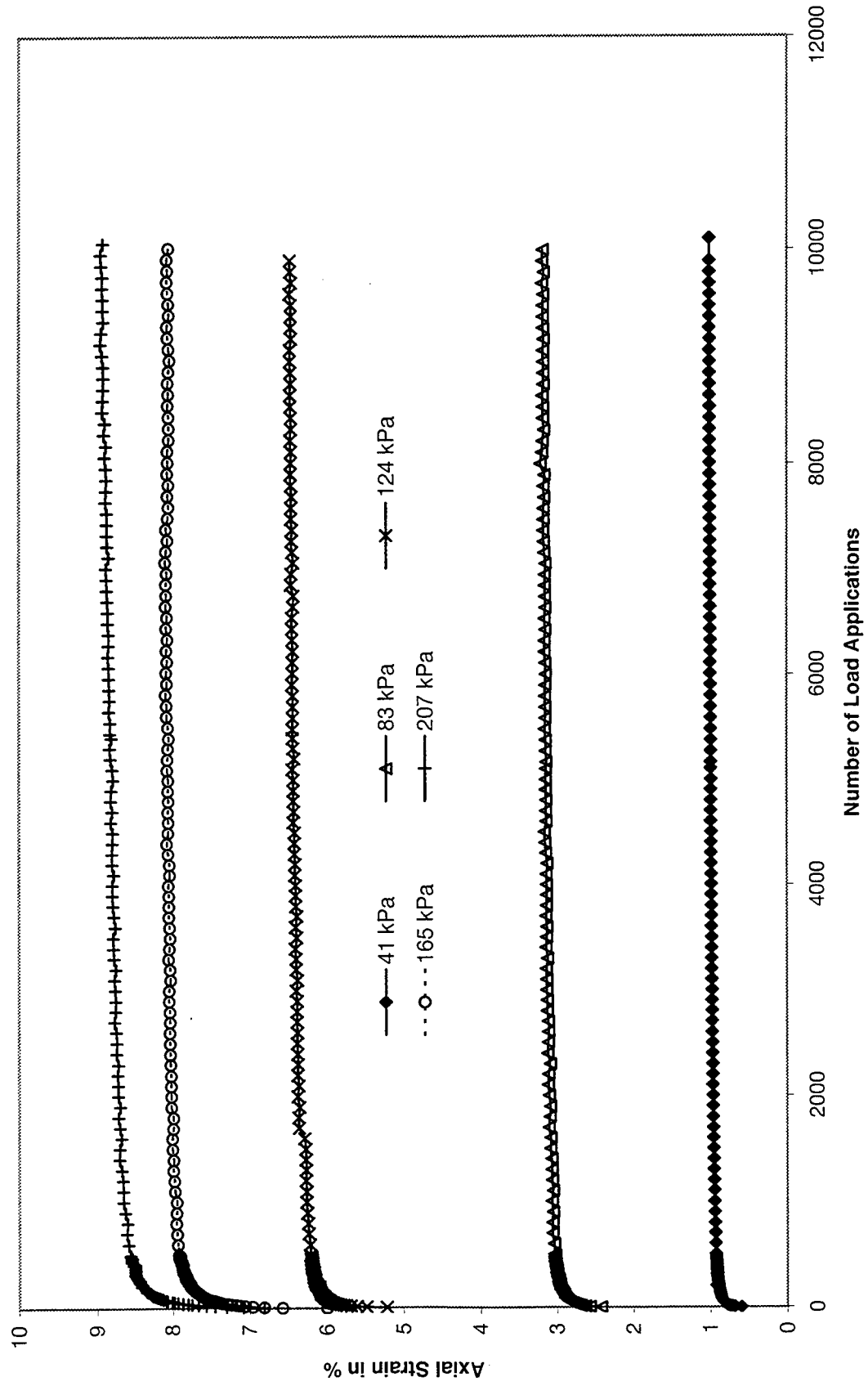


Figure A-22 Repeated Load Test Results for Sacul
(Moisture Content at 105% of OMC)



**Figure A-23 Repeated Load Test Results for Sacul
(Moisture Content at 110% of OMC)**

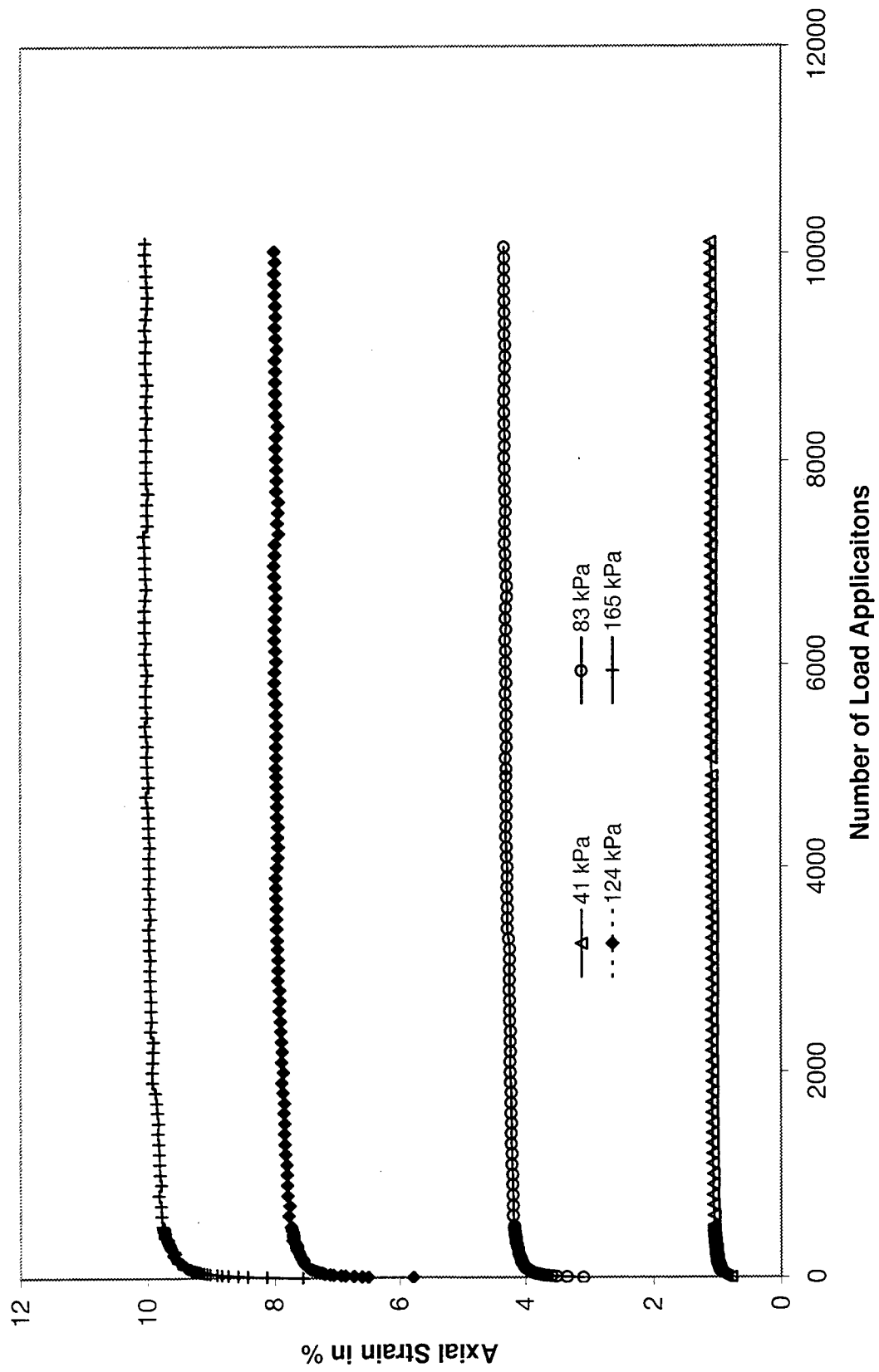


Figure A-24 Repeated Load Test Results for Sacul
(Moisture Content at 120% of OMC)

