EVALUATION OF AGGREGATES FOR BASE COURSE CONSTRUCTION

FINAL REPORT

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The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation or the U.S. Department of Transportation.

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EXECUTIVE SUMMARY

An investigation of limestone base course aggregates was performed to ascertain if strength and stiffness changes in carbonate aggregates could be evaluated for the purpose of quantifying their effects on the base structural layer coefficient (a_2) used in pavement design. One of the goals of this approach was to develop a laboratory test or series of tests, which the FDOT might use to quantify or predict strength and stiffness gains, that could be generally applied to a range of materials types given field operating conditions. Materials of varying carbonate content were selected, prepared at optimum moisture content and compacted by modified proctor for testing at different ages after curing by two methods (soak and moisture room). Replicate specimens were prepared with 1.0 percent lime and tested for the purpose of accelerating cementation or modifying clay contained in the aggregate to simulate observed increases in field based strength performance. Limerock Bearing Ratio, cohesion and angle of internal friction, triaxial resilient modulus (M_R), and gyratory shear (G_s) tests were performed and evaluated.

Based on the data accumulated with this study, carbonate content does not necessarily relate to higher strength gain. This does not mean that high carbonate content materials cannot achieve cementation and greater strength, rather that the series of tests included in this report were unable to quantify and/or accurately reproduce the effect of cementation within a curing time of 60 or less days. However, it does suggest that use of a higher layer coefficient for high carbonate aggregates strictly based on percent carbonates may not be appropriate.

Several key complications in ascertaining the relationship between carbonate content and potential strength gain were identified as a result of this study. First, the use of the term carbonate content alone as an aggregate descriptor is problematic. Variations in aggregate carbonate mineralogy (low-Mg calcite, high-Mg calcite, aragonite, and dolomite) and crystallite/particle size among the various lithologies used in this study should have a significant impact on cementation potential, based on both kinetic and thermodynamic constraints. As a result, in order to fully ascertain the importance of aggregate carbonate content to strength gain potential, aggregates may need to be evaluated on a lithological basis, as the character of carbonate mineralogy varies among the aggregate sources employed as base course in Florida. Second, test variables other than carbonate content were found to have a major impact on strength gain, particularly dry density (γ_d) and aggregate gradation, impacting test ability to elucidate the role of carbonate content. Lastly, poor test precision added further to the difficulty in identifying a relationship, if any, between carbonate content and strength gain in the materials tested.

Lime addition (1.0 percent) produced both increases and decreases in strength-associated properties depending upon the material source. Results also varied among the different tests employed with this study for individual sources, and under different curing conditions. Triaxial M_R values gave a fairly consistent range in values. Computation of a mean layer coefficient from the M_R of the different aggregates indicated that an average a_2 value of 0.18 was typical for both limestone and bank-run shell aggregates. A relationship between G_s and M_R was developed to facilitate the computation of a_2 using G_s data.

An attempt was made to develop a rapid and practical method to accelerate cementation of base course materials in order to predict increases in field-based strength. Both untreated and treated (1% hydrated lime) samples from several pit locations, representing both high carbonate and low carbonate aggregate sources were prepared using a variety of experimental procedures, and then tested using an unconfined compression test in order to determine the unconfined shear

strength of the materials. Although it was believed that a controlled environment of some combination of variable humidity and variable CO_2 pressure would result in the conditions necessary to accelerate cementation, the experiments failed to produce the desired results. Apparently, we have been unable to mimic the proper natural field conditions over a short time span that will accelerate the increases in observed field-based strength performance.


STATE ROAD
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INTRODUCTION

Research into the characterization of carbonate materials used for highway construction in Florida is of great interest to the Florida Department of Transportation (FDOT). As new quarry locations are opened, and new materials are used, it becomes more and more important to carefully monitor these materials to insure that proper specifications are being met. Recent studies of base course materials have been one of many areas of focus. The research outlined in this report was undertaken to evaluate the engineering properties of limestone base course materials for the potential assessment of their structural properties for use in pavement design.

The FDOT requires that aggregates to be used for base course meet the following specification requirements for approval with designated layer coefficients as outlined in Table 1.

Table 1. Standard FDOT specifications for materials used in base course construction

MATERIAL TYPE	STANDARD SPECIFICATION	MINIMUM LBR	MINIMUM CARBONATES (%)	LAYER COEFFICIENT (STD. INDEX)
Limerock	911	100	70	0.18
Shell	913	100	50	0.18
Shell-Rock	913A	100	50	0.18
Cemented Coquina	915	100	45	0.18
Graded Aggregate	204	100	0	0.15

In 1961, the AASHO Committee on Design of Flexible Pavements first proposed structural layer coefficients for base course materials (Zimpfer et al., 1973). These coefficients, adopted at the time by the FDOT, were based on the AASHO Road Test, which began in 1958, and used local Illinois base materials for the study. As part of the recommendations of the AASHO Committee on Design, utilization of satellite test pavements by the states was suggested as a means of supplementing and adjusting the AASHO Road Test findings to local conditions. During the 1960's many states followed this suggestion, including Florida (Schrivner and Moore, 1968). Zimpfer et al. (1973) were the first to point out that a combination of (1) AASHO coefficients, (2) Florida satellite studies, (3) field performance studies, (4) laboratory and test pit studies, and (5) research by other agencies was most likely required to develop reasonable estimates for structural layer coefficients that can account for environmental and material factors unique to Florida.

The AASHO Road Test coefficients initially were established as interim values based on the materials used in the study. In that study, the base materials included crushed stone, gravel, cement-treated gravel, and bituminous-treated gravel. The crushed stone base was a well-graded crushed dolomitic limestone with an approximate LBR value of 140. A structural coefficient of 0.14 was established for this material based on the AASHO Road Test. Based on a comparison of Florida limestones to the AASHO crushed limestone (Zimpfer et al., 1973), the FDOT established a layer coefficient of 0.15 for limerock materials used in the state, and a minimum LBR strength requirement of 100. This coefficient was correlated to an LBR value of 140, and

was approximately the mid-range of materials tested. Furthermore, it was recognized that the FDOT required AASHTO T-180 density requirements for limerock base course construction. A review of the approach to this conclusion is documented in Research Report 177, "Structural Layer Coefficients for Flexible Pavement Design", August, 1973. With the concurrence of the Federal Highway Administration (FHWA), the FDOT later raised the structural layer coefficient of limerock from 0.15 to 0.18 in accordance with recommendations of a 1981 FDOT research report FL/DOT/OMR-235/81 entitled "Pavement Design Coefficients, A Reevaluation of Florida Base Materials" (Smith and Lofroos, 1981). This report studied the strength and stiffness increase over a five, six, and nine year period of three roads constructed with limerock bases. The study showed that field plate moduli increased significantly to levels above 40,000 psi, which exceeded a structural coefficient of 0.18 denoted in the AASHO Design nomograph from NCHRP Report 128. Potential reasons for the strength and stiffness increase were suggested, but no attempt was made to establish a method of predicting these increases.

A potential problem arises because the FDOT cannot evaluate a new material and assign a layer coefficient equivalent to limerock, based on equivalent performance in the FDOT's test pit and/or a test road section (per FDOT Procedure 675-000-004-a) without significant time delay. The decision cannot be made on the basis of the new material's initial performance, without understanding its potential strength gain or the field conditions that may contribute to strength gain.

The issue of strength and stiffness gain also highlights the controversial issue of minimum required carbonates. It has been suggested that strength and stiffness gains may be caused by cementation of base course aggregate, and that a minimum carbonate requirement is essential to achieve this result. In fact, high carbonate content aggregates (especially, high-CaO) have for some time been known to exhibit long-term gains in strength due to cementing action (Gartland, 1979; Zimpher, 1981; Graves, 1987). In these earlier studies, the materials used were mixtures of pure limestone ($CaCO_3$) with varying amounts of quartz sand. However, this is not fully representative of the various lithologies employed as base material in Florida. From the previous table (Table 1), it is evident that some disparities appear to exist between the required minimum carbonate content of various aggregates, with no clear correlation to layer coefficient. It should be noted for Table 1 that graded aggregate may use either Group 1 aggregates (limestone, marble, or dolomite) or Group 2 aggregates (granite, gneiss, or quartzite), and as such, the minimum carbonate content of the material may be 0 % if Group 2 aggregates are employed.

Based solely on the disparities seen in Table 1, it is evident that there is a need to verify the validity of the carbonate strength gain hypothesis and to determine whether it is a relevant specification for assigning a structural number. Part of the problem with deciphering this relationship is the present terminology used with the study of high versus low carbonate base materials. The term high carbonate historically has been used by the FDOT for materials high in carbonates of calcium and/or magnesium. Whether the material in question is a limestone ($CaCO_3$), a dolomitic limestone ($CaCO_3$ and $CaMg(CO_3)_2$), or a dolostone ($CaMg(CO_3)_2$) will have a significant impact on the likelihood for strength gain derived through cementation based on kinetic considerations. Furthermore, even the mineral speciation within various limestones ($CaCO_3$ as low-Mg calcite, high-Mg calcite, and/or aragonite) should have an impact on cementation potential for the same reason. Therefore, one must consider the source lithology of base materials in question in order to fully ascertain the likelihood for strength gain via carbonate cementation.

Currently, no laboratory tests are used by the FDOT to quantify or predict strength and stiffness gains that could be generically applied to a range of material types. There is a need to

quantify potential increase in performance characteristics of an aggregate base, and to identify the causal physical/chemical characteristic of the aggregate. There also is a need to investigate other laboratory test procedures that might be useful in supplementing the LBR test. These tests could be used on low-cohesive materials or on water-sensitive materials to estimate constructability or durability issues to which the LBR test may not be adequately sensitive.

Objectives

1. To develop and evaluate test procedures for the evaluation of base course materials (not currently specified) based on generic, measurable engineering properties and not based on limited chemical or mineralogical criteria. These measured properties will include aggregate properties and predictions of strength gains over varying time periods using methodologies reported in the technical literature and of practical use to the FDOT.

2. To evaluate the performance of these new tests on current and proposed aggregate sources and aggregate substitutes, including recycled products, to determine the acceptance of these materials for use as base materials in traditional roadway designs, specifically to ensure conformance to AASHTO design requirements.

3. To select materials being used or having been used in current and previous field construction projects.

Both high carbonate and low carbonate (high-SiO_2) aggregates from different quarries (pits) that conformed to FDOT base course specifications were selected for this study and tested using Limerock Bearing Ratio (LBR), triaxial shear, repeated triaxial resilient modulus (M_R), gyratory shear (G_S), and unconfined compression (UCT) tests. These aggregates were prepared with and without one (1.0) percent lime for the purpose of accelerating strength gain and/or cementation of carbonate materials. High carbonate content aggregates (both high-CaO and low-CaO) selected for the study came from both limestone lithologies (Suwannee Limestone, Ocala Limestone, Tamiami Formation, etc.) and dolostone/limestone lithologies (Avon Park Formation), while low carbonate content aggregates (high-SiO_2) came from limestone lithologies known for a high silica sand content (Ft. Thompson Formation, Anastasia Formation, etc.).

Results

Results of the study are as follows:

(1) The test results indicated that variability in LBR values over various time periods up to 60 days impacted the analyses and consequently, dry density (γ_d) was the only significant factor affecting the LBR values, primarily with the untreated samples, in Part 1 of the LBR study. In Part 2 of the LBR study, the only correlation observed with LBR data seemed to be material gradation, however, that was found to be a statistical artifact of the gradation of MX411. When MX411 was excluded from analysis, no correlation was found to exist among the Florida materials tested. Dry density was held more constant for the samples used in Part 2, and therefore was not

found to impact LBR results as much as was observed in Part 1. LBR data for treated samples (1 percent lime) from both Part 1 and Part 2 also showed the most statistically significant correlations to gradation, although the correlations in Part 2 were again an artifact of MX411. The effect of strength gain by cementation (carbonate content versus LBR) was not statistically significant in either part of the LBR portion of this study, and no equations predicting LBR results based on carbonate content were produced which were statistically significant.

(2) Triaxial shear tests were inconclusive. The effect of time on strength gain of lime treated aggregates was minor although the lime treatment appeared to produce a small increase in angle of internal friction (Φ). Tangent moduli derived from these tests gave no indication of time dependent effects although the moduli for lime treated aggregates were in all cases slightly greater than for untreated aggregate.

(3) The Resilient Moduli (M_R) test results were very consistent with aging time having no apparent effect on the test results for aggregate from all the pit locations tested. These results combined with FDOT data from prior tests on seven other aggregates were analyzed to determine AASHTO structural design coefficient a_2 for sum of principal stresses (Θ) equal to 137.9 kPa (20 psi). Values of a_2 ranging from 0.15 to 0.22 were obtained which were similar to the range (0.16 to 0.23) of 10 different bank-run shell specimens.

(4) Limited tests performed using the Gyratory Testing Machine (GTM) equipped with air roller gave lower gyratory shear (G_s) strength with lime treated Pit 36-246 high carbonate aggregate than the untreated aggregate. Conversely, low carbonate (44%) aggregate from Pit 70-279 produced higher shear strength for the lime treated aggregate. The effect of density was not apparent except for lime treated aggregates from Pit 56-465 which showed a substantial increase in shear strength with densification. Apparently, this material most likely contained clay, which may have reacted to the lime treatment. A tentative relationship between the G_s and the M_R values was developed and used to establish a prediction equation for a_2 based upon this relationship.

(5) Unconfined compression tests (UCT) performed on both high carbonate (Pit 36-246 and Pit 56-465) and low carbonate (Pit 70-279 and Pit 93-406) materials was undertaken as a means of developing a practical method to accelerate cementation of limestone base course materials in order to predict increases in field based strength performance. Through experimenting with a total of eleven autoclave-based treatments of prepared test specimens, it was hoped that a rapid and reliable technique could be developed. However, average failure stress values showed no correlation to either aggregate carbonate content or to the other engineering parameters measured in this study over the short time spans tested. Untreated samples did, however, show greater strength gains in almost all experiments.

The ensuing sections of this report present the test conditions, testing procedures, analysis, and the results of the various tests conducted on base course aggregates from a variety of quarries (pits) located around the state of Florida.

TESTING AND EVALUATION OF LIMEROCK BEARING RATIO AND MOISTURE-DENSITY DATA

Materials, Test Specimen Preparation, and LBR Testing (Part 1)

For the first stage of this study (Part 1), base course aggregates from seven (7) sources (pits) were selected and used to prepare lime treated and untreated test specimens for the purpose of evaluating strength gain effects on the Limerock Bearing Ratio (LBR). Two (2) separate splits from pit 93-406 were examined in this part of the study, resulting in a total of eight (8) samples. Initially, four to five specimens, each at different moisture contents, were compacted according to AASHTO Method T-180 to establish moisture-density curves. The optimum moisture content was determined from these curves for each source (pit) of aggregate. Treated aggregate samples were prepared by the addition of one (1.0) percent of lime (by weight) prior to the addition of water. Table 2 presents basic information on the aggregate and optimum moisture content for each source of material, while Table 3 outlines the material type, lithology, and mineralogy of the materials studied. The quantitative X-ray diffraction (XRD) data outlined in Table 3 was determined using a Rietveld refinement technique.

Table 2. Composition and optimum moisture contents for base materials (Part 1)

PIT NO.	PERCENT CARBONATES	% PASSING 4.75 mm	% RETAINED 4.75 mm	OPTIMUM MOISTURE CONTENT (%)	
				Untreated	Treated
36-246	98	82	18	10.0	11.0
56-465	77	74	26	8.0	9.0
12-008	70	49	51	7.0	8.0
87-090	70	66	34	6.0	7.0
17-091	52	80	20	8.0	9.0
93-406	47	73	27	7.0	7.0
93-406	40	64	36	7.0	8.0
70-279	40	78	22	7.0	7.0

Five samples of untreated and lime treated materials were prepared for each aggregate source. Moisture-density data for the compacted LBR test samples are given in Tables A-1 and A-2 of Appendix A. The dry density (γ_d) values were based upon the test specimen volume, sample weight, and moisture content after LBR testing at the different ages (3, 7, 14, 28, and 60-day).

LBR tests were initially conducted using a modification of Florida test method FM-515, for which samples were continually soaked in plain tap water during curing. Continuous soaking was performed for several reasons. This is the standard method for LBR testing used at the FDOT (although normally for 2 days), and Gartland (1979) showed that continuous soaking in plain water resulted in some of the largest strength gains compared to other methods of curing

Table 3. Lithology and mineralogy of base course materials (Part 1)

PIT NO.	MATERIAL TYPE	FORMATION	Calcite (%)	Dolomite (%)	Quartz (%)	Aragonite (%)	R (%)*
36-246	Limerock	Ocala	100	---	---	---	5.9
56-465	Limerock	Avon Park	73.6	1.8	12.6	11.9	9.1
12-008	Limerock	Tamiami	61.5	36.2	2.3	---	12.1
87-090	Limerock	Ft. Thompson	81.5	---	18.5	---	15.8
17-091	Shell	Tamiami	22.2	---	41.9	35.9	18.5
93-406	Shell-rock	Anastasia	38.1	---	37.4	24.6	34.7
70-279	Coquina	Anastasia	31.2	---	58.4	10.4	26.2

* R-values are residuals from quantitative Rietveld refinement of XRD data

Table 4. LBR values of untreated and treated aggregates (Part 1)

PIT NO. (% CARB.)	36-246 (98%)	56-465 (77%)	12-008 (70%)	87-090 (70%)	17-091 (52%)	93-406 (47%)	93-406 (40%)	70-279 (40%)
3-Day:								
Untreated	75*	(27)*	174	119	143	138	160	129
Treated	99*	158	165	199	132	138	205	140
% Change	32	485	-5	67	-8	0	29	8
7-Day:								
Untreated	(66)*	(44)*	137	124	137	135	171	122
Treated	168	178	143	210	160	155	217	165
% Change	154	305	4	69	44	15	27	35
14-Day:								
Untreated	(50)*	(12)*	150	130	122	124	196	116
Treated	166	199	199	202	150	192	186	160
% Change	232	1558	33	55	23	55	-5	38
28-Day:								
Untreated	(71)*	(6)*	173	130	114	161	169	132
Treated	165	158	232	238	179	129	233	183
% Change	132	2533	34	83	57	-20	38	39
60-Day:								
Untreated	(57)*	(29)*	119	109	153	156	150	137
Treated	174	129	256	209	163	170	215	191
% Change	205	345	115	92	6	13	43	39

* Fails FDOT requirement for minimum LBR of 100.

( ) Denotes very low LBR values and significant improvement with the addition of 1.0% lime.

involving wetting and drying cycles or CO_2 treatment. Since temperature remains fairly constant over the soaking time intervals, it was believed that carbonate material would dissolve and precipitate as cement due to changes in atmospheric pressure causing pore water CO2 partial pressures to fluctuate (Graves, 1987).

Current FDOT specifications require a minimum LBR of 100 for compacted base course materials. Test results for the untreated and treated base course aggregates at the different ages are given in Table 4. LBR values for all untreated materials except those from Pits 36-246 and 56-465 exceeded 100, and on the average ranged between 127 and 169 (Fig. 1). None of the samples exhibit any discernable trend with age. The low values for 36-246 and 56-465 may have been due to relatively low dry density/high moisture content or perhaps relatively high clay content (56-465). The dry density for these two samples averaged nearly 200 kg/m^3 less than that of the other samples studied, and the moisture content averaged approximately 3% more. However, the same differences in dry density and moisture content occur with the lime treated samples, but without the poor LBR results.

As outlined by Graves (1987), addition of lime to the dry base course materials before compaction and soaking was done in an attempt to enhance cementation and therefore strength gain variation with differences in composition. Lime treated aggregates on the average varied between an LBR of 154 and 212 (Fig. 2). Treated aggregates from Pit Nos. 12-008, 87-090, and 93-406 (40% carbonates) provided the highest mean LBR values (199 to 212). Unlike the lack of any discernable trends seen with the untreated aggregates, treated samples from Pit Nos. 36-246, 12-008, 17-091, and 70-279 appear to show an increasing trend with age. However, as with 36-246, most of the increase occurs early, suggesting that cementation is completed, the lime is depleted early, or the lime acted as a modifier/stabilizing agent. For most of the materials tested, the lime treated samples consistently show higher LBR values (Fig. 3). This is particularly noted with 36-246 and 56-465. However, there appeared to be no differences between untreated and treated materials from Pit Nos. 17-091 and 93-406 (47% carbonates). This is probably due to either test variability (e.g. dry density and moisture content) or a mineralogical control. The latter explanation may be associated with the high aragonite content of 17-091 (35.9%) and 93-406 (24.6%) being the primary cementing agent, thereby limiting the lime treatment to having little additional effect.

As noted previously, the most noticeable increase in LBR values for treated aggregates occurred with materials from Pit Nos. 36-246 and 56-465. The mean LBR values for the untreated materials, as given in Table 4, were extremely low, indicating substandard quality which could be attributed to moisture-density, gradation, excessive soak time during curing, and/or mineral composition (e.g. clay content). The effect of lime treatment on the LBR values of Pit No. 56-465 aggregate was extremely high. The mean LBR values increased almost 700 percent over those for the untreated material. As will be demonstrated in a subsequent section of this report, the gyratory shear strength of the treated 56-465 material increased substantially with densification whereas the untreated material had much lower strength, which did not change appreciably with densification. Undoubtedly the lime produced the improvement in properties. It is believed that chemical interactions such as the stabilization of clay minerals altered the behavior of the aggregate from Pit No. 56-465.

A scatter plot showing strength change of treated base course samples versus carbonate content was prepared for the total data set (Fig. 4). The plot suggests that base materials with higher carbonate content show greater strength gain with lime addition, as indicated by the positive slope of the fitted linear regression curves. However, the linear regression curves exhibit fair to good correlation for 7- and 60-day curing times ($R^2 = 0.37$ and 0.55, respectively) only, and no correlation for 3-, 14-, and 28-day curing times ($R^2 = 0.12$, 0.17, and 0.11,

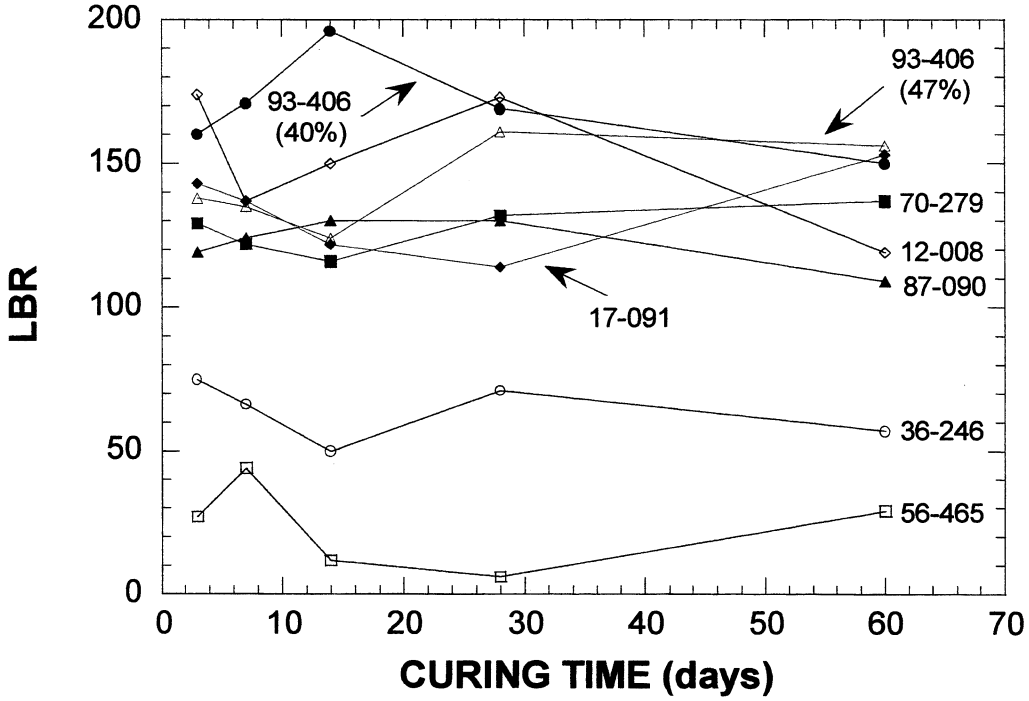


Figure 1. Plot of LBR data for untreated base course materials (Part 1).

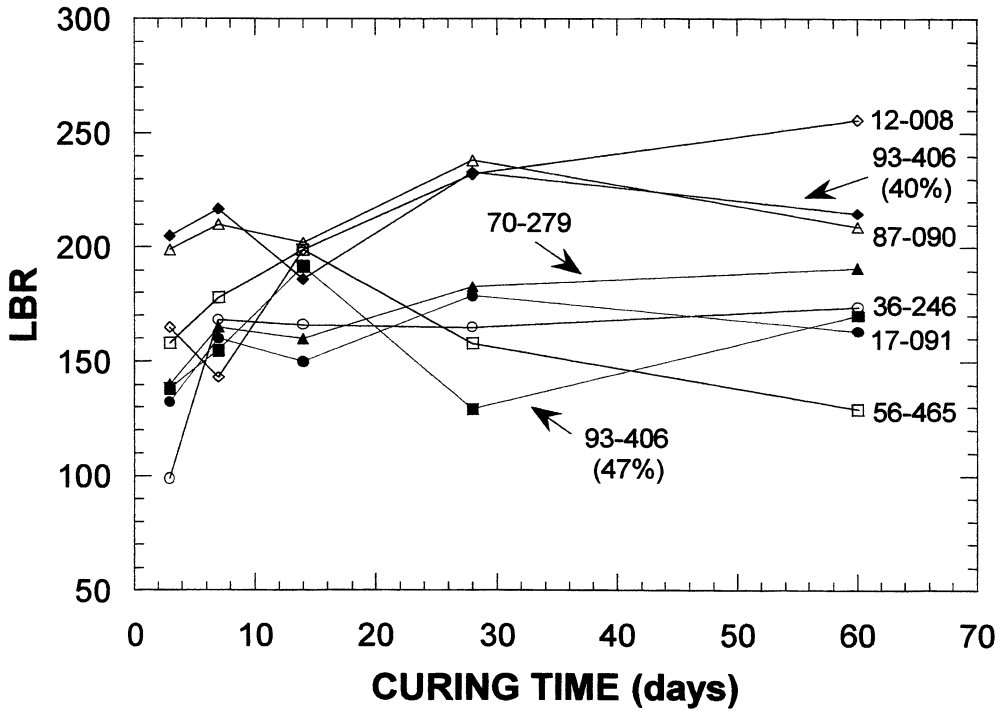


Figure 2. Plot of LBR data for treated base course materials (Part 1).

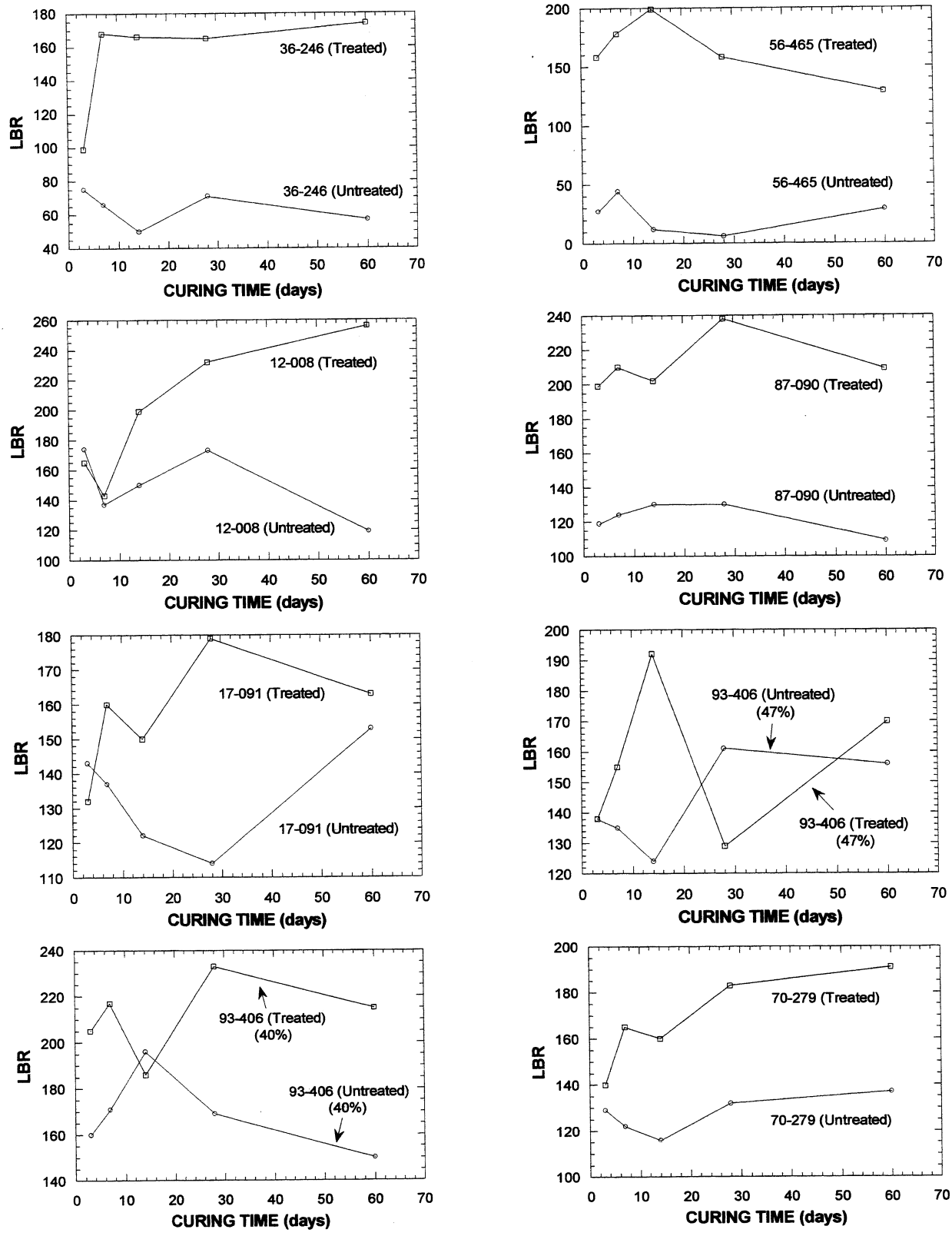


Figure 3. Plots illustrating the differences in LBR test results between untreated and treated base course materials (Part 1).

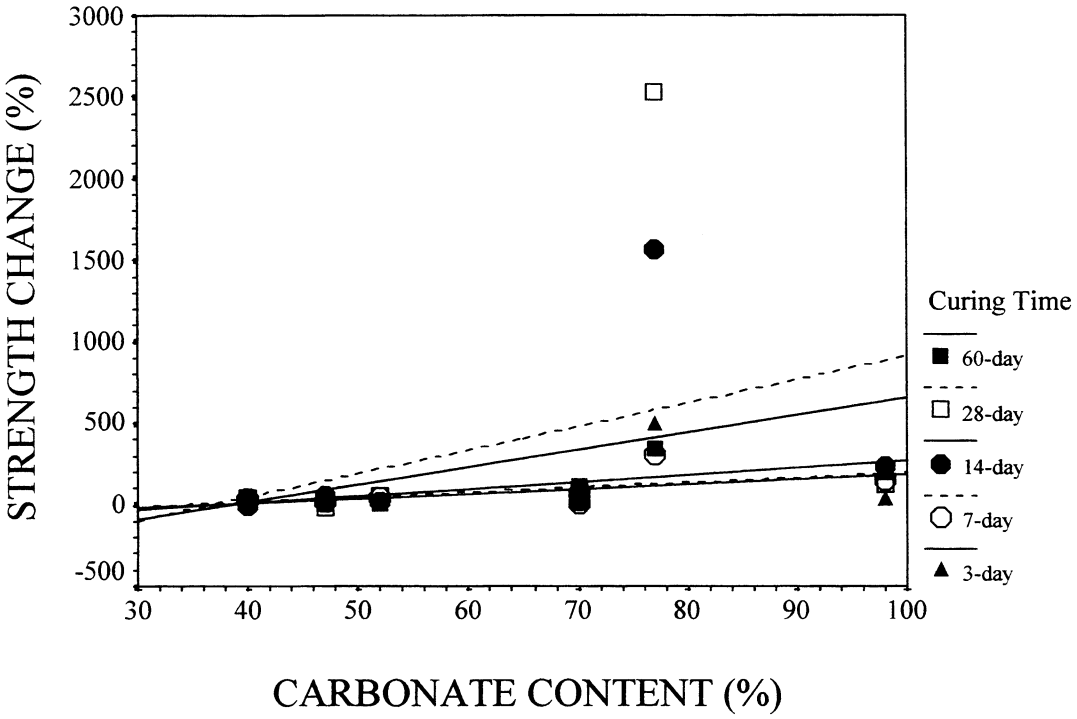


Figure 4. Scatter plot of strength change and carbonate content illustrating the relationship between curing time and the strength difference observed for treated versus untreated samples (Part 1).

respectively). This latter observation is most likely the result of the extreme LBR improvement seen with the samples from Pit No. 56-465 (77% carbonates) causing the poor curve fit.

Analysis of Variables Affecting LBR Values (Part 1)

Untreated Aggregates

In an effort to define the influence of density, moisture content, gradation, and carbonate content on the Limerock Bearing Ratio (LBR) of untreated base course materials, statistical procedures were used to produce graphs of LBR versus carbonate content for use in regression analyses. As a first step in this process, a bivariate correlation matrix which included mineralogical parameters was prepared for both untreated and treated aggregate LBR test variables (Tables 5 and 8). Only correlations possessing a Pearson correlation coefficient ≥ 0.6 were considered significant for this study.

Examination of Table 5 shows that LBR values for untreated aggregate samples exhibit a positive correlation to dry density (0.870) and negative correlations to both carbonate content (-0.679) and moisture content (-0.753). LBR also correlates negatively to calcite content (-0.602), but as calcite is the dominant mineral phase in most of the samples studied, it acts as a proxy for carbonate content. Therefore, LBR-calcite content correlations will not be examined further for this study. Of note, however, is the positive correlation between quartz and aragonite content (0.654), and the negative correlations they have with carbonate content (-0.897 and –0.659,

respectively). This suggests that quartz acts as the primary diluting phase for carbonate content, and that samples containing quartz also tend to be more enriched in aragonite relative to calcite as the carbonate phase. This is of interest, as increased carbonate content under these test conditions is associated with an overall decrease in LBR values. Such an observation is in conflict with the hypothesis proposed by this study that high carbonate materials should exhibit greater strength gain due to cementation. A major cause for this conflicting observation is the exceptionally poor test results acquired for 36-246 and 56-465, the materials possessing the highest carbonate contents (98% and 77%, respectively) of those studied. Furthermore, as none of the untreated samples showed any discernable increase in strength with age, it is unlikely that the test parameters employed with this phase of the study (e.g. soaked curing) accurately reproduced the field conditions necessary for cementation.

Scatter plots of dry density, moisture content, carbonate content, and minus #4 (used as a proxy for gradation) versus LBR further illustrate the correlations of these variables for the total data set (Fig. 5). It can be seen that dry density and moisture content mirror one another, reflecting the fact that dry density decreases with increased moisture content. This relationship is driven, in part, by the dry density/moisture content correlation seen with samples from 36-246 and 56-465, which consistently gave poor results in this part of the study. Simple linear regression models for these variables are given in Table 6, and include models derived for the total data set, as well as models derived for the individual curing times of 3-, 7-, 14-, 28-, and 60-days. Regression equations were developed according to the following format:

$$LBR = a + b(var) \qquad \text{eqn. 1}$$

where, LBR = Limerock Bearing Ratio
var = γ_d (Dry density, kg/m^3), MC (Moisture Content, %), CA (Carbonate Content, %), or M4 (Minus #4, %)

The strongest correlation to LBR tests in the regression models remains to be dry density, for both the total data set and the individual curing times, excluding the model for the 7-day curing time. Moisture content shows the strongest correlation for that curing time and is consistently the second strongest correlation other than for the 60-day curing time, for which carbonate content is the second strongest correlation. The content of minus #4 material consistently exhibits the poorest correlation to LBR of any of the other variables. Although the specific gravity of the aggregates from different pits may influence dry density, it is likely that gradation may be a primary reason for the range of dry density values observed with these LBR tests.

Examining the scatter plot for LBR versus dry density in more detail shows that data from individual pits appear to exhibit a positive correlation (Fig. 6). In fact, several of the individual pits tested, including Pit Nos. 36-246 ($R^2 = 0.66$), 56-465 ($R^2 = 0.78$), 12-008 ($R^2 = 0.76$), and 93-406 (47% carbonates) ($R^2 = 0.76$), show strong correlation to linear regression modeling of this relationship. If not for the variability in test specimen dry density among individual pits, dry density and LBR results would likely not have such an important correlation as seen with this data set.

Table 5. Bivariate correlation matrix for untreated aggregate samples (Part 1)

	CARB. CONT.	DRY DEN.	MOIST. CONT.	LBR	MINUS #4	CALC. CONT.	DOLO. CONT.	QTZ. CONT.	ARAG. CONT.	CURING TIME
CARB. CONT.										
DRY DEN.	-.666** (.000)									
MOIST. CONT.	.577** (.000)	-.840** (.000)								
LBR	-.679** (.000)	.870** (.000)	-.753** (.000)							
MINUS #4	.067 (.680)	-.513** (.001)	.543** (.000)	-.449** (.004)						
CALC. CONT.	.920** (.000)	-.626** (.000)	.385* (.014)	-.602** (.000)	-.048 (.769)					
DOLO. CONT.	.179 (.270)	.334* (.035)	-.230 (.154)	.235 (.144)	-.810** (.000)	.097 (.550)				
QTZ. CONT.	-.897** (.000)	.454** (.003)	-.377* (.016)	.445** (.004)	.346* (.029)	-.858** (.000)	-.477** (.002)			
ARAG. CONT.	-.659** (.000)	.262 (.103)	.010 (.953)	.320* (.044)	.324* (.042)	-.803** (.000)	-.402* (.010)	.654** (.000)		
CURING TIME	.000 (1.000)	-.003 (.985)	.002 (.991)	-.029 (.860)	.000 (1.000)	.000 (1.000)	.000 (1.000)	.000 (1.000)	.000 (1.000)	

Note: Shaded cells indicate correlations considered to be statistically significant for this study (Pearson correlation coefficient ≥ 0.6).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

( ) sig. (2-tailed), n = 40.

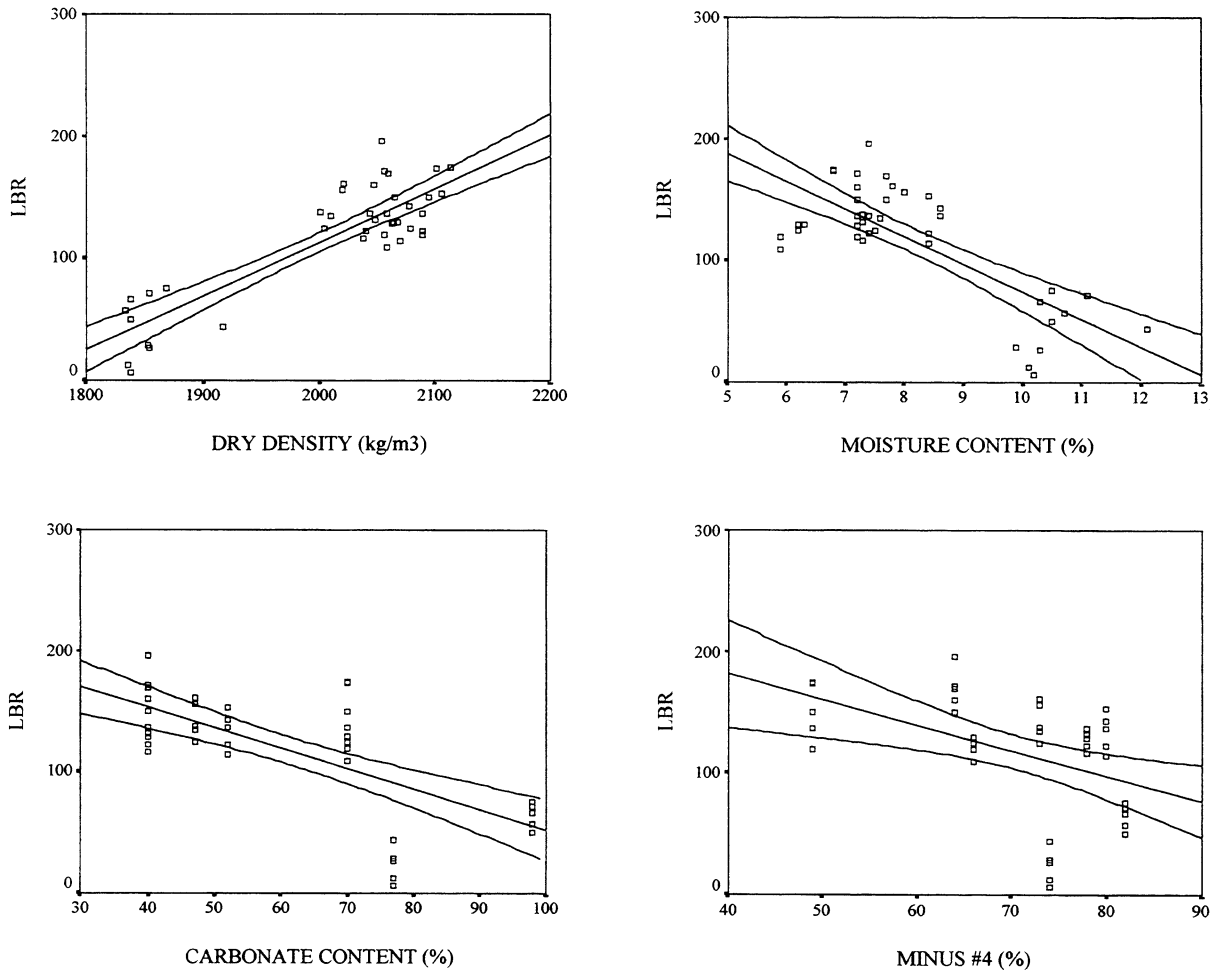


Figure 5. Scatter plots of variables thought to affect LBR test results of untreated aggregate samples (Part 1). (*Note*: Lines surrounding linear regression curves define the 95% confidence interval)

Table 6. LBR linear regression models for untreated aggregate samples (Part 1)

LINEAR REGRES. MODEL	R^2	STD. ERROR OF EST.	UNSTANDARDIZED COEFFICIENTS			
			CONSTANT	STD. ERROR	INDEPENDENT VARIABLE	STD. ERROR
TOTAL						
Dry Den.	0.76	23.98	-763.17	81.11	0.44	0.04
Moist. Cont.	0.57	32.00	302.00	26.79	-22.75	3.23
Carb. Cont.	0.46	35.66	220.23	19.01	-1.68	0.29
Minus #4	0.20	43.41	265.10	48.41	-2.10	0.68
3-DAY						
Dry Den.	0.83	21.26	-780.67	165.60	0.45	0.08
Moist. Cont.	0.58	33.62	295.11	61.84	-21.88	7.61
Carb. Cont.	0.37	41.26	208.12	49.20	-1.42	0.76
Minus #4	0.28	43.95	286.82	109.59	-2.35	1.53
7-DAY						
Dry Den.	0.69	25.13	-662.99	215.92	0.39	0.11
Moist. Cont.	0.74	22.98	270.57	38.33	-18.39	4.49
Carb. Cont.	0.57	29.47	211.11	35.14	-1.52	0.54
Minus #4	0.19	40.25	236.02	100.36	-1.68	1.40
14-DAY						
Dry Den.	0.75	30.77	-823.60	219.62	0.47	0.11
Moist. Cont.	0.65	36.74	360.21	75.87	-30.68	9.26
Carb. Cont.	0.45	45.91	227.94	54.73	-1.87	0.85
Minus #4	0.29	51.94	315.15	129.52	-2.86	1.81
28-DAY						
Dry Den.	0.77	29.36	-855.40	217.26	0.49	0.11
Moist. Cont.	0.61	38.12	339.50	72.52	-26.83	8.69
Carb. Cont.	0.36	49.18	221.69	58.63	-1.66	0.91
Minus #4	0.29	51.58	320.08	128.62	-2.84	1.80
60-DAY						
Dry Den.	0.76	24.79	-669.02	177.80	0.39	0.09
Moist. Cont.	0.40	39.62	270.39	79.98	-19.28	9.69
Carb. Cont.	0.69	28.28	232.26	33.71	-1.92	0.52
Minus #4	0.03	50.27	167.45	125.35	-0.76	1.75

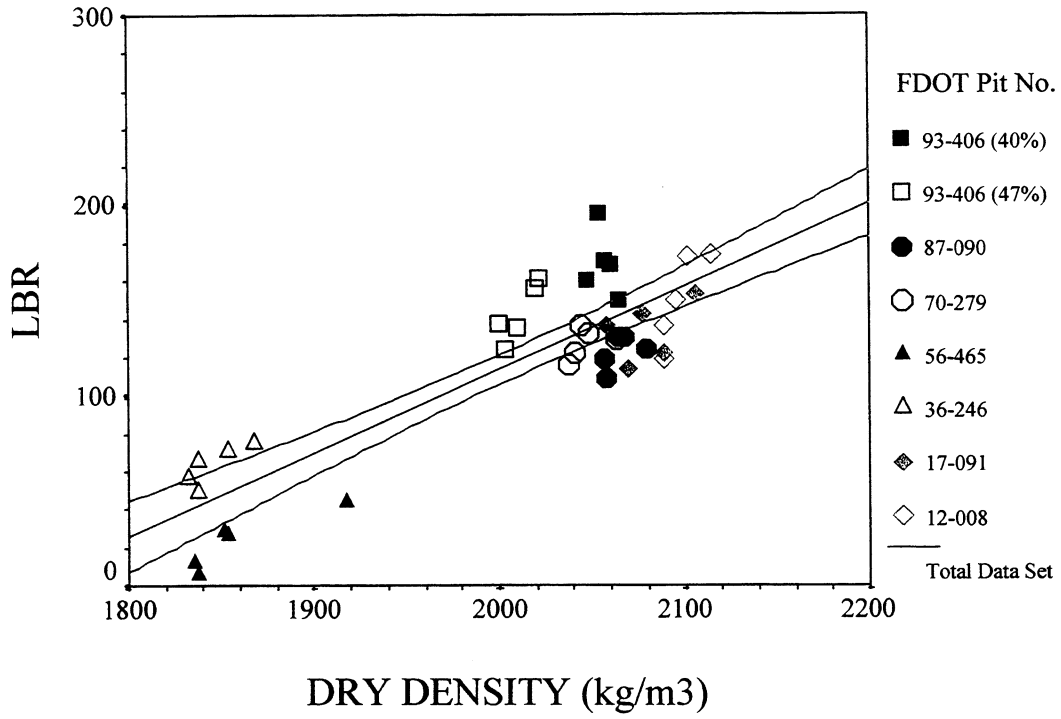


Figure 6. Scatter plot of LBR and dry density illustrating the relationship between pit source and location on the plot for untreated aggregate samples (Part 1).

In an effort to quantify the correlations between LBR values and the variables of dry density, moisture content, and carbonate content, a multiple regression approach was attempted, even though several of the variables appear to be cross-correlated (e.g. dry density and moisture content). Regression analyses for the different curing times (3-, 7-, 14-, 28-, and 60-day) were performed and regression equations developed according to the following equation format:

$$LBR = a + b(\gamma_d) + c(MC) + d(CA) \qquad \text{eqn. 2}$$

where, LBR = Limerock Bearing Ratio
γ_d = Dry density, kg/m^3
MC = Moisture Content, %
CA = Carbonate Content, %

Table 7 presents a comparison of the measured values of untreated samples at different ages with those values predicted by the regression equations. In general, the predicted values are good estimates of the measured LBR values even though the coefficients of determination (R^2) values are not exceptionally good. As seen previously with bivariate correlation and simple regression, dry density has the greatest effect on the LBR values whereas moisture content and percent carbonates have almost no influence on the LBR (probably statistically insignificant).

Table 7. Comparison of measured and predicted LBR values - untreated (Part 1)

PIT NO. (%CARB.)	3-DAY[a]		7-DAY[b]		14-DAY[c]		28-DAY[d]		60-DAY[e]	
	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.
36-246 (98%)	75	55	66	54	50	25	71	46	57	37
56-465 (77%)	27	51	44	56	12	38	6	35	29	58
12-008 (70%)	174	165	137	128	150	144	173	164	119	127
87-090 (70%)	119	138	124	141	130	140	130	143	109	107
17-091 (52%)	143	153	137	124	122	143	114	154	153	160
93-406 (47%)	138	118	135	136	124	124	161	126	156	131
93-406 (40%)	160	139	171	149	196	144	169	147	150	151
70-279 (40%)	129	146	122	145	116	139	132	139	137	140

Regression Equations:

(a) LBR (3-d) $= -781.97 + 0.4483(\gamma_d) + 1.24(MC) - 0.14(CA)$
$n = 8, R^2 = 0.83$

(b) LBR (7-d) $= 108.61 + 0.0730(\gamma_d) - 11.50(MC) - 0.70(CA)$
$n = 8, R^2 = 0.85$

(c) LBR (14-d) $= -449.92 + 0.3222(\gamma_d) - 6.46(MC) - 0.49(CA)$
$n = 8, R^2 = 0.78$

(d) LBR (28-d) $= -991.69 + 0.5382(\gamma_d) + 4.36(MC) - 0.08(CA)$
$n = 8, R^2 = 0.77$

(e) LBR (60-d) $= -595.75 + 0.3515(\gamma_d) + 7.61(MC) - 0.94(CA)$
$n = 8, R^2 = 0.87$

In an effort to relate LBR values to carbonate content, the multiple regression equations for 3- and 60-days were used to prepare LBR prediction lines using moisture content values of 6% and 12%, and dry density (γ_d) values of 1840 kg/m^3 and 2080 kg/m^3 (Fig. 7). The resulting figure illustrates that moisture content and carbonate content appear to have less affect on LBR results than dry density. As noted before, variations in gradation are believed to be an important factor in producing the range of dry density values encountered with this study. In an effort to reproduce field-like conditions for this study, gradation was not held as a constant, complicating the ability of the LBR tests to elucidate the role of carbonate content in predicting strength gain. Furthermore, as shown in Figure 7, both 3-and 60-day prediction lines indicate that LBR values decrease with an increase in carbonate content. As noted previously, this observation is opposite of what was expected, with the magnitude of the relationship due, in part, to the poor test results achieved for Pit Nos. 36-246 and 56-465. Furthermore, the 3- and 60-day prediction lines overlap, illustrating the lack of an observed strength gain that was expected with this test. This supports the contention that employing a continuous soak method of curing the LBR samples did

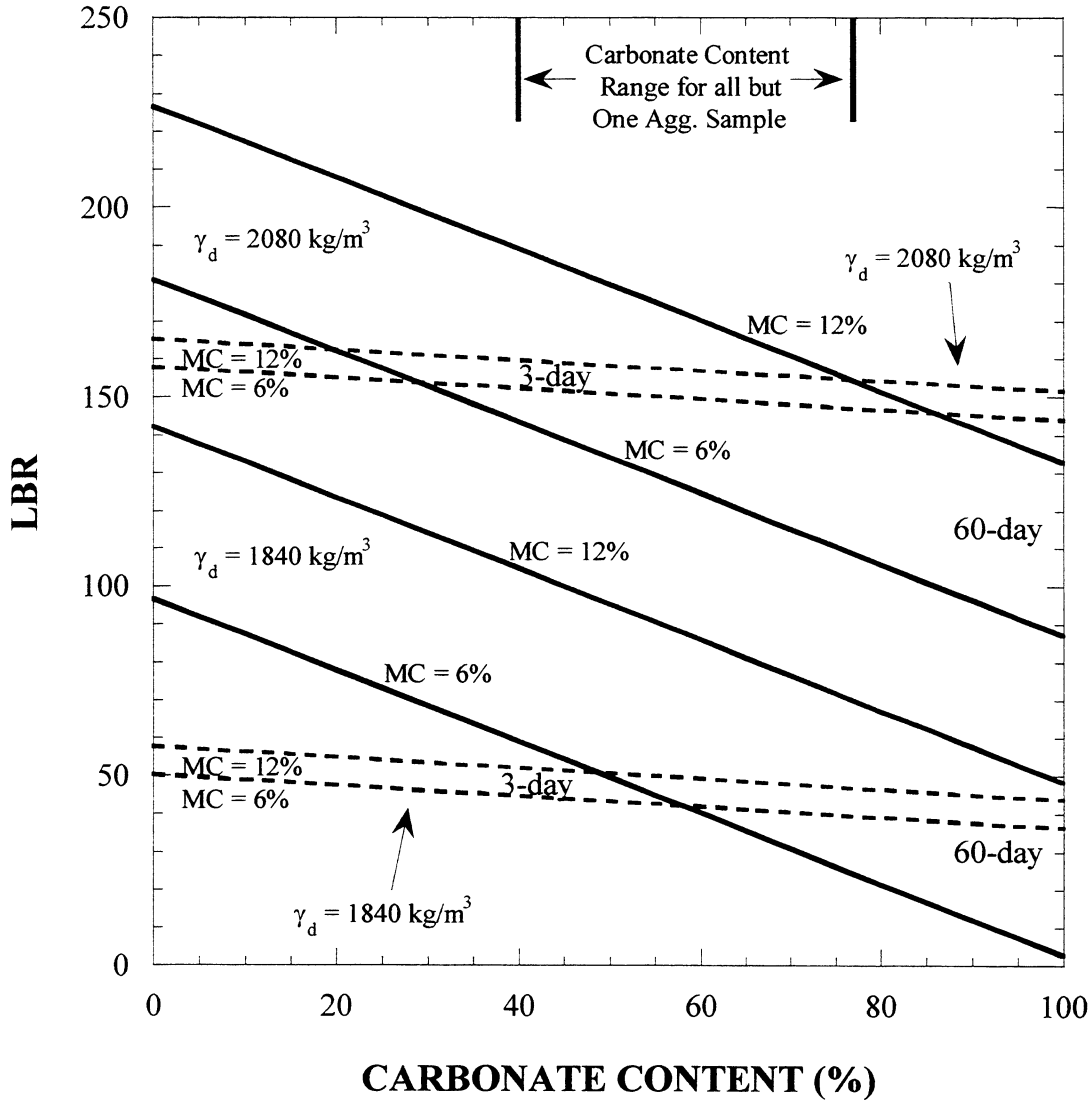


Figure 7. Prediction plot of LBR value as a function of carbonate content for untreated aggregate samples (Part 1). (*Note*: Prediction lines were generated using the 3- and 60 -day regression equations shown in Table 7)

not produce the conditions necessary for subsequent cementation after initial compaction of the samples, or that lithological variability among the samples used in the study prevented observation of this phenomenon. As a result, the prediction lines shown in Figure 7 should not be used to predict LBR test results based on carbonate content for the purpose of estimating field performance.

