

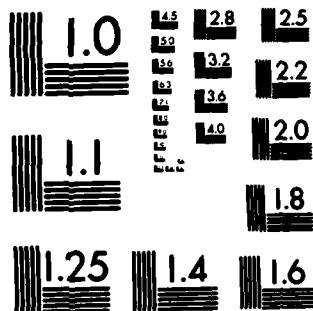
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MECHANICAL RESPONSE OF DRY REID-BEDFORD MODEL SAND AND
SATURATED MISERS B. (U) ARMY ENGINEER WATERWAYS
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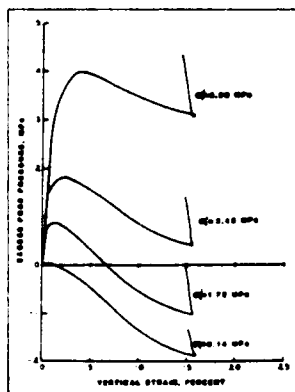
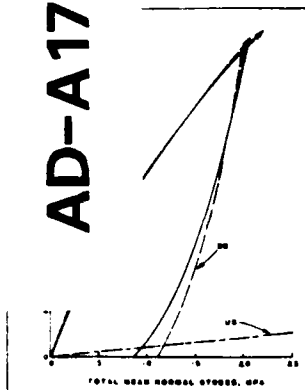


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STRUCTURES
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TECHNICAL REPORT SL-86-27

MECHANICAL RESPONSE OF DRY REID-BEDFORD MODEL SAND AND SATURATED MISERS BLUFF SAND

by

Bruce R. Phillips

Structures Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39180-0631



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19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report presents a collection of data from laboratory mechanical property tests on dry Reid-Bedford Model sand and saturated MISERS BLUFF sand which were conducted by the US Army Engineer Waterways Experiment Station in support of a variety of projects since 1972. The data have been assembled for use in evaluating the ability of mathematical constitutive models to simulate the behavior of soils to complex dynamic loadings produced by both explosive- and earthquake-induced ground shock. Reid-Bedford Model sand is a fine-grained, uniform sand obtained along the Big Black River in Mississippi; the data presented are for air-dried specimens remolded and tested at a dry density of approximately 1.65 g/cc. MISERS BLUFF sand is a medium- to coarse-grained, silty sand obtained at Planet Ranch, Arizona; the data presented are for tests performed on back-pressure saturated specimens initially remolded to a dry density of approximately 1.72 g/cc. Laboratory preparation and test procedures are documented and the data for both sands are presented.					
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PREFACE

The U.S. Army Engineer Waterways Experiment Station (WES) was requested by the Air Force Office of Scientific Research (AFOSR) to provide a complete and consistent set of laboratory properties for two soils to be used in support of AFOSR contract number F49620-80-C-008, "Fundamental Properties of Soils for Complex Dynamic Loading," with Applied Research Associates, Inc., Albuquerque, New Mexico. The work reported herein was funded under AFOSR-MIPR-82-00003, Project 2307/C1 FY 82; the technical contact was LTC John J. Allen, AFOSR/NA.

The WES project engineer for this study was Mr. B. R. Phillips of the Geomechanics Division (GD), Structures Laboratory (SL), working under the general direction of Mr. J. Q. Ehrigott, Chief, Operations Group, GD, and Dr. J. G. Jackson, Jr., Chief, GD. The laboratory composition and mechanical property tests were conducted by personnel of GD and the Instrumentation Services Division. The laboratory classification and index tests were conducted by personnel of the Soils Testing Facility, Soil Mechanics Division, Geotechnical Laboratory. This report was prepared by Mr. Phillips and was transmitted to the sponsor in January 1982.

COL Tilford C. Creel, CE, and COL Robert C. Lee, CE, were the Commanders and Directors of WES during this investigation. COL Allen F. Grum, USA, was the previous Director and COL Dwayne G. Lee, CE, is the present Commander and Director. Mr. F. R. Brown and Dr. Robert W. Whalin were the WES Technical Directors. Mr. Bryant Mather was Chief, SL.



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CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI (metric) units as follows:

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
degrees (angle)	0.01745329	radians
feet	0.3048	metres
gallons (US liquid)	3.785412	cubic decimetres (litres)
inches	2.54	centimetres
kips (force)	4.448222	kilonewtons
kips (force) per square inch	6.894757	megapascals
megatons (nuclear equivalent of TNT)	4.184	petajoules
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic metre

MECHANICAL RESPONSE OF DRY REID-BEDFORD MODEL SAND
AND SATURATED MISERS BLUFF SAND

INTRODUCTION.

Applied Research Associates, Inc. (ARA), has been funded by the Air Force Office of Scientific Research (AFOSR) to evaluate the ability of different mathematical constitutive models to simulate the behavior of soils to complex dynamic loadings produced by both explosive- and earthquake-induced ground shock. To accomplish this study, ARA requires a complete set of laboratory test data on two sands. A complete set of properties includes static and dynamic uniaxial strain and triaxial shear data on both dry and fully saturated specimens for each soil. The U. S. Army Engineer Waterways Experiment Station (WES) was requested by AFOSR to assemble data on two sands from their files and to supplement the existing data with additional laboratory tests. The first task consisted of assembling the available data on dry Reid-Bedford Model (RB) sand and back-pressure saturated MISERS BLUFF (MB) sand and replotting them to common scales in convenient formats for constitutive property analyses. The second and third tasks consist of conducting additional tests to define the response of dry MB sand and saturated RB sand, respectively.

RB sand is a clean, fine-grained sand obtained from Campbell Swamp along the Big Black River in Warren County, Mississippi. Air-dried specimens of this sand have been remolded to a dry density of 1.65 g/cc and tested in a variety of projects since FY 72. It has been used by the Geomechanics Division (GD) at WES as a control sand to evaluate new laboratory test devices.

MB sand is a medium- to coarse-grained sand which was sampled by WES during the preshot geotechnical investigation to support the MISERS BLUFF II test event at Planet Ranch, Arizona. The sand was obtained from a 9-meter-deep accessible shaft. The gravel-sized particles were removed by screening and the remaining material was air-dried; laboratory tests were conducted on back-pressure saturated specimens initially remolded at a dry density of 1.72 g/cc to support a study into the effects of high effective stresses on the shear strength behavior of sands. The work was performed for the Defense Nuclear Agency in FY 80 and FY 81.

PURPOSE AND SCOPE.

The purpose of this report is to document the available results of laboratory tests conducted on dry RB sand remolded to a density of 1.65 g/cc and saturated MB sand remolded to a density of 1.72 g/cc. The results of laboratory classification tests are presented as well as the results of mechanical property tests conducted on remolded specimens.

CLASSIFICATION AND INDEX TESTS.

Samples of each sand were tested to determine grain size distribution, Atterberg limits, and specific gravity (Reference 1). This information was used to classify each sand according to the Unified Soil Classification System (Reference 2); both classify as SP. Results of specific gravity G_s tests on the sands indicate a specific gravity of 2.65 for the RB sand and 2.69 for the MB sand. The Atterberg limit tests indicated that both sands are nonplastic. The results of the grain size distribution tests are shown for the RB sand and the MB sand in Figures 1 and 2, respectively.

COMPOSITION PROPERTY TESTS.

Prior to performing each mechanical property test, measurements were made of the height, diameter, and weight of the remolded specimen. With these measurements and the specific gravity of the sand, wet density γ , dry density γ_d , degree of saturation S (percent of void volume filled with water), percent volume of air V_a , and void ratio (void volume to solid volume) can be calculated. For specimens that were not saturated, posttest water content measurements were made on the specimen. For back-pressure saturated specimens, the water content was calculated based on the measured density, the specific gravity, and the assumption that the specimen was fully saturated.* These data are given for each test in Tables 1 through 4.

MECHANICAL PROPERTY TESTS.

The following types of mechanical property tests were conducted on the sands in this study:

* Full saturation was assured by monitoring the B-factor (Reference 3) during the back-pressure saturation process until a value of at least 0.95 was achieved.

- a. The isotropic compression (IC) test subjects a cylindrically shaped specimen to an equal all-around confining pressure while measurements of the specimen's height and diameter changes are made. The data are normally plotted as pressure versus volumetric strain, the slope of which is the bulk modulus K .
- b. The triaxial shear (TX) test is conducted after a desired confining pressure is applied during the IC test. While the confining pressure is held constant, axial load is increased and measurements of the specimen's height and diameter changes are made. The data can be plotted as principal stress difference versus axial strain, the slope of which is Young's modulus E , or as principal stress difference versus principal strain difference, the slope of which is twice the shear modulus G . The maximum principal stress difference the specimen can support or the principal stress difference at 15 percent axial strain (whichever occurs first) is defined as failure and describes one point on a failure surface. The failure surface is depicted as a plot of principal stress difference versus mean normal stress.
- c. Three types of uniaxial strain (UX) tests were conducted:
 - (1) The first (designated UX) is conducted by applying an axial (vertical) pressure to a wafer-shaped specimen that is physically constrained from deflecting radially. Measurements are made of the applied axial stress and the specimen's height change. The data are plotted as axial (vertical) stress versus axial (vertical) strain, the slope of which is the constrained modulus M .
 - (2) The second type of UX test (designated UX/ K_0) is conducted by applying radial pressure to a cylindrically shaped specimen until a slight inward movement of the diameter is detected. Axial load is then applied until the specimen returns to its original radial position (zero radial strain). This process is repeated throughout the loading and unloading. As in the UX test, the data are plotted as axial stress versus axial strain, the slope of which is the constrained modulus M . When the data are plotted as principal stress difference versus mean normal stress, the slope is $2G/K$ or, in terms of Poisson's ratio ν , is $3(1-2\nu)/(1+\nu)$.
 - (3) The third type of UX test (designated UX/Null) is similar to the K_0 test in that both radial and vertical pressures are controlled. A wafer-shaped specimen is remolded into a thin-walled steel cylinder which is strain gaged on the outside. As vertical pressure is applied, the circumferential strain (measured by the strain gages) on the steel cylinder is kept at zero by applying lateral pressure to the cylinder. This process is continued throughout the test. The data are plotted and properties deduced the same as those from the UX/ K_0 test.

DRY REID-BEDFORD MODEL SAND TESTS.

Selected tests on dry RB sand from the GD files consisted of results from one static IC test, five static IC-TX tests, four static UX tests, two static UX/ K_0 tests, and one static UX/Null test. All tests were performed on remolded specimens at a density of approximately 1.65 g/cc under unconsolidated-undrained conditions. UX and UX/Null specimens were prepared by a raining technique, i.e., the air-dried RB sand fell through a number of screens placed at a controlled height to form the test specimen. Trial specimens were first prepared to select the height of fall required to obtain the desired density. After a number of specimens with identical densities were obtained, the densities were thereafter assumed to be the same although occasional checks were made. A summary of the data is presented in Table 1.

During UX testing, measurements were made of applied vertical stress and vertical deflection at the center of the specimen as measured by a linear variable differential transformer (LVDT). Data were recorded on magnetic tape and light beam oscillograph for processing into applicable stresses and strains. The results of the UX tests are presented as plots of axial stress versus axial strain in Plates 1 through 4. The UX/Null test is presented as a plot of axial stress versus axial strain and a plot of principal stress difference versus mean normal stress in Plate 5.

The remaining tests were performed in the WES high-pressure triaxial test device. A steel remolding jacket containing a thin rubber membrane was placed around the specimen base. A vacuum was applied through the jacket to pull the membrane against the sides. A measured weight of air-dried RB sand was rained into the membrane through a funnel at a controlled height to obtain the desired density. All specimens for IC-TX testing were 5.4 centimeters in diameter and 12.7 centimeters tall. The UX/ K_0 and IC specimens were 5.4 centimeters in diameter and 7.6 centimeters tall. The membrane was attached to the top cap and base with rubber bands. A slight vacuum was applied to the inside of the specimen to support it until the confining pressure was applied. The specimen was instrumented with two vertically mounted LVDT's positioned 180 degrees apart on top of the specimen. The radial measurement system for the IC-TX tests was a lateral deformeter which consisted of four strain-gaged steel arms positioned equidistant around the specimen's periphery at the center of the specimen. The radial measurement system for the IC test and the UX/ K_0 tests was a single lateral deformeter

consisting of four horizontally-mounted LVDT's positioned at quarter points around the specimen. During the conduct of the UX/ K_0 test, the lateral deformer was continuously monitored to maintain the lateral deflection at zero. The chamber was assembled and the desired test was conducted. All data were continuously recorded with a light beam oscillograph. The data were later reduced by hand and processed by computer to obtain applicable stresses and strains.

The results of the IC-TX tests discussed above are shown in Plates 6 through 10. These data are plots of (a) mean normal stress versus principal stress difference, (b) mean normal stress versus volumetric strain, and (c) principal stress difference versus principal strain difference and axial strain. The values of volumetric strain shown in plot (b) are calculated based on the assumption that the specimen deforms as a right circular cylinder during the IC test. This calculation, based on the vertical and lateral measurements, is discussed in Reference 4. Plate 11 shows the failure data obtained from the TX tests as plots of maximum principal stress difference versus mean normal stress.

Specimen TH.1 was the only specimen tested in isotropic compression which was not immediately followed by a TX test. The results are plotted as mean normal pressure versus volumetric strain and are shown in Plate 12.

The results of the UX/ K_0 tests are shown in Plates 13 and 14 as plots of (a) axial stress versus axial strain and (b) principal stress difference versus mean normal stress.

SATURATED MISERS BLUFF SAND TESTS.

The tests on saturated MB sand consisted of 8 static undrained UX tests, 3 static drained UX tests, 6 dynamic drained UX tests, 23 consolidated-undrained IC-TX tests, 11 static consolidated-drained IC-TX tests, 6 static consolidated-undrained UX/ K_0 tests, and 4 consolidated-drained UX/ K_0 tests. All IC-TX tests and undrained UX/ K_0 tests were performed at one of three effective stresses: 0.15 MPa, 1.75 MPa, or 3.5 MPa. Each specimen was back-pressure saturated prior to application of the effective stress. A summary of the data is given in Tables 2, 3, and 4.

To prepare the UX test specimens, a known weight of air-dried soil was measured in order to obtain a desired air-dried density of 1.72 g/cc. The soil was then "spooned" directly into the specimen chamber which was

filled three-fourths of the way to the top with tap water. As the sand was placed into the chamber, the water was displaced and the resulting specimen was almost saturated. After assembling the test device, the specimen was saturated by concurrently applying both axial stress and back pressure. Once the specimen was saturated, a static effective axial stress was applied with the drainage line open but with the back pressure applied. The drainage line was then closed for an undrained test or left open for a drained test. Axial stress was increased either statically or dynamically to the desired pressure as measurements were made of axial stress and axial deflection. During an undrained test, measurements were also made of pore pressures by measuring the pressure through the hypodermic needle which extended into the specimen. Dynamic tests were only performed under undrained conditions. Measurements were stored on both magnetic tape and light beam oscillogram. These data were processed and plotted as axial (vertical) stress versus axial (vertical) strain and are shown in Plates 15 through 31 and summarized in Table 2. The dynamic tests are shown with a static portion and a dynamic portion. The static portion includes the back-pressure saturation phase and application of the initial effective stress; the dynamic portion is the remainder of the test.

The preparation of specimens for IC-TX tests and UX/K₀ tests was similar to that used to prepare the RB sand specimens. A known weight of air-dried MB sand was measured and "spooned" into the remolding jacket and membrane to achieve the target density. All specimens were prepared at a diameter of 5.1 centimeters and a height of 11.4 centimeters. Prior to placing the top cap, the specimen was "flooded" with de-aired water from the base until water was visible at the top. A slight vacuum was applied to the specimen while the top cap was placed and the membrane was secured to the top cap and base. The measurement system for the MB IC-TX tests was the same as that previously described for the RB IC-TX and UX/K₀ tests.

After the specimen and its instrumentation were placed, the test device was assembled and the specimen was then back-pressure saturated and one of three effective stresses (0.15, 1.75, or 3.5 MPa) was applied to the specimen with the drainage line open. If the specimen was to be tested in a drained condition, the TX test was performed immediately after the application of the effective stress. If an undrained test was desired, the drainage line was closed and an additional confining pressure or live IC loading was

applied to the specimen. Axial load was then applied to the specimen until failure occurred, with failure being defined as the point at which there was a definite decrease in the applied axial load or when the specimen exhibited 15 percent axial strain during shear, whichever occurred first. During the test, measurements were made of axial load, confining pressure, movement of the piston, and internal measurements of axial and radial deflection of the specimen. During the undrained tests, pore pressure measurements were made in addition to those mentioned above. Data were recorded by a Hewlett Packard 3052A Data Acquisition System (HP3052A) which samples the data channels at designated intervals and records the data on a minicassette tape. The data are subsequently processed and plotted. A data summary for the IC-TX tests is given in Table 3. Multiple plots are shown for the drained and undrained IC-TX tests in Plates 32 through 42 and 43 through 65, respectively and contain (a) total mean normal stress versus volumetric strain, (b) principal stress difference versus total mean normal stress, (c) principal stress difference versus principal strain difference and axial strain, (d) principal stress difference versus effective mean normal stress, and (e) pore pressure versus axial strain. Volumetric strain was calculated as outlined in Reference 4 using the deformed shape assumption of a right circular cylinder and the internal vertical and lateral deformation measurements.

The UX/K_0 specimens were prepared identically to those prepared for the IC-TX tests. Each specimen was back-pressure saturated and one of the three effective stresses was applied with the drainage line open. If the test was to be performed drained, the diameter of the specimen at the end of application of effective stress was assumed to be the zero or "null" position. As axial load was applied, the radial deflection was constantly monitored and corrected by changing the confining stress until the radial change was zero. This process was repeated throughout the test. Measurements were made of vertical deflection, applied axial load, and confining stress. If the specimen was to be tested in an undrained condition, the drainage line was closed prior to application of the axial load. Pore pressure measurements were made during undrained tests. Data were recorded on the HP3052A as described during discussion of the IC-TX tests. The results of the drained and undrained UX/K_0 tests are shown in Plates 66 through 69 and Plates 70 through 75, respectively, as plots of (a) total mean normal stress versus volumetric strain, (b) principal stress difference versus mean normal stress,

(c) total axial stress versus axial strain, (d) principal stress difference versus effective mean normal stress, and (e) pore pressure versus axial strain. All plots represent the states of stress through the entire back-pressure saturation, application of effective stress, and UX/K_0 loading. The results of the UX/K_0 tests are summarized in Table 4.

Plate 76 shows a plot of the failure data from the IC-TX tests.

Table 1. Summary of mechanical property tests on remolded Reid-Bedford Model sand.

Plate Test No.	No.	UX Tests										TX Tests									
		Air-Dried					Specific Gravity					Air Voids					Degree of Saturation				
		γ_d , g/cc	w , %	Water Content	γ_d , g/cc	G_s	V_a , %	Content	S_r , %	Ratio	Void Ratio	Test Type	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa	Peak Axial Stress MPa
1	UX.1	1.660	0.1	1.658	2.65	32.3	0.44	0.60	UX	29.0	4.7	---	---	---	---	---	---	---	---	---	---
2	UX.2	1.657	0.1	1.655	2.65	37.3	0.44	0.60	UX	36.6	6.1	---	---	---	---	---	---	---	---	---	---
3	UX.3	1.652	0.1	1.650	2.65	37.6	0.44	0.61	UX	36.6	6.0	---	---	---	---	---	---	---	---	---	---
4	UX.4	1.647	0.1	1.645	2.65	37.8	0.43	0.61	UX	34.5	5.7	---	---	---	---	---	---	---	---	---	---
5	N.1	1.658	0.03	1.658	2.68	37.4	0.13	0.60	UX/Null	10.3	2.3	---	---	---	---	---	---	---	---	---	---
6	T.1	1.634	0.03	1.634	2.65	38.3	0.13	0.62	IC-TX	---	---	---	---	---	---	---	---	---	---	---	---
7	T.2	1.629	0.03	1.629	2.65	38.5	0.13	0.63	IC-TX	---	---	---	---	---	---	---	---	---	---	---	---
8	T.3	1.634	0.03	1.634	2.65	38.3	0.13	0.62	IC-TX	---	---	---	---	---	---	---	---	---	---	---	---
9	T.4	1.632	0.03	1.632	2.65	38.4	0.13	0.62	IC-TX	---	---	---	---	---	---	---	---	---	---	---	---
10	T.6	1.658	0.03	1.658	2.65	37.4	0.13	0.60	IC-TX	---	---	---	---	---	---	---	---	---	---	---	---
12	TH.1	1.650	0.03	1.650	2.65	37.7	0.13	0.61	IC	---	---	---	---	---	---	---	---	---	---	---	---
13	TK.1	1.668	0.03	1.667	2.65	37.0	0.13	0.59	UX/K ₀	12.1	2.2	---	---	---	---	---	---	---	---	---	---
14	TK.2	1.683	0.03	1.682	2.65	36.5	0.14	0.58	UX/K ₀	12.4	1.9	---	---	---	---	---	---	---	---	---	---

Table 2. Summary of static and dynamic uniaxial strain tests on Misers Bluff sand.

Plate No.	Test Number	Air-Dried Density γ_s , g/cc	Water Content w , %	Specific Gravity G_s	Air Voids Content V_a , %	Degree of Saturation S_r , %	Void Ratio	Effective			Dynamic Rise Time To Peak Axial Stress, msec	Test Type
								Axial Stress σ_z , MPa	Peak Axial Stress σ_z , MPa	Axial Strain at Peak Axial Stress ϵ		
15	DNA.UX.1S	1.721	21.2	2.69	0.0	100	0.57	0.14	62.4	3.4	---	Static undrained
16	DNA.UX.2SA	1.721	21.2	2.69	0.0	100	0.57	1.72	61.9	1.7	---	Static undrained
17	DNA.UX.3S	1.721	21.2	2.69	0.0	100	0.57	3.45	61.4	5.2	---	Static undrained
18	DNA.UX.5S	1.721	21.2	2.69	0.0	100	0.57	3.45	20.8	10.6	---	Static drained
19	DNA.UX.5SA	1.721	21.2	2.69	0.0	100	0.57	3.45	18.5	15.1	---	Static drained
20	DNA.UX.6S	1.721	21.2	2.69	0.0	100	0.57	0.69	63.3	3.5	---	Static undrained
21	DNA.UX.7S	1.721	21.2	2.69	0.0	100	0.57	0.69	62.0	20.7	---	Static drained
22	DNA.UX.8S	1.721	21.2	2.69	0.0	100	0.57	0.69	63.2	2.8	---	Static undrained
23	DNA.UX.8SA	1.721	21.2	2.69	0.0	100	0.57	0.69	61.9	1.3	---	Static undrained
24	DNA.UX.8SB	1.721	21.2	2.69	0.0	100	0.57	0.69	63.1	1.2	---	Static undrained
25	DNA.UX.9S	1.721	21.2	2.69	0.0	100	0.57	1.72	44.0	14.3	---	Static drained
26	DNA.UX.10D	1.721	21.2	2.69	0.0	100	0.57	0.69	38.2	1.0	100	Dynamic undrained
27	DNA.UX.11D	1.721	21.2	2.69	0.0	100	0.57	0.69	50.5	0.9	50	Dynamic undrained
28	DNA.UX.12D	1.721	21.2	2.69	0.0	100	0.57	0.69	55.2	0.5	50	Dynamic undrained
29	DNA.UX.13D	1.721	21.2	2.69	0.0	100	0.57	0.69	65.5	1.1	10	Dynamic undrained
30	DNA.UX.14D	1.721	21.2	2.69	0.0	100	0.57	0.69	72.4	1.0	5	Dynamic undrained
31	DNA.UX.15D	1.721	21.2	2.69	0.0	100	0.57	0.69	49.1	0.9	30	Dynamic undrained

Table 3. Summary of static triaxial compression tests on Misera Bluff sand.

Plate No.	Test No.	Air-Dried Density γ_s , g/cc	Water Content w , %	Specific Gravity G_s	Degree of Saturation S_r , %	Void Ratio	Effective Stress MPa	Live IC Loading MPa	Principal Stress Difference at Failure $(\sigma_3 - \sigma_1)_f$ MPa	Effective Mean Normal Stress at Failure P_f , MPa	Axial Strain During TX at Failure ϵ_z , %
<u>DRAINED IC-TX TESTS</u>											
32	MXLD1	1.738	20.0	2.69	100.0	0.54	0.15	---	0.47	0.32	2.7
33	MXLD2	1.722	20.5	2.69	100.0	0.55	0.13	---	0.52	0.37	6.3
34	DNA21	1.709	20.0	2.69	100.0	0.54	0.12	---	1.03	0.53	9.8
35	DNA22	1.707	20.0	2.69	100.0	0.53	0.17	---	1.10	0.53	6.8
36	DNA27	1.719	19.6	2.69	100.0	0.52	0.14	---	1.10	0.53	4.0
37	DNA3	1.743	19.4	2.69	100.0	0.52	1.75	---	4.70	3.25	11.2
38	MXLD.4	1.722	20.5	2.69	100.0	0.55	1.74	---	4.46	3.22	15.0
39	DNA11	1.712	20.4	2.69	100.0	0.54	3.52	---	8.59	6.38	15.0
40	DNA12	1.725	19.6	2.69	100.0	0.52	3.50	---	8.60	6.36	15.0
41	MXLD.7	1.714	20.7	2.69	100.0	0.56	3.44	---	8.25	6.24	15.0
42	MXLD.7A	1.730	20.3	2.69	100.0	0.54	3.48	---	7.98	6.17	15.0
<u>UNDRAINED IC-TX TESTS</u>											
43	MB8A	1.738	20.2	2.69	100.0	0.54	0.09	0.0	1.16	0.89	15.0
44	MB9	1.711	21.0	2.69	100.0	0.57	0.07	3.45	1.13	0.69	15.0
45	MB10	1.719	20.7	2.69	100.0	0.56	0.01	2.07	1.28	0.83	15.0
46	MB10A	1.735	20.1	2.69	100.0	0.54	0.14	2.07	1.05	0.81	15.0
47	MB10B	1.740	19.9	2.69	100.0	0.53	0.14	2.07	1.11	0.84	15.0
48	DNA19	1.738	19.2	2.69	100.0	0.51	0.08	0.0	1.49	0.88	15.0
49	DNA20	1.716	19.7	2.69	100.0	0.53	0.09	3.45	1.28	0.73	14.2
50	DNA1	1.756	18.9	2.69	100.0	0.51	1.65	3.45	2.76	1.60	13.8
51	DNA2	1.778	18.3	2.69	100.0	0.49	1.83	3.45	2.73	1.85	12.9
52	DNA6	1.693	20.7	2.69	100.0	0.55	1.86	3.45	1.83	1.34	12.0
53	RV3A	1.720	20.6	2.69	100.0	0.55	1.93	1.72	1.86	1.37	14.2
54	RV3B	1.719	20.7	2.69	100.0	0.56	1.69	1.72	1.86	1.30	11.1
55	MB3A	1.717	20.6	2.69	100.0	0.55	1.78	6.90	1.81	1.28	12.3
56	MB4A	1.720	20.6	2.69	100.0	0.55	1.76	0.0	1.83	1.32	11.6
57	MB5A	1.722	20.5	2.69	100.0	0.55	1.77	3.45	1.77	1.28	12.8
58	MB6A	1.688	21.6	2.69	100.0	0.58	1.84	0.0	1.66	1.21	10.7
59	MB13	1.714	20.7	2.69	100.0	0.56	3.46	0.0	2.21	1.55	11.3
60	MB14	1.716	20.6	2.69	100.0	0.55	3.44	3.45	2.24	1.61	9.8
61	DNA4	1.733	19.4	2.69	100.0	0.52	3.47	0.0	3.00	1.94	10.1
62	DNA7	1.706	20.3	2.69	100.0	0.54	3.46	0.0	2.92	1.90	10.3
63	DNA8	1.695	20.6	2.69	100.0	0.55	3.32	0.3	2.63	1.78	8.9
64	DNA9	1.716	20.3	2.69	100.0	0.54	3.70	3.45	2.74	1.87	12.3
65	DNA10	1.738	19.3	2.69	100.0	0.52	3.66	5.90	2.87	1.90	9.2

Table 4. Summary of static uniaxial strain/ K_0 tests on Misers Bluff sand

Plate No.	Test No.	Air-Dried Density γ , g/cc	Water Content w , %	Specific Gravity G_s	Degree of Saturation S_r , %	Void Ratio	Effective Stress MPa	Peak Axial Stress σ_z , MPa	Axial Strain at Peak Axial Stress ϵ_z , %	Remarks
<u>DRAINED UX/K_0 TESTS</u>										
66	DNA25	1.731	19.6	2.69	100.0	0.52	0.18	9.8	4.7	
67	DNA26	1.698	20.7	2.69	100.0	0.55	0.16	10.1	4.7	
68	DNA17	1.738	19.6	2.69	100.0	0.52	3.48	19.0	6.1	
69	DNA18	1.717	20.3	2.69	100.0	0.54	3.67	9.6	1.8	Membrane leaked
<u>UNDRAINED UX/K_0 TESTS</u>										
70	DNA23	1.698	20.5	2.69	100.0	0.55	0.14	32.0	0.6	
71	DNA24	1.715	20.0	2.69	100.0	0.53	0.13	30.8	0.9	
72	DNA28	1.735	19.4	2.69	100.0	0.52	1.70	29.9	1.1	
73	DNA29	1.727	19.5	2.69	100.0	0.52	1.70	32.7	1.2	
74	DNA15	1.719	20.0	2.69	100.0	0.53	3.53	30.8	0.9	
75	DNA16	1.721	20.3	2.69	100.0	0.54	3.55	31.8	1.5	

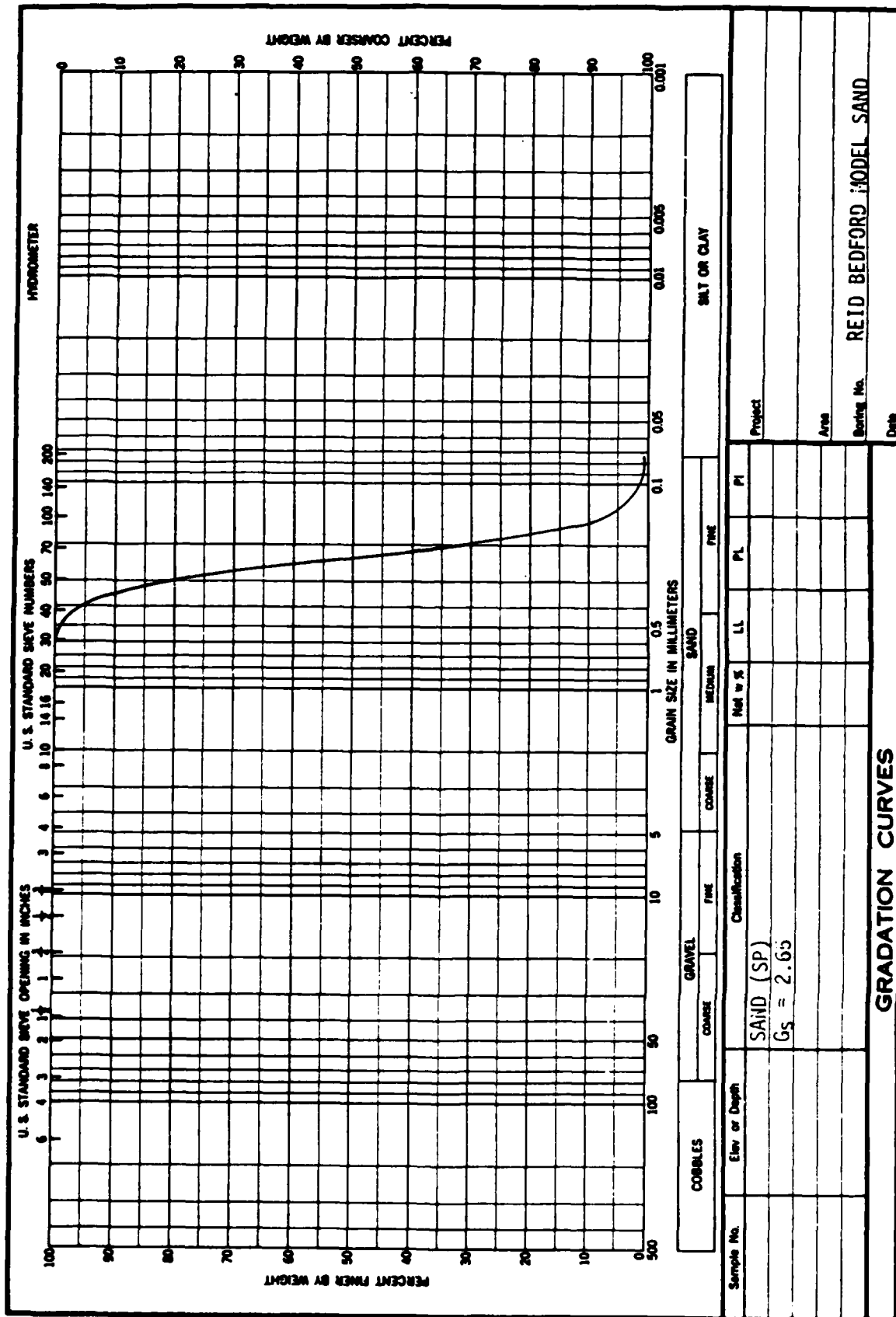
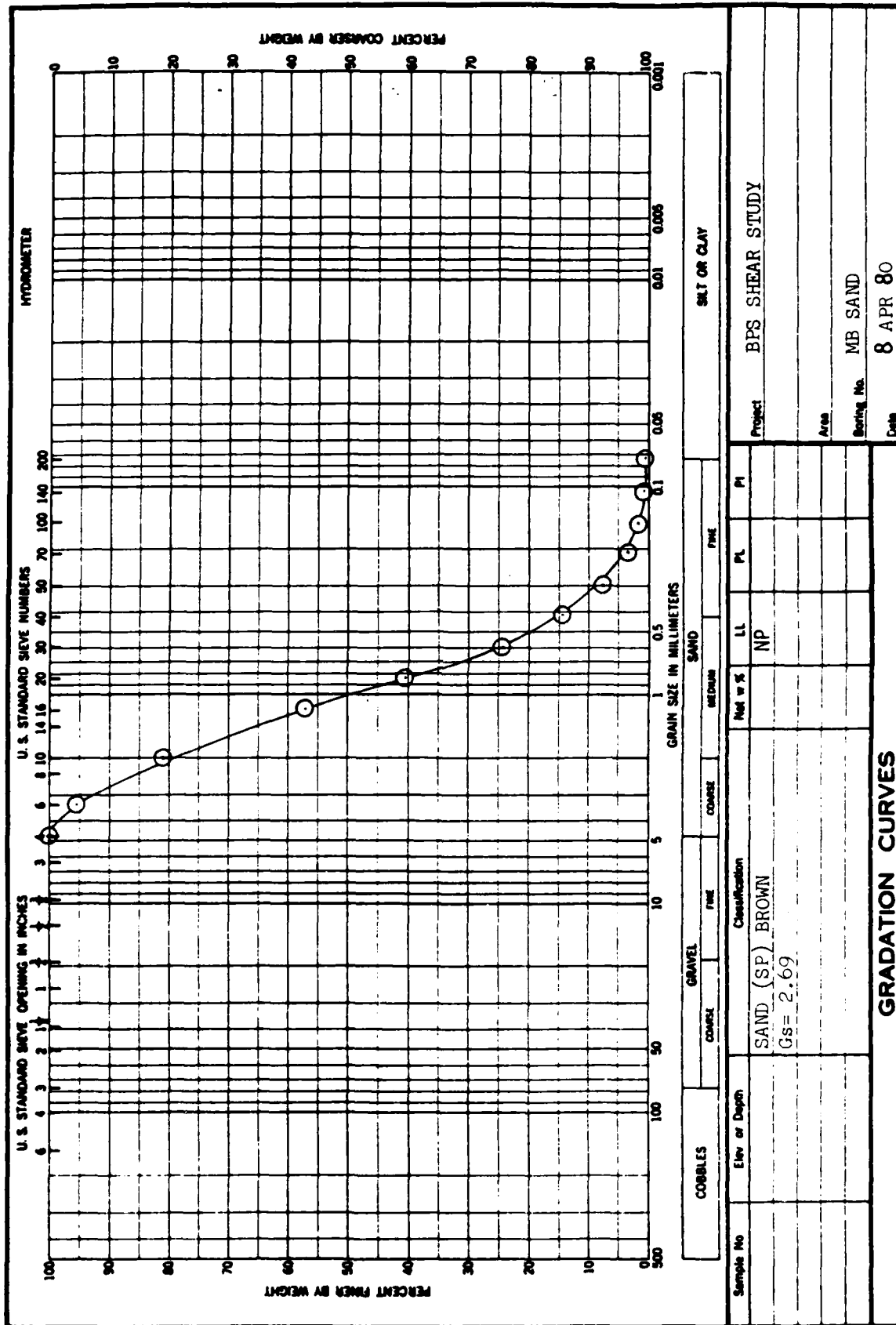


Figure 1. Gratation of Reid-Bedford Model sand

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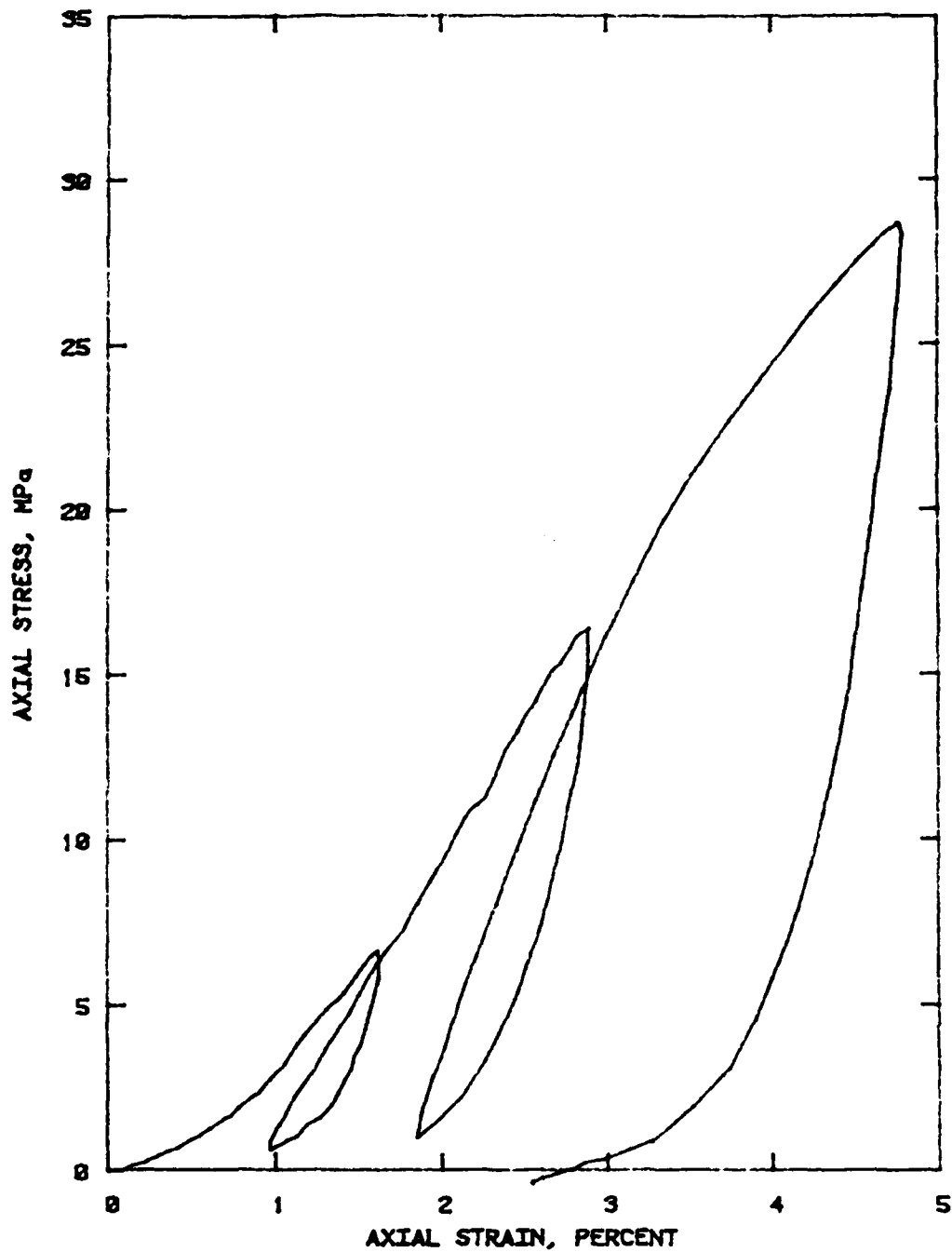
ENG FORM 1 MAY 83 2087

Figure 2. Gratation of Hisers Bluff sand

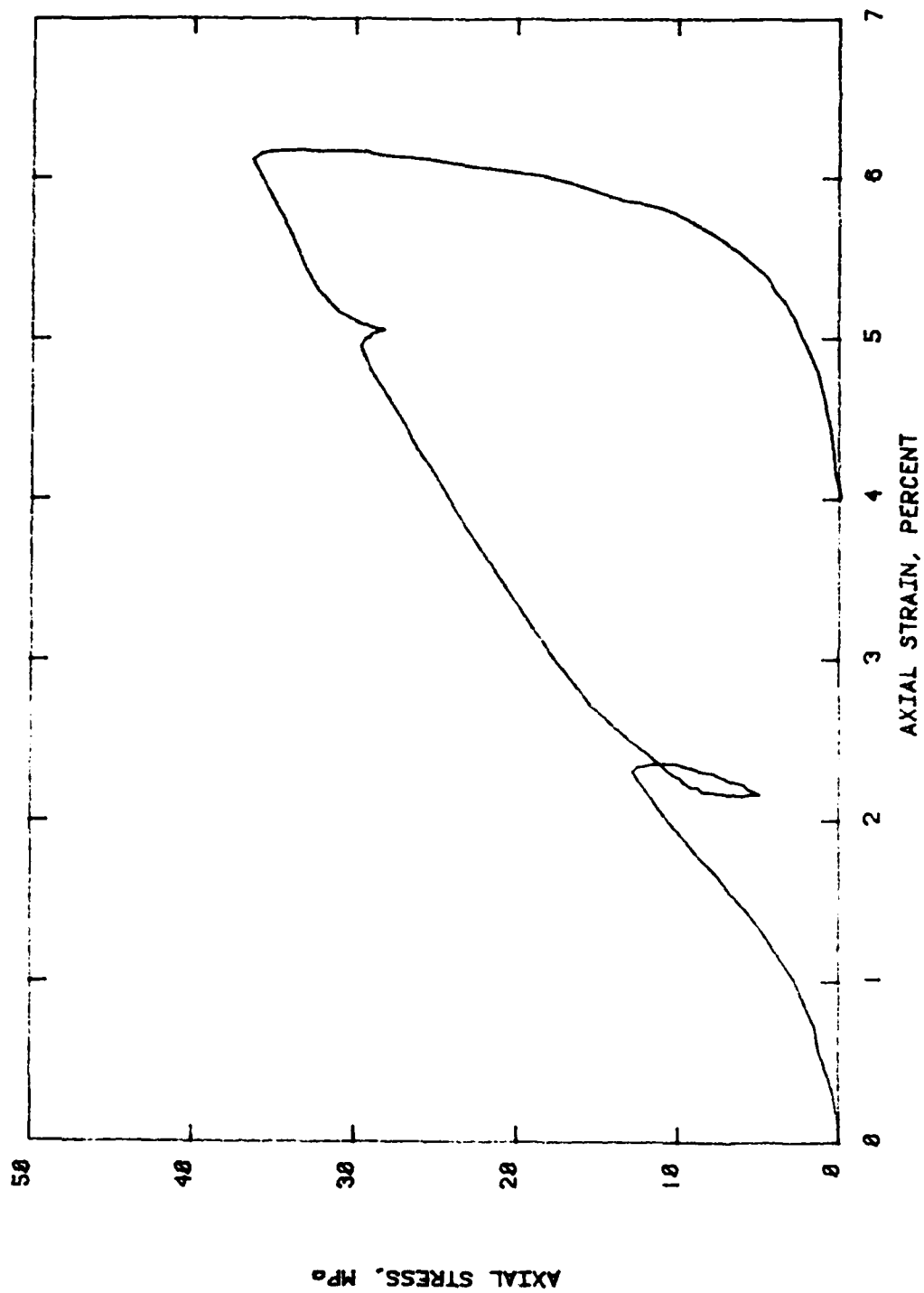
REFERENCES

1. Headquarters, Department of the Army, Office, Chief of Engineers; "Laboratory Soils Testing"; Engineering Manual No. EM-1110-2-1906, 30 November 1970; Washington, DC.
2. U. S. Army Engineer Waterways Experiment Station; "The Unified Soil Classification System"; Technical Memorandum No. 3-357, April 1960 (reprinted May 1967); CE, Vicksburg, MS.
3. Alan W. Bishop and D. J. Henkel; The Measurement of Soil Properties in the Triaxial Test; 1962; Edward Arnold LTD, London.
4. J. Q. Ehrgott; "Calculation of Stress and Strain from Triaxial Test Data on Undrained Soil Specimens"; Miscellaneous Paper S-71-9, May 1971; US Army Engineer Waterways Experiment Station, CE, Vicksburg, MS.