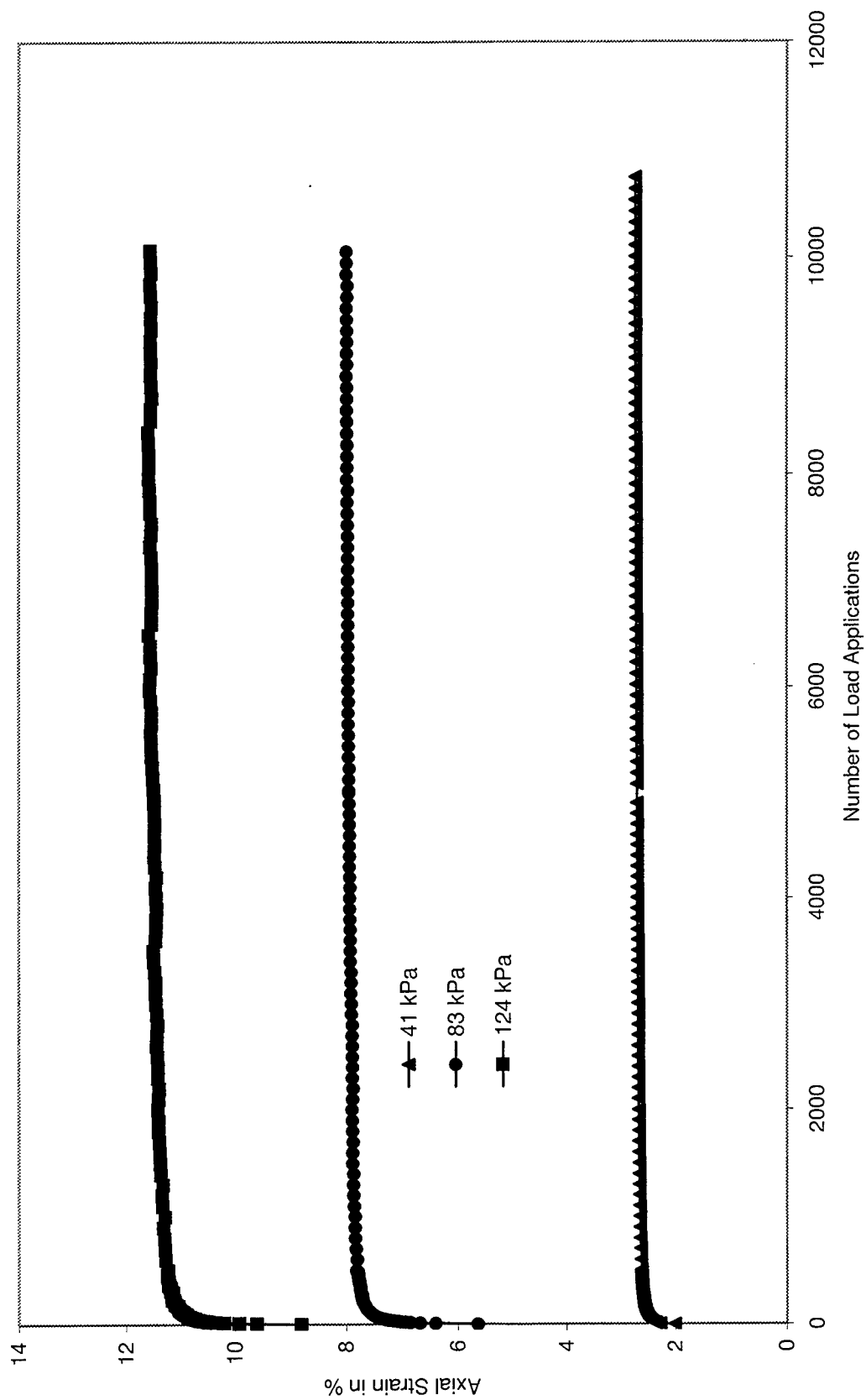


Figure A-25 Effect of Density on Permanent Strain for Sacul

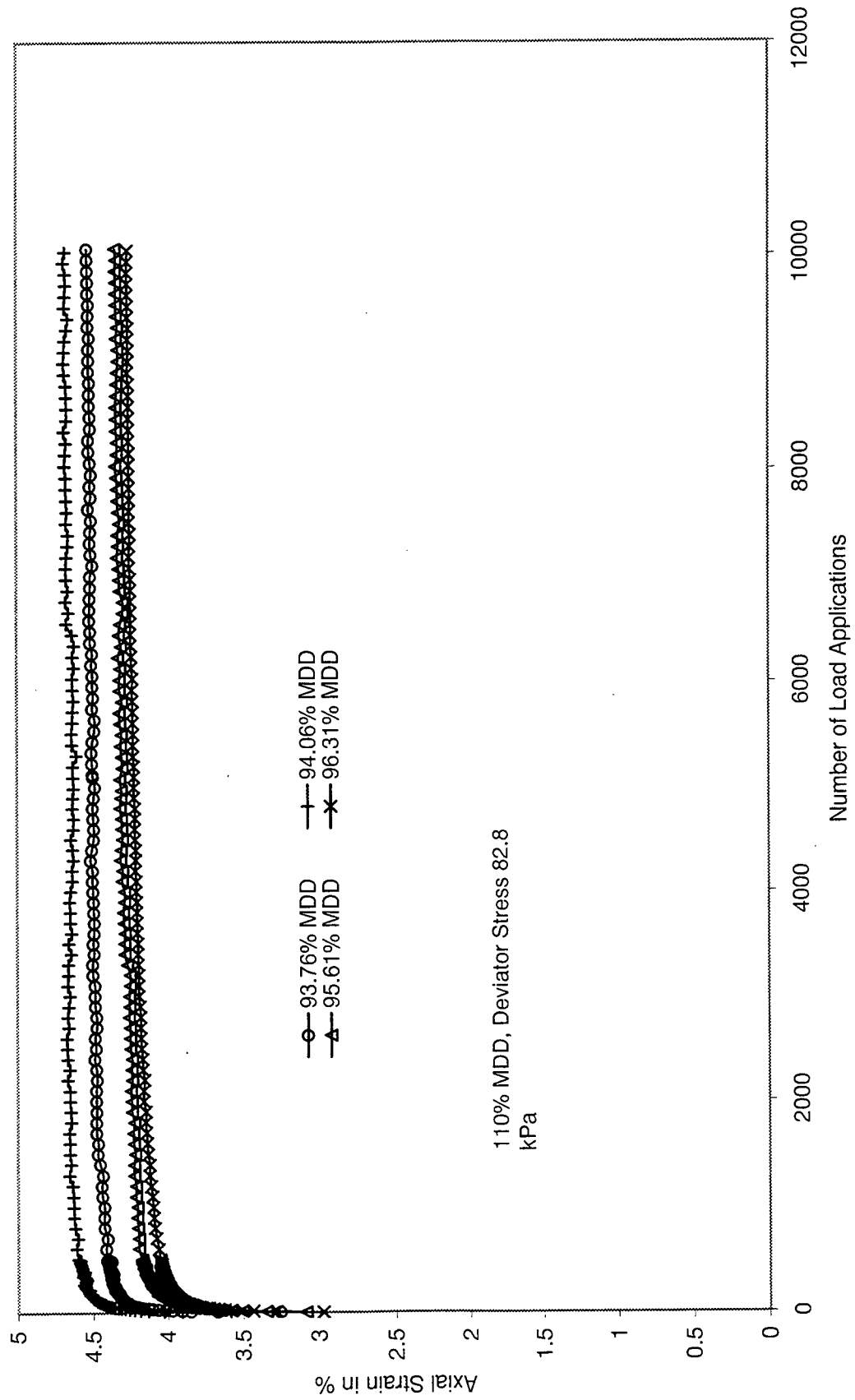
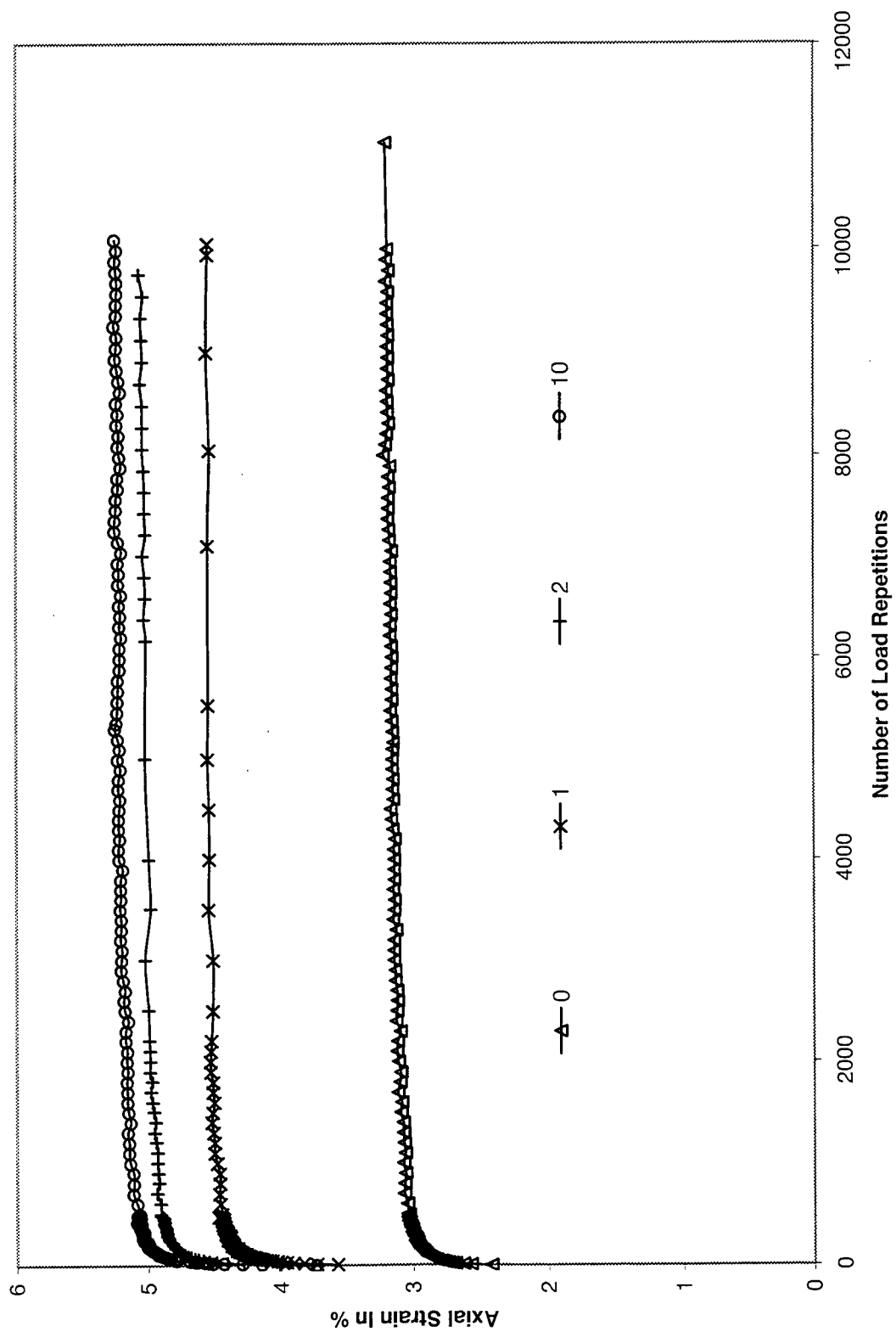


Figure A-26 Effect of Freeze-Thaw on Permanent Strain for Sacul



**Figure A-27 Effect of Stress History on Permanent Strain for Sacul
(Ultimate Deviator Stress at 124 kPa)**

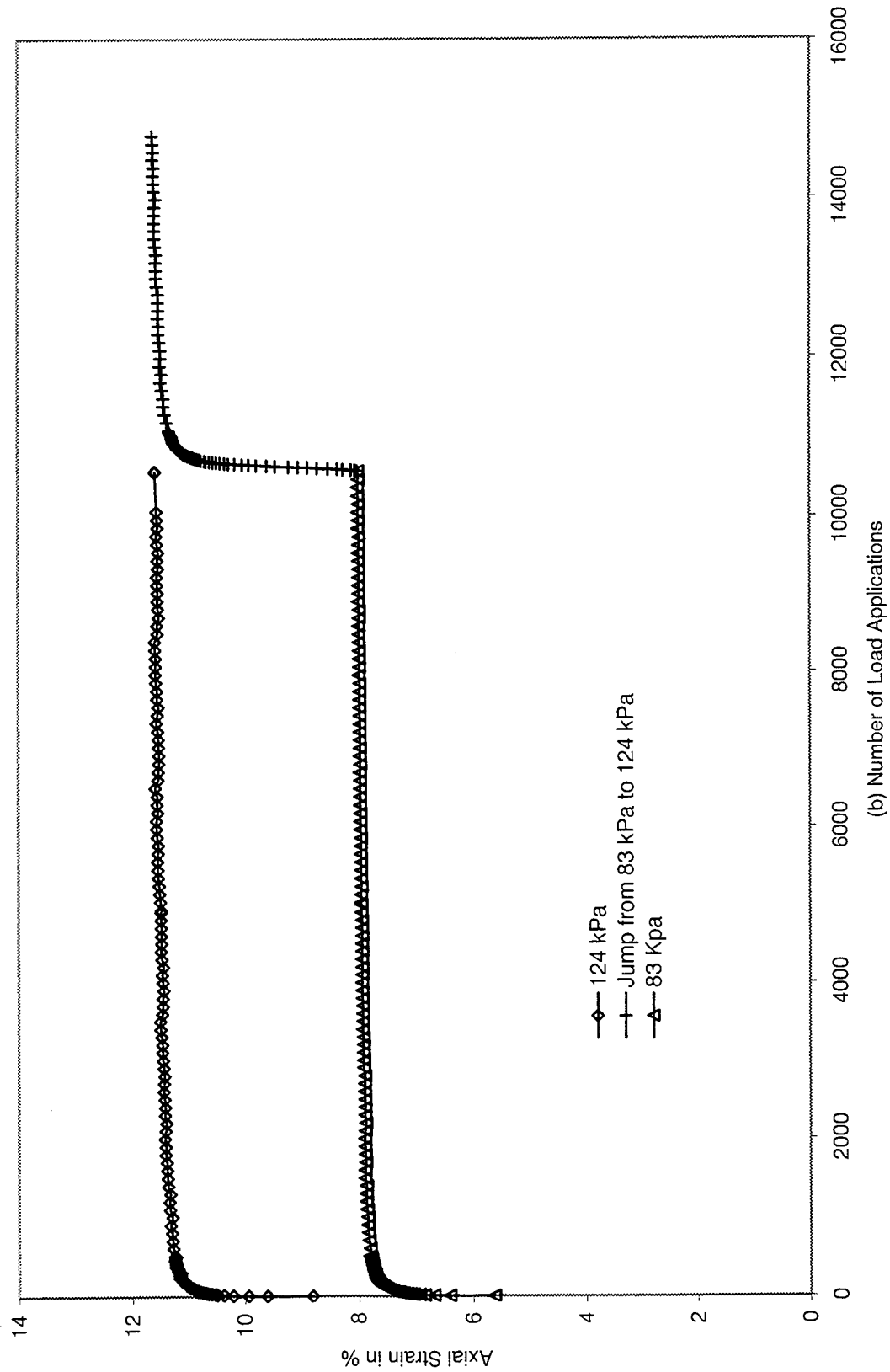


Figure A-28 Effect of Stress History on Permanent Strain for Sacul
(Ultimate Deviator Stress at 83 kPa)