Treated Aggregates

Specimens prepared with 1.0 percent lime for the purpose of accelerating and/or enhancing the cementing of high carbonate aggregates also were evaluated to assess the effects of dry density, moisture content, carbonate content, and gradation on LBR test results. As outlined in the previous section, the first step was the production of a bivariate correlation matrix (Table 8).

Examination of Table 8 shows no significant correlations (Pearson correlation coefficient ≥ 0.6) between LBR and the variables of interest. The best correlation for LBR is with minus #4 (-0.541), but is insufficient to require detailed discussion other than the observation that an increase in fines appears to accompany a decrease in LBR values. This seems to suggest that either test variability was excessive or there is no relationship between these variables (including carbonate content) and LBR test results.

For the purpose of comparison, scatter plots of dry density, moisture content, carbonate content, and minus #4 versus LBR for the total data set are included (Fig. 8). In agreement with the bivariate correlation matrix, the scatter plots show no visual evidence for correlation of the variables of interest with LBR results. Linear regression models for these variables also are included for comparison to the untreated aggregate sample data (Table 9). As before, they include models according to the format of equation 1 for the total data set, as well as the individual curing times (3-, 7-, 14-, 28-, 60-days).

A review of Table 9 shows that minus #4 correlates best with LBR test results in the 3-day ($R^2 = 0.42$), 14-day ($R^2 = 0.47$), 28-day ($R^2 = 0.47$) and 60-day ($R^2 = 0.65$) regression analyses. Dry density also shows some evidence of correlation to LBR data during later curing times of 28-days ($R^2 = 0.47$) and 60-days ($R^2 = 0.65$). The similarity in coefficients of determination (R^2) for the 28- and 60-day curing times lends further credence to the interpretation that gradation has a major impact on dictating dry density values. There appears to be absolutely no relationship between carbonate content and LBR data for this part of the study.

For comparison to the data calculated for the untreated aggregates, multiple regression analyses were once again performed for the different curing times, although they lack any real statistical significance. Using the same format illustrated with equation 2, these regression equations were used to calculate predicted LBR values (Table 10). A review of Table 10 shows that the predicted values are poor estimates of the measured LBR values, an observation in keeping with the poor statistical basis for the multiple regression analyses.

As with the untreated aggregates, the multiple regression equations for 3- and 60-days were used to prepare LBR prediction lines (Fig. 9). Although they illustrate nothing of statistical significance, the 60-day prediction lines do show a positive correlation between LBR and carbonate content, suggesting that longer curing times may permit high carbonate aggregates to undergo greater strength gain exceeding the LBR values of aggregates with lower carbonate contents, even if the lower carbonate content aggregates have greater initial LBR values. Furthermore, it is still evident that dry density has a major impact on LBR test results, and that gradation plays a significant role in dry density variability. This suggests that greater emphasis should be placed upon selecting suitable gradations to attain a high dry density, which consequently will yield higher LBR values.

If LBR is considered as a relative indicator of base course aggregate strength, then the use of high carbonate aggregates is not necessarily beneficial if low density is achieved. This is clearly illustrated by the LBR test results for Pit No. 56-465, which group into two distinctly different density levels. As a result the 7- and 14-day LBR values are greater than the 28- and 60-day values even though the aggregate contains 77 percent carbonates. Another condition that

Table 8. Bivariate correlation matrix for treated aggregate samples (Part 1)

	CARB. CONT.	DRY DEN.	MOIST. CONT.	LBR	MINUS #4	CALC. CONT.	DOLO. CONT.	QTZ. CONT.	ARAG. CONT.	CURING TIME
CARB. CONT.										
DRY DEN.	-.263 (.101)									
MOIST. CONT.	.667** (.000)	-.426** (.006)								
LBR	-.116 (.478)	.232 (.149)	-.299 (.061)							
MINUS #4	.067 (.680)	-.404** (.010)	.413** (.008)	-.541** (.000)						
CALC. CONT.	.920** (.000)	-.213 (.187)	.479** (.002)	.065 (.690)	-.048 (.769)					
DOLO. CONT.	.179 (.270)	.298 (.062)	-.143 (.379)	.234 (.146)	-.810** (.000)	.097 (.550)				
QTZ. CONT.	-.897** (.000)	.146 (.369)	-.511** (.001)	-.093 (.569)	.346* (.029)	-.858** (.000)	-.477** (.002)			
ARAG. CONT.	-.659** (.000)	-.069 (.672)	-.058 (.724)	-.207 (.201)	.324* (.042)	-.803** (.000)	-.402* (.010)	.654** (.000)		
CURING TIME	.000 (1.000)	-.003 (.984)	-.060 (.715)	.270 (.092)	.000 (1.000)	.000 (1.000)	.000 (1.000)	.000 (1.000)	.000 (1.000)	

Note: Shaded cells indicate correlations considered to be statistically significant for this study (Pearson correlation coefficient ≥ 0.6).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

( ) sig. (2-tailed), n = 40.

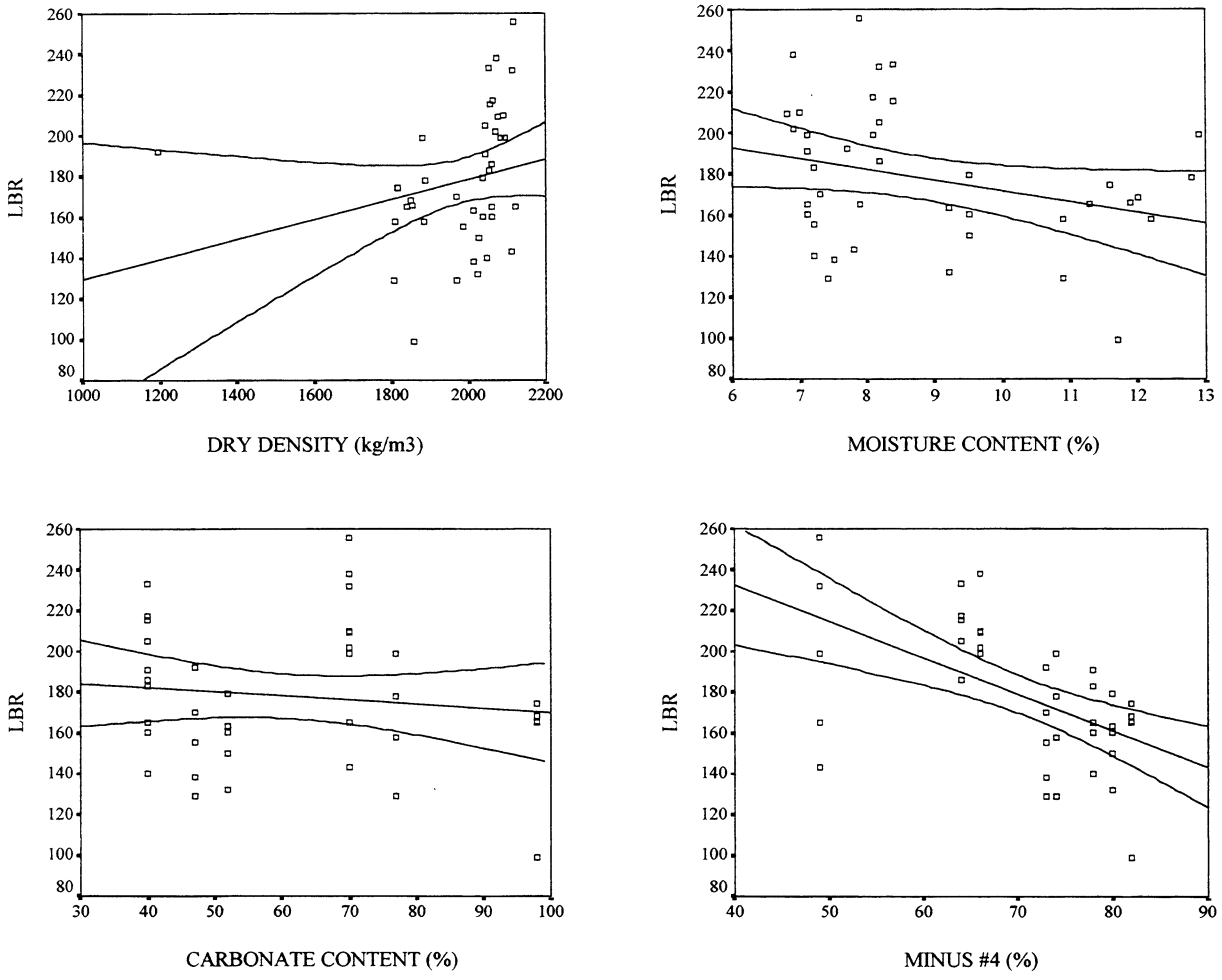


Figure 8. Scatter plots of variables thought to affect LBR test results of treated aggregate samples (Part 1). (*Note*: Lines surrounding linear regression curves define the 95% confidence interval)

is unexplained is why some of the 3-day LBR values for the lime treated aggregates are substantially greater than untreated. Does the addition of lime have an initial modification effect (change in surface chemistry) that alters the LBR values or is this indicative of testing variability? It is the prediction of these strength gain phenomena that was one of the main goals of this research.

Table 9. LBR linear regression models for treated aggregate samples (Part 1)

LINEAR REGRES. MODEL	R^2	STD. ERROR OF EST.	UNSTANDARDIZED COEFFICIENTS			
			CONSTANT	STD. ERROR	INDEPENDENT VARIABLE	STD. ERROR
TOTAL						
Dry Den.	0.05	33.41	80.74	66.08	0.05	0.03
Moist. Cont.	0.09	32.77	224.58	24.78	-5.30	2.74
Carb. Cont.	0.01	34.12	190.21	18.19	-0.20	0.28
Minus #4	0.29	28.89	304.17	32.22	-1.79	0.45
3-DAY						
Dry Den.	0.34	31.01	-291.23	254.74	0.22	0.13
Moist. Cont.	0.21	33.86	226.01	57.65	-8.06	6.35
Carb. Cont.	0.13	35.57	192.81	42.40	-0.62	0.66
Minus #4	0.42	28.92	304.70	72.13	-2.12	1.01
7-DAY						
Dry Den.	0.02	28.03	103.59	221.03	3.53	0.11
Moist. Cont.	0.01	28.19	182.22	42.73	-0.86	4.65
Carb. Cont.	0.01	28.07	183.70	33.47	-0.15	0.52
Minus #4	0.00	28.24	181.30	70.43	-0.10	0.99
14-DAY						
Dry Den.	0.03	21.54	202.36	51.89	-0.01	0.03
Moist. Cont.	0.01	21.74	188.91	34.08	-0.79	3.67
Carb. Cont.	0.04	21.44	170.40	25.56	0.18	0.40
Minus #4	0.47	15.90	272.14	39.65	-1.28	0.56
28-DAY						
Dry Den.	0.47	31.78	-302.32	213.12	0.25	0.11
Moist. Cont.	0.14	40.65	266.75	81.07	-8.84	9.15
Carb. Cont.	0.01	43.58	198.61	51.95	-0.15	0.80
Minus #4	0.47	31.76	371.07	79.20	-2.57	1.11
60-DAY						
Dry Den.	0.65	24.54	-342.17	157.96	0.27	0.08
Moist. Cont.	0.30	34.86	290.89	64.97	-11.85	7.38
Carb. Cont.	0.02	41.23	205.51	49.16	-0.28	0.76
Minus #4	0.65	24.65	391.65	61.48	-2.87	0.86

Table 10. Comparison of measured and predicted LBR values - treated with 1.0 percent lime (Part 1)

PIT NO. (%CARB.)	3-DAY[a]		7-DAY[b]		14-DAY[c]		28-DAY[d]		60-DAY[e]	
	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.
36-246 (98%)	99	118	168	167	166	181	165	172	174	161
56-465 (77%)	158	132	178	173	199	180	158	141	129	140
12-008 (70%)	165	178	143	177	199	193	232	242	256	241
87-090 (70%)	199	168	210	174	202	190	238	218	209	227
17-091 (52%)	132	165	160	178	150	185	179	205	163	190
93-406 (47%)	138	161	155	171	192	180	129	159	192	170
93-406 (40%)	205	171	214	178	186	184	233	190	215	194
70-279 (40%)	140	169	165	176	160	184	183	186	191	189

Regression Equations:

(a) LBR (3-d) $= -290.45 + 0.2235(\gamma_d) + 2.19(MC) - 0.33(CA)$
$n = 8, R^2 = 0.37$

(b) LBR (7-d) $= 42.10 + 0.0599(\gamma_d) + 2.03(MC) - 0.11(CA)$
$n = 8, R^2 = 0.02$

(c) LBR (14-d) $= -2.62 + 0.0837(\gamma_d) + 0.86(MC) + 0.19(CA)$
$n = 8, R^2 = 0.25$

(d) LBR (28-d) $= -740.11 + 0.4121(\gamma_d) + 6.65(MC) + 0.81(CA)$
$n = 8, R^2 = 0.65$

(e) LBR (60-d) $= -533.89 + 0.3409(\gamma_d) + 0.22(MC) + 0.73(CA)$
$n = 8, R^2 = 0.76$

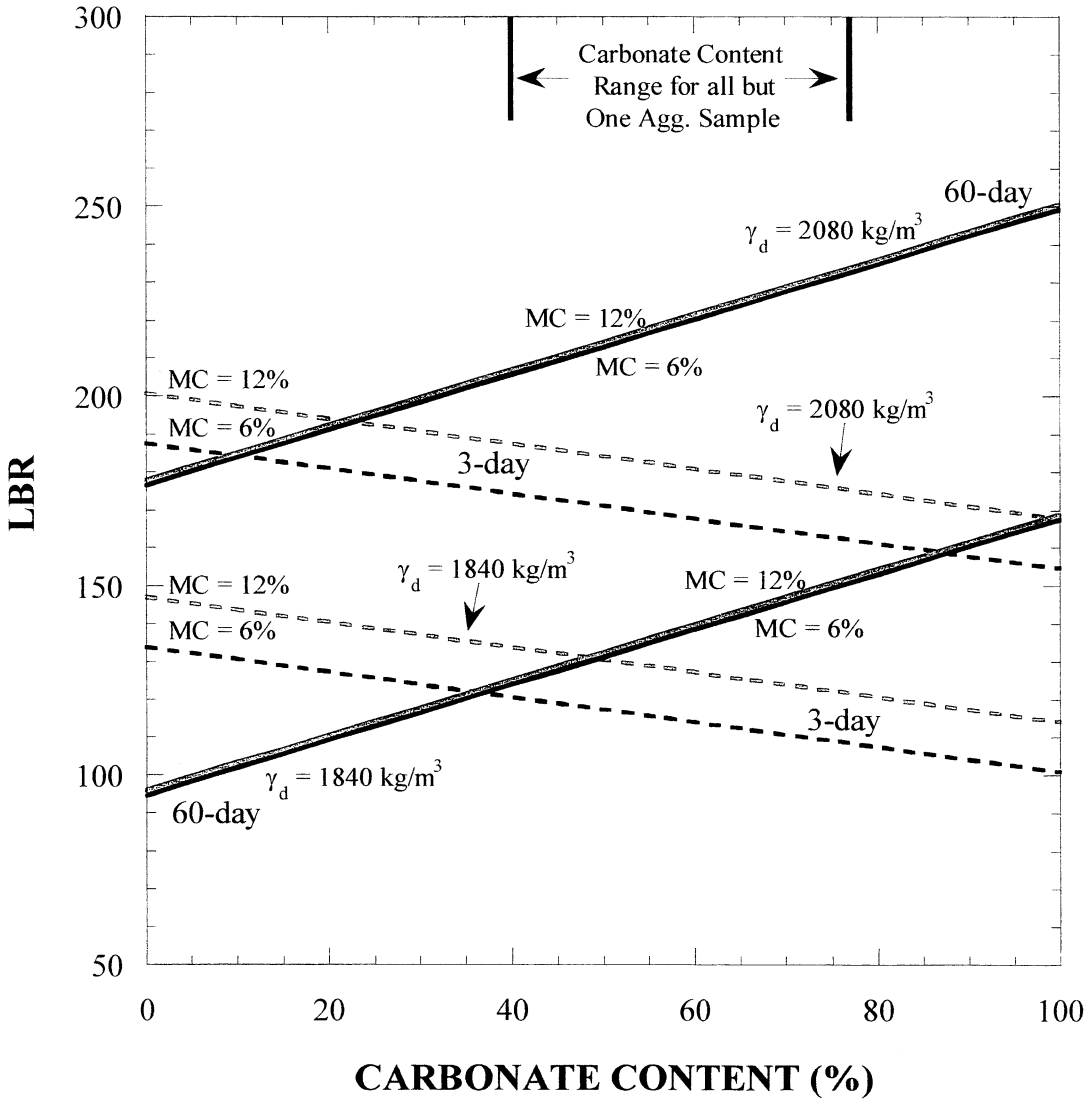


Figure 9. Prediction plot of LBR value as a function of carbonate content for treated aggregate samples (Part 1). (*Note*: Prediction lines were generated using the 3- and 60-day regression equations shown in Table 10)

Materials, Test Specimen Preparation and LBR Testing (Part 2)

For the second part of the LBR study (Part 2), base course aggregates from nine (9) sources (pits) were selected and used to prepare lime treated and untreated test specimens for the purpose of evaluating strength gain effects on the Limerock Bearing Ratio (LBR), as was done in Part 1 of the study. Included with these samples were one (1) sample of recycled crushed concrete aggregate (58-486) and two (2) samples from outside of Florida; MX411 from Mexico and AL-149 from Calera, Alabama. As with the initial set of samples tested, four to five specimens, each at different moisture contents, were compacted according to AASHTO Method T-180 to establish moisture-density curves. The optimum moisture content was determined from these curves for each source (pit) of aggregate. Treated aggregate samples were prepared by adding one (1.0) percent of lime prior to the addition of water. Table 11 presents basic information on the aggregate and optimum moisture content for each source of material, while Table 12 outlines the material type, lithology and mineralogy of the materials studied. Again, the quantitative X-ray diffraction (XRD) data outlined in Table 12 was determined using a Rietveld refinement technique.

Table 11. Composition and optimum moisture contents for base materials (Part 2)

PIT NO.	PERCENT CARBONATES	% PASSING 4.75 mm	% RETAINED 4.75 mm	OPTIMUM MOISTURE CONTENT (%)	
				Untreated	Treated
36-246	98	82	18	12.0	12.0
56-465	77	74	26	12.0	13.0
26-001	99	77	23	12.0	12.0
17-091	52	80	20	9.0	10.0
93-406	47	73	27	7.0	7.0
70-279	40	78	22	7.0	8.0
58-486	---	42	58	10.0	11.0
MX411	99	42	58	8.0	8.0
AL-149	99	51	49	6.0	6.0

For this phase of LBR testing, six samples of untreated and 1.0 percent lime treated materials were prepared for each aggregate source. Pit Nos. 36-246 and 70-279 were an exception, having eight samples of untreated and 1.0 percent lime treated materials prepared. Moisture-density data for the compacted LBR test samples are given in Tables B-1 and B-2 of Appendix B. The dry density (γ_d) values were based upon the test specimen volume, sample weight, and moisture content after LBR testing at the different ages (1, 7, 14, and 28-day). Whereas all samples were tested after curing times of 1, 14, and 28-days, Pit Nos. 36-246 and 70-279 also were tested at a 7-day curing interval.

LBR tests for this second phase of testing were conducted using a modification of Florida test method FM-515, for which samples were placed in a moisture room for curing rather than soaked. This method of curing was used after the techniques applied in Part 1 of the LBR study failed to produce expected results. Current FDOT specifications require a minimum LBR of 100 for compacted base course materials. Test results for the untreated and treated base course

Table 12. Lithology and mineralogy of base course materials (Part 2)

PIT NO.	MATERIAL TYPE	FORMATION	Calcite (%)	Dolomite (%)	Quartz (%)	Aragonite (%)	R (%)*
36-246	Limerock	Ocala	100	---	---	---	5.9
56-465	Limerock	Avon Park	73.6	1.8	12.6	11.9	9.1
26-001	Limerock	Ocala	100	---	---	---	7.7
17-091	Shell	Tamiami	22.2	---	41.9	35.9	18.5
93-406	Shell-rock	Anastasia	38.1	---	37.4	24.6	34.7
70-279	Coquina	Anastasia	31.2	---	58.4	10.4	26.2
58-486	N/S	----------	---	---	---	---	---
MX411	Limerock	----------	100	---	---	---	5.4
AL-149	Limerock	Calera	45.8	53.5	0.7	---	30.0

* R-values are residuals from quantitative Rietveld refinement of XRD data

(a) Sample 58-486 consists of crushed recycled concrete (N/S - no sample analyzed by XRD)

Table 13. LBR values of untreated and treated aggregates (Part 2)

PIT NO. (% CARB.)	36-246 (98%)	56-465 (77%)	26-001 (99%)	17-091 (52%)	93-406 (47%)	70-279 (40%)	58-486 (---)	MX411 (99%)	AL-149 (99%)
1-Day:									
Untreated[a]	128	91*	120	131	161	127	148	218	171
Treated[a]	174	133	155	135	155	148	234	233	193
% Change	36	46	29	3	-4	17	58	7	13
7-Day:									
Untreated[a]	104	---	---	---	---	112	---	---	---
Treated[a]	172	---	---	---	---	150	---	---	---
% Change	65	---	---	---	---	34	---	---	---
14-Day:									
Untreated[a]	111	117	(59)*	(82)*	119	114	207	188	182
Treated[a]	151	176	141	164	204	141	234	232	200
% Change	36	50	139	100	71	24	13	23	10
28-Day:									
Untreated[a]	126	108	113	110	137	123	228	193	145
Treated[a]	152	156	166	158	230	166	243	217	193
% Change	21	44	47	44	68	35	7	12	33

[a] Values are an average of 2 replicate tests.

* Fails FDOT requirement for minimum LBR of 100.

( ) Denotes very low LBR values and significant improvement with the addition of 1.0% lime.

aggregates at the different ages are given in Table 13. Listed LBR values in Table 13 are an average of two tests. Average LBR values for all untreated materials except from Pit 26-001 exceeded 100 and on the average ranged between 105 and 200 (Fig. 10). It should be noted that materials, which produced LBR values below the minimum of 100 from Part 1 of this study (36-246 and 56-465), performed better under the Part 2 testing protocol (36-246: LBR = 118, 56-465: LBR = 105). Only Pit No. 58-486 shows any increased strength trend with age (Fig. 10). All three of the non-Florida samples (58-486, MX411, and AL-149) possess higher LBR values than the Florida samples which are the focus of this study.

Lime treated aggregates on the average varied between an LBR of 149 and 237. Treated aggregates from Pit Nos. 58-486, MX411, AL-149, and 93-406 (47% carbonates) provided the highest mean LBR values (195 to 237). Treated aggregate samples from Pit Nos. 58-486 and 93-406 exhibit increased LBR values with age (Fig. 11). There appears to be only a minor increase in LBR values between untreated and treated materials from Pit Nos. MX411 and AL-149 (Fig. 12). This may be due to test variability (e.g. dry density) masking significant strength gain with age, or due to lithological characteristics causing lime addition to have little effect on strength gain for these materials. All other treated samples show obvious LBR increases with the addition of lime.

The most noticeable increase in LBR values for treated aggregates occurred with materials from Pit Nos. 26-001 and 17-091 (averaging 72% and 49%, respectively), although the magnitude of these increases are not comparable to those observed for Pit Nos. 36-246 and 56-465 (242% and 697%, respectively) in Part 1 of the study. The LBR values for the untreated materials, as given in Table 13, were extremely low, similar to observations for untreated materials in Part 1 of the study. This suggests substandard quality of many of these materials, which could be attributed to moisture-density, gradation, and/or mineral composition (e.g. clay content). It should be noted that the effect of lime treatment on the LBR values for Pit. No. 56-465 were not as dramatic as observed in Part 1 of the study. This might be attributed to a lower clay content in the split used in this phase of the study, or a problem with sample protocol in Part 1 with respect to preparation and curing of untreated Pit No. 56-465 samples.

A scatter plot showing strength change of treated base course samples versus carbonate content was prepared for the total data set (Fig. 13), as was done in Part 1. Linear regression curves fit to the data exhibit fair correlation for the 28-day curing time ($R^2 = 0.32$), and poor to no correlation for the 1- and 14--day curing times ($R^2 = 0.25$ and 0.01, respectively). The lack of correlation seen with the 14-day curing time data is likely due, in part, to the relatively extreme strength gain observed with the samples from Pit Nos. 26-001 (99% carbonates) and 17-091 (52% carbonates). The negative slope observed for the samples cured for 28-days (the only significant correlation) is in conflict with the curve slopes seen in Part 1 of the study, and suggests an overall decrease in strength gain with lime addition for materials with higher carbonate content. The differences in these observations may be due to the different curing protocols used in the two parts of the study, or due to lithological/mineralogical variables (aragonite content) impacting the comparison of test results.

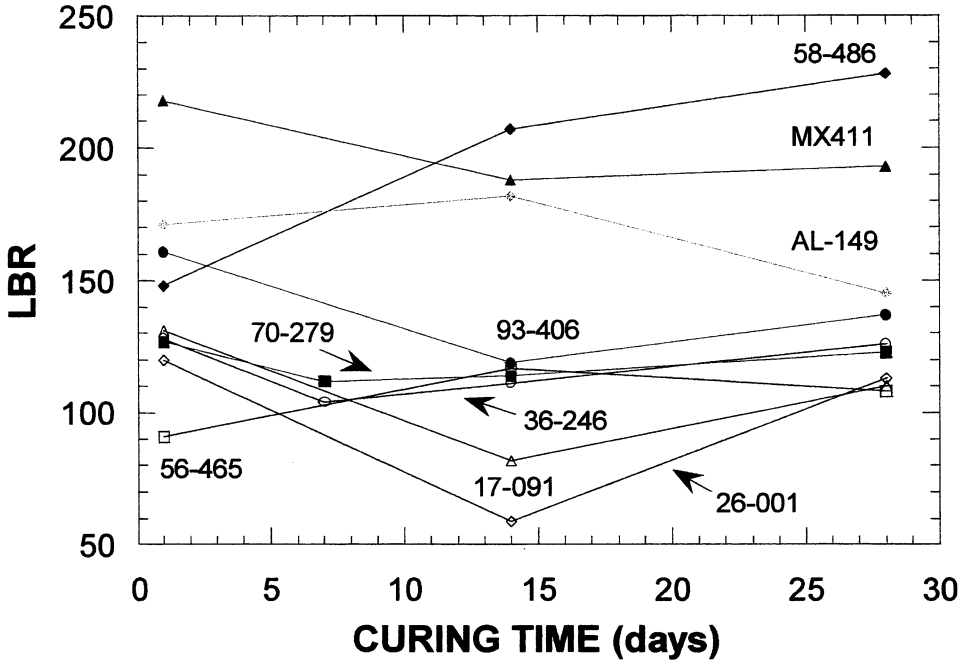


Figure 10. Plot of LBR data for untreated base course materials (Part 2).

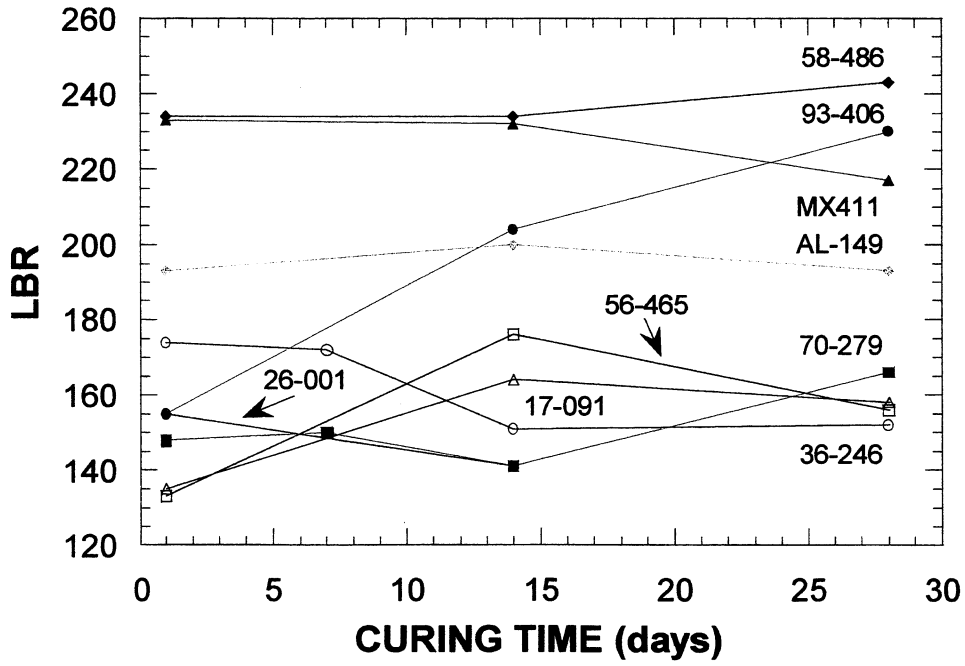


Figure 11. Plot of LBR data for treated base course materials (Part 2).

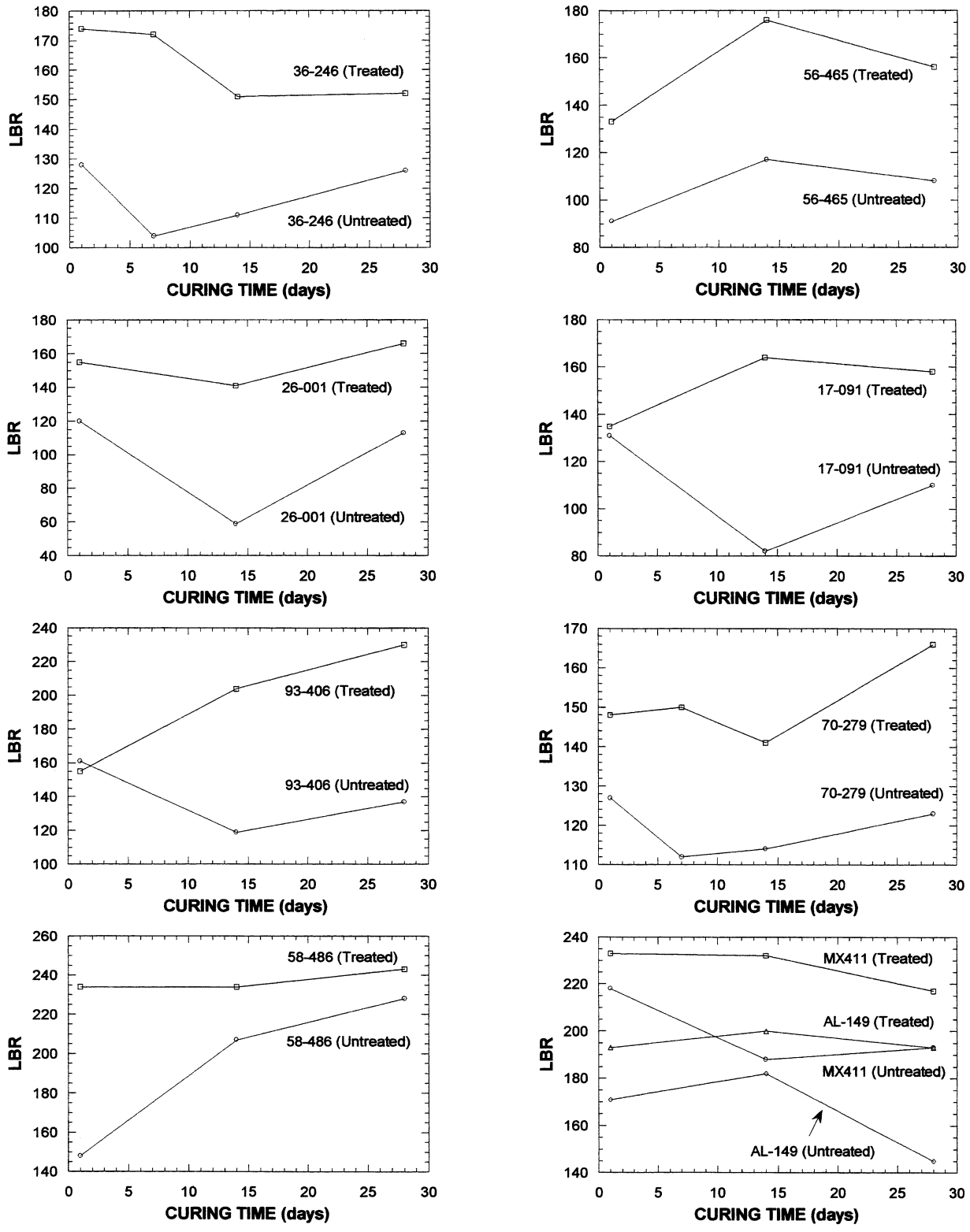


Figure 12. Plots illustrating the differences in LBR test results between untreated and treated base course materials (Part 2).

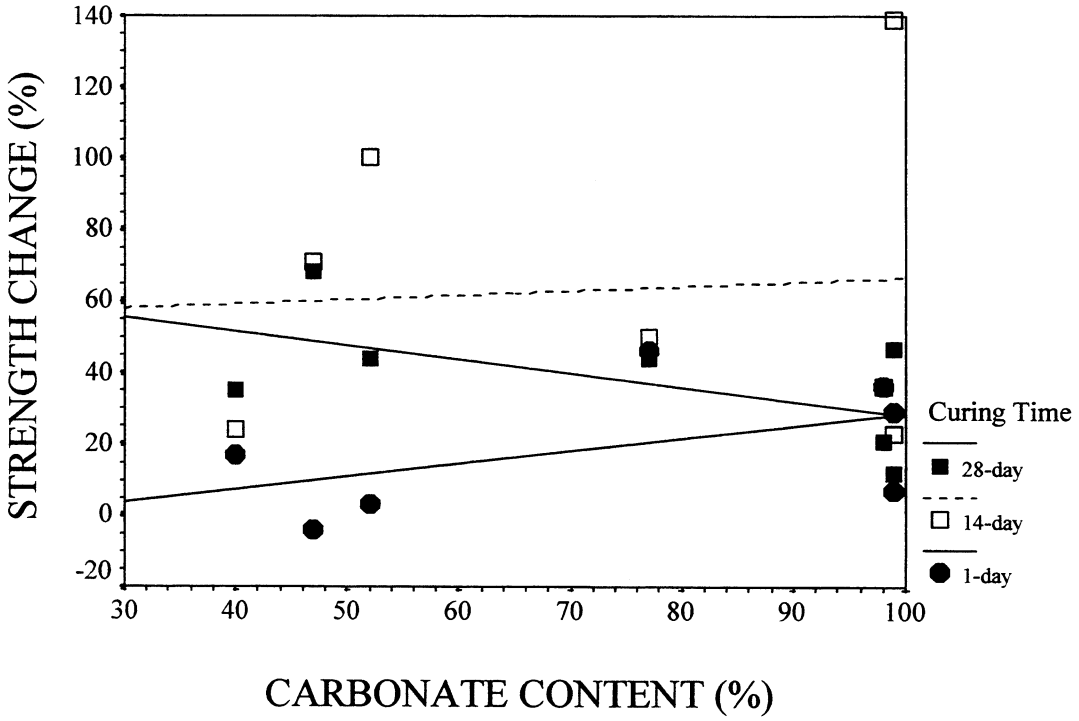


Figure 13. Scatter plot of strength change and carbonate content illustrating the relationship between curing time and the strength difference observed for treated versus untreated samples (Part 2).

Analysis of Variables Affecting LBR Values (Part 2)

Untreated Aggregates

As in Part 1 of this study, an effort was made to define the influence of density, moisture content, and carbonate content on the Limerock Bearing Ratio (LBR) results. For this purpose, these and other variables (gradation, mineralogy, and curing time) were selected for statistical analysis, and used to develop regression equations for comparison to the results obtained in Part 1 of the LBR study. Since Pit No. AL-149 represents a hard Paleozoic age dolomitic limestone significantly different in density and lithology from the "soft" limestones of Florida, it and the recycled crushed concrete sample (Pit No. 58-486) were ignored in the statistical analysis. Pit No. MX411, a "soft" limestone from Mexico, more closely resembles Florida limestone lithologies and was included in the data set. As in Part 1 of the LBR portion of this study, a bivariate correlation matrix, including mineralogical parameters, was prepared for both untreated and treated aggregate materials (Tables 14 and 17). Once again, only correlations possessing a Pearson correlation coefficient ≥ 0.6 were considered significant for this study.

Examination of Table 14 shows that LBR values for untreated aggregate samples exhibit a negative correlation to minus #4 (-0.780), but do not show correlations to dry density (0.518), moisture content (-0.463), and certainly not carbonate content (0.164) that fall within the significance threshold defined for this study (≥ 0.6). This is a significantly different outcome from that seen in Part 1 of the study, where LBR values of untreated samples exhibited fair to

good correlation with percent carbonates, moisture content, and dry density. However, in agreement with observations from Part 1, quartz and aragonite content exhibit a positive correlation (0.662), and correlate negatively to carbonate content (-0.980 and –0.743, respectively). Again, this suggests that quartz is the primary diluting phase for carbonate content, and that samples containing quartz also tend to be enriched in aragonite.

As aragonite is metastable with respect to calcite, it is likely to undergo cementation reactions more rapidly than calcite, aiding in the strength gain observed for some aragonite-rich samples. Since overall carbonate content tends to decrease with increasing aragonite content in the samples tested, this confounds our attempt at observing strength gain as a function of carbonate content. This suggests that not only is the carbonate content of a base course material likely of importance in predicting strength gain, but also the knowledge of which carbonate mineral species are present and their relative abundances. Within a single lithology (e.g. Anastasia Formation), one is likely to find that carbonate content does relate to LBR strength gain (Graves, 1987), as long as the relative abundance of carbonate mineral species stay roughly constant. If the relative abundance of aragonite, calcite, and/or dolomite varies, a relationship between carbonate content and strength gain likely will not hold.

Scatter plots of dry density, moisture content, carbonate content, and minus #4 versus LBR for the total data set further illustrate the poor correlations for all variables other than minus #4 (Fig. 14). Dry density and moisture content remain mirror images, due to a strong negative correlation (-0.882) also observed in Part 1 of the LBR study. Linear regression models for these variables are given in Table 15 using the equation 1 format, and include models derived for the total data set, as well as models derived for the individual curing times of 1-, 14-, and 28-days. The only correlation of note remains minus #4, for the total data set and the individual curing times.

A more detailed examination of the scatter plots for minus #4 (Fig. 15) and dry density (Fig. 16) versus LBR gives further insight into these test results. It is evident from the minus #4 versus LBR scatter plot that the strong correlation ($R^2 = 0.61$) is a direct result of the extreme difference in gradation between MX411 and all other samples tested. As this effectively generates a two-point curve for the regression analysis, the data were examined, excluding MX411, to determine if a correlation exists for the remaining data set. As a result, the remaining data shows no correlation for minus #4 and LBR ($R^2 = 0.02$). The dry density versus LBR scatter plot shows two important observations. First, the data for Pit Nos. MX411 ($R^2 = 0.41$) and 93-406 ($R^2 = 0.53$) do show a correlation for dry density and LBR, and second, these are the two pits that show the greatest variation in dry density data. This latter observation illustrates that the correlations discussed for dry density and LBR in Part 1 of this study are primarily a result of poor sample preparation. Without a wide range in dry density of the samples prepared for testing, this variable would not be of importance. As a result, it is apparent that dry density must be held fairly constant for individual pits if one is to quantify the effects on LBR testing of other variables such as carbonate content.

In an effort to relate the data acquired in this part of the study to that of Part 1, multiple regression analyses were again performed for the different curing times (1-, 14-, and 28-days) in order to quantify the relationship between LBR and the variables of dry density, moisture content, and carbonate content. Although of no statistical significance to this part of the study, the equation 2 format was used to calculate predicted LBR values (Table 16). A review of Table 16 shows that the predicted values are fairly poor estimates of the measured LBR values, in agreement with the poor statistical basis for the multiple regression analyses. Although the coefficient of determination (R^2) is quite good for each of the regression equations derived, this parameter is a poor indicator of the relationship between LBR and the independent variables

Table14. Bivariate correlation matrix for untreated aggregate samples (Part 2)

	CARB. CONT.	DRY DEN.	MOIST. CONT.	LBR	MINUS #4	CALC. CONT.	DOLO. CONT.	QTZ. CONT.	ARAG. CONT.	CURING TIME
CARB. CONT.										
DRY DEN.	-.603** .000									
MOIST. CONT.	.644** .000	-.882** .000								
LBR	.164 .276	.518** .000	-.463** .001							
MINUS #4	-.324* .028	-.505** .000	.383** .009	-.780** .000						
CALC. CONT.	.975** .000	-.622** .000	.592** .000	.189 .208	-.336* .002					
DOLO. CONT.	.065 .665	-.225 .133	.484** .001	-.215 .152	.033 .829	.086 .572				
QTZ. CONT.	-.980** .000	.587** .000	-.672** .000	-.161 .286	.321* .030	-.957** .000	-.160 .289			
ARAG. CONT.	-.743** .000	.552** .000	-.332* .024	-.186 .215	.283 .057	-.851** .000	.020 .895	.662** .000		
CURING TIME	.009 .953	-.009 .954	.003 .986	-.065 .669	-.034 .823	.001 .993	.023 .879	-.018 .905	.029 .850	

Note: Shaded cells indicate correlations considered to be statistically significant for this study (Pearson correlation coefficient ≥ 0.6).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

( ) sigma (2-tailed), n = 46.

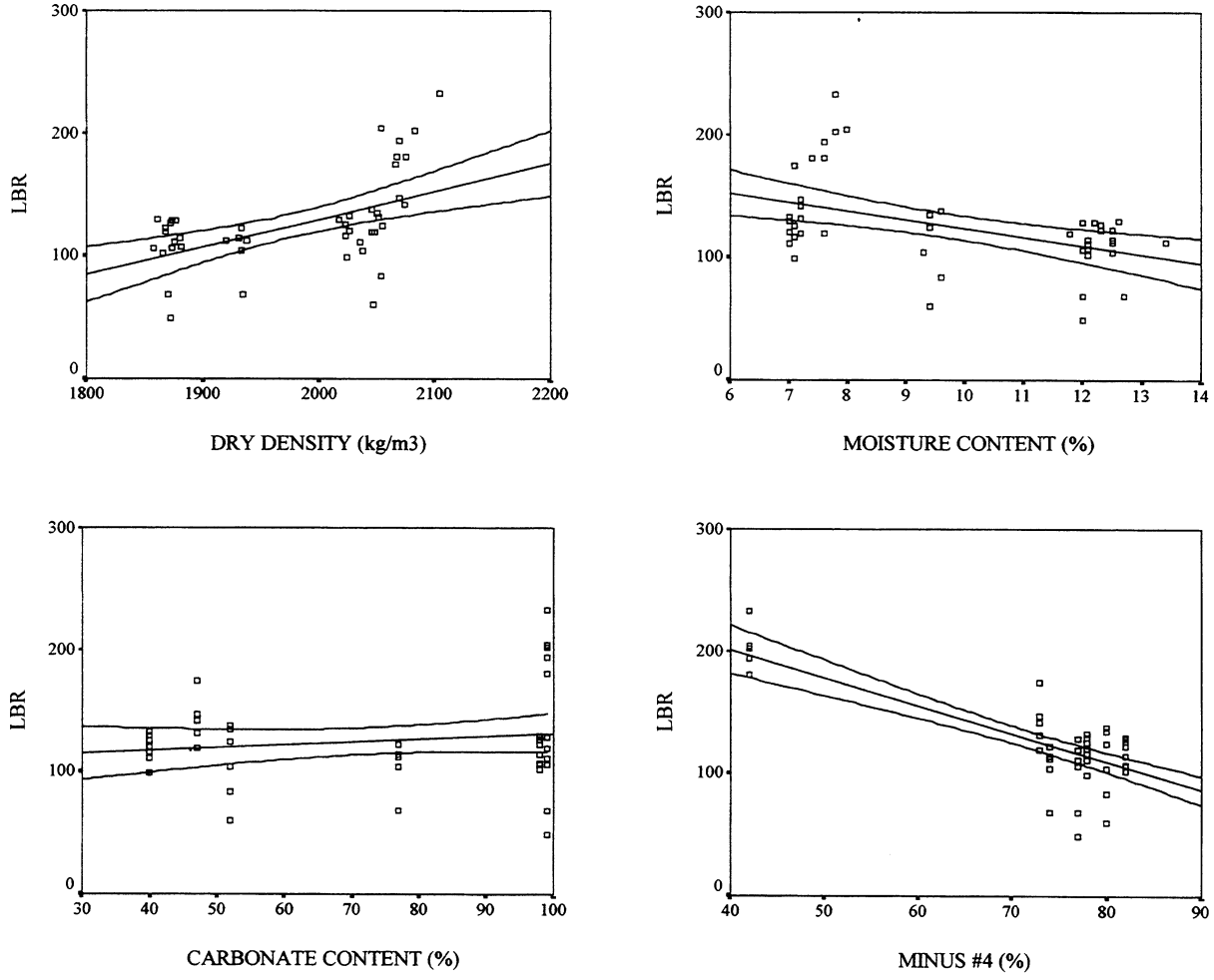


Figure 14. Scatter plots of variables thought to affect LBR test results of untreated aggregate samples (Part 2). (*Note*: Lines surrounding linear regression curves define the 95% confidence interval)

used to construct the equations. Similar to what was observed with Part 1, the overall poor result is most likely a consequence of the small data set (n = 14 for individual curing times), lithological variability among the samples, and internal inconsistencies in the data collected.

Similar to Part 1, the multiple regression equations for 1- and 28-days were used to prepare LBR prediction lines (Fig. 17). As before, moisture content values of 6% and 12%, and dry density (γ_d) values of 1840 kg/m^3 and 2080 kg/m^3 were used in the calculation of the prediction lines. Although the figure illustrates nothing of statistical significance, it suggests there is little to no effect of curing time on the LBR test, and that samples with a low moisture content and high dry density and carbonate content consistently give higher LBR results. As noted previously, dry density plays an important role in the LBR test results, and correspondingly, so does gradation.

Table 15. LBR linear regression models for untreated aggregate samples (Part 2)

LINEAR REGRES. MODEL	R^2	STD. ERROR OF EST.	UNSTANDARDIZED COEFFICIENTS			
			CONSTANT	STD. ERROR	INDEPENDENT VARIABLE	STD. ERROR
TOTAL						
Dry Den.	0.27	31.88	-323.04	111.83	0.23	0.06
Moist. Cont.	0.22	33.02	195.66	20.80	-7.19	2.07
Carb. Cont.	0.03	36.76	108.08	16.72	0.24	0.22
Minus #4	0.61	23.33	293.46	20.62	-2.30	0.28
1-DAY						
Dry Den.	0.41	32.42	-443.84	200.65	0.29	0.10
Moist. Cont.	0.36	33.85	238.05	39.04	-10.12	3.89
Carb. Cont.	0.03	41.77	120.03	35.16	0.26	0.46
Minus #4	0.63	25.63	316.75	39.58	-2.46	0.54
14-DAY						
Dry Den.	0.28	34.94	-395.00	234.06	0.26	0.12
Moist. Cont.	0.20	36.83	183.91	42.13	-7.30	4.19
Carb. Cont.	0.02	40.79	95.98	34.33	0.23	0.45
Minus #4	0.66	23.95	289.39	36.98	-2.45	0.50
28-DAY						
Dry Den.	0.17	29.16	-165.67	187.28	0.15	0.09
Moist. Cont.	0.23	28.14	189.46	32.52	-6.12	3.24
Carb. Cont.	0.08	30.69	104.32	25.84	0.35	0.34
Minus #4	0.72	16.82	273.48	25.98	-1.99	0.35

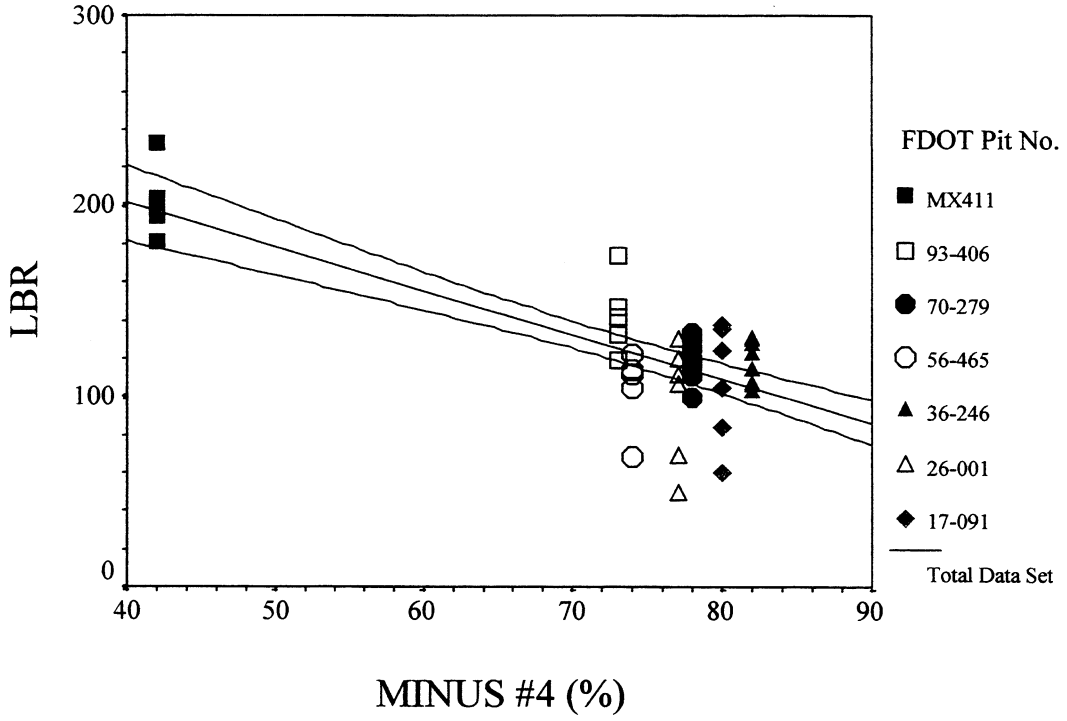


Figure 15. Scatter plot of LBR and minus #4 illustrating the relationship between pit source and location on the plot for untreated aggregate samples (Part 2).

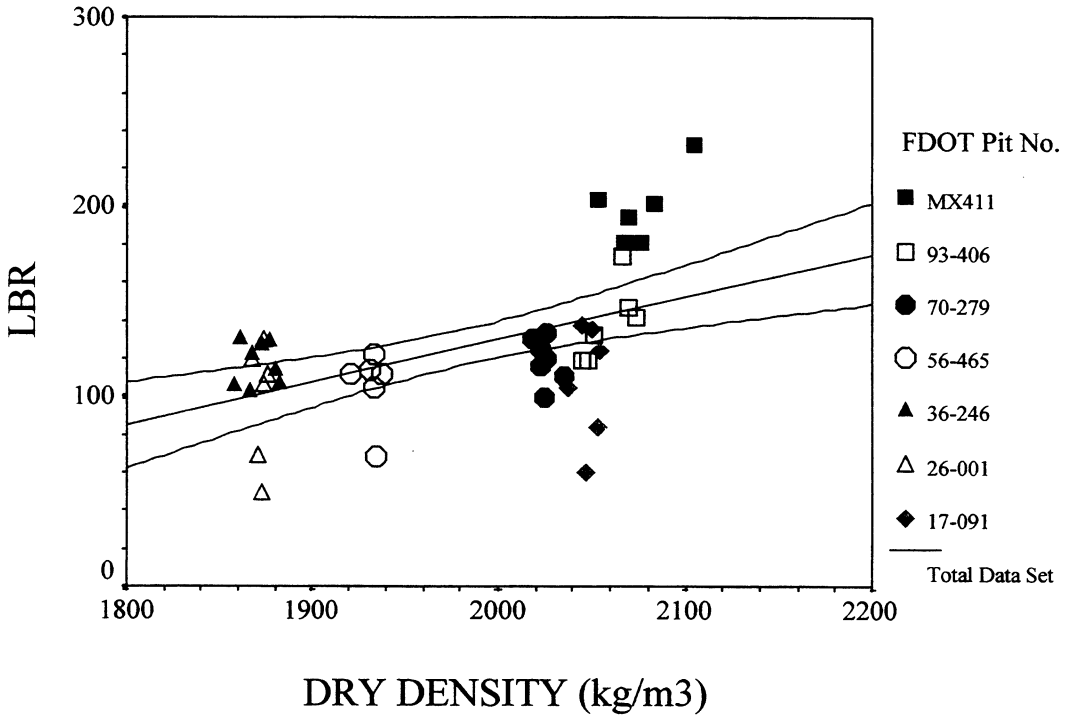


Figure 16. Scatter plot of LBR and dry density illustrating the relationship between pit source and location on the plot for untreated aggregate samples (Part 2).