REID BEDFORD MODEL SAND
STATIC UX AND UX/NULL TESTS



RB SAND
TEST NUMBER: UX.1
STATIC UNIAXIAL STRAIN TEST



RB SAND
TEST NUMBER: UX.2
STATIC UNIAXIAL STRAIN TEST

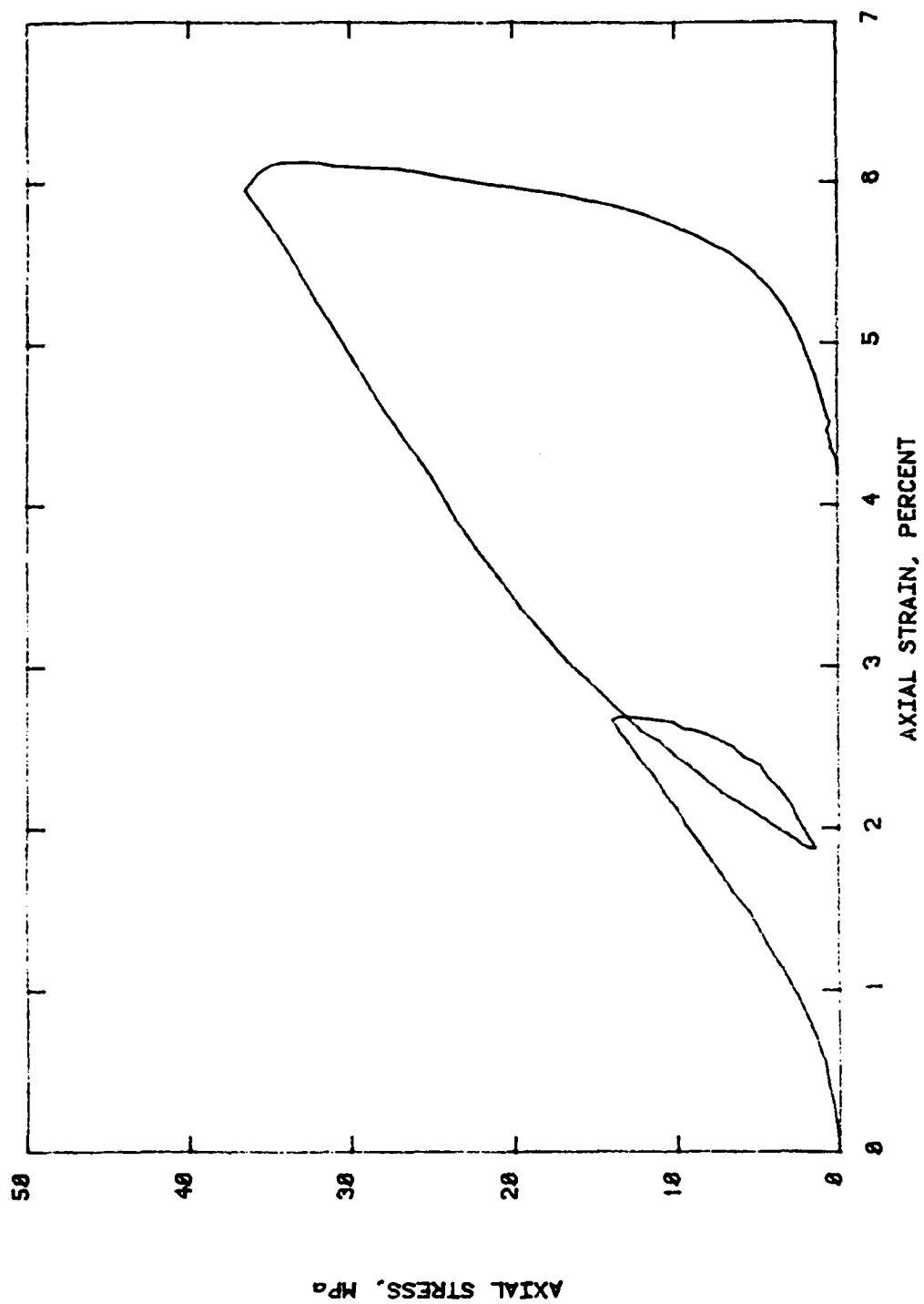
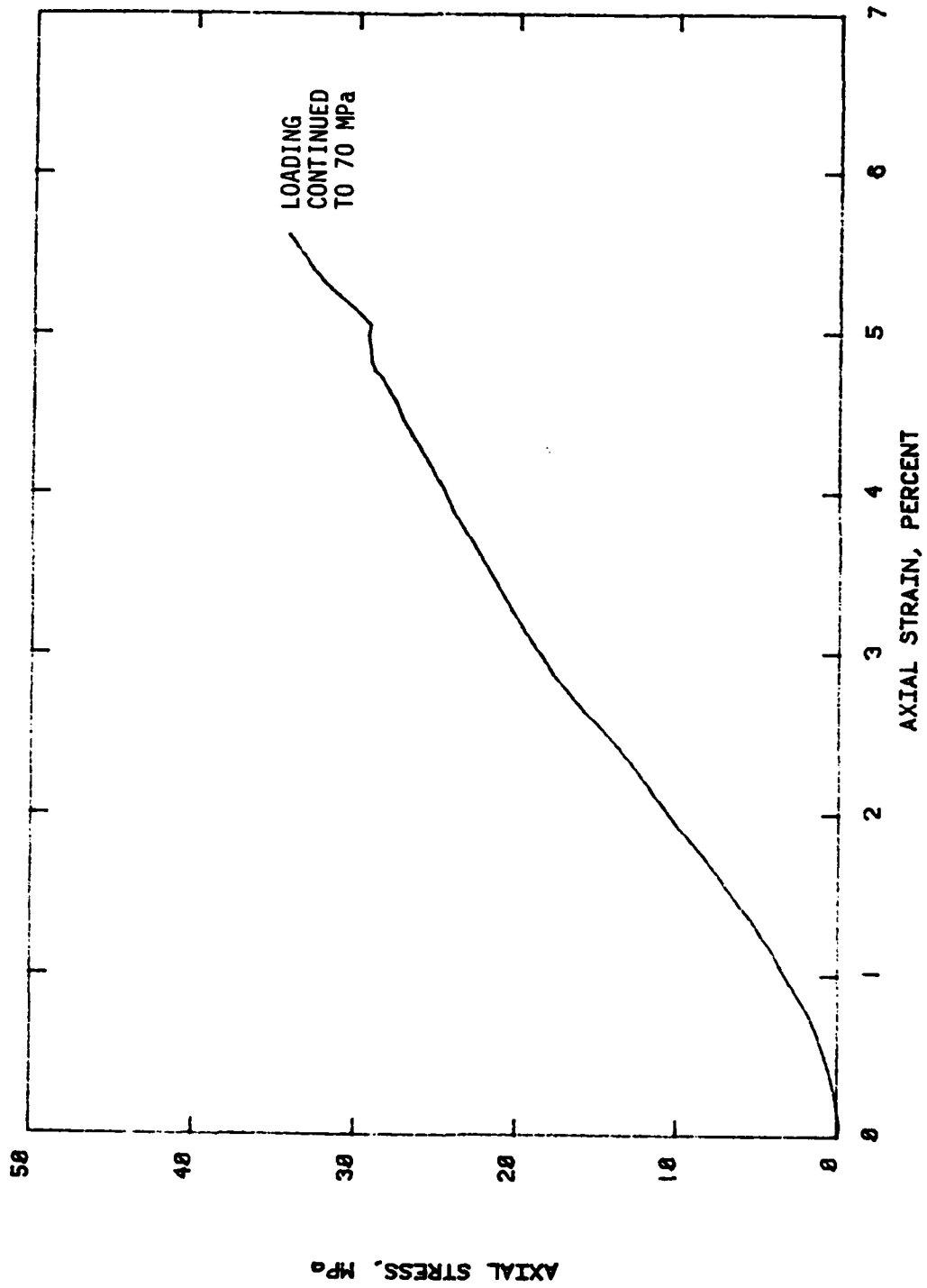


PLATE 3

RB SAND
TEST NUMBER: UX.3
STATIC UNIAXIAL STRAIN TEST

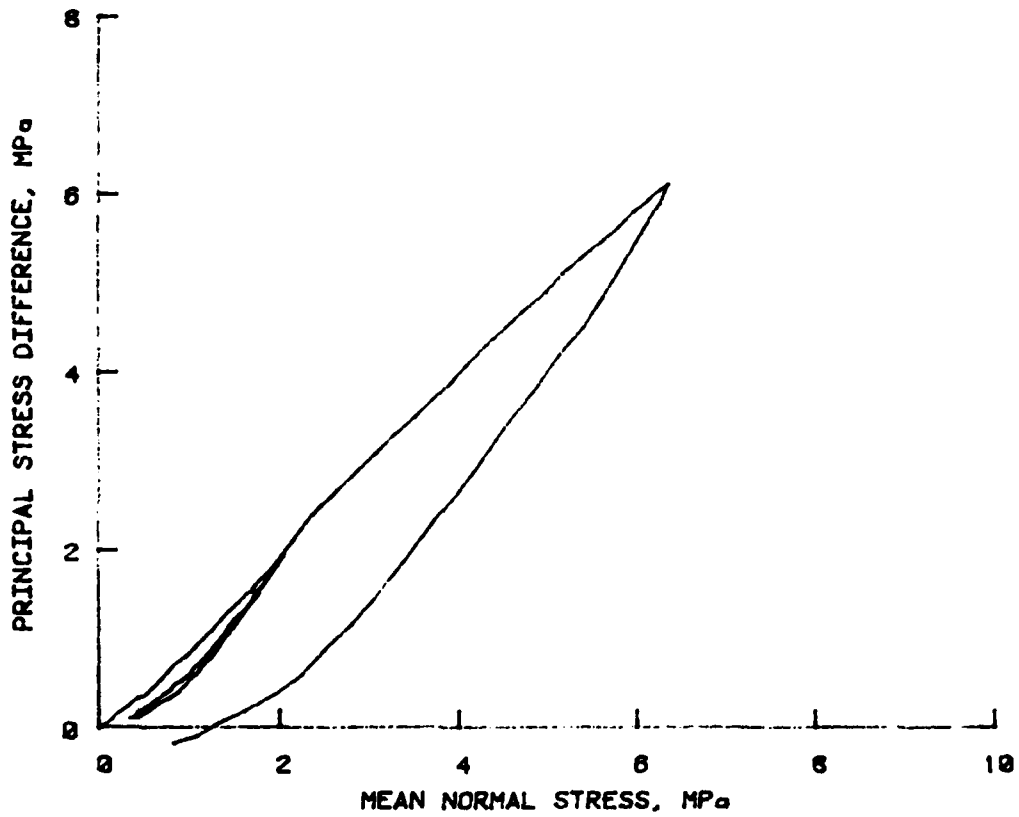
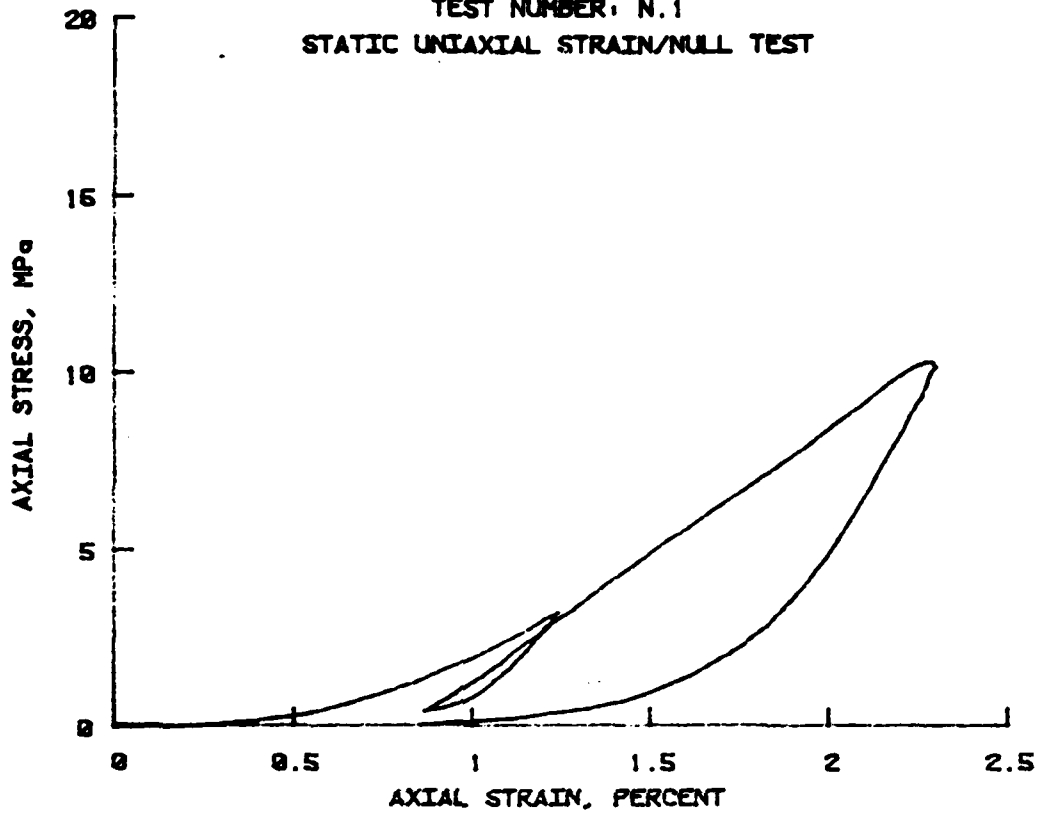


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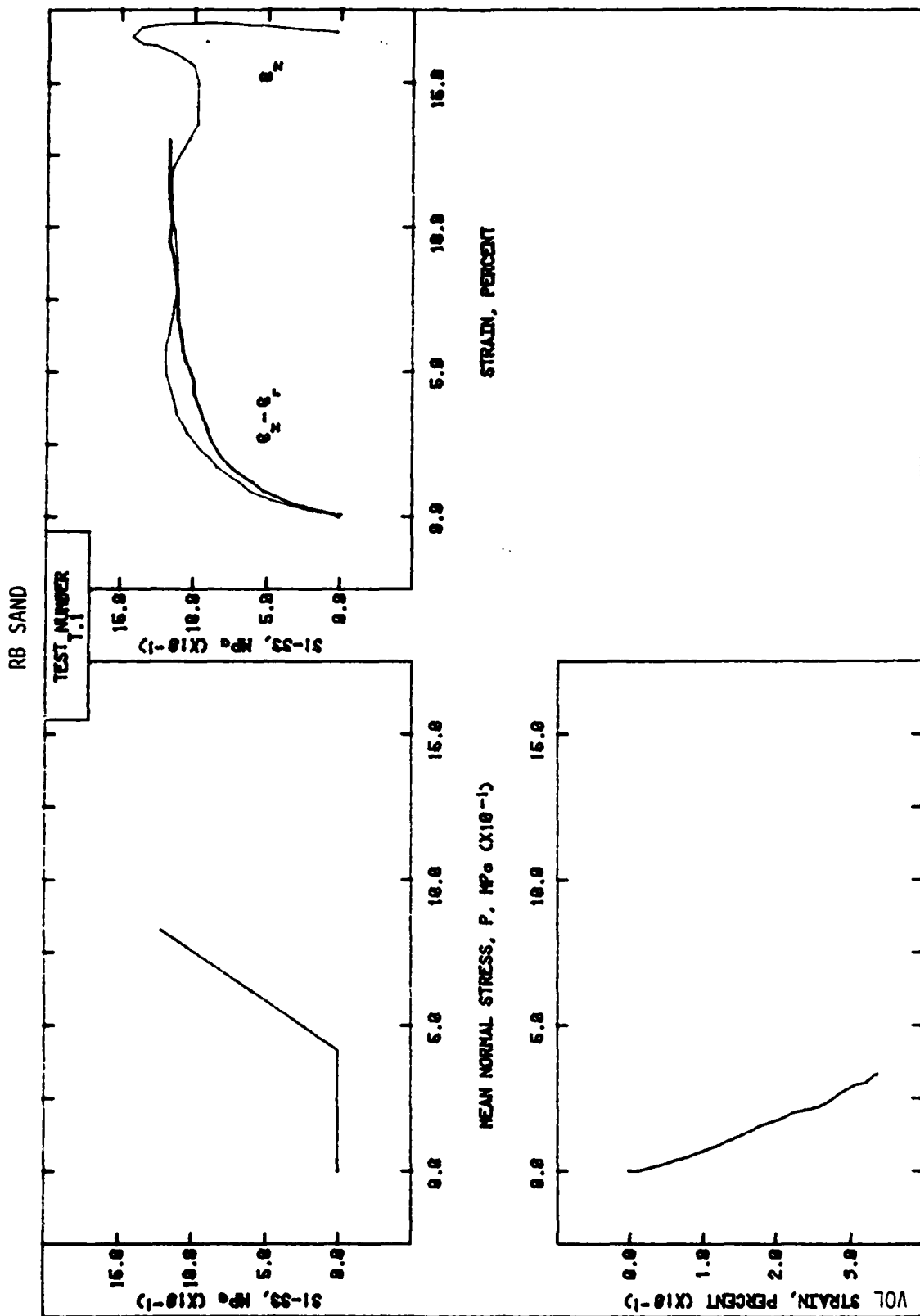
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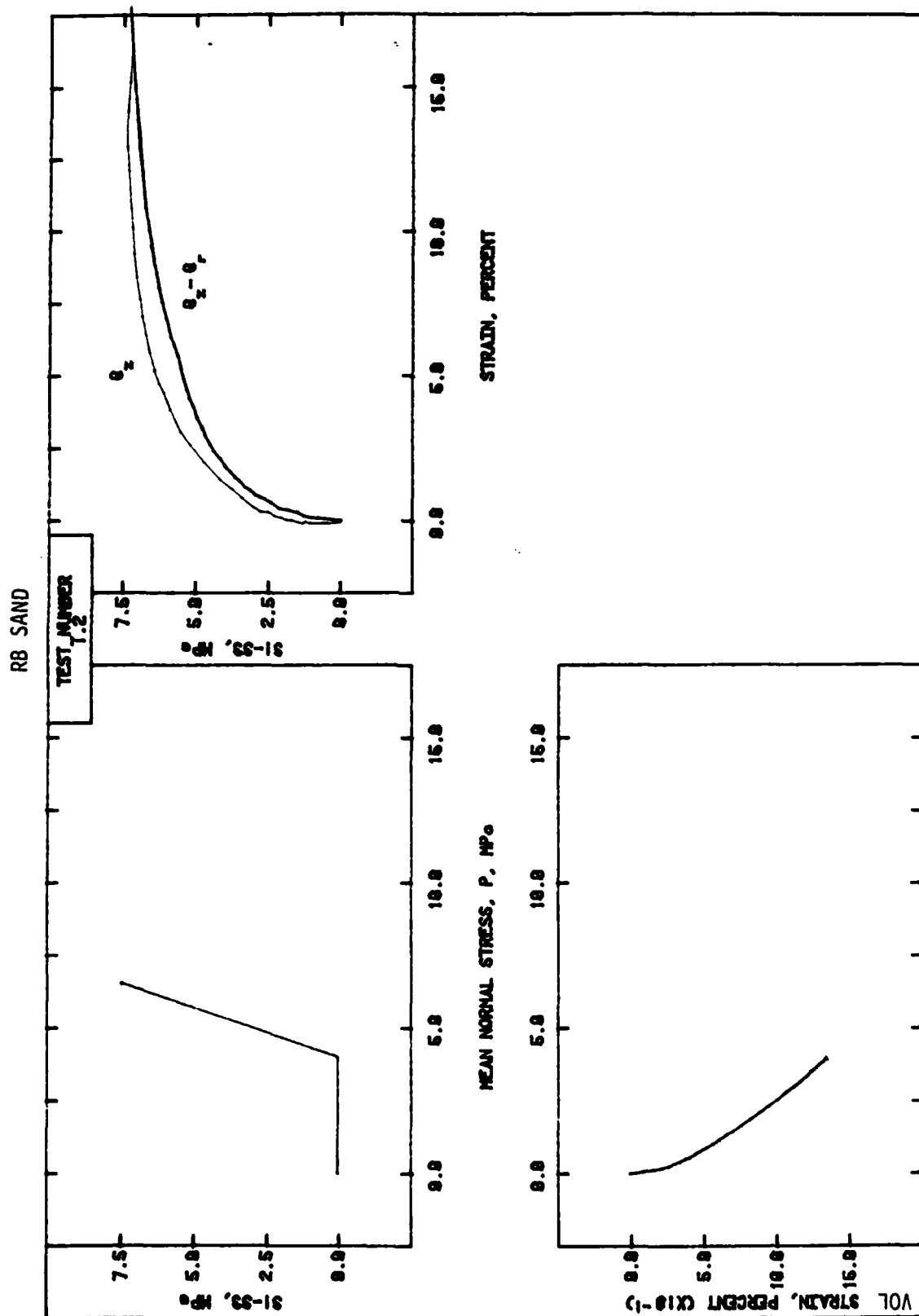
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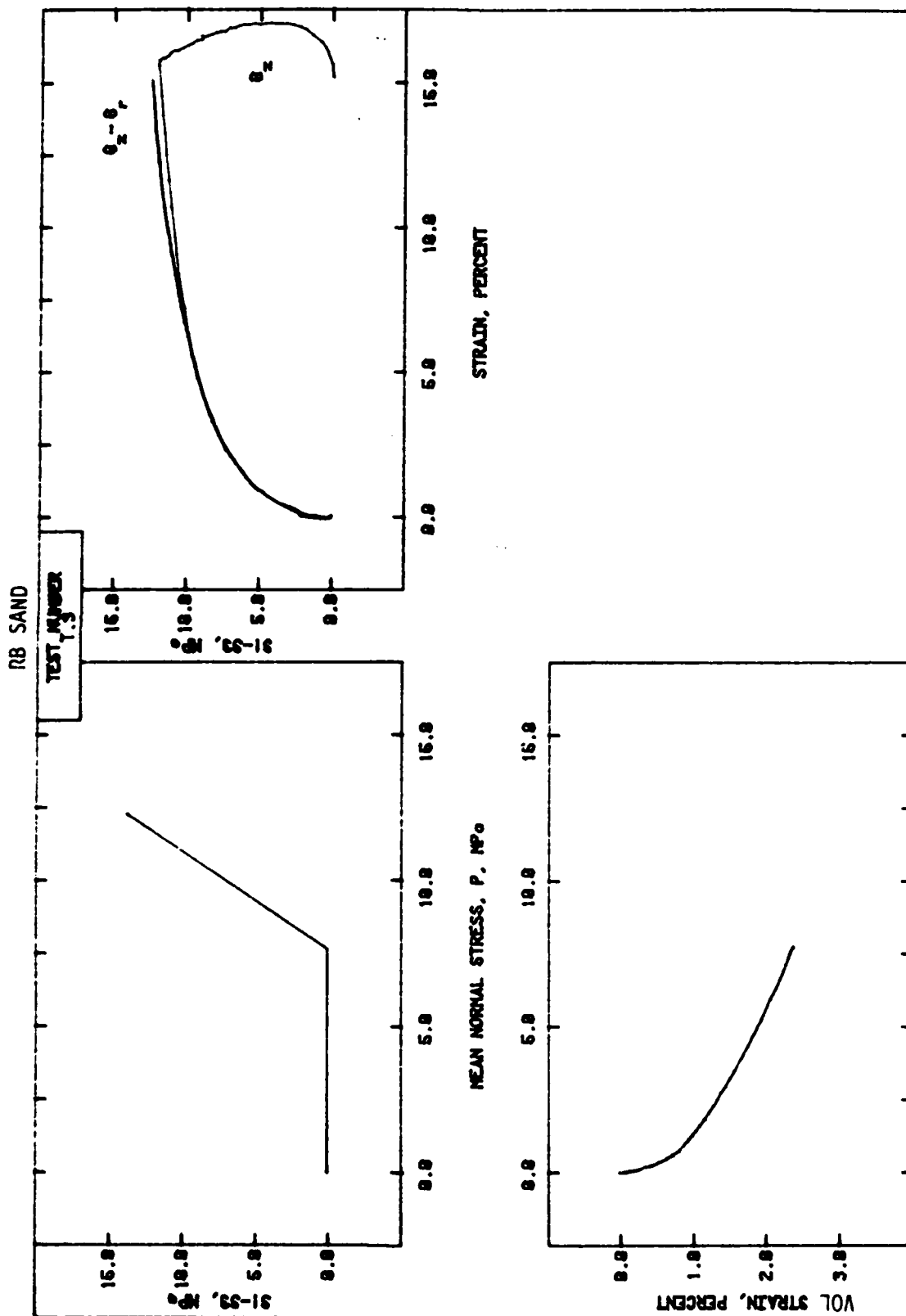
RB SAND
TEST NUMBER: N.1
STATIC UNIAXIAL STRAIN/NULL TEST

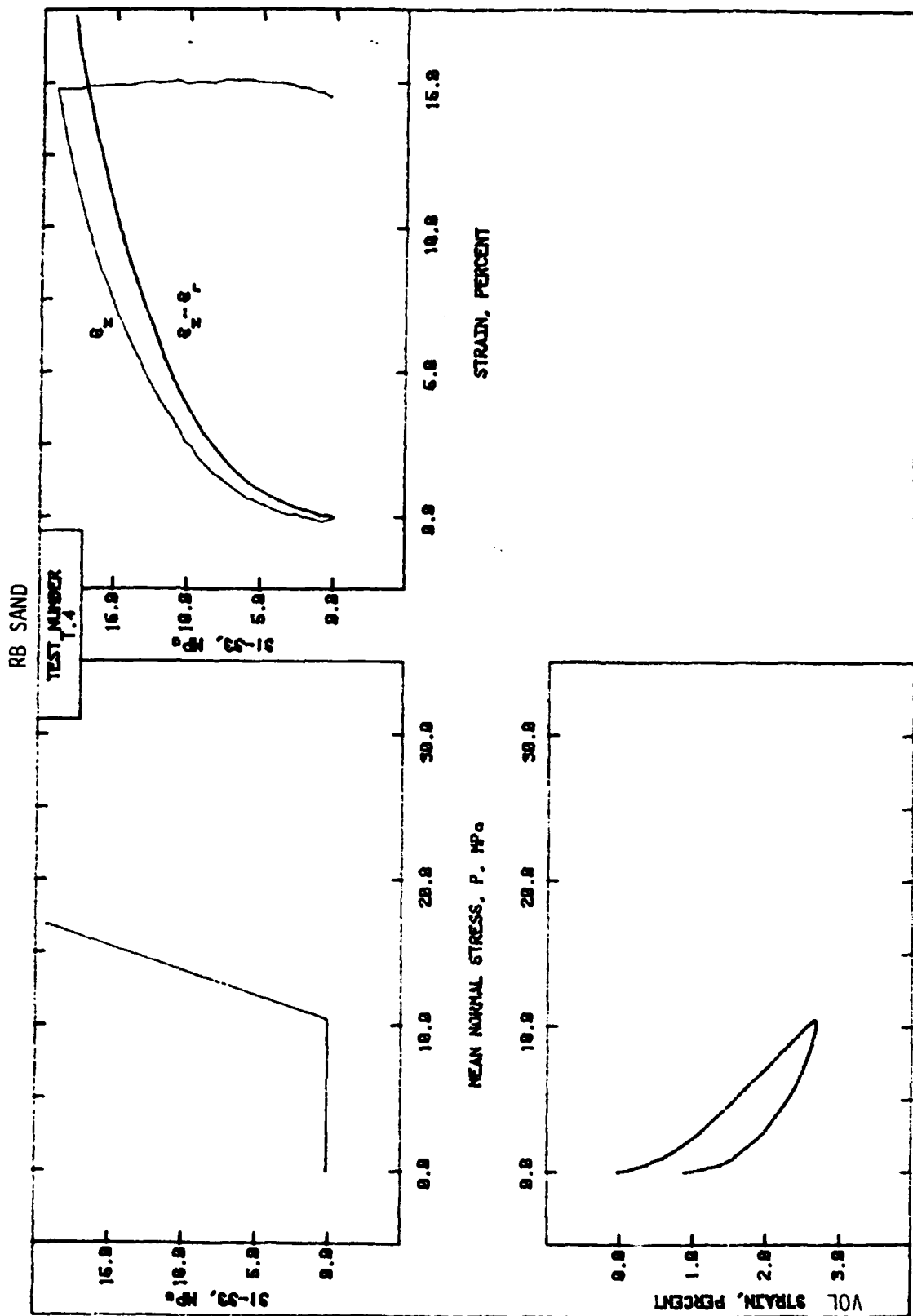


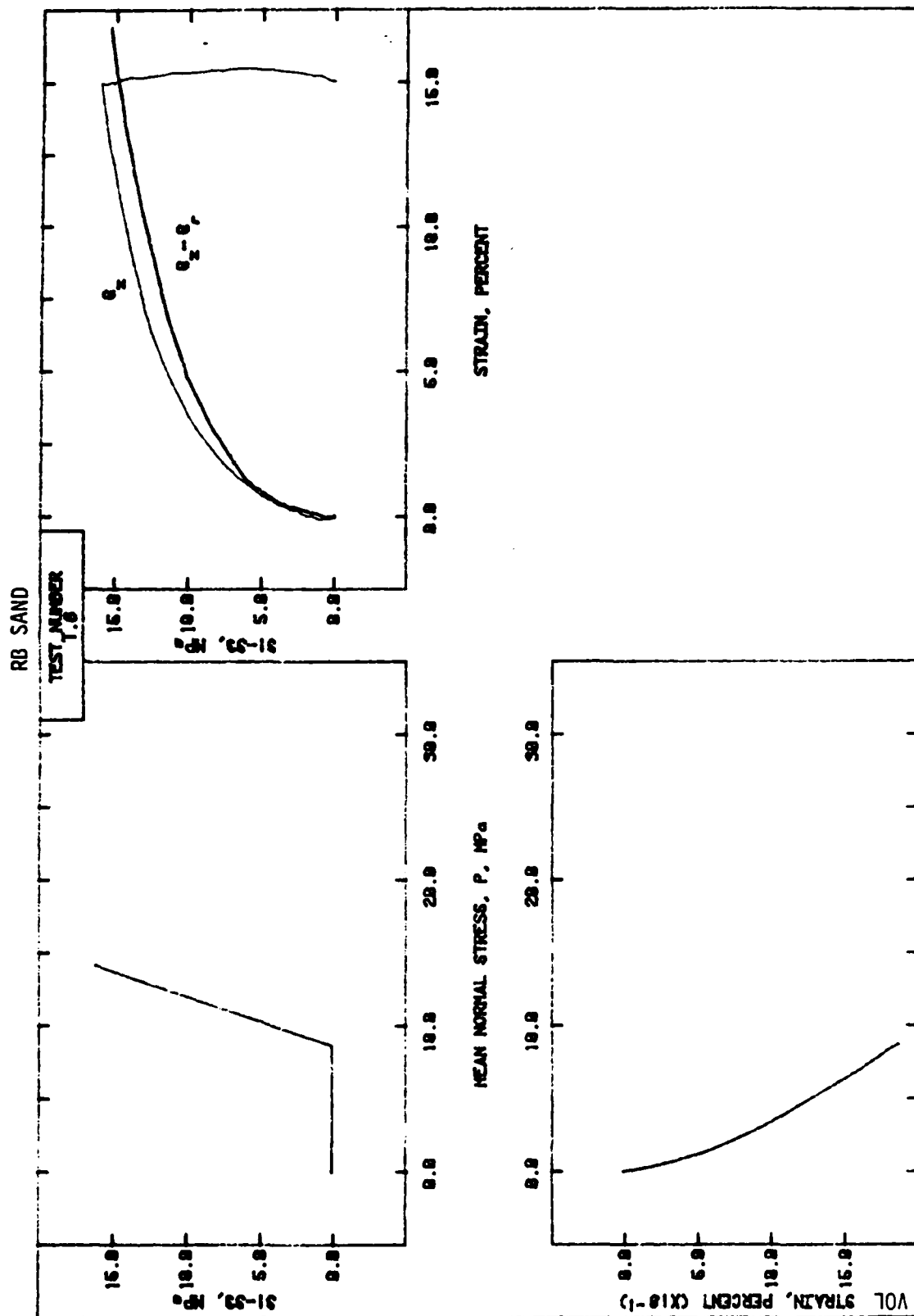
REID BEDFORD MODEL SAND
STATIC IC-TX AND IC TESTS