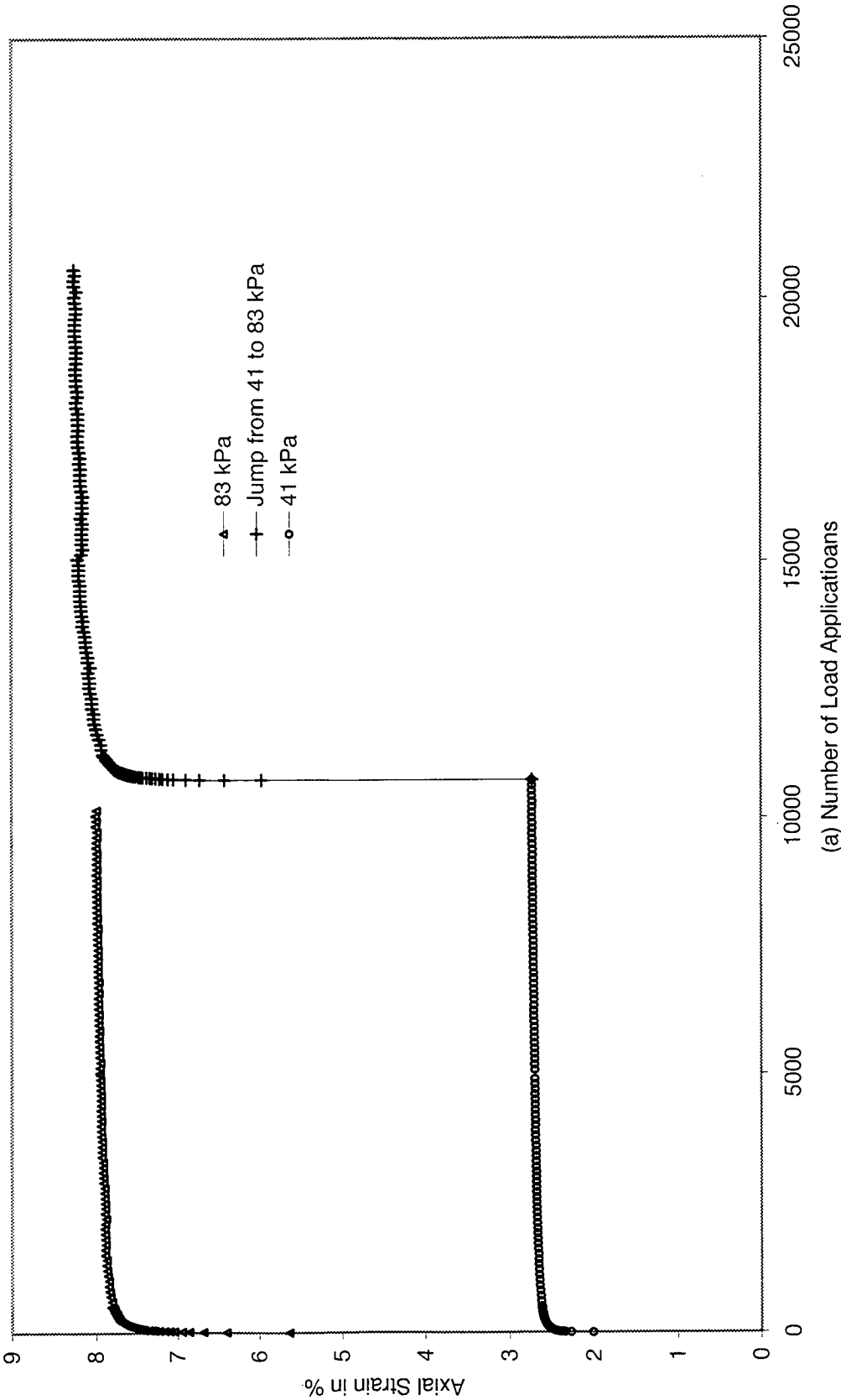


TABLE A-1 DATA FOR FIGURE A-1

Deviator= 28Kpa		Deviator= 41kPa		Deviator= 62kPa		Deviator= 83kPa		Deviator= 103kPa	
N	%	N	%	N	%	N	%	N	%
1	0.80	1	2.04	1	4.15	1	6.72	1	7.93
6	1.00	6	2.45	6	4.81	6	7.46	6	8.84
11	1.11	11	2.66	11	5.27	11	7.86	11	9.44
49	1.55	50	3.56	51	6.46	49	9.38	49	11.24
102	1.75	103	3.90	100	6.93	101	10.13	101	12.09
109	1.77	108	3.93	106	7.00	106	10.19	106	12.13
151	1.85	152	4.08	151	7.24	152	10.50	152	12.50
201	1.93	204	4.21	202	7.48	203	10.71	204	12.77
250	1.98	255	4.30	254	7.63	249	10.86	253	12.95
302	2.05	302	4.35	304	7.71	303	11.00	301	13.05
309	2.05	307	4.36	311	7.73	308	11.01	307	13.06
354	2.09	350	4.40	356	7.81	351	11.08	354	13.17
401	2.10	404	4.44	409	7.87	397	11.16	406	13.26
453	2.13	449	4.48	455	7.90	454	11.23	454	13.34
505	2.15	502	4.50	502	7.95	505	11.29	503	13.42
601	2.26	602	4.56	602	8.01	603	11.37	605	13.53
705	2.30	705	4.59	704	8.05	705	11.47	702	13.61
804	2.32	803	4.61	801	8.08	803	11.54	804	13.66
904	2.34	902	4.64	904	8.12	905	11.59	904	13.71
1002	2.35	1006	4.66	1001	8.13	1003	11.66	1005	13.71
1201	2.36	1202	4.69	1201	8.17	1205	11.73	1205	13.84
1403	2.38	1403	4.73	1401	8.21	1401	11.78	1401	13.90
1606	2.39	1604	4.74	1605	8.25	1604	11.81	1602	13.95
1801	2.39	1805	4.79	1805	8.27	1804	11.81	1803	13.98
2008	2.40	2001	4.79	2006	8.29	2002	11.81	2005	14.01
2204	2.40	2202	4.81	2202	8.29	2205	11.89	2203	14.03
2401	2.40	2404	4.83	2405	8.31	2403	11.87	2404	14.04
2604	2.40	2605	4.85	2604	8.33	2602	11.87	2605	14.07
2802	2.41	2801	4.86	2803	8.35	2807	11.88	2801	14.12
3005	2.41	3002	4.87	3002	8.35	3004	11.89	3003	14.11
3203	2.42	3204	4.89	3201	8.37	3205	11.91	3205	14.14
3401	2.43	3405	4.92	3401	8.38	3404	11.92	3401	14.14
3604	2.44	3601	4.93	3601	8.38	3603	11.90	3603	14.18
3802	2.44	3803	4.94	3805	8.39	3804	11.94	3805	14.20
4005	2.44	4004	4.94	4004	8.39	4005	11.92	4002	14.18
4204	2.45	4201	4.97	4203	8.40	4202	11.91	4205	14.23
4402	2.45	4403	4.97	4403	8.40	4403	11.92	4402	14.24
4605	2.46	4604	4.98	4603	8.40	4603	11.94	4604	14.24
4804	2.47	4801	5.00	4803	8.42	4807	11.94	4802	14.29
5003	2.47	5003	5.02	5003	8.42	5001	11.93	5004	14.33
6010	2.47	5973	5.06	6032	8.41	5996	11.98	6059	14.35
7058	2.48	7021	5.04	7080	8.43	7051	12.03	7111	14.36
8001	2.49	7965	5.08	8026	8.47	7994	12.05	8058	14.46
9049	2.50	9019	5.08	9083	8.50	9042	12.03	9007	14.50
10096	2.50	10077	5.10	10032	8.52	11033	12.08	10055	14.52

TABLE A-2 DATA FOR FIGURE A-2

Deviator = 28 kPa		Deviator= 41 kPa		Deviator= 62 kPa		Deviator= 83 kPa	
N	%	N	%	N	%	N	%
1	1.21	1	3.49	1	5.75	1	8.87
6	1.53	14	4.32	6	6.55	6	9.65
11	1.70	27	4.69	11	7.18	11	10.25
50	2.25	41	4.99	49	8.81	51	12.30
104	2.49	55	5.23	53	8.89	56	12.46
113	2.51	109	5.73	107	9.61	96	13.28
155	2.59	157	5.93	150	10.01	153	13.94
203	2.66	203	6.06	200	10.26	205	14.33
253	2.72	248	6.14	250	10.39	251	14.58
305	2.75	309	6.21	303	10.53	301	14.79
355	2.77	355	6.27	351	10.61	353	14.95
407	2.79	400	6.31	403	10.68	405	15.11
453	2.80	446	6.33	453	10.75	457	15.25
499	2.81	508	6.36	494	10.78	503	15.36
601	2.83	600	6.41	605	10.90	606	15.55
702	2.86	710	6.45	702	10.95	708	15.75
804	2.88	803	6.47	806	11.02	803	15.86
903	2.89	903	6.48	905	11.04	901	15.98
1003	2.89	1009	6.50	1005	11.10	1004	16.09
1201	2.91	1219	6.54	1203	11.15		
1405	2.92	1413	6.56	1404	11.19		
1606	2.94	1620	6.59	1606	11.22		
1805	2.93	1805	6.59	1806	11.24		
2005	2.93	2014	6.62	2005	11.25		
2204	2.94	2203	6.63	2201	11.28		
2403	2.95	2413	6.66	2404	11.28		
2601	2.95	2601	6.66	2604	11.31		
2804	2.95	2804	6.67	2805	11.32		
3002	2.96	3014	6.68	3008	11.34		
3204	2.96	3220	6.68	3202	11.34		
3402	2.95	3406	6.69	3405	11.36		
3605	2.96	3614	6.70	3607	11.37		
3803	2.97	3800	6.71	3805	11.39		
4001	2.96	4007	6.72	4004	11.38		
4204	2.97	4222	6.72	4206	11.36		
4402	2.98	4414	6.72	4405	11.35		
4601	2.97	4603	6.72	4604	11.36		
4801	2.99	4812	6.72	4803	11.37		
5004	2.98	5003	6.73	5002	11.37		
6018	2.98	6000	6.72	6025	11.41		
6126	2.99	6105	6.73	6129	11.40		
7072	2.99	7014	6.75	7073	11.43		
8016	3.00	7902	6.77	8015	11.45		
9066	3.01	8911	6.77	9063	11.47		
10011	3.02	10002	6.78	10006	11.49		

DATA FOR FIGURE A-3

Deviator = 28 kPa	
N	%
1	2.73
6	3.42
11	4.00
52	4.86
102	5.18
151	5.34
156	5.35
203	5.45
254	5.52
303	5.57
352	5.59
399	5.62
450	5.64
501	5.67
604	5.70
703	5.71
801	5.73
904	5.74
1005	5.75
1203	5.77
1401	5.78
1605	5.80
1805	5.80
2005	5.81
2205	5.83
2405	5.83
2605	5.84
2805	5.84
3002	5.86
3203	5.85
3404	5.86
3604	5.87
3805	5.87
4006	5.87
4201	5.89
4402	5.89
4603	5.89
4804	5.90
5005	5.89
6061	5.91
7006	5.91
8054	5.92
8998	5.92
10046	5.93

Deviator= 41 kPa	
N	%
1	4.44
6	4.94
11	5.39
49	6.69
102	7.25
150	7.52
155	7.53
201	7.76
253	7.88
300	7.97
352	8.06
407	8.12
453	8.16
503	8.20
602	8.26
705	8.32
801	8.35
907	8.40
1006	8.43
1203	8.48
1404	8.52
1602	8.55
1802	8.57
2002	8.59
2202	8.61
2402	8.62
2604	8.65
2806	8.66
3001	8.67
3203	8.67
3403	8.68
3603	8.69
3803	8.70
4003	8.70
4203	8.71
4403	8.71
4603	8.71
4804	8.72
5004	8.73
6000	8.73
6944	8.74
7994	8.77
8938	8.78
9986	8.79

TABLE A-4 DATA FOR FIGURE A-4

Density= 95.46%	
N	%
1	3.205714
6	3.687543
11	4.115457
54	5.1578
101	5.514314
151	5.704229
200	5.842171
250	5.900457
300	5.983029
350	6.0214
412	6.081143
460	6.094743
514	6.1166
619	6.128257
711	6.149143
803	6.159343
902	6.171971
1000	6.182657
1201	6.208886
1404	6.221029
1601	6.224914
1802	6.234143
2004	6.240943
2200	6.245314
2402	6.257457
2603	6.259886
2800	6.268143
3003	6.267657
3200	6.271057
3401	6.273486
3603	6.275429
3803	6.276886
4000	6.284657
4204	6.286114
4401	6.284171
4603	6.288057
4800	6.288057
5002	6.298257
5988	6.299229
7038	6.319629
8094	6.324
9142	6.321086
10190	6.3274

Density= 91.68%	
N	%
1	3.493743
14	4.323829
55	5.231629
68	5.363743
109	5.733371
157	5.927657
203	6.0554
248	6.1438
309	6.214229
355	6.267171
400	6.308457
446	6.330314
508	6.361886
600	6.406571
710	6.446886
803	6.470686
903	6.481857
1009	6.499829
1219	6.5382
1413	6.563457
1620	6.587257
1805	6.591629
2014	6.619314
2203	6.6334
2413	6.656229
2601	6.658657
2804	6.672743
3014	6.684886
3220	6.683914
3406	6.687314
3614	6.697029
3800	6.706257
4007	6.716457
4222	6.717914
4414	6.722771
4603	6.723257
4812	6.717429
5003	6.7252
6000	6.724229
7014	6.753371
8006	6.7694
9018	6.771829
10002	6.778143

Density= 97.86%	
N	%
1	2.591771
8	3.410686
14	3.771086
53	4.577857
106	4.940686
156	5.121371
201	5.211229
250	5.285057
303	5.340429
349	5.375886
397	5.399686
455	5.426886
502	5.441457
623	5.4774
832	5.519171
905	5.5284
1002	5.546371
1204	5.551229
1405	5.565314
1600	5.584257
1802	5.592514
2003	5.604171
2209	5.615343
2402	5.6202
2609	5.632829
2800	5.629914
3006	5.631857
3207	5.6372
3403	5.641571
3606	5.644971
3807	5.648857
4002	5.6542
4201	5.649343
4409	5.656629
4606	5.656143
4801	5.659543
5002	5.668286
6000	5.673143
6901	5.684314
7901	5.695486
8006	5.696457
9008	5.7052
10007	5.712486

TABLE A-5 DATA FOR FIGURE A-5

No FT		One FT	
N	%	N	%
1	1.145314	1	1.908371
9	1.508143	16	2.259057
53	2.218743	58	2.674829
104	2.519886	110	2.888057
157	2.6554	156	3.013857
207	2.739429	204	3.093029
250	2.800629	252	3.157143
298	2.8288	299	3.210086
351	2.869114	346	3.252829
397	2.887571	407	3.292171
468	2.924	449	3.314029
506	2.935657	510	3.338314
620	2.975	613	3.382029
718	2.996371	701	3.399029
818	3.011429	817	3.421857
911	3.0226	901	3.448086
992	3.0328	1004	3.448086
1208	3.051743	1215	3.469943
1410	3.063886	1406	3.489371
1609	3.073114	1617	3.502
1810	3.086714	1806	3.5088
2009	3.092543	2018	3.514629
2209	3.100314	2208	3.520457
2407	3.103714	2419	3.528714
2627	3.108086	2609	3.535514
2805	3.110514	2802	3.541829
3013	3.115857	3017	3.547657
3220	3.120229	3208	3.554457
3428	3.121686	3402	3.561743
3613	3.126057	3615	3.565143
3803	3.126057	3807	3.574857
4013	3.131886	4021	3.576314
4211	3.131886	4213	3.580686
4410	3.136743	4405	3.585543
4604	3.139171	4620	3.592829
4804	3.141114	4812	3.595743
5006	3.143543	5004	3.598171
6001	3.157629	6001	3.608857
7014	3.170743	7012	3.612743
8017	3.176086	8002	3.616629
9021	3.184829	9011	3.621971
10058	3.1858	10005	3.624886