Table 16. Comparison of measured and predicted LBR values - untreated (Part 2)

PIT NO. (%CARB.)	1-DAY[a]		1-DAY[a]		14-DAY[b]		14-DAY[b]		28-DAY[c]		28-DAY[c]	
	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.
36-246 (98%)	127	117	129	119	107	96	114	95	122	119	130	115
56-465 (77%)	114	98	68	97	122	94	112	87	112	101	104	101
26-001 (99%)	129	122	111	122	68	93	49	93	106	124	119	125
17-091 (52%)	124	128	138	123	104	114	60	118	135	116	84	115
93-406 (47%)	147	151	174	151	119	115	119	116	132	132	142	135
70-279 (40%)	133	135	120	135	111	104	116	99	130	121	116	121
MX411 (99%)	233	222	202	218	194	180	181	182	181	193	204	185

Regression Equations:

(a) LBR (1-d) = $-264.83 + 0.212(\gamma_d) - 12.14(MC) + 1.37(CA)$

$n = 14$, $R^2 = 0.87$

(b) LBR (14-d) = $-749.86 + 0.404(\gamma_d) - 1.51(MC) + 1.06(CA)$

$n = 14$, $R^2 = 0.59$

(c) LBR (28-d) = $-116.37 + 0.128(\gamma_d) - 9.63(MC) + 1.17(CA)$

$n = 14$, $R^2 = 0.79$

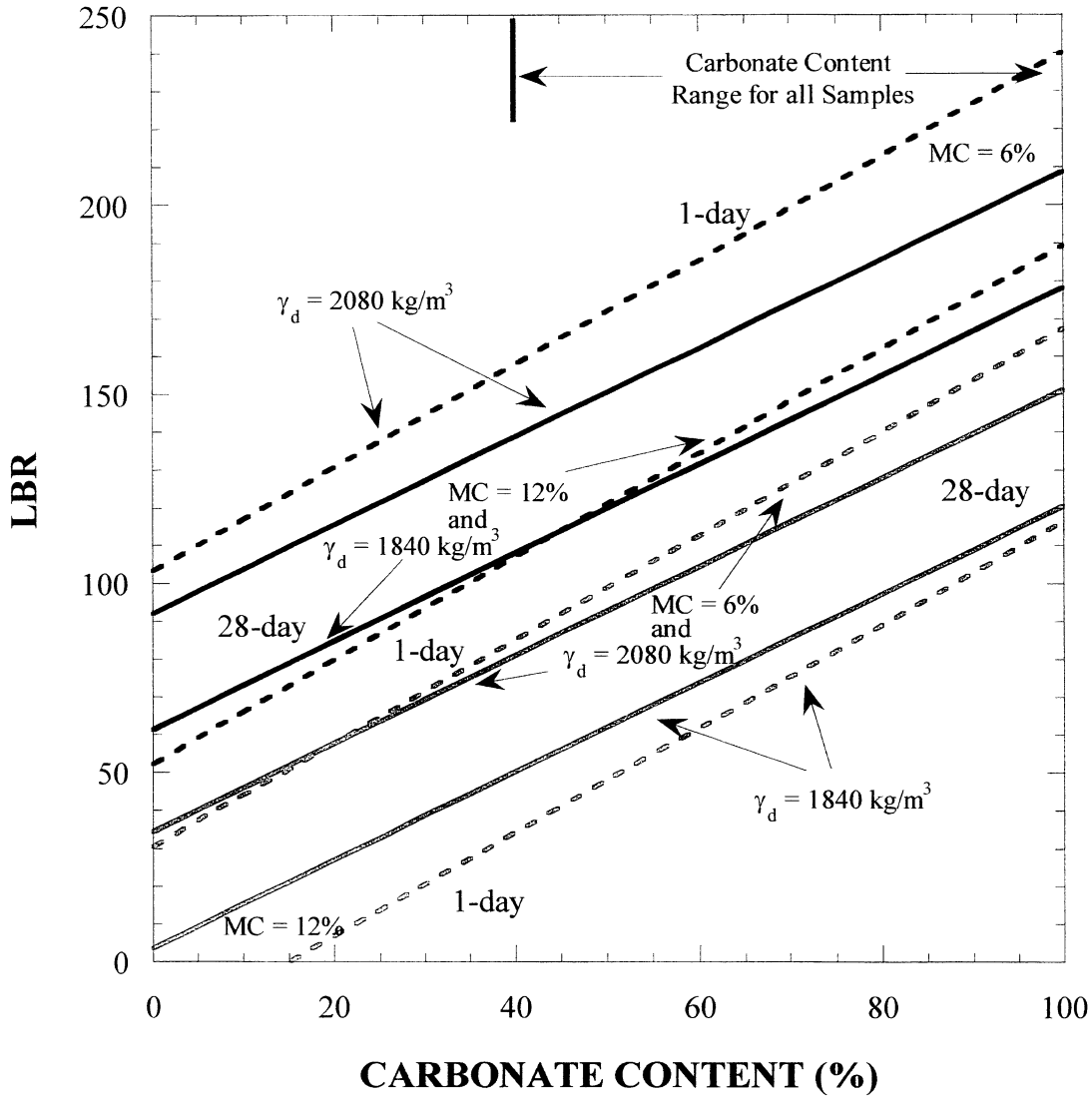


Figure 17. Prediction plot of LBR value as a function of carbonate content for untreated aggregate samples (Part 2). (*Note*: Prediction lines were generated using the 1- and 28-day regression equations shown in Table 16)

Treated Aggregates

As in Part 1 of the study, specimens prepared with 1.0 percent lime for the purpose of accelerating and/or enhancing the cementing of high carbonate aggregates also were evaluated to assess the effects of dry density, moisture content, carbonate content, and gradation on LBR test results. Again, the first step was production of a bivariate correlation matrix (Table 17).

Examination of Table 17 shows that LBR values for treated aggregate exhibit a negative correlation to minus #4 (-0.703), but do not show correlations to dry density (0.342), moisture content (-0.476), or carbonate content (0.199) that are significant (Pearson correlation coefficient ≥ 0.6). For comparison to the untreated aggregate data and data from Part 1 of this study, scatter plots of these variables are included for review (Fig. 18). In agreement with the bivariate correlation matrix, these plots illustrate the same relationships outlined for the untreated samples, with only minus #4 showing any visual evidence of correlation to LBR data. Linear regression models prepared according to that illustrated by equation 1 are included for comparison to the untreated aggregate data and the data from Part 1 (Table 18). As previously, they include models for the total data set, as well as the individual curing times employed with this part of the study (1-, 14-, and 28-days).

A review of Table 18 shows that the correlation for minus #4 remains the only relationship of note for the total data set and the individual curing times. However, one must consider the observation discussed for MX411, where an extreme difference in gradation produces the apparent correlation between minus #4 and LBR values. Again, if the data for MX411 are excluded from the analysis, it is apparent that there is actually no correlation for minus #4 and LBR ($R^2 = 0.08$) for the remaining data set. This suggests that there is either no relationship between these variables, or that lithological and/or test variables preclude identification of these statistical relationships.

In an effort to relate this data to other data in the study, multiple regression analyses were performed for the different curing times (1-, 14-, and 28-days) in order to quantify the relationship between LBR and the variables of dry density, moisture content, and carbonate content. Although of no statistical significance, the equation 2 format was used to calculate predicted LBR values (Table 19). As was observed with the untreated aggregate samples, a review of Table 19 shows that the predicted values are again fairly poor estimates of measured LBR values. Again, although the coefficient of determination (R^2) is quite good for the derived regression equations, the equations lack a good statistical basis.

As with the untreated aggregate samples, multiple regression equations for 1- and 28-days were used to prepare LBR prediction lines (Fig. 19). Although the figure illustrates nothing of statistical significance, it suggests observations similar to those outlined for the untreated aggregate samples, except that with lime treatment, carbonate content seems to have far less effect on strength gain of samples cured for longer periods (28-day), and that the lower dry density samples seem to exhibit greater LBR values with longer curing times (28-day) as well. This latter observation may be related to the effect of lime addition to the high carbonate base materials from Pit Nos. 36-246, 56-465, and 26-001, which possess relatively low dry densities. As discussed in the work of Graves (1987), lime addition was found to have the greatest effect for strength gain in high carbonate base course materials versus what was observed with lower carbonate materials containing a greater percentage of quartz sand.

As suggested in Part 1 of the study, if LBR is considered as a relative indicator of base course aggregate strength, then the use of high carbonate aggregates is not necessarily beneficial based on this data set. However, carbonate content has been documented to effect strength gain in both the laboratory and field by cementation (Gartland, 1979; Zimpher, 1981; Graves, 1987). In the research done by Graves (1979), samples of cemented coquina base course quarried from

Table 17. Bivariate correlation matrix for treated aggregate samples (Part 2)

	CARB. CONT.	DRY DEN.	MOIST. CONT.	LBR	MINUS #4	CALC. CONT.	DOLO. CONT.	QTZ. CONT.	ARAG. CONT.	CURING TIME
CARB. CONT.										
DRY DEN.	-.676** .000									
MOIST. CONT.	.515** .000	-.891** .000								
LBR	.199 .186	.342* .020	-.476** .001							
MINUS #4	-.324* .028	-.414** .004	.462** .001	-.703** .000						
CALC. CONT.	.975** .000	-.673** .000	.451** .002	.221 .139	-.336* .002					
DOLO. CONT.	.065 .665	-.322* .029	.544** .000	-.174 .248	.033 .829	.086 .572				
QTZ. CONT.	-.980** .000	.687** .000	-.530** .000	-.236 .114	.321* .030	-.957** .000	-.160 .289			
ARAG. CONT.	-.743** .000	.506** .000	-.230 .124	-.132 .382	.283 .057	-.851** .000	.020 .895	.662** .000		
CURING TIME	.009 .953	-.050 .740	.014 .925	.202 .178	-.034 .823	.001 .993	.023 .879	-.018 .905	.029 .850	

Note: Shaded cells indicate correlations considered to be statistically significant for this study (Pearson correlation coefficient ≥ 0.6).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

( ) sigma (2-tailed), n = 46.

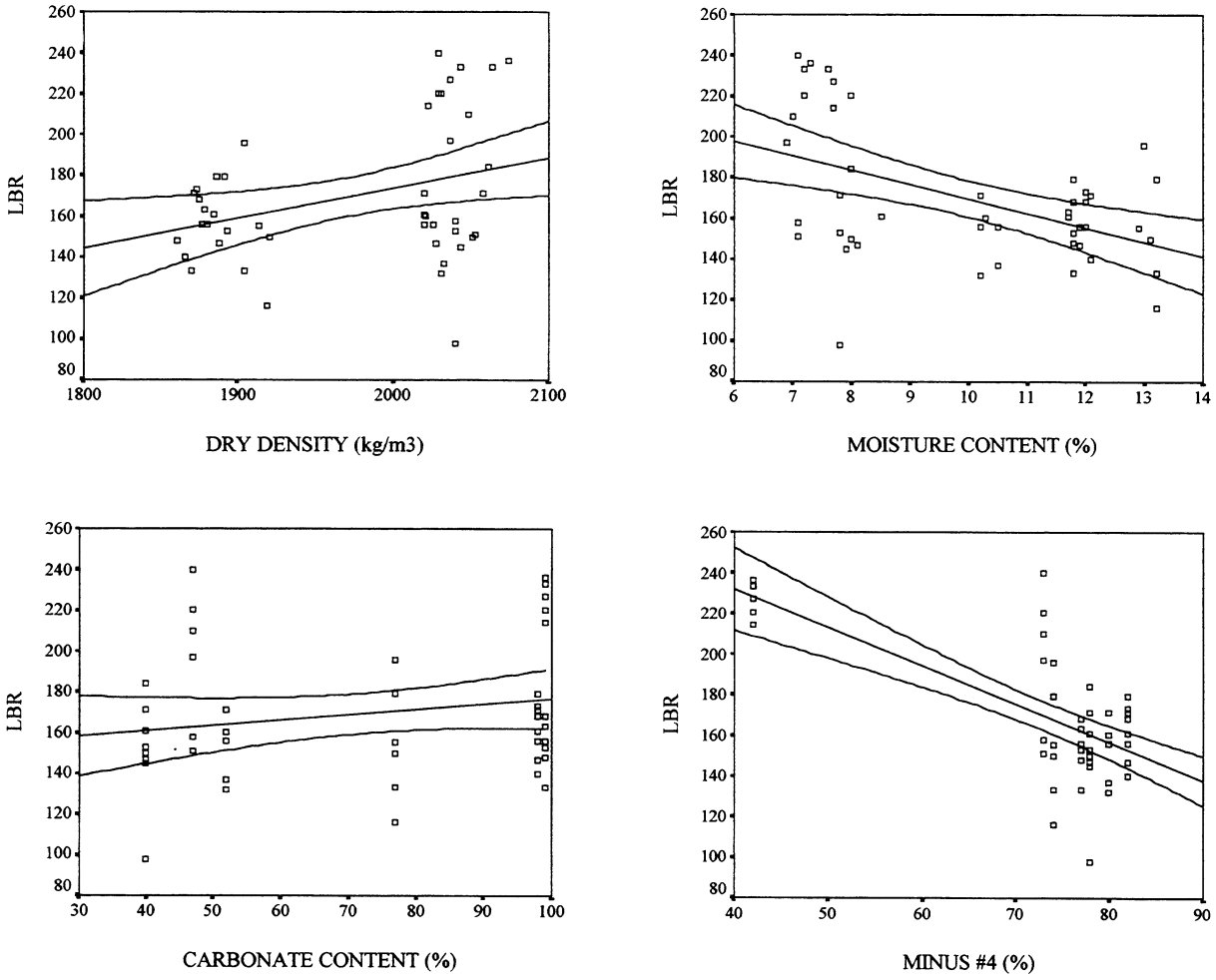


Figure 18. Scatter plots of variables thought to affect LBR test results of treated aggregate samples (Part 2). (*Note*: Lines surrounding linear regression curves define the 95% confidence interval)

the Anastasia Formation were cored from in-service highways (3-5 years) in southeast Florida, and showed strong evidence for cementation in the materials as a function of carbonate content. Furthermore, these observations agreed with cementation effects observed for LBR tests performed to illustrate strength gain due to the cementation phenomenon, and agreed with the laboratory based observations of both Gartland (1979) and Zimpher (1981). Based on these observations, it is likely that this database does not allow for the quantification of the effect that carbonate content has on strength gain due to the many competing variables observed in the data, including dry density, moisture content, gradation, carbonate content, carbonate mineralogy, quartz sand content, and general lithological variability. If more variables were held constant, it might be more probable to quantify the role of carbonate content.

Table 18. LBR linear regression models for treated aggregate samples (Part 2)

LINEAR REGRES. MODEL	R^2	STD. ERROR OF EST.	UNSTANDARDIZED COEFFICIENTS			
			CONSTANT	STD. ERROR	INDEPENDENT VARIABLE	STD. ERROR
TOTAL						
Dry Den.	0.12	31.80	-121.32	120.44	0.15	0.06
Moist. Cont.	0.23	29.76	240.20	20.12	-7.07	1.97
Carb. Cont.	0.04	33.17	150.48	15.09	0.26	0.20
Minus #4	0.49	24.06	307.23	21.27	-1.89	0.29
1-DAY						
Dry Den.	0.05	34.38	-23.85	242.23	0.09	0.12
Moist. Cont.	0.19	31.69	223.42	37.88	-6.22	3.71
Carb. Cont.	0.30	29.40	107.95	24.75	0.73	0.32
Minus #4	0.70	19.30	316.64	29.81	-2.15	0.41
14-DAY						
Dry Den.	0.23	35.01	-264.20	229.03	0.22	0.12
Moist. Cont.	0.21	35.52	246.73	42.72	-7.51	4.20
Carb. Cont.	0.01	39.80	162.07	33.50	0.14	0.43
Minus #4	0.52	27.68	324.20	42.75	-2.10	0.58
28-DAY						
Dry Den.	0.29	28.48	-277.43	208.36	0.23	0.11
Moist. Cont.	0.57	22.10	285.73	27.77	-10.76	2.70
Carb. Cont.	0.01	33.47	188.12	28.17	-0.14	0.37
Minus #4	0.39	26.40	287.86	40.77	-1.52	0.56

Table 19. Comparison of measured and predicted LBR values – treated with 1.0 percent lime (Part 2)

PIT NO. (%CARB.)	1-DAY[a]		1-DAY[a]		14-DAY[b]		14-DAY[b]		28-DAY[c]		28-DAY[c]	
	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.
36-246 (98%)	168	161	179	164	161	160	140	152	147	166	156	167
56-465 (77%)	150	131	116	129	155	155	196	151	179	138	133	136
26-001 (99%)	153	167	156	164	133	154	148	150	163	172	168	170
17-091 (52%)	137	136	132	138	171	174	156	174	156	161	160	160
93-406 (47%)	151	159	158	157	197	169	210	174	240	211	220	210
70-279 (40%)	150	142	145	141	98	165	184	176	171	193	161	187
MX411 (99%)	233	234	233	227	227	224	236	240	214	216	220	209

Regression Equations:

(a) LBR (1-d) $= -214.62 + 0.177(\gamma_d) - 7.89(MC) + 1.41(CA)$
$n = 14, R^2 = 0.91$

(b) LBR (14-d) $= -870.22 + 0.478(\gamma_d) + 2.49(MC) + 1.02(CA)$
$n = 14, R^2 = 0.50$

(c) LBR (28-d) $= 652.26 - 0.164(\gamma_d) - 16.96(MC) + 0.26(CA)$
$n = 14, R^2 = 0.67$

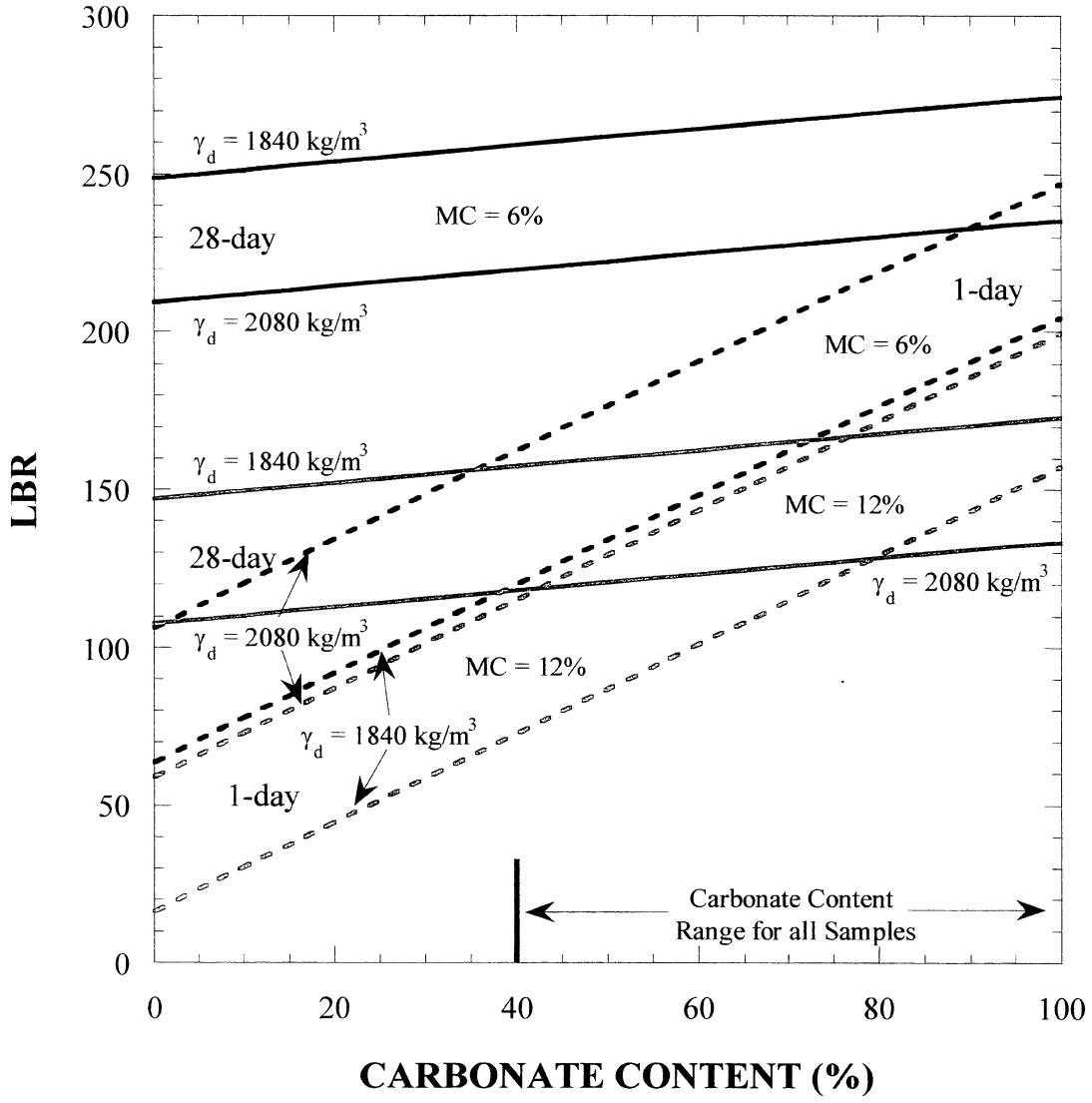


Figure 19. Prediction plot of LBR value as a function of carbonate content for treated aggregate samples (Part 2). (*Note*: Prediction lines were generated using the 1- and 28-day regression equations shown in Table 19)

TRIAXIAL SHEAR TESTS, RESULTS AND ANAYSIS

Test Specimen Preparation and Testing

In this phase of the study, one high carbonate (36-246) and one low carbonate (70-279) base course sample was selected to determine if the shear strength parameters of cohesion (C) and angle of internal friction (Φ) would identify differences in aggregate properties and degree of cementation. Modified Proctor compacted samples were prepared with and without 1.0 percent lime at optimum moisture content using granular base materials from Pit Nos. 36-246 and 70-276 which had 98 percent and 44 percent carbonates of calcium and magnesium, respectively. Six samples were prepared from each pit as both untreated and 1.0 percent lime treated (12 total samples). Two replicate samples were tested at each time period (1-, 7-, and 30-days). Triaxial compression tests were performed at confining pressures of 34.5 kPa and 138 kPa (5 and 20 psi, respectively). Test data report sheets are given in Appendix C.

Test Results and Analyses

A summary of the test results is presented in Table 20. The only sample to show a consistent increase in cohesion (C) with an increase in curing time was the untreated material from Pit No. 70-279 (Fig. 20). All other samples exhibited inconsistent cohesion data. Moreover, the treated samples from both pits exhibit a consistent slight increase in Φ with an increase in curing time (Fig. 21). The data not only suggest that the lime addition improves Φ with time, but also that the lime treated aggregate specimens achieved higher Φ values than the untreated materials. The low carbonate material from Pit No. 70-279 appeared to benefit more from lime treatment than the Pit No. 36-246 aggregates. The mean Φ value increased about 6 degrees with the addition of lime as compared to about 4 degrees for the high carbonate aggregates. This may be due to the reduction in dry density (γ_d) obtained with the lime treatment of Pit No. 36-246 samples. Conversely, material from Pit No. 70-279 increased in γ_d when lime was added.

A plot comparing the percentage of change in the values for both cohesion (C) and the angle of internal friction (Φ) between untreated and treated samples was prepared for Pit Nos. 36-246 and 70-279 (Fig. 22). The figure suggests that the majority of change caused by lime treatment for values of cohesion occur early during curing, while the majority of change observed for values of Φ seems to be concentrated more in the 30-day curing time values. Only the line illustrating the change in Φ values for 36-246 shows a consistent trend, exhibiting an increase in change with increased curing time.

Triaxial shear test data for Pit Nos. 36-246 and 70-279 were analyzed and tangent moduli computed for confining pressures of 34.5 kPa and 138 kPa (5 and 20 psi, respectively). Values for treated and untreated base materials were determined for the 1, 7, and 30 day tests (Appendix D). The results in Table 21 are somewhat difficult to interpret, probably due to the combination of test variability and data interpretation. In general, time (age) effects were not noticeable. The mean values indicate a slight increase in tangent modulus with increasing confining pressure and for treated versus untreated materials. These moduli are exceedingly low in relation to values obtained in the field from plate bearing and nondestructive tests (e.g. Dynaflect or FWD),

Table 20. Summary of shear strength parameters from triaxial tests

PIT NO./ CONDITION	AGE (days)	MOISTURE CONTENT w %	DRY DENSITY γ_d (kg/m^3)	SHEAR STRENGTH PARAMETERS	
				C (kPa)	Φ (degrees)
36-246/untreated	1	10.0	1899		
	1	10.3	1890	81.4	48.0
	7	10.4	1893		
	7	10.2	1893	69.6	46.2
	30	10.4	1866		
	30	10.4	1882	125.5	46.9
	Mean	10.3	1887	92.2	47.0
36-246/treated	1	10.0	1869		
	1	10.2	1856	131.0	49.0
	7	10.2	1857		
	7	10.1	1866	63.4	51.1
	30	10.1	1860		
	30	9.9	1861	118.6	53.3
	Mean	10.1	1861	104.3	51.1
Change (%)	1	---	---	60.9	2.1
	7	---	---	-8.9	10.6
	30	---	---	-5.5	13.7
	Mean	---	-1.4	13.12	8.7
70-279/untreated	1	7.1	2022		
	1	7.1	2026	60.0	42.5
	7	7.1	2036		
	7	7.1	2026	64.8	45.0
	30	7.2	2039		
	30	7.0	2036	83.4	39.4
	Mean	7.1	2031	69.4	42.3
70-279/treated	1	7.0	2053		
	1	7.2	2049	56.5	47.7
	7	7.1	2043		
	7	7.2	2042	102.0	48.8
	30	7.2	2037		
	30	7.2	2042	55.2	49.5
	Mean	7.2	2044	71.2	48.7
Change (%)	1	---	---	-5.8	12.2
	7	---	---	57.4	8.4
	30	---	---	-33.8	25.6
	Mean	---	0.6	2.6	15.1

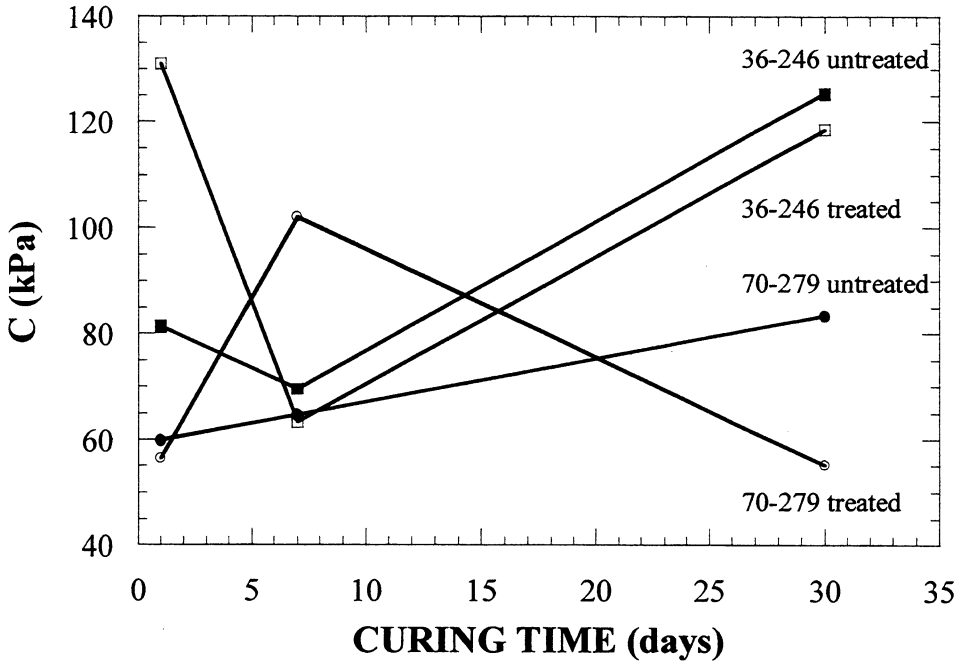


Figure 20. Plot of cohesion (C) versus curing time for both untreated and treated base course materials from Pit Nos. 36-246 and 70-279.

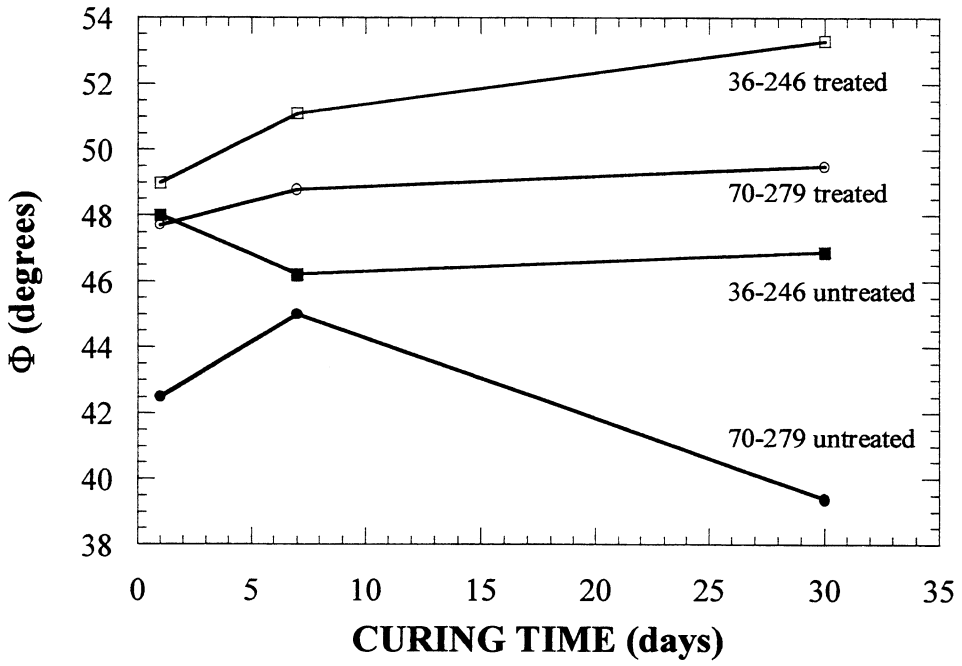


Figure 21. Plot of angle of internal friction (Φ) versus curing time for both untreated and treated base course materials from Pit Nos. 36-246 and 70-279.

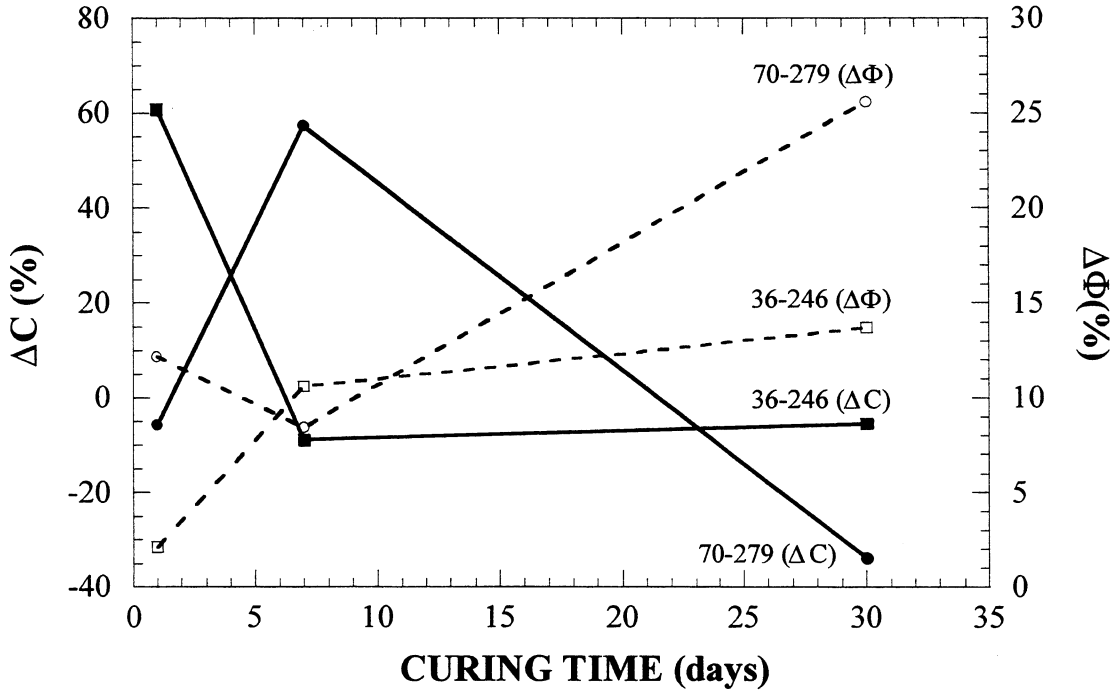


Figure 22. Plot of the percentage change in cohesion (C) and angle of internal friction (Φ) versus curing time for base course materials from Pit Nos. 36-246 and 70-279.

although it is difficult to compare these tests to the triaxial shear test results due to differences in strain conditions.

Table 21. Tangent moduli derived from triaxial shear tests

TIME (days)	CONFINING PRESSURE	PIT 36-246 UNTREATED Modulus (psi)	PIT 36-246 TREATED Modulus (psi)	PIT 36-246 CHANGE (%)	PIT 70-279 UNTREATED Modulus (psi)	PIT 70-279 TREATED Modulus (psi)	PIT 70-279 CHANGE (%)
1	5 psi	8125.0	12216.7	50.4	5990.9	6426.4	7.3
	20 psi	15930.0	18714.3	17.5	10975.0	11175.0	1.8
7	5 psi	7890.9	9633.3	22.1	7518.2	8440.0	12.3
	20 psi	11612.5	12807.1	10.3	12083.3	13083.3	8.3
30	5 psi	11514.3	12971.4	12.7	7391.7	11814.3	59.8
	20 psi	13976.9	15511.8	11.0	9336.4	13961.5	49.5
Mean	5 psi	9176.7	11607.1	26.5	6966.9	8893.6	27.6
	20 psi	13839.8	15677.7	13.3	10798.2	12739.9	18.0

TRIAXIAL RESILIENT MODULUS TESTS, RESULTS AND ANALYSIS

Test Specimen Preparation and Testing

Resilient modulus (M_R) tests were performed at the FDOT Office of Materials on limestone base course aggregates from Pit Nos. 36-246, 70-279, 56-465, 17-091, 93-406, 26-001, 58-486 (crushed concrete), MX411, and AL-149. Test specimens were prepared and compacted according to T180, modified proctor. Test procedures conforming to AASHTO T294-92 were used to obtain M_R values at three different axial stress conditions and at confining stresses of 20.7 kPa (3 psi), 34.5 kPa (5 psi), 69.0 kPa (10 psi), 103.4 kPa (15 psi), and 137.9 kPa (20 psi). In the case of Pit Nos. 36-246 and 70-279, two replicated tests were performed at 1-, 7-, 14-, and 28-days for lime treated and untreated materials. Based on the initial results acquired with tests for Pit Nos. 36-246 and 70-279, only 1- and 28-day tests were selected in order to save time for the remainder of the materials studied. Both external and internal LVDT measurements of deformation were obtained and used to define the resilient modulus values for all samples.

Test Results and Analyses

Test results summarizing mean triaxial resilient modulus (M_R) values for both internal and external deformation at 20 psi confining horizontal stress are given in Table 22. Data include M_R values for both untreated and treated base course materials, as well as the change in M_R values (ΔM_R) for both internal and external deformation after lime treatment. It is evident from examination of Table 22 that there are no distinct trends in M_R values with curing time. This observation is further illustrated by the plot of internal and external M_R values for Pit Nos. 36-246 and 70-279 (Fig. 23). There is little increase or decrease in the M_R data, the one exception being the treated sample from Pit No. 56-465 which shows a significant increase in M_R (internal), likely due to the clay stabilization phenomenon previously discussed for this material in the LBR section of this report.

Lime treatment of base course materials appears to generate both strength gain and loss in different pit samples. This is illustrated in both Table 22 and Fig. 23, as Pit Nos. 70-279, 56-465, 17-091, 93-406, and MX411 exhibit strength improvement, while Pit Nos. 36-246, 26-001, 58-486, and AL-149 exhibit a reduction in M_R values. In fact, some of the materials with the highest carbonate contents (36-246 and 26-001) show the worst declines in strength. In order to quantify this relationship, scatter plots of M_R versus carbonate content for both internal and external deformation were prepared for the total data set (Figs. 24 and 25). Linear regression curves fit to the data exhibit good to poor correlation for the 1-day curing time on both graphs ($R^2 = 0.50$ and 0.22, respectively), but show poor to no correlation for the 28-day curing time ($R^2 = 0.06$ and 0.20, respectively) and the total data set ($R^2 = 0.15$ and 0.21, respectively). However, if the 28-day data point for Pit No. 56-465 is removed due to the unusual phenomenon responsible for its strength gain, both the 28-day curing time data ($R^2 = 0.63$ and 0.68, respectively) and total data set data ($R^2 = 0.66$ and 0.53, respectively) exhibit good correlations between M_R values and carbonate.

Table 22. Mean triaxial resilient modulus test results for both untreated and treated base course samples at 20 psi confining horizontal stress

PIT NO.	CURING TIME (days)	M_R (20psi)* UNTREATED		M_R (20psi)* TREATED		Δ M_R (20psi)	
		Internal (psi)	External (psi)	Internal (psi)	External (psi)	Internal (%)	External (%)
36-246	1	85424	60366	70361	54274	-17.6	-10.1
	7	87604	59835	77891	56909	-11.1	-4.9
	14	88038	62123	77443	57460	-12.0	-7.5
	28	87988	62614	81801	60117	-7.0	-4.0
70-279	1	110243	71677	122044	76404	10.7	6.6
	7	104030	69190	128454	78306	23.5	13.2
	14	103301	68781	131688	81255	27.5	18.1
	28	103588	67234	129670	80689	25.2	20.0
56-465	1	64867	42682	74078	50987	14.2	19.5
	28	61648	30938	130475	51356	111.6	66.0
17-091	1	94833	65096	102457	68834	8.0	5.7
	28	86190	58807	95386	59604	10.7	1.4
93-406	1	104297	64097	114969	71731	10.2	11.9
	28	105712	51437	134614	70229	27.3	36.5
26-001	1	88954	61516	73057	53344	-17.9	-13.3
	28	89656	63149	75753	56278	-15.5	-10.9
MX411	1	109620	57686	113978	64059	4.0	11.0
	28	111710	72955	126607	66469	13.3	-8.9
58-486	1	86611	54336	86247	44998	-0.4	-17.2
	28	129526	61216	122889	59394	-5.1	-3.0
AL-149	1	128529	77889	120933	71910	-5.9	-7.7
	28	---	---	107984	44711	---	---

* Values are an average of two replicate tests.

(a) $M_R = a(\Theta)^b$, psi (Θ = sum of principal stresses). To convert to kPa multiply by 6.895.

Note: M_R results from Internal deformation measurements are considered more representative than External measured values because of end restraint conditions.

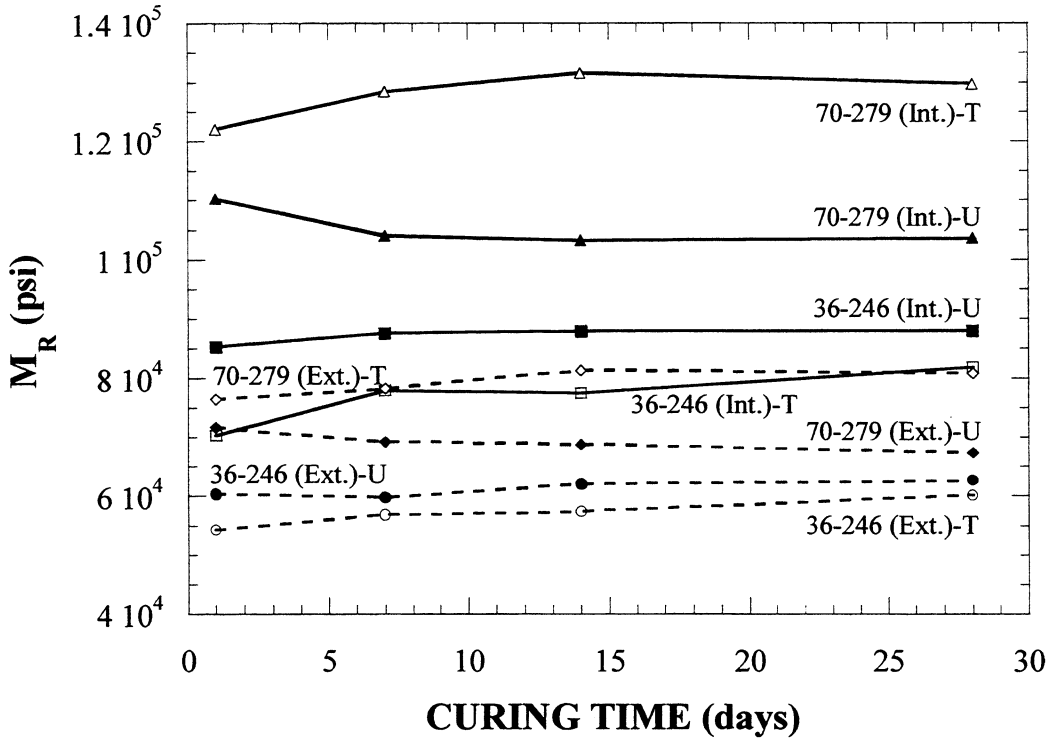


Figure 23. Plot of triaxial resilient modulus (M_R) data as a function of curing time for Pit Nos. 36-246 and 70-279 (untreated and treated samples).

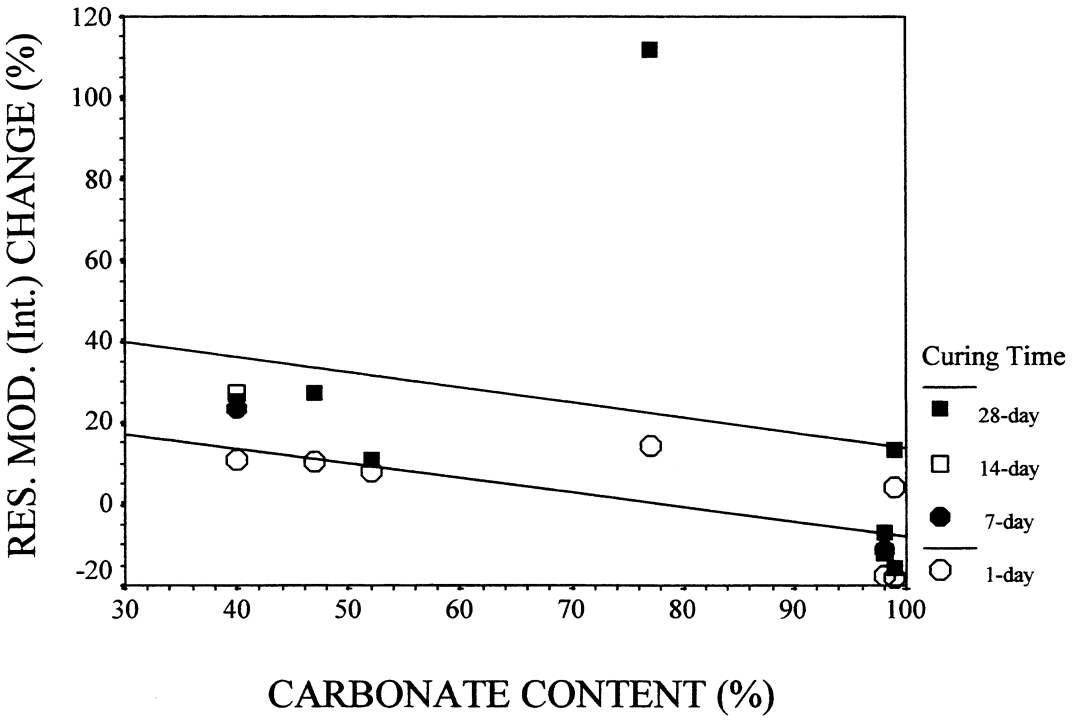


Figure 24. Scatter plot of M_R change (internal) and carbonate content illustrating the relationship between curing time and the strength difference for treated versus untreated samples.

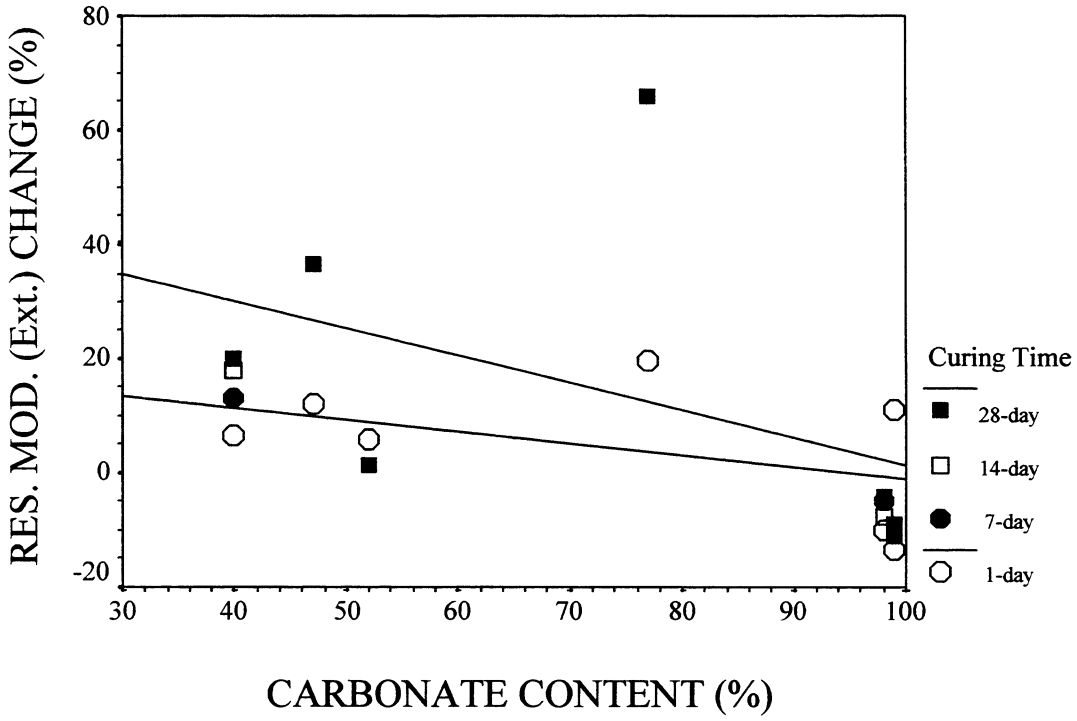


Figure 25. Scatter plot of M_R change (external) and carbonate content illustrating the relationship between curing time and the strength difference for treated versus untreated samples.

Data reduction and computation of resilient moduli values were very time-consuming due to the lack of computer software to facilitate computations. Fifteen M_R values were computed for each test specimen and plots of these M_R values versus the sum of principal stresses (Θ) were prepared for both internal and external deformation measurements. Power law regression analyses were performed to establish relationships according to the following equation:

$$M_R = a(\Theta)^b$$

where: M_R = modulus of resilience, psi
a = coefficient
b = exponent
Θ = sum of principal stresses, psi

or

$$M_R\,(kPa) = a(\Theta)^b * 6.895 \qquad \text{eqn. 3}$$

Tables 23 through 31 present a listing of the results derived from the regression analyses for materials from each pit. It should be noted that M_R results from internal deformation measurements are considered more representative than external measured values because of end restraint conditions. Furthermore, moisture content and density values for the tested specimens also are given in Tables 32 through 34 for comparison purposes. Appendix E contains the complete test data.

The regression equations for Pit Nos. 36-246 and 70-279 (Tables 23 and 24) were used to compute moduli values at Θ of 10 and 100 psi (68.95 and 689.5 kPa, respectively). These values were then subjected to additional regression analyses to obtain master equations for each material assuming that age (time) had no effect on the M_R. The results in Table 35 show a negligible increase in slope (exponent b) for treated 36-246 aggregate and a more substantial decrease in slope for treated 70-279 as compared to that for the untreated aggregates. Data from the other sources were not analyzed in this manner.

Since both slope (b) and coefficient (a) interchange in magnitude between treated and untreated, M_R values were computed using different stress conditions (Θ). These results gave 13 to 15 percent reduction in M_R regardless of stress level for the treated 36-246 material as compared to the untreated. Conversely, M_R for the untreated 70-279 aggregate was 21 to 23 percent less than the treated. The improvement in M_R for 70-279 is believed to be related to the presence of lime improving cementation, and correspondingly strength gain, due to the presence of aragonite in the sample. As seen in the LBR part of this study, samples containing aragonite show potential for strength gain often greater than materials that are 100% carbonate. Apparently, the testing procedure used in this part of the study favored strength gain of base course materials containing aragonite (70-279: 10.4%, 56-465: 11.9%, 17-091: 35.9%, and 93-406: 24.6%) over materials without aragonite. A comparison of the M_R values for materials from Pit Nos. 36-246 and 70-279 with and without lime treatment is presented in Fig 26.

Table 23. Regression equations derived from triaxial M_R tests for Pit No. 36-246

CONDITION	CURING TIME (days)	INTERNAL[(a)]			EXTERNAL[(a)]		
		a	b	R^2	a	b	R^2
Untreated	1	6612.8	0.5859	0.904	586.68	—	—
	1	5999.5	0.5732	0.925	3389.1	0.6326	0.949
	7	5977.8	0.5974	0.947	2760.6	0.6877	0.972
	7	4637.9	0.6379	0.963	2107.3	0.7361	0.977
	14	4994.9	0.6239	0.9469	2333.3	0.7193	0.971
	14	8648.2	0.5122	0.908	3819.6	0.6251	0.960
	28	5610.1	0.6178	0.950	2378.9	0.7263	0.970
	28	5696.2	0.5846	0.939	2998.6	0.6701	0.962
	Mean	6022.2	0.5916		2826.8	0.6853	
Treated	1	4704.6	0.5913	0.938	2743.6	0.6585	0.969
	1	4700.0	0.5912	0.955	3063.6	0.6325	0.960
	7	4204.8	0.6406	0.968	2771.1	0.6704	0.970
	7	4767.0	0.6123	0.957	2688.1	0.6708	0.974
	14	4762.8	0.6249	0.970	2509.7	0.6902	0.979
	14	4495.6	0.6126	0.948	2836.0	0.6683	0.971
	28	5302.4	0.5996	0.952	2761.9	0.6773	0.975
	28	6460.8	0.5537	0.913	3612.4	0.6241	0.964
	Mean	4924.8	0.6033		2873.3	0.6615	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 24. Regression equations derived from triaxial M_R tests for Pit No. 70-279

CONDITION	CURING TIME (days)	INTERNAL[a]			EXTERNAL[a]		
		a	b	R^2	a	b	R^2
Untreated	1	7382.9	0.6068	0.971	3279.2	0.6884	0.979
	1	8907.8	0.5603	0.959	3406.8	0.6865	0.981
	7	7041.6	0.6093	0.983	2858.2	0.7151	0.985
	7	8162.4	0.5637	0.965	3066.3	0.6975	0.982
	14	6997.0	0.6175	0.972	3016.6	0.7056	0.980
	14	6143.0	0.6168	0.960	2776.5	0.7187	0.983
	28	7023.0	0.6005	0.970	3103.6	0.6894	0.981
	28	7147.8	0.5962	0.969	2980.9	0.6988	0.982
	Mean	7350.7	0.5964		3061.0	0.7000	
Treated	1	9217.0	0.5849	0.966	3619.0	0.6857	0.981
	1	6591.5	0.6447	0.977	3123.5	0.7187	0.981
	7	11575.0	0.5368	0.936	4506.7	0.6361	0.975
	7	8865.8	0.5958	0.9644	4102.6	0.6610	0.979
	14	13147.0	0.5172	0.925	4563.5	0.6446	0.976
	14	9590.2	0.5757	0.959	4796.1	0.6300	0.972
	28	12720.0	0.5132	0.929	3965.6	0.6741	0.973
	28	13162.0	0.5074	0.936	5651.8	0.5943	0.967
	Mean	10608.6	0.5595		4291.1	0.6556	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 25. Regression equations derived from triaxial M_R tests for Pit No. 56-465

CONDITION	CURING TIME (days)	INTERNAL[a]			EXTERNAL[a]		
		a	b	R^2	a	b	R^2
Untreated	1	3503.1	0.6542	0.933	1352.7	0.7755	0.967
	1	3325.2	0.6607	0.893	1616.6	0.7375	0.953
	28	4729.8	0.5946	0.955	1869.7	0.6488	0.968
	28	2459.9	0.6972	0.946	1260.2	0.7030	0.976
	Mean	3504.5	0.6517		1524.8	0.7162	
Treated	1	3025.8	0.7401	0.936	1285.3	0.8374	0.957
	1	896.44	0.9685	0.971	738.59	0.9368	0.984
	28	107672	0.0054	0.000	4268.8	0.5665	0.951
	28	175977	-0.0730	0.143	2616.0	0.6747	0.967
	Mean	71892.8	0.4103		2227.2	0.7539	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 26. Regression equations derived from triaxial M_R tests for Pit No. 17-091

CONDITION	CURING TIME (days)	INTERNAL[a]			EXTERNAL[a]		
		a	b	R^2	a	b	R^2
Untreated	1	7058.0	0.5702	0.927	3882.8	0.6265	0.961
	1	6655.2	0.5964	0.929	3419.2	0.6594	0.957
	28	3350.2	0.7386	0.954	1899.6	0.7721	0.977
	28	3396.9	0.7117	0.960	2166.3	0.7372	0.974
	Mean	5115.1	0.6542		2842.0	0.6988	
Treated	1	8874.2	0.5319	0.885	4858.8	0.5895	0.934
	1	8436.2	0.5515	0.884	4631.2	0.5938	0.936
	28	7156.9	0.5711	0.894	3271.5	0.6391	0.953
	28	7629.9	0.5595	0.880	3945.6	0.6103	0.942
	Mean	8024.3	0.5535		4176.8	0.6082	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 27. Regression equations derived from triaxial M_R tests for Pit No. 93-406

CONDITION	CURING TIME (days)	INTERNAL[a]			EXTERNAL[a]		
		a	b	R^2	a	b	R^2
Untreated	1	7738.0	0.5973	0.961	4630.3	0.5940	0.959
	1	8251.7	0.5675	0.960	3252.3	0.6731	0.977
	28	5769.6	0.6524	0.971	753.99	0.9408	0.980
	28	4872.2	0.6911	0.969	1066.5	0.8781	0.985
	Mean	6657.9	0.6271		2425.8	0.7715	
Treated	1	7535.7	0.5984	0.935	5445.6	0.5792	0.953
	1	9967.8	0.5412	0.896	5399.2	0.5655	0.946
	28	16066.0	0.4543	0.952	1842.2	0.8398	0.987
	28	16487.0	0.4641	0.832	1183.7	0.8928	0.981
	Mean	12514.1	0.5145		3467.7	0.7193	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 28. Regression equations derived from triaxial M_R tests for Pit No. 26-001

CONDITION	CURING TIME (days)	INTERNAL[(a)]			EXTERNAL[(a)]		
		a	b	R^2	a	b	R^2
Untreated	1	6383.3	0.5786	0.920	4255.7	0.5983	0.949
	1	4847.7	0.6354	0.960	2542.2	0.6930	0.967
	28	5115.0	0.6300	0.939	3577.6	0.6375	0.969
	28	5192.6	0.6205	0.951	2568.1	0.7084	0.983
	Mean	5384.7	0.6161		3235.9	0.6593	
Treated	1	4839.8	0.6027	0.953	2833.3	0.6464	0.967
	1	4665.0	0.5951	0.950	3194.0	0.6221	0.963
	28	3683.3	0.6624	0.972	2369.2	0.7049	0.981
	28	3739.6	0.6666	0.971	2639.0	0.6751	0.982
	Mean	4231.9	0.6317		2758.9	0.6621	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 29. Regression equations derived from triaxial M_R tests for Pit No. 58-486

CONDITION	CURING TIME (days)	INTERNAL[(a)]			EXTERNAL[(a)]		
		a	b	R^2	a	b	R^2
Untreated	1	6374.2	0.5832	0.981	975.2	0.8872	0.988
	1	8264.4	0.5127	0.946	1234.6	0.8624	0.986
	28	—	—	—	—	—	—
	28	9242.5	0.9763	0.976	1481.2	0.8358	0.987
	Mean	7960.4	0.6907		1230.3	0.8618	
Treated	1	6736.9	0.5952	0.994	908.9	0.8865	0.989
	1	5140.0	0.6059	0.989	1341.1	0.7906	0.989
	28	18348.0	0.4326	0.938	1096.5	0.9153	0.984
	28	12164.0	0.4714	0.875	1009.2	0.9074	0.983
	Mean	10597.2	0.5263		1088.9	0.8750	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 30. Regression equations derived from triaxial M_R tests for Pit No. MX411

CONDITION	CURING TIME (days)	INTERNAL[a]			EXTERNAL[a]		
		a	b	R^2	a	b	R^2
Untreated	1	7886.8	0.5906	0.948	1112.4	0.8474	0.968
	1	14299.0	0.4243	0.863	2154.7	0.7450	0.978
	28	9540.4	0.5594	0.976	1255.4	0.9161	0.983
	28	9872.7	0.9272	0.927	1451.7	0.8794	0.985
	Mean	10399.7	0.6254		1493.6	0.8470	
Treated	1	23110.0	0.3557	0.802	1065.4	0.9247	0.981
	1	14312.0	0.4351	0.866	3169.9	0.6694	0.958
	28	16077.0	0.4542	0.949	1841.2	0.8399	0.987
	28	28662.0	0.3152	0.841	1437.6	0.8288	0.986
	Mean	20540.3	0.3901		1878.5	0.8157	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 31. Regression equations derived from triaxial M_R tests for Pit No. AL-149

CONDITION	CURING TIME (days)	INTERNAL[a]			EXTERNAL[a]		
		a	b	R^2	a	b	R^2
Untreated	1	10392.0	0.5654	0.976	1011.8	0.9689	0.988
	1	8222.9	0.5876	0.957	1299.8	0.9342	0.989
	28	—	—	—	—	—	—
	28	—	—	—	—	—	—
	Mean	9307.5	0.5765		1155.8	0.9516	
Treated	1	6322.3	0.6409	0.982	1122.5	0.9355	0.990
	1	9892.6	0.5645	0.978	947.1	0.9766	0.986
	28	5914.0	0.6581	0.985	828.4	0.9012	0.987
	28	8809.1	0.5460	0.982	961.1	0.8563	0.990
	Mean	7734.5	0.6024		964.8	0.9174	

(a) $M_R = a(\Theta)^b$, psi. To convert to kPa multiply by 6.895.