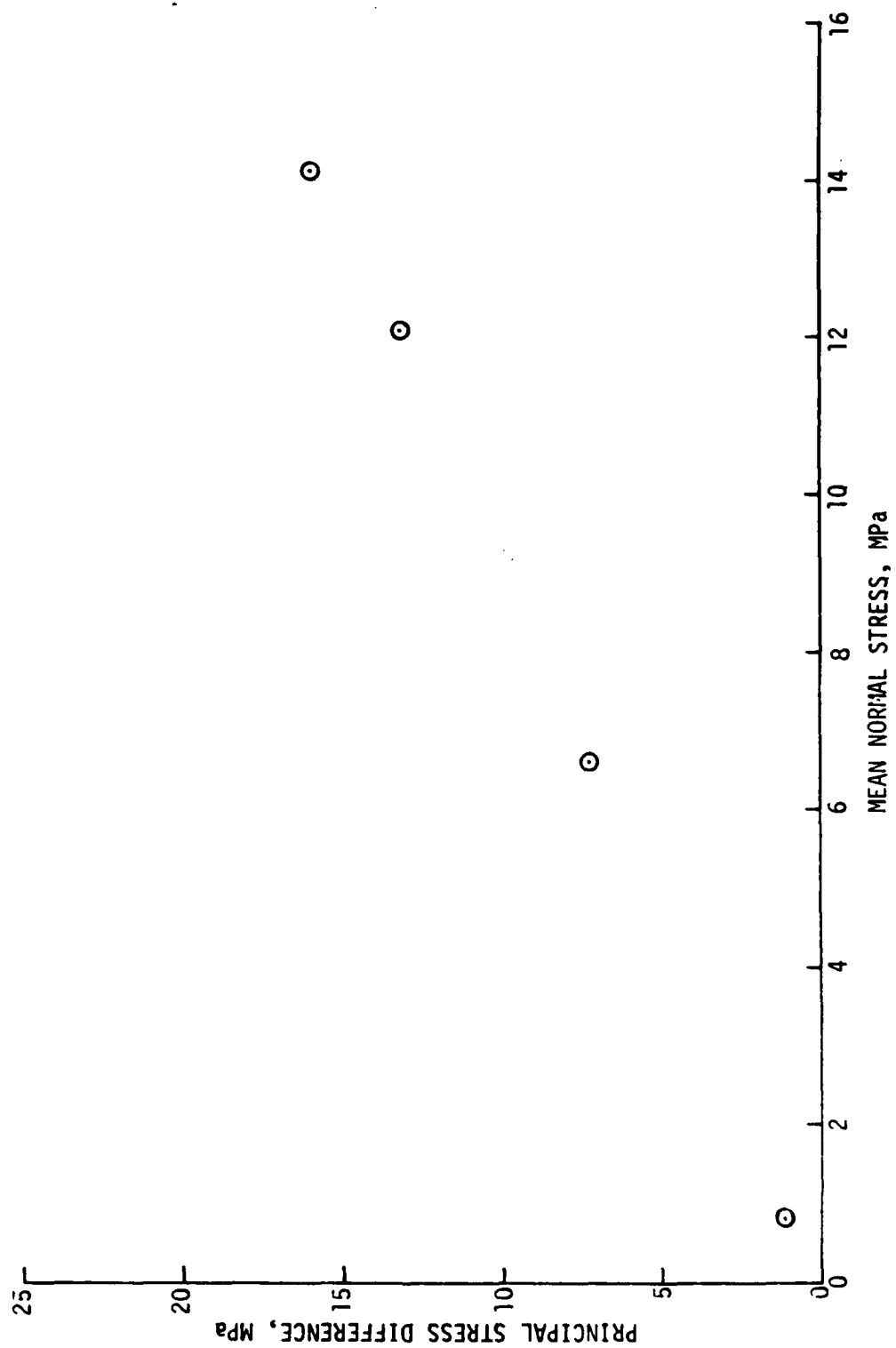




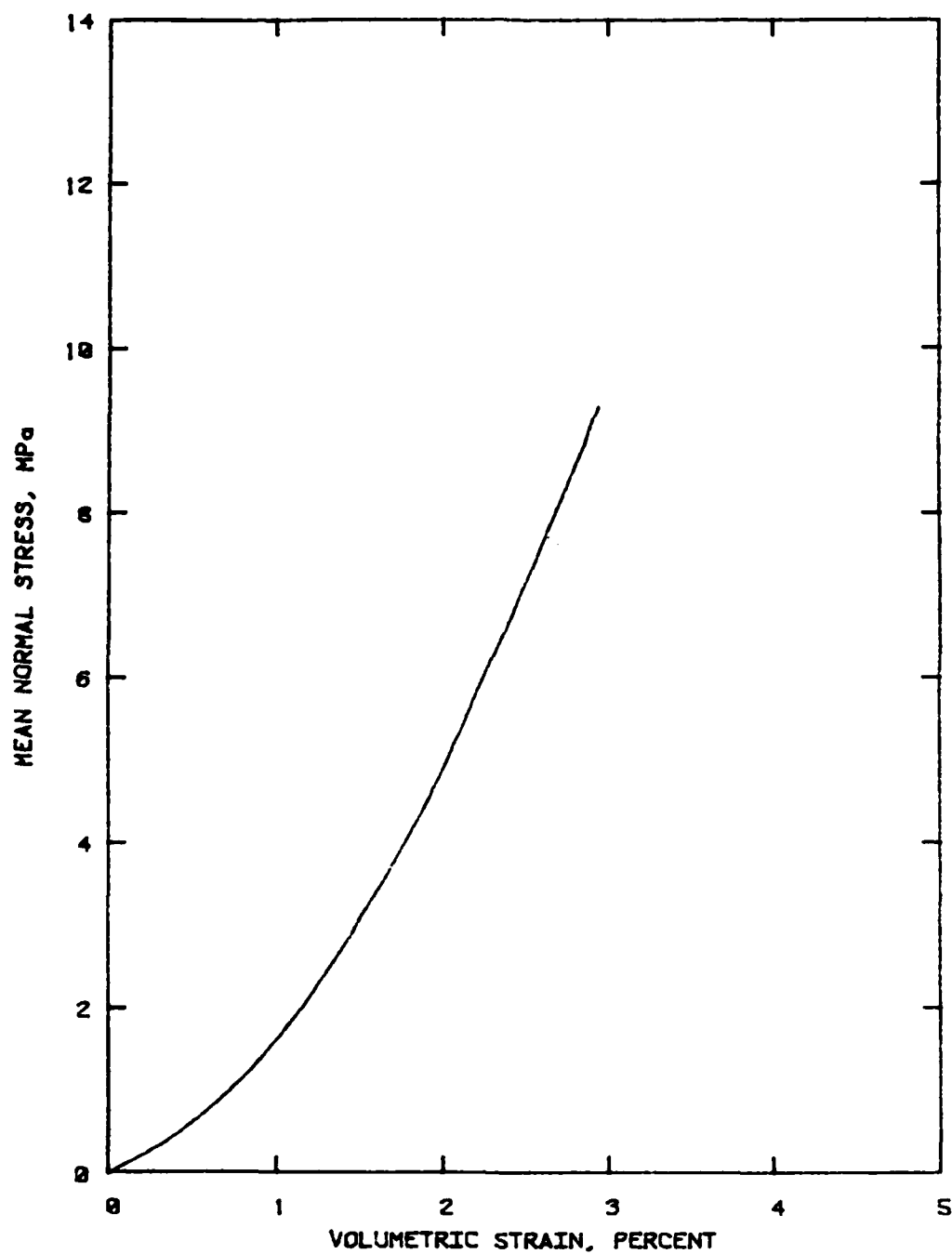








Failure data for Reid Bedford Model sand specimens

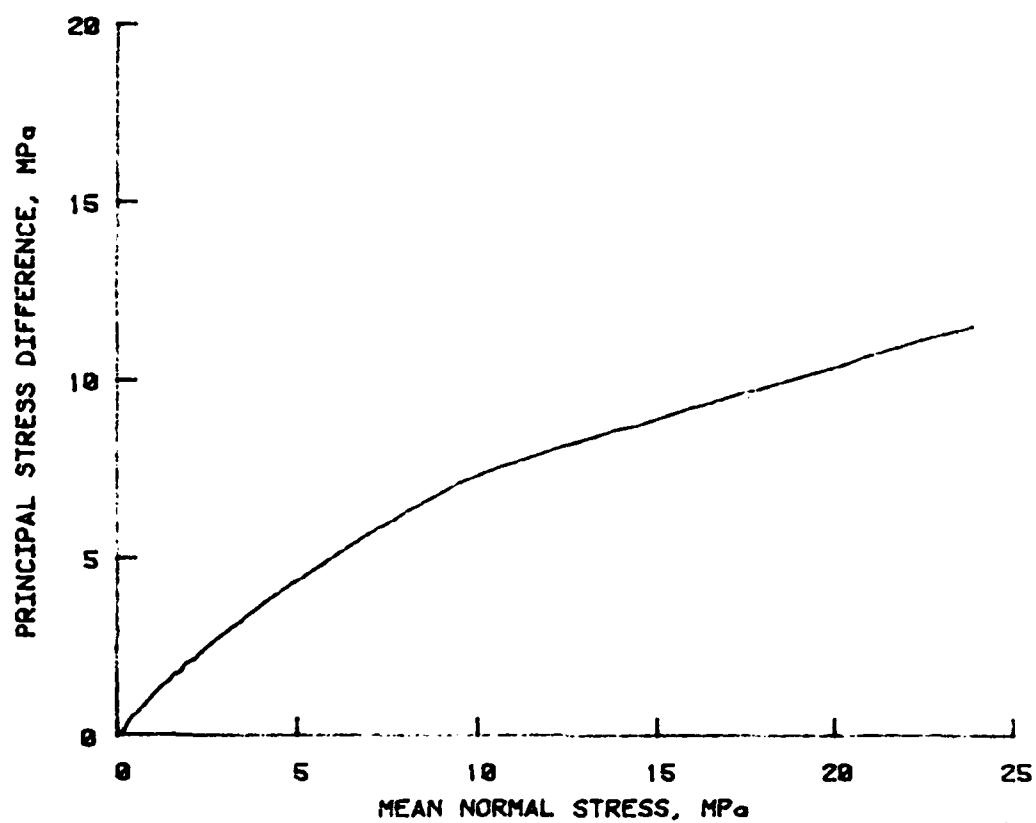
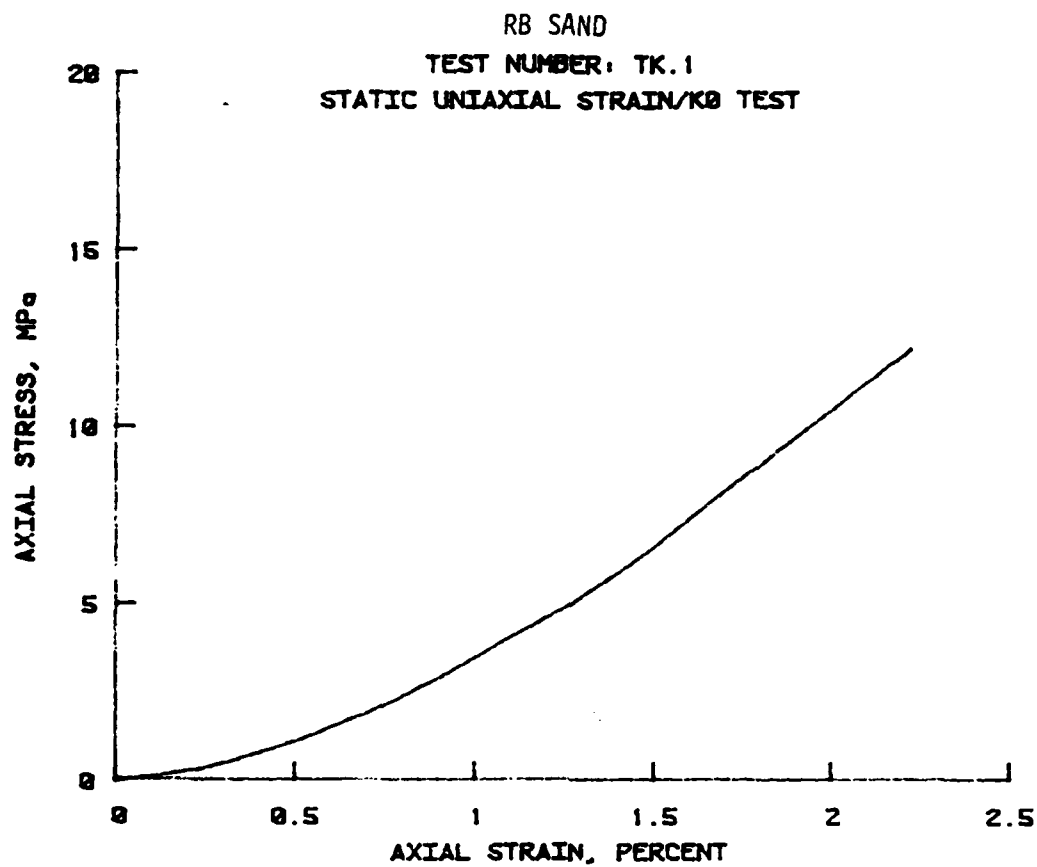


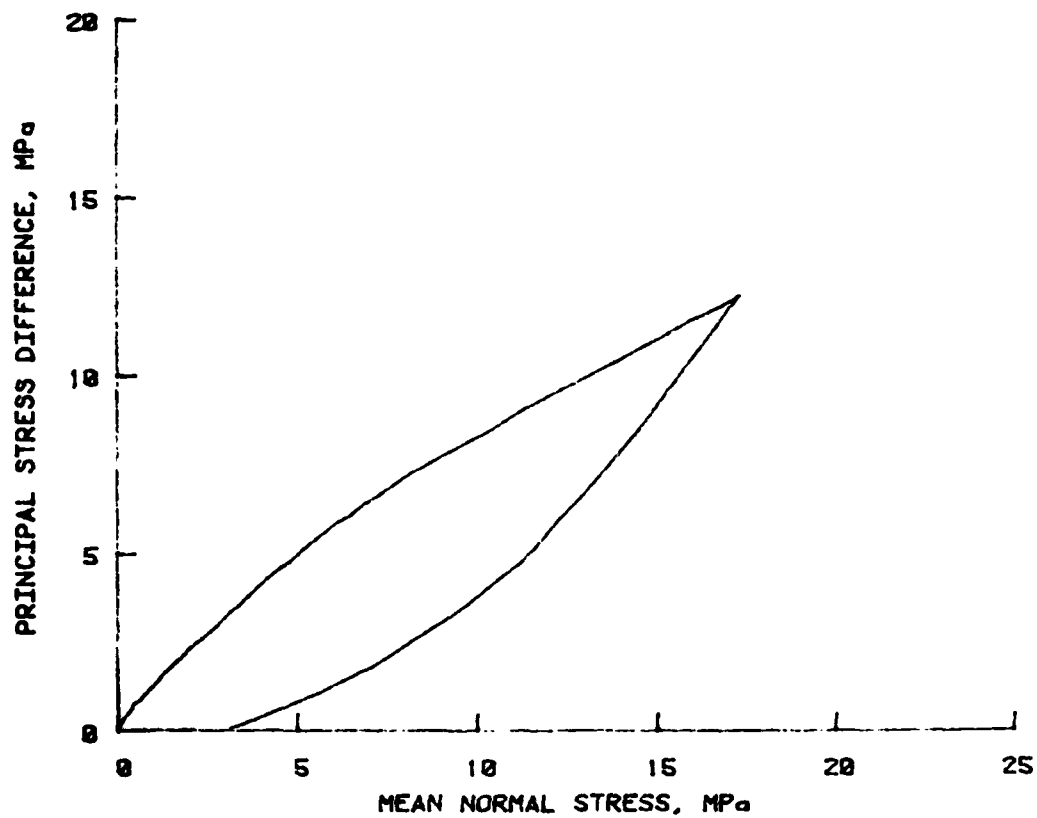
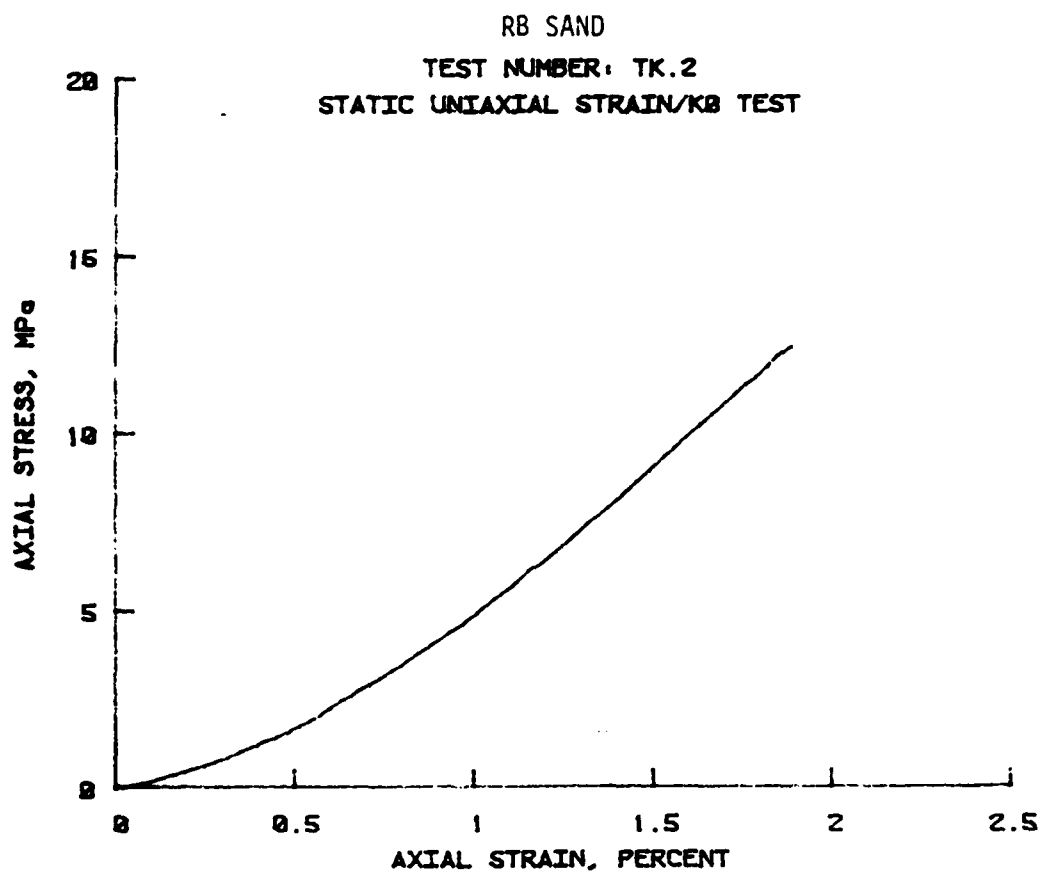
RB SAND
TEST NUMBER: TH.1
STATIC ISOTROPIC COMPRESSION TEST

PLATE 12

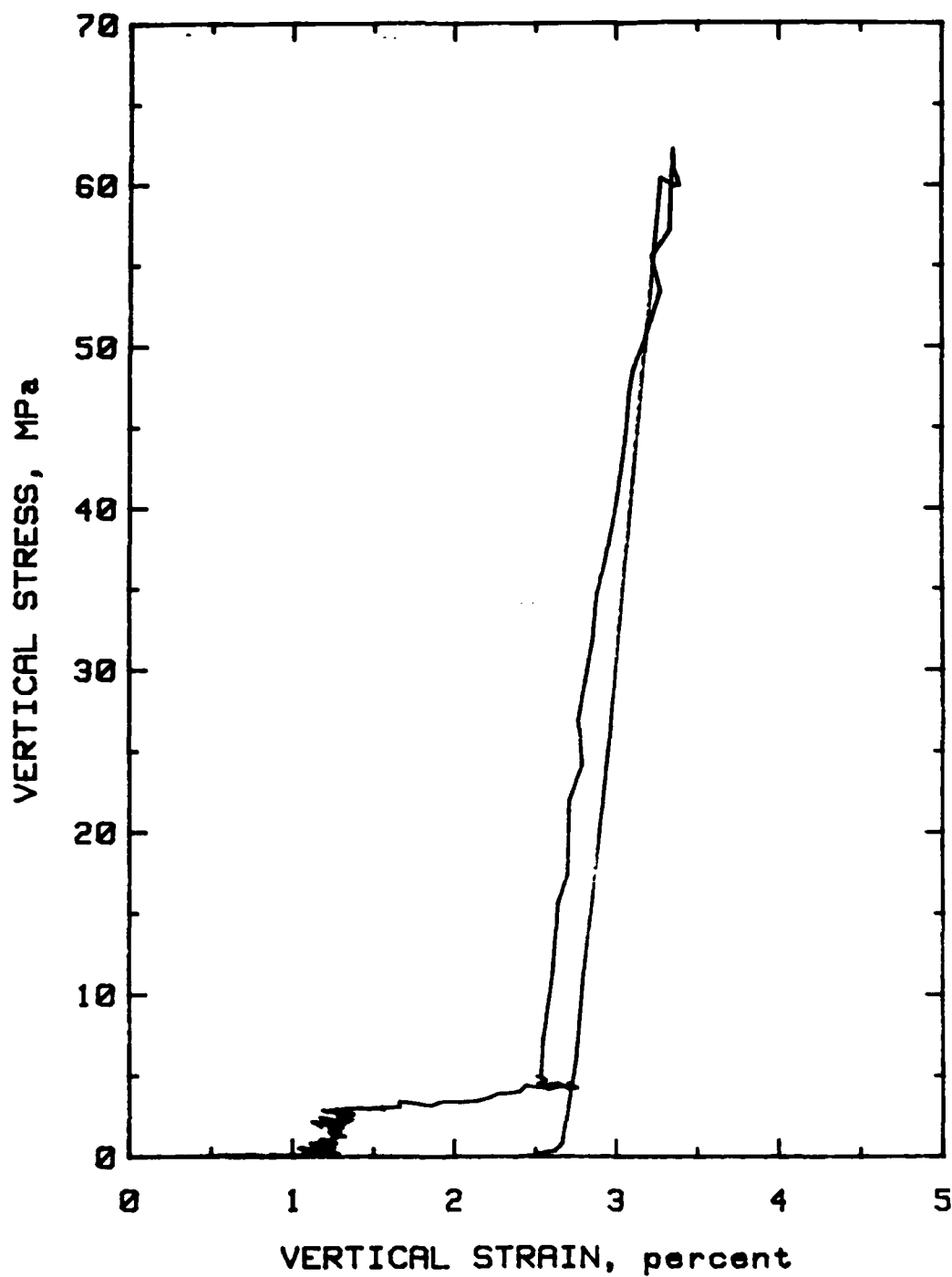
REID BEDFORD MODEL SAND

STATIC UX/K_0 TESTS





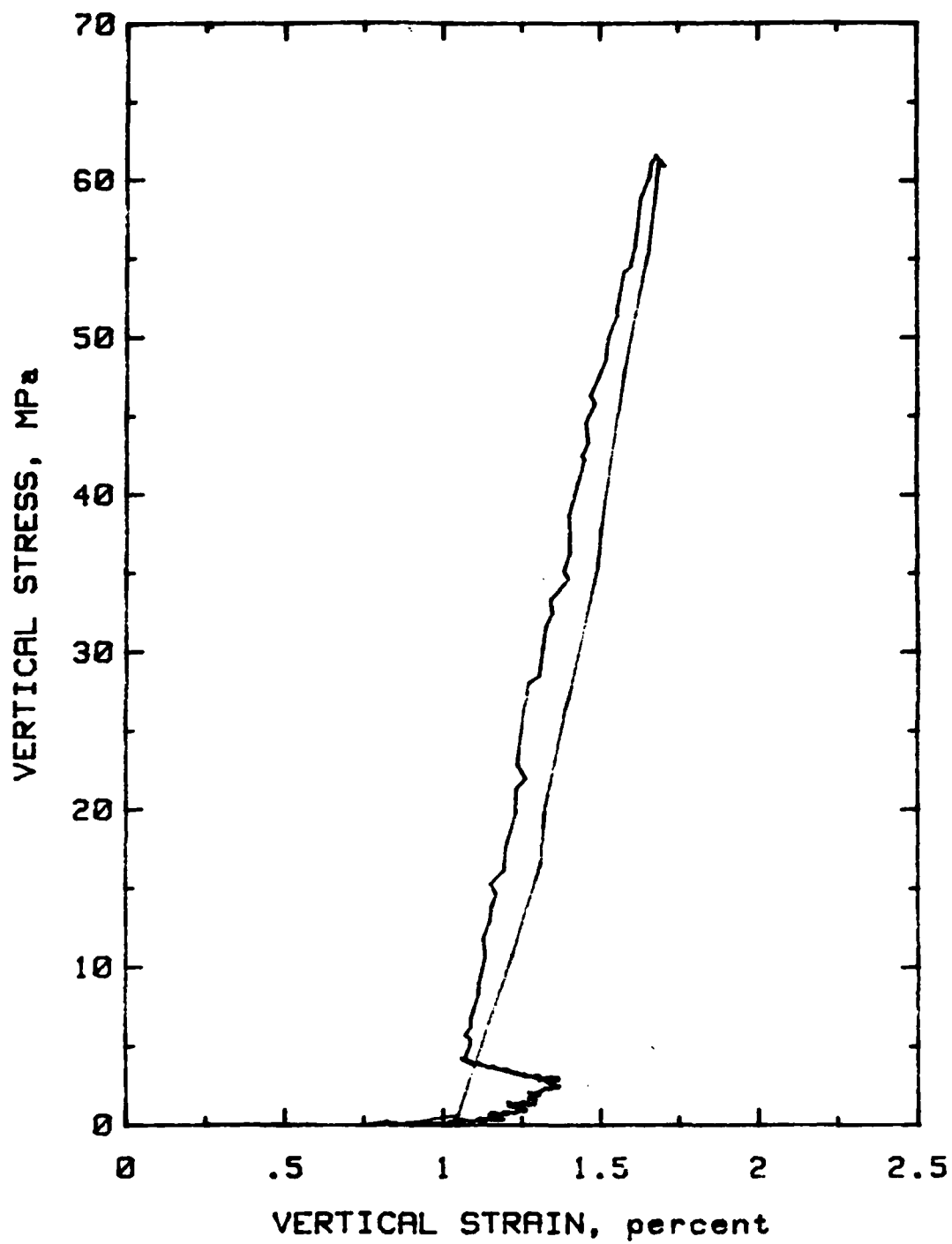
MISERS BLUFF SAND
STATIC AND DYNAMIC UX TESTS



BACK PRESSURE SATURATED CONSOLIDATED
STATIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNR.UX.1S

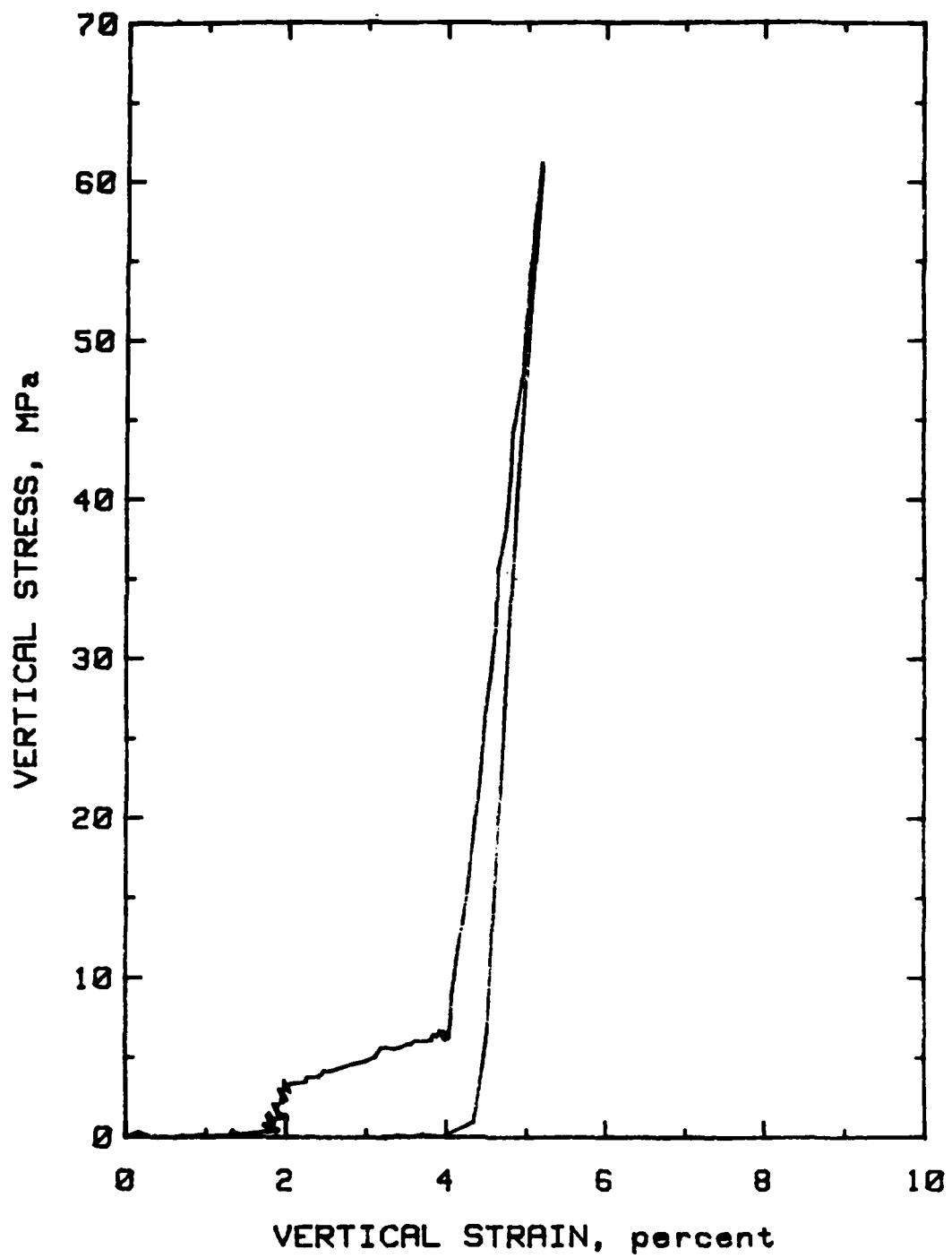
MB SAND

PLATE 15



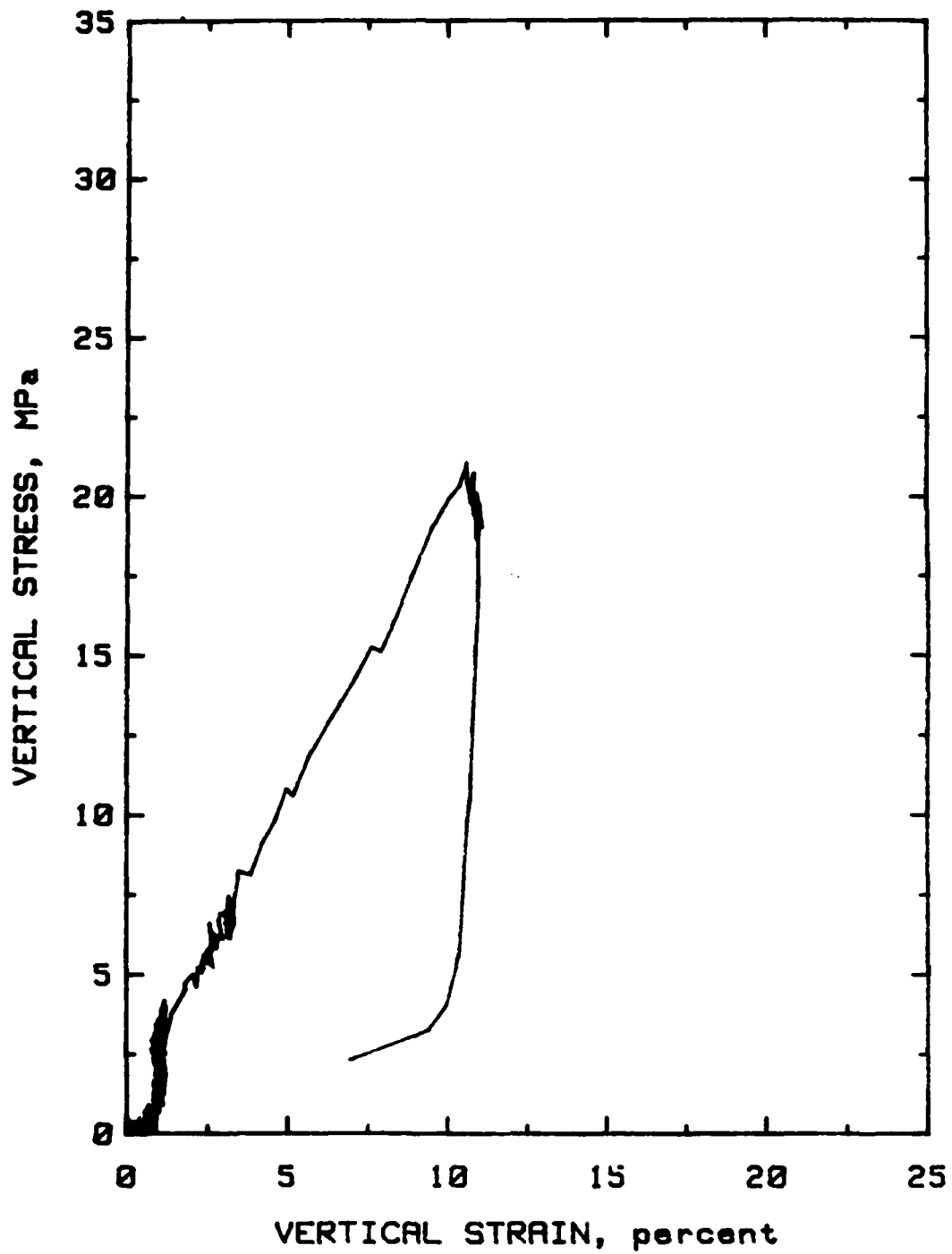
BACK PRESSURE SATURATED CONSOLIDATED
STATIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.26A

MB SAND



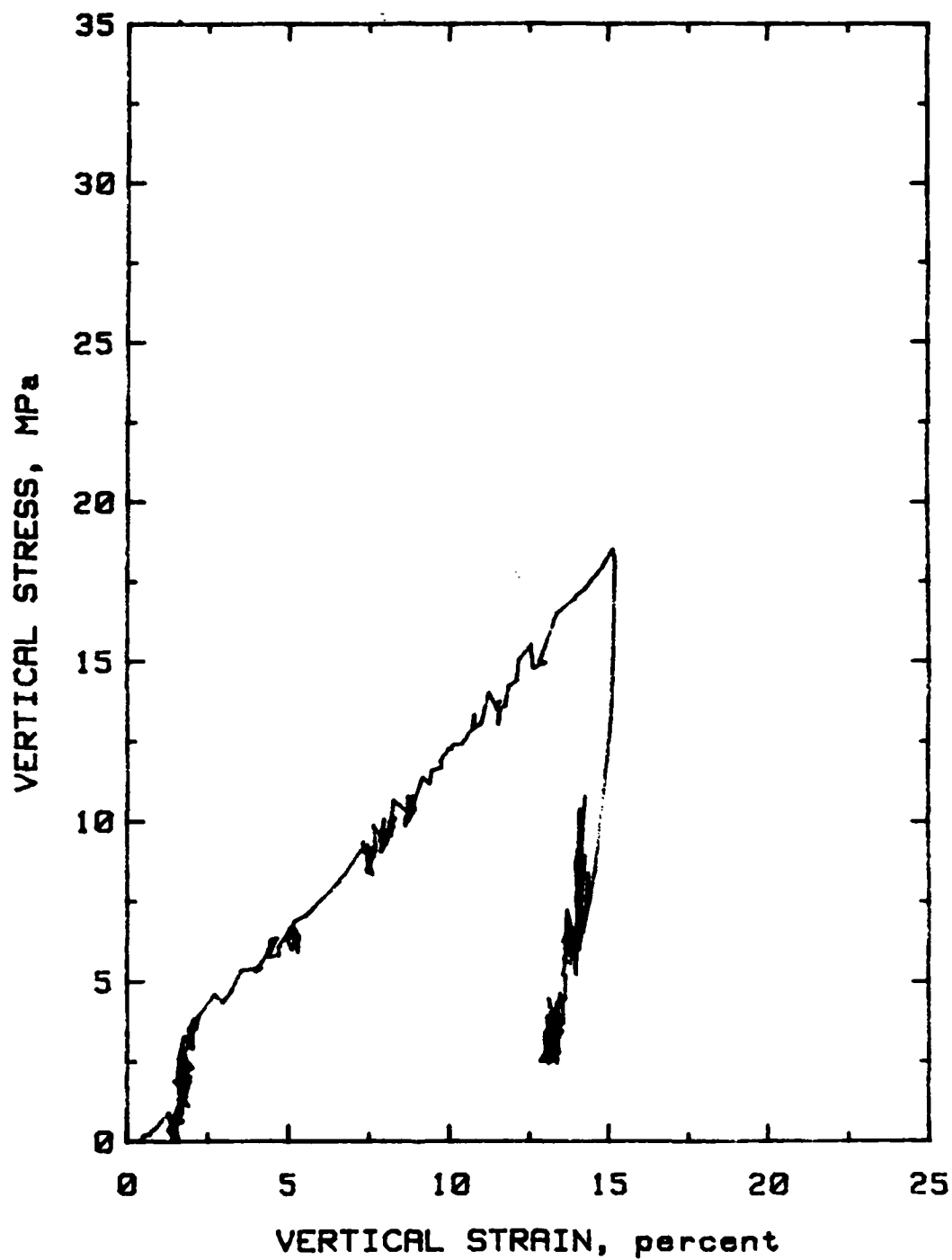
BACK PRESSURE SATURATED CONSOLIDATED
STATIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNR.UX.3S
MB SAND

PLATE 17

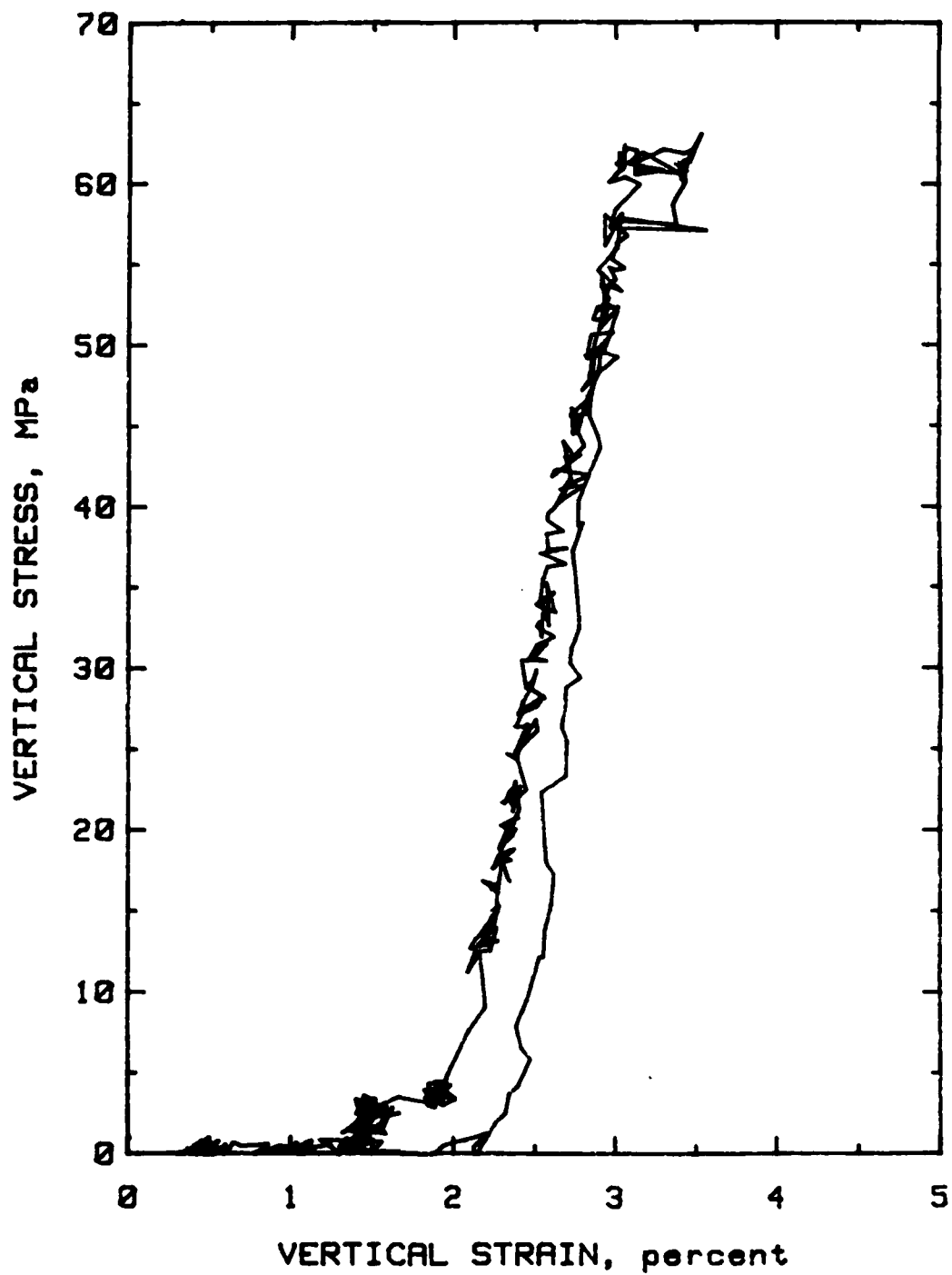


BACK PRESSURE SATURATED CONSOLIDATED
STATIC DRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.5S

MB SAND

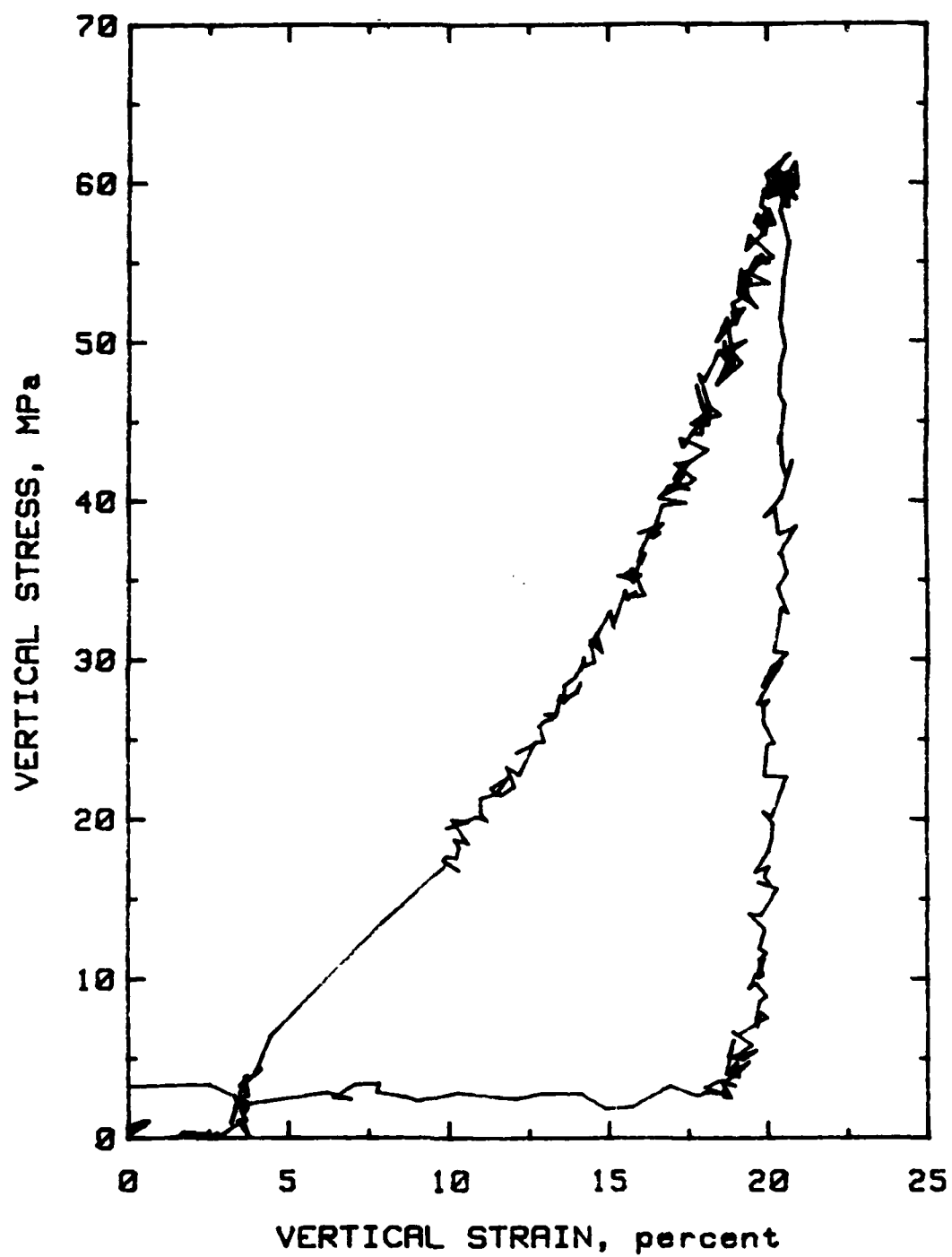


BACK PRESSURE SATURATED CONSOLIDATED
STATIC DRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.5SA
MB SAND



BACK PRESSURE SATURATED CONSOLIDATED
STATIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.6S

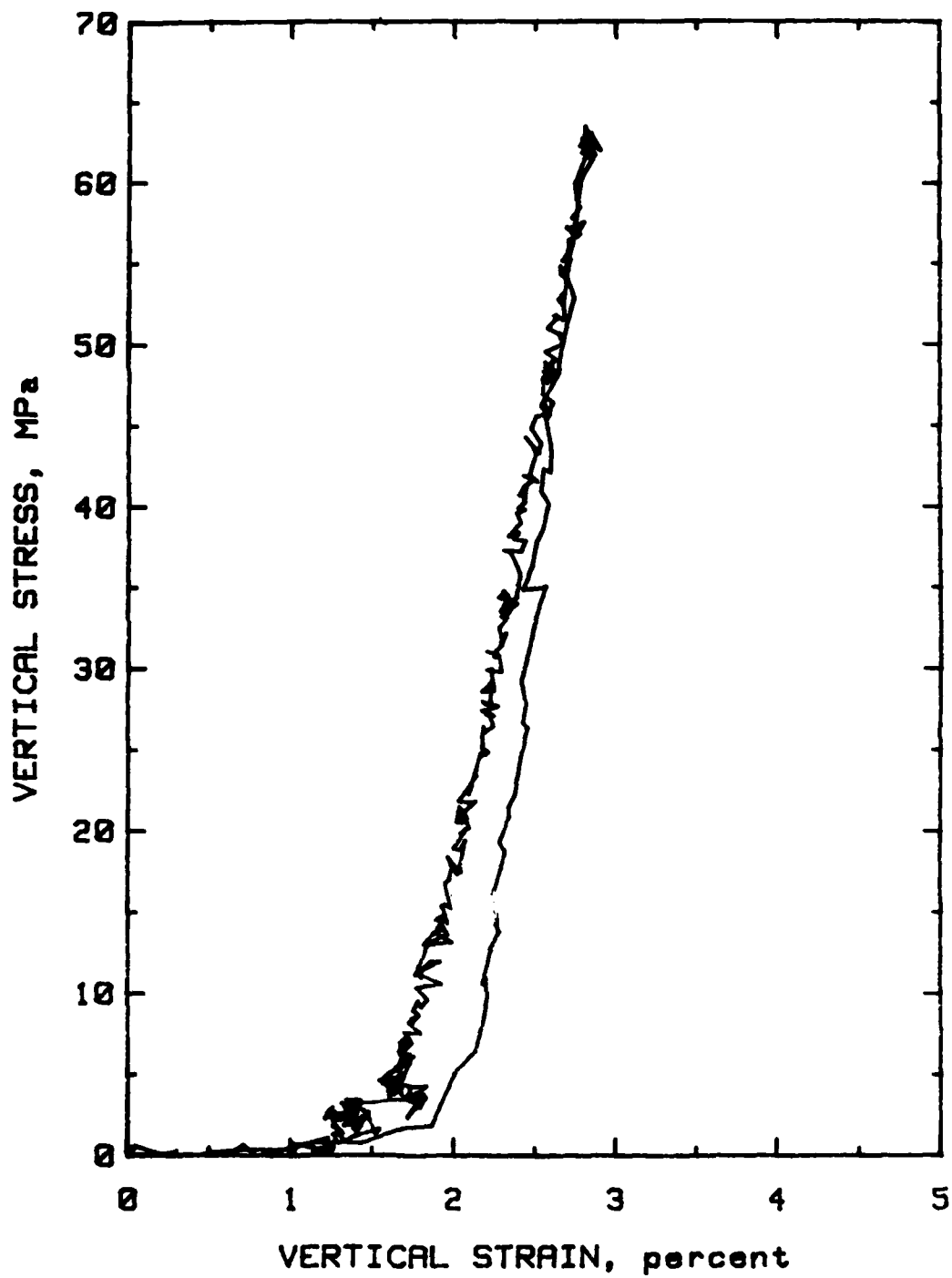
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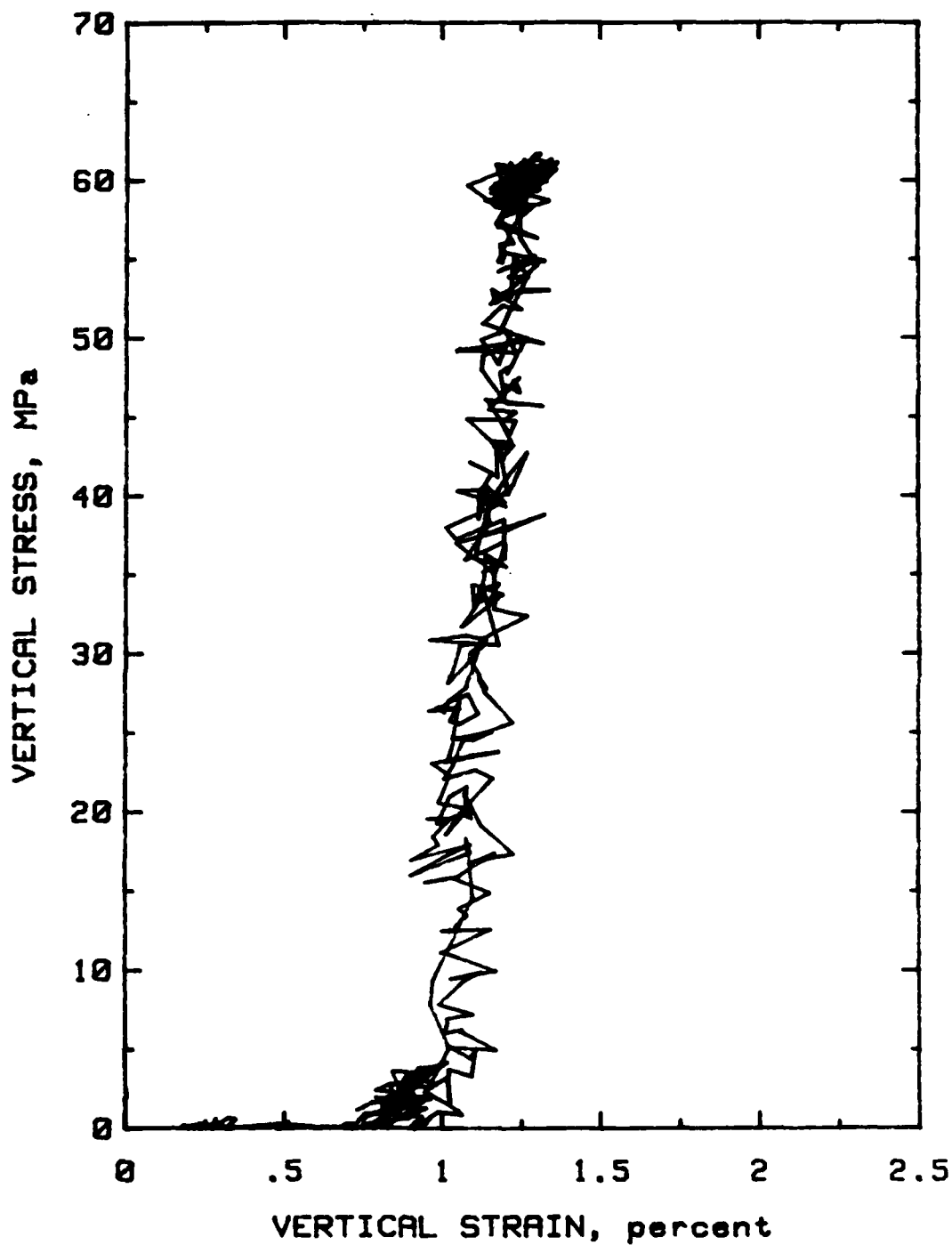
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SPECIMEN D9A.UX.7S