TABLE A-6 DATA FOR FIGURE A-6

62kPa		jump to 62kPa		28 kPa	
N	%	N	%	N	%
1	5.750857	10646	3.020171	1	1.212343
6	6.5518	10647	3.580905	6	1.525629
49	8.813286	10652	4.015889	11	1.701943
107	9.609857	10700	6.368365	50	2.245943
150	10.01154	10803	7.403477	104	2.490743
200	10.25829	10902	7.786651	150	2.5874
250	10.39429	11005	7.952334	203	2.659771
303	10.5332	11100	8.048937	247	2.708343
346	10.61723	11242	8.16281	305	2.754486
403	10.68183	11345	8.224873	355	2.773429
453	10.74789	11441	8.24754	400	2.793829
503	10.79937	11544	8.290715	448	2.804029
605	10.897	11644	8.335508	499	2.810829
702	10.9548	11743	8.360873	504	2.812771
806	11.01551	11846	8.361413	601	2.831714
905	11.03543	11943	8.413223	702	2.8594
1005	11.09614	12043	8.41808	804	2.881257
1203	11.1452	12142	8.433731	903	2.8866
1404	11.19183	12245	8.456397	1003	2.893886
1606	11.22486	12345	8.476365	1201	2.905057
1806	11.23943	12444	8.447762	1405	2.916229
2005	11.25206	12544	8.474746	1606	2.9376
2201	11.28023	12645	8.487159	1805	2.932743
2404	11.27537	12743	8.478524	2005	2.929829
2604	11.30791	12842	8.493096	2204	2.936143
2805	11.32103	12941	8.488238	2403	2.952657
3008	11.34143	13045	8.514683	2601	2.950229
3202	11.34483	13144	8.487159	2804	2.9512
3405	11.35746	13243	8.519	3002	2.9614
3607	11.3696	13341	8.527096	3204	2.960914
3805	11.38757	13445	8.510905	3402	2.9546
4004	11.37931	13544	8.534111	3605	2.962371
4206	11.356	13643	8.542207	3803	2.969171
4405	11.35406	13742	8.538969	4204	2.967714
4604	11.35843	13845	8.537889	4402	2.975486
4803	11.37446	14043	8.542207	4601	2.974514
5002	11.37446	14542	8.600492	4801	2.987143
6025	11.40797	14943	8.58808	5004	2.980829
7073	11.42691	15043	8.602111	6018	2.984229
8015	11.45363	16217	8.63827	6967	2.993943
9063	11.46917	16742	8.661477	8016	2.997343
13358	11.48083	17161	8.662556	9066	3.008029
13463	11.48617	17686	8.667413	10011	3.018714
13567	11.48666	18001	8.690619		

TABLE A-7 DATA FOR FIGURE A-7

103 kPa		62 kPa		jump to 103kPa	
N	%	N	%	N	%
1	7.933657	1	4.145571		
6	8.838543	6	4.806143	10765	8.541286
11	9.4418	11	5.27	10766	8.566654
49	11.24283	51	6.457571	10805	8.847829
101	12.08846	100	6.933571	10901	9.86621
147	12.46197	151	7.242971	10993	10.58884
198	12.7432	208	7.487286	11101	11.1825
253	12.94526	265	7.643686	11203	11.61262
301	13.05454	311	7.726257	11366	12.02116
348	13.16966	356	7.807857	11466	12.16094
401	13.23474	409	7.8744	11567	12.27535
447	13.35034	455	7.902571	11668	12.38491
503	13.42029	502	7.947743	11769	12.4351
605	13.52811	602	8.006029	11867	12.52145
702	13.60874	704	8.053143	11970	12.54088
804	13.66363	801	8.079857	12070	12.61967
904	13.70734	904	8.116771	12165	12.65853
1005	13.70977	1001	8.131829	12270	12.66554
1205	13.84091	1201	8.1736	12370	12.6758
1401	13.89871	1401	8.211	12466	12.71573
1602	13.95166	1605	8.245	12567	12.71196
1803	13.98177	1805	8.266371	12670	12.71681
2005	14.00946	2006	8.287743	12765	12.75513
2203	14.02597	2202	8.293571	12872	12.80154
2404	14.042	2405	8.308629	12966	12.79561
2605	14.06531	2604	8.327571	13065	12.78157
2801	14.11729	2803	8.346029	13167	12.8037
3003	14.10806	3002	8.345543	13269	12.77186
3205	14.13866	3201	8.373714	13369	12.80478
3401	14.14303	3401	8.3776	13467	12.83338
3603	14.17994	3601	8.383429	13565	12.835
3805	14.19549	3805	8.388286	13668	12.85821
4002	14.17849	4004	8.393629	13767	12.8717
4205	14.22949	4203	8.4014	13865	12.87818
4402	14.23871	4403	8.395086	13968	12.88897
4604	14.24454	4603	8.401886	14067	12.88304
4802	14.28874	4803	8.417914	14165	12.90678
5004	14.33391	5003	8.416457	14268	12.89761
5103	14.33877	5105	8.417429	14366	12.89923
6059	14.3548	6032	8.409657	14465	12.93538
7006	14.36694	6975	8.420343	14568	12.937
8058	14.45534	8026	8.474257	14666	12.94618
9007	14.50489	8976	8.483971	14769	12.98557
10055	14.52043	10032	8.516029	14868	12.92189
10160	14.5486	10137	8.5306	15070	12.94456
11103	14.59086	10241	8.528171	15266	12.98288
11731	14.60009	10451	8.524286	15470	12.89869
13303	14.63846	10660	8.527686	15665	12.95427
13932	14.64283	10765	8.541286	15978	12.99529

TABLE A-8 DATA FOR FIGURE A-8

28kPa		41kPa		62kPa		83kPa		103kPa	
N	%	N	%	N	%	N	%	N	%
1	0.435686	1	0.7684	1	1.960829	1	4.573	1	7.186413
6	0.492029	6	0.9282	6	2.173571	6	5.010629	6	8.155143
11	0.522143	11	0.9928	11	2.3698	11	5.267571	11	8.600921
53	0.644057	49	1.2104	52	2.9172	49	6.183629	49	9.596095
101	0.685343	103	1.320657	103	3.1892	102	6.500314	104	9.957683
154	0.713029	156	1.388657	155	3.346571	153	6.662543	150	10.0899
198	0.732943	202	1.416829	208	3.421857	198	6.735886	195	10.16816
250	0.740714	252	1.444029	252	3.480629	250	6.788829	242	10.22321
304	0.753343	310	1.468314	302	3.518029	307	6.845171	296	10.27124
351	0.759657	359	1.477057	351	3.5598	353	6.888886	348	10.30308
403	0.766943	407	1.484829	396	3.590886	407	6.925314	394	10.3306
453	0.7718	450	1.501829	450	3.611771	452	6.932114	451	10.38349
505	0.7718	500	1.511543	500	3.638971	501	6.9394	503	10.38781
602	0.7854	505	1.507171	505	3.639943	601	6.960771	604	10.43746
702	0.790257	603	1.527571	604	3.676371	701	6.986514	702	10.45581
802	0.790743	701	1.534857	701	3.703086	805	7.015657	805	10.48765
901	0.796571	804	1.542629	803	3.722514	902	7.0448	901	10.48549
1002	0.8058	902	1.552343	906	3.74	1006	7.064714	1002	10.49305
1205	0.808714	1104	1.572257	1103	3.764771	1202	7.092886	1202	10.56698
1405	0.818429	1305	1.593143	1304	3.7808	1401	7.105029	1402	10.60314
1605	0.825229	1501	1.598	1502	3.7944	1602	7.126886	1604	10.62257
1801	0.826686	1703	1.596057	1702	3.805086	1802	7.139514	1802	10.62311
2001	0.8364	1899	1.607229	1903	3.822571	2003	7.157	2001	10.60098
2202	0.838343	2103	1.606743	2104	3.830829	2203	7.179829	2201	10.61825
2405	0.840771	2301	1.6082	2304	3.846371	2401	7.185171	2400	10.64794
2603	0.844171	2504	1.6184	2505	3.851714	2604	7.193914	2605	10.62473
2801	0.8466	2703	1.617429	2701	3.863857	2805	7.206543	2804	10.68517
3004	0.847086	2906	1.632	2902	3.870657	3002	7.212371	3004	10.67222
3202	0.849029	3104	1.636857	3103	3.878914	3203	7.2352	3203	10.70568
3405	0.851457	3302	1.631514	3304	3.889114	3403	7.245886	3403	10.71594
3603	0.853886	3501	1.648029	3506	3.8896	3604	7.233743	3602	10.72781
3801	0.860686	3704	1.644143	3701	3.897371	3805	7.251714	3800	10.74778
4004	0.859229	3905	1.648514	3903	3.907571	4002	7.243457	4000	10.73159
4203	0.865543	4103	1.650457	4105	3.911943	4204	7.257543	4204	10.71648
4406	0.867971	4303	1.6592	4301	3.918743	4405	7.259	4403	10.71432
4604	0.870886	4503	1.660657	4503	3.9236	4602	7.269686	4604	10.6733
4803	0.869914	4704	1.658714	4705	3.931857	4804	7.264829	4800	10.72403
5002	0.8738	4903	1.663086	5005	3.940114	5006	7.274543	5900	10.77692
6061	0.880114	5884	1.675714	6017	3.961971	6024	7.316314	6215	10.75749
6166	0.879143	6094	1.677171	6123	3.964886	6129	7.305143	7054	10.77314
7025	0.882057	6933	1.686886	6964	3.977514	6970	7.305629	8102	10.74346
8074	0.888371	7982	1.702429	8017	3.993543	8027	7.362457	8207	10.73806
9017	0.895171	8926	1.709714	8963	4.004714	8970	7.385771	9045	10.72241
10065	0.908286	9975	1.716514	10017	4.016857	10018	7.409086	10093	10.69705

TABLE A-9 DATA FOR FIGURE A-9

28kPa		41kPa		62kPa		83kPa	
N	%	N	%	N	%	N	%
1	0.920914	1	1.258479	1	3.663743	1	5.254949
6	1.033114	6	1.554279	6	4.5628	6	5.938349
11	1.095771	11	1.736422	11	4.873171	11	6.518778
55	1.442086	51	2.298879	49	5.891714	49	7.813206
103	1.5878	104	2.533479	98	6.217629	98	8.123578
150	1.674257	159	2.626737	148	6.342943	148	8.246463
204	1.735943	218	2.719994	203	6.440086	203	8.300863
252	1.761686	273	2.741851	303	6.515371	297	8.350406
349	1.792771	357	2.797708	362	6.578514	354	8.409663
399	1.809286	412	2.813737	415	6.579486	403	8.451435
444	1.821429	469	2.856965	475	6.607171	457	8.482521
592	1.848143	504	2.872022	507	6.614943	504	8.496121
696	1.860286	604	2.887079	602	6.652343	602	8.549063
795	1.868057	705	2.923994	703	6.652343	705	8.542263
794	1.873886	803	2.934679	803	6.686829	808	8.591806
896	1.880686	902	2.915251	902	6.688771	903	8.589378
994	1.887971	1002	2.936622	1004	6.703343	1001	8.604435
1191	1.903029	1203	2.960422	1204	6.751914	1203	8.604435
1391	1.9142	1405	2.988108	1404	6.743657	1404	8.644263
1594	1.923429	1601	3.006565	1604	6.762114	1600	8.645721
1796	1.934114	1803	3.014337	1804	6.786886	1804	8.650092
1993	1.937514	2004	3.025994	2004	6.764057	2004	8.655921
2194	1.945771	2201	3.046879	2204	6.773771	2202	8.662721
2394	1.952571	2403	3.048337	2404	6.792229	2406	8.677292
2591	1.955971	2604	3.064851	2604	6.814086	2605	8.691863
2798	1.961314	2801	3.060479	2805	6.8	2803	8.711292
2995	1.964714	3002	3.070194	3005	6.818457	3003	8.651063
3195	1.969571	3204	3.079908	3201	6.822829	3201	8.681178
3394	1.974429	3405	3.090594	3401	6.859257	3406	8.684578
3592	1.977343	3601	3.099822	3602	6.851	3601	8.715663
3795	1.986086	3802	3.098365	3803	6.857314	3805	8.675349
3993	1.987057	4003	3.094965	4004	6.8748	4005	8.715178
4094	1.988029	4106	3.102737	4103	6.884514	4105	8.705949
4196	1.990943	4205	3.116822	4206	6.886457	4204	8.687006
4393	1.9958	4406	3.105165	4403	6.909286	4405	8.723921
4592	1.9992	4603	3.104679	4605	6.882571	4604	8.728778
4794	2.002114	4800	3.111965	4805	6.9054	4804	8.740435
4992	2.006	5000	3.120708	5004	6.892286	5001	8.729749
5959	2.021057	5991	3.120708	6056	6.9428	5971	8.734606
7007	2.037086	7039	3.132365	7105	6.957371	7028	8.752578
8056	2.052143	8088	3.174137	8154	6.979714	8084	8.792892
8999	2.059914	9032	3.180451	9097	6.991857	9029	8.791435
10050	2.066229	10080	3.174622	10151	7.025857	10078	8.796292