Table 32. Moisture-density of resilient modulus test specimens 36-246 and 70-279

CONDITION	CURING TIME (days)	PIT NO. 36-246		PIT NO. 70-279	
		w (%)	γ_d (kg/m^3)	w (%)	γ_d (kg/m^3)
Untreated	1	12.0	1874.0	7.1	2031.0
	1	12.2	1862.8	7.2	2027.8
	Mean	12.1	1868.4	7.2	2029.4
	7	12.1	1883.6	7.2	2026.1
	7	12.0	1865.0	7.1	2023.0
	Mean	12.1	1874.8	7.2	2024.6
	14	12.0	1864.4	7.1	2027.8
	14	12.0	1862.8	7.2	2021.3
	Mean	12.0	1863.6	7.2	2024.6
	28	12.0	1866.0	7.2	2031.0
	28	12.0	1872.4	7.0	2031.0
	Mean	12.0	1869.2	7.1	2031.0
Treated	1	12.1	1856.4	8.0	2040.6
	1	11.9	1862.8	8.1	2042.2
	Mean	12.0	1859.6	8.1	2041.4
	7	12.0	1858.0	8.0	2042.2
	7	12.0	1853.2	7.5	2047.0
	Mean	12.0	1855.6	7.8	2044.6
	14	11.9	1862.8	7.9	2045.4
	14	11.9	1856.4	8.1	2043.8
	Mean	11.9	1862.6	8.0	2044.6
	28	11.9	1854.8	8.0	2042.2
	28	12.0	1859.6	8.0	2035.8
	Mean	12.0	1857.2	8.0	2039.0

Table 33. Moisture-density of resilient modulus test specimens 56-465, 17-091, 93-406 and 26-001

CONDITION	CURING TIME (days)	PIT NO. 56-465		PIT NO. 17-091		PIT NO. 93-406		PIT NO. 26-001	
		w (%)	γ_d (kg/m^3)	w (%)	γ_d (kg/m^3)	w (%)	γ_d (kg/m^3)	w (%)	γ_d (kg/m^3)
Untreated	1	12.4	1925.2	9.3	2024.5	7.3	2050.2	12.1	1856.4
	1	12.4	1934.8	9.5	2021.3	7.0	2051.8	12.0	1853.2
	Mean	12.4	1930.0	9.4	2022.9	7.2	2051.0	12.1	1854.8
	28	12.1	1926.8	9.4	2026.1	7.3	2051.8	12.0	1858.0
	28	12.4	1926.8	9.2	2037.4	7.2	2045.4	12.0	1858.0
	Mean	12.3	1926.8	9.3	2031.8	7.3	2048.6	12.0	1858.0
Treated	1	13.7	1877.2	10.4	2005.3	7.0	2027.7	11.9	1851.6
	1	13.4	1900.0	10.2	2016.5	7.1	2018.1	11.7	1854.8
	Mean	13.6	1888.6	10.3	2010.9	7.1	2022.9	11.8	1853.2
	28	13.3	1894.8	10.4	2005.3	7.1	2002.1	11.8	1850.0
	28	13.0	1891.6	10.1	2003.7	6.9	2029.3	11.8	1850.0
	Mean	13.2	1893.2	10.3	2004.5	7.0	2015.7	11.8	1850.0

Table 34. Moisture-density of resilient modulus test specimens 58-486, MX411 and AL-149

CONDITION	CURING TIME (days)	PIT NO. 58-486		PIT NO. MX411		PIT NO. AL-149	
		w (%)	γ_d (kg/m^3)	w (%)	γ_d (kg/m^3)	w (%)	γ_d (kg/m^3)
Untreated	1	11.5	1915.6	7.9	2002.1	5.7	2280.8
	1	13.1	1910.8	7.9	2034.1	5.9	2268.0
	Mean	12.3	1913.2	7.9	2018.1	5.8	2274.4
	28	12.1	1893.2	8.4	2034.1	—	—
	28	11.5	1920.4	7.9	2022.9	—	—
	Mean	11.8	1906.8	8.2	2028.5		
Treated	1	12.0	1925.2	8.0	2034.1	5.8	2279.2
	1	12.4	1918.8	7.7	2003.7	6.3	2245.6
	Mean	12.2	1922.0	7.9	2018.9	6.1	2262.4
	28	12.9	1906.0	7.7	2022.9	5.7	2277.6
	28	12.4	1922.0	7.7	2003.7	5.7	2272.8
	Mean	12.7	1914.0	7.7	2013.3	5.7	2275.2

Table 35. Result of regression analyses for Pit Nos. 36-246 and 70-279 assuming no effect of time

PIT NO./ CONDITION	a*	b*	# VALUES	R^2
36-246 / Untreated	5924.8	0.5916	16	0.986
36-246 / Treated	4886.6	0.6033	16	0.990
70-279 / Untreated	7310.3	0.5964	16	0.990
70-279 / Treated	10349.2	0.5595	16	0.981

*$M_R = a(\Theta)^b$, psi or
$M_R = a(\Theta)^b \times 6.895 = kPa$

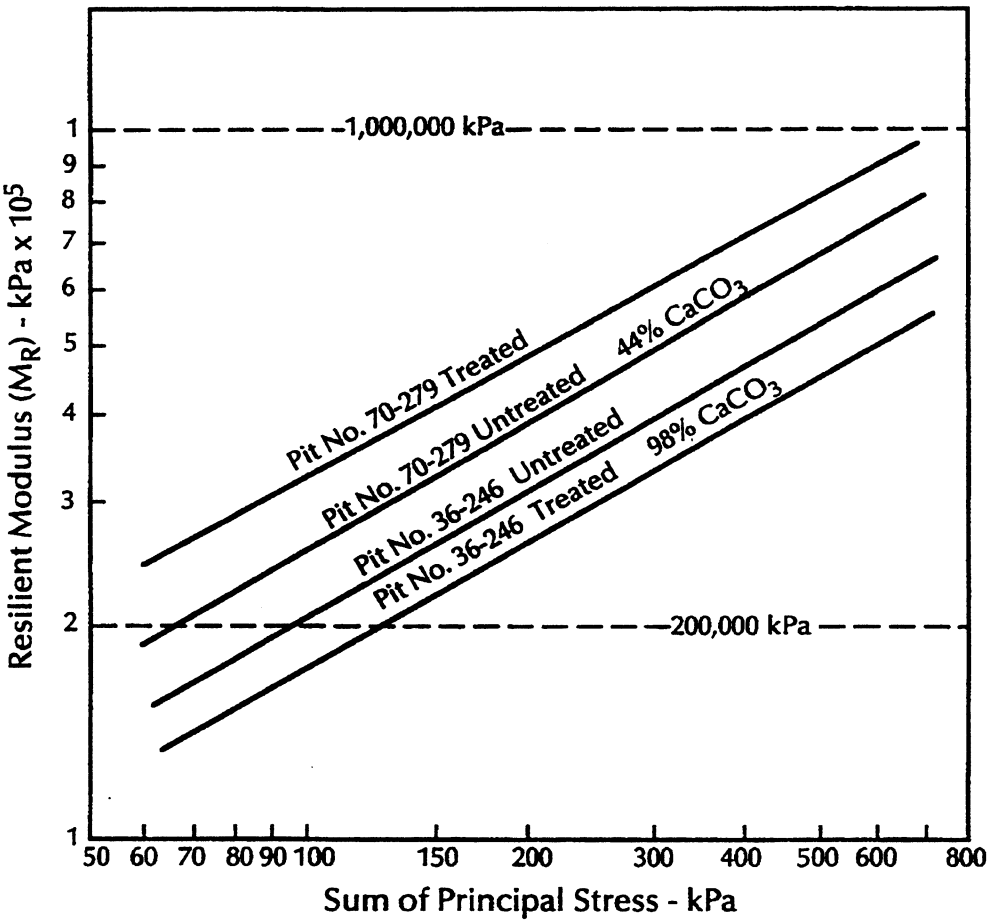


Figure 26. Comparison of predicted resilient moduli for Pit Nos. 36-246 and 70-279.

Analysis of Variables Affecting M_R Values

Untreated Aggregates

As was done in the LBR portion of this study, an effort was made to define the influence of relevent test variables on the triaxial resilient modulus test. For this purpose, the variables of dry density, moisture content, gradation, carbonate content, mineralogy, and curing time were selected for statistical analysis, and analyzed following a methodology similar to that employed in the LBR part of this study. As before, data from Pit Nos. 58-486 and AL-149 were excluded from these analyses.

A bivariate correlation matrix, including mineralogical parameters, was first prepared for both untreated and treated aggregate materials (Tables 36 and 37). Once again, only correlations possessing a Pearson correlation coefficient ≥ 0.6 were considered significant for this study. As noted previously, internal deformation M_R values will be stressed, as they are considered more representative than external measured values.

Examination of Table 36 shows that M_R (int.) values for untreated aggregate samples exhibit a negative correlation to moisture content (-0.792) and a fair to poor positive correlation to dry density (0.585) that falls below the ≥ 0.6 significance threshold used for this study.

Table 36. M_R correlation matrix for untreated aggregate samples

	CARB. CONT.	DRY DEN.	MOIST. CONT.	M_R INT.	M_R INT.	MINUS #4	CALC. CONT.	DOLO. CONT.	QTZ. CONT.	ARAG. CONT.	CURING TIME
CARB. CONT.											
DRY DEN.	-.777** (.000)										
MOIST. CONT.	.743** (.000)	-.921** (.000)									
M_R INT.	-.318 (.063)	.585** (.000)	-.792** (.000)								
M_R EXT.	-.172 (.323)	.253 (.142)	-.484** (.003)	.752** (.000)							
MINUS #4	-.266 (.116)	-.360* (.031)	.329 (.050)	-.392* (.020)	-.052 (.769)						
CALC. CONT.	.978** (.000)	-.779** (.000)	.694** (.000)	-.271 (.115)	-.159 (.362)	-.275 (.104)					
DOLO. CONT.	.066 (.702)	-.163 (.342)	.413* (.012)	-.743** (.000)	-.827** (.000)	.000 (1.000)	.079 (.648)				
QTZ. CONT.	-.982** (.000)	.754** (.000)	-.760** (.000)	.386* (.022)	.296 (.084)	.267 (.116)	-.958** (.000)	-.154 (.369)			
ARAG. CONT.	-.711** (.000)	.630** (.000)	-.396* (.017)	-.001 (.994)	-.126 (.470)	.218 (.202)	-.821** (.000)	.046 (.791)	.624** (.000)		
CURING TIME	.009 (.957)	.030 (.864)	.000 (.998)	-.040 (.821)	-.118 (.500)	-.038 (.828)	.001 (.993)	.026 (.881)	-.018 (.916)	.032 (.855)	

Note: Shaded cells indicate correlations considered to be statistically significant for this study (Pearson correlation coefficient ≥ 0.6).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

( ) sigma (2-tailed), n = 36.

M_R (ext.) values show no significant correlations to the variables in question. Mineralogical relationships are similar to those outlined in the LBR part of the study, and require no further discussion. However, the negative correlation between M_R (int.) and dolomite (-0.743) is unlike LBR observations, but since only one sample contains significant dolomite, this relationship will be ignored.

Scatter plots of dry density and moisture content versus M_R (int.) for the total data set further illustrate the correlations previously discussed (Fig. 27). As noted in the LBR portion of the study, these two variables are negatively cross-correlated. Simple linear regression of these data sets exhibit coefficient of determination (R^2) values of 0.34 and 0.63, respectively. No further statistical analysis of the untreated sample data set was performed as a result of these observations.

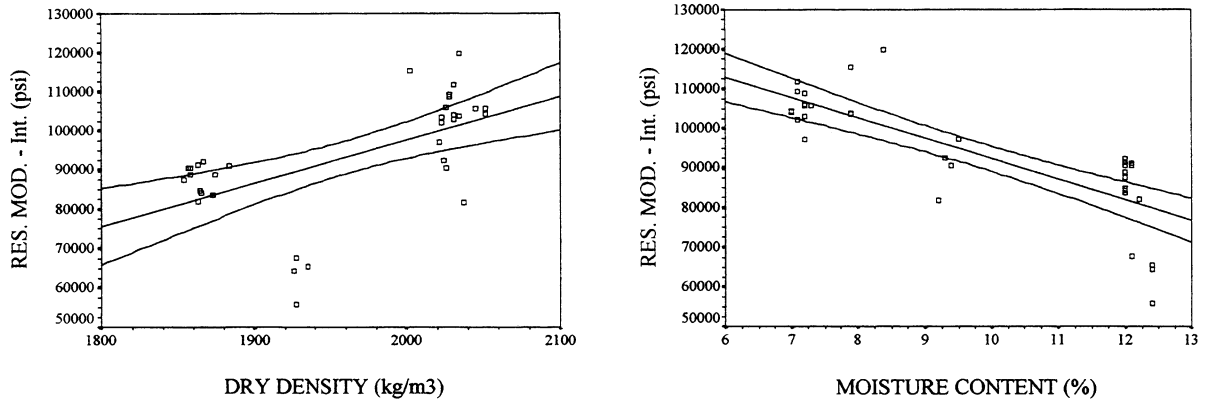


Figure 27. Scatter plots of variables thought to affect triaxial resilient modulus test results of untreated aggregate samples. (*Note*: Lines surrounding linear regression curves define the 95% confidence interval)

Treated Aggregates

As in the first part of the triaxial resilient modulus study, specimens prepared with 1.0 percent lime for the purpose of accelerating and/or enhancing the cementing of high carbonate aggregates were evaluated to assess the effects of the same variables studied for untreated samples. As with the untreated samples, the first step was production of a bivariate correlation matrix (Table 37).

Examination of Table 37 shows that M_R (int.) values for treated aggregate exhibit negative correlations to moisture content (-0.755) and carbonate content (-0.662), and a positive correlation to dry density (0.823). Mineralogically, M_R (int.) values exhibit a positive correlation to quartz content (0.651). M_R (ext.) values also exhibit similar correlations to moisture content (-0.827), carbonate content (-0.747), dry density (0.827), and quartz (0.800), but also possess a negative correlation to calcite content (-0.680). The relationships to dry density and moisture content are similar to correlations observed with LBR data. However, the negative correlations between M_R values and carbonate content are contradictory to what was expected, as high carbonate aggregates were expected to show the greatest strength gain potential. This observation is further supported by the quartz and calcite correlations, and further

Table 37. M_R correlation matrix for treated aggregate samples

	CARB. CONT.	DRY DEN.	MOIST. CONT.	M_R INT.	M_R INT.	MINUS #4	CALC. CONT.	DOLO. CONT.	QTZ. CONT.	ARAG. CONT.	CURING TIME
CARB. CONT.											
DRY DEN.	-.784** (.000)										
MOIST. CONT.	.599** (.000)	-.889** (.000)									
M_R INT.	-.662** (.000)	.823** (.000)	-.755** (.000)								
M_R EXT.	-.747** (.000)	.827** (.000)	-.827** (.000)	.706** (.000)							
MINUS #4	-.266 (.116)	-.334* (.047)	.411* (.013)	-.351* (.036)	-.056 (.744)						
CALC. CONT.	.978** (.000)	-.772** (.000)	.541** (.001)	-.597** (.000)	-.680** (.000)	-.275 (.104)					
DOLO. CONT.	.066 (.702)	-.274 (.107)	.531** (.001)	-.016 (.927)	-.450** (.006)	.000 (1.000)	.079 (.648)				
QTZ. CONT.	-.982** (.000)	.798** (.000)	-.613** (.000)	.651** (.000)	.800** (.000)	.267 (.116)	-.958** (.000)	-.154 (.369)			
ARAG. CONT.	-.711** (.000)	.526** (.001)	-.278 (.101)	.329* (.050)	.278 (.101)	.218 (.202)	-.821** (.000)	.046 (.791)	.624** (.000)		
CURING TIME	.009 (.957)	-.014 (.937)	-.017 (.923)	.262 (.123)	.007 (.969)	-.038 (.828)	.001 (.993)	.026 (.881)	-.018 (.916)	.032 (.855)	

Note: Shaded cells indicate correlations considered to be statistically significant for this study (Pearson correlation coefficient ≥ 0.6).

* Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

( ) sigma (2-tailed), n = 36.

illustrates the greater strength gain seen with this test for low carbonate/high SiO_2/high aragonite samples.

For comparison to untreated sample data, scatter plots were prepared for the variables of dry density, moisture content, and carbonate content versus M_R (int.) (Fig. 28). Simple linear regression of these scatter plots exhibits coefficient of determination (R^2) values of 0.68, 0.57, and 0.44, respectively. More complete linear regression models prepared according to equation 1 are included for the total data set and 1- and 28-day curing times (Table 38). Review of Table 38 shows that dry density consistently exhibits the strongest correlation to M_R (int.) values, followed by moisture content and carbonate content, respectively.

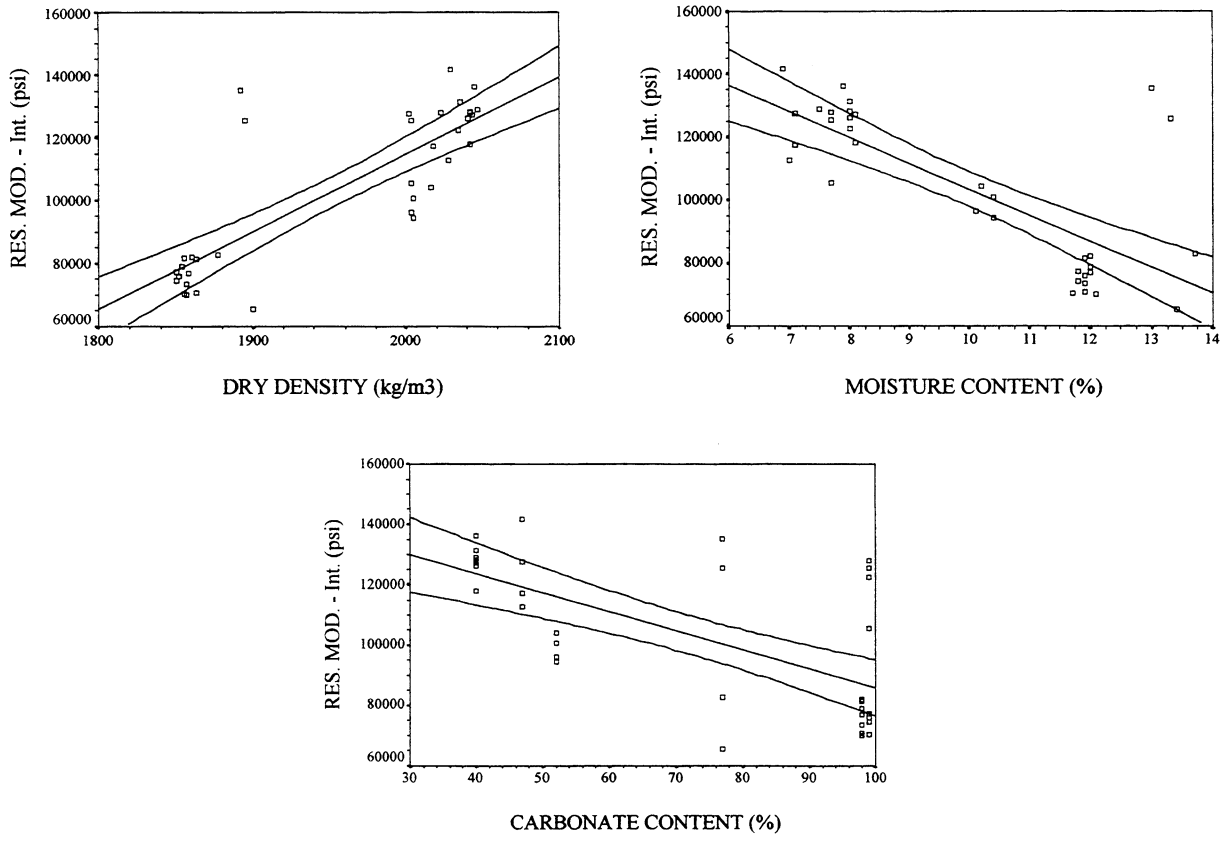


Figure 28. Scatter plots of variables thought to affect triaxial resilient modulus test results of treated aggregate samples. (*Note*: Lines surrounding linear regression curves define the 95% confidence interval)

Table 38. M_R (internal) linear regression models for treated aggregate samples

LINEAR REGRES. MODEL	R^2	STD. ERROR OF EST.	UNSTANDARDIZED COEFFICIENTS			
			CONSTANT	STD. ERROR	INDEPENDENT VARIABLE	STD. ERROR
TOTAL						
Dry Den.	0.68	14301.17	-377789	57110.47	246.24	29.20
Moist. Cont.	0.57	16495.67	186240.0	12655.15	-8282.07	1234.60
Carb. Cont.	0.44	18850.18	148962.3	9397.04	-631.23	122.63
1-DAY						
Dry Den.	0.90	7226.86	-412033	47937.41	259.59	24.48
Moist. Cont.	0.80	10315.13	180471.0	12390.02	-8390.30	1197.68
Carb. Cont.	0.40	17975.46	136713.5	15130.30	-558.70	196.16
28-DAY						
Dry Den.	0.45	18985.26	-295472	129169.70	207.90	66.08
Moist. Cont.	0.31	21275.98	169472.3	25874.02	-5898.39	2529.57
Carb. Cont.	0.26	22104.04	146578.1	18605.41	-491.69	241.21

In an effort to use the variables examined to predict M_R (both internal and external) values for treated samples, multiple regression analyses were performed for the different curing times (1- and 28-days) and for the total data set. The variables of dry density and carbonate content were used according to the following format:

$$M_R = a + b(\gamma_d) + c(CA) \qquad \text{eqn. 4}$$

where: M_R = modulus of resilience, psi
γ_d = dry density, kg/m^3
CA = carbonate content, %

Moisture content was not included in the equation as it is cross-correlated with dry density. A review of Table 39 shows that the predicted values are a fair estimate of the measured M_R for both internal and external values.

Similar to the LBR study, the multiple regression equations derived to produce Table 39, as well as the equations for the total data set were used to prepare M_R prediction lines for both internal (Fig. 29) and external measurements (Fig. 30). As seen previously, the figures show that dry density variation can have a large effect on M_R results, and that overall, (except for M_R (int.) data for a 1-day curing time) treated samples with higher carbonate contents tend to under perform treated materials that had lower carbonate contents, higher quartz, and higher aragonite. This latter observation was somewhat unexpected, although the presence of aragonite may be an important factor in generating the strength gain observed with this data set.

Table 39. Comparison of measured and predicted M_R values (psi) - treated

PIT NO. (%CARB.)	1-DAY[(a)] – INT.		1-DAY[(b)] – EXT.		28-DAY[(c)] – INT.		28-DAY[(d)] – EXT.	
	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.
36-246 (98%)	70054	70011	54068	51559	81566	89411	59156	54653
36-246 (98%)	70667	71738	54480	52089	82035	90340	61077	55043
70-279 (40%)	126040	116974	76496	73729	128071	129307	79709	71946
70-279 (40%)	118048	117406	76311	73861	131268	128069	81669	71425
56-465 (77%)	82796	74635	54401	55786	125637	98468	52333	58647
56-465 (77%)	65359	80786	47572	57674	135313	97849	50378	58387
17-091 (52%)	100723	108016	69822	69375	94416	121415	58072	68521
17-091 (52%)	104191	111037	67845	70302	96356	121105	61136	68390
93-406 (47%)	112645	113823	73984	71826	127581	121110	75796	68436
93-406 (47%)	117293	111234	69477	71031	141646	126372	64662	70650
26-001 (99%)	75807	68764	52893	51043	74311	88420	56995	54227
26-001 (99%)	70306	69627	53794	51308	77194	88420	55560	54227
MX411 (99%)	122584	117995	64357	66156	127787	121869	75805	68299
MX411 (99%)	105371	109794	63760	63638	125426	118155	57132	66737

Regression Equations:

(a) M_R - int. (1-d) = -435379 + 269.76(γ_d) + 47.02(CA)
n = 14, R^2 = 0.91

(b) M_R - ext. (1-d) = -90483.5 + 82.81(γ_d) – 119.24(CA)
n = 14, R^2 = 0.88

(c) M_R - int. (28-d) = -263266 + 193.76(γ_d) – 62.78(CA)
n = 14, R^2 = 0.45

(d) M_R - ext. (28-d) = -92860.8 + 81.39(γ_d) – 35.19(CA)
n = 14, R^2 = 0.47

* Regression equations for total data set are:

M_R - int. = -354780 + 236.00(γ_d) – 41.59(CA)
n = 36, R^2 = 0.68

M_R - ext. = -83486.7 + 79.47(γ_d) – 103.15(CA)
n = 36, R^2 = 0.71

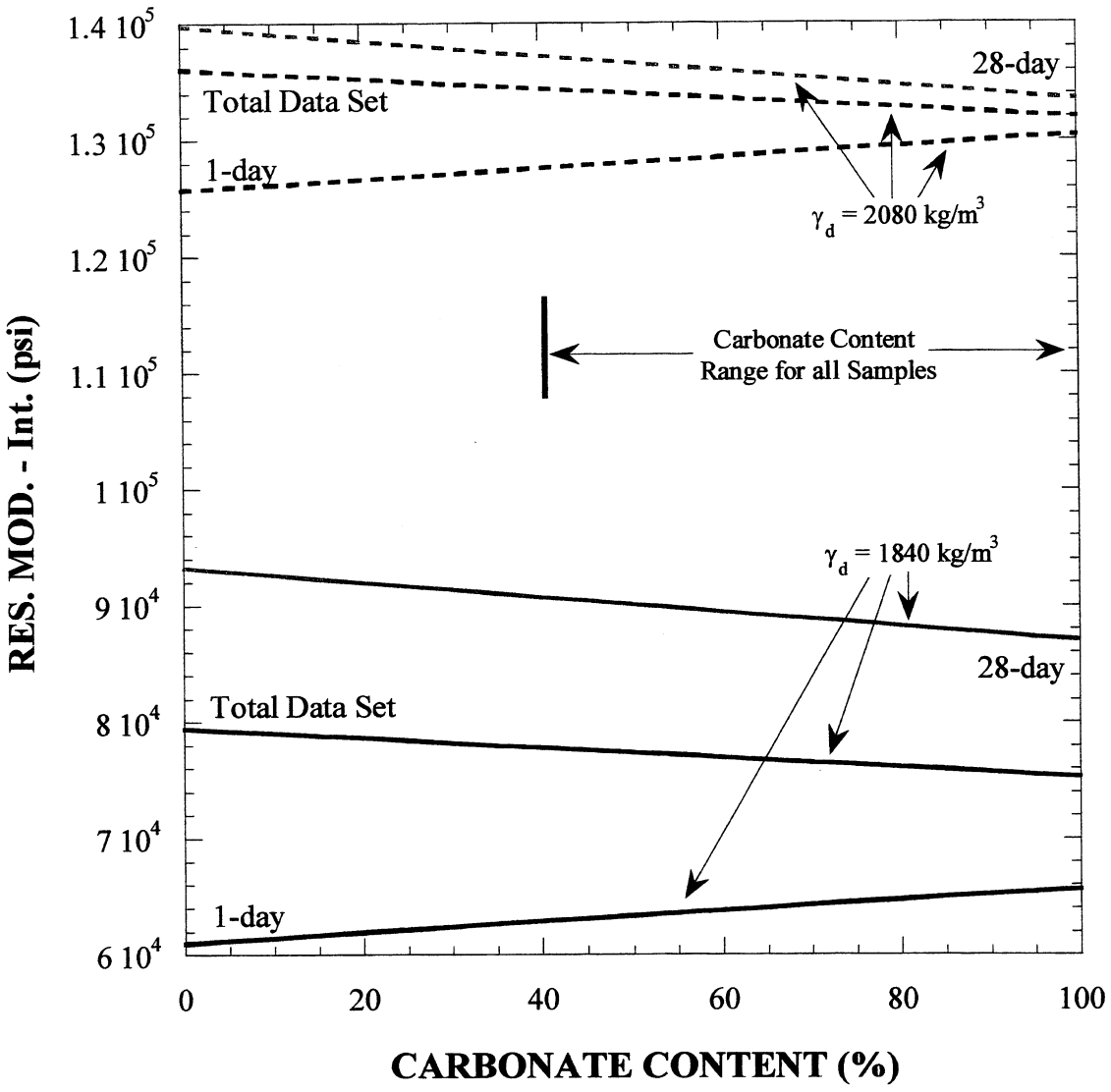


Figure 29. Prediction plot of M_R (int.) value as a function of carbonate content for treated aggregate samples. (*Note*: Prediction lines were generated using the 1- and 28-day regression equations shown in Table 39)

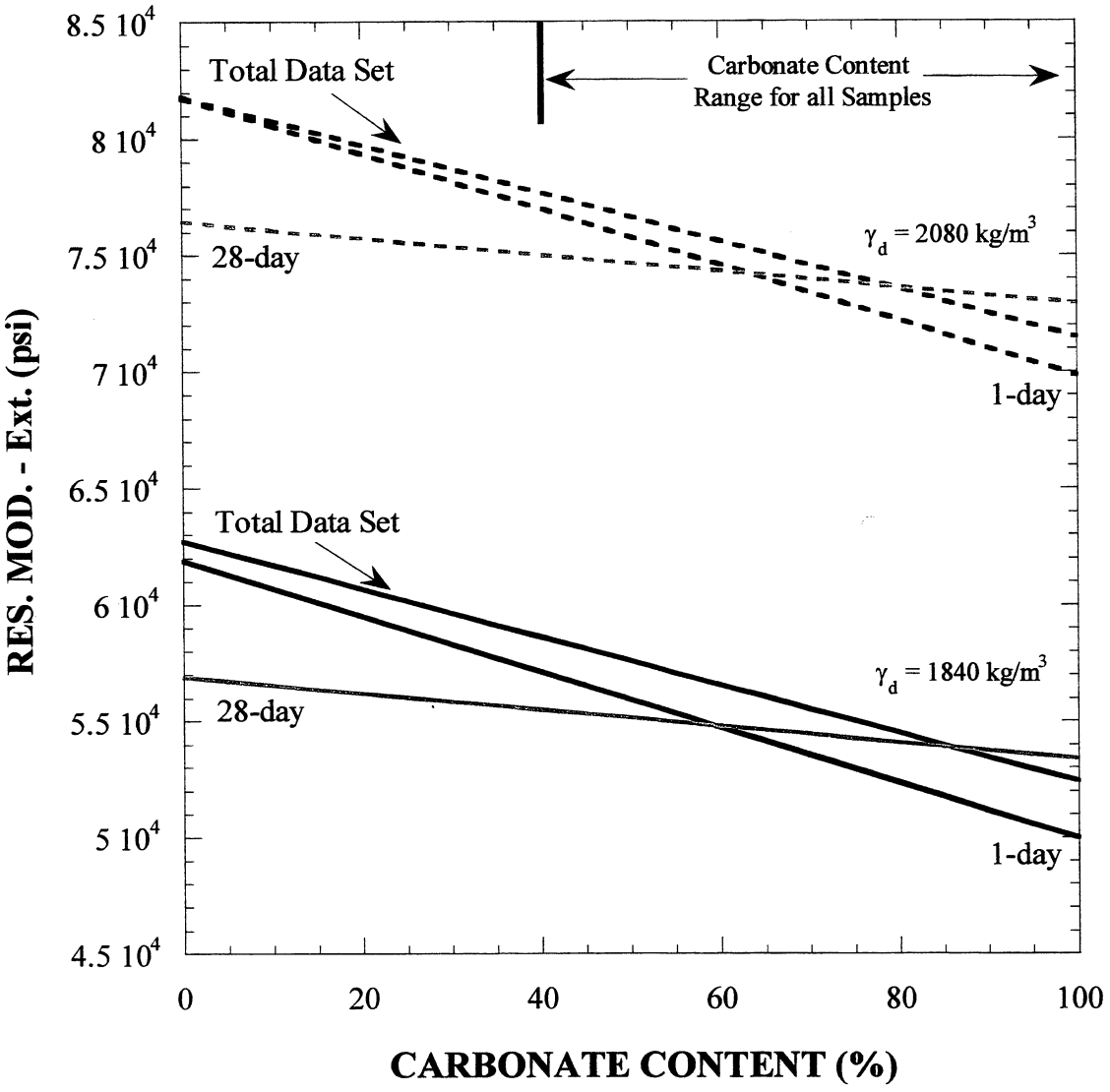


Figure 30. Prediction plot of M_R (ext.) value as a function of carbonate content for treated aggregate samples. (*Note*: Prediction lines were generated using the 1- and 28-day regression equations shown in Table 39)

ANALYSIS OF DATA COMBINED WITH PREVIOUS FDOT RESILIENT MODULUS TRIAXIAL TEST RESULTS

Methods of Data Analysis

Data from an FDOT report by Susan A. Moore was used in combination with the test results for base course aggregates from Pit Nos. 36-296 and 70-279. Initially the M_R values were computed using the k_1 and k_2 values derived from regression analysis at a Θ value of 50 psi (345 kPa). Table 40 gives these results along with moisture content, dry density, and percent passing the # 4 sieve. An effort was made to develop prediction equations using these parameters. Regression analyses were performed according to each of the following models:

$$M_R = a + b(w) + c\,(\gamma_d) \qquad \text{eqn. 5}$$

$$M_R = a + b(w) + c(\gamma_d) + d\,(<\#4) \qquad \text{eqn. 6}$$

where: M_R = modulus of resilience, psi
w = moisture content, percent
γ_d = dry density, pcf
<#4 = percent passing # 4 sieve
a, b, c, and d = constant and coefficients

The results of these analyses are also given in Table 40.

Discussion of Results

The coefficients of determination (R^2) were 0.89 and 0.93 for eqns. 5 and 6, respectively. Predicted M_R values (eqn. 5) were within 9 percent of the measured values except for Pit Nos. 16-231 and 38-036 that differed by about 16 percent. The resulting regression equation predicted a reduction in M_R due to moisture content that conforms with the anticipated behavior of the materials. Normally an increase in dry density would produce an increase in M_R, not a reduction as given in these equations. This is probably a direct effect of testing at optimum moisture content where higher density could produce a greater degree of saturation and lower M_R or shear strength. In retrospect, the testing program should have included specimens at several moisture contents below optimum. Similarly, an increase in the percent passing the #4 sieve increased the M_R, which may or may not be logical. The lack of data for a wide range of percent passing values and the slight improvement in R^2 suggests that this parameter is not significant.

M_R values were also computed for four lower stress states (Θ) that were considered typical by AASHTO for the testing of base course materials. Table 41 lists these Θ values. The values of k_1 and k_2 derived from repetitive triaxial tests and the M_R values computed for the different Θ values are presented in Table 42. Several of the k_1 and k_2 values fell outside those considered typical by AASHTO.

Table 40. Prediction of M_R values @ Θ = 50 psi

PIT NO.	MOISTURE CONTENT (w %)	DRY DENSITY γ_d, pcf	% PASSING #4 SIEVE	M_R (Θ = 50 psi) – psi[e]		
				Meas.[a]	Eqn. 5[b]	Eqn. 6[c]
36-246	12.0	116.7	82	59,950	55,997	61,690
70-279	7.2	126.6	78	75,370	72,301	75,815
12-008[d]	8.3	128.2	—	60,937	50,725	—
16-231[d]	10.5	120.7	63	48,857	56,913	54,093
08-015[d]	13.5	113.5	64	51,211	51,393	50,808
08-050[d]	12.0	117.5	69	53,958	52,308	52,072
26-096[d]	11.0	113.0	44	84,597	85,966	85,612
26-100[d]	12.1	116.2	60	54,366	57,012	55,011
38-036[d]	10.3	119.8	64	69,808	63,645	63,016

(a) Based on k_1 and k_2 from regression analyses of triaxial test data according to $M_R = k_1\Theta^{k2}$

(b) M_R (psi) = 749015 – 12907.2(w) – 4611.23(γ_d)
n = 8, R^2 = 0.89

(c) M_R (psi) = 922233 – 15670.9 (w) – 6022.0(γ_d) + 369.21(<#4)
n = 8, R^2 = 0.93

(d) Data from an FDOT report by Susan A. Moore entitled "A Determination of Resilient Modulus and Permanent Deformation of Bank-Run Shell and Limerock Using Repetitive Triaxial Testing", April 1985.

(e) M_R (psi) × 6.895 = M_R (kPa)

Table 41. Typical values of Θ for base course

ASPHALT CONCRETE THICKNESS IN (mm)	M_R SUBGRADE (psi)		
	3000	7500	15000
	Θ (sum of principal stresses)		
< 2 (50)	20	25	30
2-4 (50 to 100)	10	15	20
4-6 (100 to 150)	5	10	15
> 6 (150)	5	5	5

1.0 psi = 6.895 kPa

Table 42. Resilient moduli for different limestones

PIT NO.	k_1	k_2	M_R (psi)[(c)] @ DIFFERENT Θ			
			5 psi	10 psi	15 psi	20 psi
(a) 36-296	5924.8	0.5916	15,353	23,135	29,407	34,863
(a) 70-279	7310.3	0.5964	19,090	28,863	36,758	43,638
(b) 12-008	21,357.7*	0.268*	32,876	39,587	44,131	47,668
(b) 16-231	9338.2	0.423	18,447	24,732	29,360	33,759
(b) 08-015	9598.5	0.428	19,114	25,716	30,589	34,597
(b) 08-050	15,191.0*	0.324*	25,589	32,032	36,529	40,098
(b) 26-096	26,574.1*	0.296*	42,791	52,536	59,235	64,500
(b) 26-100	9722.6	0.440	19,739	26,778	32,008	36,328
(b) 38-036	32,809.6*	0.193*	44,761	51,168	55,333	58,492

(a) Results from this investigation

(b) Data from an FDOT report by Susan A. Moore entitled "A Determination of Resilient Modulus and Permanent Deformation of Bank-Run Shell and Limerock Using Repetitive Triaxial Testing", April 1985.

(c) M_R (psi) × 6.895 = M_R (kPa)

* Values of k1 and k2 fall outside typical AASHTO values:

k_1 (dry) = 6000 to 10000 and k_2 (dry) = 0.4 to 0.7

k_1 (damp) = 4000 to 6000 and k_2 (damp) = 0.4 to 0.7

k_1 (wet) = 2000 to 4000 and k_2 (wet) = 0.4 to 0.7

Regression analyses were performed using the parameters and measured M_R data given in Table 43. The results were not as good (R^2 = 0.70) as previously developed using a greater Θ value. The M_R data trends illustrated in Fig. 31 suggest that M_R at Θ values between 40 psi (276 kPa) and 100 psi (690 kPa) tend to merge even though the slopes as defined by k_2 are substantially different. At Θ equal to 50 psi (345 kPa), M_R values ranged between 50,000 psi (345 MPa) and 85,000 psi (586 MPa), about a 70 percent increase over the low value. Similarly, at Θ of 20 psi (138 kPa), M_R was between 33,800 and 64,500 psi (233 to 445 MPa), an increase of about 90 percent. Again, the dispersion in test results cannot be assigned to material quality or characteristics because of an insufficient range in moisture contents and dry density for M_R test data.

Tables 44 and 45 list the AASHTO structural coefficients for base (a_2) and subbase (a_3) computed for limestone and bank-run shell materials, respectively, for a Θ of 20 psi (138 kPa). In consideration of the mean a_2 values and the range in these values for both types of materials, a larger coefficient of 0.18 (FDOT for LBR > 100) seems appropriate for both limestone and bank-run shell materials. The critical aspects of M_R evaluation and determination of a_2 and a_3 are related to moisture content, dry density, and probably gradation of the coarse aggregate relative to the amount and type of fine aggregate. Also, it should be recognized that regardless of layer coefficient, its behavior and performance in the pavement may be significantly altered due to moisture content fluctuations relative to clay content, mineralogy, etc.

Table 43. Prediction of M_R values @ Θ = 20 psi

PIT NO.	MOISTURE CONTENT (w %)	DRY DENSITY γ_d, pcf	% PASSING #4 SIEVE	M_R (Θ = 20 psi) – psi		
				Measured	Predicted[a]	± % Diff.
36-296	12.0	116.7	82	34,863	35,884	+ 2.9
70-279	7.2	126.6	78	43,638	47,168	+ 8.1
12-008	8.3	128.2	—	47,688	—	—
16-231	10.5	120.7	63	33,759	39,802	+ 17.9
08-015	13.5	113.5	64	34,597	36,548	+ 5.6
08-050	12.0	117.5	69	40,098	35,700	- 11.0
26-096	11.0	113.0	44	64,500	65,544	+ 1.6
26-100	12.1	116.2	60	36,328	41,051	+ 13.0
38-036	10.3	119.8	64	58,495	44,579	- 23.8

(a) $M_R = 567547 - 9317.7(w) - 3458.1(\gamma_d) - 198.6(<\#4)$
$n = 8$, $R^2 = 0.70$

Table 44. AASHTO base and subbase coefficients for limestone aggregates

PIT NO.	M_R @ Θ = 20 psi	BASE COURSE COEFF., a_2*	SUBBASE COEFF., a_3**
36-296	34,863	0.15	0.19
70-279	43,638	0.18	0.21
12-008	47,688	0.19	0.22
16-231	33,759	0.15	0.19
08-015	34,597	0.15	0.19
08-050	40,098	0.17	0.21
26-096	64,500	0.22	0.25
26-100	36,328	0.16	0.20
38-036	58,495	0.21	0.24
Mean	43,774	0.176	0.211
Range	33,759 to 64,500	0.15 to 0.22	0.19 to 0.25

* $a_2 = 0.249(\log E_2) - 0.977$, (Moore, 1985)
** $a_3 = 0.227(\log E_3) - 0.839$, (Moore, 1985)

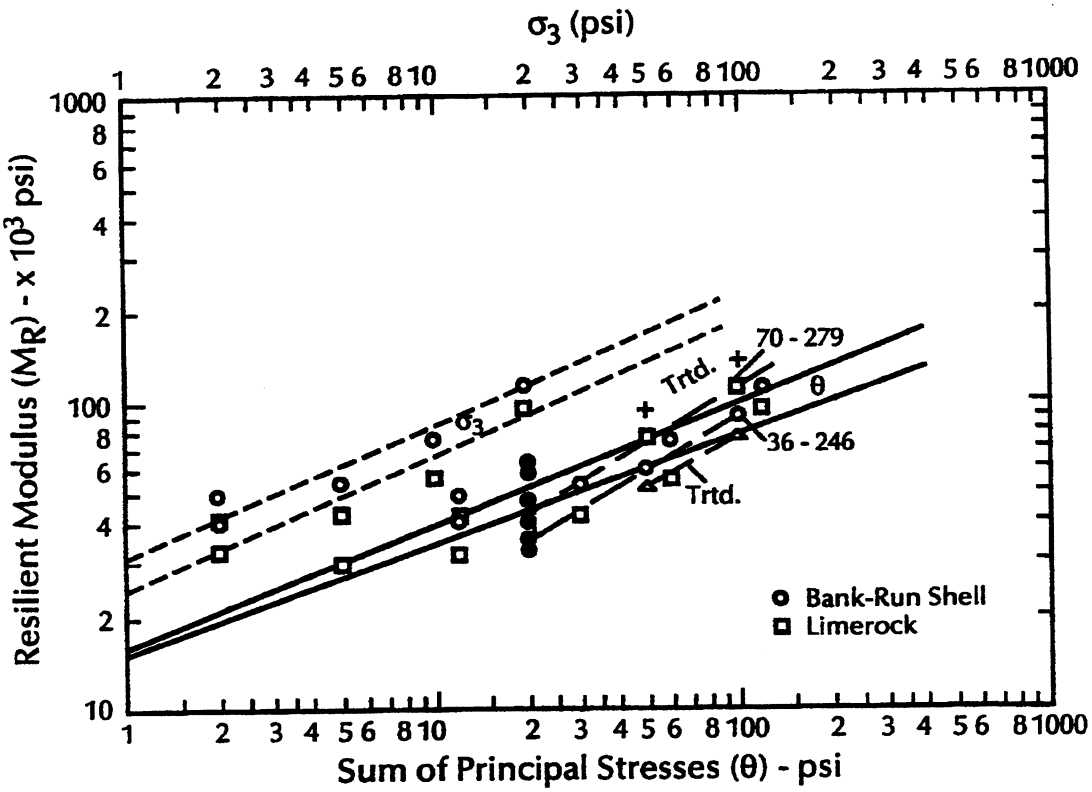


Figure 31. Average M_R versus Θ and σ_3.

Table 45. AASHTO base and subbase coefficients for bank-run shell[(a)]

BANK-RUN SHELL	M_R @ Θ = 20 psi	BASE COURSE COEFFICIENT, a_2*	SUBBASE COEFFICIENT, a_3**
10-285	47,825	0.19	0.22
17-087	50,143	0.19	0.23
17-197	45,962	0.18	0.22
17-091	38,856	0.17	0.20
10-217	41,058	0.17	0.21
10-052	62,270	0.22	0.25
01-274	44,286	0.18	0.22
05-238	66,804	0.22	0.26
01-220	50,385	0.19	0.23
12-249	67,226	0.23	0.26
Mean	47,057	0.194	0.230
Range	38,856 to 67,226	0.17 to 0.23	0.20 to 0.26

(a) M_R Data from a FDOT report by Susan A. Moore entitled "A Determination of Resilient Modulus and Permanent Deformation of Bank-Run Shell and Limerock Using Repetitive Triaxial Testing", April 1985.

* $a_2 = 0.249(\log E_2) - 0.977$, (Moore, 1985)

** $a_3 = 0.227(\log E_3) - 0.839$, (Moore, 1985)

GYRATORY TESTING, DATA ANALYSIS AND COMPARISONS

Gyratory (GTM) compaction and shear tests were performed on aggregates from Pit Nos. 36-246, 70-279, and 56-465. Initially, specimens were compacted to different numbers of GTM revolutions (15 to 25) to produce approximately the same dry density (γ_d) as was previously obtained with modified Proctor compaction. Subsequently, 18 revolutions, considered as typical of asphalt concrete paving compaction, were used to compact the specimens. After compaction, the specimens in the molds were placed in sealed plastic bags with wet paper towels for 14 days of curing. Then the specimens were tested in the GTM for 50 revolutions to obtain the gyratory shear strength and density. The GTM test conditions used were:

Initial angle of gyration:	3-degrees
Initial air-roller pressure:	62 kPa
Ram Pressure:	690 kPa
Compaction revolutions:	18 (except where otherwise noted)
Densification after 14-days:	zero to 50 with data recorded at various increments of revolutions

Upon completion of these tests the samples were extruded, broken down in pans and placed in a 105°C oven for removal of moisture. Moisture contents and dry densities were then calculated using these data and volumetric information from the GTM.

Table 46 Gives the dry densities (γ_d) for the compacted and densified specimens. Samples prepared at different times are designated as DS1 through DS4, which denotes Data Set 1, etc. Since a few grams of material were lost during compaction, the sample height at zero revolutions prior to densification to 50 revolutions was used with extruded sample weights to calculate γ_d. There was little difference between the untreated and treated (1.0% hydrated lime) γ_d values for Pit 36-246 or Pit 70-279. However, untreated γ_d values for Pit 56-465 were approximately 65 kg/m^3 (3 pcf) greater than the treated samples.

Figures 32, 33, and 34 illustrate the G_s trends for aggregates from Pit Nos. 36-246, 70-279 and 56-465, respectively. Also shown on the figures are linear regression equations conforming to the following format:

$$G_s = a + b\ (\text{Rev.})$$

where G_s = Gyration shear, kPa
a = constant
b = coefficient
(Rev.) = Number of revolutions

The trends depicted in the figures conform to the regression equations except for the treated aggregate for Pit No. 56-465 which is shown as a power law trend according to the equation:

$$G_s = a(\text{Rev.})^b$$

Table 46. GTM dry density results

	Sample No.	Moisture Content, %	GTM Compaction – Densification				
			No. Rev.	Density (γ_d)		Density @ 50 Revolutions	
				Kg/m^3	pcf	Kg/m^3	pcf
Pit 36-246 (98% $CaCO_3$)							
Untreated	1 (DS1)	9.90[b]	20	1784	111.3	1933	120.6
"	2 (DS1)	10.48[b]	20	1827	114.0	1922	119.9
"	1 (DS4)	7.51	18	1710	106.7	1819	113.5
"	2 (DS4)	7.49	18	1805	112.6	1879	117.2
"	3 (DS4)	7.70	18	1783	111.3	1848	115.3
Treated	3 (DS1)[a]	11.16[b]	20	1808	112.8	1869	116.6
"	4 (DS1)	10.16[b]	25	1799	112.3	1888	117.8
"	4 (DS4)	7.69	18	1773	110.6	1860	116.1
"	5 (DS4)	7.83	18	1775	110.8	1875	117.0
Pit 70-279 (44% $CaCO_3$)							
Untreated	5 (DS2)	7.05	21	1999	124.7	2084	130.0
"	6 (DS2)	7.07	15	1854	115.7	2020	126.0
Treated	7 (DS2)	7.00	21	1958	122.2	2032	126.8
"	8 (DS2)	6.91	21	1859	116.0	1989	124.1
Pit 56-465 (77% $CaCO_3$)							
Untreated	6 (DS3)	11.07	18	1860	116.0	1987	124.0
"	7 (DS3)	11.05	18	1859	116.0	1974	123.2
Treated	8 (DS3)	11.10	18	1735	108.2	1813	113.2
"	9 (DS3)	11.15	18	1768	110.3	1837	114.7
"	1 (DS5)	10.77	18	1868	116.5	1931	120.5
"	2 (DS5)	11.10	18	1859	116.0	1904	118.8
"	3 (DS5)	10.76	18	1892	118.0	1929	120.4
"	4 (DS5)	11.04	18	1845	115.1	1900	118.6

[a] Error - sample weight 100g low, therefore higher w%
[b] Moisture Content reduced for Data Set 4 (DS4).

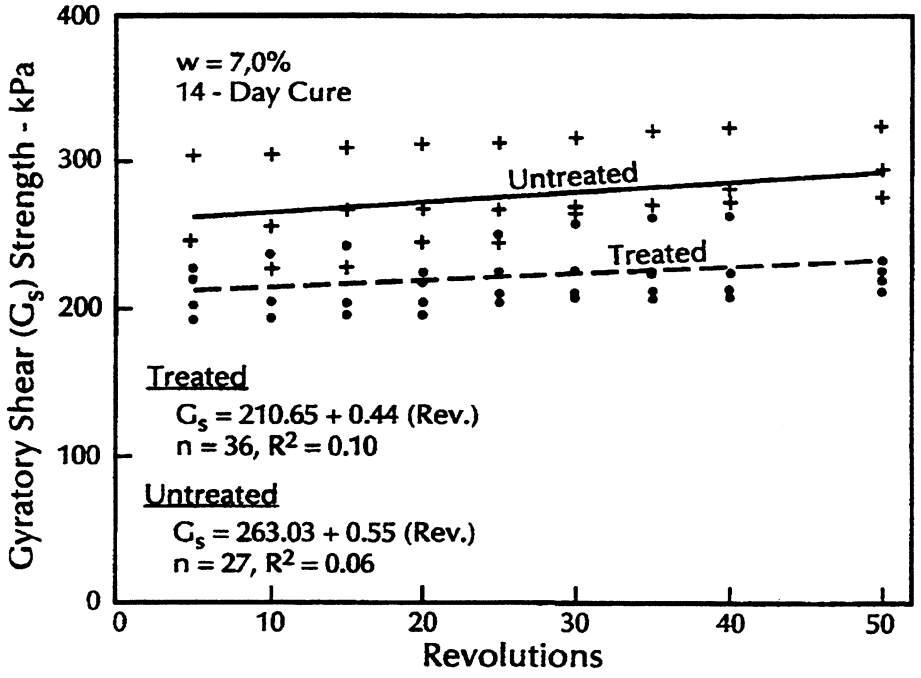


Figure 32. Gyratory shear strength for Pit No. 36-246.