MB SAND

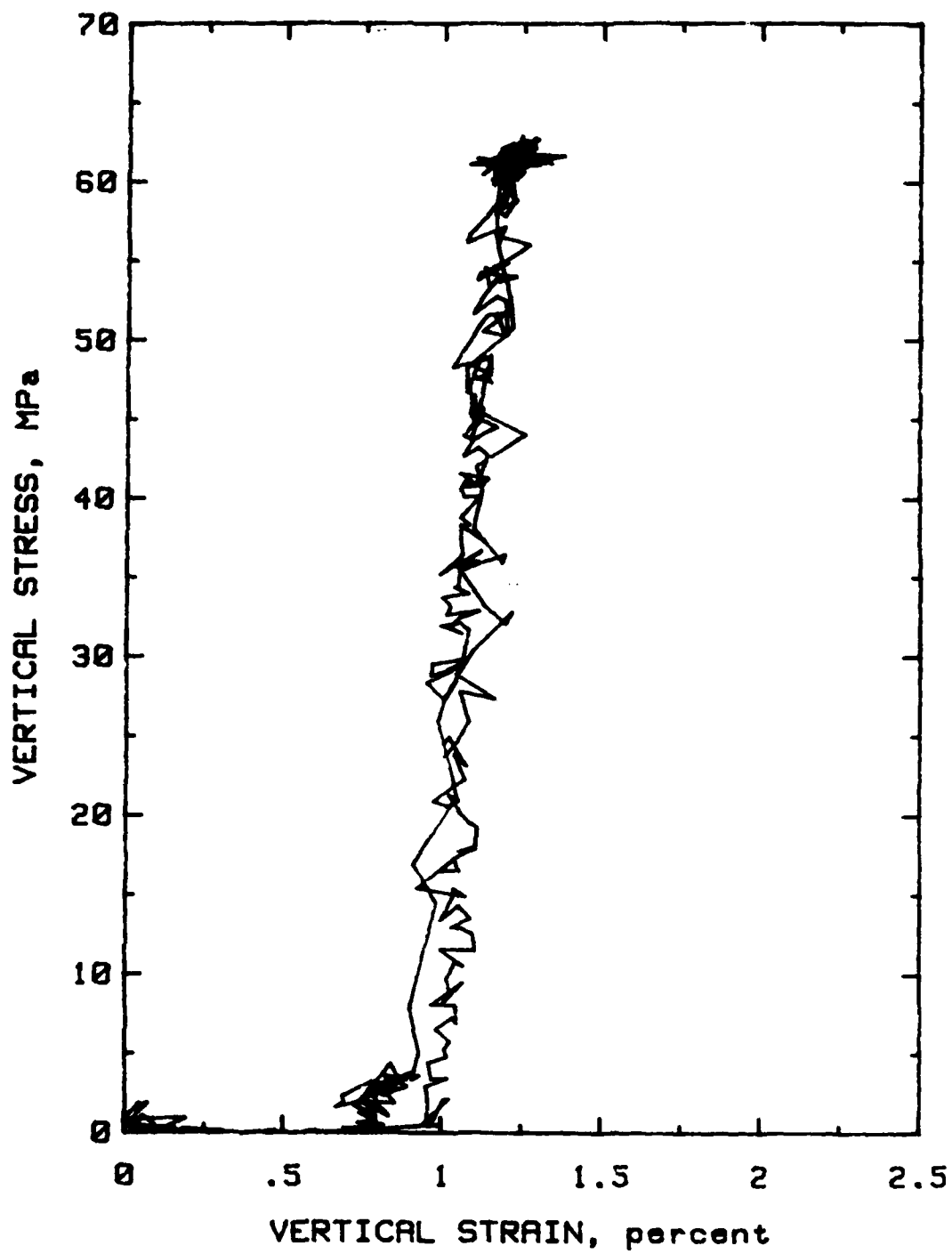
PLATE 21



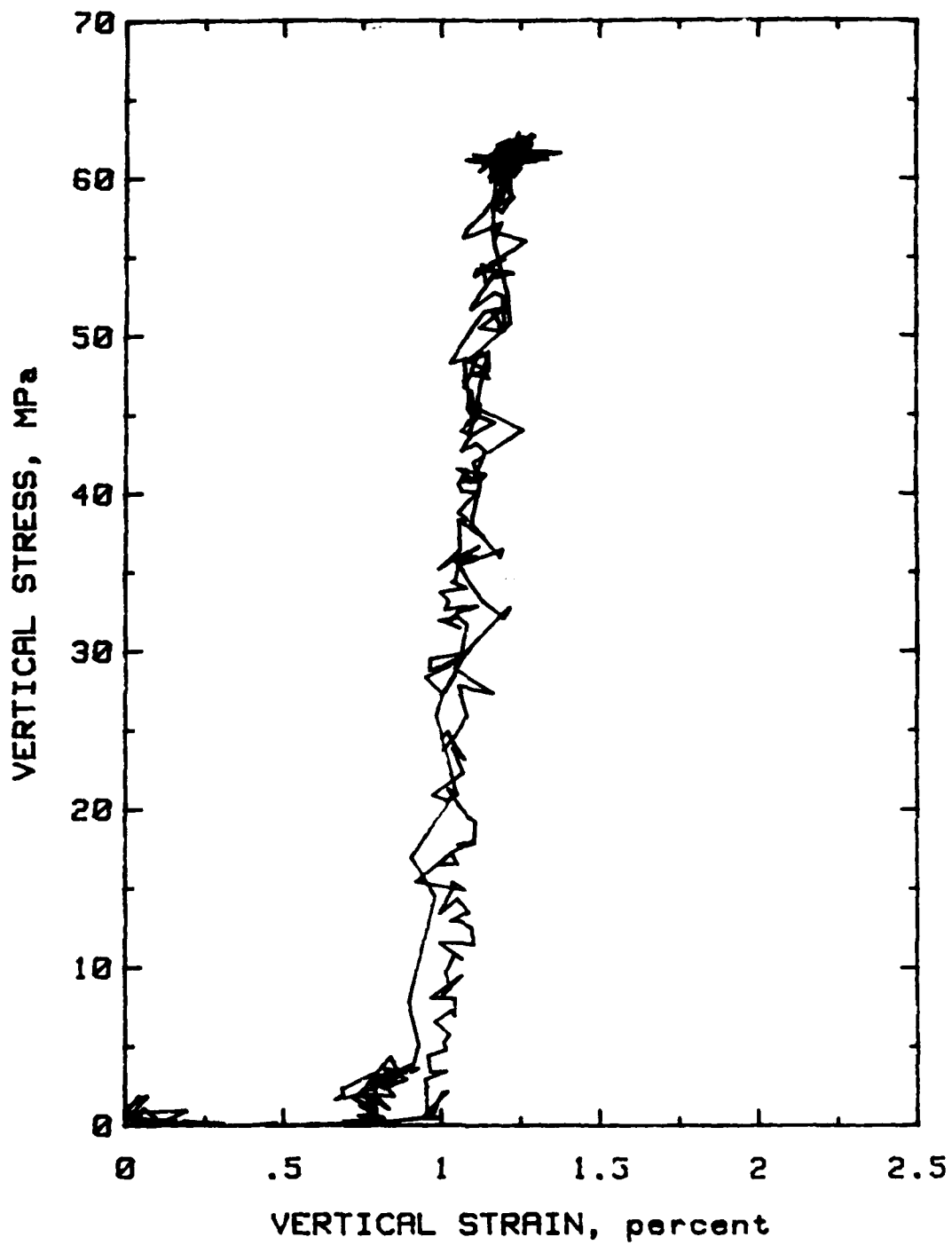
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SPECIMEN DNA.UX.8S
MB SAND



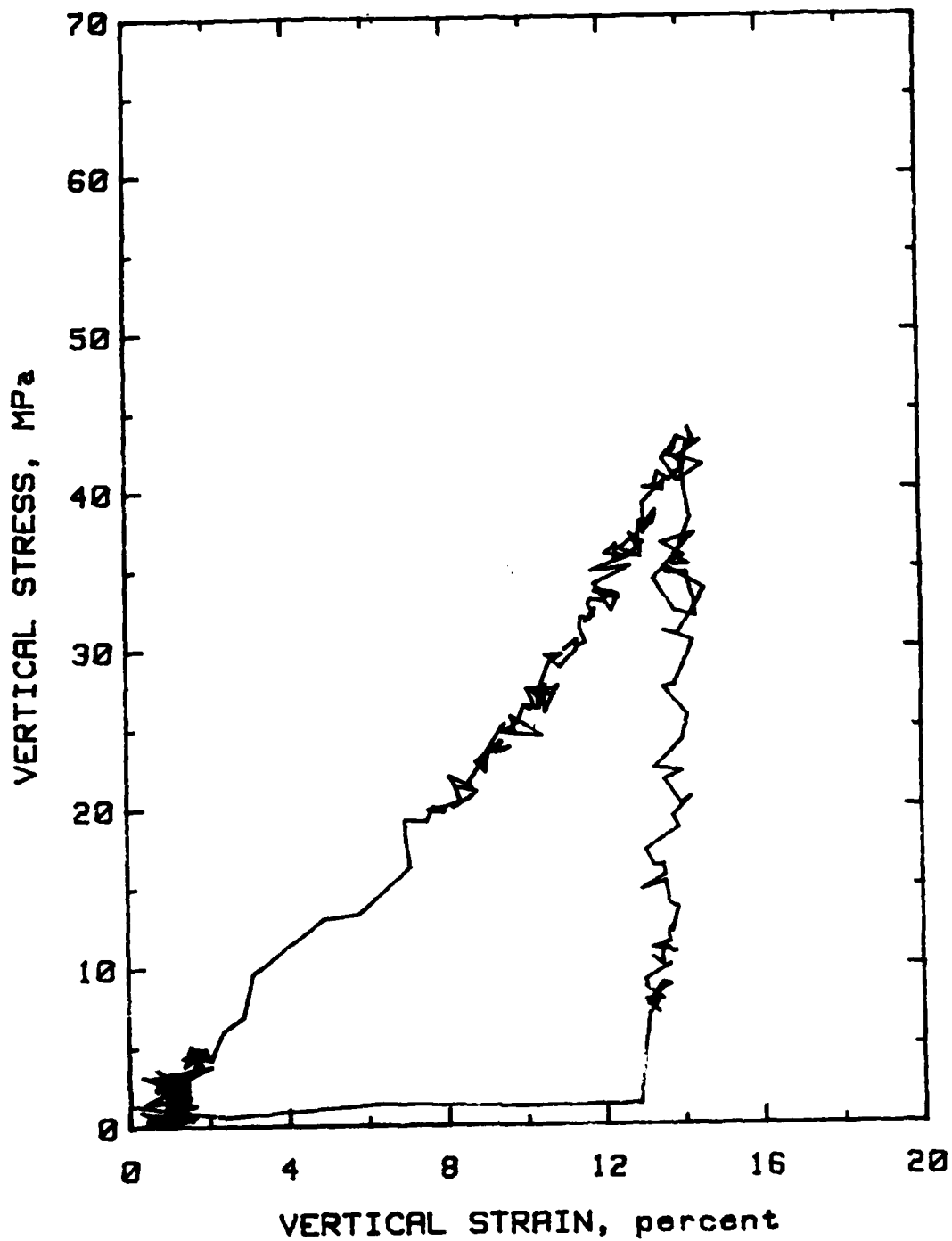
BACK PRESSURE SATURATED CONSOLIDATED
STATIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNR.UX.8SA
MB SAND



BACK PRESSURE SATURATED CONSOLIDATED
STATIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.8SB
MB SAND



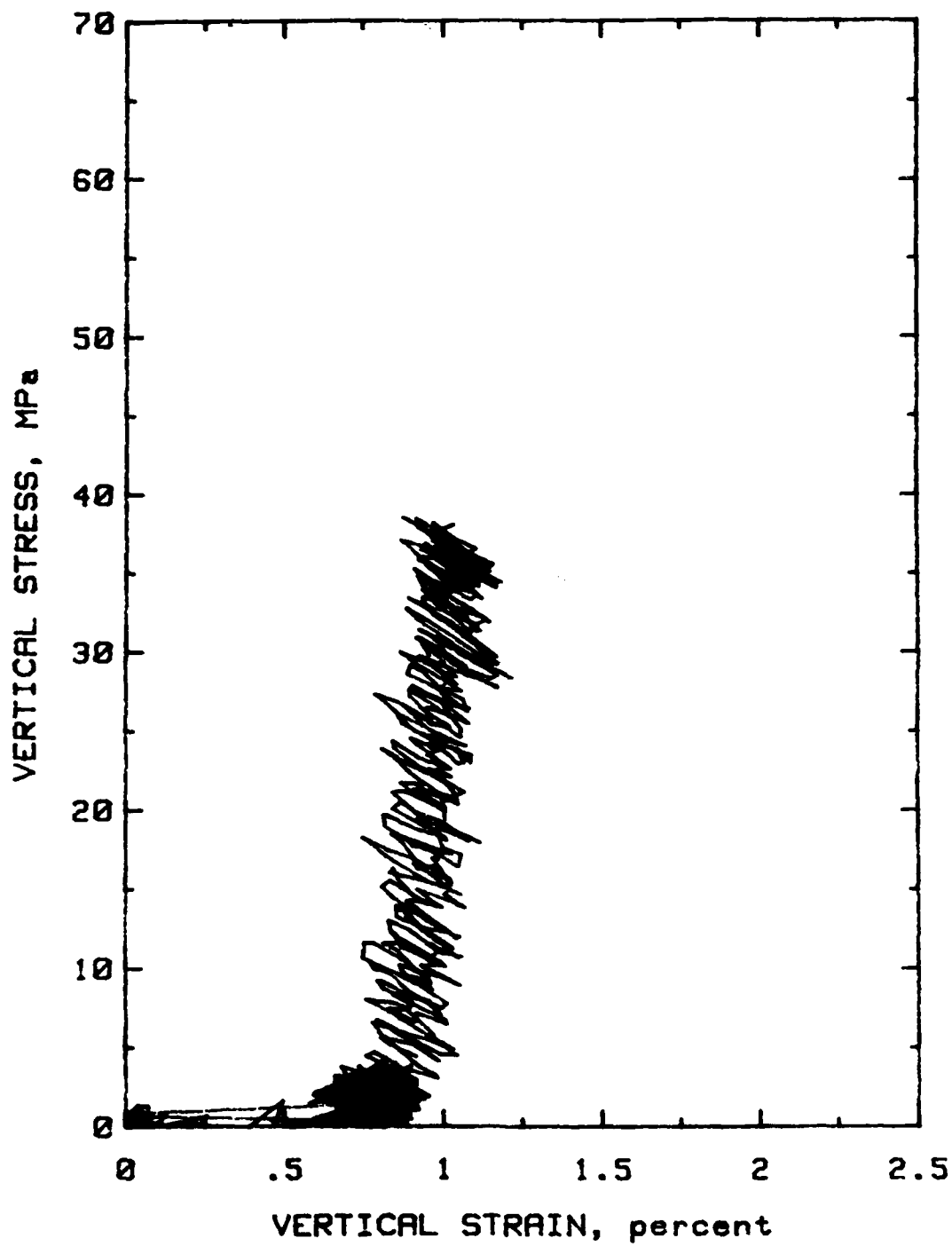
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SPECIMEN DNA.UX.8SB
MB SAND



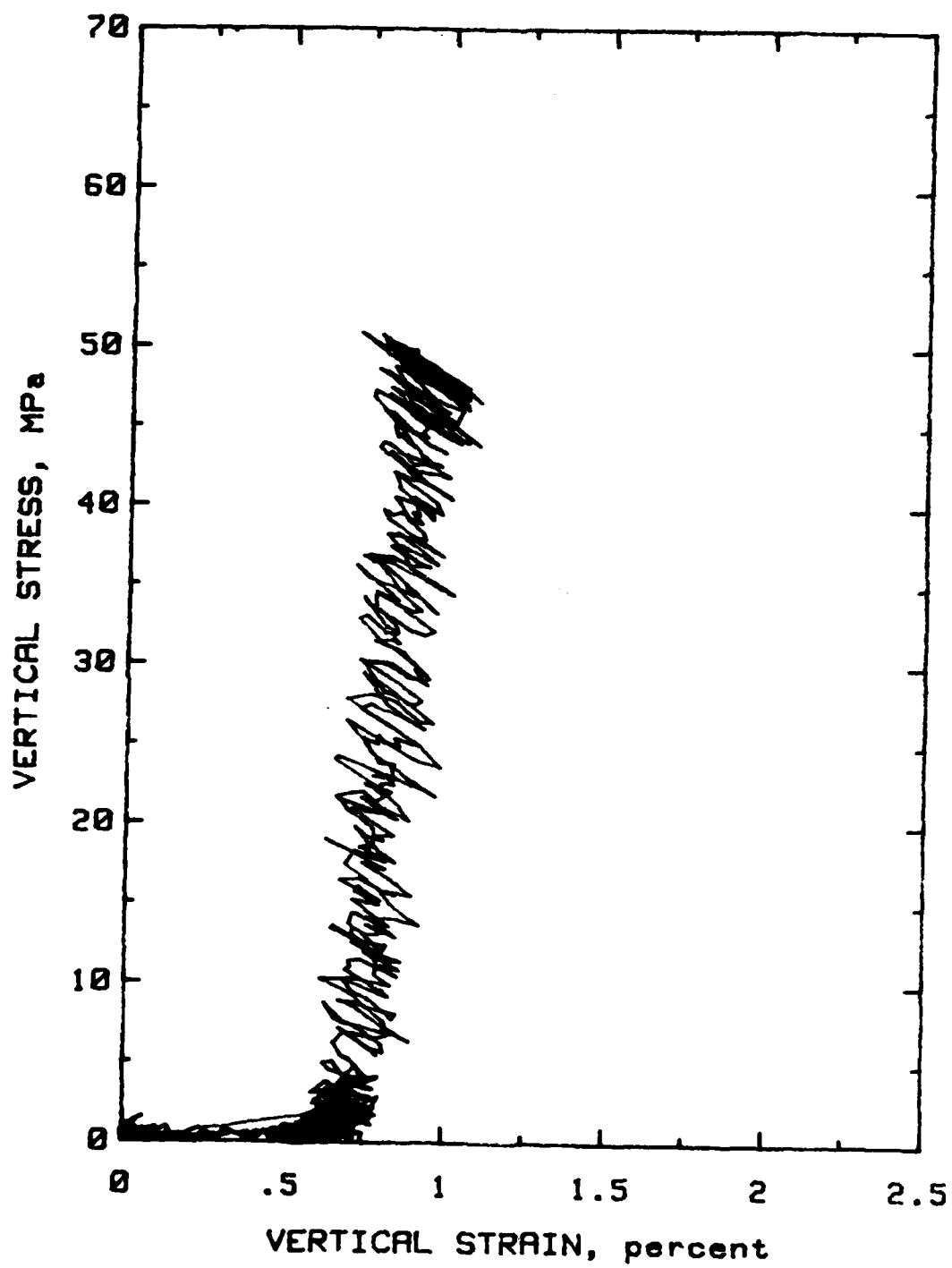
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STATIC DRAINED UNIAXIAL STRAIN
SPECIMEN DNR.UX.9S

MB SAND

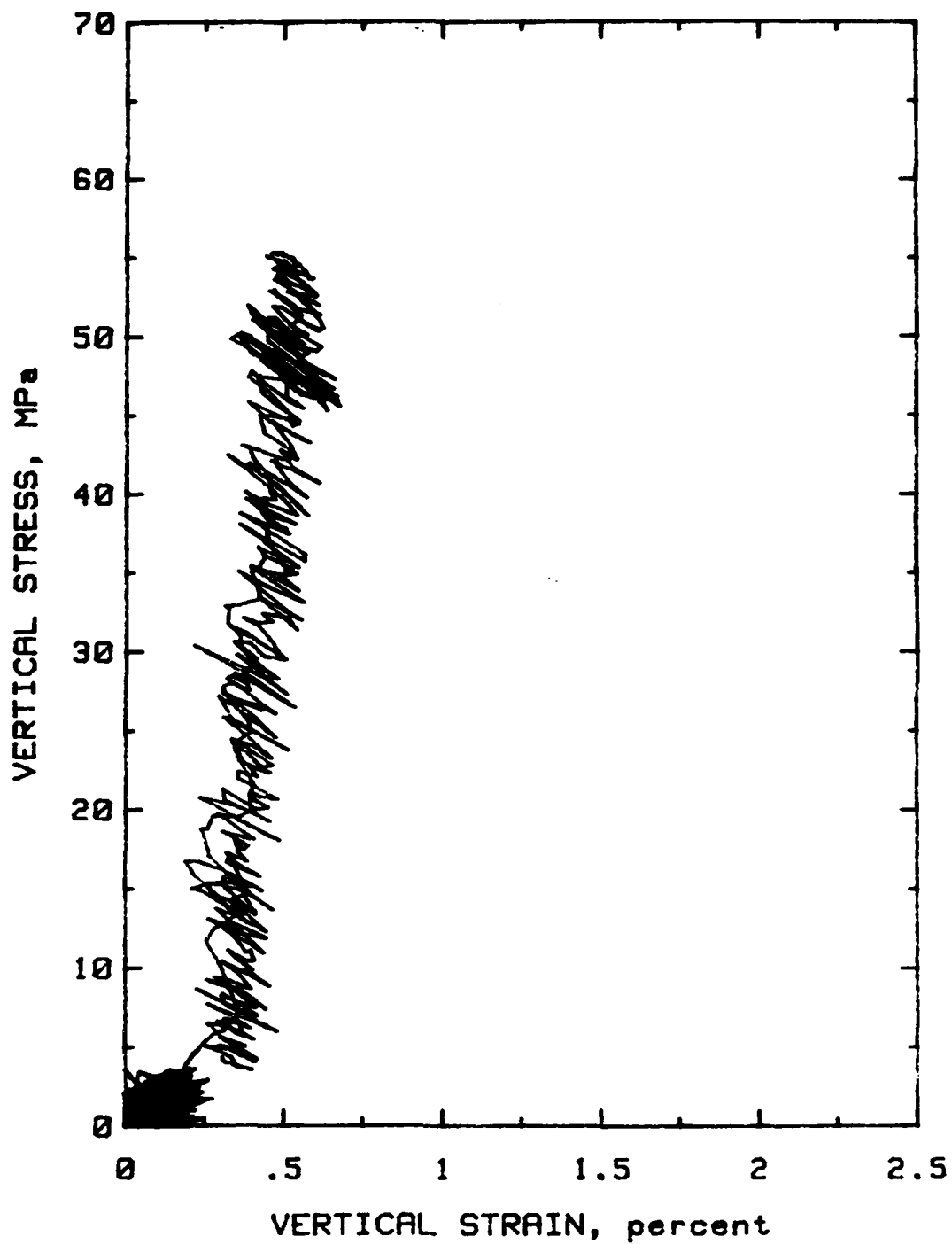
PLATE 25



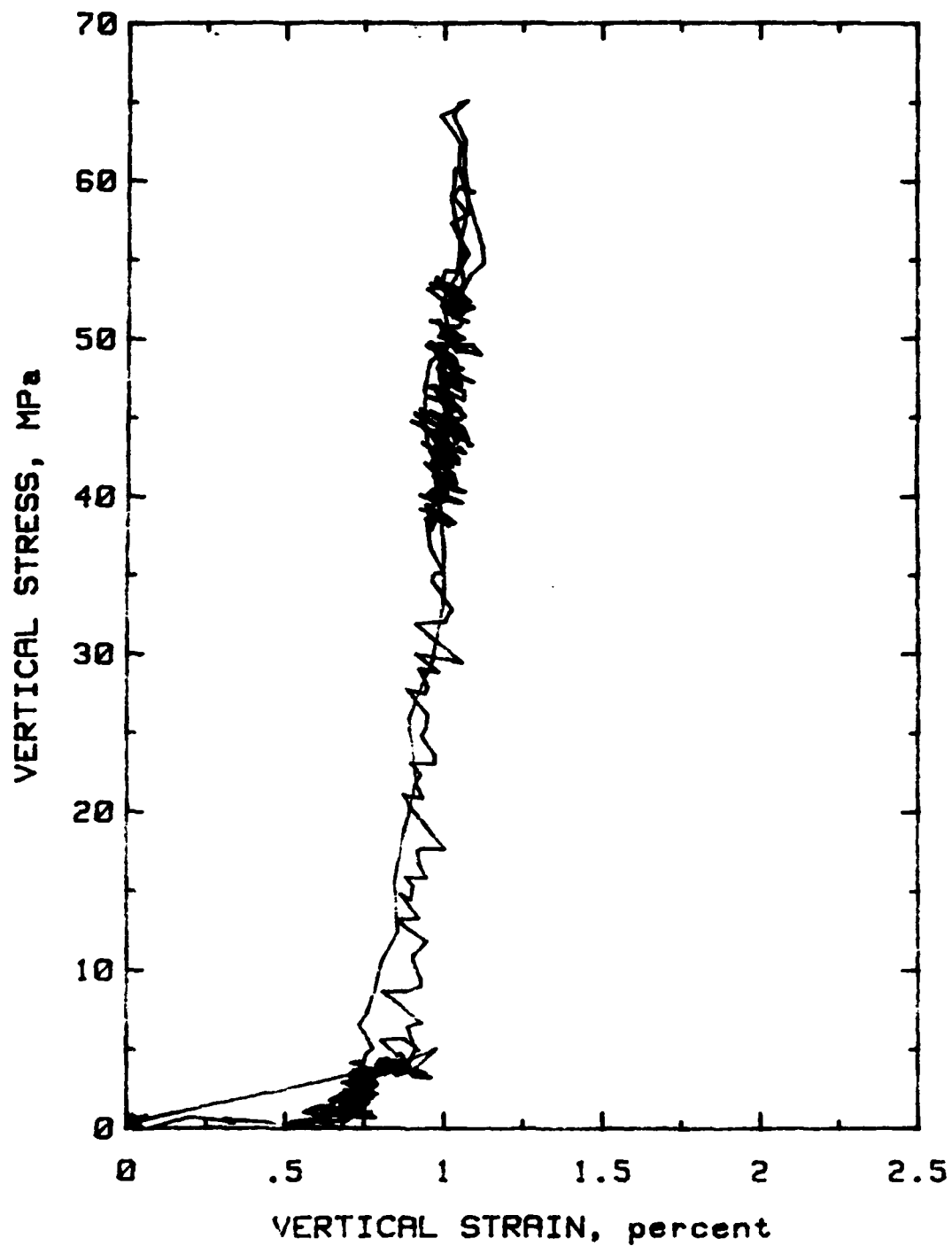
BACK PRESSURE SATURATED CONSOLIDATED
DYNAMIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNR.UX.10D
MB SAND



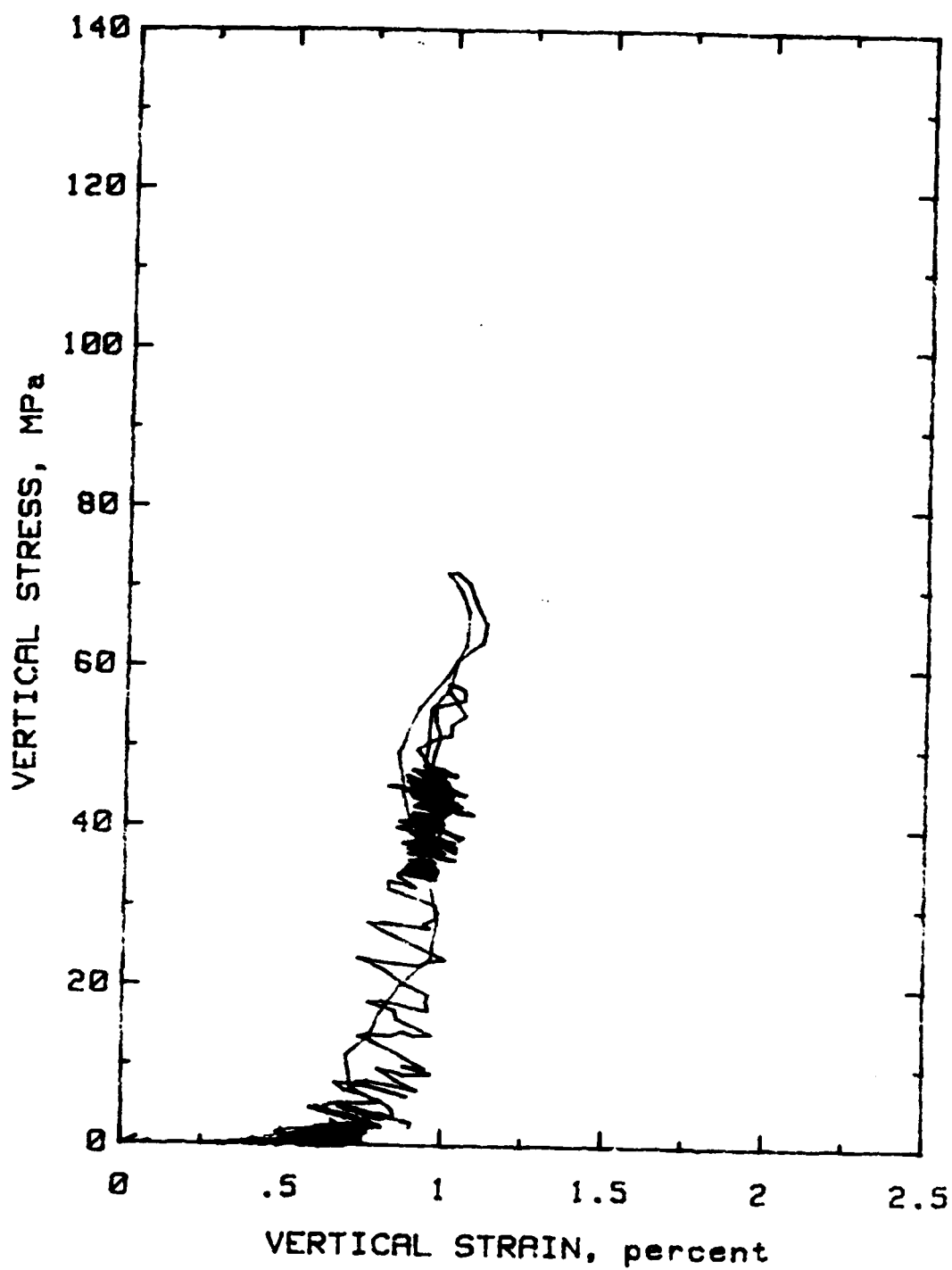
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DYNAMIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.11D
MB SAND



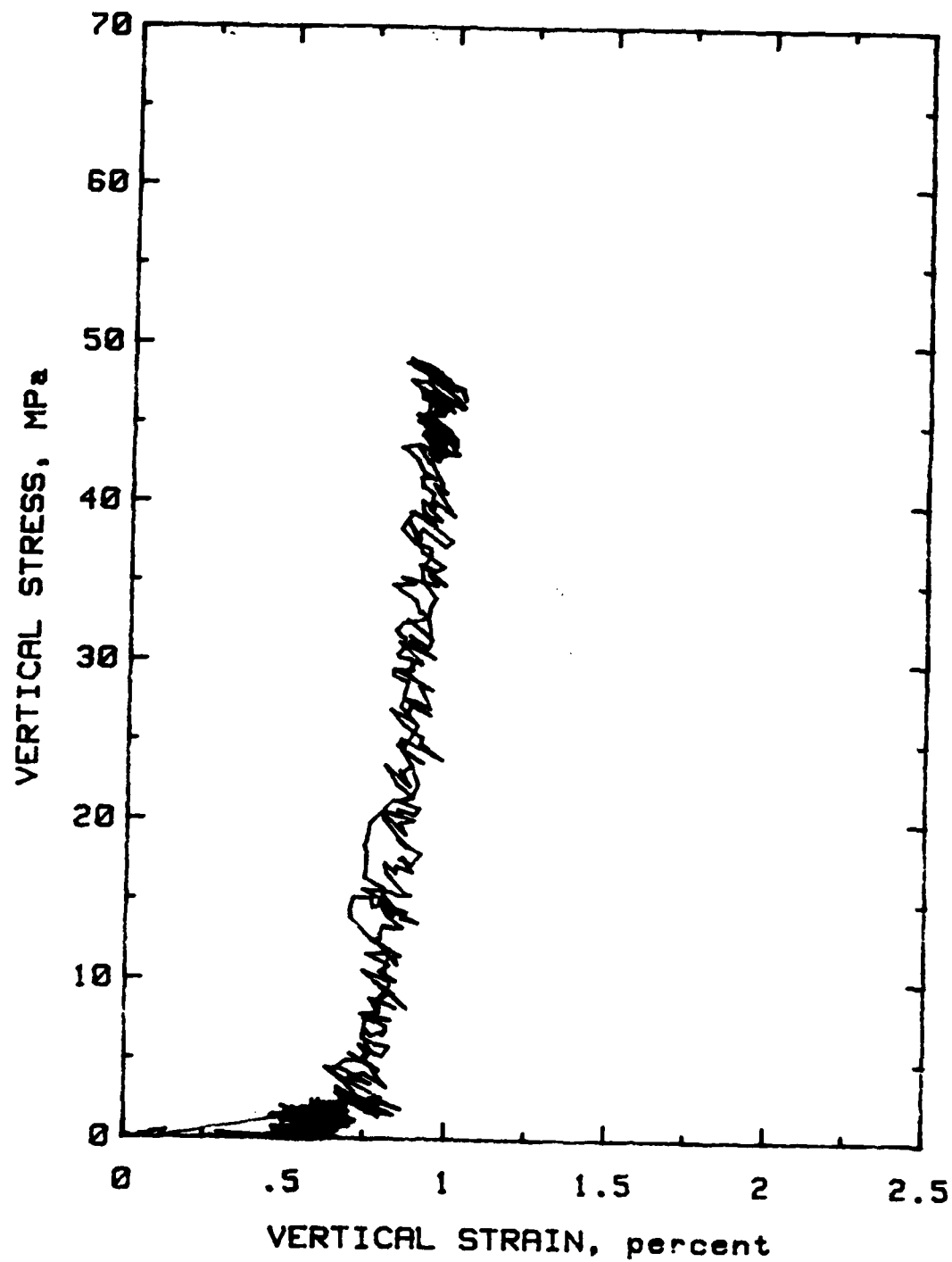
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DYNAMIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.12D
MB SAND



BACK PRESSURE SATURATED CONSOLIDATED
DYNAMIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.13D
MB SAND



BACK PRESSURE SATURATED CONSOLIDATED
DYNAMIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.14D
MB SAND

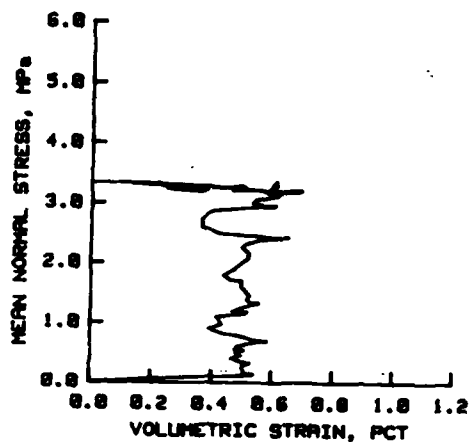


BACK PRESSURE SATURATED CONSOLIDATED
DYNAMIC UNDRAINED UNIAXIAL STRAIN
SPECIMEN DNA.UX.15D

MB SAND

PLATE 31

MISERS BLUFF SAND
STATIC IC-TX TESTS



MB SAND TEST MXLD 1

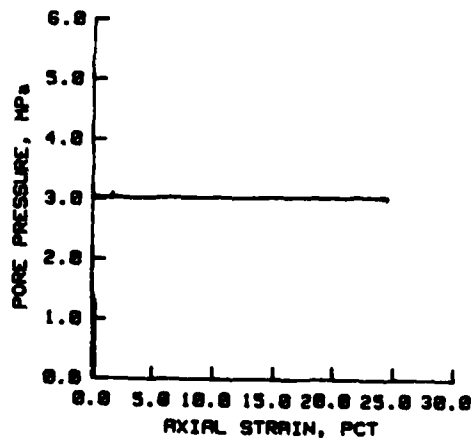
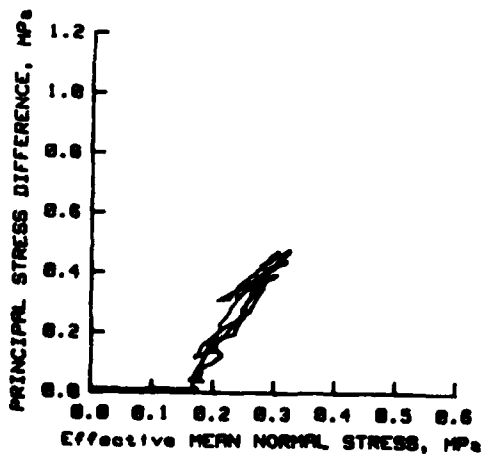
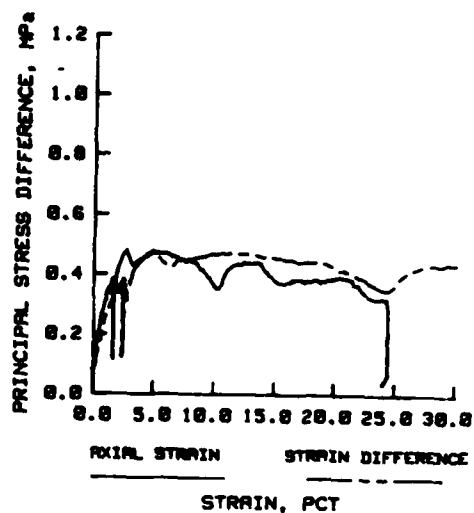
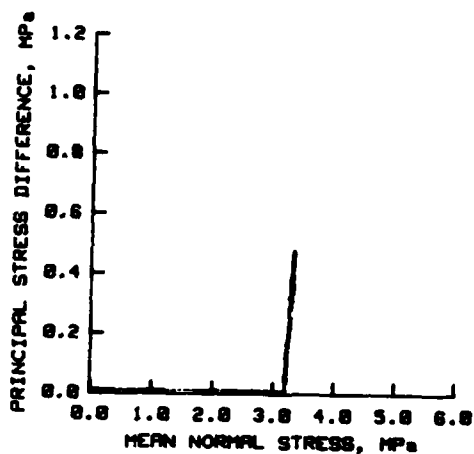
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COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.889 gm/cc
 Water content: 28.8 pct
 Dry density: 1.758 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.21
 Pore pressure: 3.85