TABLE A-10 DATA FOR FIGURE A-10

28kPa		41kPa		62kPa	
N	%	N	%	N	%
1	1.239057	1	3.798286	1	8.537363
6	1.562057	6	4.823629	6	9.463621
11	1.758286	11	5.243771	11	10.08971
49	2.480057	50	6.358	49	11.55122
97	2.845314	100	6.741714	103	12.12728
151	2.976943	150	6.889371	152	12.28028
201	3.0124	200	7.012257	204	12.43425
250	3.037657	248	7.081229	255	12.51682
299	3.065343	302	7.132714	309	12.57268
351	3.123143	360	7.160886	359	12.63631
403	3.139171	400	7.1842	402	12.64505
451	3.154714	453	7.2114	455	12.70528
503	3.166857	514	7.246857	502	12.73005
601	3.186286	613	7.274543	602	12.75288
705	3.215914	714	7.284743	705	12.79076
805	3.2504	813	7.31	804	12.82428
904	3.260114	912	7.326514	904	12.86119
1005	3.281486	1013	7.361971	1003	12.87819
1205	3.300429	1215	7.359057	1202	12.93065
1406	3.354829	1411	7.389171	1404	12.93842
1603	3.372314	1612	7.407629	1603	12.98651
1803	3.372314	1814	7.4392	1803	13.01662
2006	3.3796	2015	7.407143	2002	13.04771
2301	3.3932	2212	7.423657	2201	13.05208
2401	3.399029	2413	7.446	2401	13.08802
2600	3.403886	2614	7.461543	2605	13.12833
2800	3.419914	2811	7.471743	2805	13.13465
3003	3.419914	3012	7.412	3005	13.13999
3203	3.422829	3214	7.417829	3201	13.16913
3405	3.428657	3411	7.429971	3401	13.15068
3504	3.431086	3514	7.423171	3504	13.16573
3804	3.422829	3814	7.438714	3801	13.21236
4006	3.425257	4015	7.454257	4001	13.21673
4202	3.426229	4212	7.479029	4202	13.24831
4401	3.425743	4414	7.487286	4402	13.23859
4598	3.428657	4616	7.455714	4603	13.22839
4800	3.433514	4813	7.461057	4803	13.27793
5002	3.436429	5015	7.491657	5004	13.29736
6007	3.443229	6044	7.510114	6073	13.30562
6981	3.457314	7103	7.479514	7121	13.34156
7925	3.466057	8057	7.495543	8064	13.34253
8974	3.481114	9000	7.511571	9007	13.32116
10128	3.493743	10152	7.516914	10159	13.38625

TABLE A-11 DATA FOR FIGURE A-11

Density 98.05%	
N	%
1	0.794413
6	1.144667
11	1.269333
51	1.667079
107	1.845175
152	1.907778
204	1.969841
253	2.015175
303	2.045397
353	2.055651
410	2.076698
451	2.084254
504	2.119873
606	2.123651
704	2.148476
805	2.169524
906	2.182476
1003	2.194889
1204	2.213778
1405	2.248857
1606	2.241302
1803	2.26181
2004	2.272603
2205	2.287714
2402	2.276921
2603	2.286635
2803	2.287175
3001	2.297429
3201	2.308222
3402	2.312
3603	2.29527
3804	2.307683
4006	2.310381
4202	2.322794
4403	2.339524
4605	2.336825
4801	2.351937
5003	2.354635
6009	2.349778
7059	2.365429
8005	2.377302
9056	2.391333
9999	2.410222

Density 95.46%	
N	%
1	1.249905
6	1.390222
11	1.500317
49	1.783111
102	1.894825
155	1.95581
202	1.990133
250	2.025105
303	2.063962
351	2.098933
408	2.134488
449	2.136625
502	2.139053
604	2.153843
703	2.168633
803	2.183423
906	2.198213
998	2.213003
1204	2.234083
1405	2.246663
1606	2.259243
1802	2.271823
2003	2.283189
2205	2.29334
2406	2.303492
2603	2.311215
2804	2.318938
3006	2.32666
3203	2.334383
3405	2.342106

Density 93.54%	
N	%
1	1.277429
6	1.41073
11	1.496
49	1.763143
101	1.90346
149	1.970381
201	2.027587
244	2.048635
301	2.084794
346	2.101524
400	2.145238
450	2.161429
503	2.181397
606	2.203524
705	2.212698
804	2.224571
904	2.245079
1003	2.255333
1202	2.27746
1406	2.285556
1603	2.299048
1806	2.304444
2003	2.331429
2205	2.337905
2402	2.344381
2604	2.350857
2801	2.357333
3003	2.36381
3205	2.370286
3402	2.376762
3605	2.383238
3802	2.389714
4001	2.39619
4205	2.402667
4403	2.409143
4602	2.41454
4801	2.416159
4973	2.421556
6020	2.443143
7068	2.44908
8011	2.451778
9059	2.456095
10002	2.460413

TABLE A-12 DATA FOR FIGURE A-12

No FT		One FT	
N	%	N	%
1	0.435686	1	0.958317
6	0.492029	6	1.049632
11	0.522143	11	1.107432
53	0.644057	46	1.262375
101	0.685343	99	1.352717
154	0.713029	152	1.384775
198	0.732943	201	1.412946
250	0.740714	255	1.437717
298	0.750429	308	1.44986
351	0.759657	351	1.463946
398	0.769371	401	1.476575
447	0.770343	451	1.484346
505	0.7718	502	1.491632
602	0.7854	600	1.503775
702	0.790257	703	1.524175
802	0.790743	803	1.519803
901	0.796571	907	1.51446
1002	0.8058	1003	1.526603
1205	0.808714	1202	1.529517
1405	0.818429	1402	1.560117
1605	0.825229	1602	1.553317
1801	0.826686	1801	1.561089
2001	0.8364	2001	1.574203
2202	0.838343	2201	1.569832
2405	0.840771	2405	1.58246
2603	0.844171	2605	1.584403
2801	0.8466	2805	1.584889
3004	0.847086	3005	1.601889
3202	0.849029	3205	1.58926
3405	0.851457	3405	1.597517
3603	0.853886	3600	1.603346
3801	0.860686	3801	1.606746
4004	0.859229	4001	1.606746
4203	0.865543	4201	1.60286
4406	0.867971	4402	1.624717
4604	0.870886	4605	1.628603
4803	0.869914	4801	1.62666
5002	0.8738	5001	1.629089
5956	0.879143	5957	1.639775
7025	0.882057	7007	1.662117
8074	0.888371	8057	1.671832
9017	0.895171	9002	1.673289
10065	0.908286	10050	1.667946

TABLE A-13 DATA FOR FIGURE A-13

jump to 83 kPa	
N	%
10799	0.909257
10800	4.504622
10897	7.045448
10999	7.329321
11102	7.438876
11204	7.484749
11301	7.507416
11404	7.565702
11501	7.601321
11604	7.622908
11709	7.631543
11803	7.646654
11904	7.655289
11998	7.675257
12003	7.674717
12011	7.674178
12016	7.681194
12021	7.686051
12027	7.689829
12032	7.68659
12038	7.6704
12047	7.660146
12052	7.6704
12058	7.663924
12064	7.666083
12070	7.661765
12077	7.674178
12084	7.676876
12091	7.68659
12098	7.699543
12123	7.695765
12128	7.697924

28 kPa	
N	%
1	0.435686
6	0.492029
11	0.522143
53	0.644057
101	0.685343
149	0.714486
198	0.732943
244	0.741686
294	0.748971
345	0.755771
392	0.770343
447	0.770343
505	0.7718
602	0.7854
702	0.790257
802	0.790743
901	0.796571
1002	0.8058
1205	0.808714
1405	0.818429
1605	0.825229
1801	0.826686
2001	0.8364
2202	0.838343
2405	0.840771
2603	0.844171
2801	0.8466
3004	0.847086
3202	0.849029
3405	0.851457
3603	0.853886
3801	0.860686
4004	0.859229
4203	0.865543
4406	0.867971
4505	0.865543
4604	0.870886
4803	0.869914
5002	0.8738
6061	0.880114
7025	0.882057
8074	0.888371
9017	0.895171
10065	0.908286

83 kPa	
N	%
1	4.573
6	5.010629
11	5.267571
44	6.1268
102	6.500314
153	6.662543
203	6.739771
250	6.788829
301	6.829629
353	6.888886
400	6.928229
452	6.932114
501	6.9394
601	6.960771
701	6.986514
805	7.015657
902	7.0448
1006	7.064714
1202	7.092886
1401	7.105029
1602	7.126886
1802	7.139514
2003	7.157
2203	7.179829
2401	7.185171
2604	7.193914
2805	7.206543
3002	7.212371
3203	7.2352
3403	7.245886
3604	7.233743
3805	7.251714
4002	7.243457
4204	7.257543
4405	7.259
4504	7.230829
4602	7.269686
4804	7.264829
5006	7.274543
6024	7.316314
6970	7.305629
8027	7.362457
8970	7.385771
10018	7.409086

TABLE A-14 DATA FOR FIGURE A-14

jump to 62 kPa		41 kPa		62 kPa	
N	%	N	%	N	%
1	0.229365	1	2.299587	1	5.479937
11	0.359968	10	3.954254	3	7.253333
51	0.512698	49	4.96346	6	7.604127
100	0.583397	96	5.176635	8	7.70181
148	0.616857	144	5.254889	11	7.781143
199	0.635746	194	5.308317	53	8.645175
249	0.647079	251	5.352032	99	9.018095
299	0.661651	300	5.364984	145	9.185937
400	0.682698	400	5.42381	194	9.320857
499	0.695651	500	5.455651	250	9.407206
599	0.705365	600	5.479397	302	9.443365
700	0.710222	699	5.506921	399	9.504889
798	0.719397	799	5.50854	500	9.552381
899	0.718857	899	5.531746	600	9.588
998	0.726952	999	5.546857	701	9.633333
1099	0.73127	1100	5.534444	801	9.641968
1200	0.728032	2000	5.613778	899	9.664095
1299	0.732889	3057	5.648317	1000	9.657619
1400	0.740984	3965	5.69473	1101	9.684603
1499	0.753937	4267	5.712	1201	9.715905
1601	0.750698	4569	5.736286	1300	9.68946
1700	0.754476	4872	5.714159	1400	9.719683
1801	0.758254	5174	5.740603	1501	9.763937
1898	0.76527	6988	5.78054	1600	9.763397
1998	0.766889	8802	5.693111	1701	9.755841
3100	0.786317	10314	5.709841	1799	9.766095
4007	0.792794	12733	5.802127	1900	9.763937
5217	0.810063	15152	5.805365	2002	9.756921
6124	0.821397	20292	5.870127	2300	9.770413
8241	0.839746	25130	5.818317	2566	9.759079
10358	1.253683	30874	5.764349	2868	9.82546
10380	2.404286	31177	5.741683	3171	9.778508
10415	2.956921	31479	5.791873	3474	9.799556
10502	3.404318	31781	5.761111	3776	9.827619
20990	4.143683	32084	5.755175	4079	9.848127
21001	4.710349	32386	5.753556	4381	9.820603
21004	4.874413	32688	5.749238	4684	9.854603
21006	5.200381	32991	5.748698	4986	9.835175
21008	5.431905	33293	5.754095	5288	9.871333
21012	5.902508	33596	5.748698	6195	9.872413
21016	6.34073	33898	5.795111	6498	9.885905
21019	6.655365			6800	9.89346
21038	7.841587			7102	9.897238
21061	8.526444			7405	9.941492
21122	9.071524			7707	9.959302
21188	9.340286			8009	9.973333
23467	10.00302			8312	9.990063
25886	10.1687				