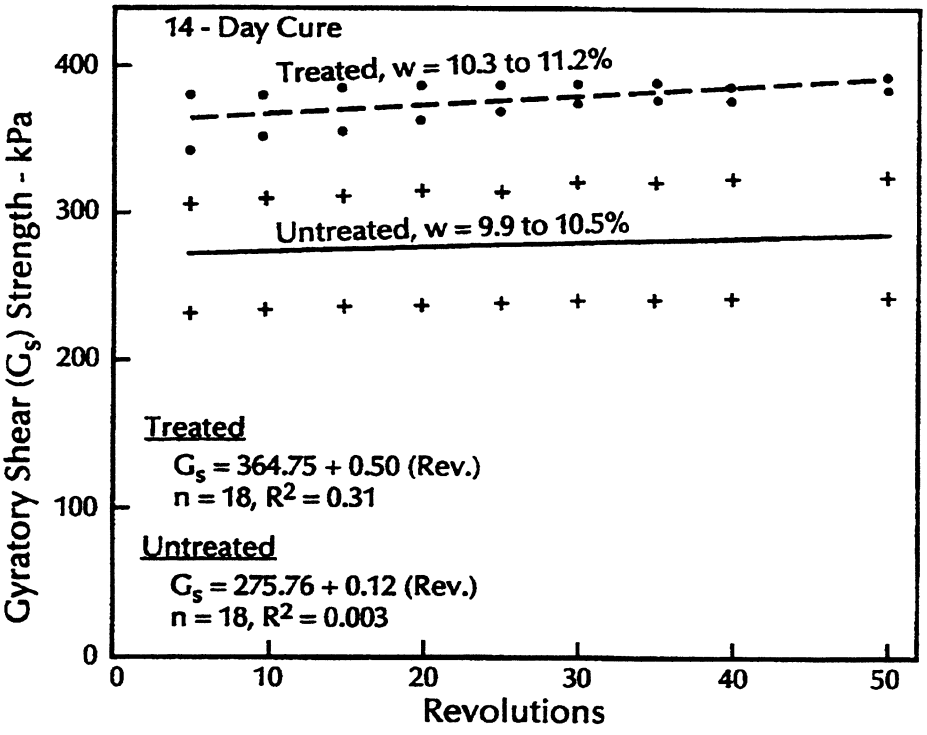


Figure 33. Gyratory shear strength for Pit No. 70-279.

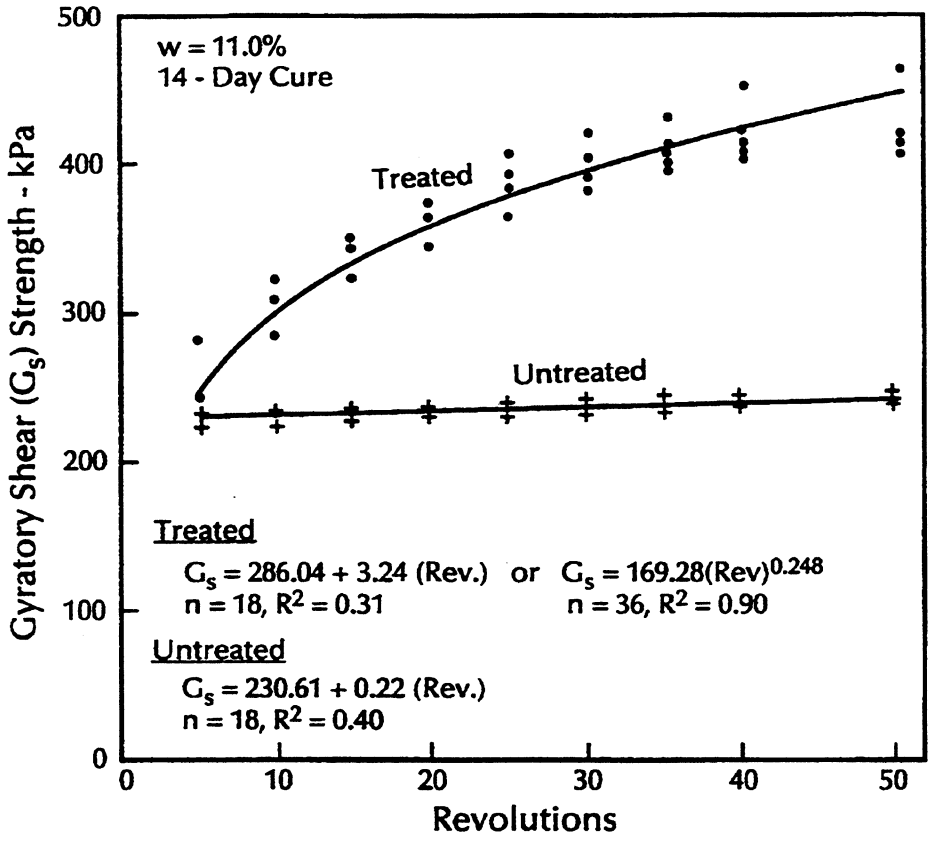


Figure 34. Gyratory shear strength for Pit No. 56-465.

The linear trends are compared in Figure 35. The G_s values for untreated aggregate from the three pits are very similar except that Pit 56-465 has a slightly lower shear resistance. In all cases the shear resistance increased only slightly with densification. Treated aggregate for Pit 36-246 appears similar to the untreated material but the addition of lime reduced its shear resistance. Pit 70-279 aggregate treated with one percent lime almost doubled its G_s values as compared to the untreated material. Only the treated aggregate from Pit 56-465 showed substantial increase in G_s with densification. All other materials were insensitive to densification above that produced using 18 revolutions for compaction.

The effect of density was evaluated for each test specimen by regression analysis according to the following linear model:

$$G_s = a + b(\gamma_d)$$

where: G_s = Gyratory shear, kPa
γ_d = Dry density, kg/m^3

The results given in Table 47 indicate only slight increases in shear resistance except for treated Pit 56-465 material. Table 48 presents a comparison of measured and predicted G_s values at different γ_d values. Untreated materials from all three pits gave densified G_s values at 14 days less than the 18 revolution compacted values. There was very little difference in G_s between

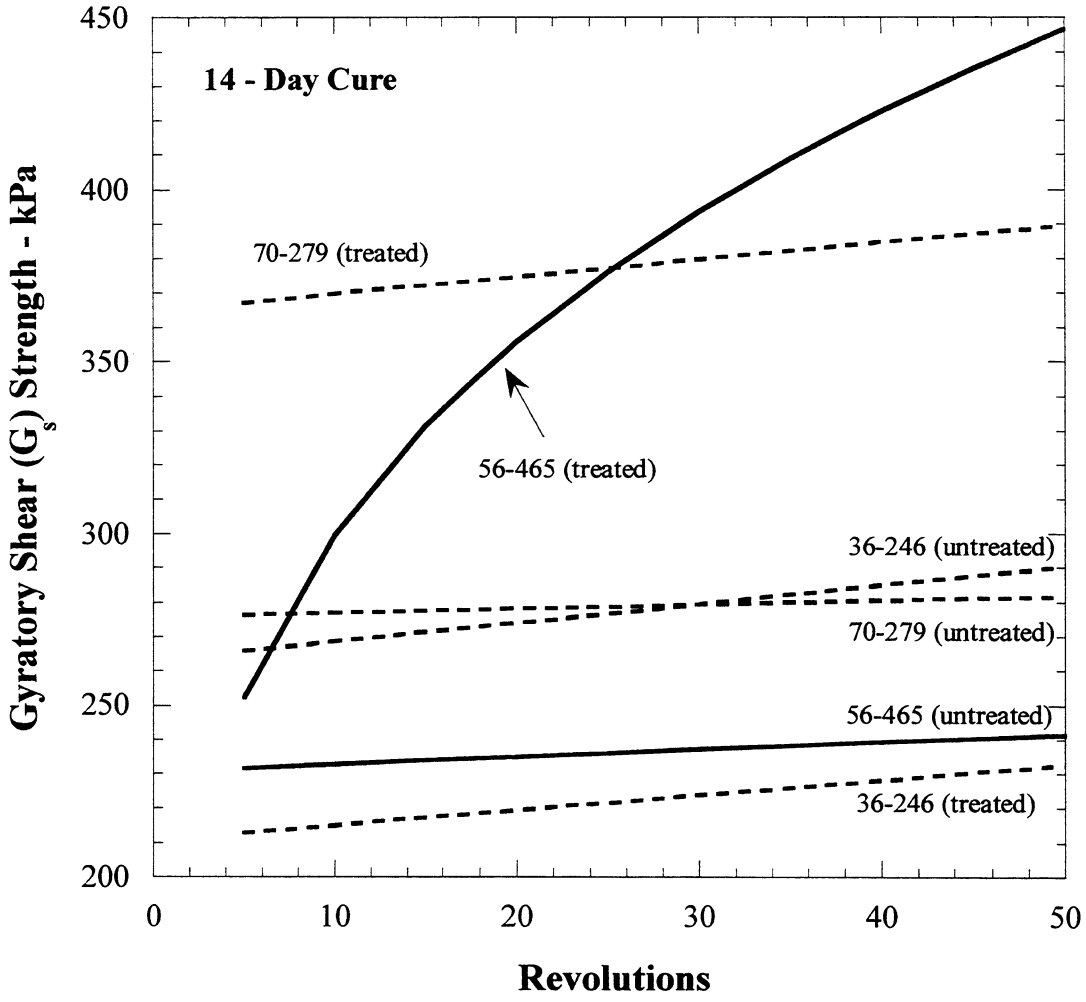


Figure 35. Comparison of gyratory shear trends for aggregates from Pit Nos. 36-246, 70-279, and 56-465.

Table 47. Results of regression analyses

	Sample No.	n	R^2	a*	b*
Pit 36-246					
Untreated	1 (DS1)**	9	0.95	-1387.2	0.9168
"	2 (DS1)	9	0.85	-462.3	0.3839
"	1 (DS4)	9	0.99	-0.05	0.1750
"	2 (DS4)	9	0.98	-2259.7	1.3565
"	3 (DS4)	9	0.88	-647.3	0.4877
Treated	3 (DS1)	9	0.98	-3.9	0.1235
"	4 (DS1)	9	0.96	-845.6	0.5897
"	4 (DS4)	9	0.72	-109.2	0.1737
"	5 (DS4)	9	0.88	-286.8	0.2670
Pit 70-279					
Untreated	5 (DS2)	9	0.91	-356.2	0.3269
"	6 (DS2)	9	0.99	-29.7	0.1357
Treated	7 (DS2)	9	0.96	-1.1247	0.7428
"	8 (DS2)	9	0.79	-4.4	0.1986
Pit 56-465					
Untreated	6 (DS3)	9	0.04	+232.1	0.0000
"	7 (DS3)	9	1.00	-0.62	0.1242
Treated	8 (DS3)	9	0.98	-3246.3	1.9865
"	9 (DS3)	9	0.92	-605.7	0.4436
"	1 (DS5)	9	0.99	-6251.8	3.4745
"	2 (DS5)	9	0.99	-4453.1	2.5575
"	3 (DS5)	9	0.98	-7852.3	4.2921
"	4 (DS5)	9	1.00	-5142.3	2926.1

*Regression Equation: $G_s = a + b(\gamma_d)$
where: G_s = Gyratory shear, kPa
γ_d = Dry density, kg/m^3
**Data Set 1, etc.

Table 48. Summary of gyratory shear results

Pit No.	Sample No.	Gyratory Shear (G_s) – kPa						
		Compacted	Densified		Predicted @ γ_d =			
		18 Rev.	5 Rev.	50 Rev.	1800	1850	1900	1950
36-246/Un	1 (DS1)	402	322	393	263	309	—	—
	2 (DS1)	289	249	272	228	248	—	—
	1 (DS4)	441	305	318	315	324	—	—
	2 (DS4)	279	196	290	182	250	—	—
	3 (DS4)	293	221	257	231	255	—	—
Mean		341	(259)	306	(244)	277	—	—
36-246/Tr	3 (DS1)*	286	221	227	218	225	—	—
	4 (DS1)	362	228	265	216	245	—	—
	4 (DS4)	311	202	220	204	212	—	—
	5 (DS4)	348	194	213	194	207	—	—
Mean		327	(211)	231	(217)	237	—	—
70-279/Un	5 (DS2)	365	309	325	232	249	—	281
	6 (DS2)	338	233	244	215	221	—	235
Mean		352	(271)	285	224	235	—	(258)
70-279/Tr	7 (DS2)	376	347	382	212	249	—	324
	8 (DS2)	348	382	391	353	363	—	383
Mean		362	(365)	387	283	306	—	(354)
56-465/Un	6 (DS3)	303	226	237	232	232	—	232
	7 (DS3)	356	234	245	223	229	—	242
Mean		330	(230)	241	(228)	231	—	237
56-465/Tr	8 (DS3)	388	216	346	329	429	528	627
	9 (DS3)	398	182	208	193	215	237	259
Mean		393	(199)	277	(261)	322	382	443
	1 (DS5)	417	218	462	—	176	345	523
	2 (DS5)	434	283	407	—	278	406	534
	3 (DS5)	355	230	412	—	88	303	517
	4 (DS5)	393	244	416	—	271	417	564
Mean		400	(244)	424	—	(203)	368	535

( ) represent values at 5 revolutions and at constant density within the range γ_d test results.

*Error - sample weight 100g low

treated and untreated materials for the compacted condition, however, as illustrated in Fig. 35, both Pit 70-279 and 56-465 exhibited substantially higher G_s for the treated aggregate than untreated material. The test results for the high carbonate (98%) limestone aggregate from Pit 36-246 did not produce any noticeable differences in shear resistance between treated and untreated materials.

Relationships between G_S and Φ

A comparative analysis of G_s and Φ is presented in Table 49. Individual and mean γ_d values from triaxial shear tests were used to predict G_s values. Then regression analyses were performed to determine if relationships between G_s and angle of internal friction (Φ) from the triaxial shear tests could be established to verify the shear strength trends. Table 50 presents results from regression analyses for Pits 36-246 and 70-279. The coefficient of determination (R^2) was poor ($R^2 < 0.55$) except for Pit 70-279 where average G_s and Φ values were used in the analysis. In this case the effect of lime treatment appeared to be substantial and verified by both GTM and triaxial shear tests.

In summary, the test results generally indicated very little difference between the untreated and treated shear resistance (G_s) of the different aggregates. Only the aggregate from Pit 70-279 uniformly gave a substantial increase in G_s for the lime treated material.

Relationships between G_S and M_R

A relationship was developed between Gs and MR using values corresponding to similar moisture content and density for test samples. Table 51 indicates that the GTM sample densities were almost the same as produced by Modified Proctor for MR triaxial tests. Also, moisture contents were the same except for untreated Pit 36-296 aggregates. The Gs and MR values given in Table 51 were subjected to regression analyses and plotted as shown in Fig. 36. Regression analysis of data for treated materials for Pits 36-296 and 70-279 provided the following results,

$$M_R = -121.33 + 1.3366(G_s)$$
$$n = 8, \quad R^2 = 0.92$$

where M_R = Resilient Modulus, MPa
G_s = Gyratory Shear, kPa

The number of values used in the analysis was increased from four as given in Table 51 to eight by using each of the two G_s values with each M_R value in an effort to give representative results. The regression line depicted in Figure 36 also intersects the data for untreated samples. The dispersion of this data and the lack of range in G_s and M_R prevented the development of any meaningful relationship.

Table 49. Comparative analyses of G_s and Φ

PIT NO.	CURING TIME (days)	w%	γ_d		Φ	GTM @ γ_d[(a)]				PREDICTED G_s using regression eqns. & γ_d[(b)]
			pcf	kg/m^3		REV.	G_s, kPa	REV.	G_s, kPa	
36-246										
Untreated	1	10.0	118.03	1891.5	48.0	15	344	20	268	
	7	10.4	118.2	1894.2	46.2	15	344	20	268	
	30	10.4	119.3	1911.9	46.9	35	372	40	271	
Mean		10.3	118.5	1899.2	47.0		353		269	354/267
Treated	1	10.0	116.7	1870.2	49.0	50	227	30	260	
	7	10.2	115.9	1857.4	51.1	35	225	20	245	
	30	10.1	116.1	1860.6	53.3	40	226	25	252	
Mean		10.1	116.2	1862.7	51.1		226		252	226/253
70-279										
Untreated	1	7.1	126.3	2024.0	42.5	5	309	40	244	
	7	7.1	127.1	2036.9	45.0	10	311	50	244	
	30	7.2	127.3	2040.1	39.4	10	311	50	244	
Mean		7.1	126.9	2033.7	42.0		310		244	309/246
Treated	1	7.0	128.2	2054.5	47.7	50	382	50	391	
	7	7.1	127.2	2043.3	49.5	50	382	50	391	
	30	7.2	127.2	2038.5	48.8	50	382	50	391	
Mean		7.1	127.6	2045.4	48.7		382		391	395/402

(a) G_s values (14-day) at γ_d corresponding to triaxial shear test specimens. Values may be slightly low where G_s at 50 revolutions is given since γ_d may occur at > 50 revolutions.

(b) Prediction eqn. format: $G_s = a + b(\gamma_d)$

Table 50. Relationships between G_s and Φ

Pit No.	Φ (avg.)	Gs @ γ_d (avg.)	n	R^2	$N = a + bG_s$	
					a	b
#36-246 (98% $CaCO_3$)	47.0	345/267	4	0.55	57.76	-0.032
	51.1	266/253				
	( )	( )	12	0.41	58.04	-0.0326
#70-279 (44% $CaCO_3$)	42.0	309/246	4	0.90	27.57	+0.052
	48.7	395/402				
	( )	( )	12	0.33	26.76	+0.054

( ) Φ and G_s values correspond to γ_d

Table 51. G_s and M_R data at 14-days

Pit No.	Condition	w%[(a)]	Gyratory @ 14-Day		M_R Triaxial Data @ 14-Day	
			kg/m^3 @ 50 Rev.	G_s, kPa	γ_d, kg/m^3	M_R, MPa[(b)]
36-246	Untreated	7.5/12.0	1879	290	1864	223.2
		7.7/12.0	1848	257	1863	276.6
	Treated	11.2/11.9	1869	227	1863	213.5
		10.2/11.9	1888	265	1856	194.2
70-279	Untreated	7.0/7.1	2084	325	2028	306.8
		7.1/7.1	2020	244	2021	321.7
	Treated	7.0/7.9	2032	382	2045	426.8
		6.9/8.1	1989	391	2044	371.0

(a) Moisture Content - Gyratory/Proctor for M_R

(b) M_R computed using k_1 and k_2 for 14-day test specimens and Θ = 137.9 kPa (20 psi)

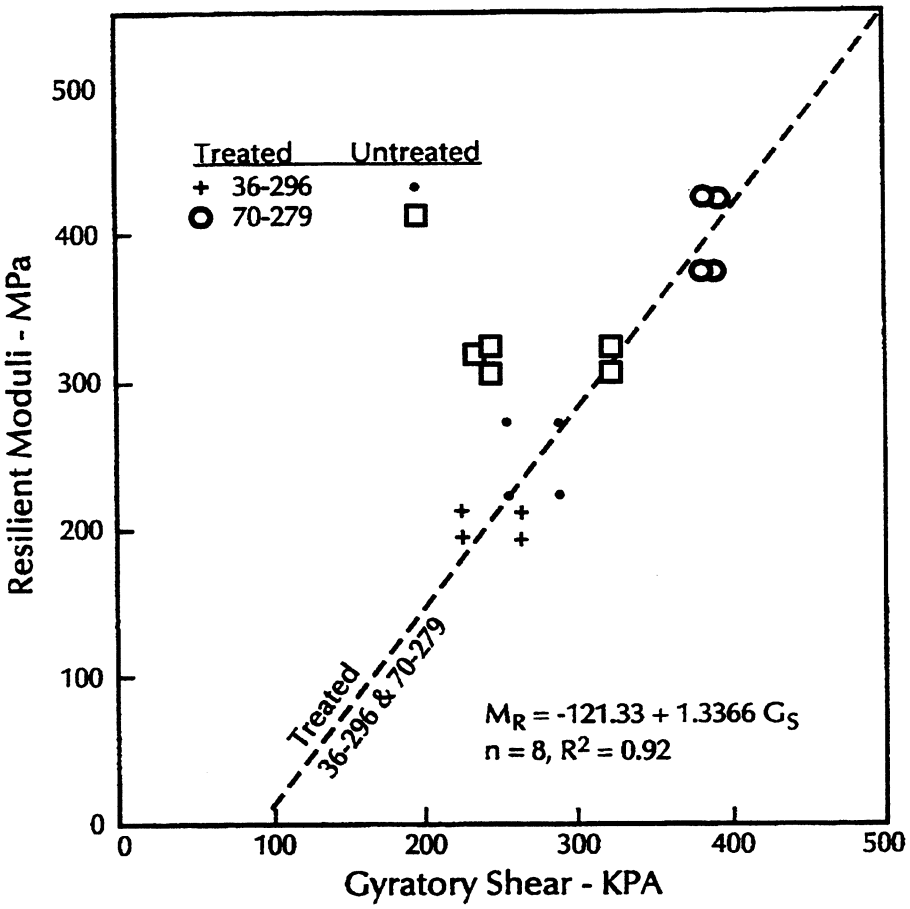


Figure 36. Correlation of G_s and M_R at $\Theta = 138$ kPa.

The correlation should not be used without verification or modification by additional data from other pits. However, it does appear that the GTM offers a fairly fast and perhaps reliable assessment of M_R. The following equation incorporates the M_R prediction equation into the AASHTO Base Coefficient equation for a_2:

$$a_2 = 0.249 \text{ Log } ((-121.33 + 1.3366G_s)/6895 \text{ E-6}) - 0.977$$

The predicted a_2 values for G_s of 200, 300, and 400 kPa are 0.10, 0.17, and 0.21, respectively. Mean values of G_s for 14-day tests were used to predict the M_R values for Pits. 36-296 and 70-279. These results are given in Table 52.

Table 52. a_2 predictions from G_s

Pit No.	Condition	Predicted M_R, MPa
36-296	Untreated	0.16
	Treated	0.14
70-279	Untreated	0.16
	Treated	0.21

TESTING AND EVALUATION OF RAPID PROCEDURES TO DETERMINE RECEMENTATION POTENTIAL

The cementation potential of carbonate base course materials is of major importance to highway construction. Although both limestones and dolomites used for base course material in Florida possess relatively low physical strength properties, their potential for cementation after initial compaction is great, favoring notable strength increases with time. The beneficial effects of permanent strength gain, associated with carbonate bases has been recognized for years (Graves, 1987; Gartland, 1979), yet development of a rapid means of predicting such gains has not been developed.

Previous research aimed at evaluating the cementation potential of Florida carbonate base course materials has primarily focused on chemical and mineralogical characterization (Graves, 1987; Gartland, 1979), rather than engineering properties (Zimpfer, 1989). Several factors that influence these engineering properties include grain size distribution, shape, and mineral composition (Graves, 1987). All play some role in the cementation of base course carbonates, yet understanding the interaction between these factors and the environmental conditions which drive the dissolution and recrystallization reactions responsible for strength gains remains unclear. For this portion of the study, our focus is on the evaluation and development of a practical method, particularly one with measurable parameters, that accelerates the cementation of limestone base course materials in order to predict increases in field based strength performance.

Materials, Test Specimen Preparation and UCT Testing

Analysis using an unconfined compression test (UCT) based on a modified Proctor approach was selected as a rapid means of measuring the unconfined shear strength of base course materials. Samples were subjected to a variety of additives and pretreatments (hydrated lime, CO_2 saturation, elevated humidity, etc.) at various pressures and temperatures with the ultimate goal of evaluating the effect of these additives and pretreatments on the cementation potential of base course materials. The eleven (Series A-K) procedures followed were:

Series A:	H_2O saturated atmosphere at 100°C for 72 hours
Series B:	CO_2 (15 lbs.) saturated atmosphere at 100°C for 72 hours
Series C:	CO_2 (15 lbs.) and H_2O saturated atmosphere at 100°C for 72 hours
Series D:	CO_2 (15 lbs.) and H_2O saturated atmosphere at room temp. for 72 hours
Series E:	CO_2 (15 lbs.) and H_2O saturated atmosphere (24 hour cycle) at room temp. for 96 hours
Series F:	CO_2 (110 lbs.) and H_2O saturated atmosphere at room temp. for 96 hours
Series G:	CO_2 (110 lbs.) and H_2O saturated atmosphere (24 hour cycle) at room temp. for 96 hours
Series H:	CO_2 (100 lbs.) and H_2O saturated atmosphere at room temp. for 48 hours, followed by 96 hours at 100°C with no CO_2
Series I:	CO_2 (100 lbs.) and H_2O saturated atmosphere at room temp. for 48 hours, followed by 7 days at 60°C

Series J: CO_2 (100 lbs.) and H_2O saturated atmosphere at room temp. for 48 hours, followed by 96 hours at 60°C to 10°C (24 hour cycle)

Series K: CO_2 (100 lbs.) and H_2O saturated atmosphere at room temp. for 72 hours, followed by 7 days in a dessicator under natural barometric pressure

Materials selected for analysis included two high carbonate (Pit 36-246 and Pit 56-465) and two low carbonate (Pit 70-279 and Pit 93-406) samples. Samples from each pit were first split into 150 g subsamples and placed in plastic bags. To each sample, D.I. water was added to achieve optimum moisture as determined by LBR testing, and the samples agitated to insure an even moisture content. Both untreated and treated samples (containing 1% hydrated lime - $Ca(OH)_2$) from each quarry were prepared in this manner.

Core samples for unconfined strength tests were prepared in a 1.25" by 2.75" mold using a modified Proctor approach to sample preparation. Approximately 50 ml of sample was placed in the mold and compacted using a hammer with a 1 ft throw. Three layers were compacted in this manner, employing 5 drops of the hammer for each layer, producing a 6 ft lb/in^2 compactive effort per layer. After each core was completed, it was wrapped in a moist paper towel until placed into an autoclave

The autoclave was prepared with a custom built rack allowing 12 samples to be analyzed simultaneously in 3 levels containing 4 samples each. Prior to the day samples were placed in the autoclave, the temperature was preset and a CO_2 cylinder attached which would allow for pressurization of the autoclave to levels desired for each experiment.

Test Results and Analyses

Two cores each of both untreated and treated base course material (4 total) from each of the pit locations were analyzed according to each of the eleven experimental conditions outlined. Table 53 summarizes the results for this part of the study, with the complete data for each experiment included in Appendix F. The percent carbonate and optimum moisture content of each sample is that given in Table 2. Percent fines (passing 200 mesh) for each material were 37.0% (Pit 36-246), 13.0% (Pit 70-279), 29.4% (Pit 56-465), and 15.7% (Pit 93-406).

In almost all of the experiments the untreated samples showed greater strength (gain?). This may be due to the hydrated lime acting as a fine lubricant, reducing the internal friction of the base course mixes, as well as reducing the dry density, over the short time span confined by these experiments. No correlation is observed between these experiments and the LBR data for these materials, nor does there appear to be any correlation to carbonate content, % fines, or any of the other engineering parameters measured in this study. Although it was believed that a controlled environment of some combination of variable humidity and variable CO_2 pressure would result in the conditions necessary to accelerate cementation, the experiments failed to produce the desired results. Apparently, we have been unable to mimic the proper natural field conditions over a short time span that will facilitate acceleration of the cementation process observed in the field.

Table 53. Unconfined compression test results

	36-246 Untreated	36-246 Treated	56-465 Untreated	56-465 Treated	70-279 Untreated	70-279 Treated	93-406 Untreated	93-406 Treated
Series A	73.24	72.84	192.11	112.10	29.48	53.99	82.66	59.32
Series B	108.86	46.21	128.84	66.64	60.17	51.95	106.78	89.25
Series C	44.50	64.62	142.78	136.61	41.72	36.39	99.39	97.35
Series D	71.04	63.02	160.31	107.18	47.06	35.18	67.09	49.91
Series E	174.30	53.18	110.46	51.14	40.91	18.01	56.47	50.74
Series F	85.51	47.05	101.47	38.06	28.24	24.95	48.66	50.33
Series G	53.99	29.88	95.74	39.67	36.31	33.13	53.59	30.69
Series H	45.44	45.00	86.32	49.50	29.48	27.40	73.64	46.65
Series I	70.38	40.48	98.18	32.33	59.72	47.89	84.67	51.54
Series J	37.53	38.43	119.85	71.19	37.66	35.61	107.20	60.56
Series K	65.05	42.52	94.09	58.11	65.99	46.65	53.41	33.57

* Values of average failure stress are in psi.

CONCLUSIONS AND RECOMMENDATIONS

Evaluation of the results from the testing of base course aggregates provided the following specific conclusions for each of the tests conducted in the research.

Limerock Bearing Ratio (LBR)

1. Density, moisture content, carbonate content, and perhaps gradation were found to have variable statistical significance on LBR values throughout the LBR study. Dry density appears to be the most significant variable if test samples vary in dry density within the constraints of the sample protocol that is employed.

2. Regression analyses indicted that high carbonate content aggregates are not necessarily beneficial (part 1), and regression equations developed to give an estimate of the effect of the different variables on LBR should not be used as predictors. The variability in equation constants at different ages combined with the relatively low R^2 values preclude their use except as supplemental information to actual test data. The collection of additional data for analysis in the future may yield a more reliable prediction equation for LBR that may be dependent on lithology. Observations suggest that aragonite content may be of importance in the final assessment of the role of carbonate content to strength gain potential.

3. The effect of lime on accelerating cementation and increasing LBR was only slightly apparent with most materials when considering high variability in test data. However, lime treated aggregates from Pit. No. 56-465 produce a 400 percent or more increase in LBR over that for the untreated aggregate that was attributed to the influence of lime on possible clays contained in the aggregate.

Triaxial Shear

1. The angle of internal friction (Φ) was on the average 4 to 6 degrees greater for lime treated aggregates than the untreated aggregates from Pits 36-246 and 70-279.

2. Increases in Φ with time (1, 7, and 30-days) were very small and probably not significant.

3. Tangent moduli derived from the tests were in the range of 69 to 110 MPa (10 to 16 ksi) which is exceedingly lower than typical results from plate bearing tests or FWD back calculated moduli, although comparison at different strain conditions is problematic.

Triaxial Resilient Modulus (M_R)

1. Low carbonate (44%) aggregate from Pit 70-279 treated with lime provided about a 20 to 30 percent increase in M_R values over that of the untreated aggregates, but Pit No. 36-246 (98% carbonate) gave about a 20 percent reduction in M_R when treated with lime.

2. Aging of specimens up to 28-days had no observable effect on M_R. The effect of lime appeared to be almost immediate within less that 1-day.

3. M_R data from the total data set suggests that lime treatment produces the greatest strength gain in materials possessing low carbonate contents. However, this observation is complicated by the presence of aragonite in the low carbonate samples, and its likely importance as a cementing phase responsible for observed strength gain.

4. Regression analyses show M_R data to correlate with the variables of dry density, moisture content, and carbonate content in the treated samples. This permitted development of prediction curves for treated sample M_R values, which are a fair estimate of measured M_R data.

Gyratory Shear (G_S) Testing

1. The G_s results from the Gyratory Testing Machine verified the relative effect of lime treatment on the two aggregates (i.e. treated gave lower G_s for Pit No. 36-246 and higher for Pit No. 70-279).

2. Densification had little effect on G_s except for treated aggregate from Pit No. 56-465. In this case the G_s increased substantially with density.

Development of M_R and a_2 Predictions

AASHTO base coefficients, a_2, that were computed at a Θ = 138 kPa (20 psi) for nine limestone aggregates and ten bank-run shell materials suggests there is very little difference between the materials. The a_2 values ranged between 0.15 and 0.23. A mean value of 0.18 was selected as being a typical or acceptable value.

A relationship was developed to predict M_R from G_s values. This was substituted in the AASHTO equation for calculation of a_2. G_s predictions of a_2 for 36-246 and 70-279 were 0.14 and 0.21 for the lime treated aggregate, respectively and 0.16 for both of the untreated materials.

Unconfined Compression Test (UCT)

The only noticeable observation from these experiments was the greater strength associated with the untreated samples over that observed for samples treated with 1% hydrated lime. No other correlations were observed between these experiments and either measured physical parameters (carbonate content, % fines, etc.) or engineering parameters determined as a part of this study. These experiments failed to produce the desired results of producing a rapid

means of determining the cementation potential of base course materials. Apparently, we were unable to produce the conditions, over a short time span, necessary to accelerate the cementation process observed in the field.

Summary of Conclusions

The differences in aggregate gradation, particle shape and texture, clay and silt content, moisture content, and compacted or in-place density precludes the use of generalized characterization for determination of structural coefficients or behavior. The triaxial resilient modulus is a time consuming but reliable test method. The GTM has the advantage of providing G_s data throughout a range in density thus making it a quick and efficient method for testing aggregates at different moisture contents.

It is recommended that the FDOT consider an investigation to verify or modify the M_R and a_2 prediction equations based upon G_s test values. This will require a comprehensive test program involving aggregates from different pits, modification of aggregate blends and gradations, different moisture contents, and different density levels to ascertain the effect of variables and to develop a reliable relationship using G_s or perhaps other aggregate characterization variables.

In the interim, it is suggested that aggregates having long term strength gain potential be considered on the basis of as placed, short-term properties. Test results imply that carbonate content is not necessarily the parameter that relates to the strength gain in structural properties or bearing capacity of limestone base course aggregates. If it is assumed that M_R calculation of a_2 is reliable, then to what degree will testing variability and differences in density/moisture content affect this value and behavior of the pavement? Consequently until further research is performed, it is suggested that an a_2 value of 0.18 for $\Theta = 138$ kPa be used for these materials conforming to FDOT specifications.

LBR testing also may offer a good method of eventually evaluating the importance of carbonate content to base course strength gain phenomena. However, test variables observed in this study may require that individual lithologies be independently evaluated, as carbonate content has a variable meaning in different materials around the state. It also is of importance to evaluate the role of aragonite content and gradation within the context of cementation and/or base course strength gain.

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APPENDICES

APPENDIX A: MODIFIED PROCTOR MOISTURE-DENSITY DATA FOR UNTREATED AND TREATED BASE COURSE AGGREGATES (PART 1)

Table A-1. Modified proctor moisture/density data for untreated base course aggregates (part 1)

Pit No. (% Carbonates)	3-day		7-day		14-day		28-day		60-day	
	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d
36-246 (98%)	10.5	1867.6	10.3	1837.1	10.5	1837.1	11.1	1853.2	10.7	1832.3
56-465 (77%)	10.3	1853.2	12.1	1917.2	10.1	1835.5	10.2	1837.1	9.9	1851.6
12-008 (70%)	6.8	2114.2	7.4	2088.6	7.2	2095.0	6.8	2101.4	7.2	2088.6
87-090 (70%)	5.9	2056.5	6.2	2079.0	6.2	2064.5	6.3	2067.8	5.9	2058.2
17-091 (52%)	8.6	2077.4	8.6	2058.2	8.4	2088.6	8.4	2069.4	8.4	2106.2
93-406 (47%)	7.3	2000.5	7.6	2010.1	7.5	2003.7	7.8	2021.3	8.0	2019.7
93-406 (40%)	7.2	2047.0	7.2	2056.6	7.4	2053.4	7.7	2059.8	7.7	2064.6
70-279 (40%)	7.2	2063.0	7.4	2040.6	7.3	2037.4	7.3	2048.6	7.2	2043.8

(a) Percent moisture by weight of dry aggregate
(b) Specimen dry density - kg/m^3

Table A-2. Modified proctor moisture/density data for lime treated base course aggregates (part 1)

Pit No. (% Carbonates)	3-day		7-day		14-day		28-day		60-day	
	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d
36-246 (98%)	11.7	1858.0	12.0	1848.4	11.9	1851.6	11.3	1838.7	11.6	1816.3
56-465 (77%)	12.2	1883.6	12.8	1886.8	12.9	1878.8	10.9	1809.9	10.9	1806.7
12-008 (70%)	7.9	2122.3	7.8	2111.0	8.1	2095.0	8.2	2114.2	7.9	2117.4
87-090 (70%)	7.1	2085.4	7.0	2091.8	6.9	2071.0	6.9	2075.8	6.8	2077.4
17-091 (52%)	9.2	2022.9	9.5	2035.8	9.5	2027.8	9.5	2037.4	9.2	2011.7
93-406 (47%)	7.5	2011.7	7.2	1984.5	7.7	1192.5	7.4	1970.0	7.3	1970.0
93-406 (40%)	8.2	2042.2	8.1	2064.6	8.2	2061.4	8.4	2053.4	8.4	2056.6
70-279 (40%)	7.2	2047.0	7.1	2061.4	7.1	2061.4	7.2	2053.4	7.1	2042.2

(a) Percent moisture by weight of dry aggregate
(b) Specimen dry density - kg/m^3

APPENDIX B: MODIFIED PROCTOR MOISTURE-DENSITY DATA FOR UNTREATED AND TREATED BASE COURSE AGGREGATES (PART 2)

Table B-1. Modified proctor moisture/density data for untreated base course aggregates (part 2)

Pit No. (% Carbonates)	1-day		1-day		7-day		7-day		14-day		14-day		28-day		28-day	
	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d
36-246 (98%)	12.3	1872.4	12.2	1877.2	12.1	1858.0	12.1	1866.0	12.1	1882.0	12.1	1880.4	12.3	1867.6	12.6	1861.2
70-279 (40%)	7.0	2026.1	7.0	2026.1	7.1	2022.9	7.1	2024.5	7.0	2035.8	7.1	2022.9	7.0	2018.1	7.1	2022.9
56-465 (77%)	12.5	1931.6	12.7	1934.8	----------		----------		12.5	1933.2	13.4	1920.4	12.5	1938.0	12.5	1933.2
17-091 (52%)	9.4	2055.0	9.6	2045.4	----------		----------		9.3	2037.4	9.4	2047.0	9.4	2050.2	9.6	2053.4
93-406 (47%)	7.2	2069.4	7.1	2066.2	----------		----------		7.2	2045.4	7.6	2048.6	7.2	2051.8	7.2	2074.2
26-001 (99%)	12.0	1874.0	12.1	1875.6	----------		----------		12.0	1870.8	12.0	1872.4	12.0	1874.0	11.8	1867.6
58-486 (-- %)	10.9	1901.2	11.5	1902.8	----------		----------		10.7	1957.3	11.5	1965.3	10.7	1965.3	11.4	1957.3
MX411 (99%)	7.8	2104.6	7.8	2083.8	----------		----------		7.6	2069.4	7.6	2075.8	7.4	2067.8	8.0	2053.4
AL-149 (99%)	5.9	2280.8	5.9	2290.4	----------		----------		5.9	2298.4	5.8	2332.1	5.7	2303.2	5.8	2277.6

(a) Percent moisture by weight of dry aggregate
(b) Specimen dry density - kg/m^3

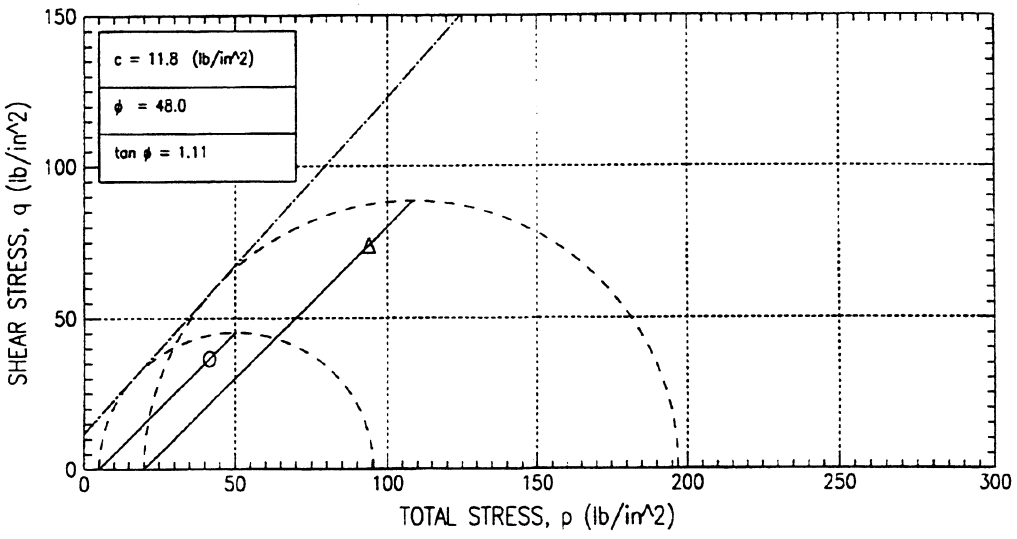
Table B-2 Modified proctor moisture/density data for lime treated base course aggregates (part 2)

Pit No. (% Carbonates)	1-day		1-day		7-day		7-day		14-day		14-day		28-day		28-day	
	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d	w%	γ_d
36-246 (98%)	12.0	1875.6	11.8	1886.8	12.1	1872.4	12.0	1874.0	11.7	1885.2	12.1	1866.0	11.9	1888.4	12.0	1877.2
70-279 (40%)	8.0	2051.8	7.9	2043.8	8.1	2027.7	7.8	2040.6	7.8	2040.6	8.0	2061.4	7.8	2058.2	8.5	2019.7
56-465 (77%)	13.1	1920.4	13.2	1918.8	----------		----------		12.9	1914.0	13.0	1904.4	13.2	1891.6	13.2	1904.4
17-091 (52%)	10.5	2032.5	10.2	2030.9	----------		----------		10.2	2019.7	10.5	2019.7	10.2	2026.1	10.3	2021.3
93-406 (47%)	7.1	2053.4	7.1	2040.6	----------		----------		6.9	2037.4	7.0	2048.6	7.1	2029.3	7.2	2029.3
26-001 (99%)	11.8	1893.2	11.9	1880.4	----------		----------		11.8	1870.8	11.8	1861.2	11.7	1878.8	11.8	1875.6
58-486 (-- %)	12.7	1947.7	12.6	1957.3	----------		----------		12.9	1949.3	13.2	1952.5	13.0	1950.9	12.5	1947.7
MX411 (99%)	7.2	2064.6	7.6	2043.8	----------		----------		7.7	2037.4	7.3	2074.2	7.7	2022.9	8.0	2030.9
AL-149 (99%)	6.4	2282.4	5.6	2332.1	----------		----------		6.1	2332.1	5.8	2296.8	5.8	2292.0	5.9	2314.4

(a) Percent moisture by weight of dry aggregate
(b) Specimen dry density - kg/m^3

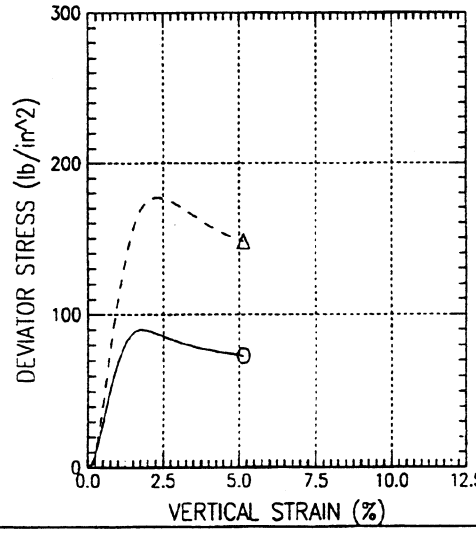
APPENDIX C: RESULTS FROM TRIAXIAL SHEAR TESTS

Limestone Pit #36-246 Untreated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1g (5)	2g (20)		
INITIAL	WATER CONTENT (%)	10.01	10.25		
	DRY DENSITY (lb/ft^3)	118.59	118.03		
	SATURATION (%)	67.27	67.70		
	VOID RATIO	0.394	0.401		
BEFORE SHEAR	WATER CONTENT (%)	10.01	10.25		
	DRY DENSITY (lb/ft^3)	118.59	118.03		
	SATURATION (%)	67.27	67.70		
	VOID RATIO	0.394	0.401		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		90.34	176.98		
TIME TO FAILURE (min)		7.35	9.52		
RATE OF STRAIN INCR (%/min)		0.25	0.25		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B -VALUE		0.00	0.00		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) Untreated Limestone Pit#36-246 (5) psi 2) Untreated Limestone Pit#36-246 (20) psi 24 hr.

LL	PL	PI	GS 2.65

REMARKS:

1) 98% Calcium Carbonates

2) 98% Calcium Carbonates

TYPE OF SPECIMEN untreated — TYPE OF TEST UU (Q)

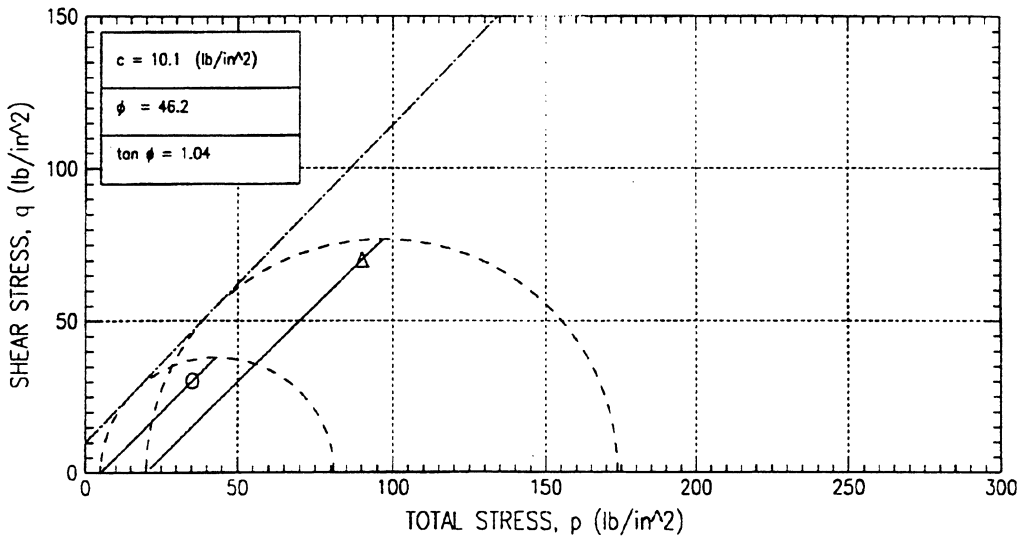
PROJECT 1g (5) psi

PROJECT NO. 1g

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10-14-97	10-14-97

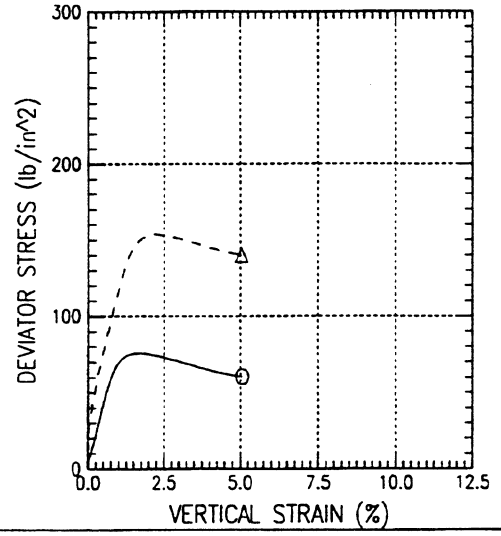
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #36-246 Untreated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1K (5PSI)	2K (20PSI)		
INITIAL	WATER CONTENT (%)	10.37	10.24		
	DRY DENSITY (lb/ft^3)	118.20	118.19		
	SATURATION (%)	68.90	67.99		
	VOID RATIO	0.399	0.399		
BEFORE SHEAR	WATER CONTENT (%)	10.37	10.24		
	DRY DENSITY (lb/ft^3)	118.20	118.19		
	SATURATION (%)	68.90	67.99		
	VOID RATIO	0.399	0.399		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		76.02	153.73		
TIME TO FAILURE (min)		7.60	10.08		
RATE OF STRAIN INCR (%/min)		0.00	0.00		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		203.20	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) UNTREATED LIMESTONE PIT #36-246 (5PSI) UNTREATED LIMESTONE PIT #36-246 (20PSI)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN UNTREATED	TYPE OF TEST UU (Q)

REMARKS:

1) 98% CALCIUM CARBONATES

2) 98% CALCIUM CARBONATES

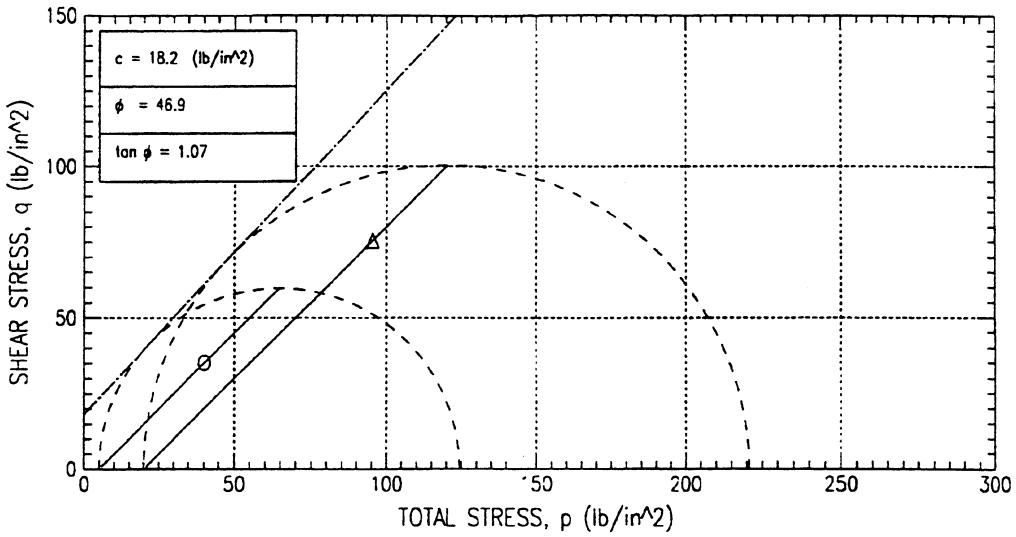
PROJECT BASE-COARSE STUDY

PROJECT NO.ku17

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10/23/97	10/23/97

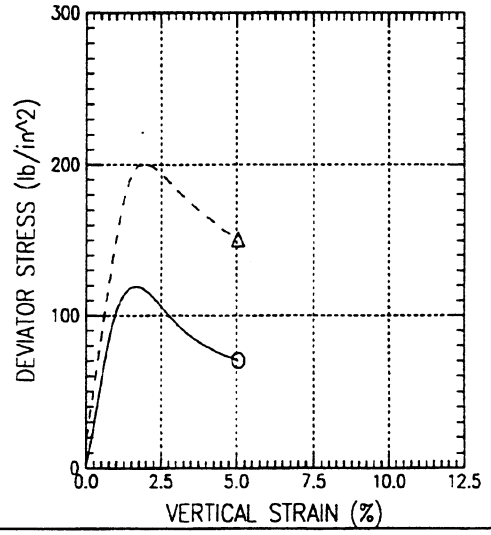
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #36-246 Untreated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1IU(5PSI)	2IU 20 PSI		
INITIAL	WATER CONTENT (%)	10.35	10.42		
	DRY DENSITY (lb/ft^3)	116.52	117.53		
	SATURATION (%)	65.42	67.86		
	VOID RATIO	0.419	0.407		
BEFORE SHEAR	WATER CONTENT (%)	10.35	10.42		
	DRY DENSITY (lb/ft^3)	116.52	117.53		
	SATURATION (%)	65.42	67.86		
	VOID RATIO	0.419	0.407		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		119.34	200.70		
TIME TO FAILURE (min)		7.60	9.43		
RATE OF STRAIN INCR (%/min)		0.01	0.00		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		203.20	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) Untreated Limestone pit #36-246 (5psi) 2) Untreated limestone Pit #36-246 (20psi)

LL	PL	PI	GS 2.65

REMARKS:

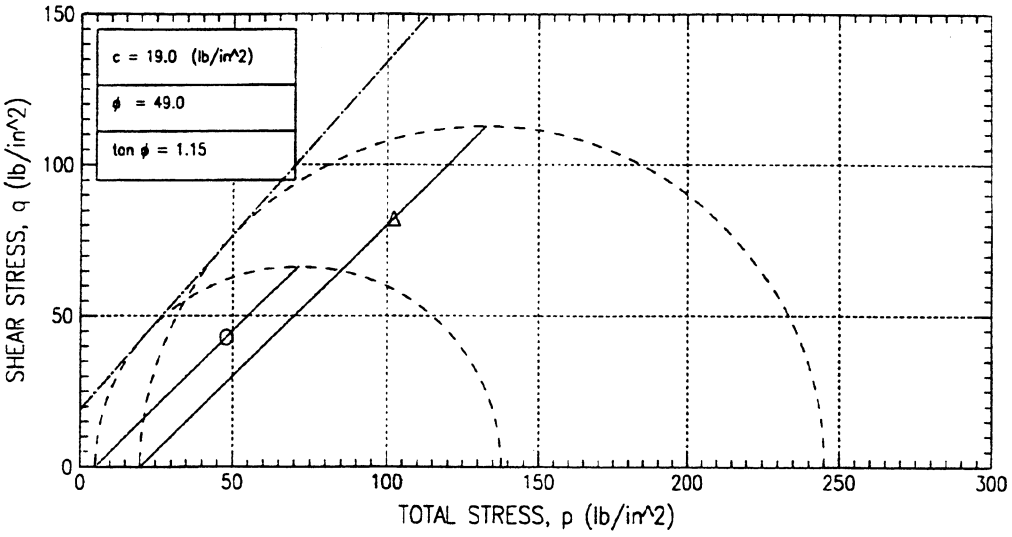
1) 98% Calcium Carbonates

2) 98% Calcium Carbonates

TYPE OF SPECIMEN UNTREATED		TYPE OF TEST UU (Q)				
PROJECT Base-Coarse Agg. Res.						
PROJECT NO.IU130						
BORING NO.	SAMPLE NO.	1	2			
TECH.	DEPTH/ELEV	RR	RR			
LABORATORY	DATE	11/20/97	11/20/97			

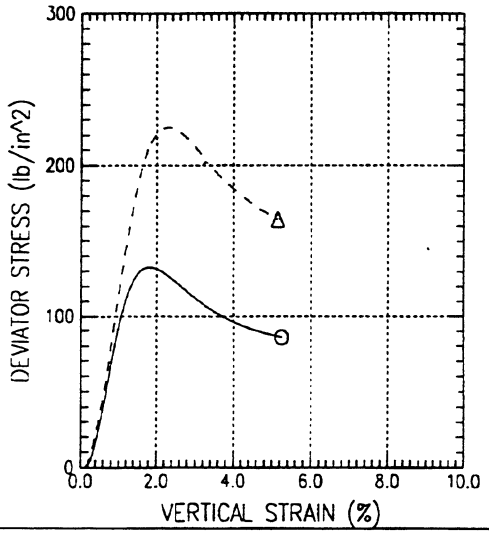
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #36-246 Treated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1B (5)	2B (20)		
INITIAL	WATER CONTENT (%)	10.03	10.22		
	DRY DENSITY (lb/ft^3)	116.70	115.87		
	SATURATION (%)	63.74	63.41		
	VOID RATIO	0.417	0.427		
BEFORE SHEAR	WATER CONTENT (%)	10.03	10.22		
	DRY DENSITY (lb/ft^3)	116.70	115.87		
	SATURATION (%)	63.74	63.41		
	VOID RATIO	0.417	0.427		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		132.69	225.20		
TIME TO FAILURE (min)		7.43	10.02		
RATE OF STRAIN INCR (%/min)		0.25	0.25		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		0.00	0.00		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) Treated Limestone Pit #36-246 (5psi) 2) Treated Limestone Pit #36-246 (20psi)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN Treated	TYPE OF TEST CU (R)

REMARKS:

1) 98% Calcium Carbonates

2) 98% Calcium Carbonates

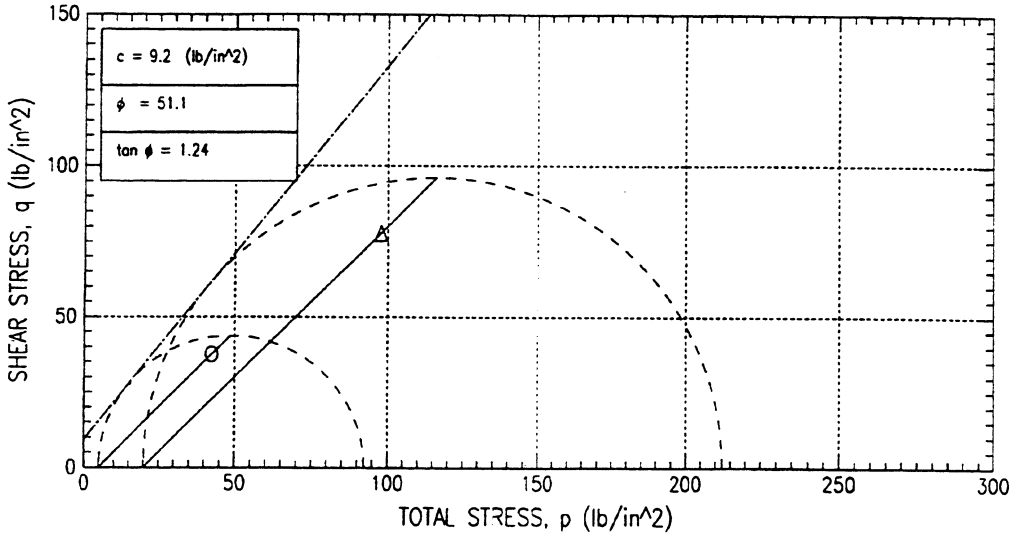
PROJECT Geo-Fiber Research

PROJECT NO.