MB SAND TEST MXLD 2

Density as remolded: 1.722 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.889 gm/cc

Water content: 28.5 pct

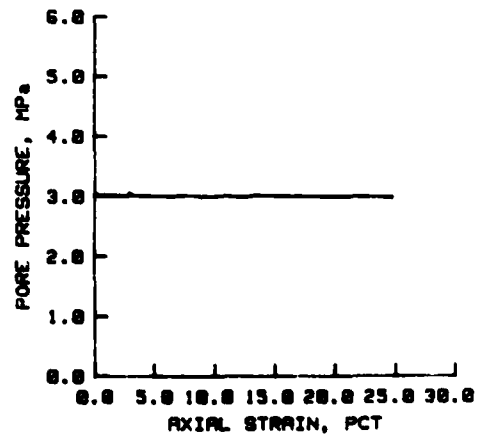
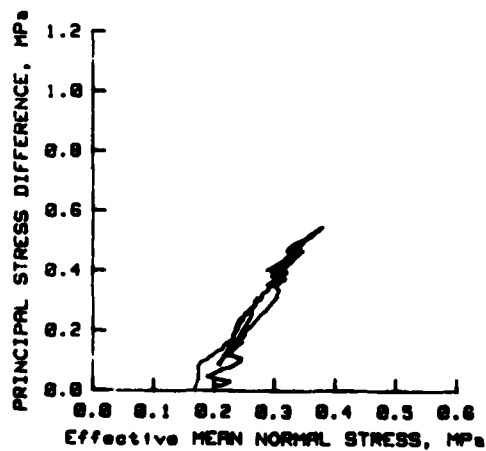
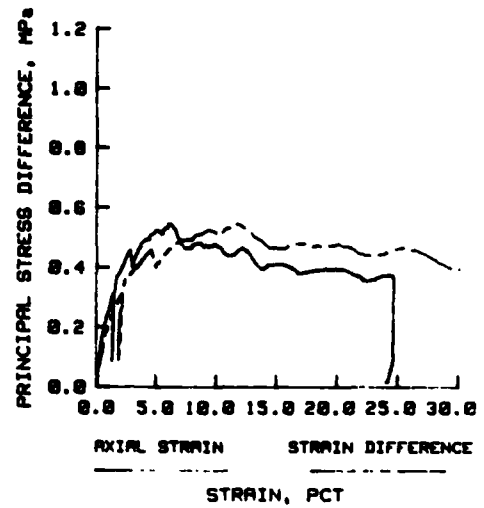
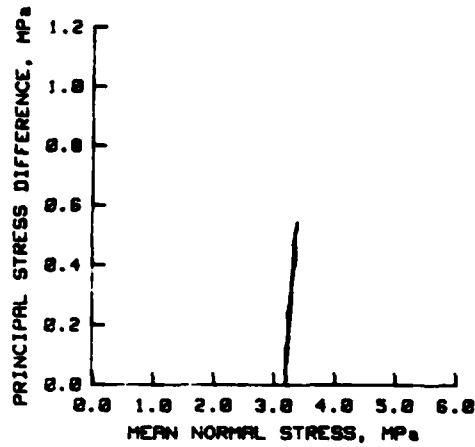
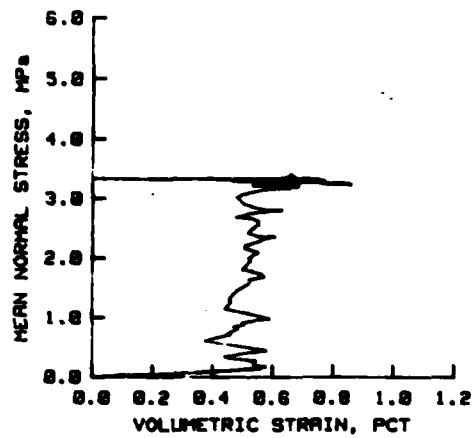
Dry density: 1.734 gm/cc

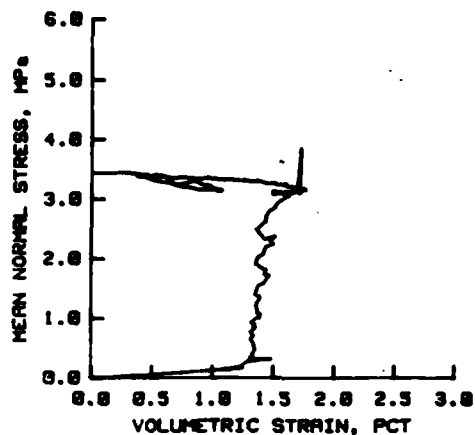
Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.17

Pore pressure: 2.99





MB SAND TEST DNA 21

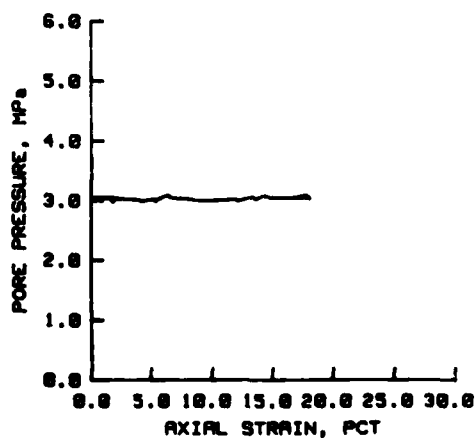
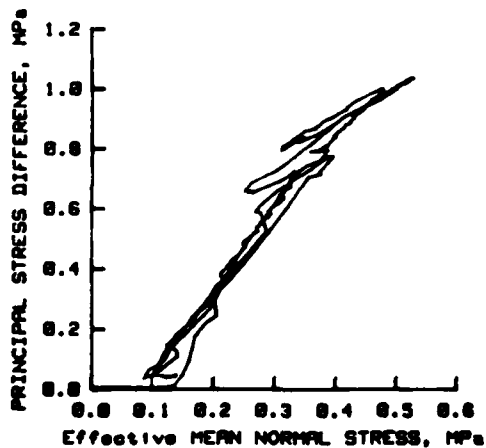
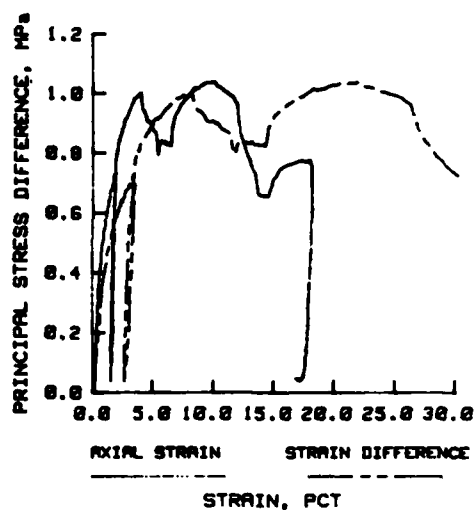
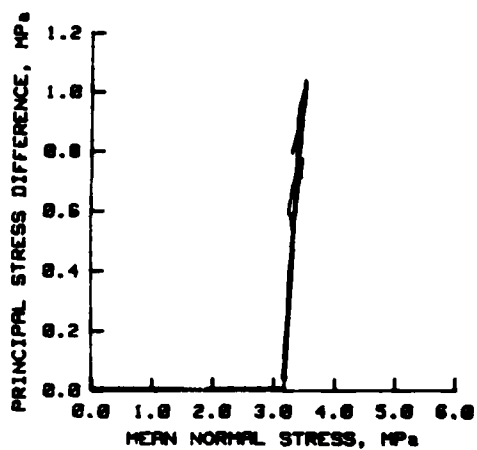
Density as remolded: 1.708 gm/cc

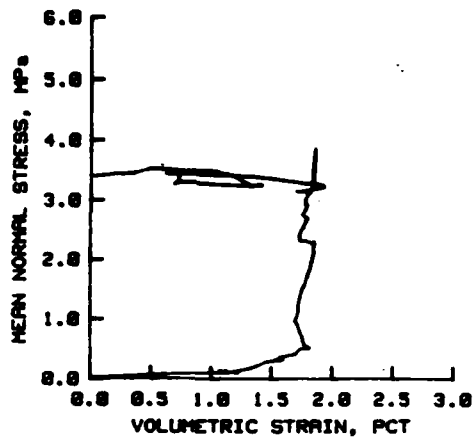
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.808 gm/cc
 Water content: 28.8 pct
 Dry density: 1.739 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.82
 Pore pressure: 3.83





MB SAND TEST DNA 22

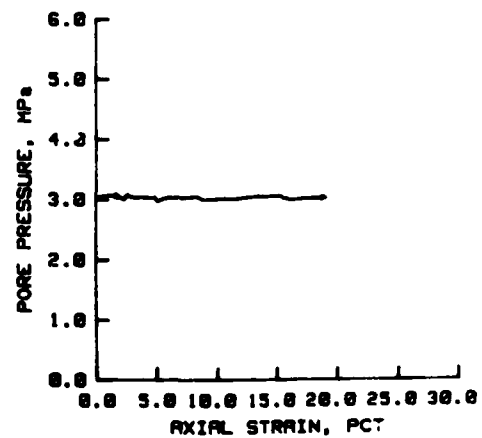
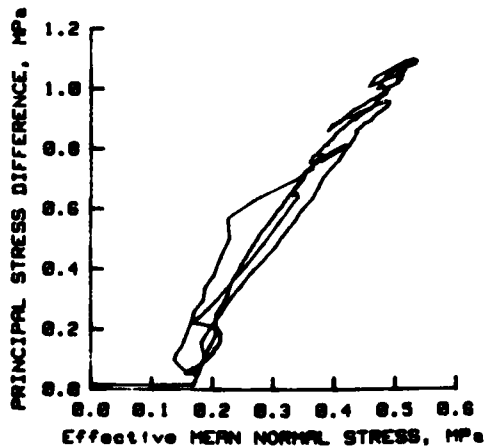
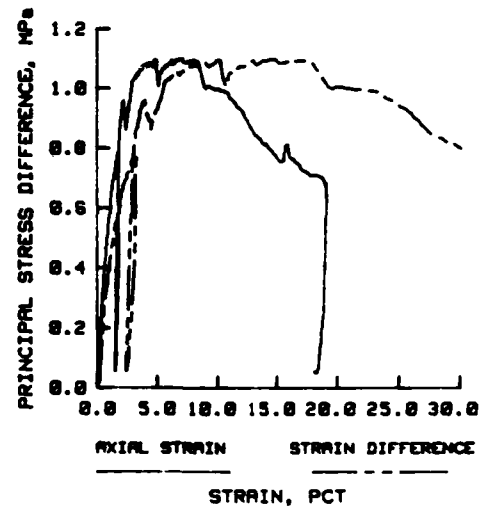
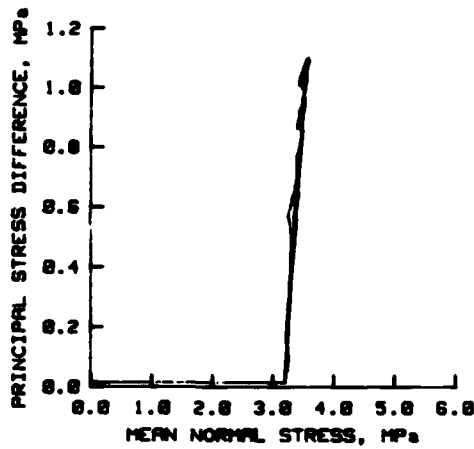
Density as remolded: 1.787 gm/cc

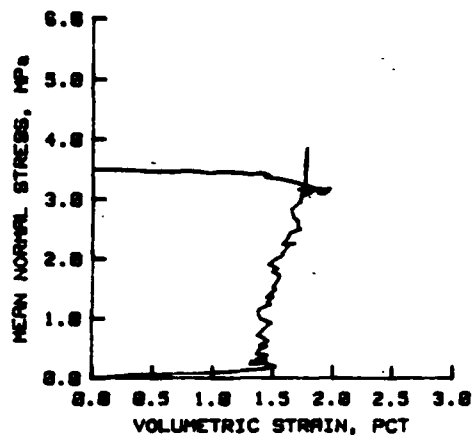
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.088 gm/cc
 Water content: 20.0 pct
 Dry density: 1.748 gm/cc
 Void ratio: 0.53

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.16
 Pore pressure: 3.04





MB SAND TEST DNA 27

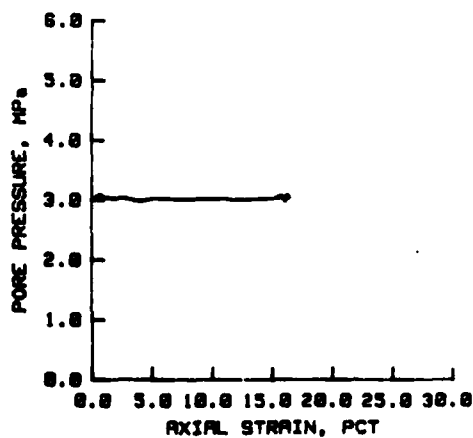
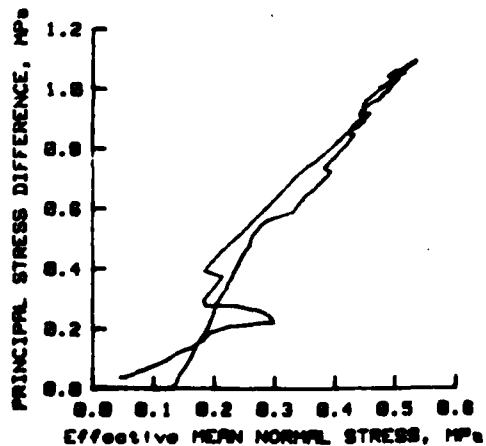
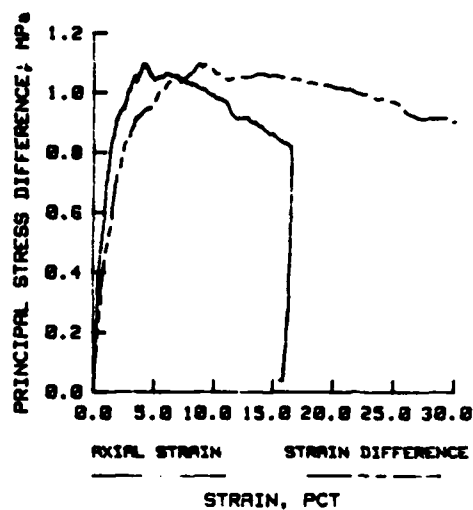
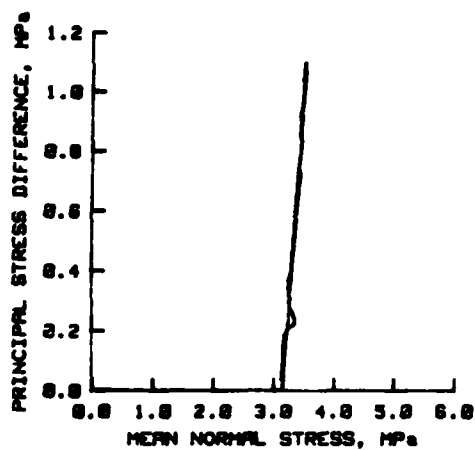
Density as remolded: 1.719 gm/cc

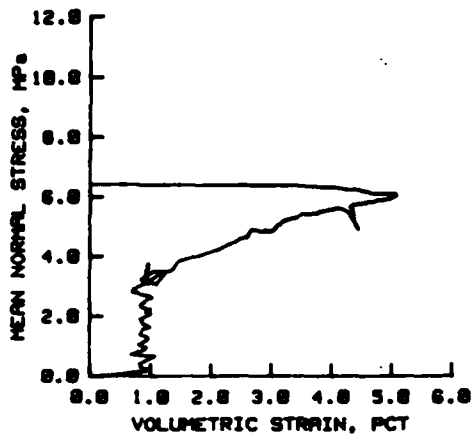
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.886 gm/cc
 Water content: 18.8 pct
 Dry density: 1.752 gm/cc
 Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.14
 Pore pressure: 3.88





MB SAND TEST DNA 3

Density as remolded: 1.743 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.898 gm/cc

Water content: 19.4 pct

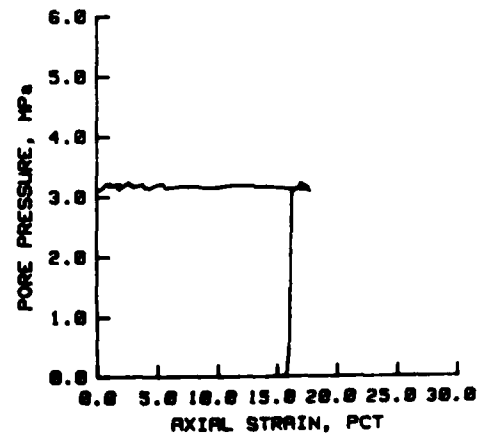
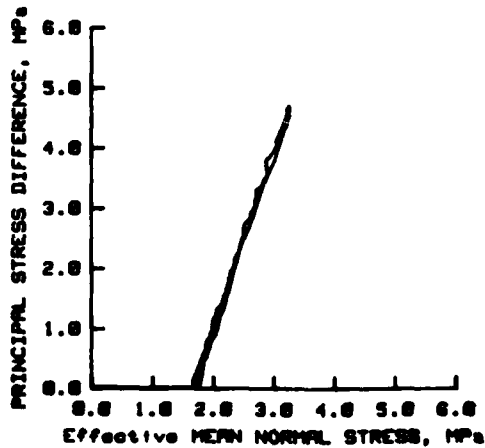
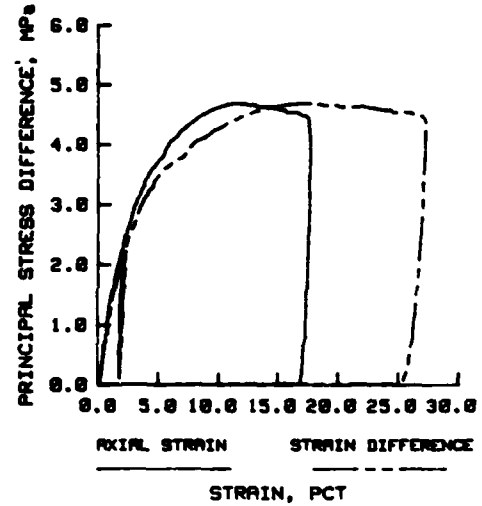
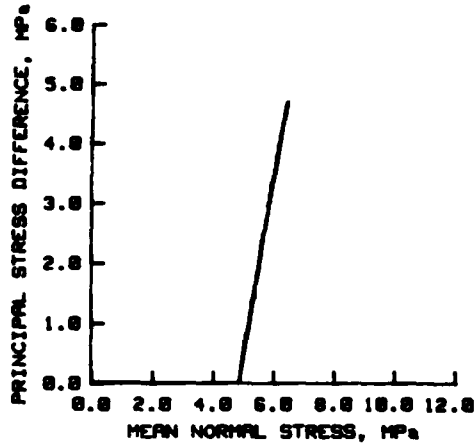
Dry density: 1.758 gm/cc

Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.18

Pore pressure: 3.81



MB SAND TEST MXLD 4

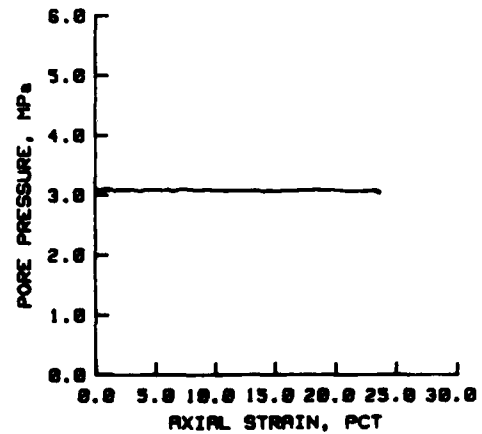
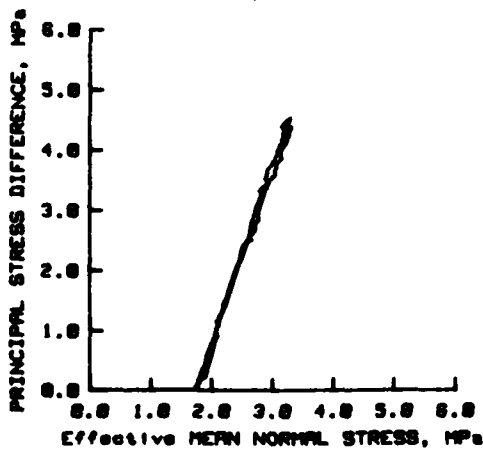
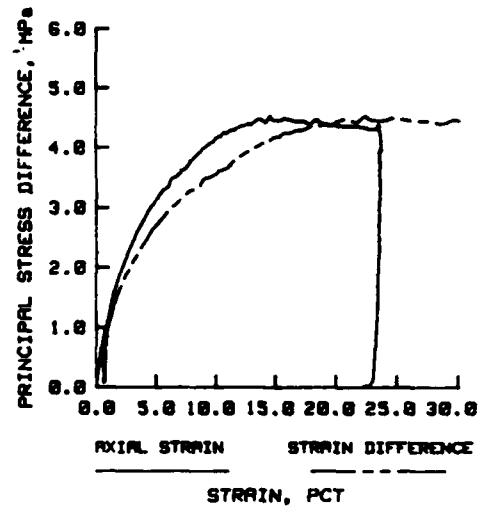
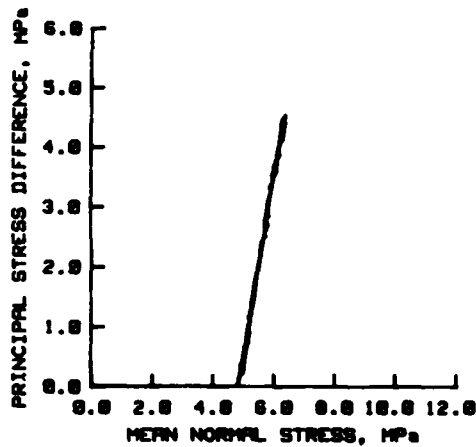
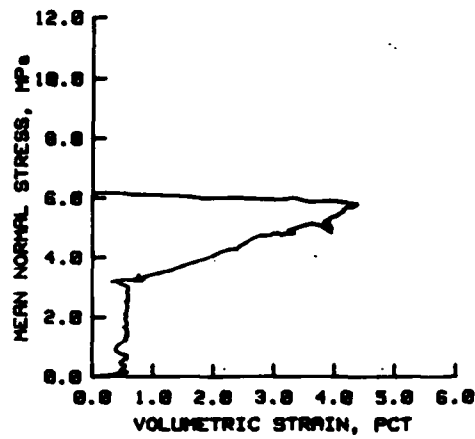
Density as remolded: 1.722 gm/cc

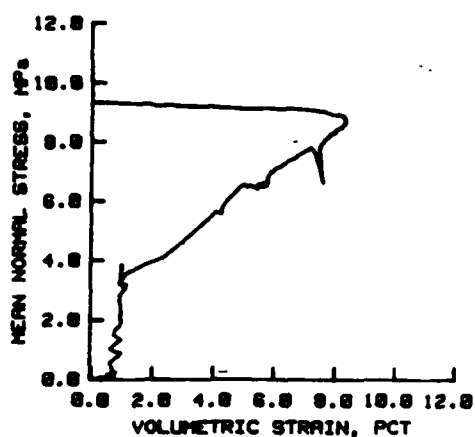
COMPOSITION PROPERTIES AT END OF BPS

Net density: 2.688 gm/cc
 Water content: 28.5 pct
 Dry density: 1.735 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.24
 Pore pressure: 3.18





MB SAND TEST DNA 11

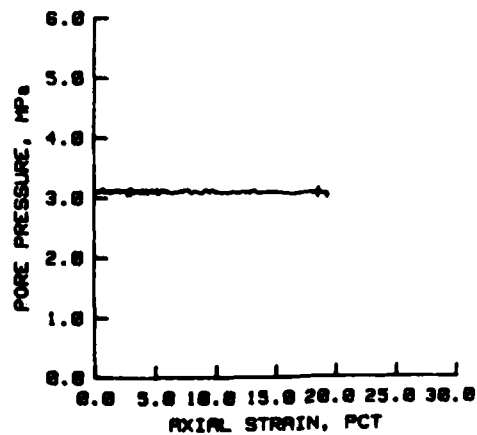
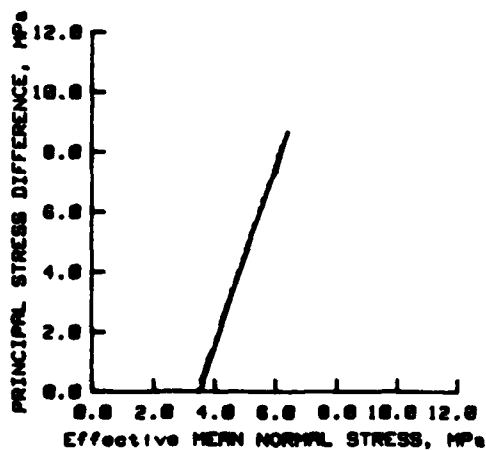
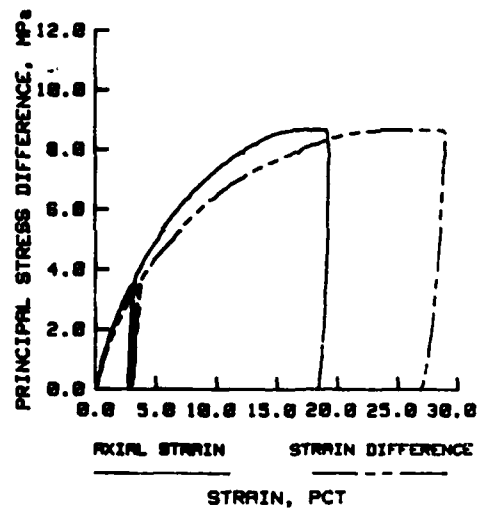
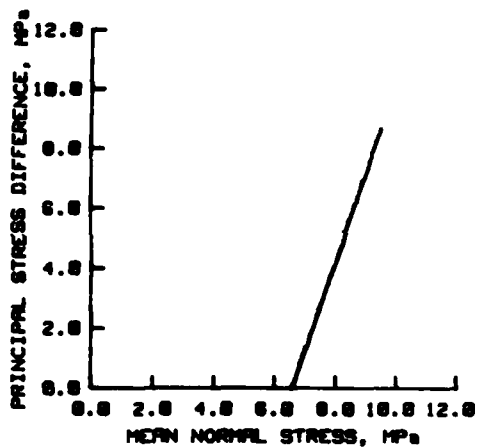
Density as remolded: 1.712 gm/cc

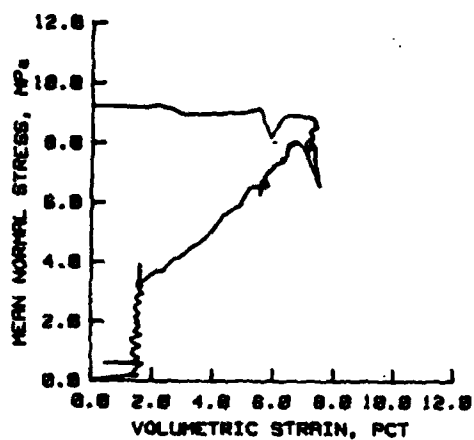
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.881 gm/cc
 Water content: 28.4 pct
 Dry density: 1.729 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.19
 Pore pressure: 3.89





MB SAND TEST DNA 12

Density as remolded: 1.725 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wat density: 2.636 gm/cc

Water content: 18.6 pct

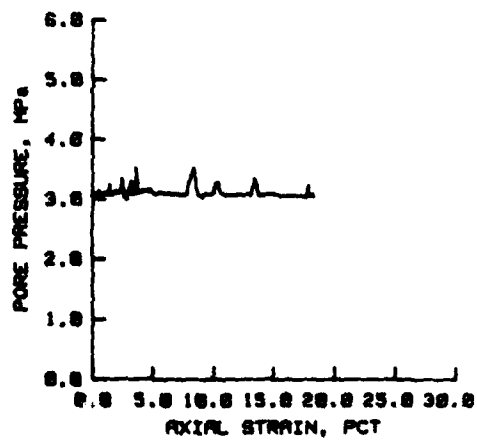
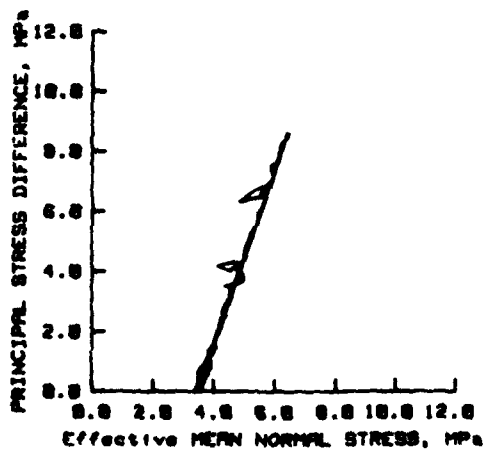
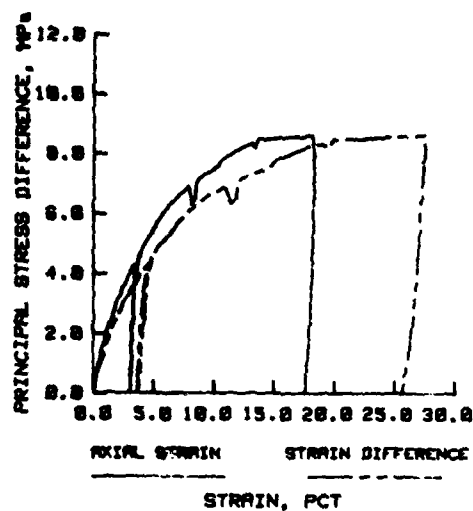
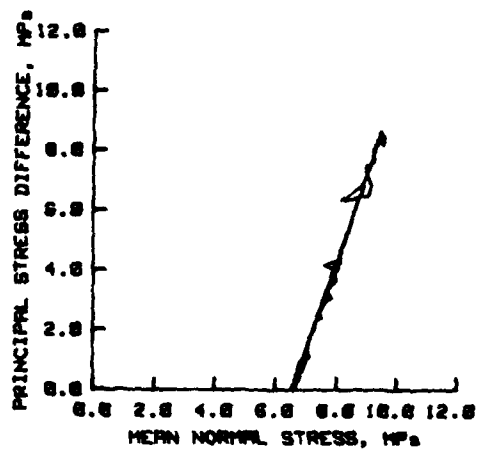
Dry density: 1.752 gm/cc

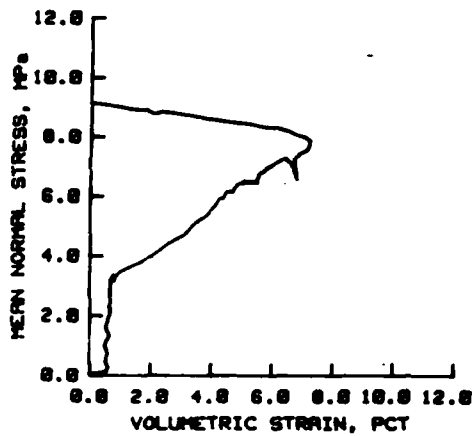
Voids ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.18

Pore pressure: 3.84





MB SAND TEST MXLD 7

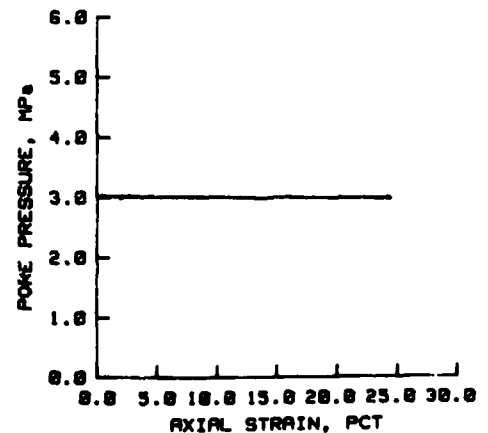
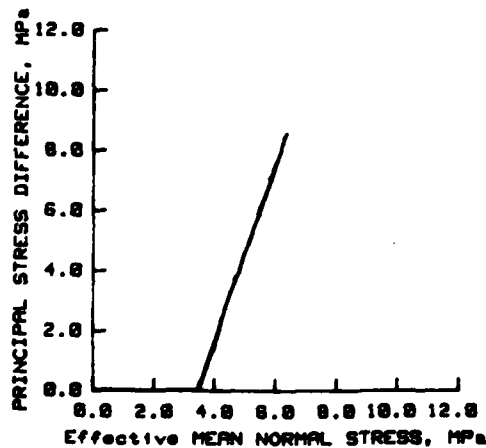
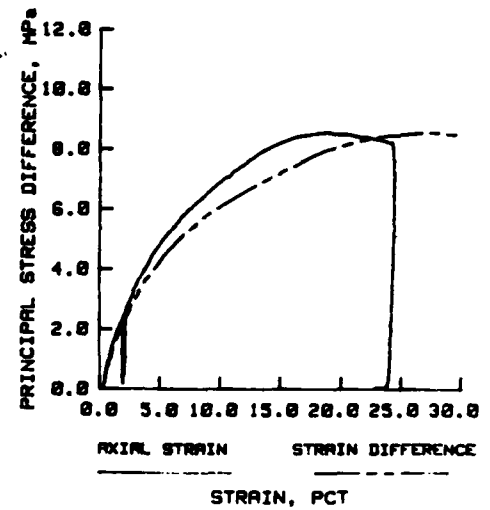
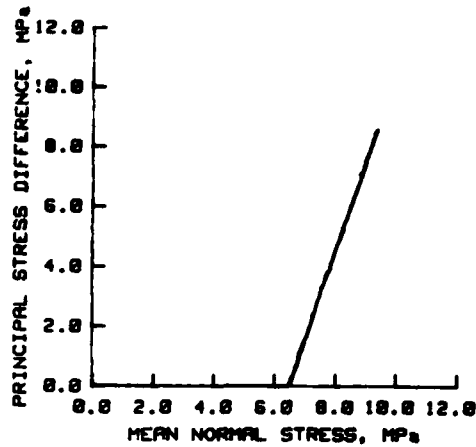
Density as remolded: 1.714 gm/cc

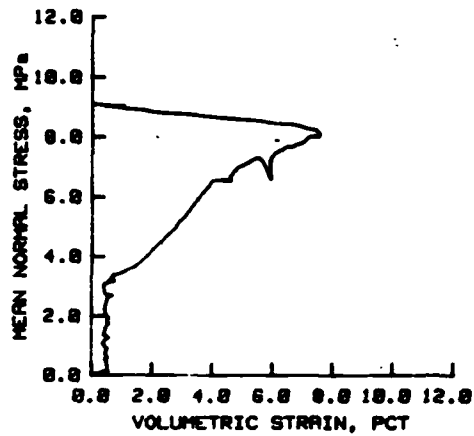
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.005 gm/cc
 Water content: 20.7 pct
 Dry density: 1.720 gm/cc
 Void ratio: 0.56

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.10
 Pore pressure: 3.03





MB SAND TEST MXLD 7R

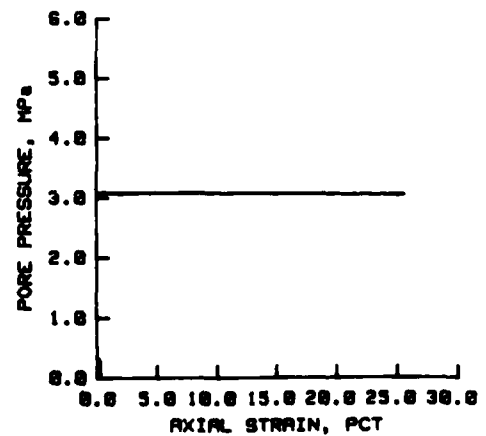
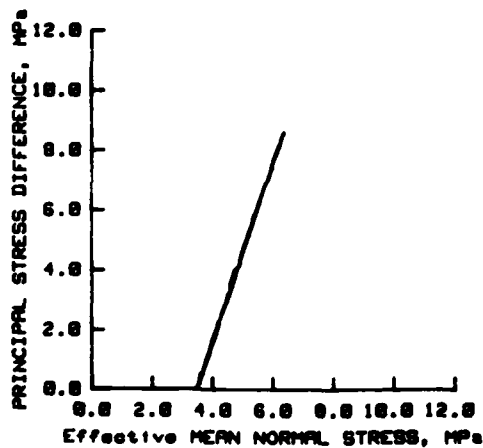
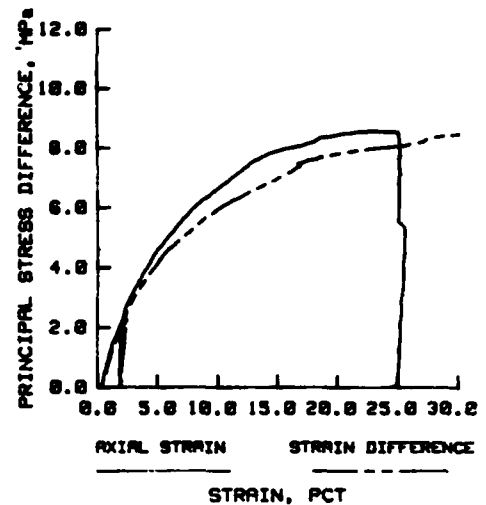
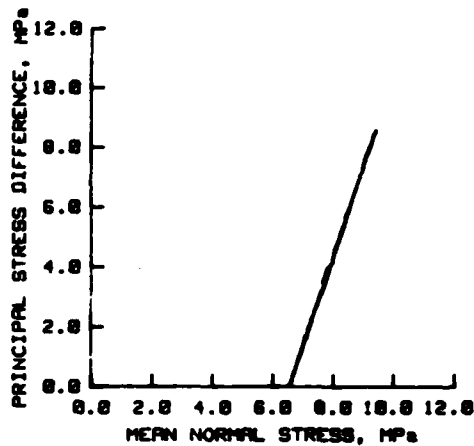
Density as remolded: 1.738 gm/cc

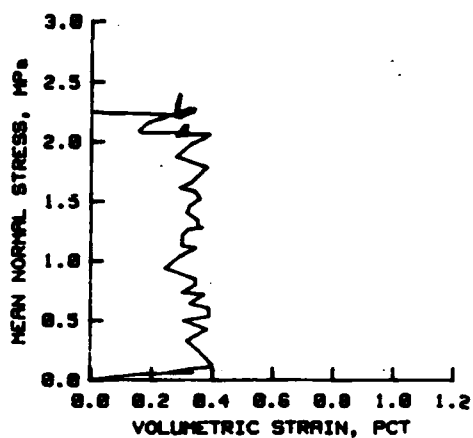
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.884 gm/cc
 Water content: 28.3 pct
 Dry density: 1.741 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.17
 Pore pressure: 3.81





MB SAND TEST MB 8A

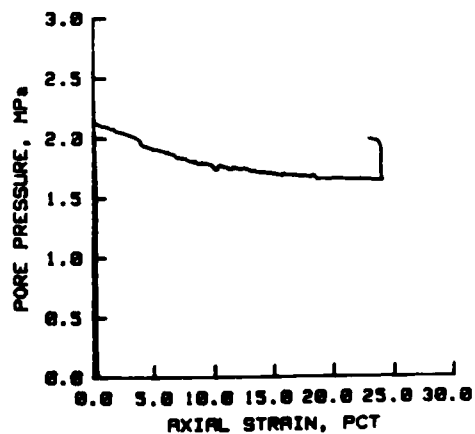
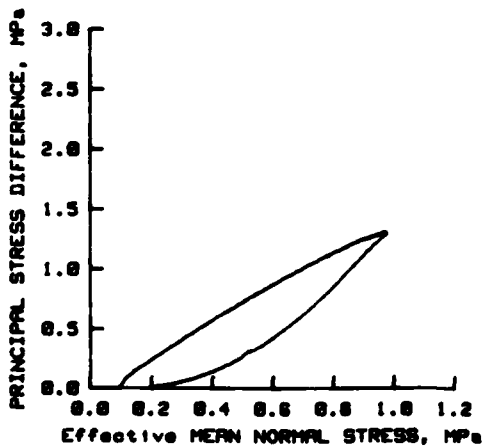
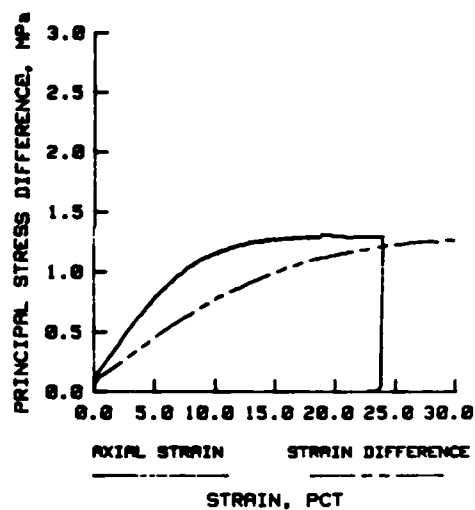
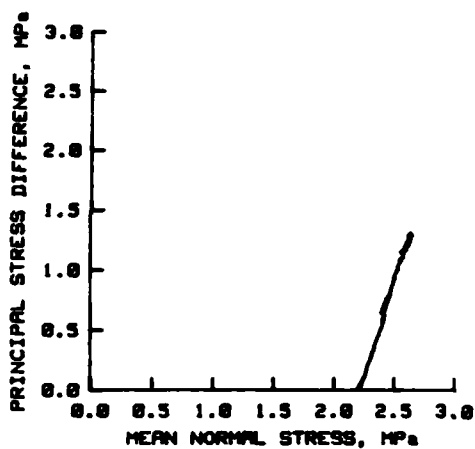
Density as received: 1.738 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.895 gm/cc
 Water content: 28.2 pct
 Dry density: 1.743 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.25
 Pore pressure: 2.16