TABLE A-15 DATA FOR FIGURE A-15

41 kPa		83 kPa		124 kPa		165 kPa		207 kPa	
N	%	N	%	N	%	N	%	N	%
1	0.143683	1	0.845045	1	1.299552	1	2.557009	1	2.86842
6	0.214381	6	0.95266	6	1.367012	6	2.697326	6	3.522515
11	0.242444	12	1.004666	11	1.437171	11	2.807422	11	3.742705
49	0.33581	55	1.110736	49	1.639012	52	3.18358	49	4.412451
101	0.376286	110	1.217441	101	1.715108	105	3.323898	98	4.641277
149	0.393016	156	1.284387	151	1.76152	156	3.361675	146	4.75515
195	0.40273	206	1.337669	201	1.809012	205	3.426437	191	4.821531
250	0.416222	262	1.364114	260	1.850028	260	3.458818	242	4.87442
304	0.425937	314	1.38553	311	1.865139	315	3.501993	297	4.922451
351	0.433492	361	1.391466	361	1.875933	366	3.521422	340	4.965086
404	0.443746	413	1.402799	418	1.890504	425	3.536533	390	4.992071
449	0.448063	454	1.406577	454	1.889425	452	3.55812	451	5.040642
524	0.457238	500	1.416291	500	1.916949	503	3.655802	498	5.053594
617	0.465873	602	1.413593	603	1.930981	605	3.675771	602	5.102166
717	0.474508	705	1.438418	705	1.939076	705	3.668215	705	5.122134
817	0.478825	803	1.451371	803	1.94879	803	3.67685	803	5.170166
919	0.490698	901	1.468101	906	1.975774	905	3.69466	906	5.198229
1016	0.494476	1004	1.458387	1003	1.984949	1002	3.698437	1003	5.217658
1216	0.50527	1203	1.48412	1204	1.975774	1201	3.711929	1203	5.279721
1419	0.510667	1401	1.480882	1405	2.004917	1405	3.717866	1405	5.286198
1616	0.515524	1604	1.505168	1605	2.006536	1605	3.723802	1601	5.320737
1816	0.517683	1801	1.509485	1801	2.020568	1802	3.737295	1801	5.346642
2016	0.52254	2000	1.514342	2002	2.026504	2003	3.769675	2006	5.360134
2217	0.529556	2203	1.533771	2203	2.035679	2205	3.759961	2201	5.379023
2416	0.532794	2401	1.557517	2404	2.039996	2402	3.772374	2406	5.395753
2616	0.541429	2603	1.554818	2605	2.037838	2603	3.803675	2606	5.428674
2817	0.542508	2801	1.564901	2801	2.038377	2805	3.77939	2801	5.436229
3018	0.546286	3001	1.582171	3003	2.059425	3002	3.818787	3001	5.438928
3218	0.549524	3200	1.58325	3204	2.028663	3204	3.809612	3201	5.443785
3418	0.553841	3401	1.590266	3406	2.049711	3406	3.811231	3402	5.486959
3618	0.556	3601	1.595123	3602	2.046473	3603	3.825802	3602	5.474547
3819	0.560317	3802	1.59944	3804	2.037298	3805	3.838215	3802	5.481563
4019	0.563016	4002	1.582171	4001	2.040536	4002	3.84739	4003	5.515563
4215	0.564635	4204	1.602679	4205	2.05079	4204	3.852787	4204	5.520959
4415	0.570032	4404	1.609155	4402	2.060504	4401	3.859802	4404	5.554959
4616	0.57219	4600	1.618329	4604	2.045393	4603	3.874914	4605	5.556039
4817	0.575968	4804	1.615631	4802	2.073457	4806	3.885707	4806	5.563055
5018	0.578127	5003	1.618869	5004	2.070758	4964	3.894342	5002	5.567912
5973	0.592159	6051	1.628044	6007	2.086949	6013	3.891644	5982	5.590578
7023	0.598635	7099	1.640456	7059	2.11879	7062	3.952628	7032	5.668293
7969	0.609429	8043	1.661504	8006	2.129584	8007	3.951009	7978	5.703912
9019	0.616444	9091	1.650171	9058	2.164123	9057	3.980152	9028	5.760039
9859	0.622381	9929	1.66798	9900	2.161965	9896	3.994183	9868	5.736293
9964	0.622921	10034	1.665821	10005	2.158727			9973	5.70715
10069	0.624	10139	1.635599	10110	2.175996			10079	5.726578

TABLE A-16 DATA FOR FIGURE A-16

41 kPa		83 kPa		124 kPa		165 kPa	
N	%	N	%	N	%	N	%
1	0.59591	1	0.820854	1	1.844016	1	2.658473
6	0.65125	6	0.959092	6	2.108642	6	3.017901
11	0.682281	11	1.023371	11	2.29262	11	3.351965
52	0.75624	49	1.209602	49	2.758841	49	4.071362
107	0.774859	100	1.286056	99	3.018641	102	4.393695
151	0.800202	146	1.316912	145	3.116617	156	4.48878
202	0.822959	201	1.388567	205	3.188233	215	4.60944
248	0.818821	249	1.362471	256	3.203472	268	4.635765
299	0.83382	303	1.383808	290	3.242479	304	4.667406
350	0.841578	356	1.404687	356	3.261429	348	4.707092
391	0.85968	398	1.411084	404	3.320568	395	4.740879
447	0.867437	456	1.462093	456	3.356391	454	4.780029
503	0.867955	504	1.470839	504	3.405545	505	4.798263
601	0.874678	602	1.455506	602	3.411455	604	4.797786
703	0.880885	701	1.503151	704	3.416457	703	4.791435
805	0.876747	801	1.489026	802	3.421747	803	4.849125
902	0.893297	903	1.509986	904	3.427036	904	4.867649
1004	0.898469	1004	1.500355	1001	3.432326	1004	4.882998
1204	0.895883	1204	1.520841	1201	3.442905	1205	4.914224
1405	0.896918	1405	1.533892	1401	3.453484	1401	4.961858
1604	0.922777	1605	1.54056	1601	3.510215	1601	4.98197
1804	0.925881	1801	1.583415	1806	3.530636	1804	5.014785
2004	0.924329	2002	1.572853	2004	3.55799	2003	5.01849
2204	0.927432	2203	1.558607	2201	3.580419	2202	5.021136
2404	0.93519	2404	1.598998	2403	3.584935	2406	5.048129
2604	0.941396	2605	1.633159	2605	3.589451	2604	5.03278
2804	0.948637	2801	1.625335	2802	3.593967	2804	5.045482
3004	0.956912	3002	1.615089	3004	3.604106	3003	5.067711
3204	0.957947	3204	1.600752	3202	3.609938	3203	5.107406
3403	0.962084	3405	1.63291	3404	3.61421	3402	5.086964
3601	0.971911	3602	1.60756	3601	3.622902	3601	5.10591
3804	0.975014	3804	1.619201	3804	3.643697	3806	5.119066
4003	0.996122	4005	1.640229	4002	3.664493	4005	5.065792
4202	1.015259	4202	1.636239	4205	3.668024	4205	5.099657
4405	1.011638	4404	1.649499	4402	3.676853	4405	5.09601
4803	1.017327	4804	1.662293	4803	3.683465	4804	5.123103
4997	1.022499	5001	1.642896	5006	3.688418	5004	5.133523
6151	1.048359	5993	1.658036	6024	3.697919	6035	5.111745
6990	1.066461	7045	1.662212	7074	3.705915	7086	5.148083
8038	1.089735	7993	1.669209	8018	3.730245	8033	5.201033
9087	1.115595	9045	1.664753	9069	3.761704	9084	5.236333
10030	1.138868	9992	1.727296	10014	3.778371	10030	5.214428

TABLE A-17 DATA FOR FIGURE A-17

41 kPa		83 kPa		124 kPa	
N	%	N	%	N	%
1	0.531507	1	2.72	1	6.34558
6	0.600046	6	3.306635	6	6.845326
11	0.636745	11	3.628825	11	7.157802
51	0.755475	49	4.893841	50	8.145422
101	0.816999	91	5.306159	93	8.459517
155	0.859094	148	5.588952	150	8.731517
207	0.879602	202	5.71146	195	8.822183
251	0.896332	248	5.770286	252	8.939834
300	0.908205	294	5.823714	301	8.947929
354	0.921697	347	5.871206	356	9.062882
404	0.93303	397	5.892794	409	9.128183
458	0.941665	445	5.918698	459	9.169199
500	0.9503	486	5.948921	504	9.176215
603	0.96757	603	6.025556	604	9.199961
703	0.976745	705	6.058476	702	9.229104
801	0.985919	803	6.078984	800	9.256088
904	0.995634	901	6.10219	903	9.264723
1002	1.003189	1004	6.124857	1001	9.281993
1204	1.01884	1204	6.172349	1200	9.314374
1405	1.032332	1404	6.20581	1404	9.356469
1601	1.041507	1605	6.228476	1604	9.350533
1802	1.053919	1805	6.23873	1800	9.398025
2004	1.062015	2001	6.251683	2000	9.433644
2200	1.067411	2202	6.286222	2200	9.442279
2402	1.075507	2402	6.304571	2401	9.476818
2604	1.079824	2603	6.319683	2601	9.451993
2801	1.0863	2804	6.332635	2802	9.437422
3003	1.089538	3005	6.343968	3003	9.45631
3201	1.096554	3202	6.346667	3203	9.47412
3403	1.098713	3403	6.367714	3405	9.466025
3601	1.107348	3604	6.37527	3601	9.509739
3803	1.110046	3801	6.39146	3801	9.513517
4001	1.113824	4003	6.396317	4000	9.555612
4203	1.116523	4205	6.405492	4200	9.586914
4401	1.118681	4402	6.417365	4402	9.550215
4604	1.125697	4604	6.42546	4601	9.574501
4802	1.128396	4801	6.434635	4801	9.602564
5005	1.133253	5003	6.440032	4971	9.607422
5924	1.146205	6000	6.497238	6033	9.620914
6976	1.162396	7052	6.503714	7080	9.579898
7923	1.169951	7999	6.518825	8023	9.62631
8975	1.181824	9051	6.542032	9071	9.677041
9922	1.190999	10000	6.554444	10015	9.731009
10027	1.189919	10105	6.560381	10224	9.736406

TABLE A-18 DATA FOR FIGURE A-18

Density N	97.84% %	Density N	93.51% %	Density N	91.84% %
1	1.106892	1	1.042123	1	1.132801
6	1.203496	6	1.14952	6	1.360547
11	1.245051	11	1.194314	11	1.455531
49	1.440416	55	1.43879	47	1.708102
104	1.558607	105	1.551044	102	1.801467
149	1.617972	154	1.616885	151	1.875404
198	1.644416	201	1.65952	199	1.885118
254	1.694067	254	1.696219	252	1.907245
304	1.717273	307	1.726441	302	1.927753
353	1.741019	360	1.745869	357	1.939626
402	1.763686	406	1.763139	406	1.94934
452	1.77448	458	1.782568	452	1.94988
501	1.789051	505	1.799838	504	1.959594
605	1.800924	604	1.829759	601	1.98442
702	1.823051	702	1.857542	704	2.008705
807	1.829527	804	1.883189	801	1.988198
903	1.838162	900	1.906698	904	2.029213
1001	1.865146	1005	1.930207	1002	2.038928
1202	1.887813	1205	1.975088	1202	2.061594
1406	1.90994	1406	2.005543	1405	2.070769
1603	1.918035	1606	2.016792	1601	2.083182
1802	1.937464	1803	2.023806	1803	2.090737
2000	1.948257	2002	2.033521	2003	2.104229
2204	1.935305	2207	2.039395	2202	2.109086
2402	1.974702	2405	2.04527	2401	2.140388
2601	1.968226	2605	2.053994	2600	2.142007
2804	1.982797	2801	2.059287	2803	2.154959
3003	2.003845	3005	2.067493	3002	2.158198
3201	1.988194	3205	2.073316	3201	2.165213
3405	2.004384	3402	2.079139	3400	2.172229
3603	2.004384	3601	2.084962	3604	2.17115
3802	2.002226	3803	2.090786	3803	2.180325
4001	2.009781	4003	2.096609	4003	2.140928
4201	2.02921	4202	2.102432	4202	2.157118
4401	2.030829	4402	2.108255	4402	2.166293
4605	2.032988	4602	2.112225	4602	2.178705
4804	2.034607	4801	2.114343	4801	2.177626
5004	2.052416	5001	2.11646	5001	2.163594
6058	2.050797	6069	2.135518	6041	2.197055
7003	2.072384	7013	2.142929	6986	2.218642
8053	2.087496	8062	2.172575	8036	2.219721
9103	2.09721	9110	2.182103	9086	2.215404
10048	2.084797	10054	2.197455	10031	2.245086
10993	2.093972	10159	2.194809	15072	2.256959
12043	2.110702	10264	2.200632	20007	2.268293

TABLE A-19 DATA FOR FIGURE A-19

One FT		No FT	
N	%	N	%
1	1.217531	1	0.845045
6	1.277436	6	0.95266
11	1.347594	12	1.004666
49	1.649817	55	1.110736
101	1.827912	105	1.201422
148	1.905086	151	1.281689
195	1.939086	199	1.320203
248	1.973086	249	1.362495
301	2.010864	304	1.38445
347	2.044864	351	1.395783
352	2.048642	356	1.396323
398	2.082642	403	1.397942
450	2.113575	454	1.406577
503	2.141575	500	1.416291
615	2.155575	602	1.413593
703	2.169575	705	1.438418
806	2.183575	803	1.451371
905	2.197575	901	1.468101
1004	2.208775	1004	1.458387
1202	2.231175	1203	1.48412
1401	2.242375	1401	1.480882
1604	2.253575	1604	1.505168
1803	2.261975	1801	1.509485
2001	2.267575	2000	1.514342
2203	2.273175	2203	1.533771
2401	2.285293	2401	1.557517
2599	2.298515	2603	1.554818
2798	2.309309	2801	1.564901
2996	2.312007	3001	1.582171
3194	2.316864	3200	1.58325
3393	2.32442	3401	1.590266
3591	2.331975	3601	1.595123
3988	2.343353	4002	1.582171
4186	2.346753	4204	1.602679
4384	2.349153	4404	1.609155
4582	2.351553	4600	1.618329
4781	2.351953	4804	1.615631
4979	2.352353	5003	1.618869
5078	2.352553	5107	1.613472
5971	2.354353	6051	1.628044
6962	2.368277	7099	1.640456
8053	2.373531	8043	1.661504
9044	2.380547	9091	1.650171
9937	2.385404	10034	1.665821