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10-14-97	10-14-97

TRIAXIAL COMPRESSION TEST REPORT

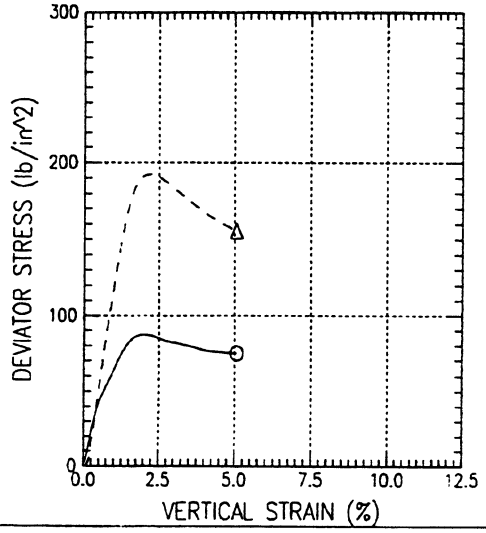
Limestone Pit #36-246 Treated



FAILURE SKETCHES

1E (5PSI)

2E (20PSI)



SYMBOL		O	Δ		
TEST NO.		1E (5PSI)	2E (20PSI)		
INITIAL	WATER CONTENT (%)	10.16	10.05		
	DRY DENSITY (lb/ft^3)	115.94	116.53		
	SATURATION (%)	63.14	63.52		
	VOID RATIO	0.426	0.419		
BEFORE SHEAR	WATER CONTENT (%)	10.16	10.05		
	DRY DENSITY (lb/ft^3)	115.94	116.53		
	SATURATION (%)	63.14	63.52		
	VOID RATIO	0.426	0.419		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		87.30	192.32		
TIME TO FAILURE (min)		8.60	9.52		
RATE OF STRAIN INCR (%/min)		0.01	0.03		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		203.20	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) TREATED LIMESTONE PIT #36-246 (5PSI) 2) TREATED LIMESTONE PIT #36-246 (20PSI)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN TREATED	TYPE OF TEST UU (0)

REMARKS:

1) 98% CALCIUM CARBONATES

2) 98% CALCIUM CARBONATES

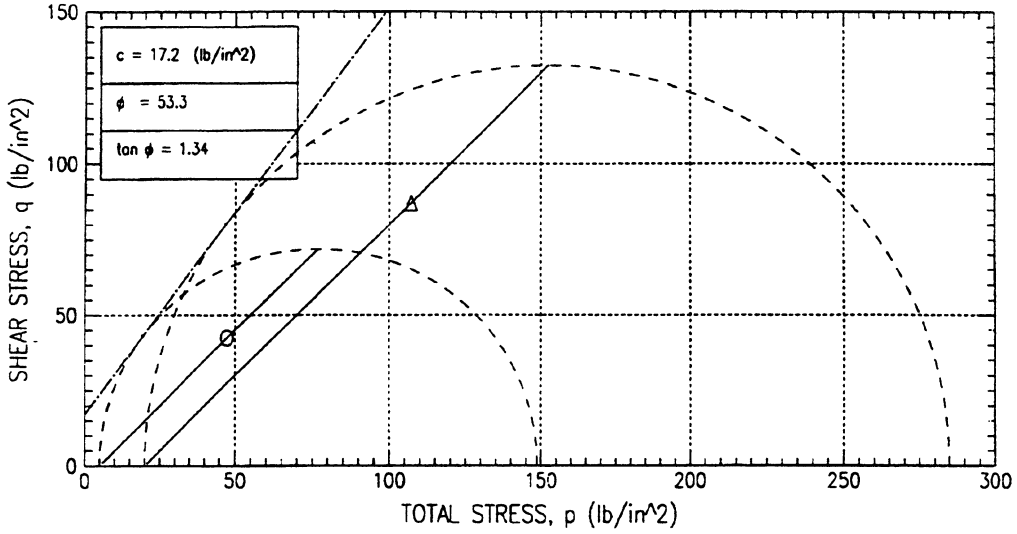
PROJECT BASE-COARSE STUDY

PROJECT NO.ET17

BORING NO.	SAMPLE NO.	1	2		
TECH.	DEPTH/ELEV				
LABORATORY	DATE	10/23/97	10/23/97		

TRIAXIAL COMPRESSION TEST REPORT

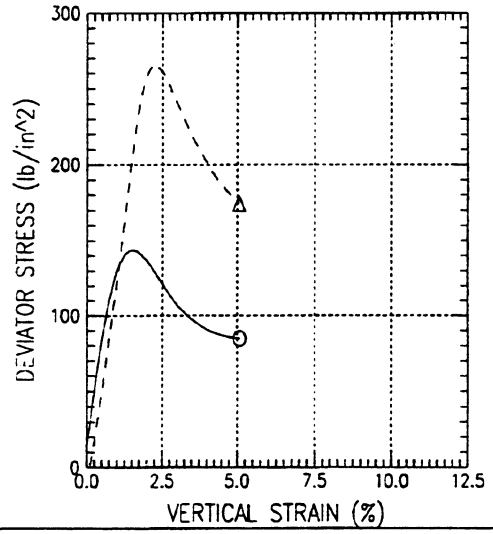
Limestone Pit #36-246 Treated



FAILURE SKETCHES

1CT (5PSI)

2CT (20PSI)



SYMBOL		O	Δ		
TEST NO.		1CT (5PSI)	2CT (20PSI		
INITIAL	WATER CONTENT (%)	10.13	9.93		
	DRY DENSITY (lb/ft^3)	116.12	116.18		
	SATURATION (%)	63.33	62.17		
	VOID RATIO	0.424	0.423		
BEFORE SHEAR	WATER CONTENT (%)	10.13	9.93		
	DRY DENSITY (lb/ft^3)	116.12	116.18		
	SATURATION (%)	63.33	62.17		
	VOID RATIO	0.424	0.423		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		143.73	264.77		
TIME TO FAILURE (min)		7.35	9.85		
RATE OF STRAIN INCR (%/min)		0.00	0.19		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		203.20	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) Treated Limestone Pit #36-246 (5psi) 2) Treated limestone Pit #36-246 (20psi)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN Treated	TYPE OF TEST CU (R)

REMARKS:

1) 98% Calcium Carbonates

2) 98% Calcium Carbonates

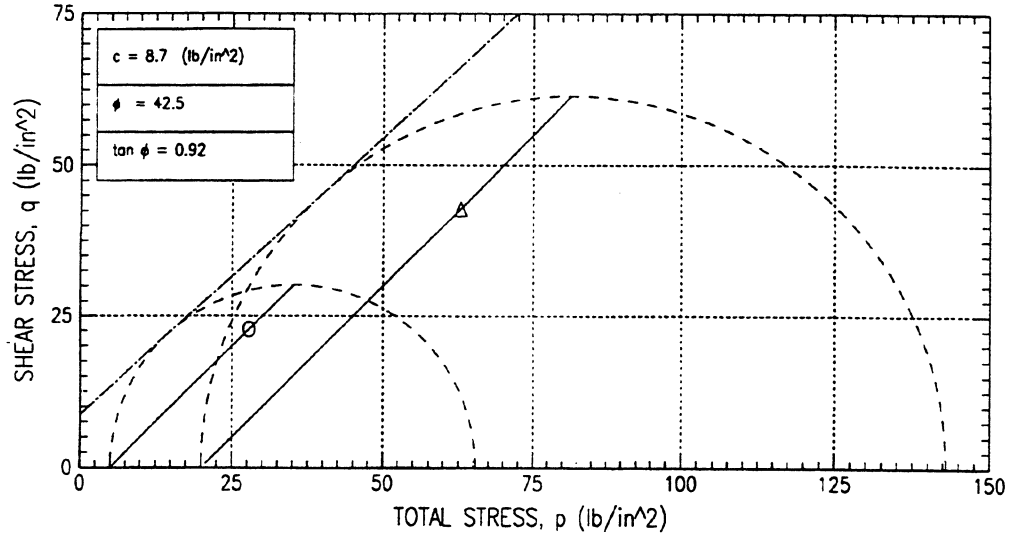
PROJECT Base-Coarse Agg. Res.

PROJECT NO.CT130

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		RR
LABORATORY	DATE	11/20/97	11/20/97

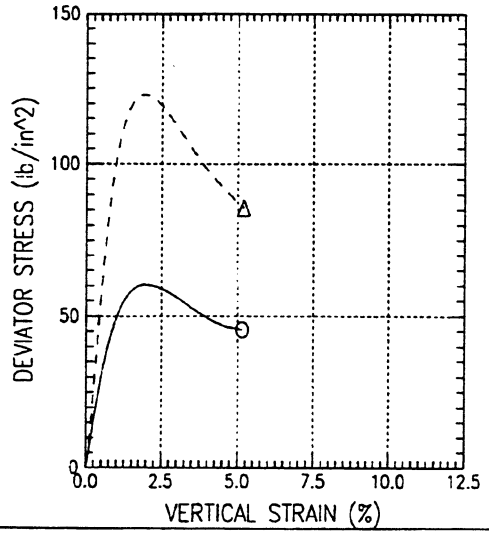
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #70-279 Untreated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1S (5)	2S (20)		
NITIAL	WATER CONTENT (%)	7.13	7.09		
	DRY DENSITY (lb/ft^3)	126.27	126.48		
	SATURATION (%)	61.04	61.15		
	VOID RATIO	0.310	0.307		
BEFORE SHEAR	WATER CONTENT (%)	7.13	7.09		
	DRY DENSITY (lb/ft^3)	126.27	126.48		
	SATURATION (%)	61.04	61.15		
	VOID RATIO	0.310	0.307		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		60.36	122.95		
TIME TO FAILURE (min)		8.10	8.52		
RATE OF STRAIN INCR (%/min)		0.25	0.25		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		0.00	0.00		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) UNTREATED LIMESTONE PIT #70-249 (5PSI) UNTREATED LIMESTONE PIT #70-279 (20)PSI

LL	PI	PI	GS 2.65	TYPE OF SPECIMEN UNTREATED	TYPE OF TEST UU (0)

REMARKS:

1) 44% CALCIUM CARBONATES

2) 44% CALCIUM CARBONATES

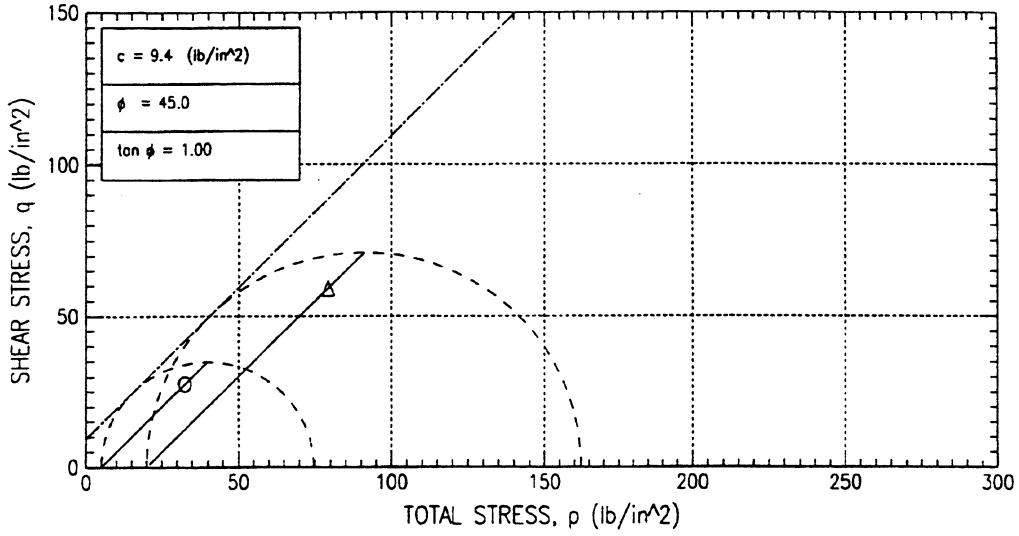
PROJECT BASE-COARSE STUDY

PROJECT NO.SU1

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10/16/97	10/16/97

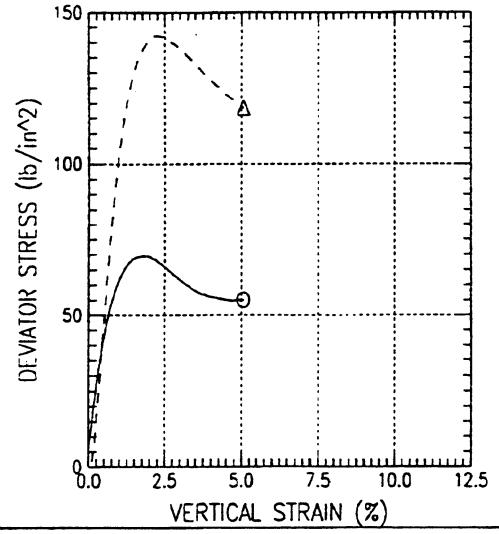
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #70-279 Untreated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1T (5PSI)	2T (20PSI)		
INITIAL	WATER CONTENT (%)	7.07	7.11		
	DRY DENSITY (lb/ft^3)	127.14	126.46		
	SATURATION (%)	62.36	61.26		
	VOID RATIO	0.301	0.308		
BEFORE SHEAR	WATER CONTENT (%)	7.07	7.11		
	DRY DENSITY (lb/ft^3)	127.14	126.46		
	SATURATION (%)	62.36	61.26		
	VOID RATIO	0.301	0.308		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		69.57	142.15		
TIME TO FAILURE (min)		8.33	9.00		
RATE OF STRAIN INCR (%/min)		0.00	0.22		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		0.00	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) UNTREATED LIMESTONE PIT #70-249 (5PSI)UNTREATED LIMESTONE PIT # 70-246 (20PSI)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN UNTREATED	TYPE OF TEST UU (Q)

REMARKS:

1) 44% CALCIUM CARBONATES

2) 44% CALCIUM CARBONATES

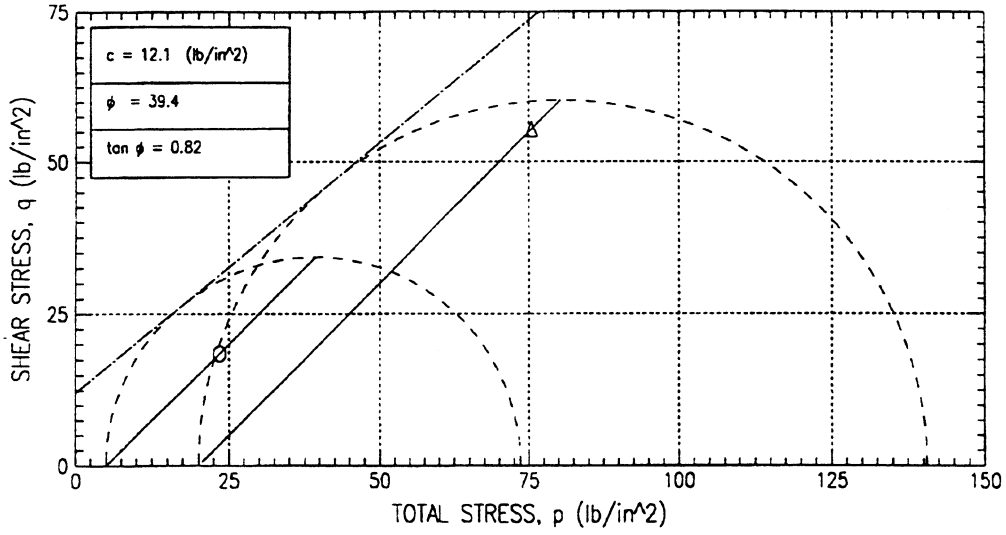
PROJECT BASE-COARSE STUDY

PROJECT NO.TU17

BORING NO.	SAMPLE NO.	1	2		
TECH.	DEPTH/ELEV				
LABORATORY	DATE	10/27/97	10/27/97		

TRIAXIAL COMPRESSION TEST REPORT

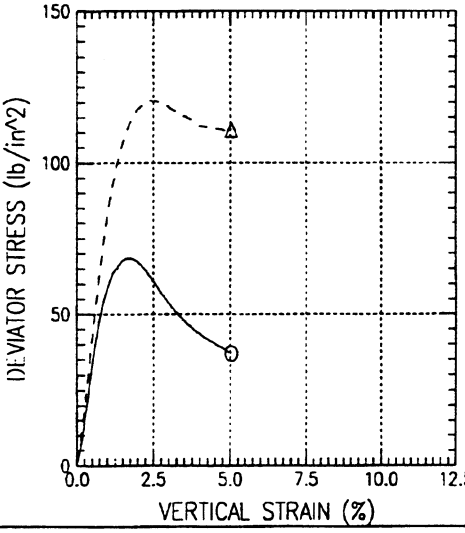
Limestone Pit #70-279 Untreated



FAILURE SKETCHES

XU1(5PSI)

XU2(20PSI)



SYMBOL		O	Δ		
TEST NO.		XU1(5PSI)	XU2(20PSI)		
INITIAL	WATER CONTENT (%)	7.21	6.97		
	DRY DENSITY (lb/ft^3)	127.31	127.11		
	SATURATION (%)	63.89	61.36		
	VOID RATIO	0.299	0.301		
BEFORE SHEAR	WATER CONTENT (%)	7.21	6.97		
	DRY DENSITY (lb/ft^3)	127.31	127.11		
	SATURATION (%)	63.89	61.36		
	VOID RATIO	0.299	0.301		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		68.57	120.56		
TIME TO FAILURE (min)		7.17	10.43		
RATE OF STRAIN INCR (%/min)		0.03	0.01		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		0.00	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) Utreated Limestone Pit #70-279 (5psi)2) Untreated Limestone Pit #70-279 (20psi)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN UNTREATED	TYPE OF TEST UU (0)

REMARKS:

1) 44% CALCIUM CARBONATES

2) 44% CALCIUM CARBONATES

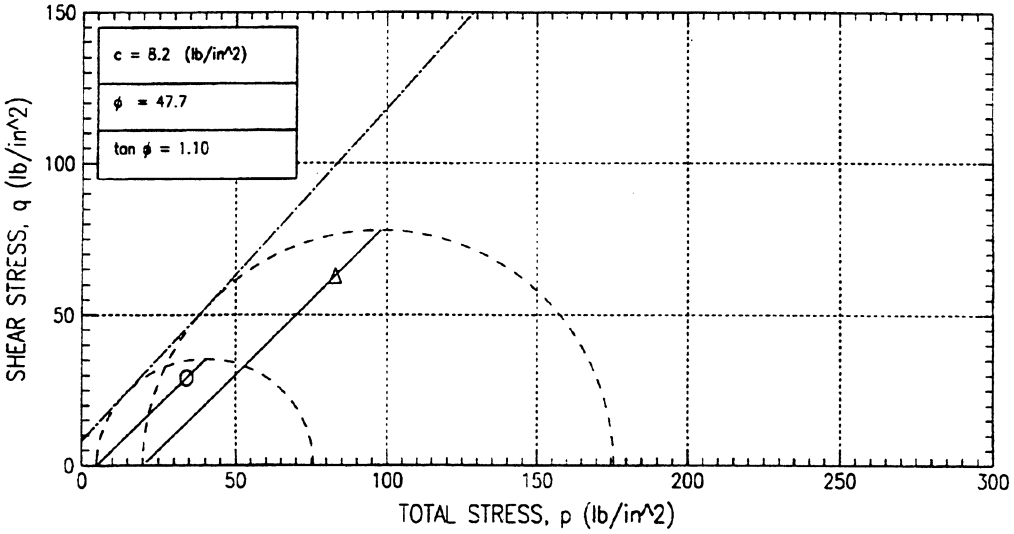
PROJECT BASE-COARSE STUDY

PROJECT NO.XU130

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	11/21/97	11/21/97

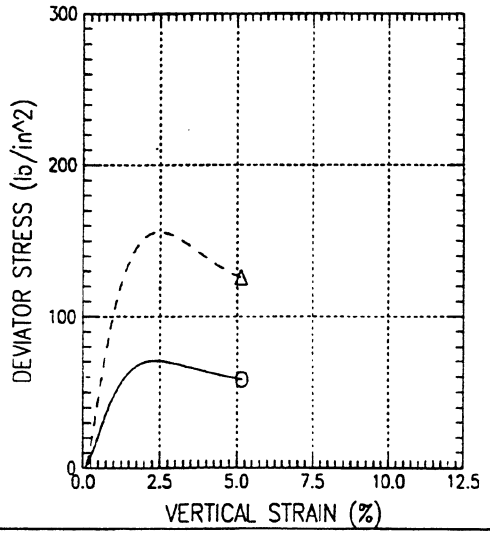
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #70-279 Treated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1M (5PSI)	2M (20PSI)		
INITIAL	WATER CONTENT (%)	7.00	7.21		
	DRY DENSITY (lb/ft^3)	128.19	127.94		
	SATURATION (%)	63.99	65.36		
	VOID RATIO	0.290	0.293		
BEFORE SHEAR	WATER CONTENT (%)	7.00	7.21		
	DRY DENSITY (lb/ft^3)	128.19	127.94		
	SATURATION (%)	63.99	65.36		
	VOID RATIO	0.290	0.293		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		70.67	155.87		
TIME TO FAILURE (min)		9.85	10.35		
RATE OF STRAIN INCR (%/min)		0.25	0.25		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		0.00	0.00		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) TREATED LIMESTONE PIT #70-279 (5PSI) 2) TREATED LIMESTONE PIT #70-279 (20PSI)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN TREATED	TYPE OF TEST UU (Q)

REMARKS:

1) 44% CALCIUM CARBONATES

2) 44% CALCIUM CARBONATES

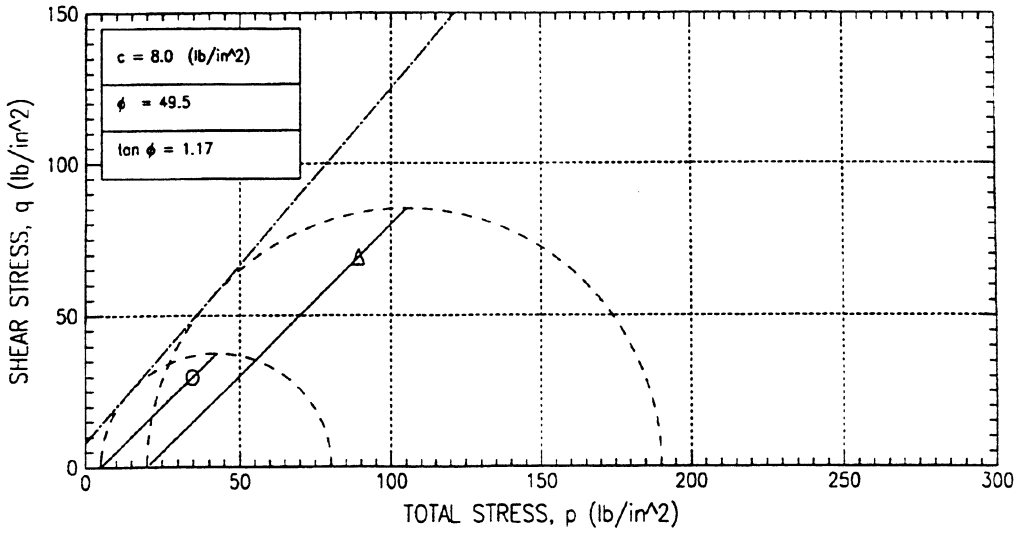
PROJECT BASE-COARSE STUDY

PROJECT NO.MT124

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10/16/97	10/16/97

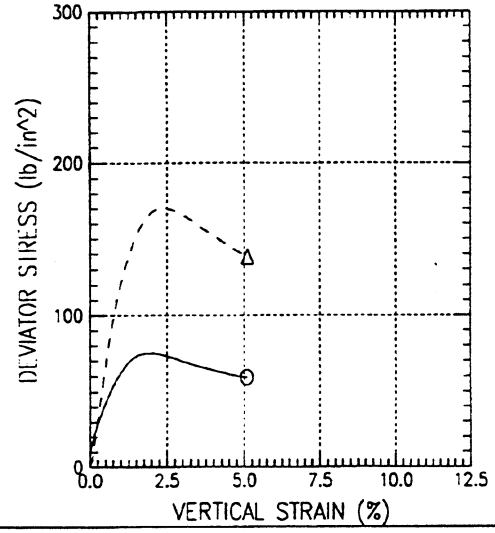
TRIAXIAL COMPRESSION TEST REPORT

Limestone Pit #70-279 Treated



FAILURE SKETCHES





SYMBOL		O	Δ		
TEST NO.		1P (5PSI)	2P (20PSI)		
INITIAL	WATER CONTENT (%)	7.13	7.19		
	DRY DENSITY (lb/ft^3)	127.55	127.48		
	SATURATION (%)	63.77	64.16		
	VOID RATIO	0.296	0.297		
BEFORE SHEAR	WATER CONTENT (%)	7.13	7.19		
	DRY DENSITY (lb/ft^3)	127.55	127.48		
	SATURATION (%)	63.77	64.16		
	VOID RATIO	0.296	0.297		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		75.17	170.28		
TIME TO FAILURE (min)		8.83	10.25		
RATE OF STRAIN INCR (%/min)		0.25	0.06		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		0.00	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) TREATED LIMESTONE PIT # 70-246 (5PSI) TREATED LIMESTONE PIT #70-246 (20PSI)

LL	PL	PI	GS 2.65	TYPE OF SPECIMEN TREATED	TYPE OF TEST UU (Q)

REMARKS:

1) 44% CALCIUM CARBONATES

2) 44% CALCIUM CARBONATES

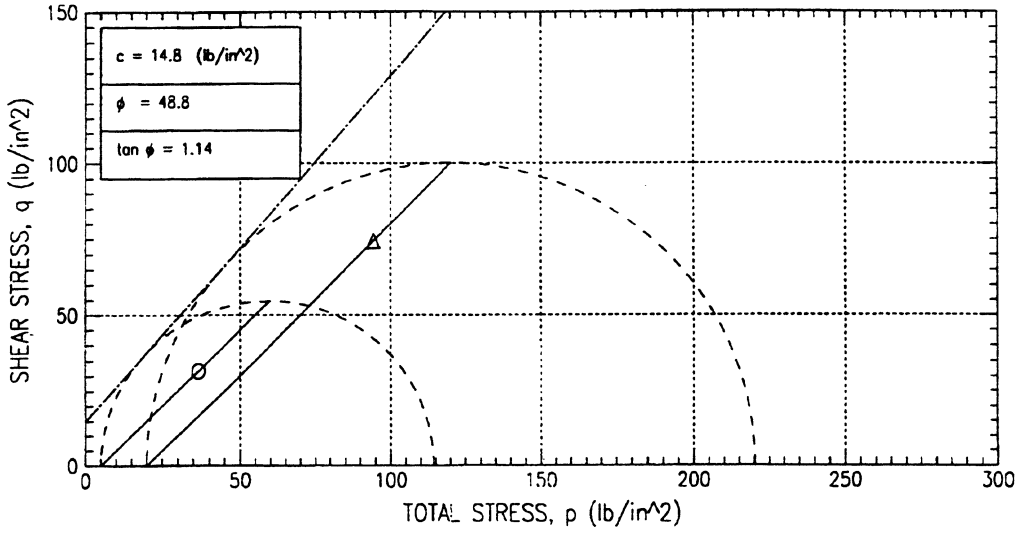
PROJECT BASE-COARSE STUDY

PROJECT NO.P-17

BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10/27/97	10/27/97

TRIAXIAL COMPRESSION TEST REPORT

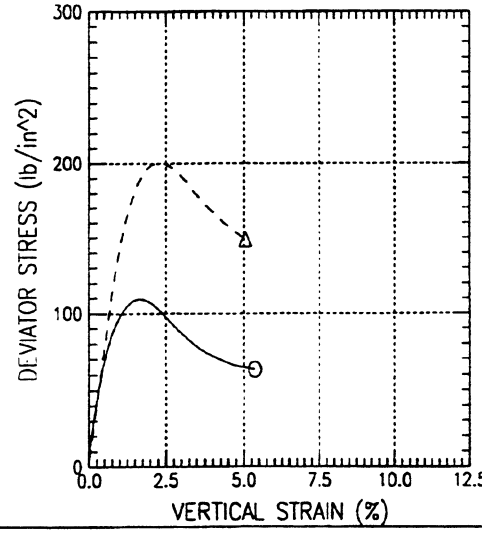
Limestone Pit #70-279 Treated



FAILURE SKETCHES

RT1(5PSI)

RT2(20PSI)



SYMBOL		O	Δ		
TEST NO.		RT1(5PSI)	RT2(20PSI)		
INITIAL	WATER CONTENT (%)	7.19	7.18		
	DRY DENSITY (lb/ft^3)	127.17	127.50		
	SATURATION (%)	63.43	64.07		
	VOID RATIO	0.300	0.297		
BEFORE SHEAR	WATER CONTENT (%)	7.19	7.18		
	DRY DENSITY (lb/ft^3)	127.17	127.50		
	SATURATION (%)	63.43	64.07		
	VOID RATIO	0.300	0.297		
	BACK PRESS. (lb/in^2)	0.00	0.00		
MINOR PRIN. STRESS (lb/in^2)		5.00	20.00		
MAX. DEV. STRESS (lb/in^2)		109.27	200.27		
TIME TO FAILURE (min)		7.77	10.35		
RATE OF STRAIN INCR (%/min)		0.00	0.00		
INITIAL DIAMETER (in)		4.00	4.00		
INITIAL HEIGHT (in)		8.00	8.00		
B-VALUE		203.20	203.20		

STRAIN CONTROLLED

DESCRIPTION OF SPECIMENS:

1) Treated Limestone Pit #70-279 (5psi) 2) Treated Limestone Pit #70-279 (20psi)

LL	PL	PI	GS 2.65

TYPE OF SPECIMEN TREATED

TYPE OF TEST UU (Q)

REMARKS:

1) 44% CALCIUM CARBONATES

2) 44% CALCIUM CARBONATES

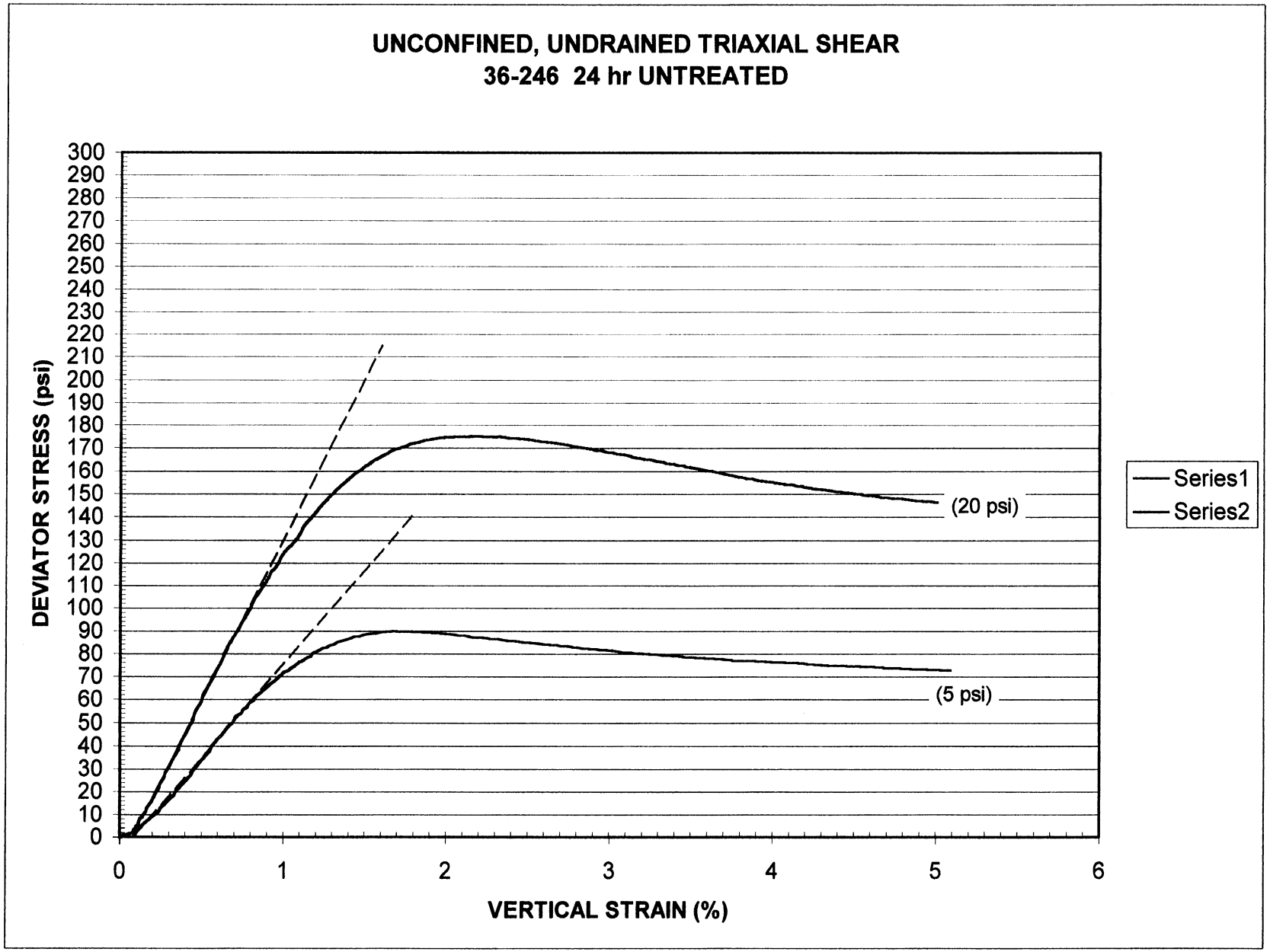
PROJECT BASE-COARSE STUDY

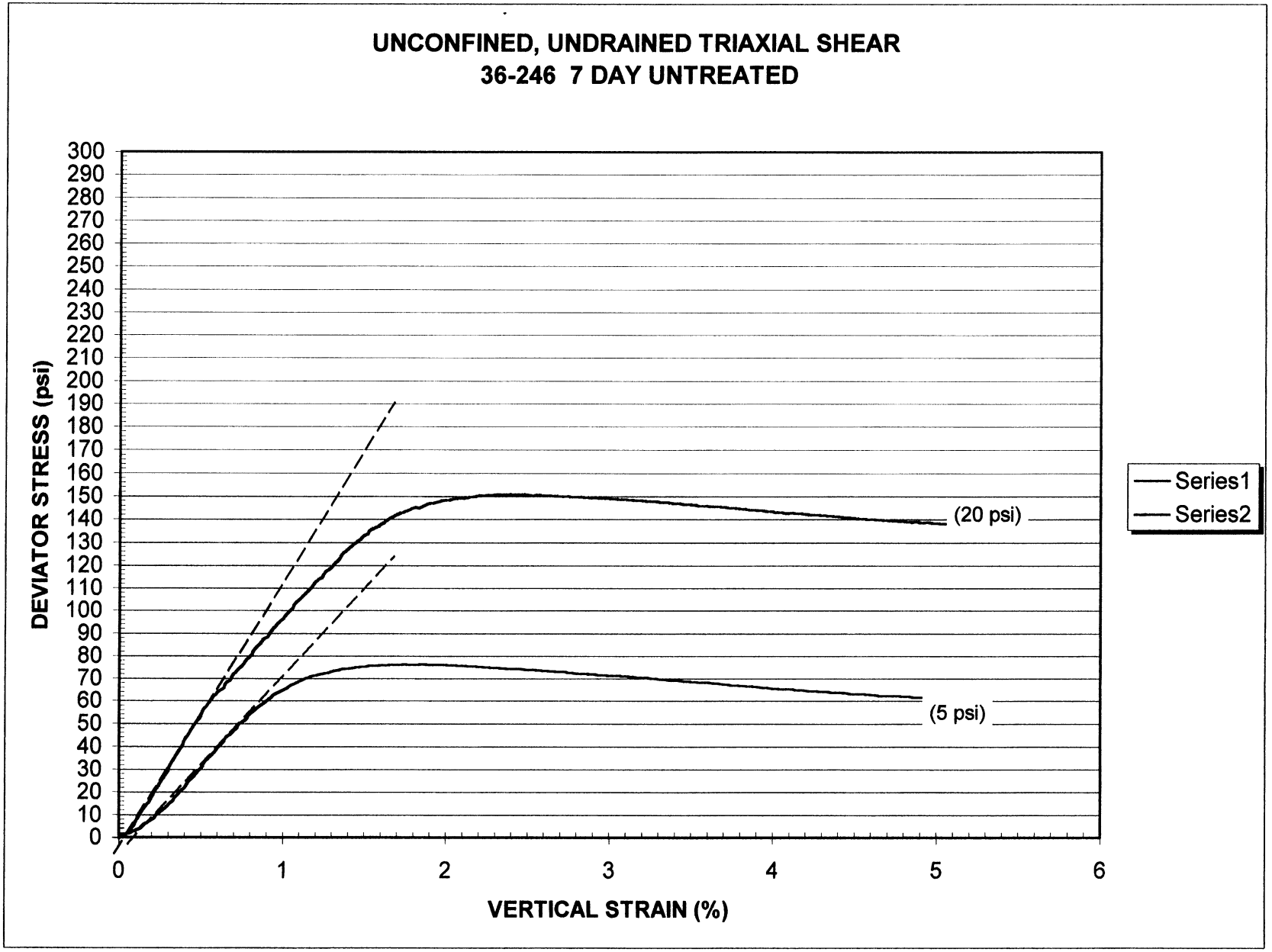
PROJECT NO.RT130

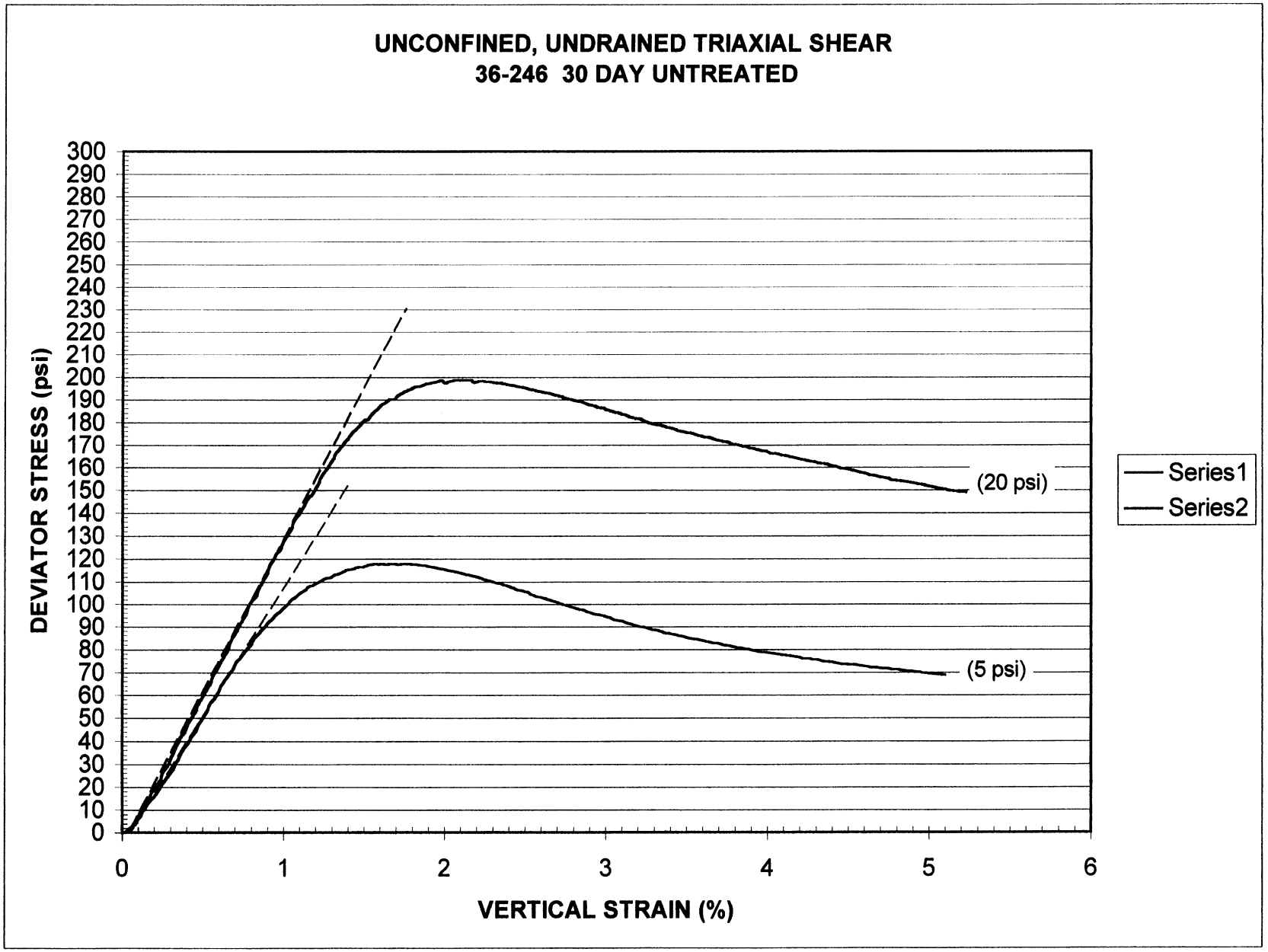
BORING NO.	SAMPLE NO.	1	2
TECH.	DEPTH/ELEV		
LABORATORY	DATE	10/27/97	10/27/97

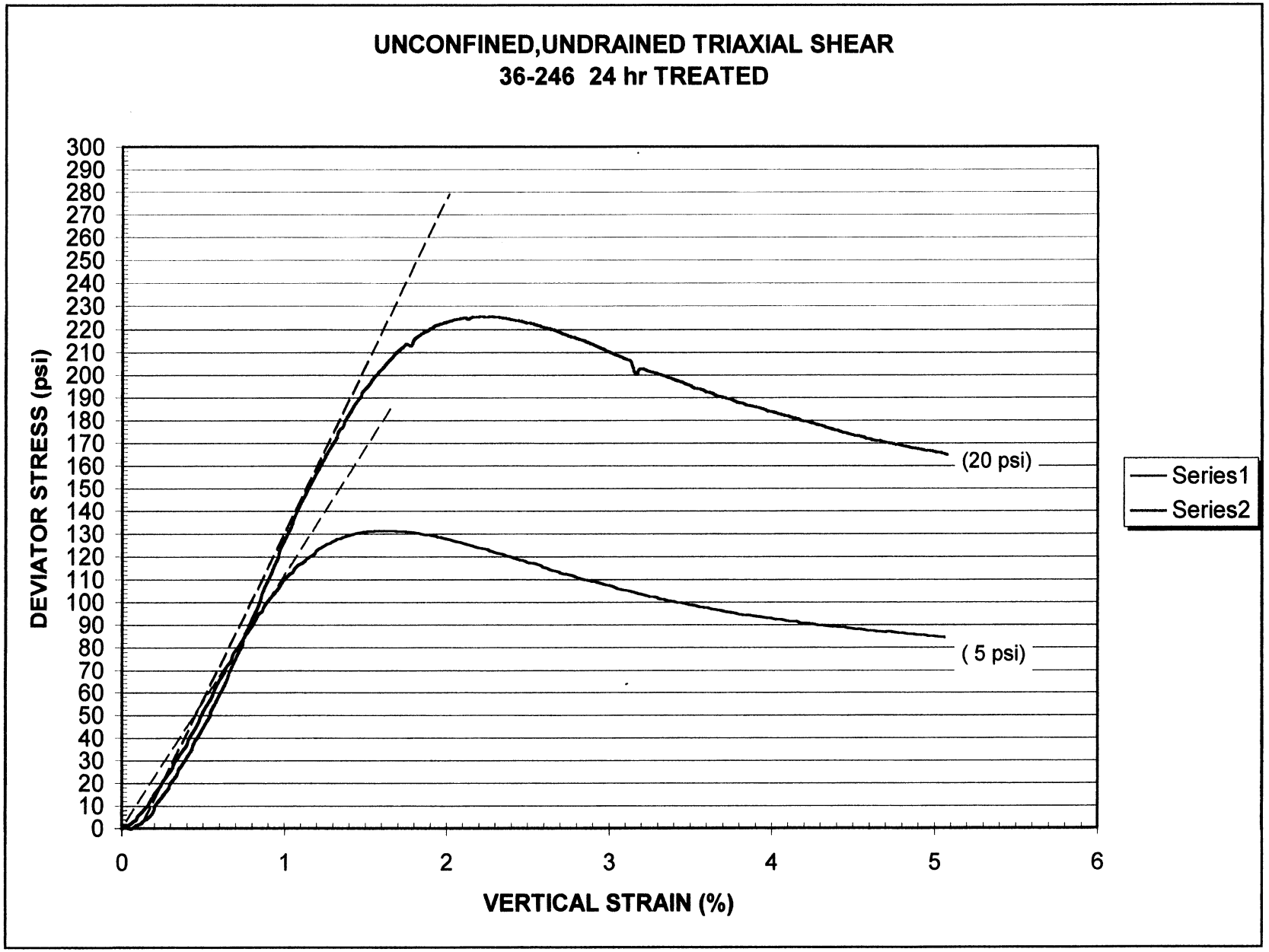
TRIAXIAL COMPRESSION TEST REPORT

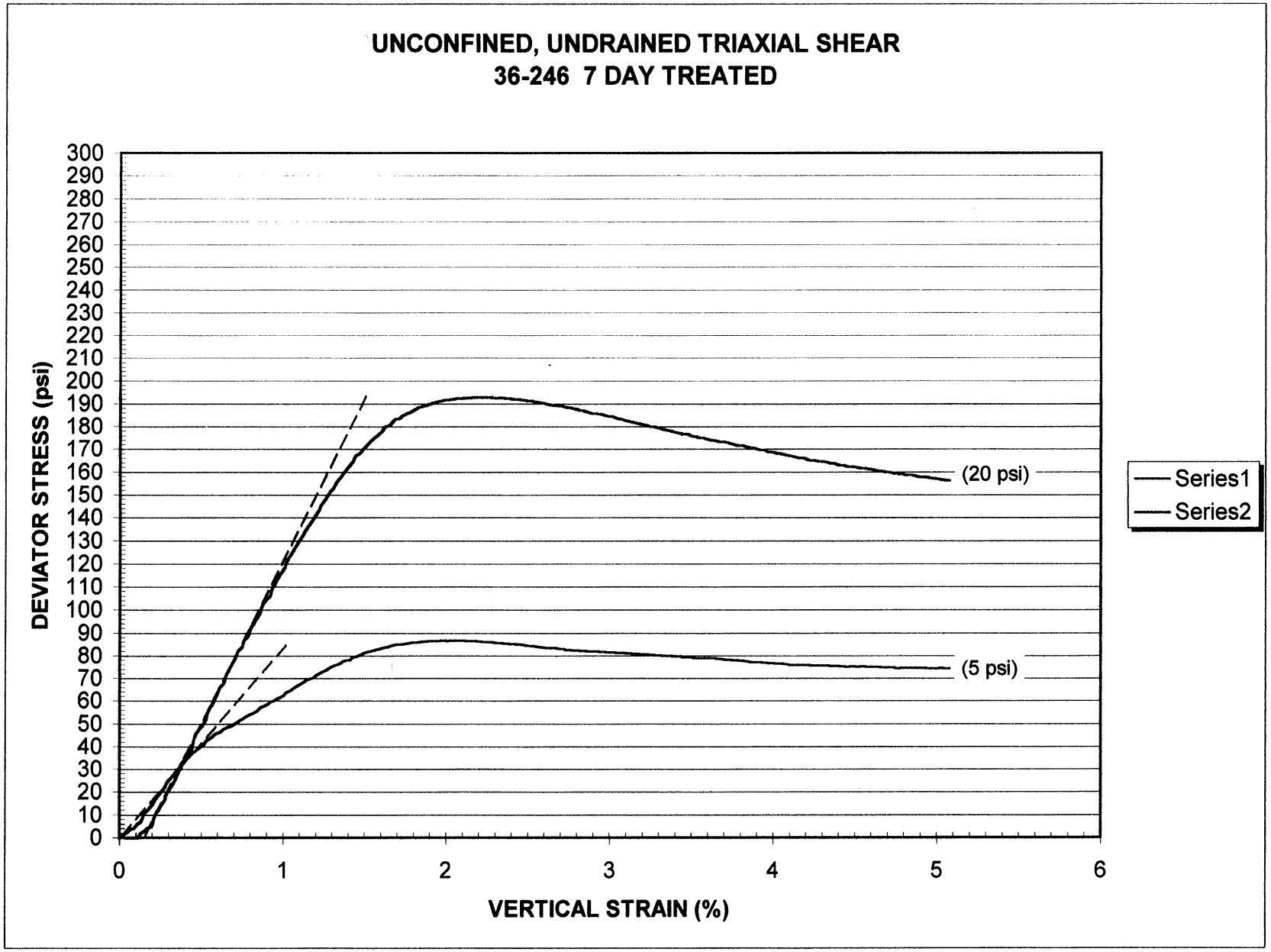
APPENDIX D: STRESS-STRAIN CURVES FROM TRIAXIAL SHEAR TESTS FOR MODULUS COMPUTATIONS