MB SAND TEST MB 9

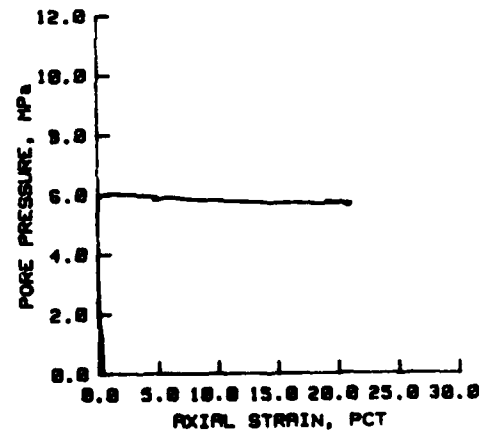
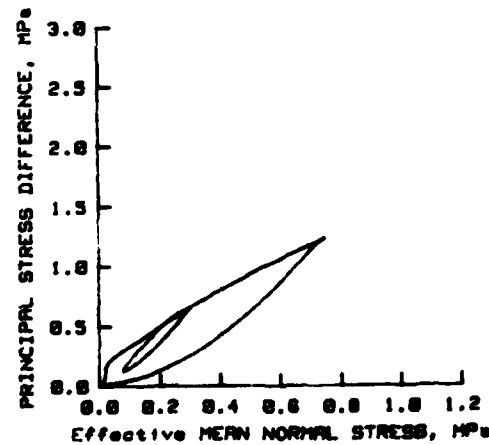
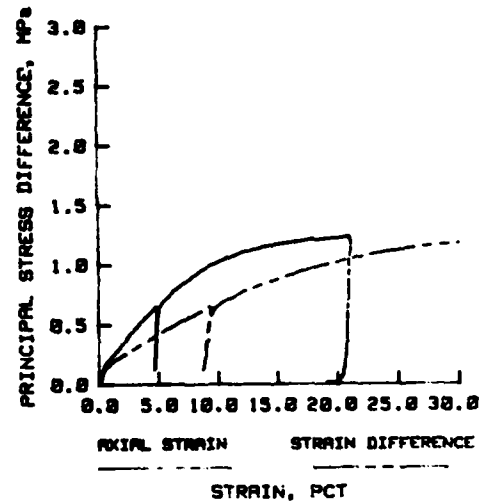
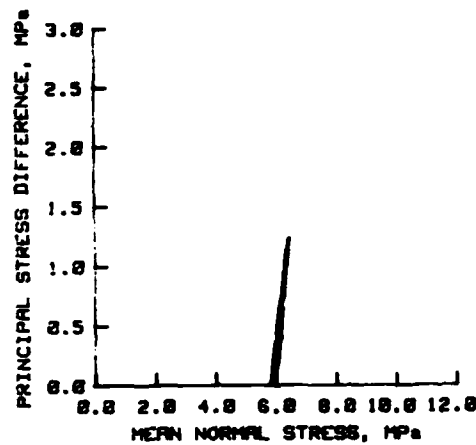
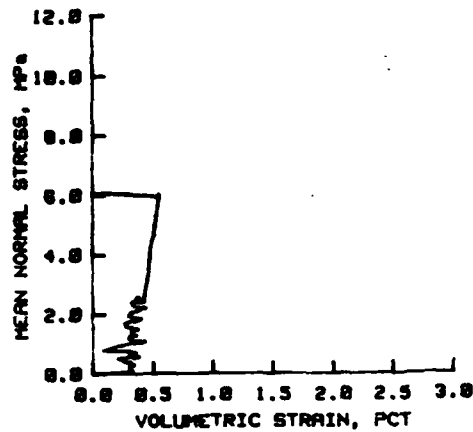
Density as remolded: 1.711 gm/cc

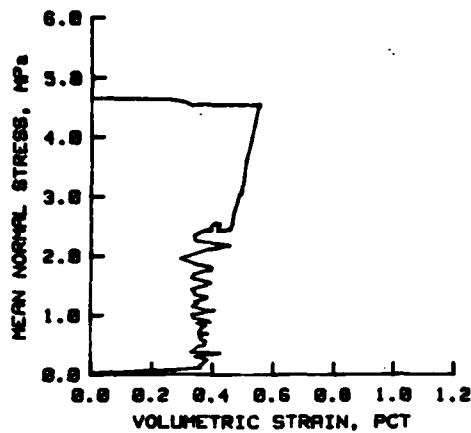
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.079 gm/cc
Water content: 21.0 pct
Dry density: 1.710 gm/cc
Void ratio: 0.57

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.45
Pore pressure: 2.43





MB SAND TEST MB 10

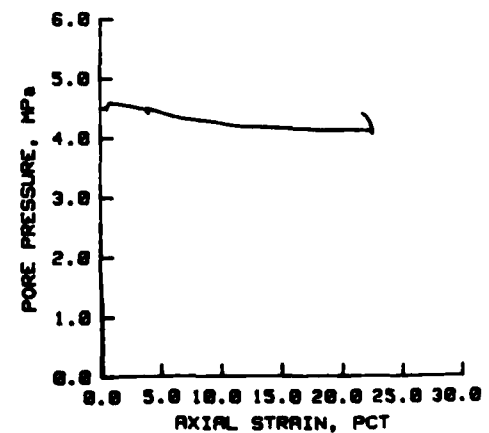
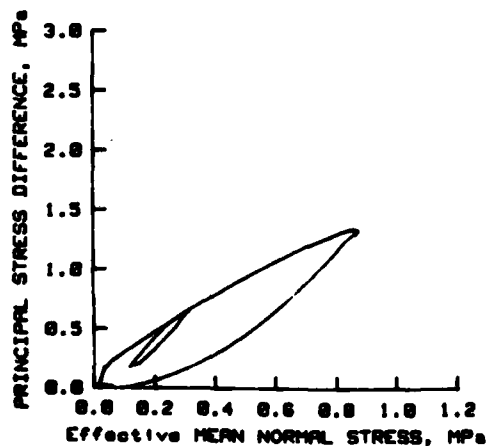
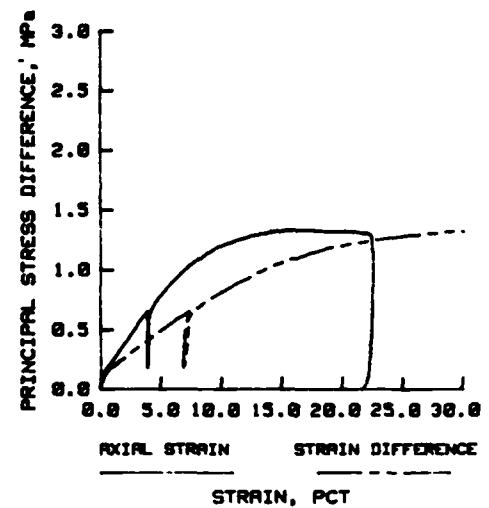
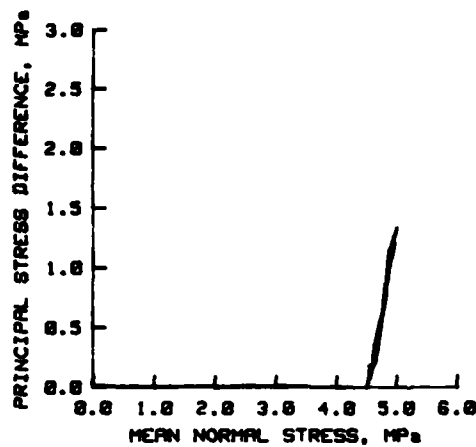
Density as remolded: 1.718 gm/cc

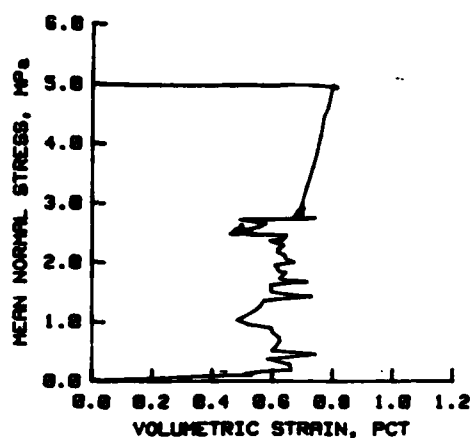
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.886 gm/cc
 Water content: 28.7 pct
 Dry density: 1.729 gm/cc
 Void ratio: 0.56

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.44
 Pore pressure: 2.44





MB SAND TEST MB 10A

Density as remolded: 1.735 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Net density: 2.898 gm/cc

Water content: 28.1 pct

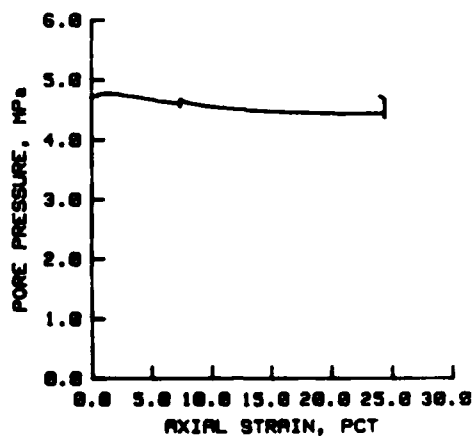
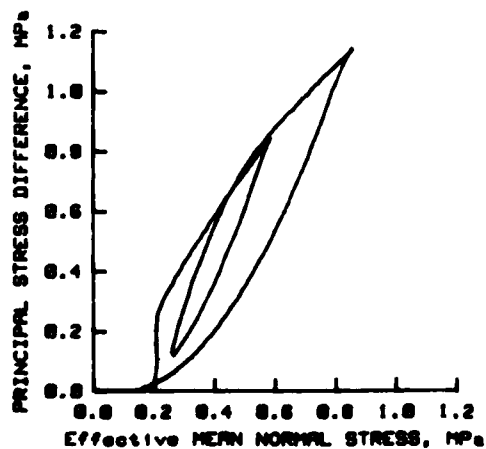
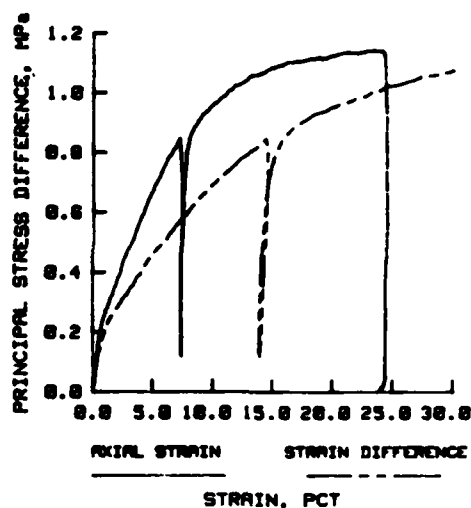
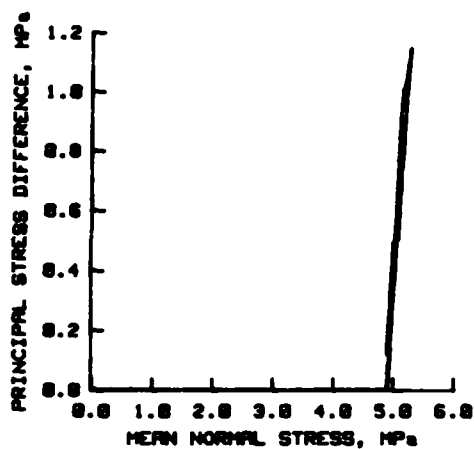
Dry density: 1.747 gm/cc

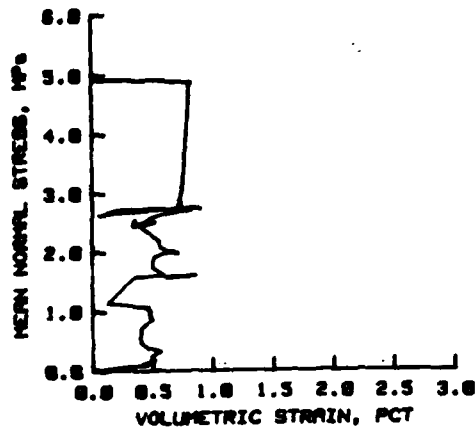
Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.74

Pore pressure: 2.58





MB SAND TEST MB 10B

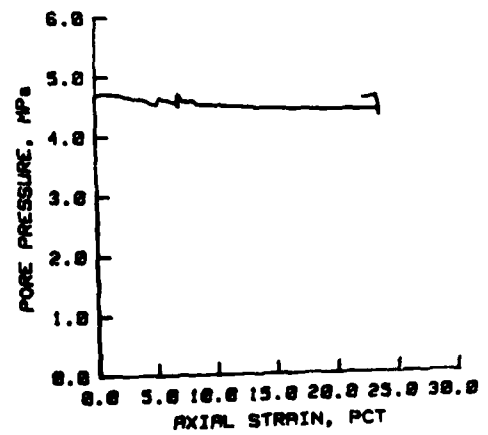
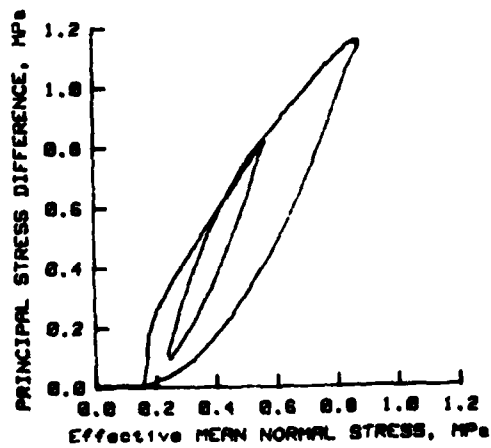
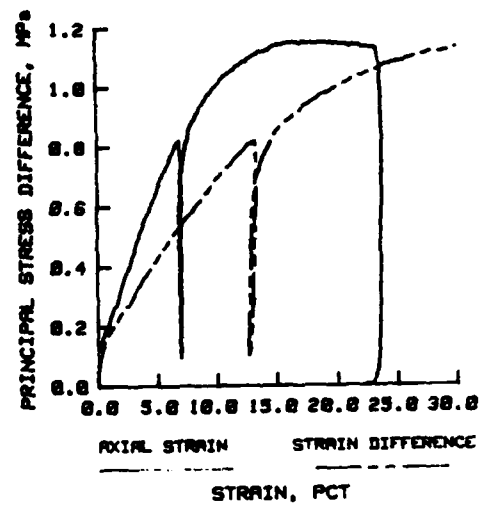
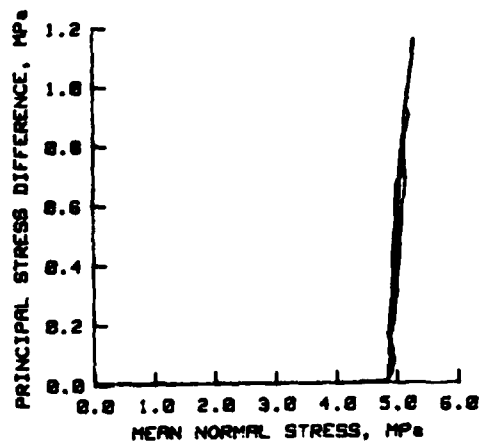
Density as remolded: 1.748 gm/cc

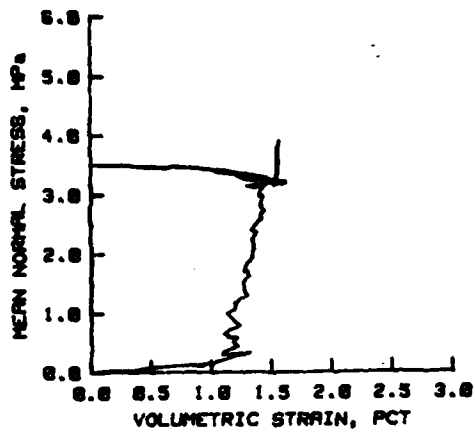
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.181 gm/cc
 Water content: 18.9 pct
 Dry density: 1.753 gm/cc
 Void ratio: 0.53

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.74
 Pore pressure: 2.61





MB SAND TEST DNR 19

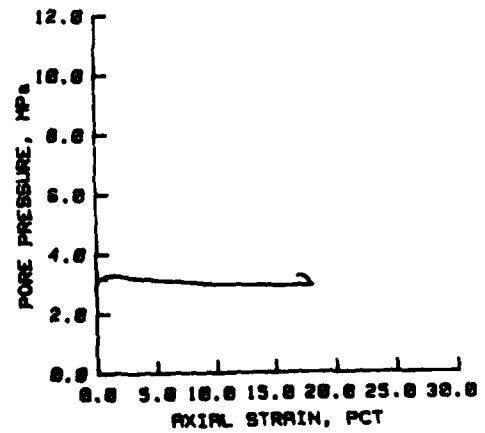
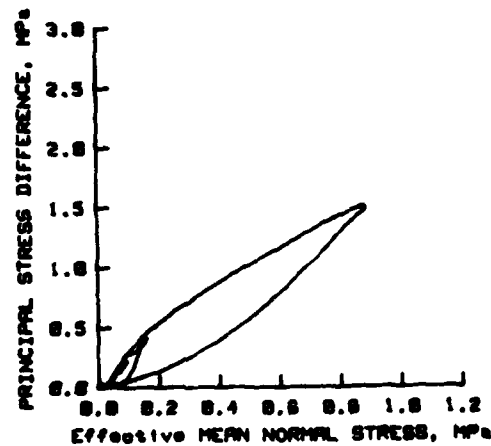
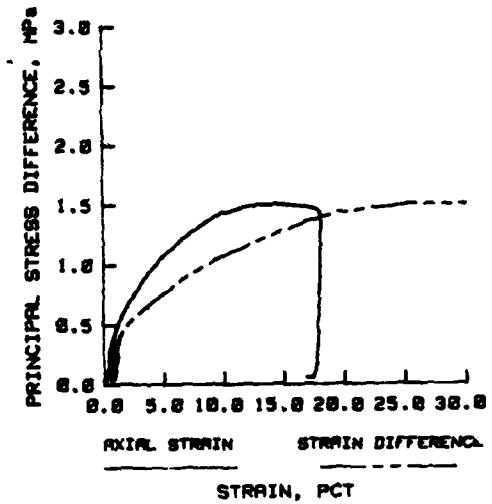
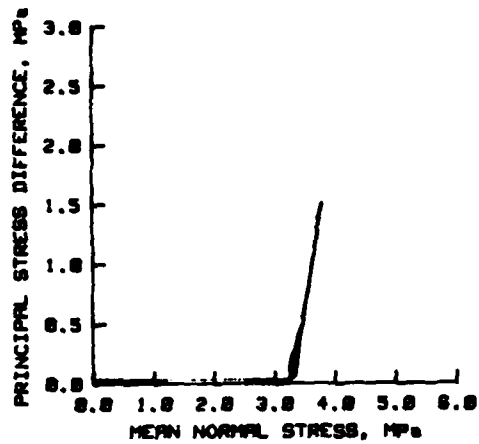
Density as remolded: 1.738 gm/cc

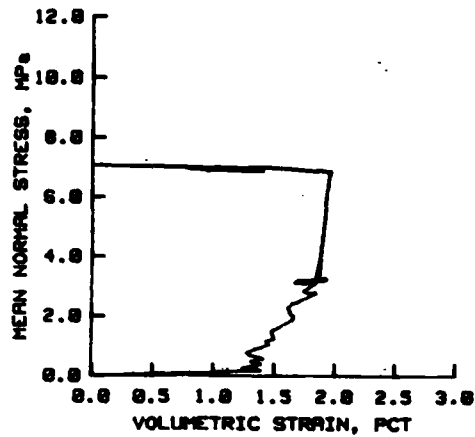
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.184 gm/cc
 Water content: 19.2 pct
 Dry density: 1.785 gm/cc
 Void ratio: 0.51

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.18
 Pore pressure: 3.63





MB SAND TEST DNA 20

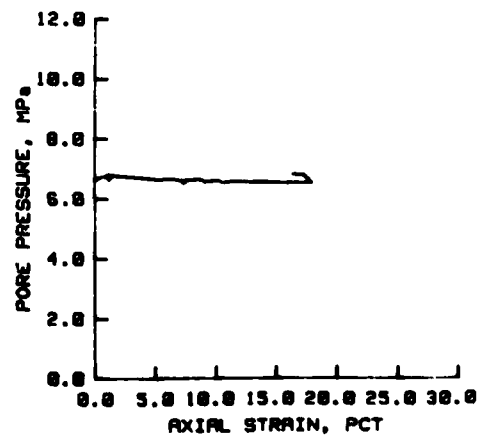
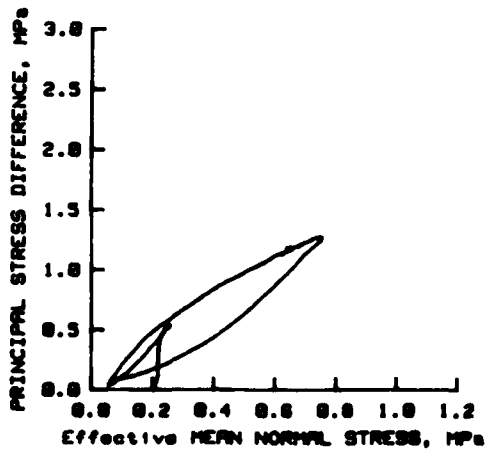
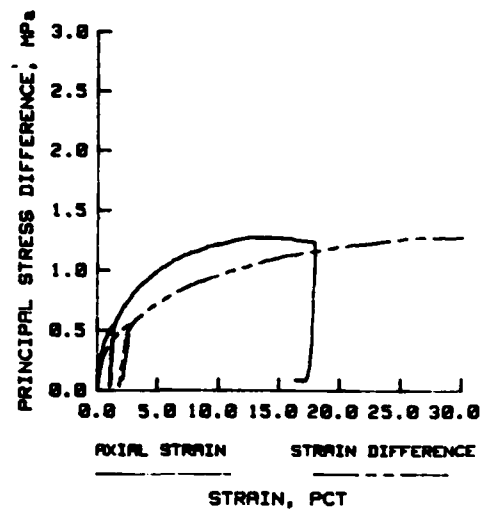
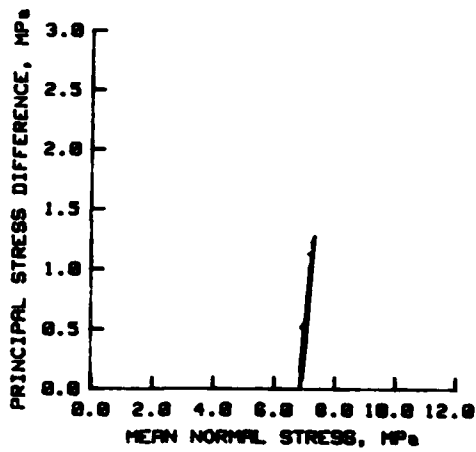
Density as remolded: 1.716 gm/cc

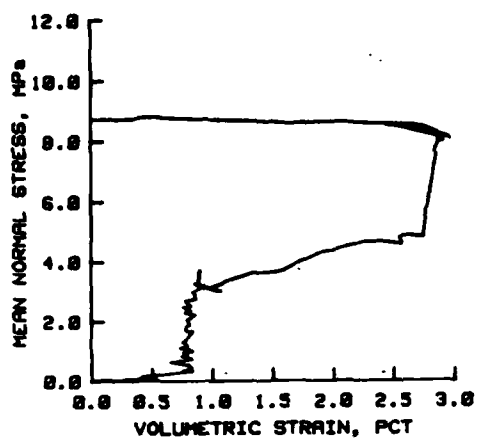
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.884 gm/cc
 Water content: 19.7 pct
 Dry density: 1.748 gm/cc
 Void ratio: 0.53

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.22
 Pore pressure: 3.18





MB SAND TEST DNA 1

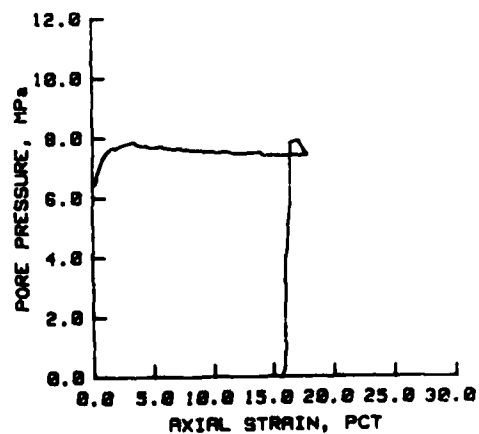
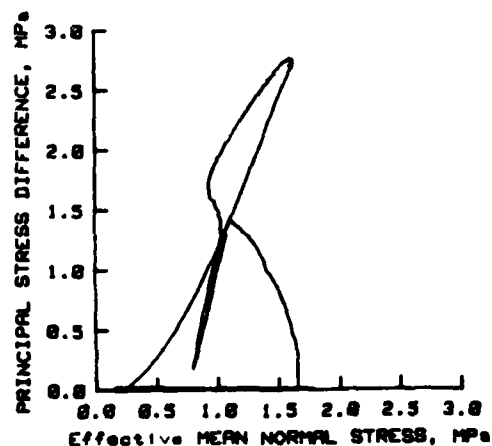
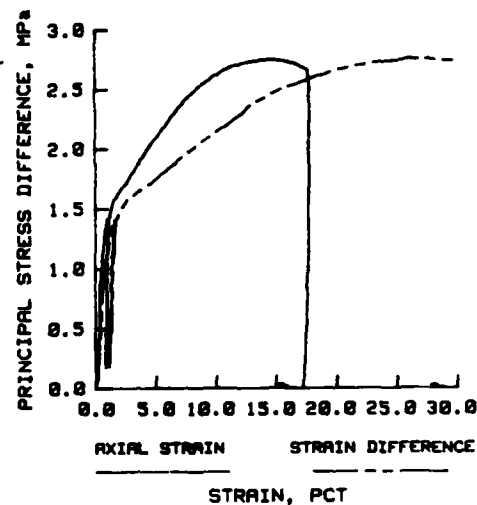
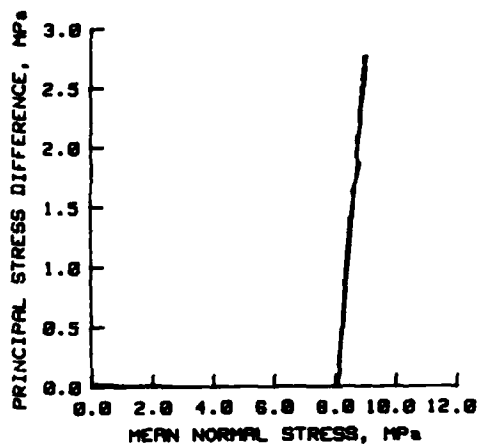
Density as remolded: 1.756 gm/cc

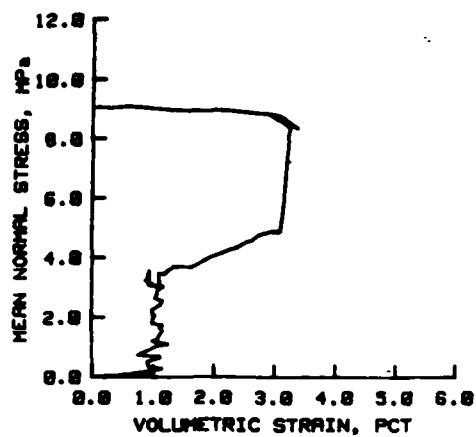
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.188 gm/cc
 Water content: 18.9 pct
 Dry density: 1.773 gm/cc
 Void ratio: 0.51

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.17
 Pore pressure: 3.18





MB SAND TEST DNA 2

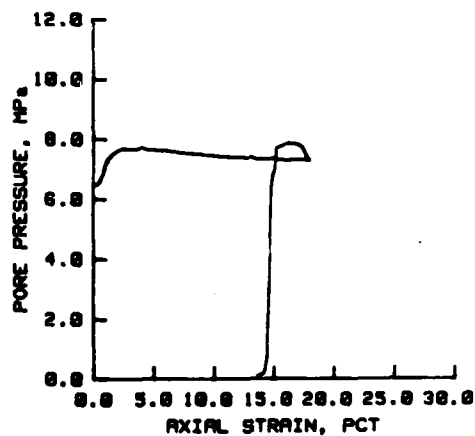
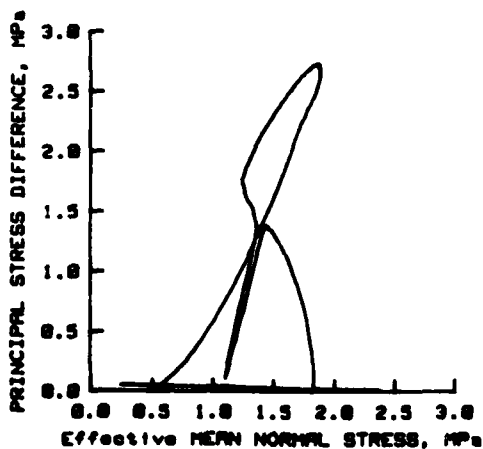
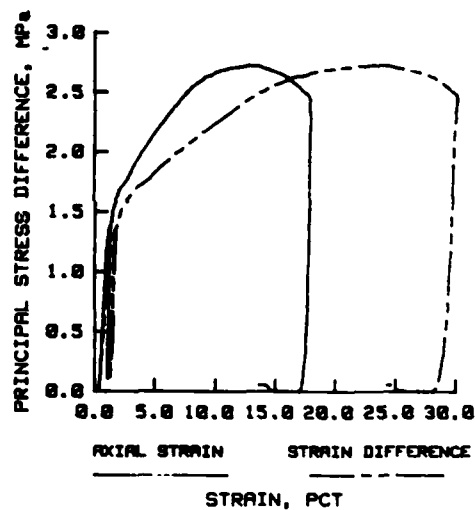
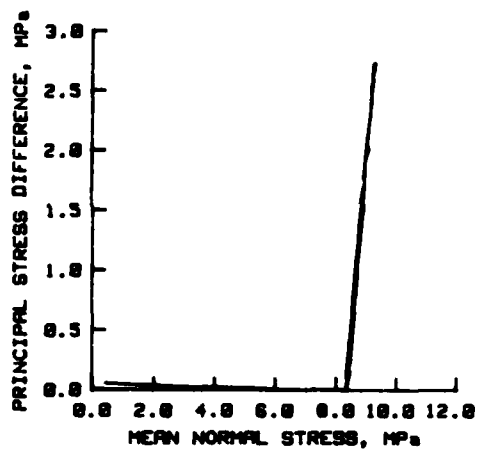
Density as remolded: 1.778 gm/cc

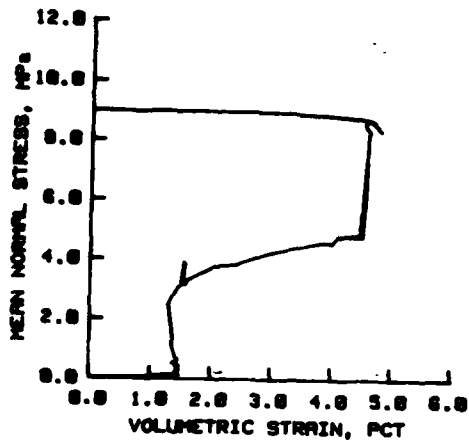
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.122 gm/cc
 Water content: 18.3 pct
 Dry density: 1.795 gm/cc
 Void ratio: 0.49

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.22
 Pore pressure: 3.87





MB SAND TEST DNR 6

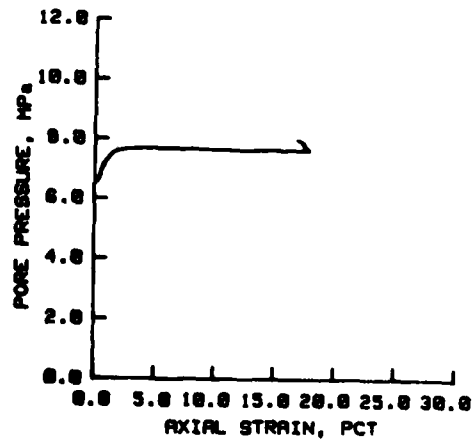
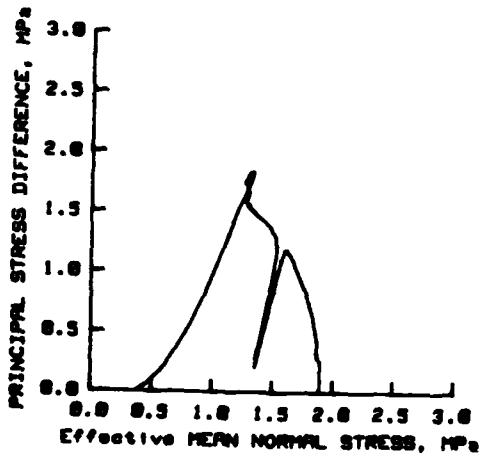
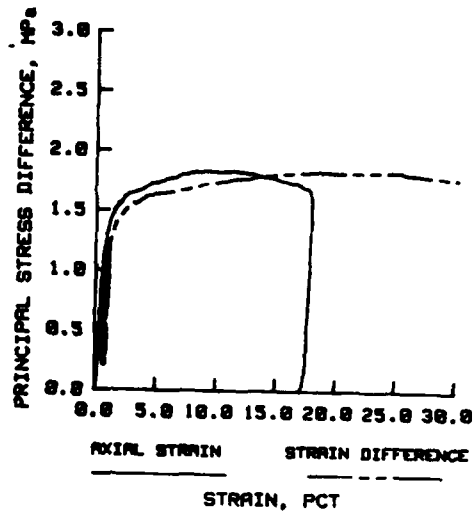
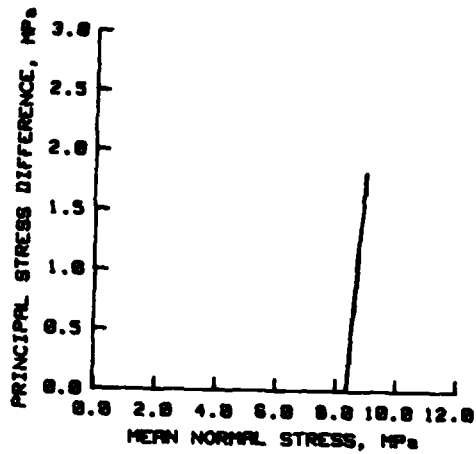
Density as remolded: 1.893 gm/cc

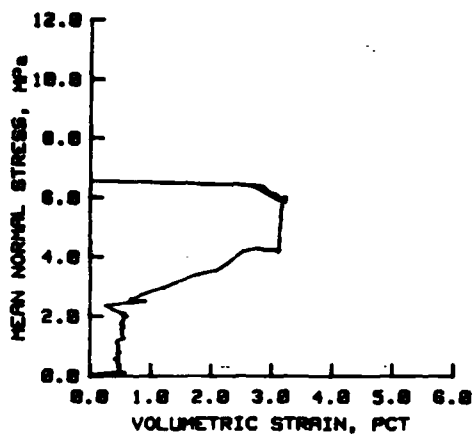
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.078 gm/cc
 Water content: 20.7 pct
 Dry density: 1.720 gm/cc
 Void ratio: 0.35

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.16
 Pore pressure: 2.97





MB SAND TEST RV 3A

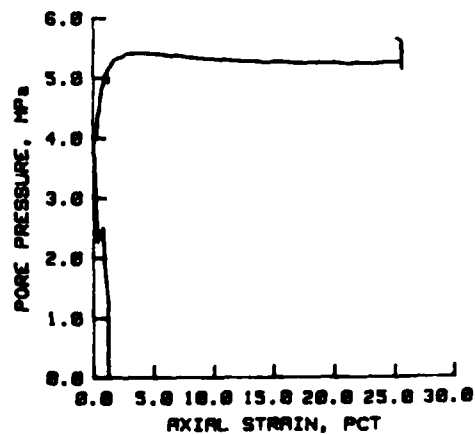
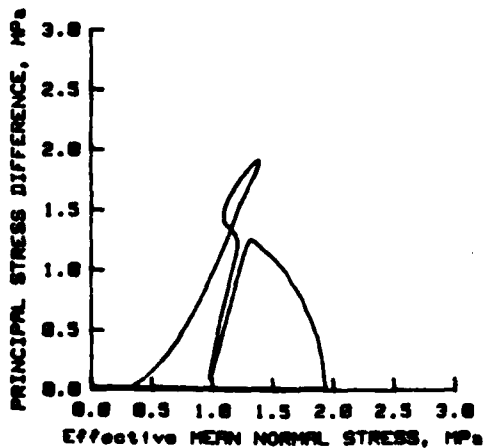
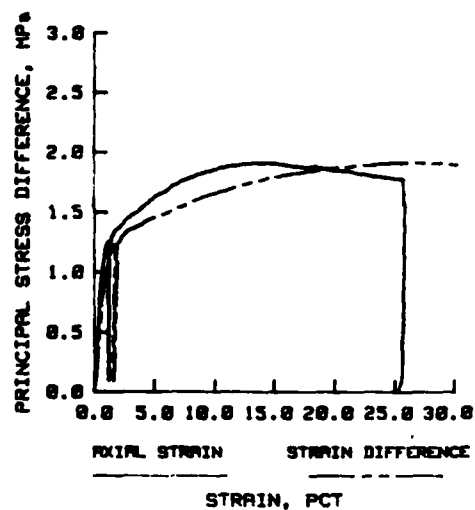
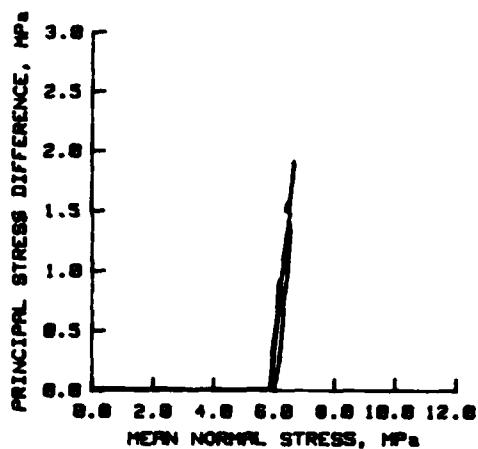
Density as remolded: 1.728 gm/cc

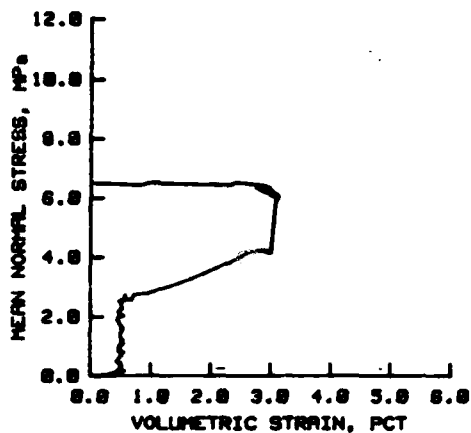
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.888 gm/cc
 Water content: 28.6 pct
 Dry density: 1.732 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.48
 Pore pressure: 2.39





MB SAND TEST RV 3B

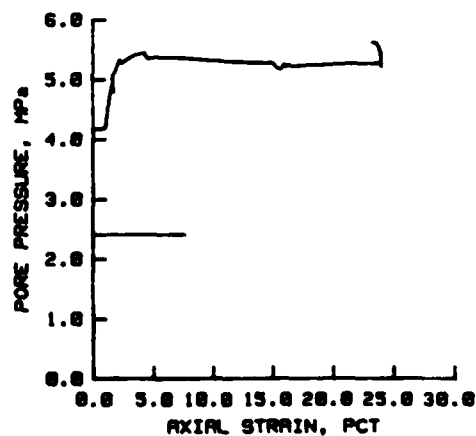
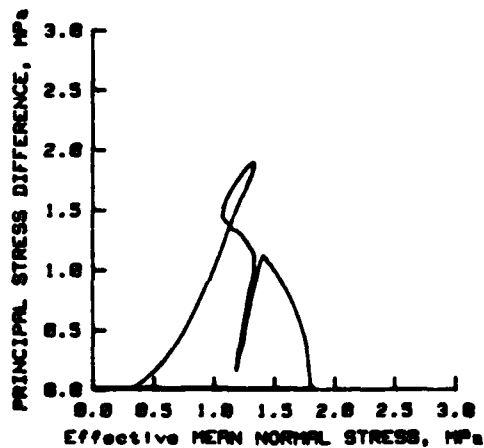
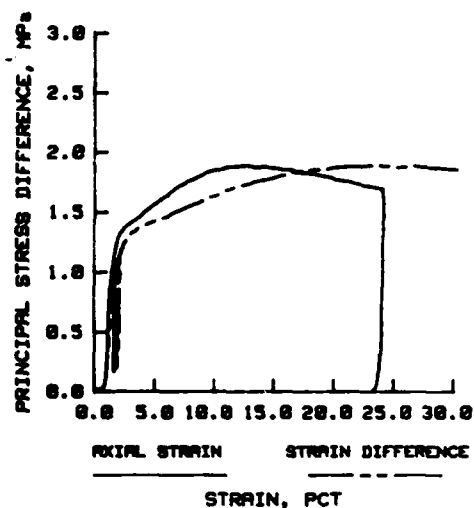
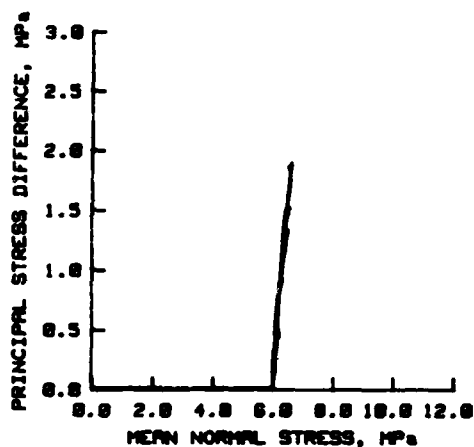
Density as remolded: 1.719 gm/cc