TABLE A-20 DATA FOR FIGURE A-20

jump to 83 kPa		28 kPa		83 kPa	
N	%	N	%	N	%
10465	0.402603	1	0.142476	1	0.820854
10466	0.593104	6	0.165683	6	0.959092
10471	0.674056	11	0.180254	11	1.023371
10512	0.900723	51	0.22073	49	1.209602
10560	0.978977	101	0.250413	100	1.286056
10609	1.02485	147	0.261746	151	1.313077
10661	1.062088	193	0.261206	201	1.388567
10716	1.080977	247	0.273079	254	1.373019
10761	1.112279	293	0.276317	303	1.383808
10809	1.113898	340	0.269302	351	1.436948
10865	1.14466	397	0.279556	408	1.430652
10912	1.153295	443	0.282794	456	1.462093
10957	1.171104	501	0.290349	504	1.470839
10962	1.168945	600	0.290349	602	1.455506
10967	1.167326	704	0.297365	701	1.503151
10973	1.172723	804	0.290889	801	1.489026
10978	1.173802	900	0.299524	903	1.509986
10983	1.172723	1004	0.294667	1004	1.500355
10993	1.175961	1202	0.302762	1204	1.520841
11004	1.187295	1401	0.309238	1405	1.533892
11014	1.182437	1603	0.319492	1605	1.54056
11024	1.183517	1902	0.327048	1904	1.56347
11034	1.182437	2100	0.325429	2105	1.562215
11045	1.184056	2403	0.32381	2301	1.586928
11055	1.189453	2804	0.32273	2502	1.591328
11065	1.185675	3001	0.329746	2904	1.626137
11076	1.188374	3203	0.33946	3106	1.628716
11086	1.187834	3404	0.335143	3302	1.611983
11096	1.188914	3601	0.330286	3503	1.609123
11106	1.191612	3803	0.330825	3705	1.620264
11320	1.21158	4000	0.341079	3902	1.619381
11392	1.215898	4200	0.334603	4301	1.621666
11474	1.254215	4400	0.343238	4503	1.63769
11555	1.260691	4503	0.347556	4705	1.63648
11559	1.261231	4903	0.345397	4902	1.641032
11564	1.260691	5013	0.349175	5001	1.642896
11569	1.257993	5747	0.35619	6098	1.655277
11576	1.260152	6376	0.35619	7571	1.654361
11581	1.259072	7214	0.369143	8729	1.659899
11586	1.252056	7949	0.385873	9571	1.679465
		9101	0.399365	10413	1.679121
		9206	0.39181	10518	1.690279

TABLE A-21 DATA FOR FIGURE A-21

28 kPa		jump to 83 kPa		83 kPa	
N	%	N	%	N	%
1	0.154896	10364	0.593118	1	2.72
6	0.195912	10365	1.769093	6	3.306635
11	0.226674	10369	2.007093	11	3.628825
50	0.308705	10413	3.040586	49	4.893841
101	0.340547	10466	3.554903	106	5.412476
150	0.355118	10518	3.74649	161	5.615937
192	0.372388	10560	3.825824	207	5.724413
252	0.383182	10601	3.891125	253	5.781079
257	0.38588	10606	3.887347	258	5.787556
302	0.383721	10652	3.942935	304	5.83019
347	0.396134	10697	3.966141	352	5.878762
397	0.404229	10749	4.012014	402	5.89819
452	0.409086	10820	4.055728	459	5.921397
496	0.417721	10938	4.105919	505	5.969968
628	0.429055	10944	4.112935	603	6.025556
728	0.432293	10949	4.116713	705	6.058476
827	0.436071	10959	4.110236	803	6.078984
927	0.446864	10964	4.115093	901	6.10219
1027	0.451182	10969	4.122649	1004	6.124857
1226	0.461436	10980	4.135601	1204	6.172349
1423	0.468991	10990	4.140998	1404	6.20581
1628	0.475467	11000	4.152871	1605	6.228476
1824	0.477086	11010	4.156649	1805	6.23873
2024	0.484102	11072	4.174998	2001	6.251683
2224	0.48842	11082	4.182554	2202	6.286222
2426	0.491118	11093	4.185792	2402	6.304571
2626	0.496515	11209	4.196046	2603	6.319683
2824	0.500293	11219	4.191189	2804	6.332635
3025	0.512166	11230	4.204681	3005	6.343968
3225	0.504071	11240	4.219252	3202	6.346667
3426	0.507309	11250	4.22303	3403	6.367714
3626	0.516483	11260	4.219252	3604	6.37527
3827	0.517023	11271	4.221411	3801	6.39146
4027	0.522959	11281	4.20522	4003	6.396317
4228	0.516483	11291	4.214935	4205	6.405492
4428	0.529436	11301	4.217093	4402	6.417365
4624	0.534293	11312	4.214395	4604	6.42546
4825	0.534832	11322	4.212776	4801	6.434635
5018	0.540769	11332	4.22249	5003	6.440032
6067	0.557499	11384	4.22357	6000	6.497238
7010	0.553182	11465	4.232205	6947	6.486444
8058	0.566134			7999	6.518825
9001	0.57315			8946	6.54581
10154	0.591499			10000	6.554444
10259	0.592578			10105	6.560381
10364	0.593118				

TABLE A-22 DATA FOR FIGURE A-22

41 kPa		83 kPa		124 kPa		165 kPa		207 kPa	
N	%	N	%	N	%	N	%	N	%
1	0.593111	1	2.422099	1	5.21981	1	5.999651	1	6.814039
6	0.681079	6	2.57375	6	5.483714	6	6.571714	6	7.084959
11	0.723714	11	2.632035	11	5.60946	11	6.811333	11	7.307309
49	0.828413	51	2.829019	50	5.923556	56	7.408222	52	7.982991
94	0.860794	101	2.902416	105	6.037429	107	7.602508	106	8.22261
151	0.881841	160	2.951527	160	6.090857	165	7.711524	162	8.333245
200	0.892635	210	2.974194	212	6.135111	218	7.76981	218	8.396928
250	0.906127	246	2.986607	246	6.151302	251	7.798952	255	8.436864
298	0.912063	298	2.999019	297	6.163714	303	7.825937	306	8.483817
350	0.916921	352	3.006035	348	6.174508	357	7.854	355	8.489213
400	0.921238	406	3.024924	401	6.190698	409	7.868571	408	8.526451
443	0.922857	453	3.0314	448	6.202571	457	7.898794	454	8.553436
506	0.928254	503	3.041115	505	6.217143	506	7.920921	502	8.56261
606	0.931492	603	3.043273	601	6.219841	603	7.932254	603	8.587975
708	0.936349	703	3.064861	706	6.237111	704	7.942508	706	8.612801
802	0.939048	802	3.063242	804	6.245206	802	7.954381	803	8.603626
901	0.942825	902	3.056765	901	6.252762	902	7.949524	902	8.633848
1000	0.945524	1006	3.071337	1004	6.263556	1005	7.946286	1004	8.655975
1204	0.949841	1202	3.067559	1205	6.271111	1206	7.977048	1205	8.662451
1403	0.954159	1405	3.074035	1403	6.269492	1402	7.987302	1404	8.707245
1601	0.959556	1604	3.08375	1604	6.286762	1607	8.004032	1604	8.679721
1800	0.962254	1805	3.095083	1805	6.362857	1804	7.988921	1803	8.721277
2003	0.963873	2005	3.106416	2003	6.373111	2005	8.016444	2006	8.721277
2202	0.96819	2205	3.112892	2204	6.371492	2202	8.018603	2206	8.731531
2401	0.96927	2401	3.122607	2401	6.373111	2402	8.029937	2406	8.745023
2600	0.973048	2605	3.112892	2603	6.377429	2605	8.036952	2608	8.74934
2804	0.974127	2802	3.128543	2803	6.384444	2802	8.034794	2806	8.758515
3003	0.975206	3003	3.136638	3001	6.39254	3004	8.045048	3006	8.762832
3202	0.979524	3204	3.137178	3204	6.392	3206	8.032635	3204	8.752578
3401	0.980603	3405	3.142035	3401	6.404413	3405	8.04127	3401	8.78388
3600	0.982762	3601	3.131781	3605	6.399556	3603	8.04019	3604	8.760134
3801	0.982222	3802	3.135019	3803	6.397397	3802	8.048825	3805	8.791436
4004	0.984381	4004	3.13394	4002	6.398476	4003	8.056381	4005	8.798991
4205	0.98654	4205	3.130162	4205	6.406032	4202	8.04127	4201	8.802769
4404	0.986	4402	3.155527	4404	6.417905	4401	8.076349	4402	8.797912
4603	0.989778	4603	3.140416	4602	6.430857	4605	8.056921	4602	8.81842
4802	0.989778	4804	3.142575	4804	6.431397	4804	8.055302	4803	8.821658
5002	0.988698	5001	3.149051	5003	6.431397	5003	8.060159	5004	8.790356
6012	0.997873	6007	3.149591	6020	6.439492	6031	8.087143	5973	8.847023
7063	0.998952	7057	3.147972	7071	6.433016	7080	8.101175	7020	8.884261
8006	1.004889	8001	3.212194	8013	6.465397	8023	8.066635	7963	8.88534
9054	1.009746	9050	3.183591	9061	6.47619	9072	8.055841	9011	8.936071
10207	1.012984	11044	3.198702	10109	6.465397	10121	8.070413	10059	8.923658

TABLE A-23 DATA FOR FIGURE A-23

41 kPa		83 kPa		124 kPa		165 kPa	
N	%	N	%	N	%	N	%
1	0.789012	1	3.087524	1	5.776762	1	7.551778
6	0.859711	6	3.345492	6	6.504794	6	8.122762
11	0.881838	11	3.506857	11	6.603556	11	8.421746
51	0.953616	49	3.878159	49	7.235524	52	9.161651
104	0.9806	102	4.006603	102	7.465968	105	9.40127
152	1.001647	151	4.047619	149	7.537206	151	9.527016
202	1.01352	200	4.077302	195	7.574984	203	9.563714
253	1.019996	251	4.111302	248	7.617619	255	9.592857
300	1.029711	298	4.123714	296	7.65	307	9.652762
351	1.038885	351	4.150159	348	7.686698	364	9.693778
397	1.04806	394	4.154476	389	7.692095	409	9.737492
448	1.052377	450	4.16527	440	7.703968	469	9.74127
504	1.053457	502	4.173905	497	7.737968	502	9.763937
602	1.054536	605	4.194413	608	7.775746	601	9.780127
704	1.062631	703	4.193873	704	7.761714	703	9.789302
801	1.067489	803	4.19927	801	7.793556	804	9.823841
904	1.06425	905	4.203587	905	7.796254	906	9.785524
1002	1.06425	1004	4.202508	1005	7.80327	1002	9.806032
1203	1.072346	1204	4.211683	1205	7.826476	1204	9.819524
1403	1.075584	1402	4.223016	1405	7.844286	1406	9.84219
1601	1.083679	1601	4.225175	1604	7.851302	1607	9.850286
1803	1.076663	1802	4.221937	1804	7.87073	1801	9.87781
2001	1.077743	2002	4.238667	2004	7.860476	2004	9.926381
2204	1.084219	2202	4.235968	2204	7.882063	2206	9.916667
2402	1.083139	2403	4.235429	2405	7.900952	2403	9.953905
2603	1.085838	2603	4.248381	2605	7.924698	2603	9.94581
2804	1.078822	2804	4.254857	2805	7.918762	2804	9.954444
3005	1.08206	3004	4.253238	3001	7.941968	3002	9.960381
3201	1.085298	3205	4.247841	3205	7.948984	3204	9.969016
3405	1.079362	3405	4.28346	3405	7.961397	3405	9.97819
3604	1.08152	3602	4.281841	3605	7.962476	3606	9.972254
3803	1.083139	3804	4.291016	3805	7.97219	3805	9.980889
4004	1.0826	4004	4.28454	4005	7.95546	4004	9.973333
4202	1.086917	4205	4.296413	4205	7.941429	4204	9.964159
4401	1.091235	4404	4.306127	4405	7.941968	4401	9.983048
4605	1.092854	4605	4.302349	4606	7.954921	4604	9.997619
4804	1.093933	4804	4.312063	4806	7.966254	4801	9.987905
5073	1.092314	4975	4.302889	5092	7.968952	5005	10.00787
6121	1.097711	6030	4.316381	6142	7.985683	6014	10.0273
7064	1.102568	6983	4.315302	7085	7.994857	6958	10.03917
8007	1.092314	7933	4.332571	8028	7.97219	7901	10.02622
9055	1.105806	9004	4.322857	9076	7.964635	8950	10.03756
9998	1.114441	9958	4.339048	10022	8.011587	9893	10.03432

TABLE A-24 DATA FOR FIGURE A-24

41 kPa		83 kPa		124 kPa	
N	%	N	%	N	%
1	2.00654	1	5.638603	1	8.815175
6	2.272603	6	6.404952	6	9.609587
11	2.350857	11	6.687746	11	9.935556
51	2.483079	51	7.320254	52	10.72619
99	2.528413	103	7.550159	103	10.91886
151	2.560794	150	7.63273	150	11.02571
204	2.576444	202	7.689397	201	11.09533
252	2.587778	252	7.713143	249	11.14984
302	2.596952	295	7.730413	294	11.12933
353	2.605587	354	7.747683	349	11.18762
400	2.611524	398	7.76981	396	11.21838
452	2.615302	453	7.78546	448	11.23295
502	2.620698	504	7.815683	505	11.23727
601	2.627175	605	7.806508	603	11.26641
703	2.632032	704	7.827016	701	11.28044
801	2.639048	805	7.83727	804	11.29124
902	2.644444	903	7.845905	901	11.31175
1005	2.647143	1006	7.843746	1005	11.2826
1205	2.653079	1204	7.866952	1205	11.33441
1401	2.658476	1406	7.868571	1401	11.3587
1605	2.664413	1603	7.890698	1605	11.37543
1805	2.666571	1804	7.88854	1805	11.3981
2000	2.671429	2006	7.896635	2005	11.41483
2204	2.674667	2203	7.879365	2205	11.3873
2405	2.677365	2405	7.88746	2405	11.40781
2605	2.679524	2602	7.895016	2604	11.43102
2804	2.682222	2804	7.893937	2804	11.41806
3005	2.681683	3001	7.909048	3004	11.44667
3200	2.684381	3204	7.914444	3205	11.4553
3405	2.687079	3401	7.929016	3404	11.49092
3606	2.687079	3604	7.925238	3602	11.458
3805	2.693016	3801	7.931175	3801	11.44721
4004	2.693016	4004	7.937651	4006	11.44559
4203	2.694095	4202	7.936032	4204	11.43803
4403	2.694635	4401	7.936032	4403	11.48067
4602	2.697333	4601	7.936571	4602	11.47635
4801	2.698413	4803	7.940889	4805	11.47851
5081	2.698413	5002	7.950603	5036	11.48984
6026	2.707587	5865	7.954381	5980	11.56216
7074	2.713524	6913	7.97219	7028	11.52276
8018	2.72	7856	7.97273	7972	11.58051
9066	2.724857	8904	7.994317	9020	11.53787
10114	2.729175	9952	7.994317	10069	11.55568
10219	2.728635	10057	8.001873	11012	11.4634