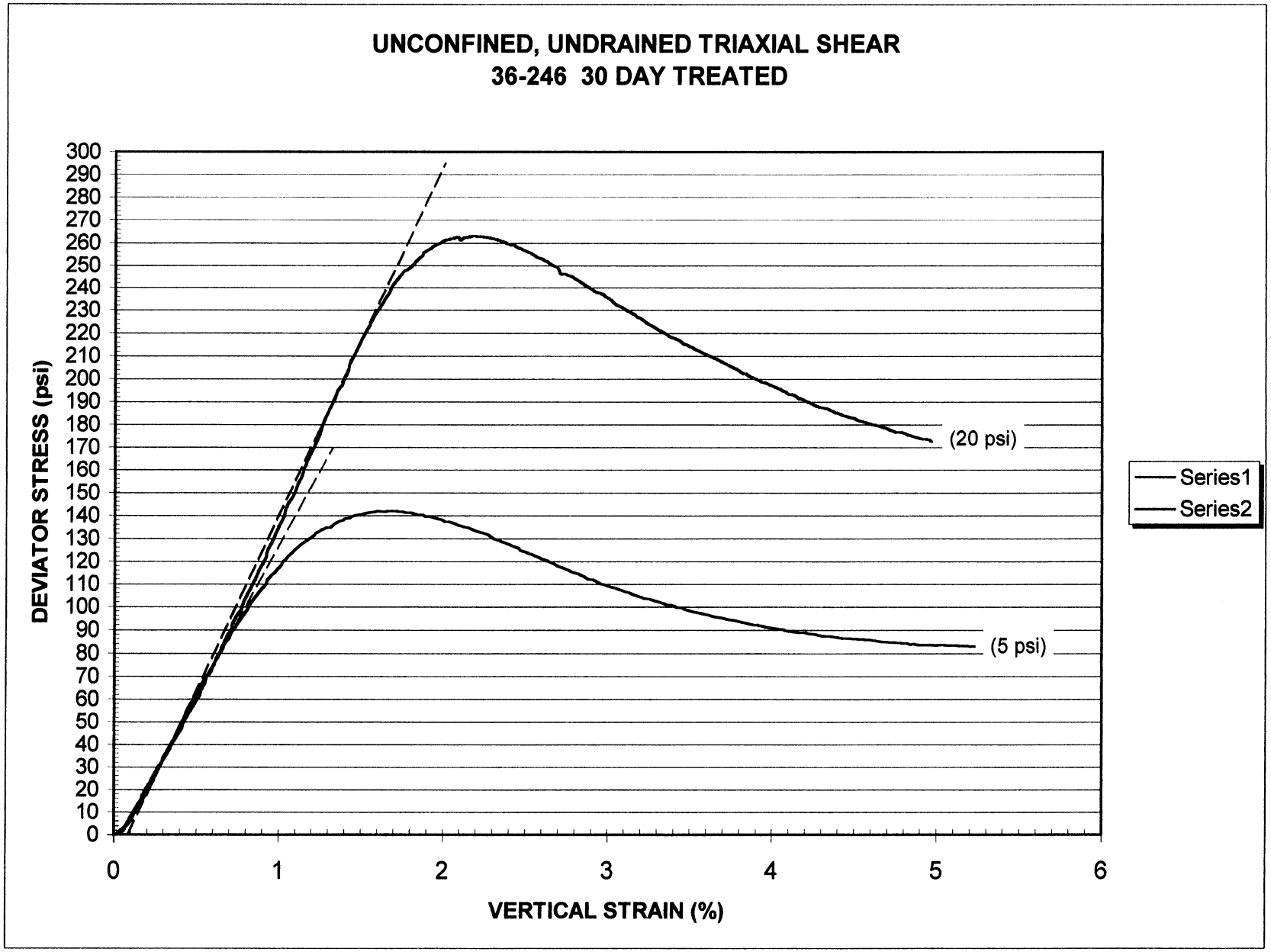

UNCONFINED, UNDRAINED TRIAXIAL SHEAR
36-246 24 hr UNTREATED
DEVIATOR STRESS (psi)
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2

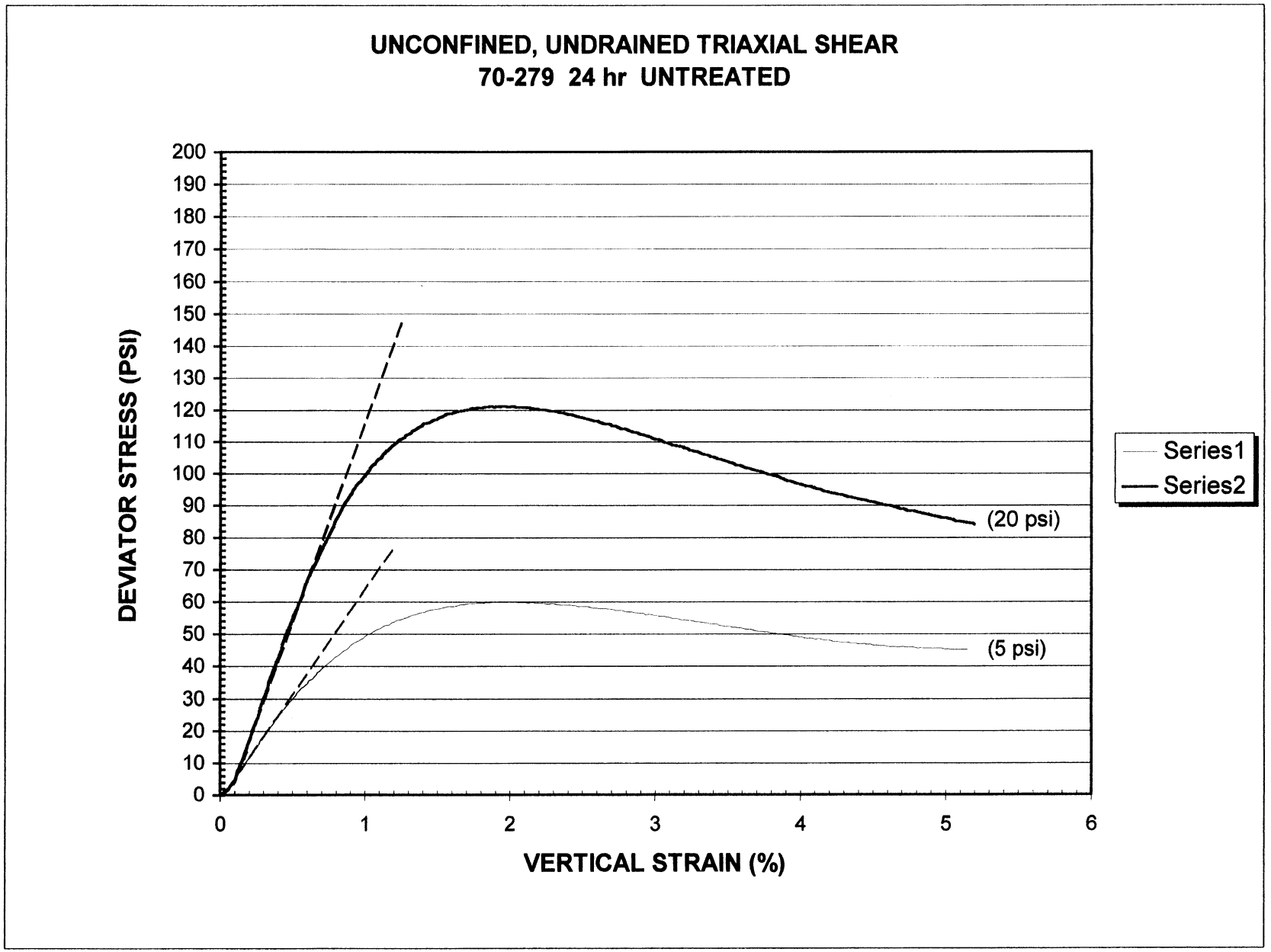

UNCONFINED, UNDRAINED TRIAXIAL SHEAR
36-246 7 DAY UNTREATED
DEVIATOR STRESS (psi)
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2

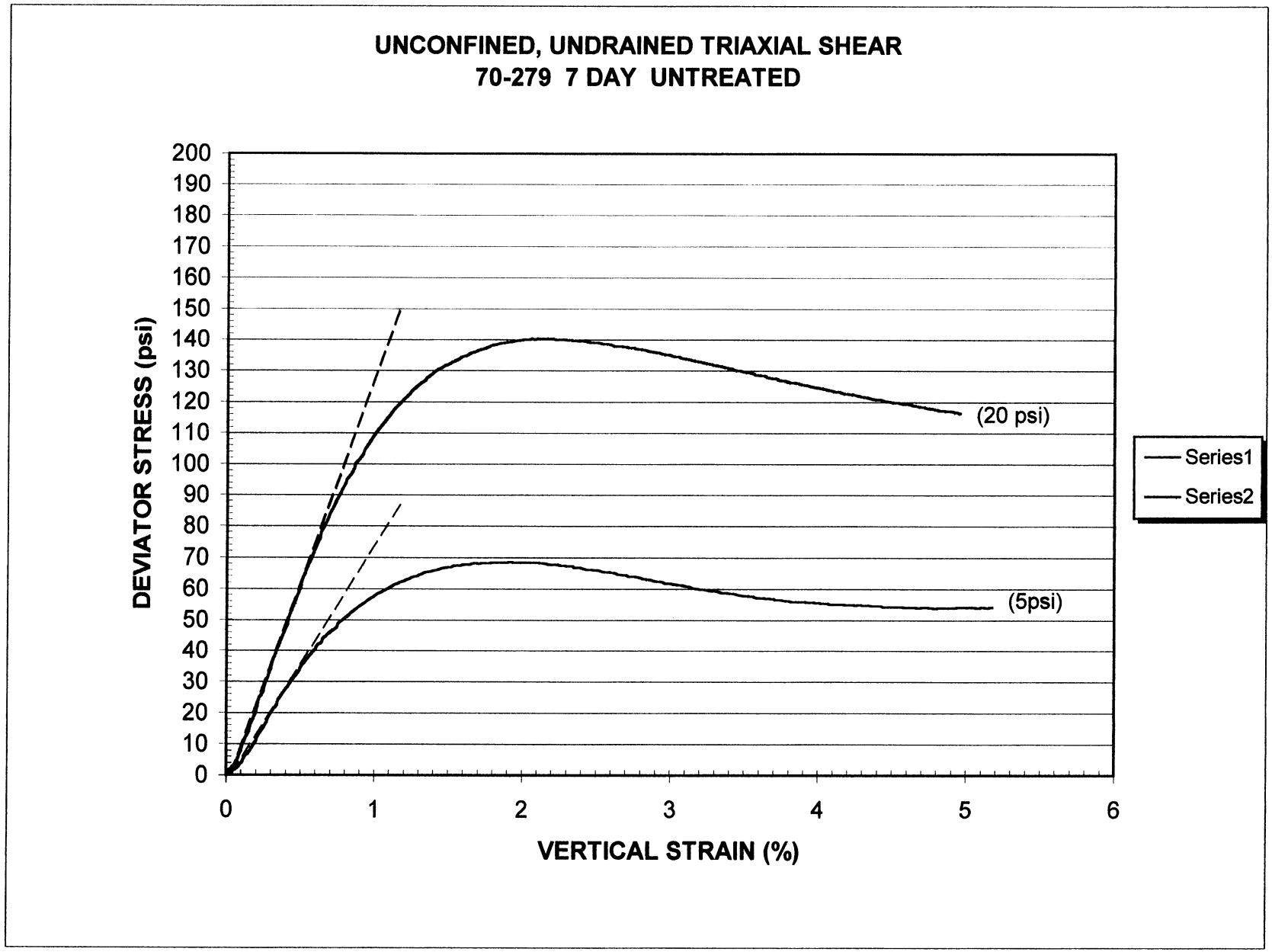

UNCONFINED, UNDRAINED TRIAXIAL SHEAR
36-246 30 DAY UNTREATED
DEVIATOR STRESS (psi)
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2

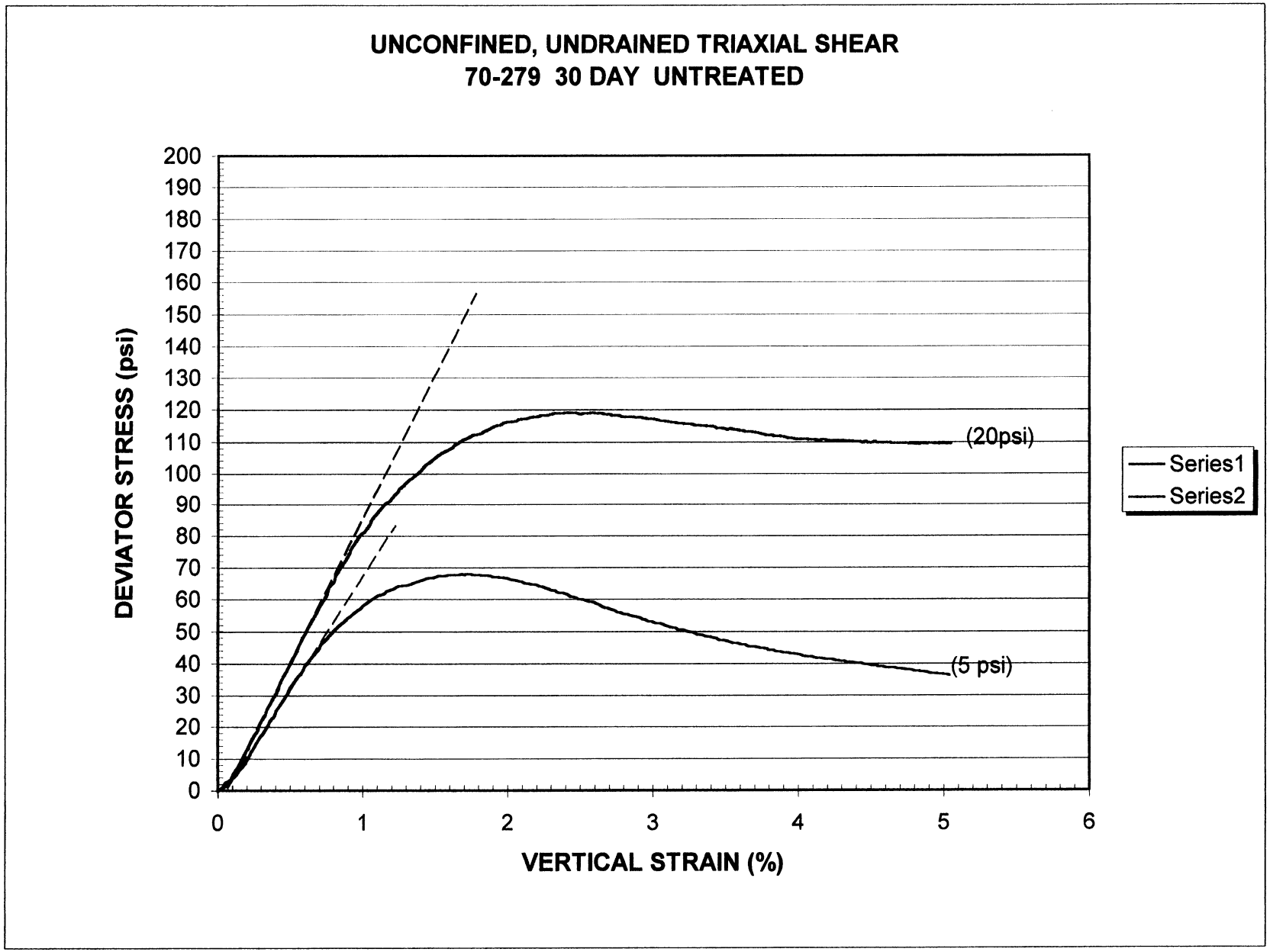

UNCONFINED,UNDRAINED TRIAXIAL SHEAR
36-246 24 hr TREATED
DEVIATOR STRESS (psi)
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2

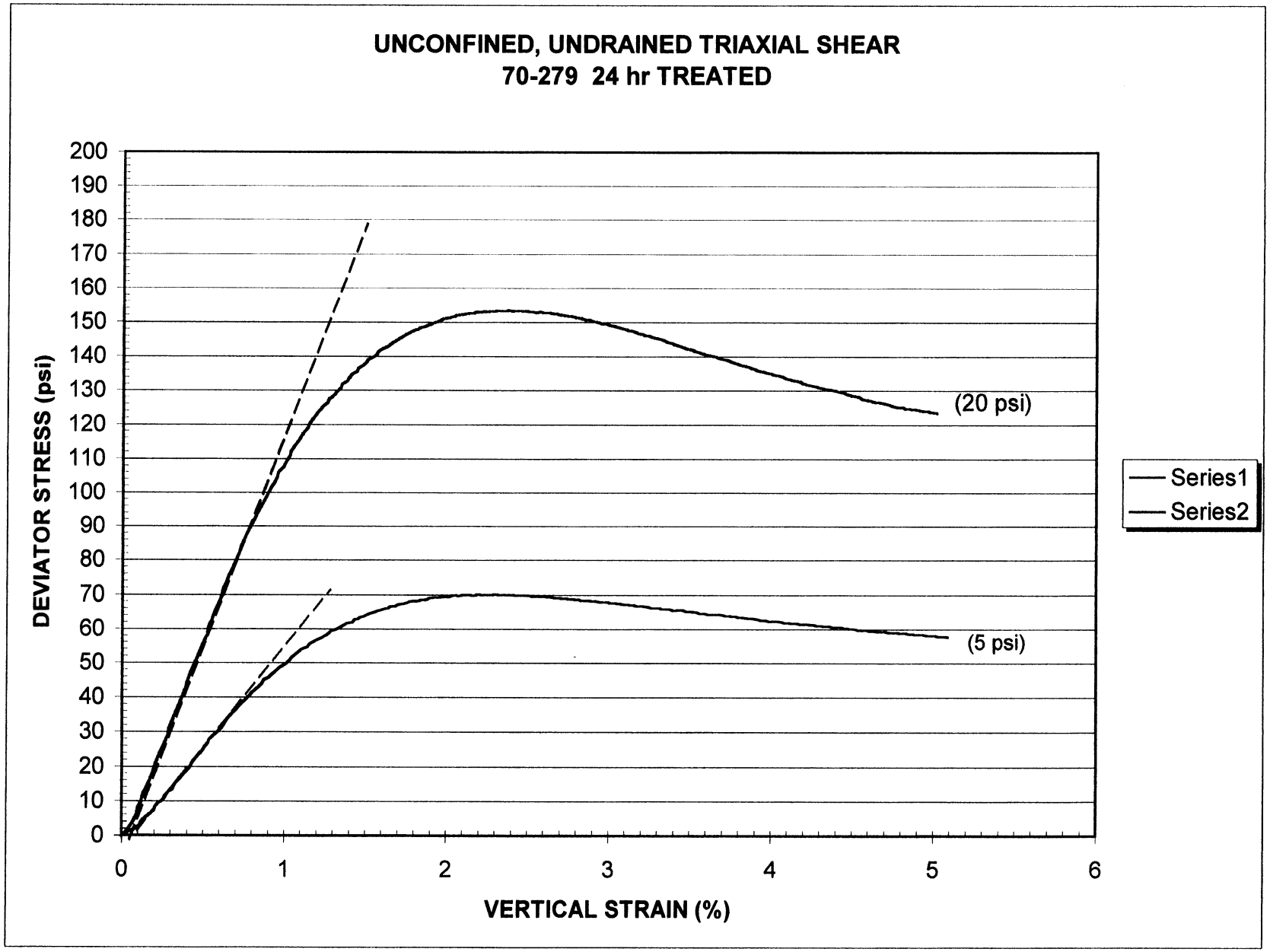

UNCONFINED, UNDRAINED TRIAXIAL SHEAR
36-246 7 DAY TREATED
DEVIATOR STRESS (psi)
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2

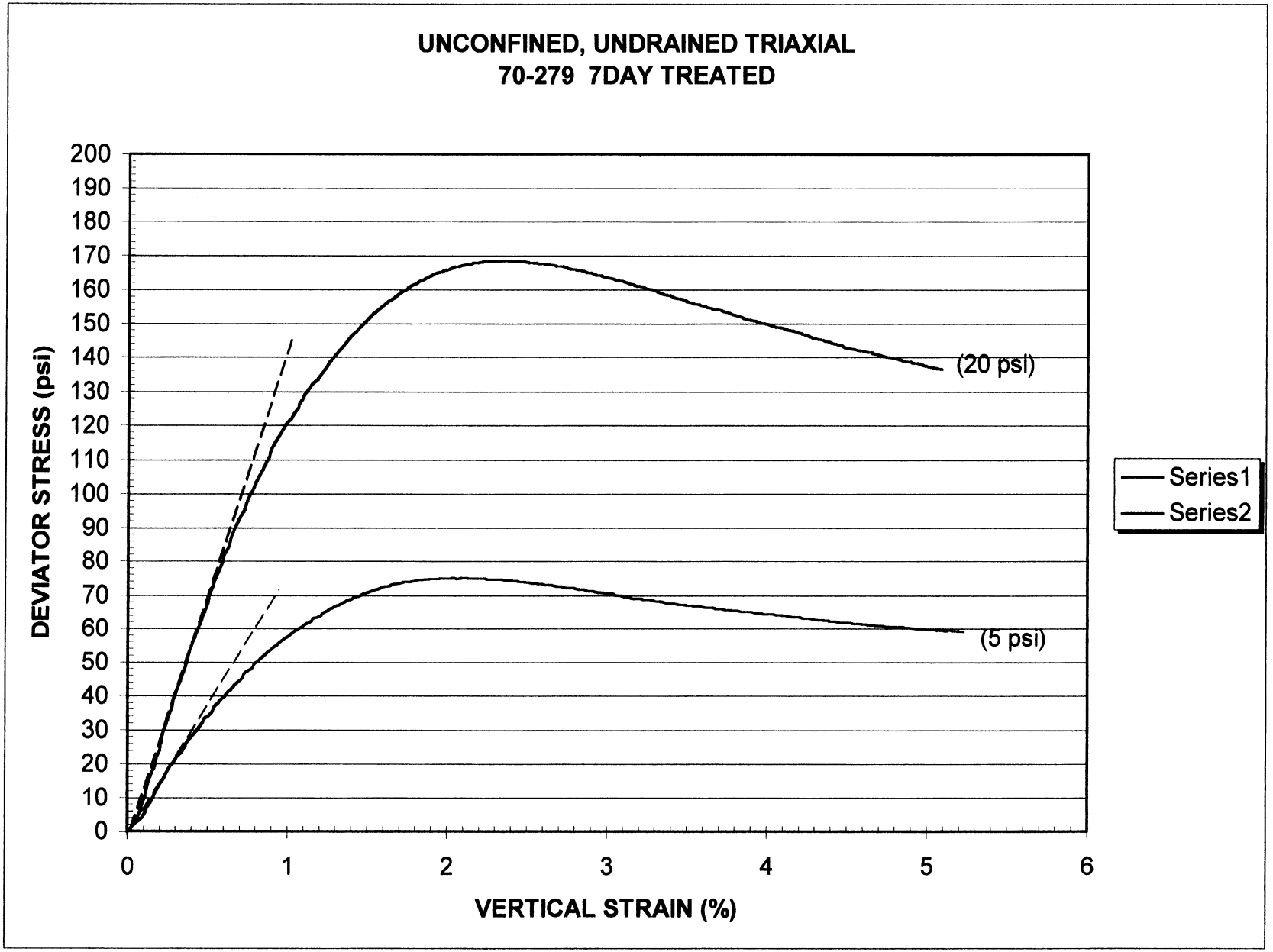

UNCONFINED, UNDRAINED TRIAXIAL SHEAR
36-246 30 DAY TREATED
DEVIATOR STRESS (psi)
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2

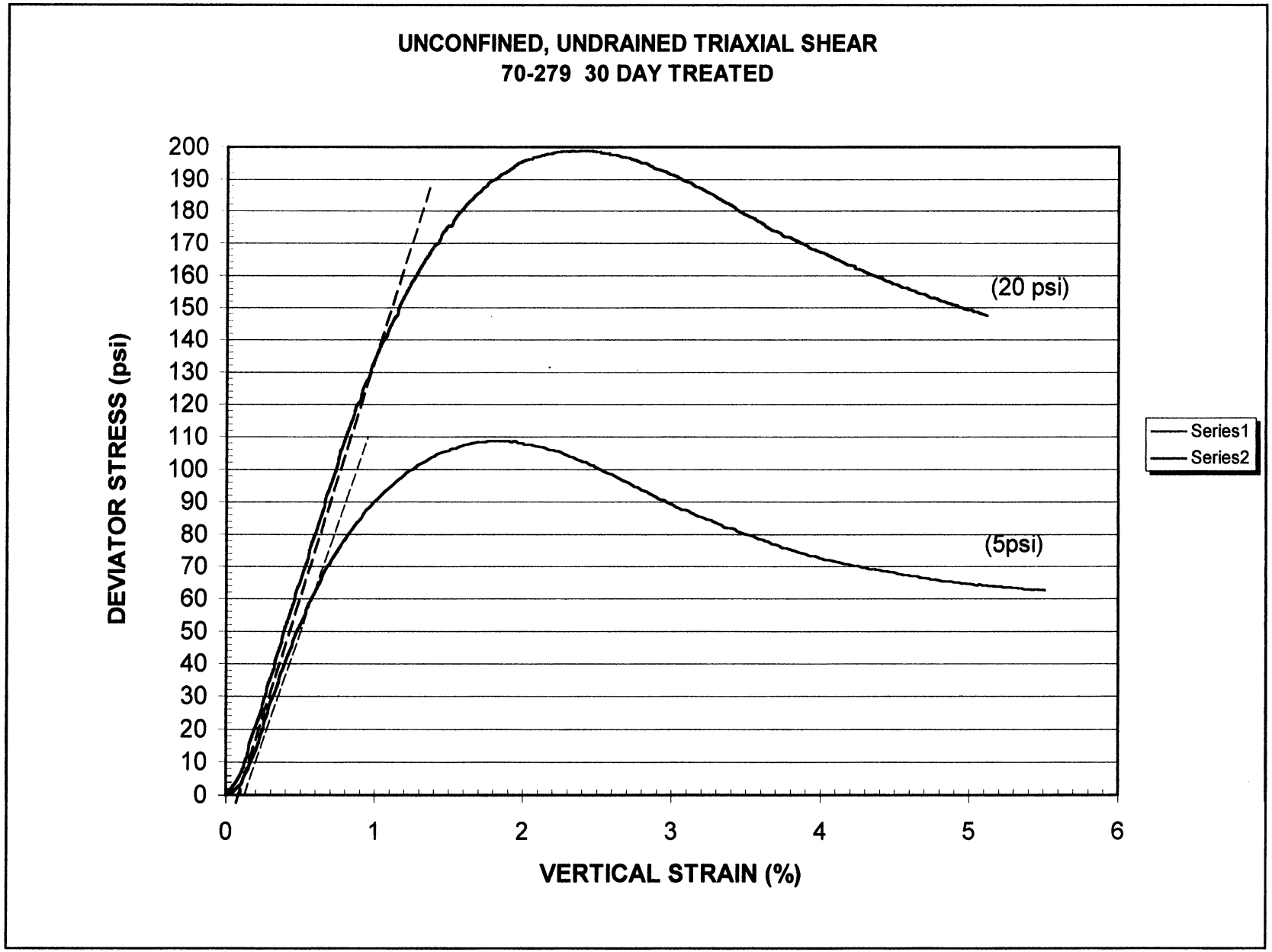

UNCONFINED, UNDRAINED TRIAXIAL SHEAR
70-279 24 hr UNTREATED
DEVIATOR STRESS (PSI)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2


UNCONFINED, UNDRAINED TRIAXIAL SHEAR
70-279 7 DAY UNTREATED
DEVIATOR STRESS (psi)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5psi)
Series1
Series2


UNCONFINED, UNDRAINED TRIAXIAL SHEAR
70-279 30 DAY UNTREATED
DEVIATOR STRESS (psi)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20psi)
(5 psi)
Series1
Series2


UNCONFINED, UNDRAINED TRIAXIAL SHEAR
70-279 24 hr TREATED
DEVIATOR STRESS (psi)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2


UNCONFINED, UNDRAINED TRIAXIAL
70-279 7DAY TREATED
DEVIATOR STRESS (psi)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5 psi)
Series1
Series2


UNCONFINED, UNDRAINED TRIAXIAL SHEAR
70-279 30 DAY TREATED
DEVIATOR STRESS (psi)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
VERTICAL STRAIN (%)
(20 psi)
(5psi)
Series1
Series2

APPENDIX E: TEST DATA AND ANALYSES FOR REPEATED LOAD TRIAXIAL RESILIENT MODULUS

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (1 day, #8, Untreated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

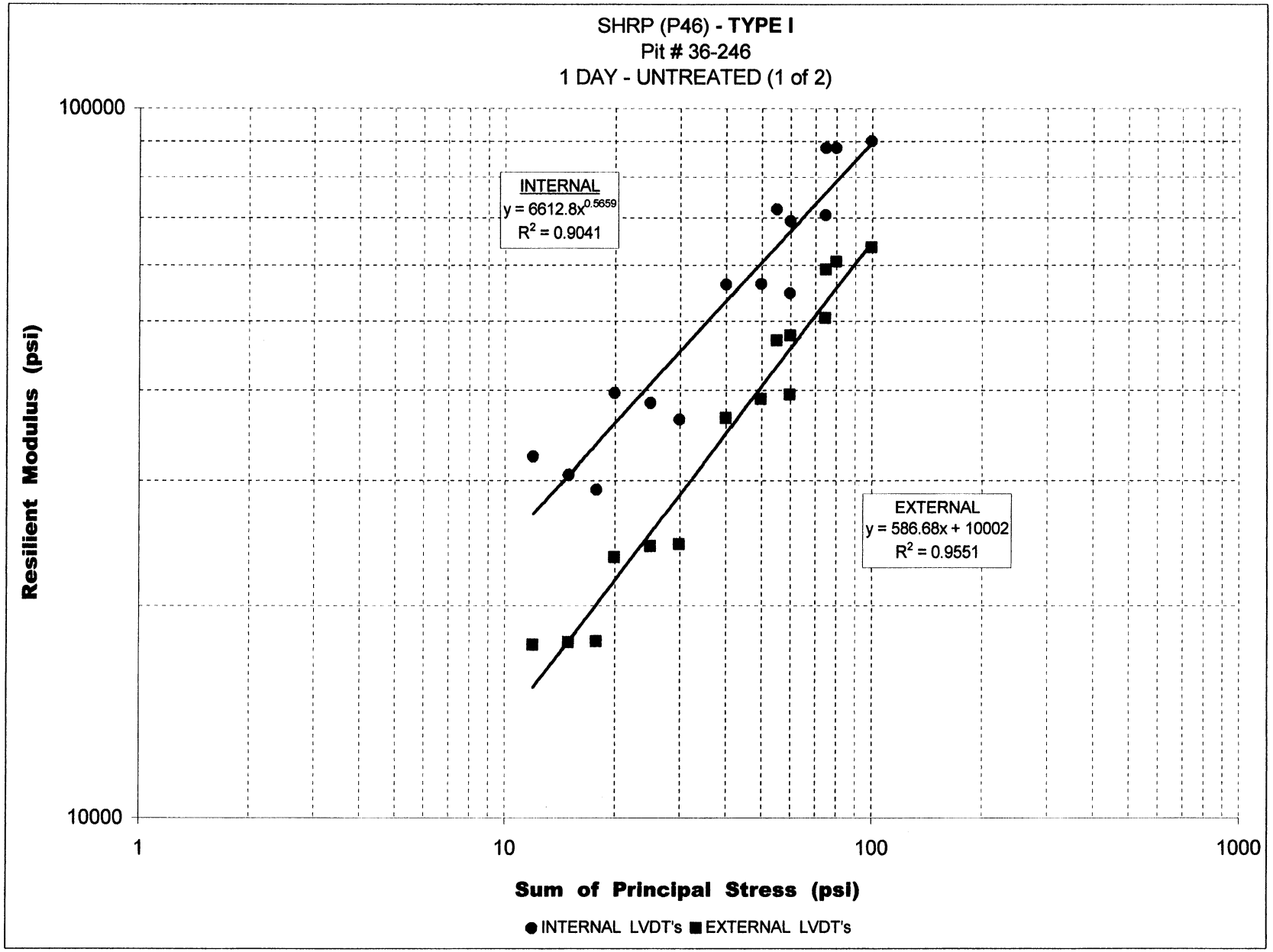
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
11.99 @ 117.0

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.31	2.95	0.00119533	0.00014942	17630
2	3	5.32	0.62	5.94	0.00239627	0.00029953	17768
3	3	7.92	0.86	8.78	0.00355369	0.00044421	17820
4	5	4.47	0.47	4.94	0.00153101	0.00019138	23356
5	5	8.91	1.04	9.95	0.00294740	0.00036842	24193
6	5	13.41	1.52	14.93	0.00440602	0.00055075	24353
7	10	8.97	1.03	10.00	0.00196062	0.00024508	36584
8	10	16.43	3.50	19.93	0.00337960	0.00042245	38882
9	10	26.79	3.02	29.81	0.00543804	0.00067975	39409
10	15	8.97	1.03	10.01	0.00152757	0.00019095	46994
11	15	13.43	1.51	14.94	0.00225321	0.00028165	47691
12	15	26.79	3.03	29.82	0.00424788	0.00053098	50462
13	20	13.38	1.51	14.89	0.00180894	0.00022612	59171
14	20	17.86	2.00	19.86	0.00235534	0.00029442	60668
15	20	35.75	3.98	39.74	0.00449435	0.00056179	63642

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.31	2.95	0.00032489	0.00008122	32432
2	3	5.32	0.62	5.94	0.00069590	0.00017397	30591
3	3	7.92	0.86	8.78	0.00108499	0.00027125	29183
4	5	4.47	0.47	4.94	0.00045029	0.00011257	39706
5	5	8.91	1.04	9.95	0.00092815	0.00023204	38413
6	5	13.41	1.52	14.93	0.00147237	0.00036809	36438
7	10	8.97	1.03	10.00	0.00063557	0.00015889	56427
8	10	16.43	3.50	19.93	0.00116385	0.00029096	56452
9	10	26.79	3.02	29.81	0.00195584	0.00048896	54787
10	15	8.97	1.03	10.01	0.00049812	0.00012453	72057
11	15	13.43	1.51	14.94	0.00077518	0.00019379	69312
12	15	26.79	3.03	29.82	0.00151546	0.00037886	70723
13	20	13.38	1.51	14.89	0.00060713	0.00015178	88150
14	20	17.86	2.00	19.86	0.00081095	0.00020274	88102
15	20	35.75	3.98	39.74	0.00158699	0.00039675	90117


SHRP (P46) - TYPE I
Pit # 36-246
1 DAY - UNTREATED (1 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 6612.8x^0.5659
R² = 0.9041
EXTERNAL
y = 586.68x + 10002
R² = 0.9551
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (1 day, #7, Untreated) Date of Compaction: 5-20-98

LAB # :

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

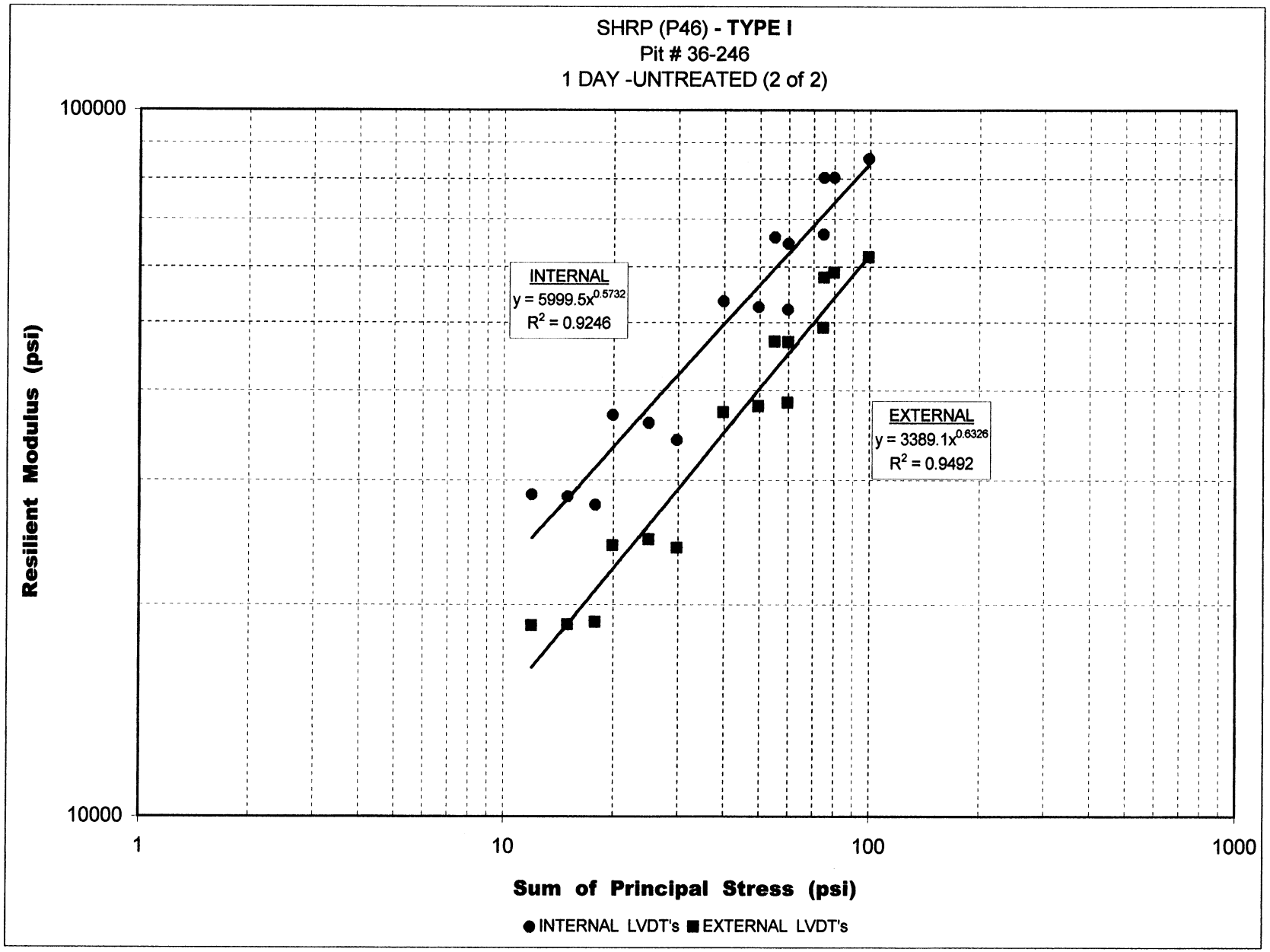
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
12.23 @ 116.3

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00112682	0.00014085	18708
2	3	5.36	0.63	5.99	0.00228423	0.00028553	18760
3	3	7.98	0.88	8.86	0.00337788	0.00042223	18902
4	5	4.45	0.47	4.93	0.00146604	0.00018326	24300
5	5	8.92	1.04	9.96	0.00288234	0.00036029	24755
6	5	13.29	1.51	14.81	0.00441593	0.00055199	24081
7	10	8.92	1.04	9.96	0.00191150	0.00023894	37341
8	10	17.73	1.99	19.72	0.00372432	0.00046554	38090
9	10	26.84	3.02	29.86	0.00557722	0.00069715	38502
10	15	8.97	1.04	10.01	0.00152670	0.00019084	46999
11	15	13.39	1.53	14.92	0.00228380	0.00028548	46905
12	15	26.65	3.01	29.67	0.00434181	0.00054273	49108
13	20	13.42	1.52	14.94	0.00185333	0.00023167	57935
14	20	17.98	1.99	19.97	0.00244066	0.00030508	58922
15	20	35.27	3.99	39.25	0.00456071	0.00057009	61860

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00036712	0.00009178	28710
2	3	5.36	0.63	5.99	0.00075191	0.00018798	28496
3	3	7.98	0.88	8.86	0.00115092	0.00028773	27738
4	5	4.45	0.47	4.93	0.00048116	0.00012029	37019
5	5	8.92	1.04	9.96	0.00098848	0.00024712	36092
6	5	13.29	1.51	14.81	0.00155554	0.00038888	34181
7	10	8.92	1.04	9.96	0.00066487	0.00016622	53678
8	10	17.73	1.99	19.72	0.00134784	0.00033696	52625
9	10	26.84	3.02	29.86	0.00205537	0.00051384	52237
10	15	8.97	1.04	10.01	0.00054250	0.00013562	66132
11	15	13.39	1.53	14.92	0.00082732	0.00020683	64741
12	15	26.65	3.01	29.67	0.00159776	0.00039944	66724
13	20	13.42	1.52	14.94	0.00066789	0.00016697	80382
14	20	17.98	1.99	19.97	0.00089454	0.00022364	80382
15	20	35.27	3.99	39.25	0.00165163	0.00041291	85408


SHRP (P46) - TYPE I
Pit # 36-246
1 DAY -UNTREATED (2 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 5999.5x^0.5732
R^2 = 0.9246
EXTERNAL
y = 3389.1x^0.6326
R^2 = 0.9492
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (7 day,#3 Untreated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

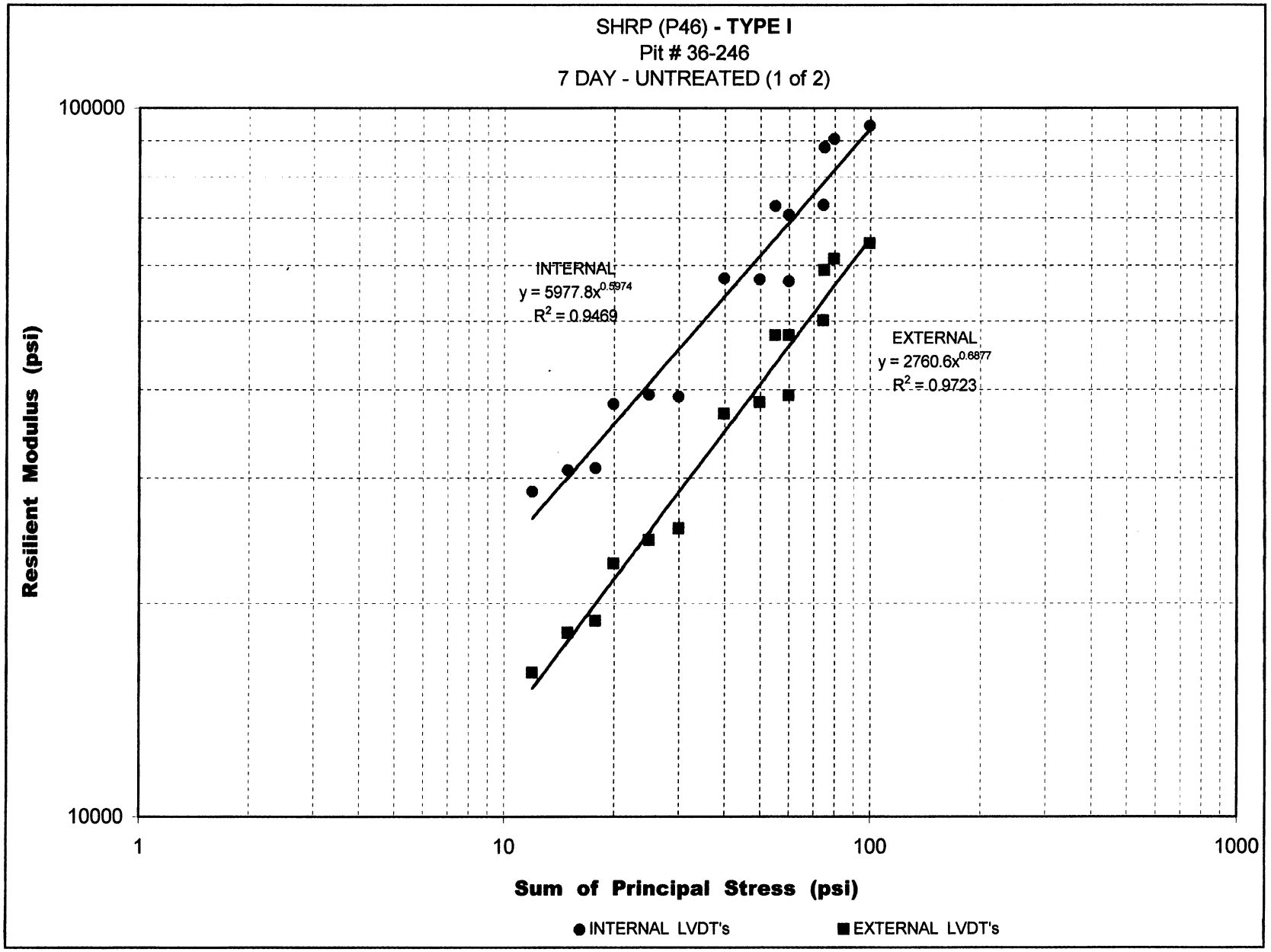
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
12.09 @ 117.6

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00130909	0.00016364	15998
2	3	5.33	0.63	5.96	0.00234413	0.00029302	18174
3	3	7.93	0.88	8.81	0.00335848	0.00041981	18887
4	5	4.44	0.48	4.92	0.00155988	0.00019498	22767
5	5	8.84	1.05	9.89	0.00288133	0.00036017	24553
6	5	13.51	1.51	15.02	0.00424443	0.00053055	25456
7	10	8.88	1.03	9.91	0.00192098	0.00024012	36985
8	10	17.85	1.99	19.84	0.00371829	0.00046479	38414
9	10	26.88	3.01	29.89	0.00547423	0.00068428	39285
10	15	8.94	1.03	9.97	0.00149697	0.00018712	47765
11	15	13.47	1.52	15.00	0.00225881	0.00028235	47719
12	15	26.62	3.02	29.64	0.00424788	0.00053098	50133
13	20	13.55	1.51	15.06	0.00183566	0.00022946	59052
14	20	17.84	1.99	19.83	0.00233293	0.00029162	61180
15	20	35.70	3.99	39.69	0.00443403	0.00055425	64414

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00036454	0.00009113	28724
2	3	5.33	0.63	5.96	0.00069116	0.00017279	30820
3	3	7.93	0.88	8.81	0.00102252	0.00025563	31018
4	5	4.44	0.48	4.92	0.00046494	0.00011623	38193
5	5	8.84	1.05	9.89	0.00089866	0.00022466	39361
6	5	13.51	1.51	15.02	0.00137973	0.00034493	39154
7	10	8.88	1.03	9.91	0.00061748	0.00015437	57531
8	10	17.85	1.99	19.84	0.00124658	0.00031165	57290
9	10	26.88	3.01	29.89	0.00188646	0.00047162	56999
10	15	8.94	1.03	9.97	0.00048993	0.00012248	72972
11	15	13.47	1.52	15.00	0.00076053	0.00019013	70863
12	15	26.62	3.02	29.64	0.00145643	0.00036411	73110
13	20	13.55	1.51	15.06	0.00061532	0.00015383	88084
14	20	17.84	1.99	19.83	0.00078768	0.00019692	90601
15	20	35.70	3.99	39.69	0.00151115	0.00037779	94503


SHRP (P46) - TYPE I
Pit # 36-246
7 DAY - UNTREATED (1 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 5977.8x^0.5974
R2 = 0.9469
EXTERNAL
y = 2760.6x^0.6877
R2 = 0.9723
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (7 day, #1, Untreated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

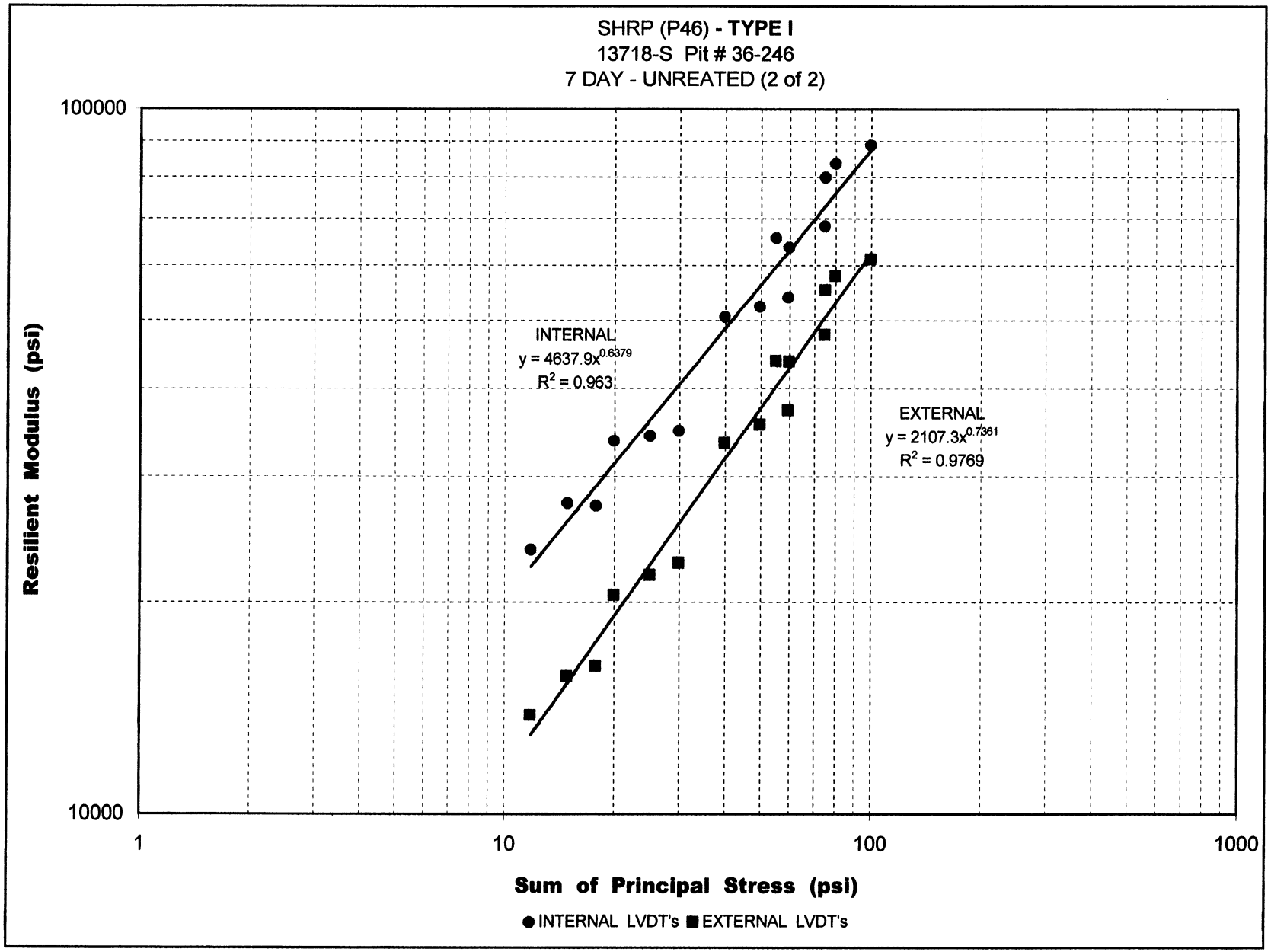
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
12.03 @ 116.5

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.46	0.32	2.78	0.00142285	0.00017786	13843
2	3	5.22	0.64	5.86	0.00266171	0.00033271	15691
3	3	7.91	0.88	8.79	0.00389238	0.00048655	16249
4	5	4.44	0.48	4.92	0.00173828	0.00021728	20434
5	5	8.97	1.04	10.00	0.00329256	0.00041157	21790
6	5	13.42	1.51	14.93	0.00473997	0.00059250	22653
7	10	8.83	1.04	9.87	0.00210756	0.00026345	33514
8	10	17.81	2.00	19.80	0.00400269	0.00050034	35592
9	10	26.39	3.02	29.42	0.00566254	0.00070782	37289
10	15	8.96	1.03	9.99	0.00163314	0.00020414	43867
11	15	13.32	1.51	14.83	0.00243247	0.00030406	43792
12	15	26.73	3.01	29.74	0.00447669	0.00055959	47765
13	20	13.49	1.51	15.01	0.00195373	0.00024422	55258
14	20	17.95	1.99	19.94	0.00247944	0.00030993	57916
15	20	35.80	3.97	39.77	0.00468094	0.00058512	61186

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.46	0.32	2.78	0.00041625	0.00010406	23660
2	3	5.22	0.64	5.86	0.00075881	0.00018970	27521
3	3	7.91	0.88	8.79	0.00115696	0.00028924	27334
4	5	4.44	0.48	4.92	0.00052612	0.00013153	33757
5	5	8.97	1.04	10.00	0.00104449	0.00026112	34345
6	5	13.42	1.51	14.93	0.00153959	0.00038490	34871
7	10	8.83	1.04	9.87	0.00069633	0.00017408	50718
8	10	17.81	2.00	19.80	0.00135818	0.00033955	52447
9	10	26.39	3.02	29.42	0.00195153	0.00048788	54098
10	15	8.96	1.03	9.99	0.00054508	0.00013627	65716
11	15	13.32	1.51	14.83	0.00083594	0.00020898	63715
12	15	26.73	3.01	29.74	0.00156544	0.00039136	68297
13	20	13.49	1.51	15.01	0.00067565	0.00016891	79893
14	20	17.95	1.99	19.94	0.00085878	0.00021469	83606
15	20	35.80	3.97	39.77	0.00161026	0.00040256	88932


SHRP (P46) - TYPE I
13718-S Pit # 36-246
7 DAY - UNREATED (2 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 4637.9x^0.6379
R2 = 0.963
EXTERNAL
y = 2107.3x^0.7361
R2 = 0.9769
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (14 day,#6, Untreated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

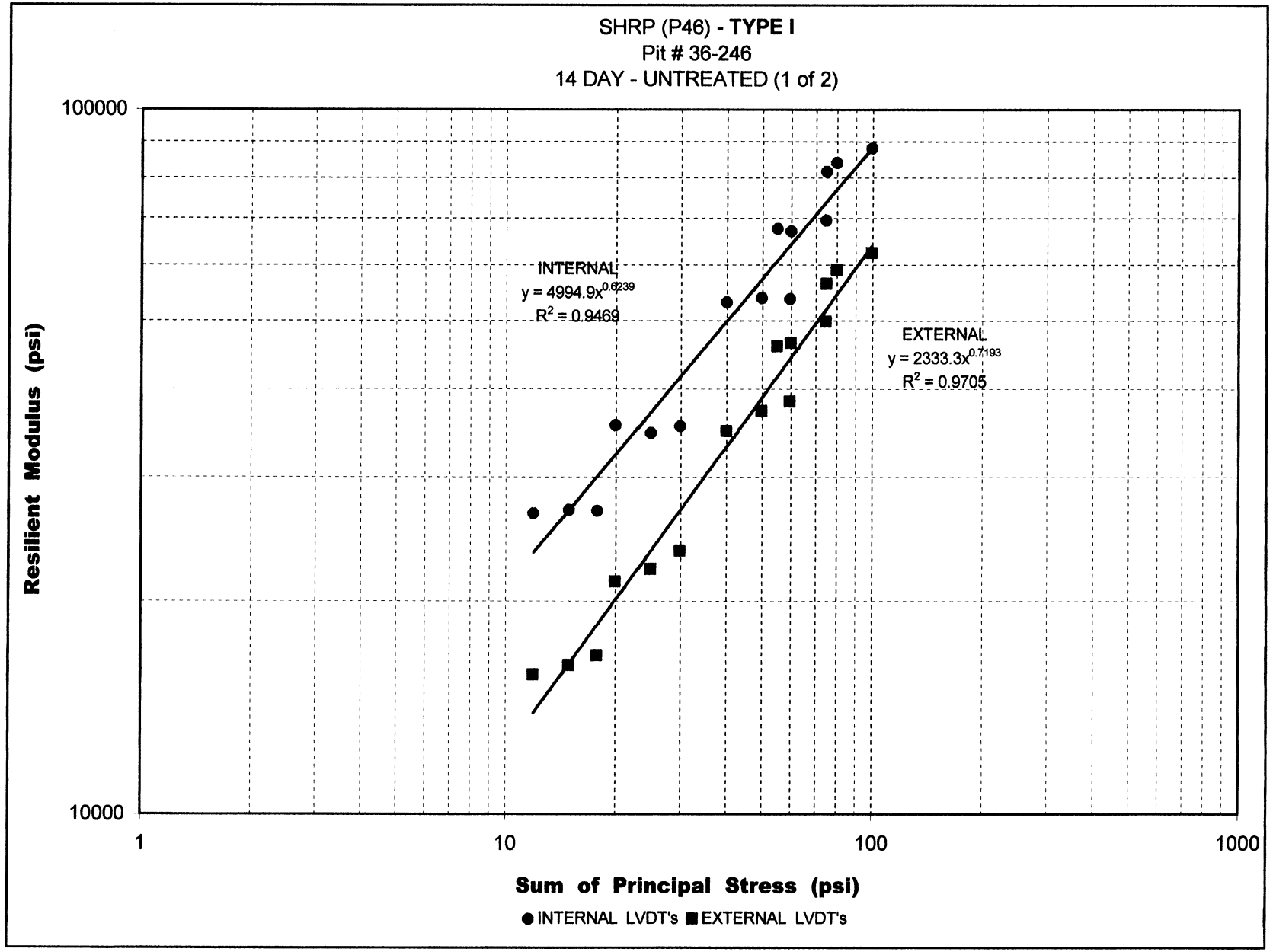
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
12.05 @ 116.4