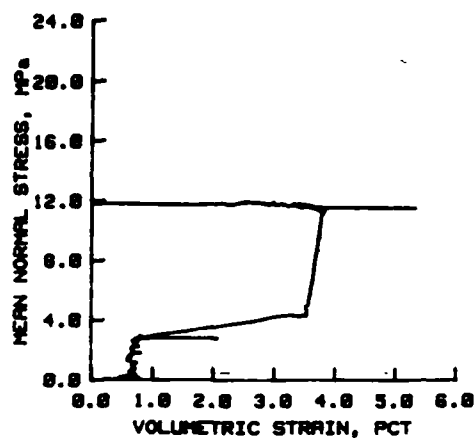
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.885 gm/cc
 Water content: 28.7 pct
 Dry density: 1.727 gm/cc
 Void ratio: 0.56

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.57
 Pore pressure: 2.48





MB SAND TEST MB 3A

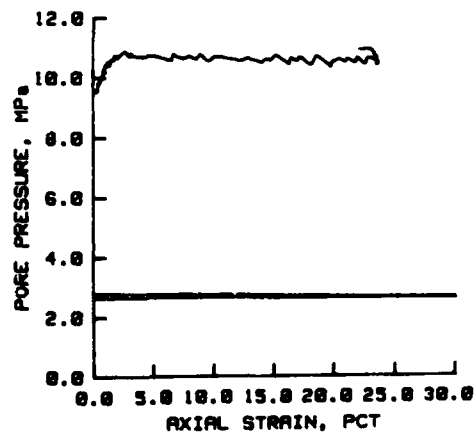
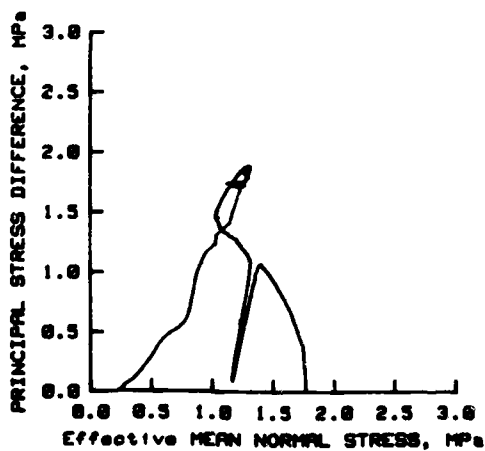
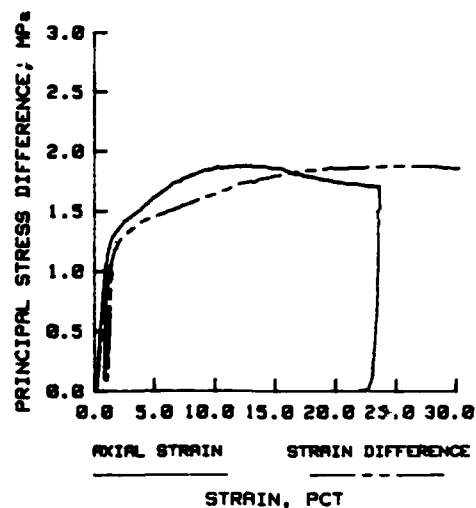
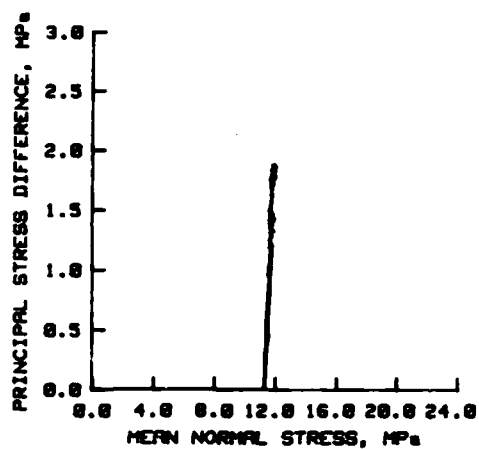
Density as remolded: 1.717 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.887 gm/cc
 Water content: 28.6 pct
 Dry density: 1.731 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.78
 Pore pressure: 2.66



MB SAND TEST MB 4A

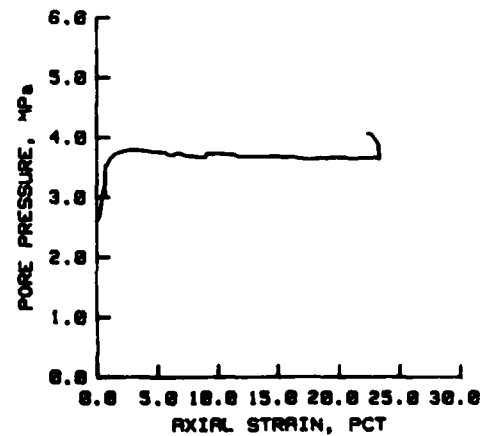
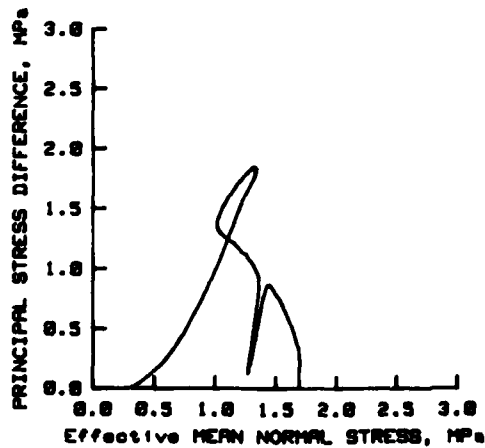
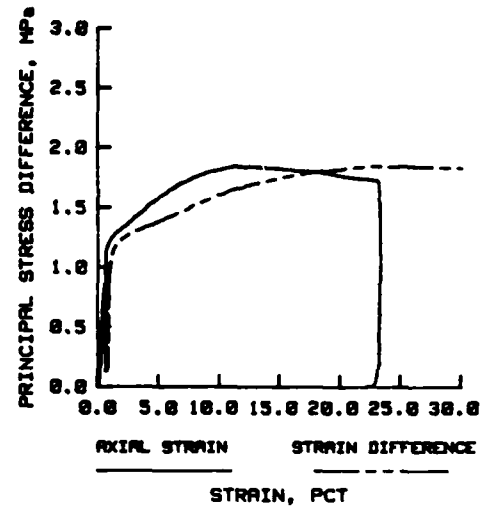
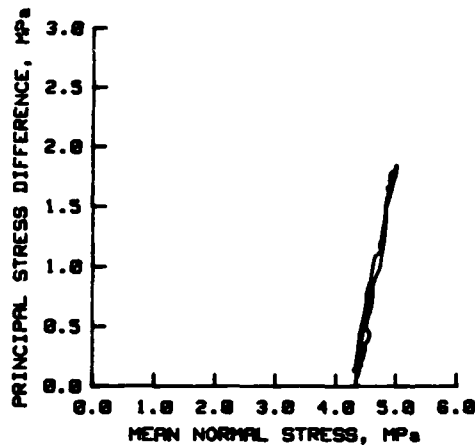
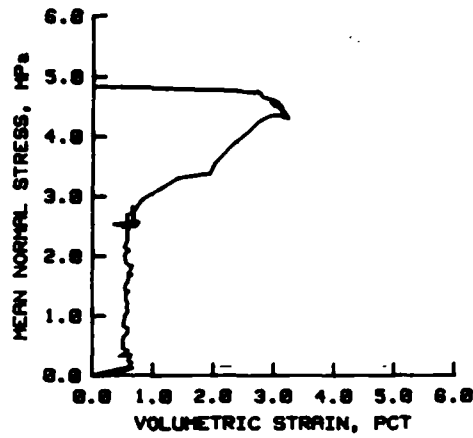
Density as remolded: 1.728 gm/cc

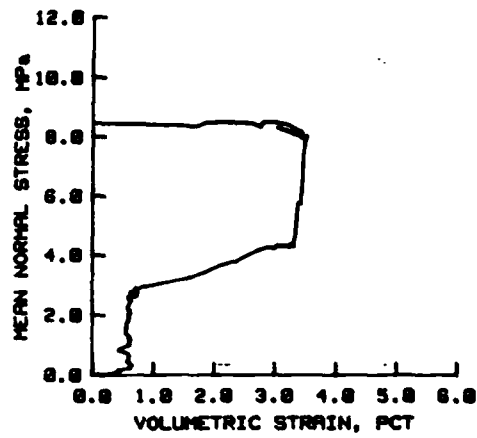
COMPOSITION PROPERTIES AT END OF BPS

Mat density: 2.800 gm/cc
 Water content: 28.6 pct
 Dry density: 1.731 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.73
 Pore pressure: 2.57





MB SAND TEST MB 5A

Density as remolded: 1.722 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Net density: 2.889 gm/cc

Water content: 28.5 pct

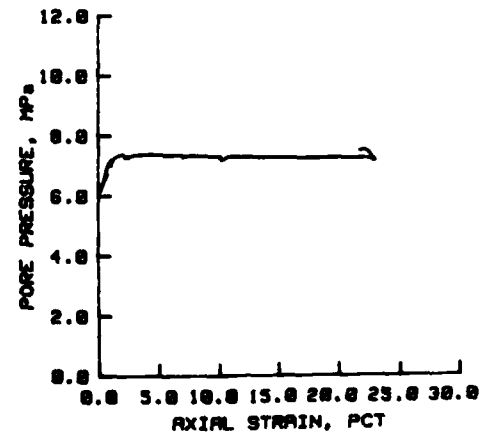
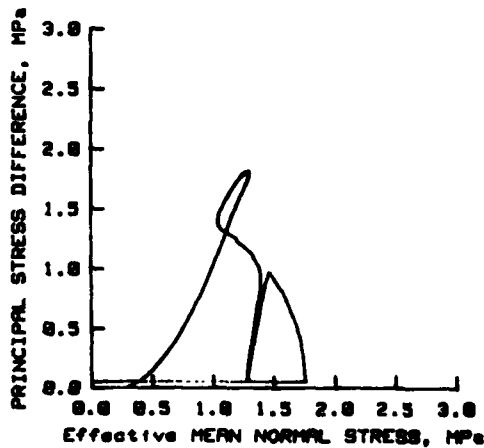
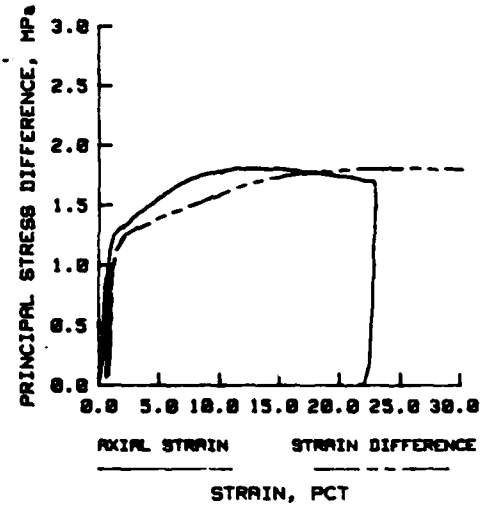
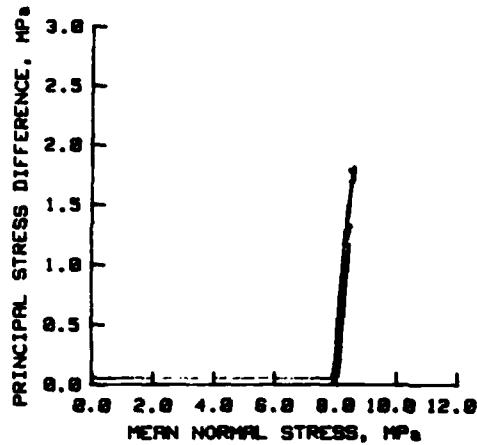
Dry density: 1.734 gm/cc

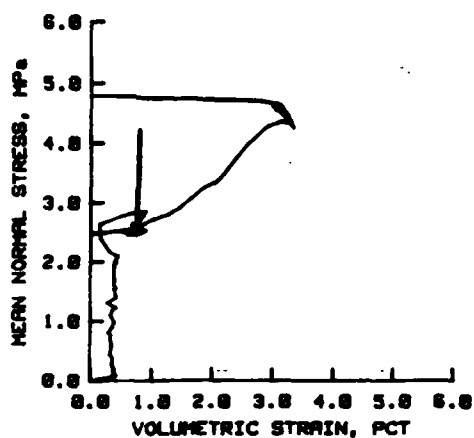
Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.77

Pore pressure: 2.68





MB SAND TEST MB 6A

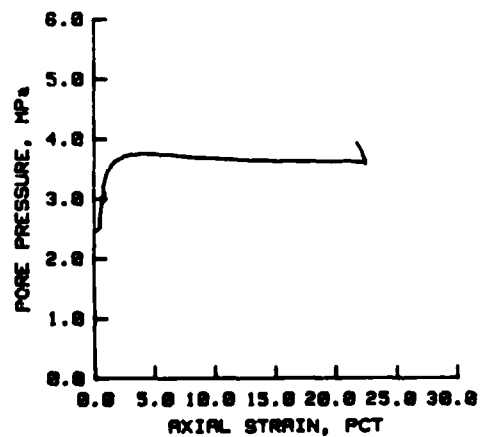
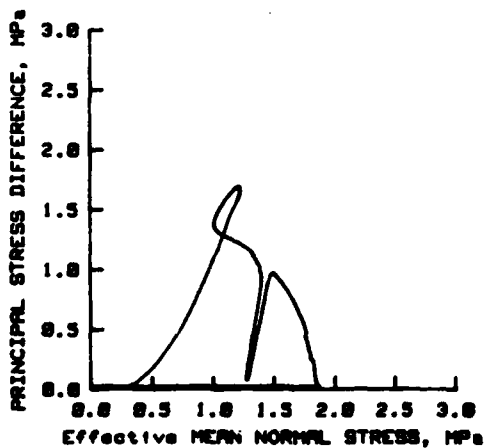
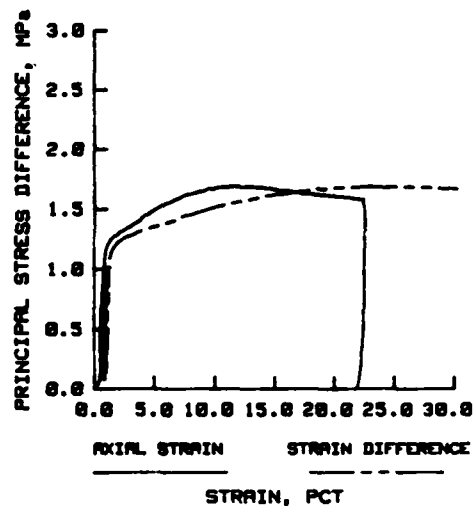
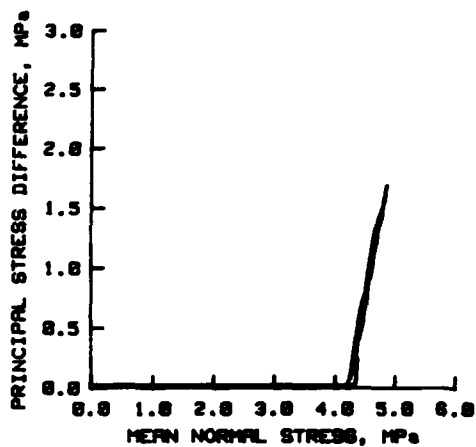
Density as remolded: 1.688 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.888 gm/cc
 Water content: 21.6 pct
 Dry density: 1.781 gm/cc
 Void ratio: 0.58

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.51
 Pore pressure: 2.36



MB SAND TEST MB 13

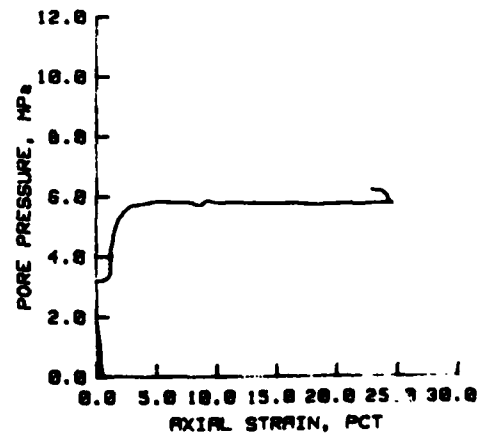
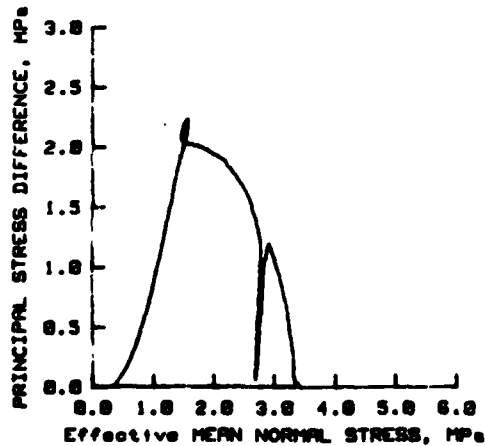
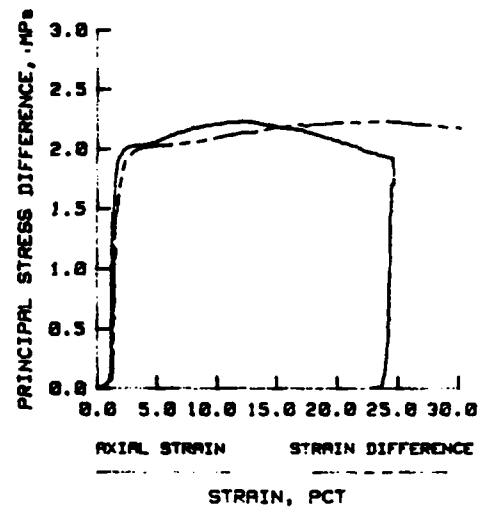
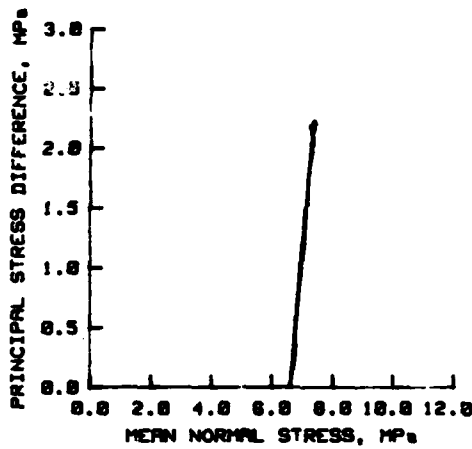
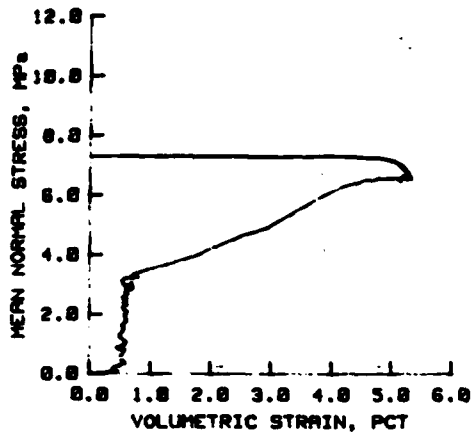
Density as remolded: 1.714 gm/cc

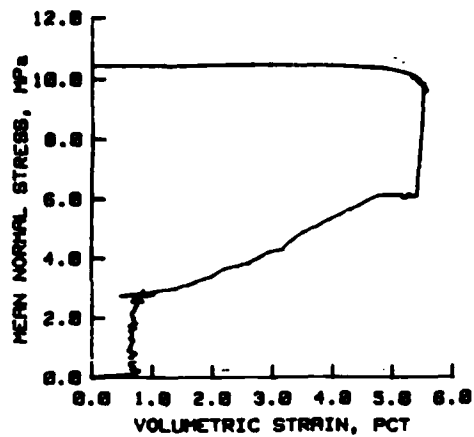
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.885 gm/cc
 Water content: 28.7 pct
 Dry density: 1.726 gm/cc
 Void ratio: 0.56

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.25
 Pore pressure: 3.89





MB SAND TEST MB 14

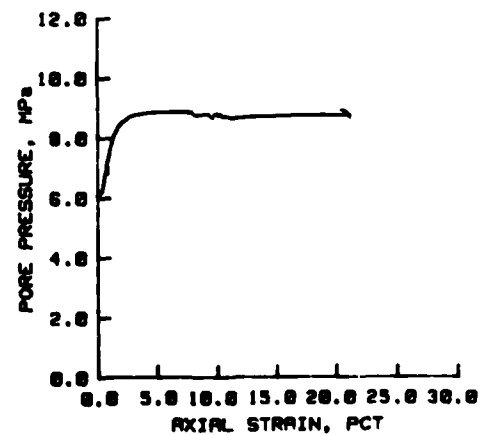
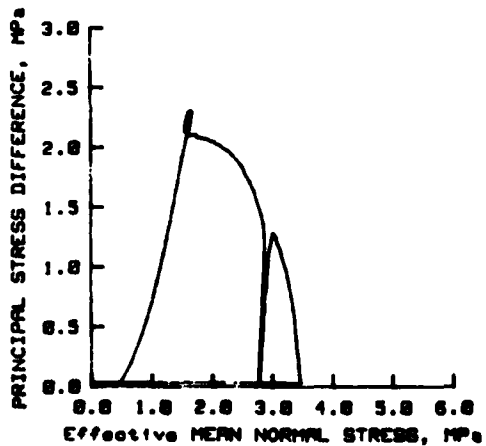
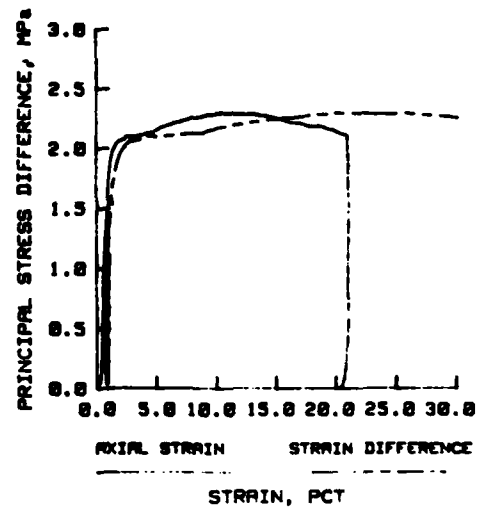
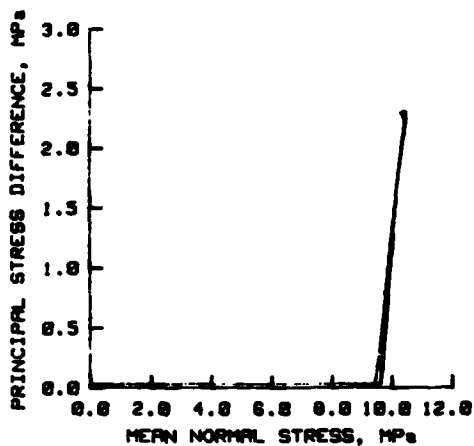
Density as remolded: 1.716 gm/cc

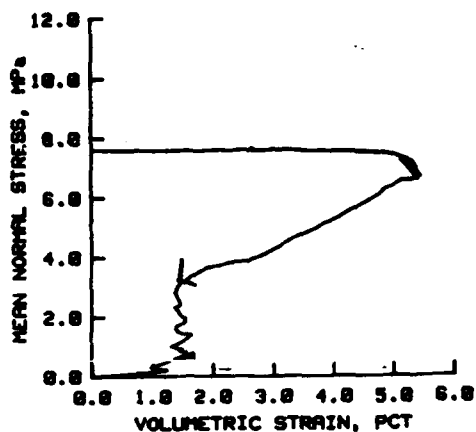
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.887 gm/cc
 Water content: 28.6 pct
 Dry density: 1.731 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 2.77
 Pore pressure: 2.59





MB SAND TEST DNA 4

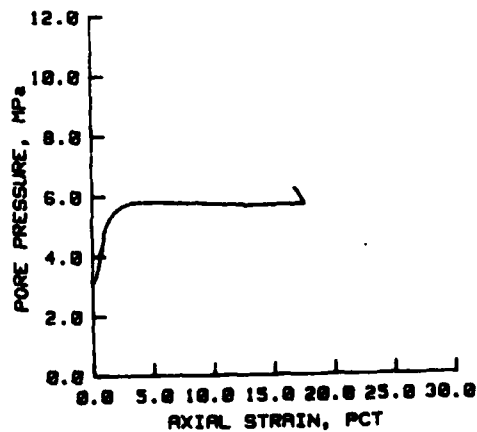
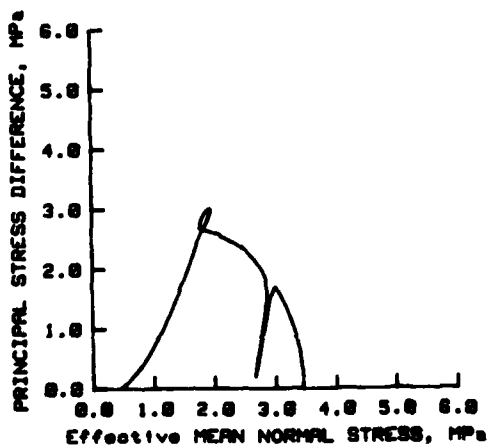
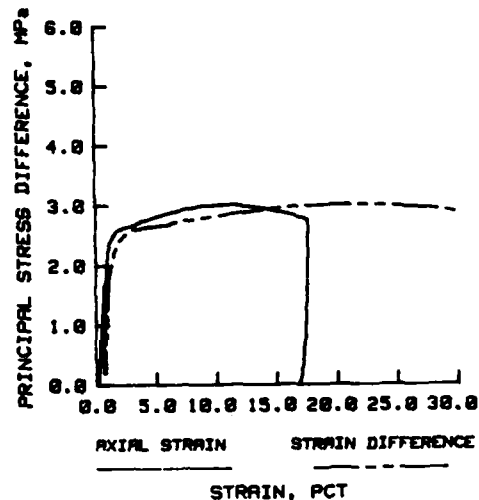
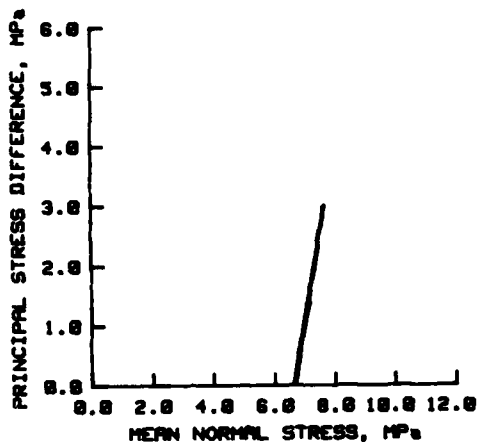
Density as remolded: 1.733 gm/cc

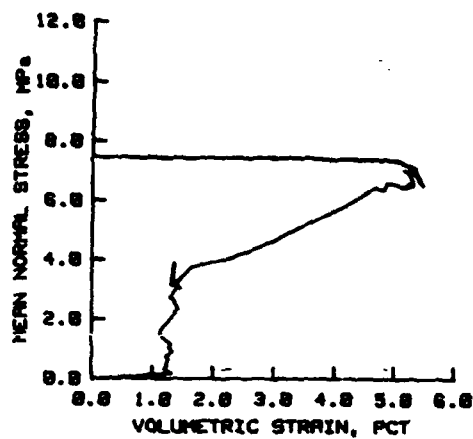
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.101 gm/cc
 Water content: 19.4 pct
 Dry density: 1.768 gm/cc
 Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.28
 Pore pressure: 3.87





MB SAND TEST DNA 7

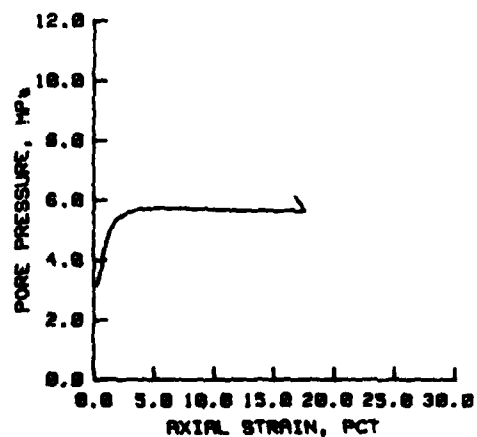
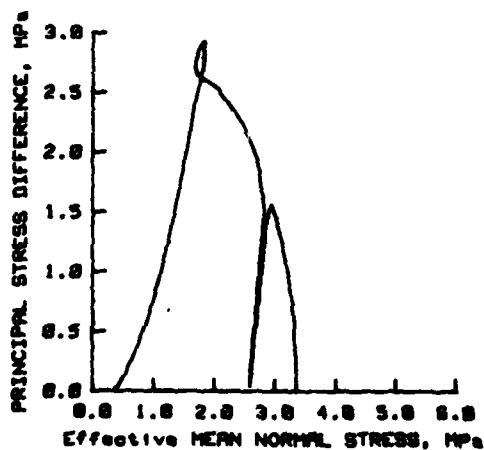
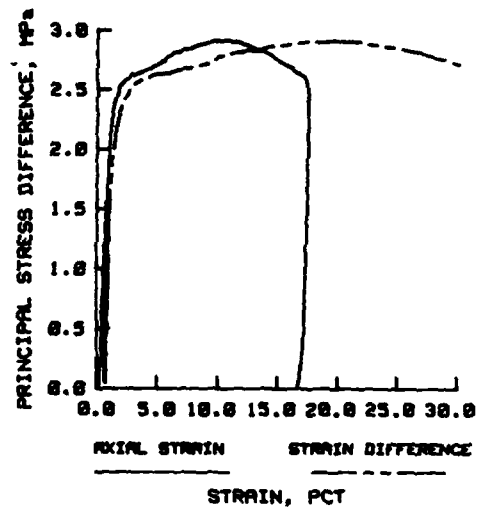
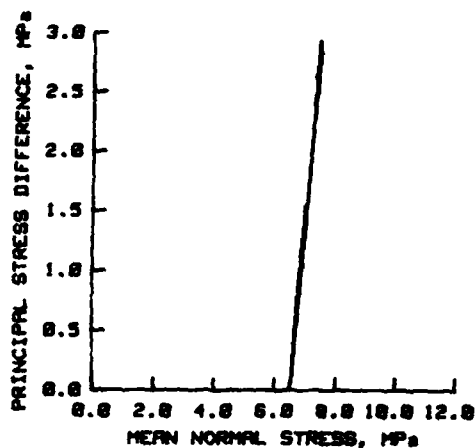
Density as remolded: 1.786 gm/cc

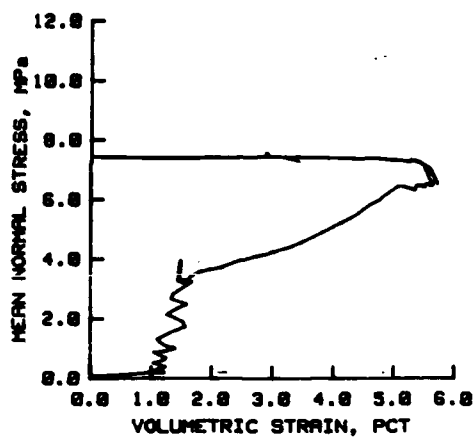
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.882 gm/cc
 Water content: 28.3 pct
 Dry density: 1.738 gm/cc
 Void ratio: 0.34

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.14
 Pore pressure: 3.88





MB SAND TEST DNR 8

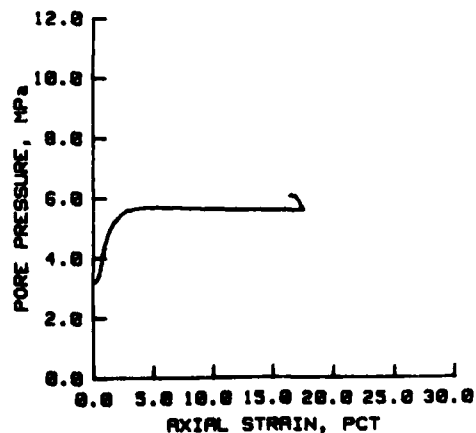
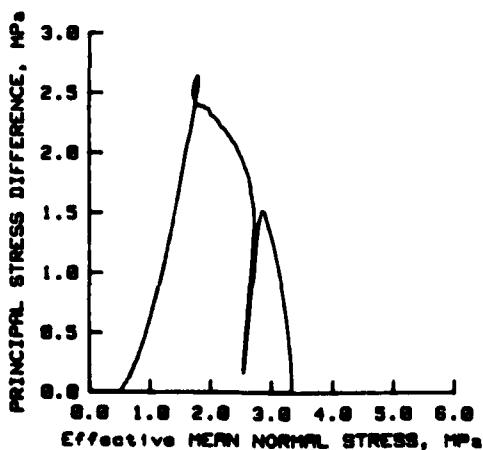
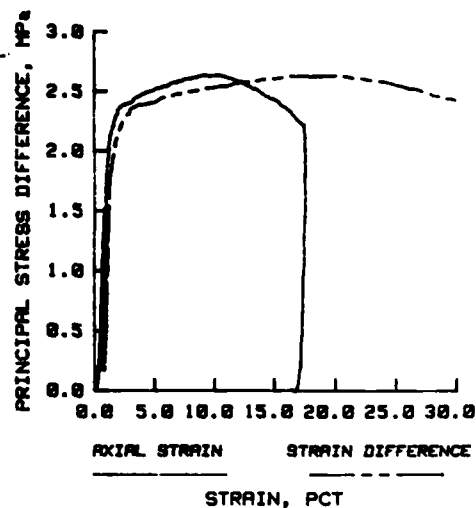
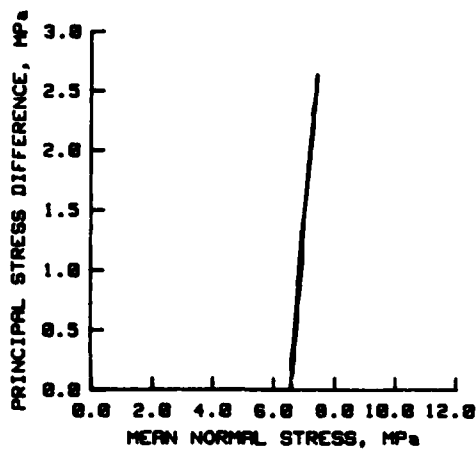
Density as remolded: 1.695 gm/cc

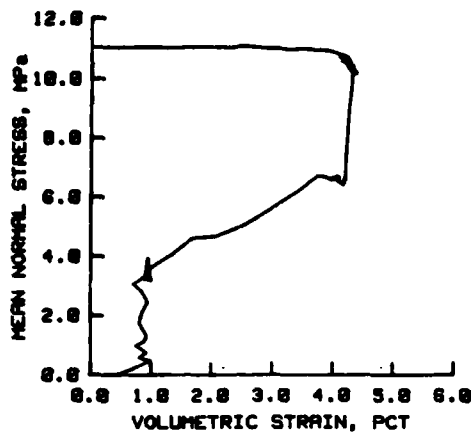
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.077 gm/cc
 Water content: 20.6 pct
 Dry density: 1.721 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.17
 Pore pressure: 3.08





MB SAND TEST DNA 9

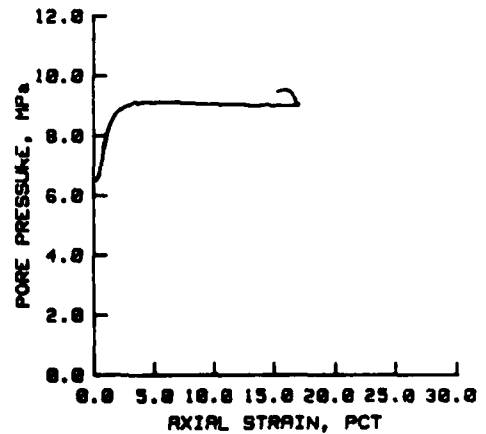
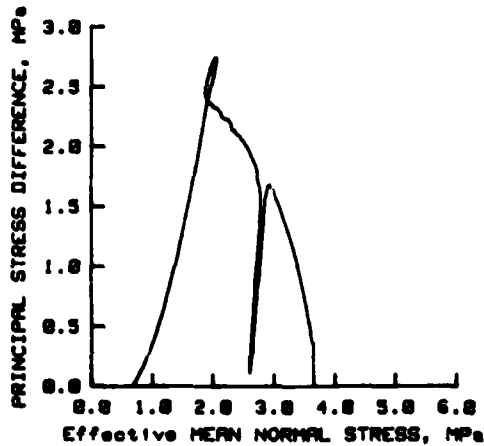
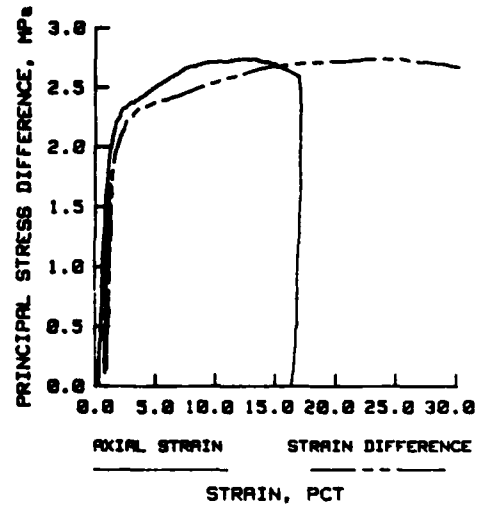
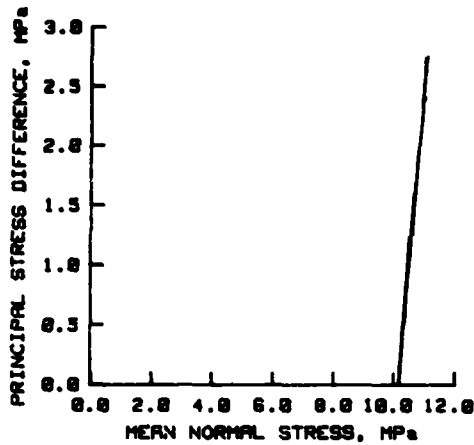
Density as remolded: 1.716 gm/cc

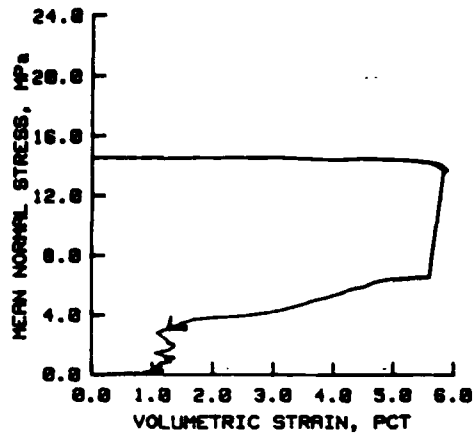
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.004 gm/cc
 Water content: 20.3 pct
 Dry density: 1.733 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.26
 Pore pressure: 3.83





MB SAND TEST DNA 10

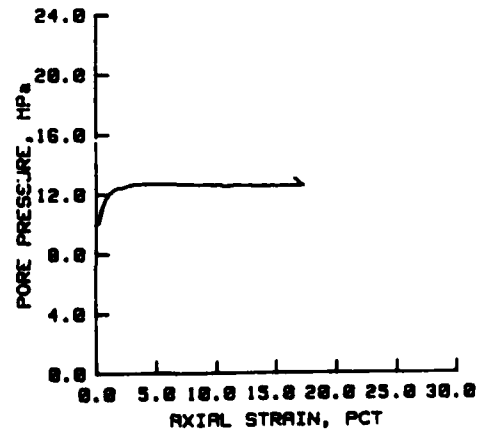
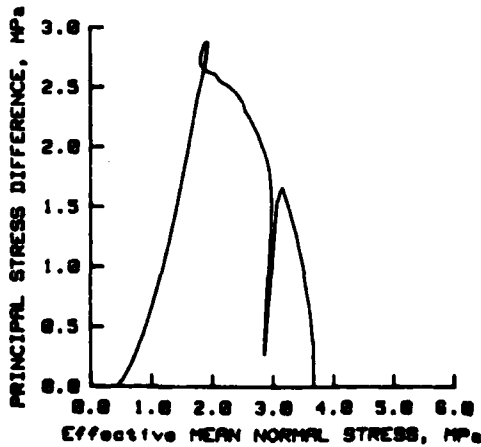
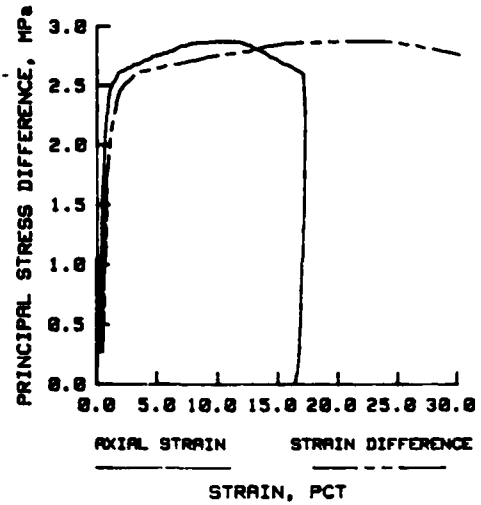
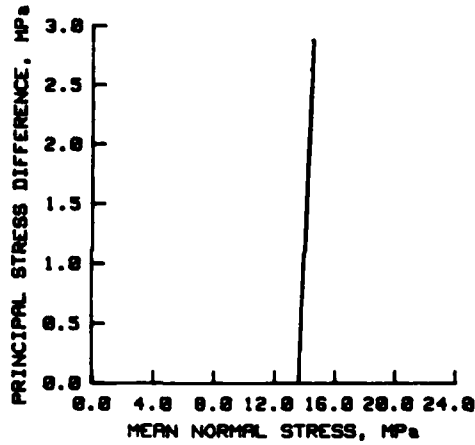
Density as remolded: 1.738 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.182 gm/cc
 Water content: 19.3 pct
 Dry density: 1.762 gm/cc
 Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.17
 Pore pressure: 3.00