TABLE A-25 DATA FOR FIGURE A-25

Density N	94.06% %	Density N	95.61% %	Density N	93.76% %	Density N	96.31% %
1	3.586194	1	3.087524	1	3.25212	1	2.973111
6	3.908384	6	3.345492	6	3.669834	6	3.28073
11	4.027654	11	3.506857	11	3.848469	11	3.434
53	4.374131	53	3.89273	53	4.193866	53	3.796127
101	4.46048	107	4.006603	101	4.277517	101	3.895429
153	4.506892	166	4.059492	155	4.314755	153	3.947778
196	4.532257	214	4.089714	208	4.342818	207	3.97854
254	4.553845	256	4.115079	254	4.360628	249	3.996349
300	4.548988	304	4.129111	309	4.369802	302	4.012
352	4.566257	356	4.149079	366	4.364945	360	4.02819
398	4.571654	404	4.153937	412	4.383295	411	4.036825
454	4.580829	450	4.16527	453	4.387612	456	4.040063
505	4.600257	502	4.173905	504	4.400025	503	4.050857
604	4.611591	605	4.194413	602	4.412437	601	4.061651
702	4.601877	703	4.193873	701	4.402723	705	4.075143
802	4.620226	803	4.19927	805	4.42431	803	4.085397
901	4.627242	905	4.203587	904	4.425929	902	4.092952
1001	4.62994	1004	4.202508	1005	4.42431	1002	4.09727
1202	4.636416	1204	4.211683	1202	4.441041	1201	4.110762
1405	4.646131	1402	4.223016	1406	4.450755	1401	4.119937
1602	4.654226	1601	4.225175	1602	4.464247	1605	4.134508
1805	4.643432	1802	4.221937	1801	4.47558	1805	4.145841
2002	4.652067	2002	4.238667	2006	4.47612	2005	4.157175
2205	4.665019	2202	4.235968	2205	4.471263	2204	4.151778
2403	4.665559	2403	4.235429	2405	4.486914	2404	4.16419
2601	4.670416	2603	4.248381	2605	4.482596	2604	4.174984
2803	4.66394	2804	4.254857	2805	4.472882	2805	4.177143
3003	4.649908	3004	4.253238	3005	4.482596	3005	4.188476
3203	4.660702	3205	4.247841	3205	4.497707	3205	4.189016
3403	4.641273	3405	4.28346	3406	4.487993	3403	4.195492
3603	4.638575	3602	4.281841	3601	4.488533	3604	4.19981
3804	4.64721	3804	4.291016	3801	4.490152	3805	4.201429
4005	4.644511	4004	4.28454	4002	4.495009	4002	4.206825
4205	4.633718	4205	4.296413	4202	4.497707	4203	4.210603
4405	4.631559	4404	4.306127	4403	4.501485	4401	4.208444
4601	4.625623	4605	4.302349	4603	4.487993	4602	4.21546
4801	4.632638	4804	4.312063	4804	4.497707	4802	4.213302
4991	4.624004	4975	4.302889	5005	4.480977	5001	4.221937
6041	4.631019	6030	4.316381	5966	4.497707	6040	4.227333
7091	4.670416	7088	4.319079	7016	4.509041	7097	4.247302
8036	4.678511	8038	4.340667	7961	4.502025	8049	4.251079
9087	4.68121	9111	4.325016	9011	4.517675	9102	4.252698
10031	4.675813	10063	4.344444	9957	4.527929	10045	4.260254

TABLE A-26 DATA FOR FIGURE A-26

Ten FT		One FT		No FT		Two FT	
N	%	N	%	N	%	N	%
1	3.728127	1	3.362765	1	2.422099	1	4.013619
6	4.14854	6	3.567845	6	2.57375	10.5	4.289397
11	4.296952	11	3.72921	11	2.632035	20	4.411905
49	4.788603	49	4.112924	51	2.829019	48.56	4.592698
91	4.893841	96	4.264035	101	2.902416	102.39	4.729778
142	4.965619	146	4.328797	152	2.941273	153.14	4.783206
199	4.999619	203	4.370353	210	2.974194	206.58	4.818825
250	5.034698	254	4.398956	252	2.983369	251.68	4.849048
304	5.039016	307	4.418384	303	3.001178	308.8	4.863079
349	5.051429	352	4.429178	352	3.006035	355.59	4.866857
401	5.059524	398	4.446448	406	3.024924	403.65	4.883048
457	5.070317	445	4.448607	459	3.03194	452.26	4.887905
501	5.064381	501	4.449686	503	3.041115	502.36	4.907333
605	5.08381	604	4.463178	603	3.043273	607.7	4.910032
701	5.111873	701	4.469654	703	3.064861	709.15	4.935937
802	5.109714	804	4.466416	802	3.063242	810.32	4.920825
906	5.111873	901	4.467496	902	3.056765	901.88	4.927841
1001	5.137778	1004	4.486384	1006	3.071337	1004.81	4.932159
1202	5.144794	1205	4.504194	1202	3.067559	1210.67	4.941333
1402	5.13346	1405	4.523623	1405	3.074035	1406.37	4.945651
1601	5.157746	1600	4.505813	1604	3.08375	1602.02	4.968857
1804	5.160984	1801	4.516067	1805	3.095083	1808.87	4.970476
2002	5.160984	2002	4.533877	2005	3.106416	2004.84	4.984508
2205	5.169079	2208	4.526861	2205	3.112892	2211.09	4.989905
2403	5.149111	3004	4.514988	2401	3.122607	3006.36	5.021206
2603	5.18473	4003	4.540353	2605	3.112892	4001.99	4.995302
2803	5.187968	5004	4.553845	2802	3.128543	6168.75	5.01473
2904	5.204159	5534	4.549527	2905	3.128543	6379.11	5.029302
3001	5.200921	7107	4.550067	3003	3.136638	6589.53	5.018508
3103	5.196603	8051	4.538194	3101	3.136099	6800.01	5.022825
3204	5.207937	8995	4.56194	3204	3.137178	7010.37	5.036317
3302	5.203079	9938	4.553845	3302	3.120988	7220.79	5.016349
3406	5.20254	10043	4.550607	3405	3.142035	7431.1	5.022286
3603	5.204698			3601	3.131781	7641.63	5.022825
3802	5.205238			3802	3.135019	7851.94	5.028762
4001	5.21873			4004	3.13394	8062.47	5.038476
4205	5.211714			4205	3.130162	8272.78	5.038476
4404	5.21981			4402	3.155527	8483.25	5.038476
4603	5.211175			4603	3.140416	8693.67	5.055206
4802	5.220349			4804	3.142575	8904.09	5.040095
5001	5.229524			5001	3.149051	9114.46	5.044952
5885	5.212254			5902	3.15175	9324.88	5.052508
5990	5.211714			6007	3.149591	9535.35	5.036317
7041	5.198762			7057	3.147972	9745.66	5.064921
8092	5.224127			8106	3.194384		
9036	5.23654			9050	3.183591		
10086	5.248413			11044	3.198702		

TABLE A-27 DATA FOR FIGURE A-27

np to 124 kPa		124 kPa		83 kPa	
N	%	N	%	N	%
10581	8.0024127	1	8.815175	1	5.638603
10582	8.02130511	6	9.609587	6	6.404952
10587	8.05530511	11	9.935556	11	6.687746
10632	9.22263845	52	10.72619	51	7.320254
10682	10.418575	103	10.91886	103	7.550159
10732	10.8244162	150	11.02571	150	7.63273
10787	11.0289559	201	11.09533	202	7.689397
10834	11.134194	249	11.14984	252	7.713143
10886	11.1978765	300	11.13365	300	7.737968
10934	11.2507654	349	11.18762	354	7.747683
10987	11.2761305	401	11.21406	403	7.76819
11037	11.3014956	448	11.23295	453	7.78546
11185	11.3662575	505	11.23727	504	7.815683
11284	11.4018765	603	11.26641	605	7.806508
11386	11.428321	701	11.28044	704	7.827016
11484	11.4294004	804	11.29124	805	7.83727
11586	11.4547654	901	11.31175	903	7.845905
11685	11.4779718	1005	11.2826	1006	7.843746
11882	11.4920035	1205	11.33441	1204	7.866952
12083	11.4849877	1401	11.3587	1406	7.868571
12285	11.5162892	1605	11.37543	1603	7.890698
12487	11.5281623	1805	11.3981	1804	7.88854
12683	11.5243845	2005	11.41483	2006	7.896635
12885	11.5448924	2205	11.3873	2203	7.879365
13086	11.5589242	2405	11.40781	2405	7.88746
13284	11.5578448	2604	11.43102	2602	7.895016
13485	11.5913051	2804	11.41806	2804	7.893937
13682	11.5961623	3004	11.44667	3001	7.909048
13885	11.5891464	3205	11.4553	3204	7.914444
14087	11.5972416	3404	11.49092	3401	7.929016
14284	11.6134321	3602	11.458	3604	7.925238
14486	11.6253051	3801	11.44721	3801	7.931175
14683	11.6209877	4006	11.44559	4004	7.937651
14785	11.632321	4204	11.43803	4202	7.936032
		4403	11.48067	4401	7.936032
		4602	11.47635	4601	7.936571
		4805	11.47851	4803	7.940889
		4931	11.47743	5002	7.950603
		6084	11.56162	6074	7.964095
		7028	11.52276	7017	7.970032
		8076	11.57403	8066	7.979746
		9020	11.53787	9009	7.987841
		10069	11.55568	10057	8.001873

TABLE A-28 DATA FOR FIGURE A-28

N	%	N	%	N	%
10743	2.731873016	1	5.638603	1	2.00654
10744	5.972666667	6	6.404952	6	2.272603
10749	6.424380952	11	6.687746	11	2.350857
10787	7.310539683	51	7.320254	51	2.483079
10845	7.582	108	7.558254	104	2.53219
10893	7.671047619	150	7.63273	151	2.560794
10945	7.755238095	202	7.689397	204	2.576444
10991	7.787079365	252	7.713143	252	2.587778
11039	7.817301587	295	7.730413	302	2.596952
11090	7.832952381	354	7.747683	353	2.605587
11136	7.856698413	398	7.76981	400	2.611524
11187	7.879904762	453	7.78546	452	2.615302
11234	7.905269841	504	7.815683	502	2.620698
11239	7.910666667	605	7.806508	601	2.627175
11244	7.914984127	704	7.827016	703	2.632032
11346	7.927936508	805	7.83727	801	2.639048
11444	7.934412698	903	7.845905	902	2.644444
11546	7.95815873	1006	7.843746	1005	2.647143
11746	7.997015873	1204	7.866952	1205	2.653079
11947	8.02184127	1406	7.868571	1401	2.658476
12147	8.042349206	1603	7.890698	1605	2.664413
12347	8.045587302	1804	7.88854	1805	2.666571
12548	8.074190476	2006	7.896635	2000	2.671429
12748	8.075809524	2203	7.879365	2204	2.674667
12944	8.06015873	2405	7.88746	2405	2.677365
13144	8.089301587	2602	7.895016	2605	2.679524
13345	8.114666667	2804	7.893937	2804	2.682222
13546	8.126539683	3001	7.909048	3005	2.681683
13747	8.154603175	3204	7.914444	3200	2.684381
13946	8.16	3401	7.929016	3405	2.687079
14144	8.173492063	3604	7.925238	3606	2.687079
14347	8.181587302	3801	7.931175	3805	2.693016
14546	8.183746032	4004	7.937651	4004	2.693016
14746	8.198857143	4202	7.936032	4203	2.694095
14946	8.195079365	4401	7.936032	4403	2.694635
15146	8.167555556	4601	7.936571	4602	2.697333
15347	8.163238095	4803	7.940889	4801	2.698413
15545	8.163777778	5002	7.950603	5081	2.698413
16477	8.175111111	5865	7.954381	6026	2.707587
17525	8.201015873	6913	7.97219	7074	2.713524
18469	8.228	7856	7.97273	8018	2.72
19517	8.242571429	8904	7.994317	9066	2.724857
20461	8.244730159	9848	8.001873	10010	2.729175
		14476	8.387494		
		22476	8.392511		