MISERS BLUFF SAND
STATIC UX/K_0 TESTS

MB SAND TEST DNF 25

Density as remolded: 1.731 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.096 gm/cc

Water content: 19.6 pct

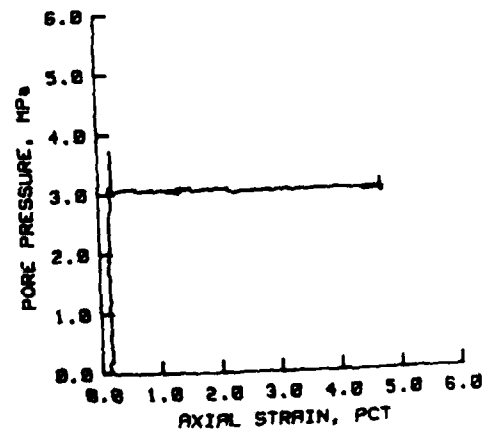
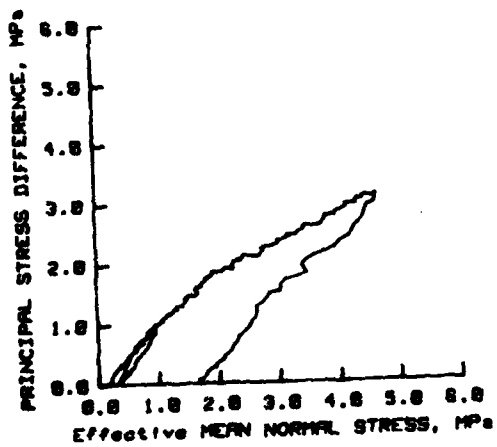
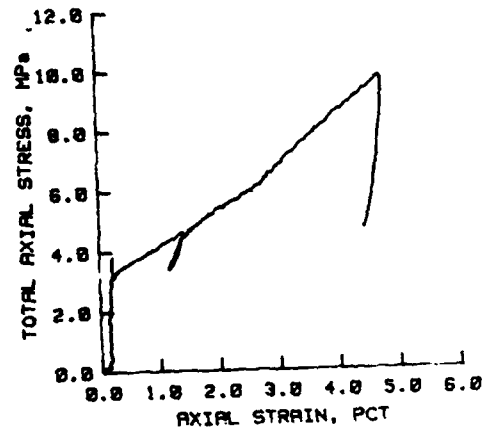
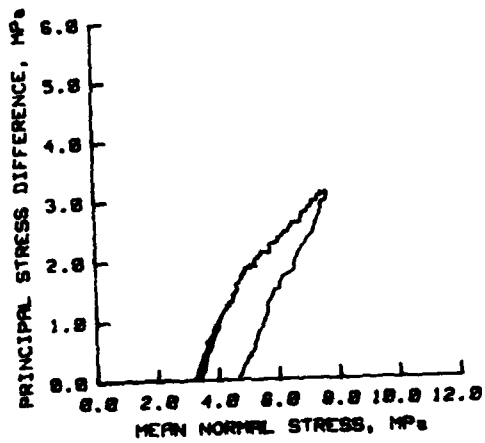
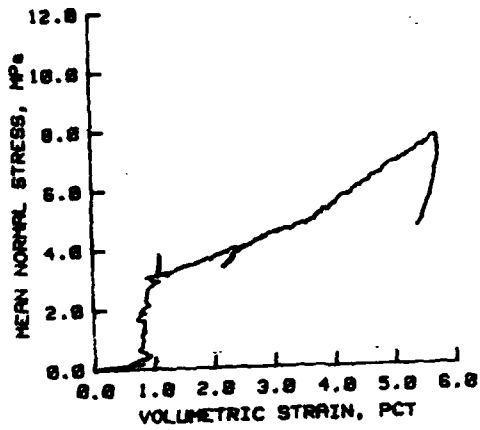
Dry density: 1.753 gm/cc

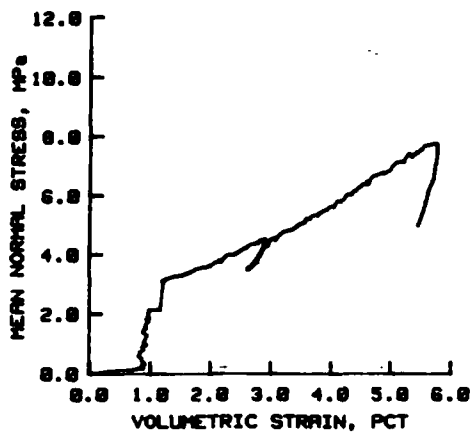
Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.20

Pore pressure: 3.84





MB SAND TEST DNA 26

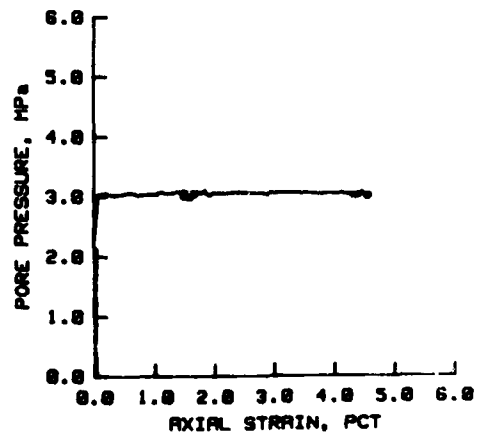
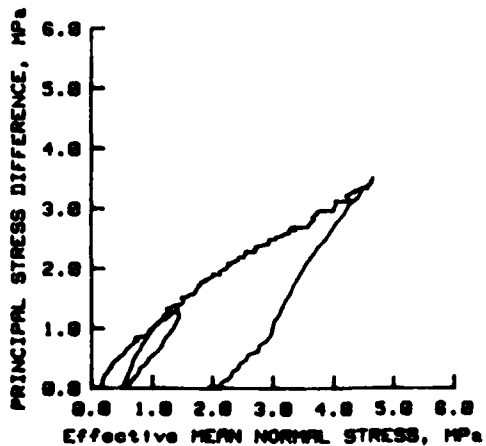
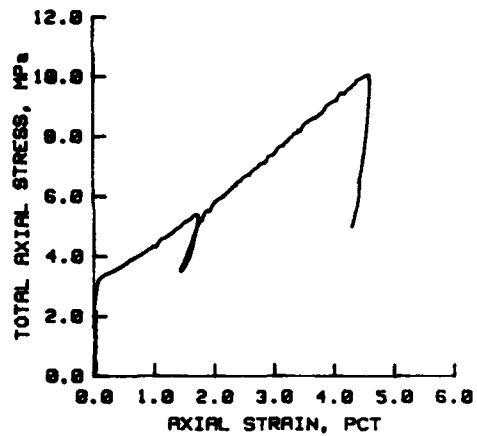
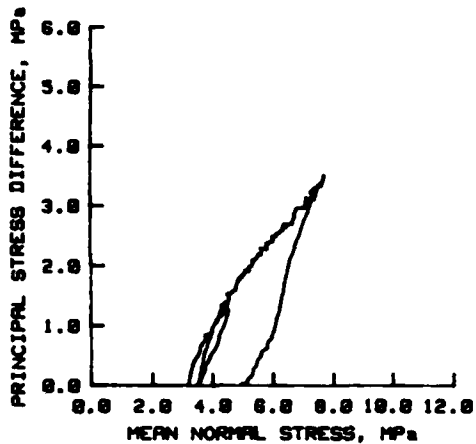
Density as recorded: 1.698 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.076 gm/cc
 Water content: 20.7 pct
 Dry density: 1.720 gm/cc
 Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.19
 Pore pressure: 3.83



AD-A171 497

MECHANICAL RESPONSE OF DRY REID-BEDFORD MODEL SAND AND

2/2

SATURATED MISTERS B. (U) ARMY ENGINEER MATERIAIS

EXPERIMENT STATION UICKSBURG MS STRUC. B R PHILLIPS

UNCLASSIFIED

SEP 86 WES/IR/SL-86-27

F/G 8/13

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XEROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

MB SAND TEST DNA 17

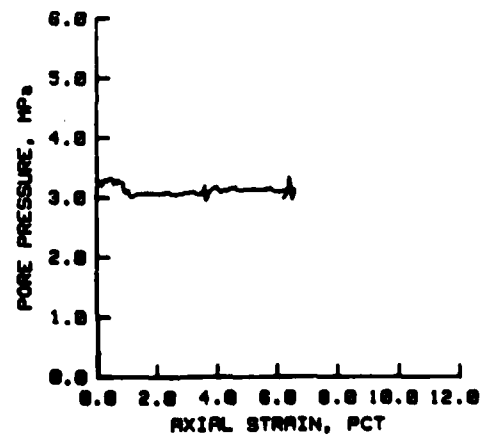
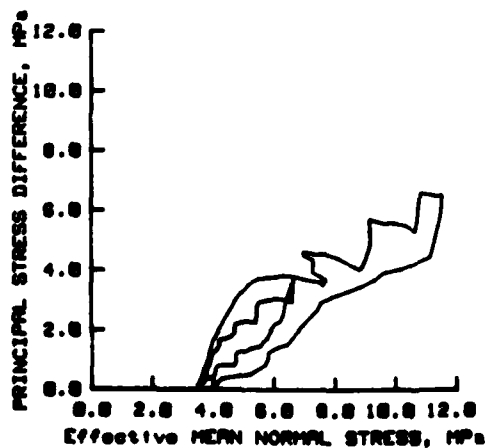
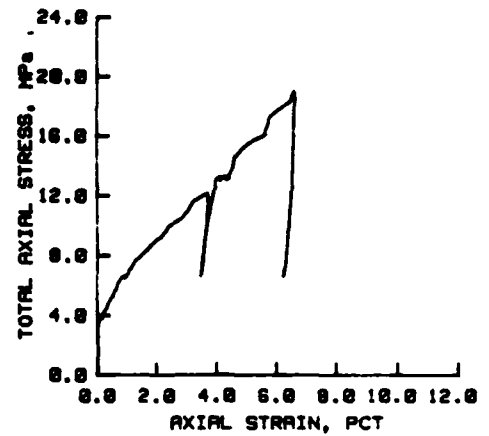
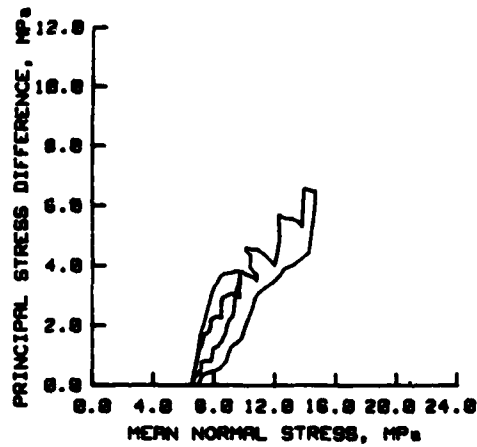
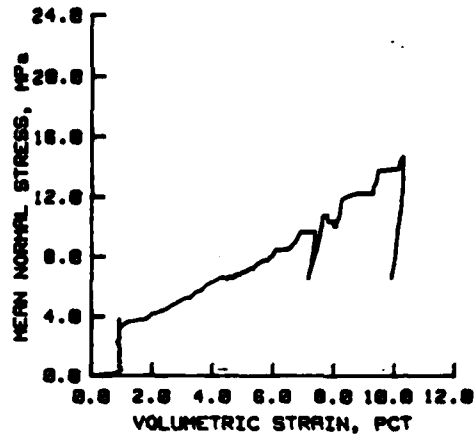
Density as remolded: 1.738 gm/cc

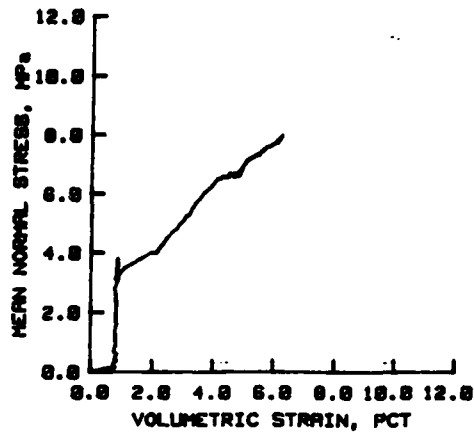
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.887 gm/cc
 Water content: 19.6 pct
 Dry density: 1.754 gm/cc
 Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.11
 Pore pressure: 2.99





MB SAND TEST DNA 18

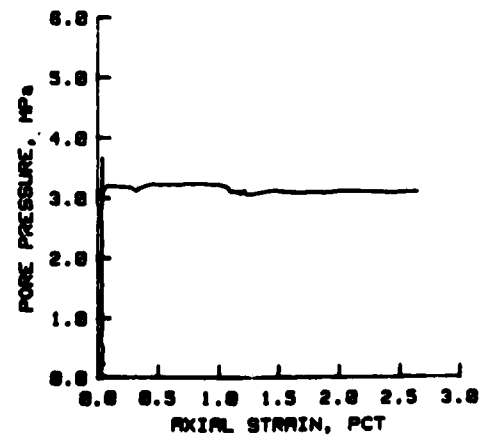
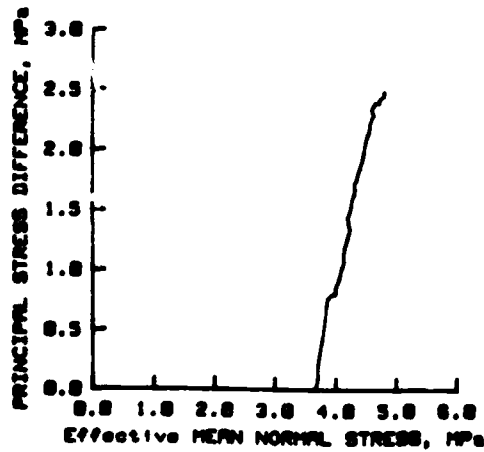
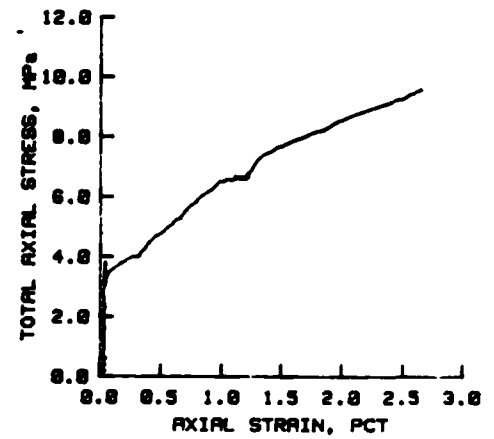
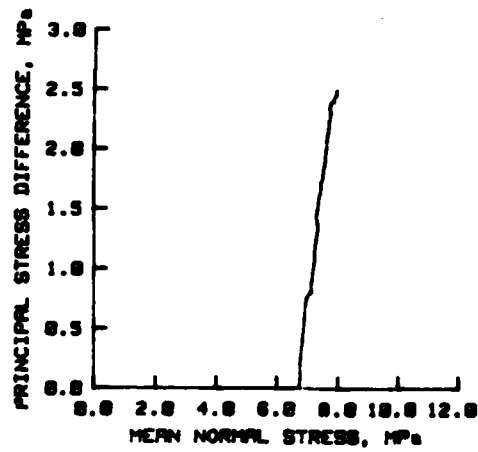
Density as remolded: 1.717 gm/cc

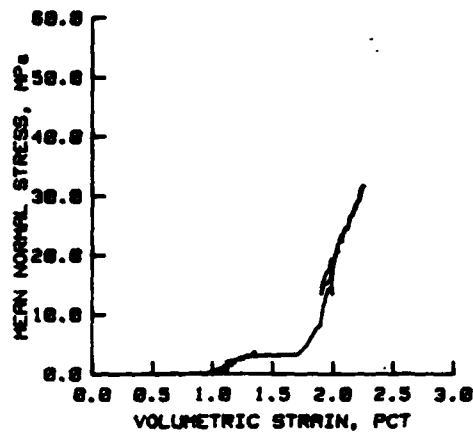
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.883 gm/cc
 Water content: 28.3 pct
 Dry density: 1.732 gm/cc
 Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.15
 Pore pressure: 3.83





MB SAND TEST DNA 23

Density as remolded: 1.688 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Net density: 2.878 gm/cc

Water content: 28.5 pct

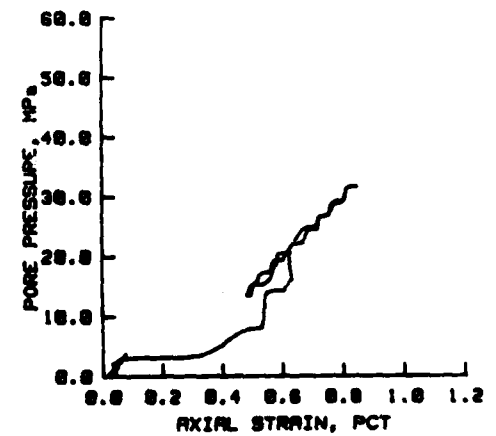
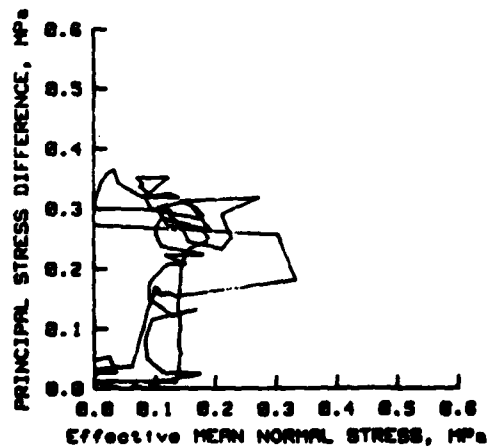
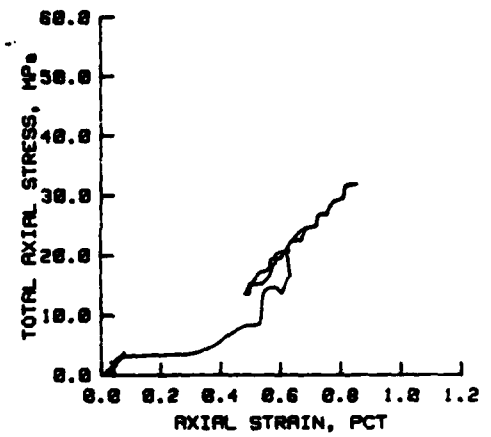
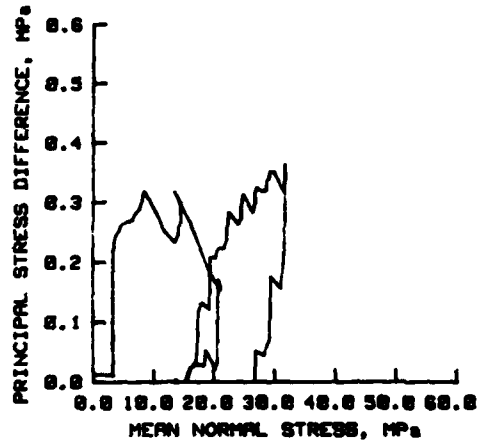
Dry density: 1.724 gm/cc

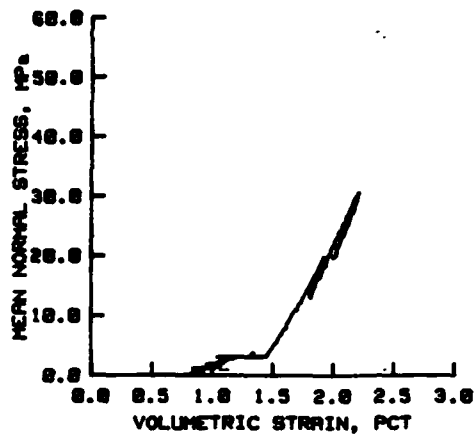
Void ratio: 0.55

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.17

Pore pressure: 3.83





MB SAND TEST DNA 24

Density as remolded: 1.715 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.000 gm/cc

Water content: 20.0 pct

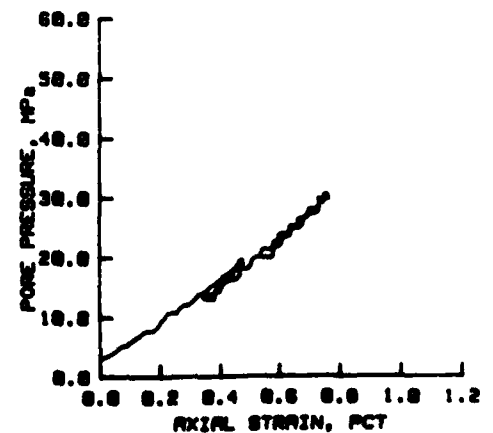
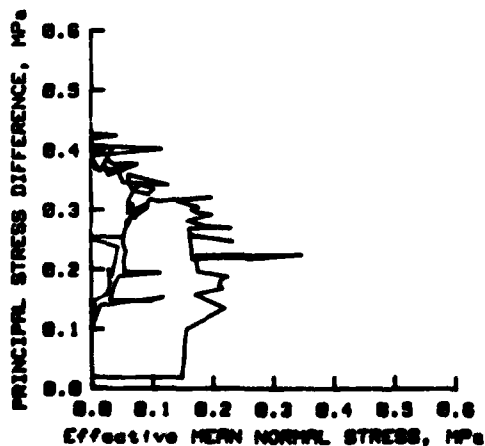
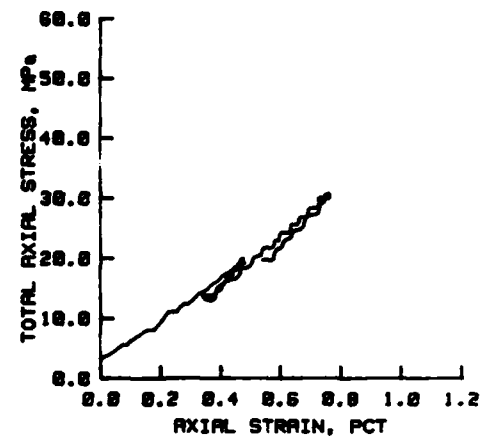
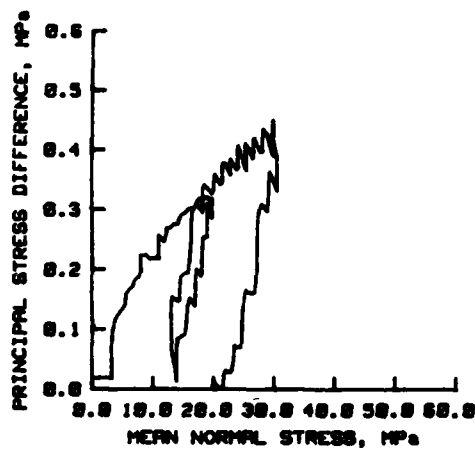
Dry density: 1.740 gm/cc

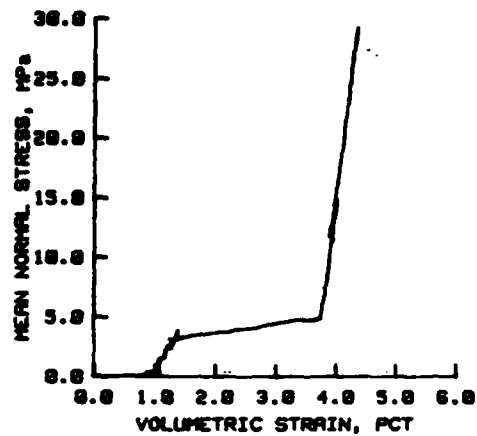
Void ratio: 0.53

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.13

Pore pressure: 3.06





MB SAND TEST DNA 28

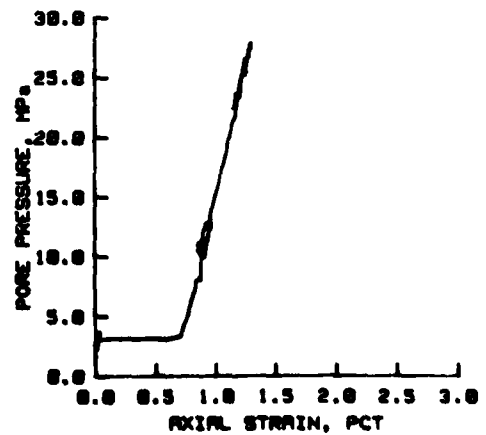
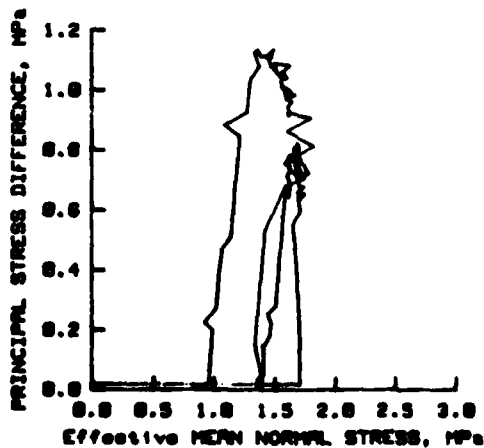
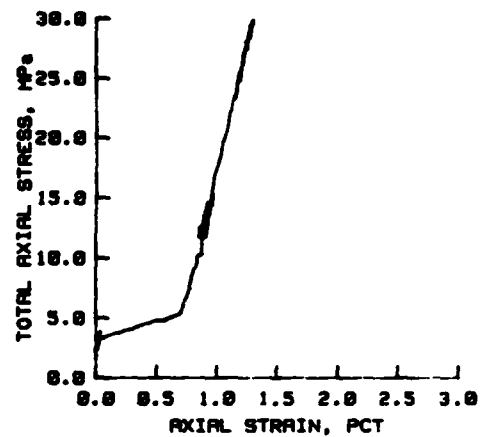
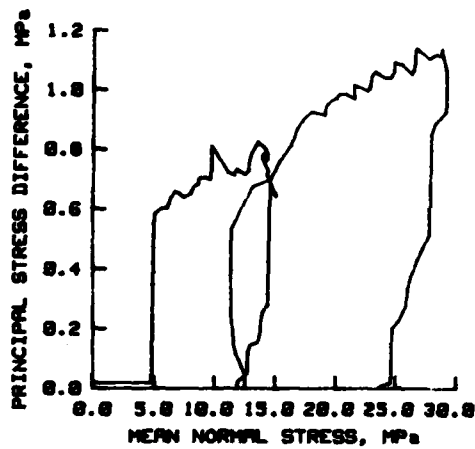
Density as remolded: 1.735 gm/cc

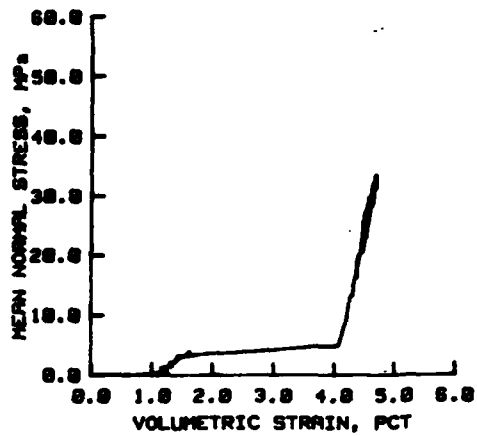
COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.180 gm/cc
 Water content: 19.4 pct
 Dry density: 1.758 gm/cc
 Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.14
 Pore pressure: 3.82





MB SAND TEST DNR 29

Density as remolded: 1.727 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.888 gm/cc

Water content: 19.5 pct

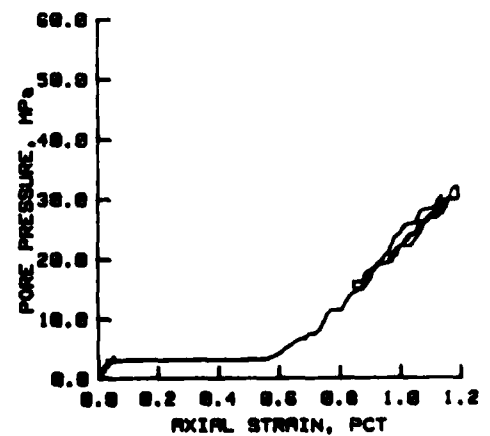
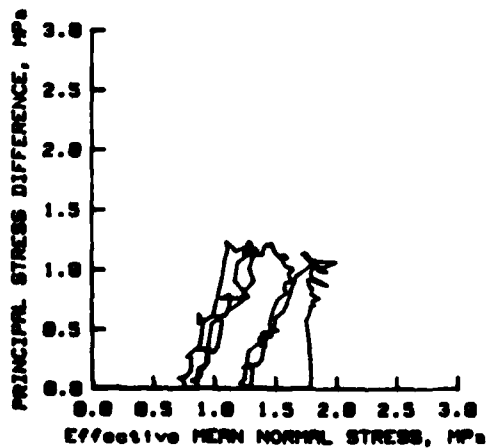
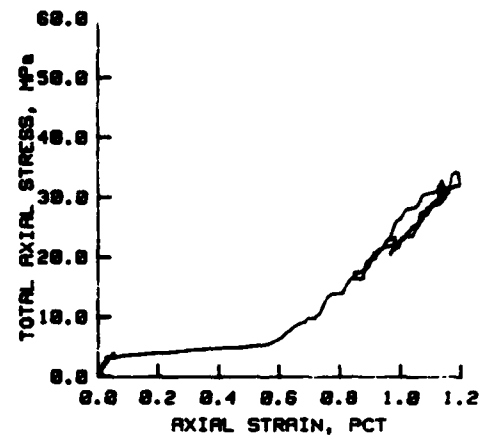
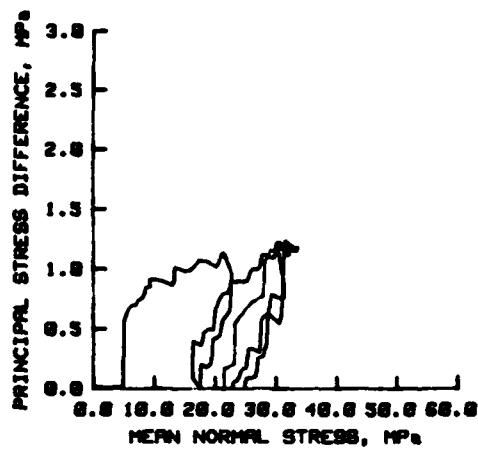
Dry density: 1.735 gm/cc

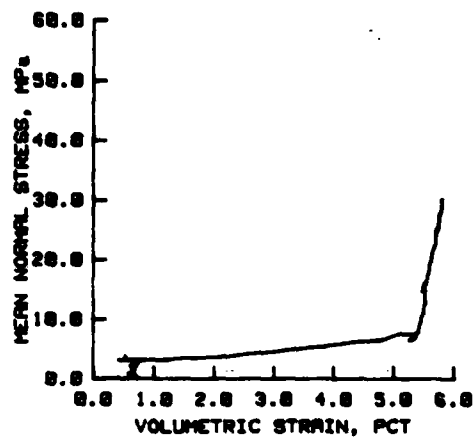
Void ratio: 0.52

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.21

Pore pressure: 3.83





MB SAND TEST DNA 15

Density as remolded: 1.719 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.889 gm/cc

Water content: 28.8 pct

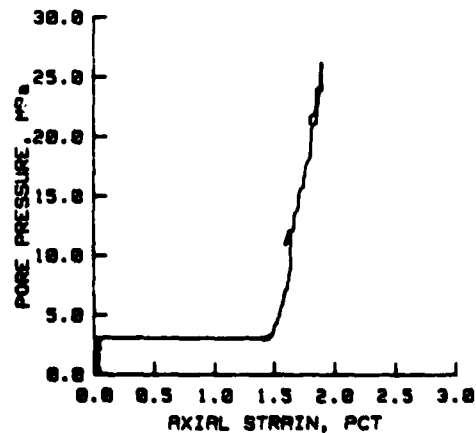
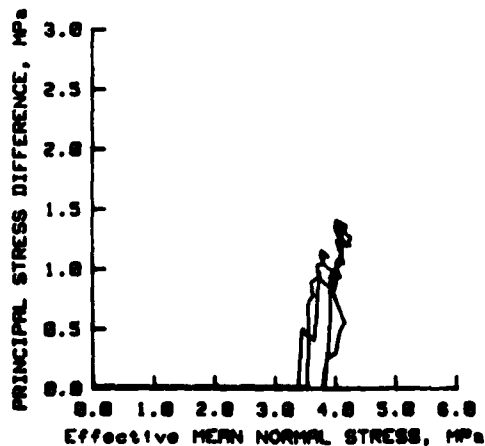
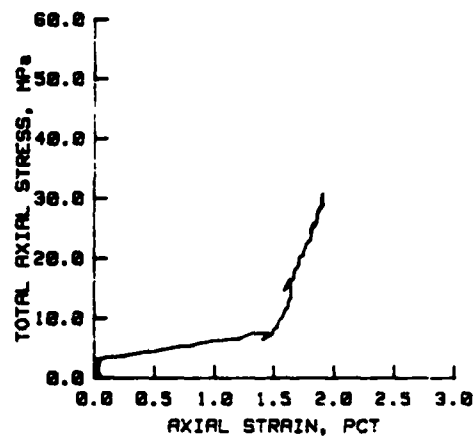
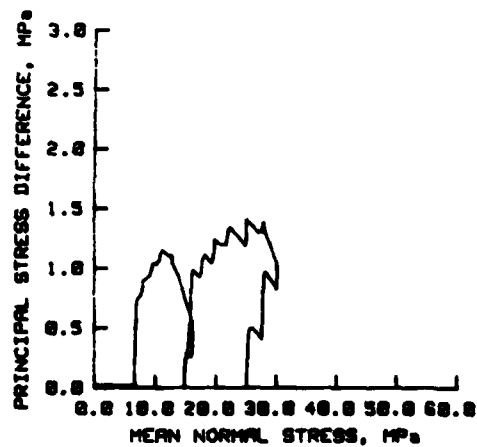
Dry density: 1.748 gm/cc

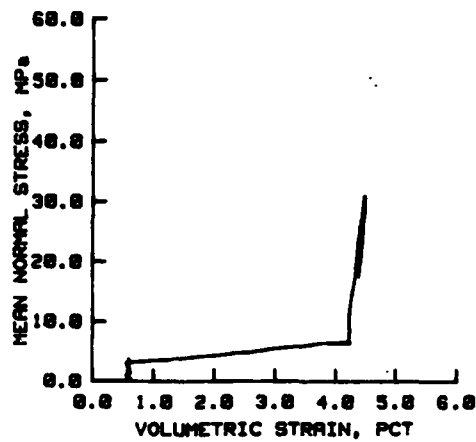
Void ratio: 0.53

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.18

Pore pressure: 3.84





MB SAND TEST DNA 16

Density as remolded: 1.721 gm/cc

COMPOSITION PROPERTIES AT END OF BPS

Wet density: 2.003 gm/cc

Water content: 20.3 pct

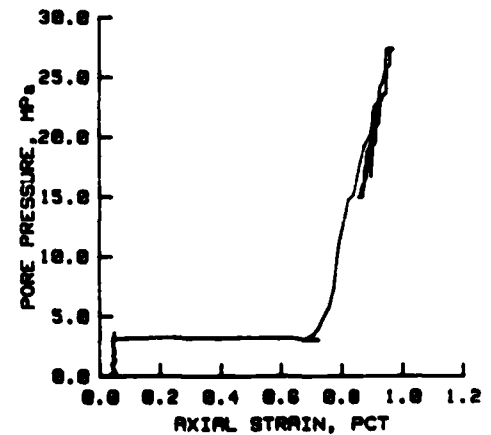
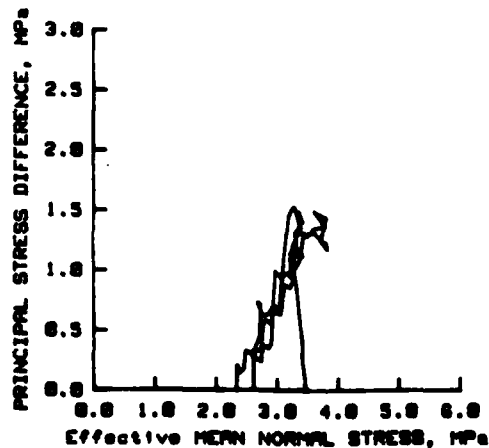
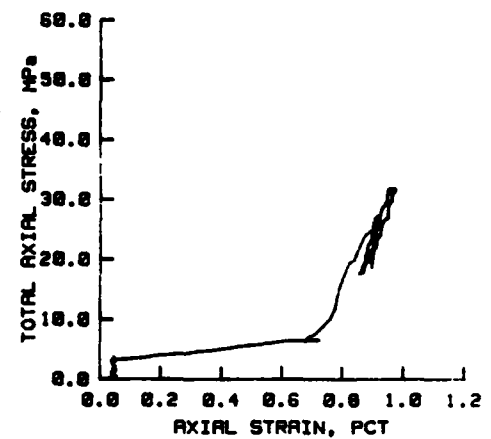
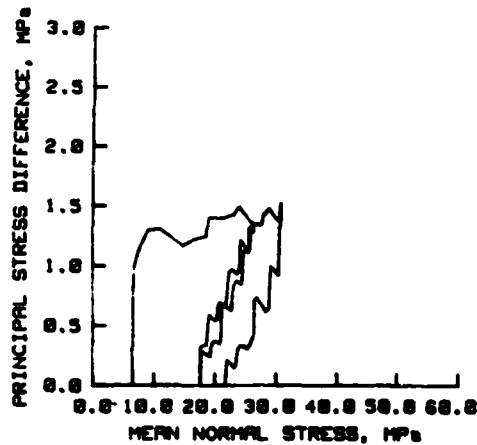
Dry density: 1.731 gm/cc

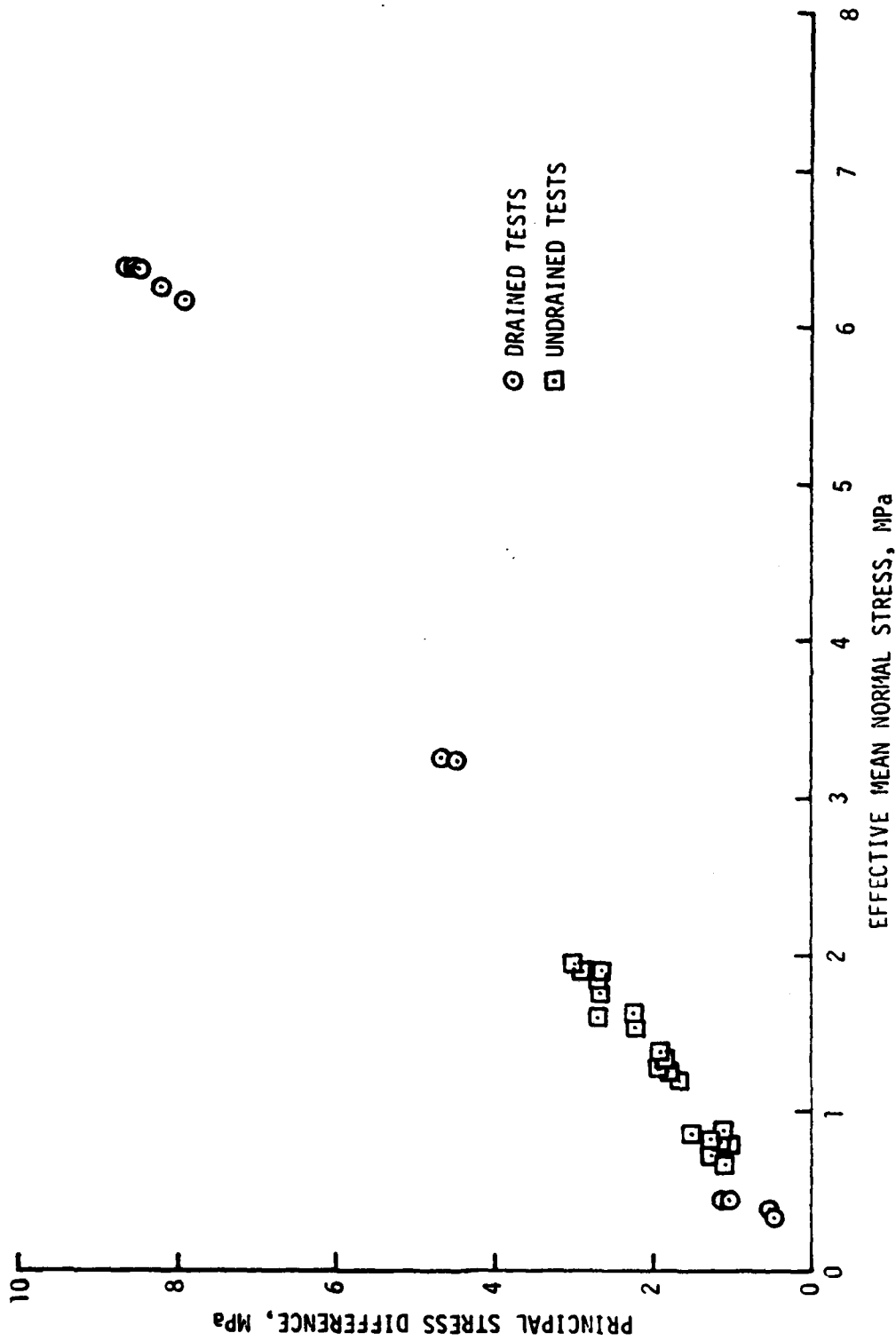
Void ratio: 0.54

PRESSURES AT END OF BPS, MPa

Confining pressure: 3.67

Pore pressure: 3.84





Failure data for Misers Bluff sand specimens

DATE
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