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.33	2.92	0.00131728	0.00016466	15733
2	3	5.23	0.64	5.87	0.00258199	0.00032275	16214
3	3	7.91	0.87	8.78	0.00378379	0.00047297	16731
4	5	4.43	0.48	4.91	0.00166201	0.00020775	21325
5	5	8.89	1.04	9.93	0.00320637	0.00040080	22173
6	5	13.41	1.51	14.92	0.00455770	0.00056971	23538
7	10	8.96	1.04	10.00	0.00205499	0.00025687	34888
8	10	17.85	2.00	19.84	0.00383334	0.00047917	37247
9	10	26.64	3.02	29.66	0.00554447	0.00069306	38440
10	15	9.01	1.04	10.05	0.00156807	0.00019601	45986
11	15	13.42	1.51	14.93	0.00230707	0.00028838	46541
12	15	26.69	3.03	29.72	0.00428149	0.00053519	49867
13	20	13.51	1.52	15.03	0.00191495	0.00023937	56428
14	20	18.02	1.99	20.01	0.00244195	0.00030524	59029
15	20	35.77	3.97	39.74	0.00458700	0.00057337	62386

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.33	2.92	0.00038867	0.00009717	26661
2	3	5.23	0.64	5.87	0.00077604	0.00019401	26973
3	3	7.91	0.87	8.78	0.00117807	0.00029452	26869
4	5	4.43	0.48	4.91	0.00049725	0.00012431	35637
5	5	8.89	1.04	9.93	0.00102467	0.00025617	34691
6	5	13.41	1.51	14.92	0.00151029	0.00037757	35517
7	10	8.96	1.04	10.00	0.00067349	0.00016837	53226
8	10	17.85	2.00	19.84	0.00132285	0.00033071	53968
9	10	26.64	3.02	29.66	0.00197953	0.00049488	53834
10	15	9.01	1.04	10.05	0.00053302	0.00013325	67642
11	15	13.42	1.51	14.93	0.00080060	0.00020015	67057
12	15	26.69	3.03	29.72	0.00153700	0.00038425	69455
13	20	13.51	1.52	15.03	0.00066185	0.00016546	81633
14	20	18.02	1.99	20.01	0.00085705	0.00021426	84094
15	20	35.77	3.97	39.74	0.00162103	0.00040526	88266


SHRP (P46) - TYPE I
Pit # 36-246
14 DAY - UNTREATED (1 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 4994.9x^0.6239
R^2 = 0.9469
EXTERNAL
y = 2333.3x^0.7193
R^2 = 0.9705
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

LAB # : 13718-S

DATE: May 21, 1998

SAMPLE # : 2 of 2

PROJ. NO.: 1909701A101-037

LBR :

MATERIAL DESCRIPTION : Tan Limerock

SOIL CLASS :

COMMENTS : Pit # 36-246 (14 day, #7, Untreated) Date of Compaction: 5-20-98

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

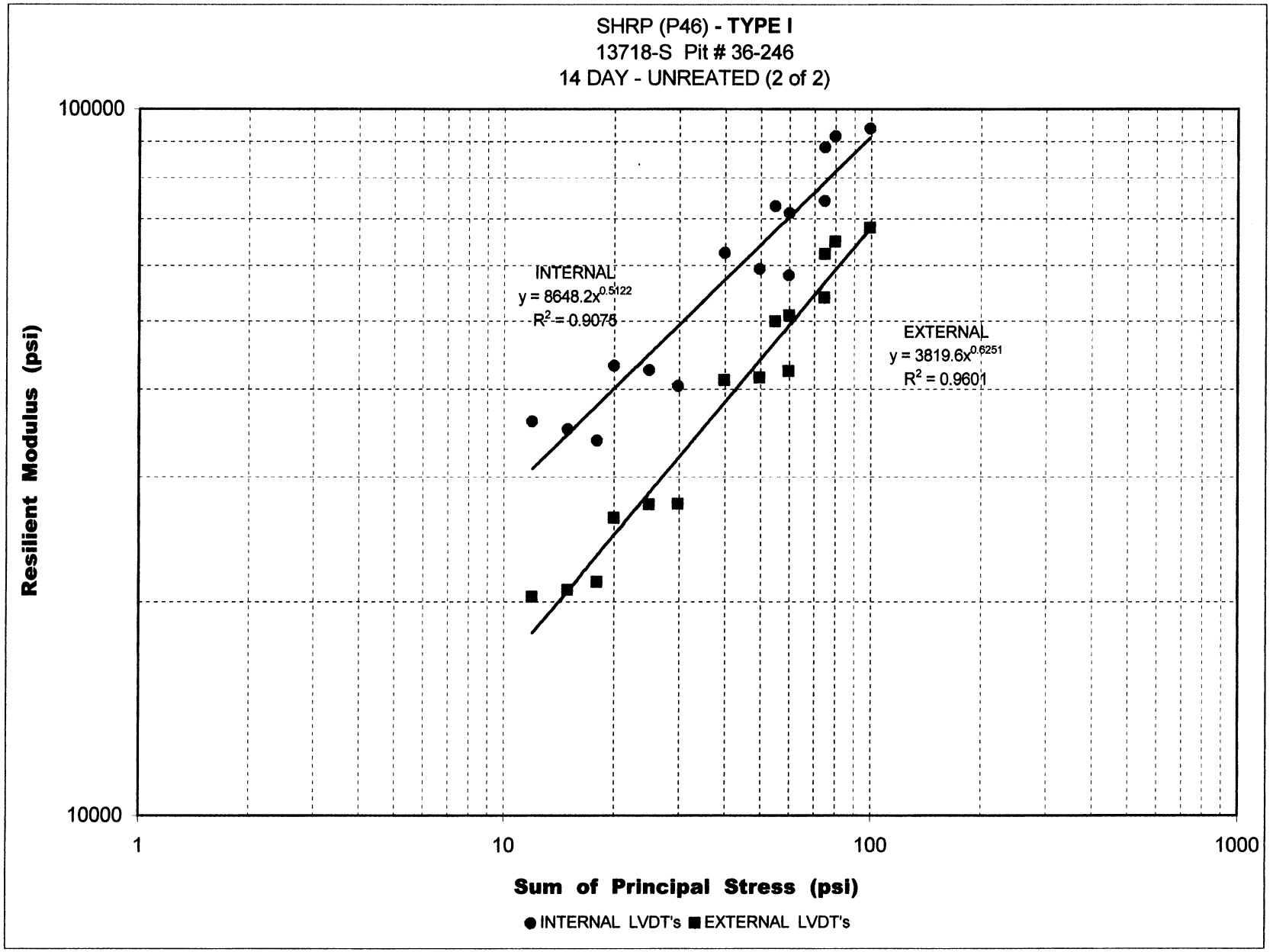
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
12.05 @ 116.3

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.31	2.96	0.00104150	0.00013019	20297
2	3	5.31	0.64	5.95	0.00204724	0.00025590	20761
3	3	8.07	0.88	8.94	0.00302668	0.00037834	21328
4	5	4.49	0.48	4.97	0.00137028	0.00017129	26216
5	5	8.85	1.03	9.88	0.00258285	0.00032286	27401
6	5	13.32	1.51	14.84	0.00388591	0.00048574	27430
7	10	8.92	1.04	9.96	0.00173354	0.00021669	41156
8	10	17.83	1.99	19.82	0.00343734	0.00042967	41508
9	10	26.68	3.03	29.71	0.00503385	0.00062923	42408
10	15	8.91	1.03	9.94	0.00142587	0.00017823	49967
11	15	13.54	1.52	15.05	0.00212781	0.00026598	50892
12	15	26.83	3.03	29.85	0.00397425	0.00049678	54004
13	20	13.45	1.52	14.97	0.00172708	0.00021588	62292
14	20	17.93	1.99	19.92	0.00221400	0.00027675	64800
15	20	35.54	3.98	39.52	0.00419401	0.00052425	67801

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.31	2.96	0.00029344	0.00007336	36020
2	3	5.31	0.64	5.95	0.00060541	0.00015135	35103
3	3	8.07	0.88	8.94	0.00095443	0.00023861	33817
4	5	4.49	0.48	4.97	0.00041581	0.00010395	43196
5	5	8.85	1.03	9.88	0.00083120	0.00020780	42572
6	5	13.32	1.51	14.84	0.00131725	0.00032931	40459
7	10	8.92	1.04	9.96	0.00056964	0.00014241	62622
8	10	17.83	1.99	19.82	0.00120177	0.00030044	59361
9	10	26.68	3.03	29.71	0.00183518	0.00045880	58161
10	15	8.91	1.03	9.94	0.00048864	0.00012216	72902
11	15	13.54	1.52	15.05	0.00075967	0.00018992	71273
12	15	26.83	3.03	29.85	0.00144436	0.00036109	74298
13	20	13.45	1.52	14.97	0.00060799	0.00015200	88474
14	20	17.93	1.99	19.92	0.00078294	0.00019573	91620
15	20	35.54	3.98	39.52	0.00151029	0.00037757	94140


SHRP (P46) - TYPE I
13718-S Pit # 36-246
14 DAY - UNREATED (2 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 8648.2x^0.5122
R2 = 0.9075
EXTERNAL
y = 3819.6x^0.6251
R2 = 0.9601
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (28 day,#4,Untreated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

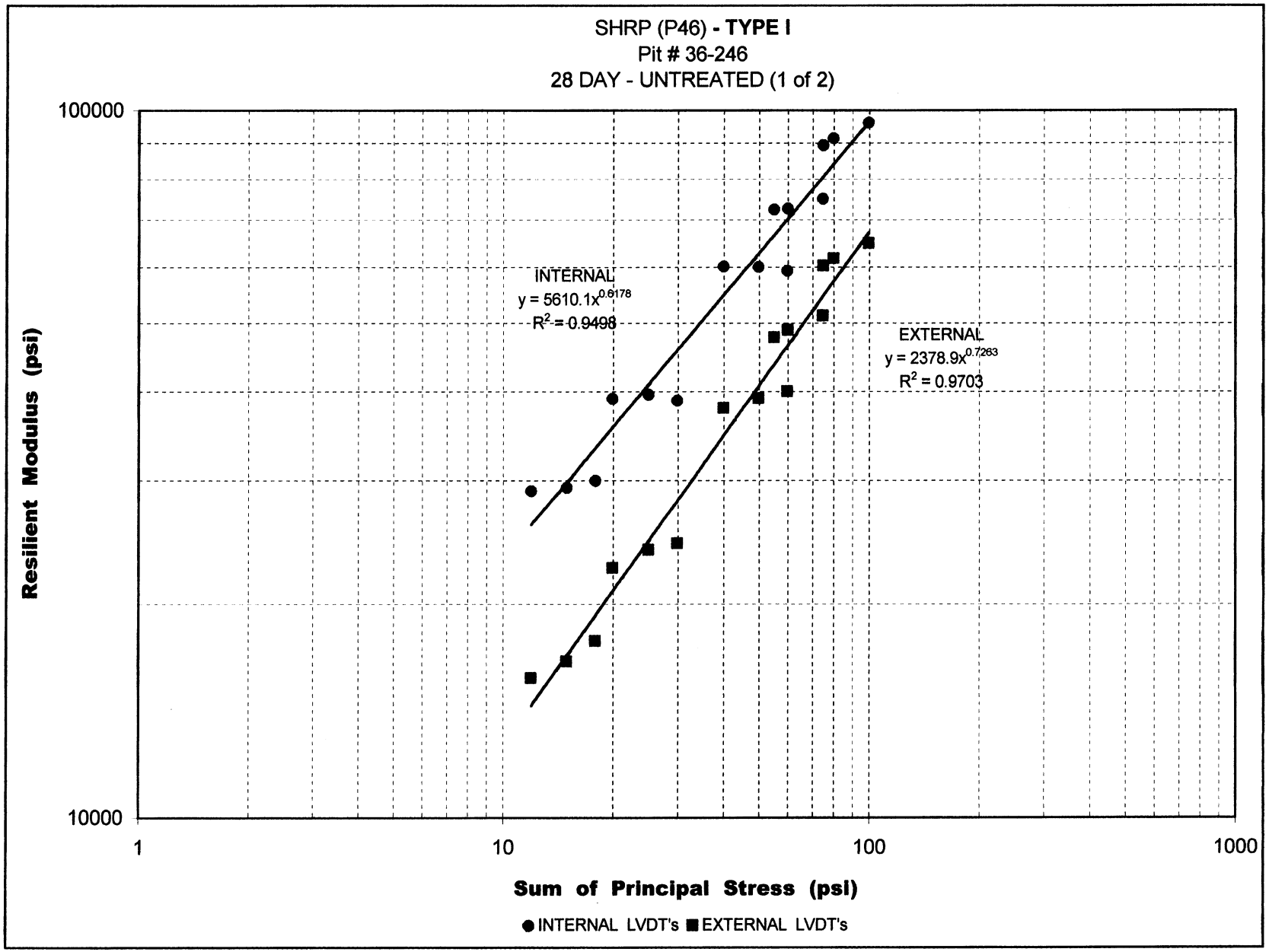
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
12.01 @ 116.5

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.93	0.00132504	0.00016563	15740
2	3	5.29	0.63	5.92	0.00254364	0.00031796	16630
3	3	8.03	0.87	8.90	0.00361186	0.00045148	17779
4	5	4.42	0.48	4.90	0.00157195	0.00019649	22509
5	5	8.97	1.04	10.01	0.00300471	0.00037559	23889
6	5	13.38	1.51	14.89	0.00438577	0.00054822	24404
7	10	8.98	1.04	10.02	0.00189513	0.00023689	37897
8	10	17.94	2.00	19.93	0.00367046	0.00045881	39092
9	10	26.78	3.02	29.80	0.00535531	0.00066941	40001
10	15	9.01	1.04	10.05	0.00150947	0.00018868	47762
11	15	13.46	1.51	14.97	0.00220280	0.00027535	48893
12	15	26.82	3.03	29.85	0.00419099	0.00052387	51193
13	20	13.42	1.52	14.93	0.00177835	0.00022229	60355
14	20	17.99	1.99	19.98	0.00233077	0.00029135	61751
15	20	35.74	3.98	39.72	0.00440042	0.00055005	64975

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.93	0.00035937	0.00008984	29018
2	3	5.29	0.63	5.92	0.00072089	0.00018022	29339
3	3	8.03	0.87	8.90	0.00106948	0.00026737	30022
4	5	4.42	0.48	4.90	0.00045244	0.00011311	39102
5	5	8.97	1.04	10.01	0.00090531	0.00022633	39643
6	5	13.38	1.51	14.89	0.00137628	0.00034407	38884
7	10	8.98	1.04	10.02	0.00059636	0.00014909	60215
8	10	17.94	2.00	19.93	0.00119315	0.00029829	60129
9	10	26.78	3.02	29.80	0.00180545	0.00045136	59325
10	15	9.01	1.04	10.05	0.00049682	0.00012421	72557
11	15	13.46	1.51	14.97	0.00074028	0.00018507	72744
12	15	26.82	3.03	29.85	0.00142755	0.00035689	75145
13	20	13.42	1.52	14.93	0.00060024	0.00015006	89409
14	20	17.99	1.99	19.98	0.00078724	0.00019681	91412
15	20	35.74	3.98	39.72	0.00148659	0.00037165	96166


SHRP (P46) - TYPE I
Pit # 36-246
28 DAY - UNTREATED (1 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 5610.1x^0.6178
R^2 = 0.9498
EXTERNAL
y = 2378.9x^0.7263
R^2 = 0.9703
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (28 day, #2, Untreated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

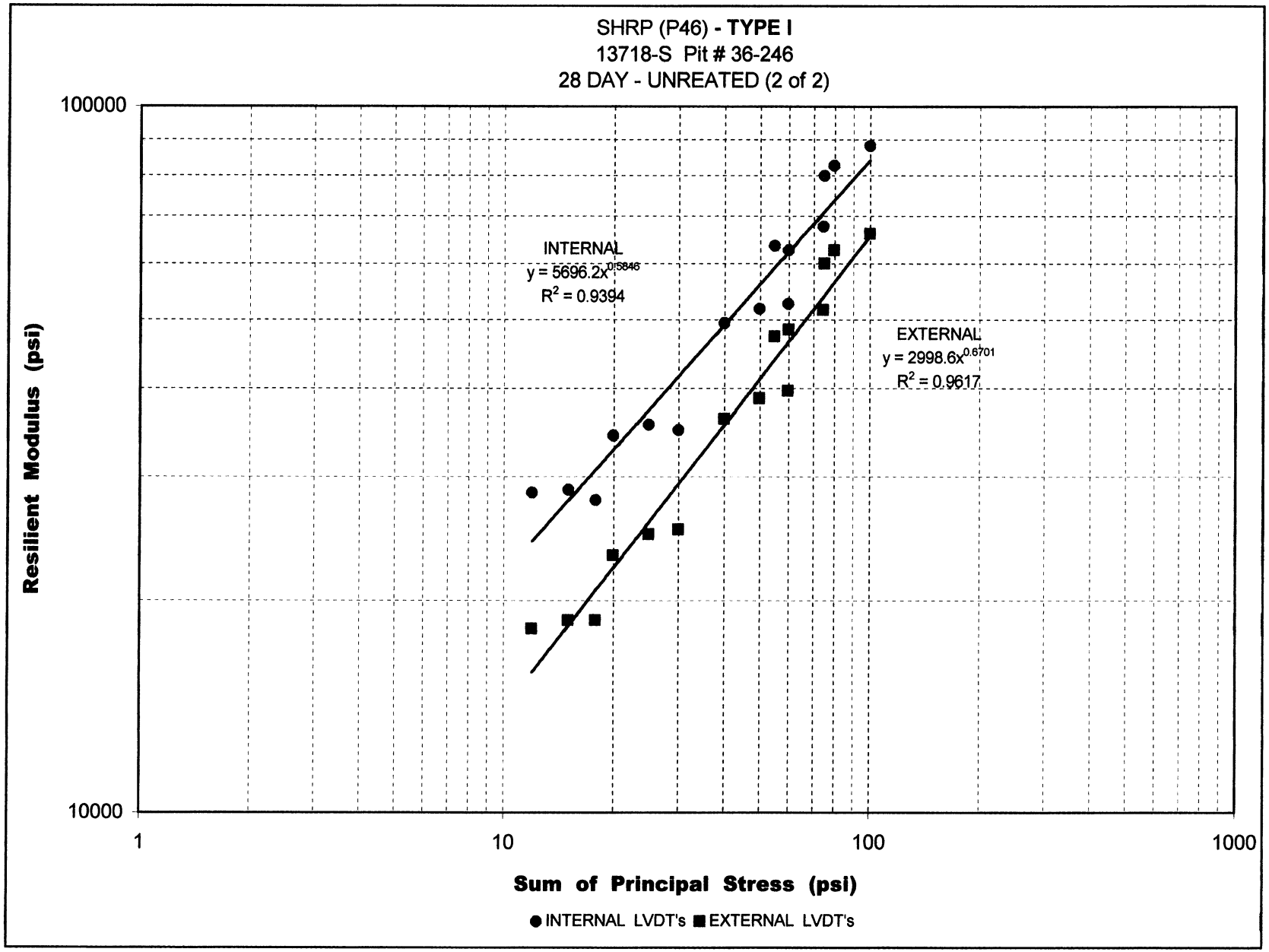
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
11.96 @ 116.9

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00115311	0.00014414	18236
2	3	5.38	0.64	6.01	0.00229544	0.00028693	18735
3	3	7.99	0.88	8.86	0.00340804	0.00042600	18748
4	5	4.43	0.48	4.90	0.00152541	0.00019068	23213
5	5	8.89	1.04	9.92	0.00285992	0.00035749	24863
6	5	13.50	1.52	15.01	0.00427416	0.00053427	25263
7	10	9.00	1.04	10.03	0.00198605	0.00024826	36248
8	10	17.93	1.99	19.92	0.00369976	0.00046247	38759
9	10	26.76	3.03	29.79	0.00539150	0.00067394	39703
10	15	8.89	1.04	9.93	0.00150171	0.00018771	47355
11	15	13.51	1.52	15.03	0.00222951	0.00027869	48479
12	15	26.58	3.02	29.60	0.00411774	0.00051472	51638
13	20	13.57	1.51	15.08	0.00181024	0.00022628	59966
14	20	17.78	1.99	19.77	0.00227303	0.00028413	62563
15	20	35.91	3.98	39.89	0.00434828	0.00054353	66074

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00036885	0.00009221	28505
2	3	5.38	0.64	6.01	0.00074717	0.00018679	28778
3	3	7.99	0.88	8.86	0.00114877	0.00028719	27810
4	5	4.43	0.48	4.90	0.00051492	0.00012873	34383
5	5	8.89	1.04	9.92	0.00099882	0.00024970	35596
6	5	13.50	1.52	15.01	0.00154260	0.00038565	34999
7	10	9.00	1.04	10.03	0.00072606	0.00018151	49576
8	10	17.93	1.99	19.92	0.00138232	0.00034558	51870
9	10	26.76	3.03	29.79	0.00202995	0.00050749	52725
10	15	8.89	1.04	9.93	0.00055844	0.00013961	63672
11	15	13.51	1.52	15.03	0.00086179	0.00021545	62709
12	15	26.58	3.02	29.60	0.00156976	0.00039244	67727
13	20	13.57	1.51	15.08	0.00067823	0.00016956	80026
14	20	17.78	1.99	19.77	0.00085964	0.00021491	82714
15	20	35.91	3.98	39.89	0.00162879	0.00040720	88197


SHRP (P46) - TYPE I
13718-S Pit # 36-246
28 DAY - UNREATED (2 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 5696.2x^0.5846
R2 = 0.9394
EXTERNAL
y = 2998.6x^0.6701
R2 = 0.9617
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (1 day, #8, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

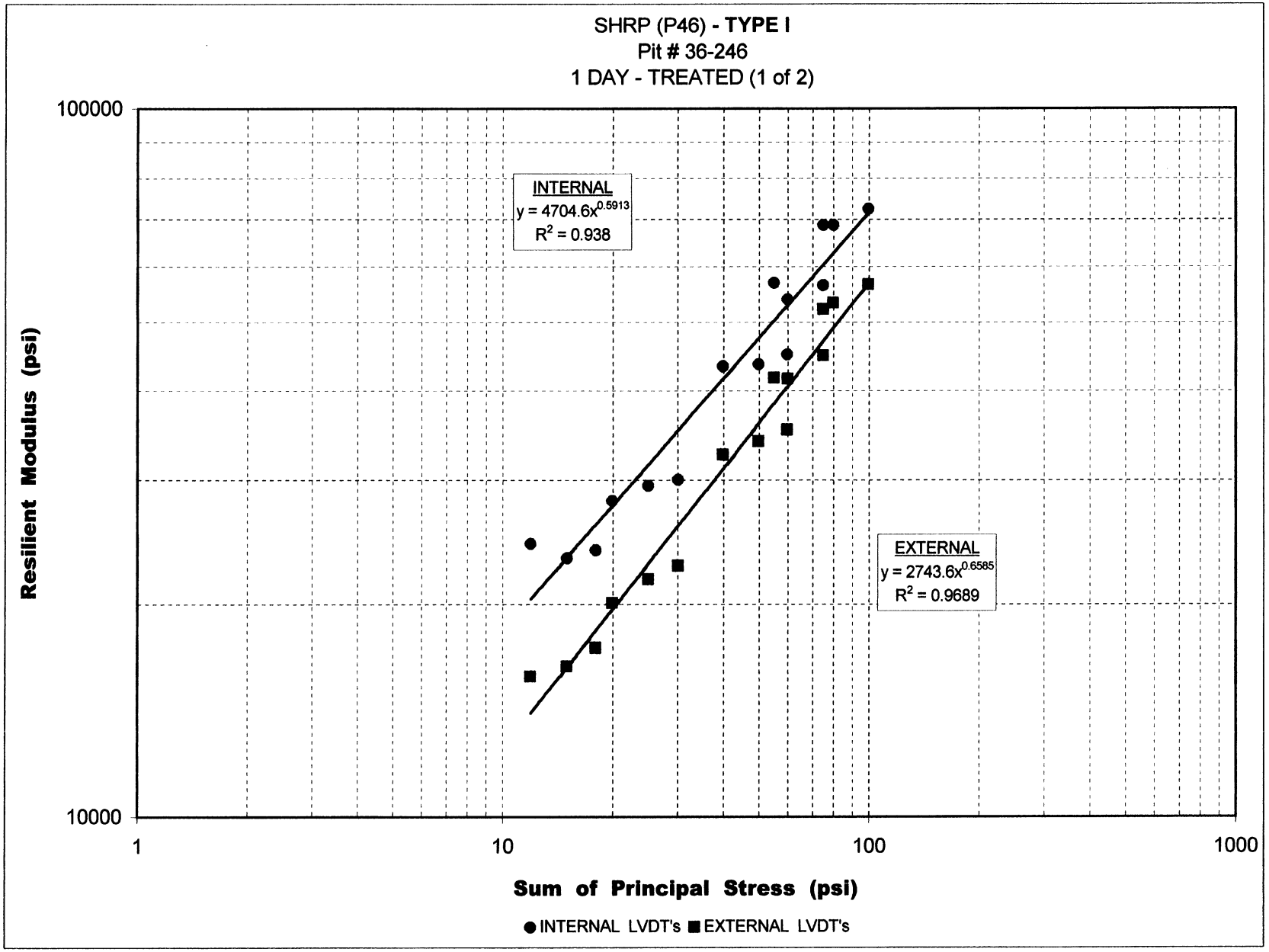
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
12.1 @ 115.9

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00131039	0.00016380	15826
2	3	5.34	0.63	5.97	0.00260784	0.00032598	16367
3	3	8.10	0.87	8.97	0.00373165	0.00046646	17359
4	5	4.46	0.48	4.93	0.00177490	0.00022186	20087
5	5	8.97	1.04	10.01	0.00330764	0.00041346	21699
6	5	13.60	1.52	15.11	0.00479771	0.00059971	22674
7	10	8.89	1.03	9.92	0.00218340	0.00027293	32573
8	10	17.93	2.00	19.93	0.00421470	0.00052684	34027
9	10	26.72	3.02	29.73	0.00605122	0.00075640	35319
10	15	8.95	1.04	9.99	0.00171458	0.00021432	41772
11	15	13.46	1.52	14.99	0.00258759	0.00032345	41623
12	15	26.93	3.02	29.95	0.00480116	0.00060014	44879
13	20	13.46	1.52	14.97	0.00206189	0.00025774	52215
14	20	17.95	2.00	19.94	0.00269403	0.00033675	53290
15	20	35.73	3.98	39.71	0.00504118	0.00063015	56700

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00042529	0.00010632	24381
2	3	5.34	0.63	5.97	0.00091738	0.00022934	23263
3	3	8.10	0.87	8.97	0.00135732	0.00033933	23862
4	5	4.46	0.48	4.93	0.00063557	0.00015889	28048
5	5	8.97	1.04	10.01	0.00121685	0.00030421	29491
6	5	13.60	1.52	15.11	0.00180933	0.00045233	30061
7	10	8.89	1.03	9.92	0.00081957	0.00020489	43389
8	10	17.93	2.00	19.93	0.00163999	0.00041000	43724
9	10	26.72	3.02	29.73	0.00236692	0.00059173	45148
10	15	8.95	1.04	9.99	0.00062825	0.00015706	57001
11	15	13.46	1.52	14.99	0.00099796	0.00024949	53961
12	15	26.93	3.02	29.95	0.00190500	0.00047625	56554
13	20	13.46	1.52	14.97	0.00078251	0.00019563	68793
14	20	17.95	2.00	19.94	0.00104320	0.00026080	68810
15	20	35.73	3.98	39.71	0.00196963	0.00049241	72560


SHRP (P46) - TYPE I
Pit # 36-246
1 DAY - TREATED (1 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 4704.6x^0.5913
R^2 = 0.938
EXTERNAL
y = 2743.6x^0.6585
R^2 = 0.9689
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (1 day, #7, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

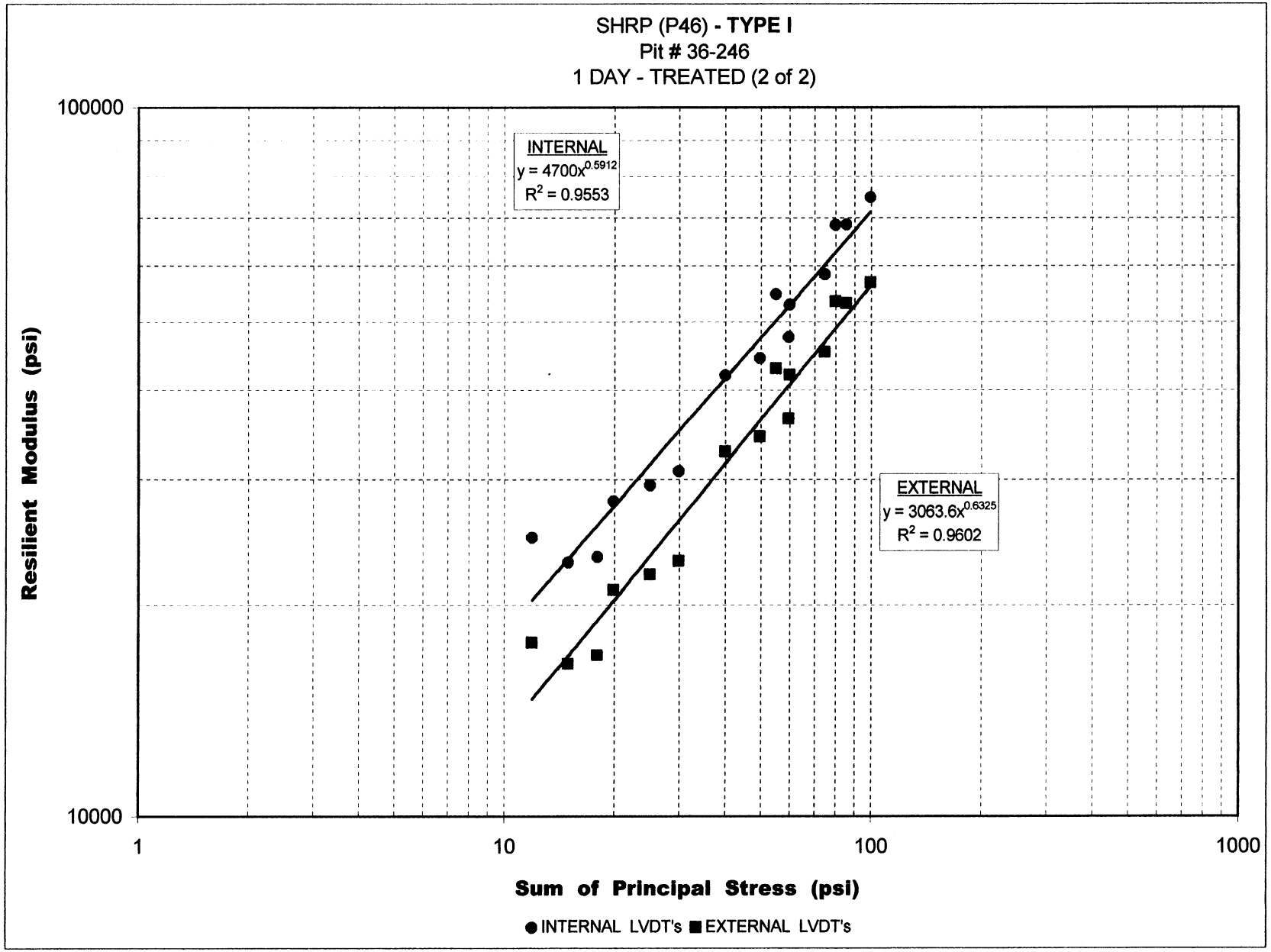
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
11.9 @ 116.3

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00117164	0.00014645	17700
2	3	5.30	0.63	5.94	0.00257165	0.00032146	16502
3	3	8.08	0.87	8.95	0.00380749	0.00047594	16968
4	5	4.40	0.48	4.88	0.00167450	0.00020931	21036
5	5	8.95	1.04	9.99	0.00324300	0.00040537	22085
6	5	13.46	1.52	14.97	0.00466456	0.00058307	23078
7	10	8.97	1.04	10.01	0.00218901	0.00027363	32773
8	10	17.81	1.99	19.81	0.00414101	0.00051763	34413
9	10	26.64	3.02	29.66	0.00584783	0.00073098	36442
10	15	8.98	1.04	10.02	0.00167192	0.00020899	42952
11	15	13.53	1.51	15.05	0.00257424	0.00032178	42061
12	15	26.85	3.02	29.87	0.00473868	0.00059233	45322
13	20	13.37	12.21	25.58	0.00201191	0.00025149	53159
14	20	17.96	1.99	19.95	0.00268670	0.00033584	53477
15	20	35.82	3.98	39.80	0.00504505	0.00063063	56805

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00041625	0.00010406	24911
2	3	5.30	0.63	5.94	0.00092341	0.00023085	22979
3	3	8.08	0.87	8.95	0.00137930	0.00034482	23420
4	5	4.40	0.48	4.88	0.00062867	0.00015717	28015
5	5	8.95	1.04	9.99	0.00121470	0.00030367	29481
6	5	13.46	1.52	14.97	0.00174556	0.00043639	30835
7	10	8.97	1.04	10.01	0.00085318	0.00021329	42043
8	10	17.81	1.99	19.81	0.00160251	0.00040063	44463
9	10	26.64	3.02	29.66	0.00223721	0.00055930	47627
10	15	8.98	1.04	10.02	0.00065540	0.00016385	54786
11	15	13.53	1.51	15.05	0.00102165	0.00025541	52990
12	15	26.85	3.02	29.87	0.00183863	0.00045966	58403
13	20	13.37	12.21	25.58	0.00077949	0.00019487	68603
14	20	17.96	1.99	19.95	0.00104923	0.00026231	68468
15	20	35.82	3.98	39.80	0.00191232	0.00047808	74931


SHRP (P46) - TYPE I
Pit # 36-246
1 DAY - TREATED (2 of 2)
INTERNAL
y = 4700x^0.5912
R² = 0.9553
EXTERNAL
y = 3063.6x^0.6325
R² = 0.9602
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (7 day,#6,Treated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

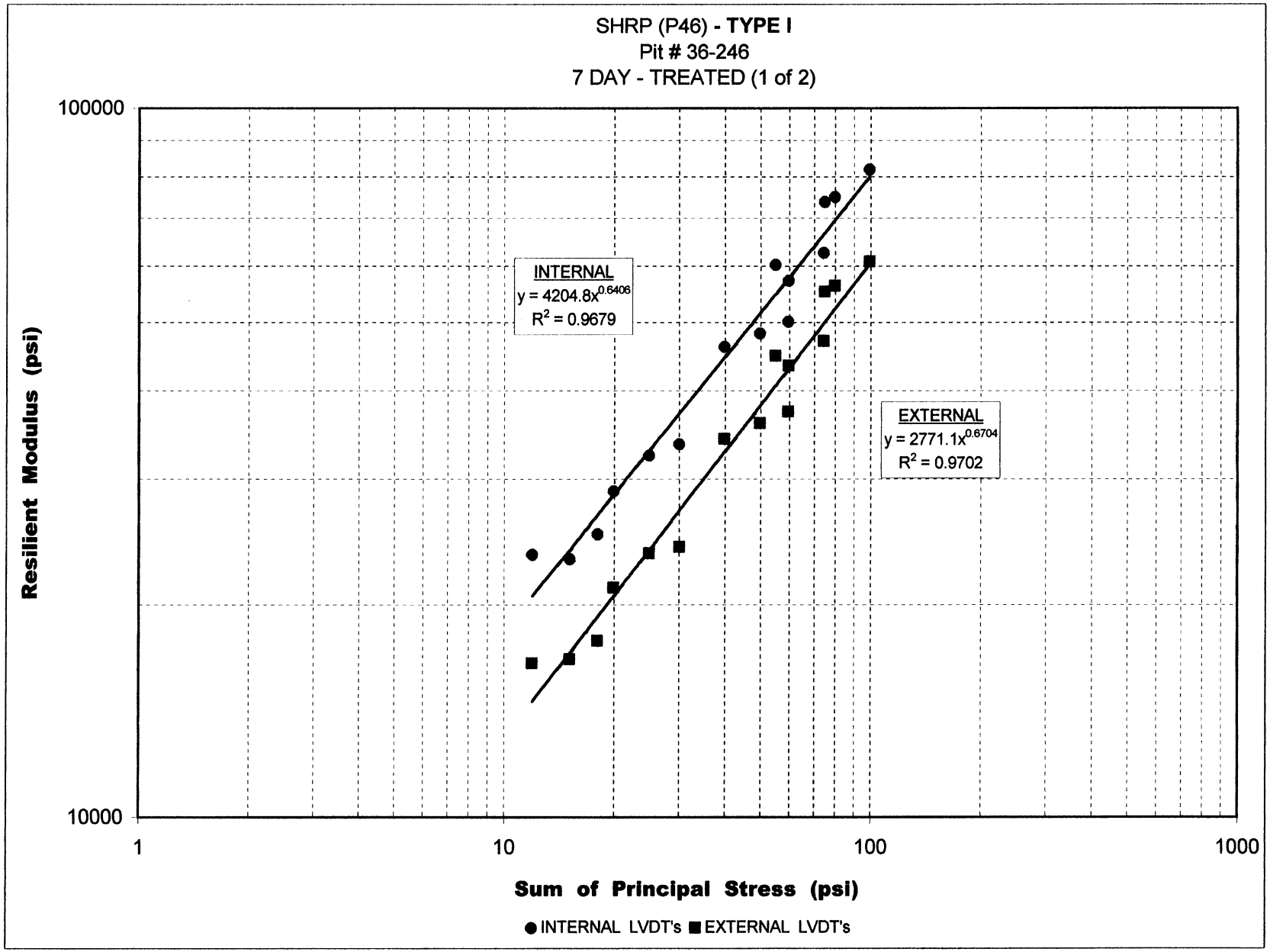
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
12.02 @ 116.0

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00126902	0.00015863	16544
2	3	5.46	0.64	6.10	0.00260699	0.00032587	16754
3	3	8.11	0.88	8.99	0.00364805	0.00045601	17793
4	5	4.41	0.48	4.89	0.00166890	0.00020861	21150
5	5	8.89	1.04	9.93	0.00300299	0.00037537	23670
6	5	13.55	1.51	15.07	0.00448574	0.00056072	24174
7	10	8.86	1.04	9.90	0.00206921	0.00025865	34259
8	10	17.95	1.99	19.95	0.00398804	0.00049850	36017
9	10	26.56	3.03	29.59	0.00568150	0.00071019	37404
10	15	8.93	1.03	9.96	0.00159263	0.00019908	44851
11	15	13.31	1.52	14.83	0.00245531	0.00030691	43382
12	15	26.44	3.03	29.47	0.00449651	0.00056206	47037
13	20	13.45	1.51	14.96	0.00194899	0.00024362	55217
14	20	17.94	2.00	19.94	0.00255183	0.00031898	56257
15	20	35.35	3.98	39.33	0.00464560	0.00058070	60877

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00044512	0.00011128	23584
2	3	5.46	0.64	6.10	0.00093936	0.00023484	23248
3	3	8.11	0.88	8.99	0.00128881	0.00032220	25181
4	5	4.41	0.48	4.89	0.00061144	0.00015286	28864
5	5	8.89	1.04	9.93	0.00109491	0.00027373	32460
6	5	13.55	1.51	15.07	0.00161026	0.00040256	33672
7	10	8.86	1.04	9.90	0.00076743	0.00019186	46187
8	10	17.95	1.99	19.95	0.00148702	0.00037176	48297
9	10	26.56	3.03	29.59	0.00211786	0.00052946	50171
10	15	8.93	1.03	9.96	0.00059205	0.00014801	60324
11	15	13.31	1.52	14.83	0.00092901	0.00023225	57328
12	15	26.44	3.03	29.47	0.00168653	0.00042163	62704
13	20	13.45	1.51	14.96	0.00072908	0.00018227	73803
14	20	17.94	2.00	19.94	0.00095702	0.00023926	75003
15	20	35.35	3.98	39.33	0.00172401	0.00043100	82021


SHRP (P46) - TYPE I
Pit # 36-246
7 DAY - TREATED (1 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 4204.8x^0.6406
R^2 = 0.9679
EXTERNAL
y = 2771.1x^0.6704
R^2 = 0.9702
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (7 day, #5, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

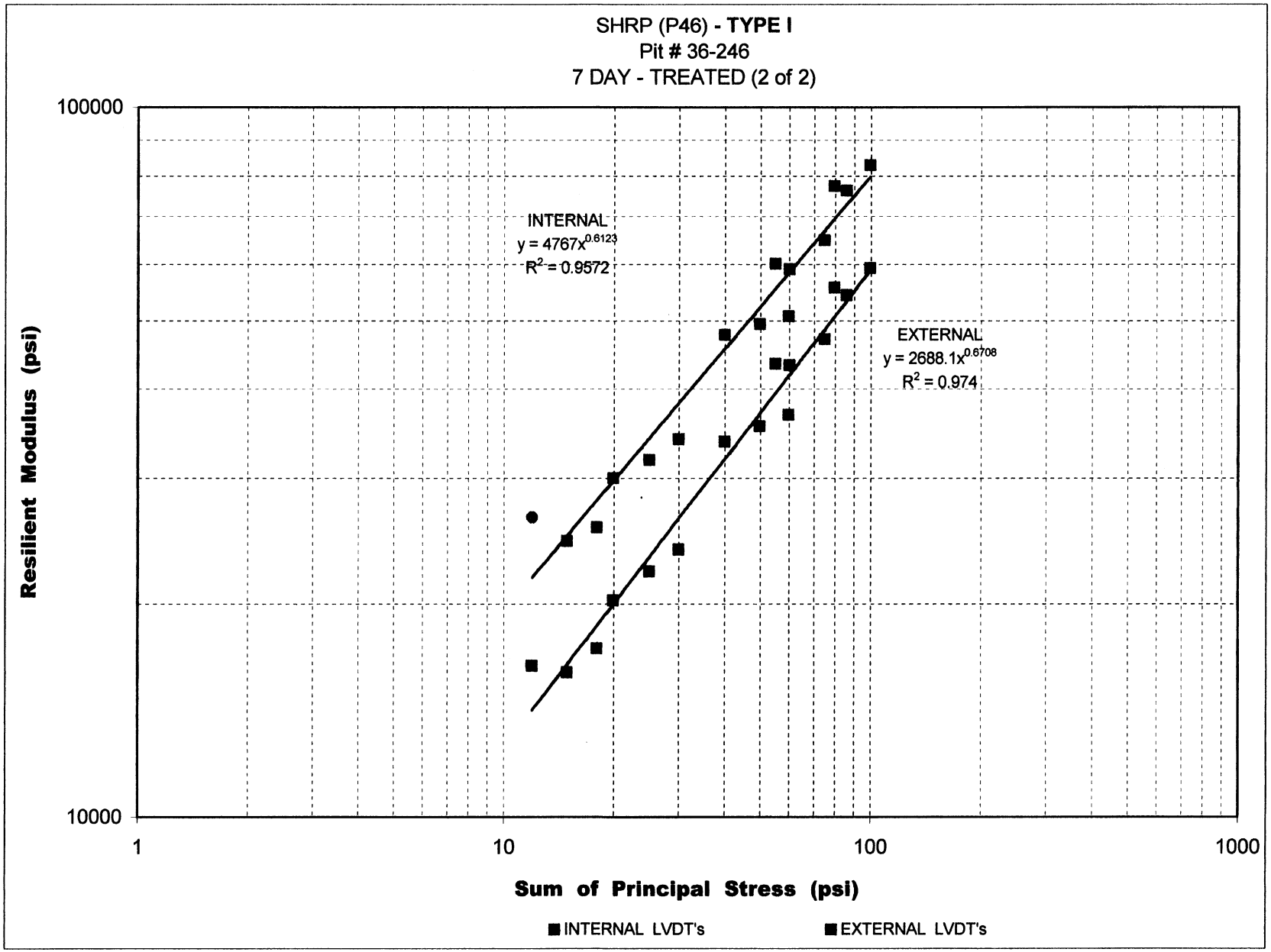
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
12.04 @ 115.7

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00127807	0.00015976	16370
2	3	5.26	0.63	5.89	0.00262638	0.00032830	16030
3	3	8.07	0.87	8.94	0.00372950	0.00046619	17305
4	5	4.45	0.48	4.93	0.00176241	0.00022030	20211
5	5	8.94	1.03	9.96	0.00322231	0.00040279	22188
6	5	13.51	1.52	15.03	0.00454434	0.00056804	23790
7	10	8.98	1.04	10.02	0.00212566	0.00026571	33796
8	10	17.88	1.99	19.87	0.00402897	0.00050362	35504
9	10	26.74	3.02	29.76	0.00580646	0.00072581	36835
10	15	9.00	1.04	10.03	0.00165770	0.00020721	43424
11	15	13.56	1.52	15.07	0.00250787	0.00031348	43248
12	15	26.95	3.01	29.96	0.00457881	0.00057235	47080
13	20	13.59	12.37	25.96	0.00200199	0.00025025	54291
14	20	17.82	1.99	19.81	0.00256518	0.00032065	55589
15	20	35.82	3.98	39.80	0.00483865	0.00060483	59225

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00039599	0.00009900	26418
2	3	5.26	0.63	5.89	0.00086007	0.00021502	24476
3	3	8.07	0.87	8.94	0.00126382	0.00031595	25534
4	5	4.45	0.48	4.93	0.00059421	0.00014855	29972
5	5	8.94	1.03	9.96	0.00112291	0.00028073	31835
6	5	13.51	1.52	15.03	0.00158828	0.00039707	34034
7	10	8.98	1.04	10.02	0.00075235	0.00018809	47743
8	10	17.88	1.99	19.87	0.00144695	0.00036174	49430
9	10	26.74	3.02	29.76	0.00210579	0.00052645	50784
10	15	9.00	1.04	10.03	0.00059895	0.00014974	60092
11	15	13.56	1.52	15.07	0.00091867	0.00022967	59031
12	15	26.95	3.01	29.96	0.00166067	0.00041517	64904
13	20	13.59	12.37	25.96	0.00071227	0.00017807	76298
14	20	17.82	1.99	19.81	0.00092169	0.00023042	77356
15	20	35.82	3.98	39.80	0.00172919	0.00043230	82863


SHRP (P46) - TYPE I
Pit # 36-246
7 DAY - TREATED (2 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 4767x^0.6123
R^2 = 0.9572
EXTERNAL
y = 2688.1x^0.6708
R^2 = 0.974
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

LAB # : Mine # 36-246

DATE: May 21, 1998

SAMPLE # : 1 of 2

PROJ. NO.: 1909701A101

LBR :

MATERIAL DESCRIPTION : Tan Limerock

SOIL CLASS :

COMMENTS : Pit # 36-246 (14 day,#3, Treated) Date of Compaction: 5-20-98

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

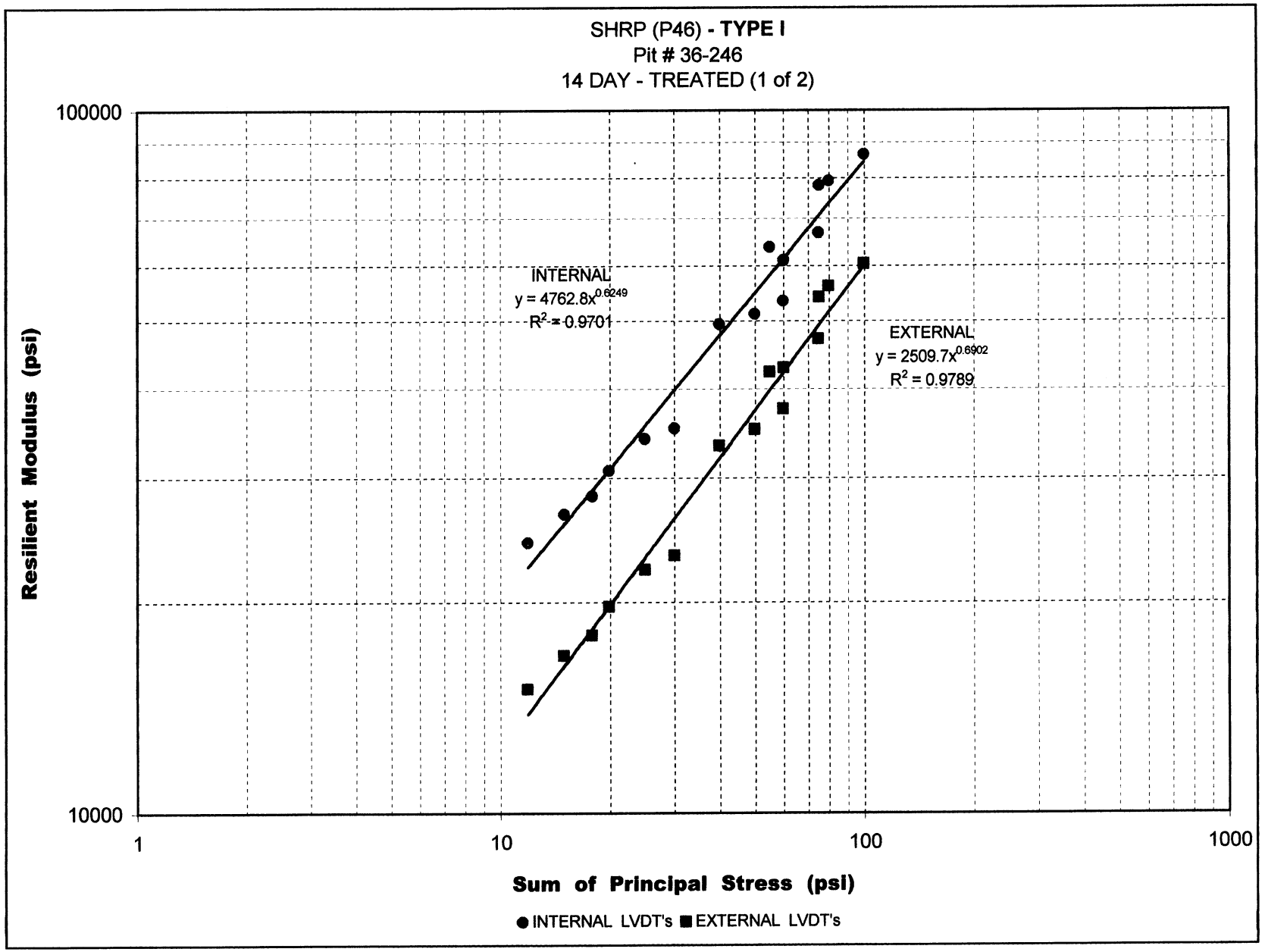
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
11.88 @ 116.3

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00136339	0.00017042	15022
2	3	5.31	0.64	5.95	0.00253158	0.00031645	16782
3	3	7.98	0.87	8.84	0.00355886	0.00044486	17931
4	5	4.39	0.48	4.87	0.00178439	0.00022305	19689
5	5	8.91	1.03	9.94	0.00321111	0.00040139	22200
6	5	13.52	1.52	15.04	0.00465422	0.00058178	23245
7	10	8.89	1.04	9.93	0.00213601	0.00026700	33293
8	10	17.91	1.99	19.90	0.00408154	0.00051019	35108
9	10	26.78	3.02	29.80	0.00571381	0.00071423	37499
10	15	8.86	1.04	9.90	0.00167407	0.00020926	42342
11	15	13.40	1.52	14.92	0.00249581	0.00031198	42963
12	15	26.76	3.03	29.79	0.00454304	0.00056788	47123
13	20	13.39	1.52	14.91	0.00197829	0.00024729	54166
14	20	17.85	2.00	19.84	0.00254062	0.00031758	56194
15	20	35.71	3.98	39.70	0.00473221	0.00059153	60376

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00042141	0.00010535	24300
2	3	5.31	0.64	5.95	0.00079629	0.00019907	26676
3	3	7.98	0.87	8.84	0.00112765	0.00028191	28295
4	5	4.39	0.48	4.87	0.00057051	0.00014263	30790
5	5	8.91	1.03	9.94	0.00104492	0.00026123	34110
6	5	13.52	1.52	15.04	0.00153270	0.00038317	35294
7	10	8.89	1.04	9.93	0.00071787	0.00017947	49531
8	10	17.91	1.99	19.90	0.00139869	0.00034967	51225
9	10	26.78	3.02	29.80	0.00199979	0.00049995	53572
10	15	8.86	1.04	9.90	0.00055499	0.00013875	63860
11	15	13.40	1.52	14.92	0.00087558	0.00021890	61232
12	15	26.76	3.03	29.79	0.00159992	0.00039998	66903
13	20	13.39	1.52	14.91	0.00068599	0.00017150	78103
14	20	17.85	2.00	19.84	0.00089971	0.00022493	79341
15	20	35.71	3.98	39.70	0.00164990	0.00041248	86585


SHRP (P46) - TYPE I
Pit # 36-246
14 DAY - TREATED (1 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 4762.8x^0.6249
R^2 = 0.9701
EXTERNAL
y = 2509.7x^0.6902
R^2 = 0.9789
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (14 day, #4, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

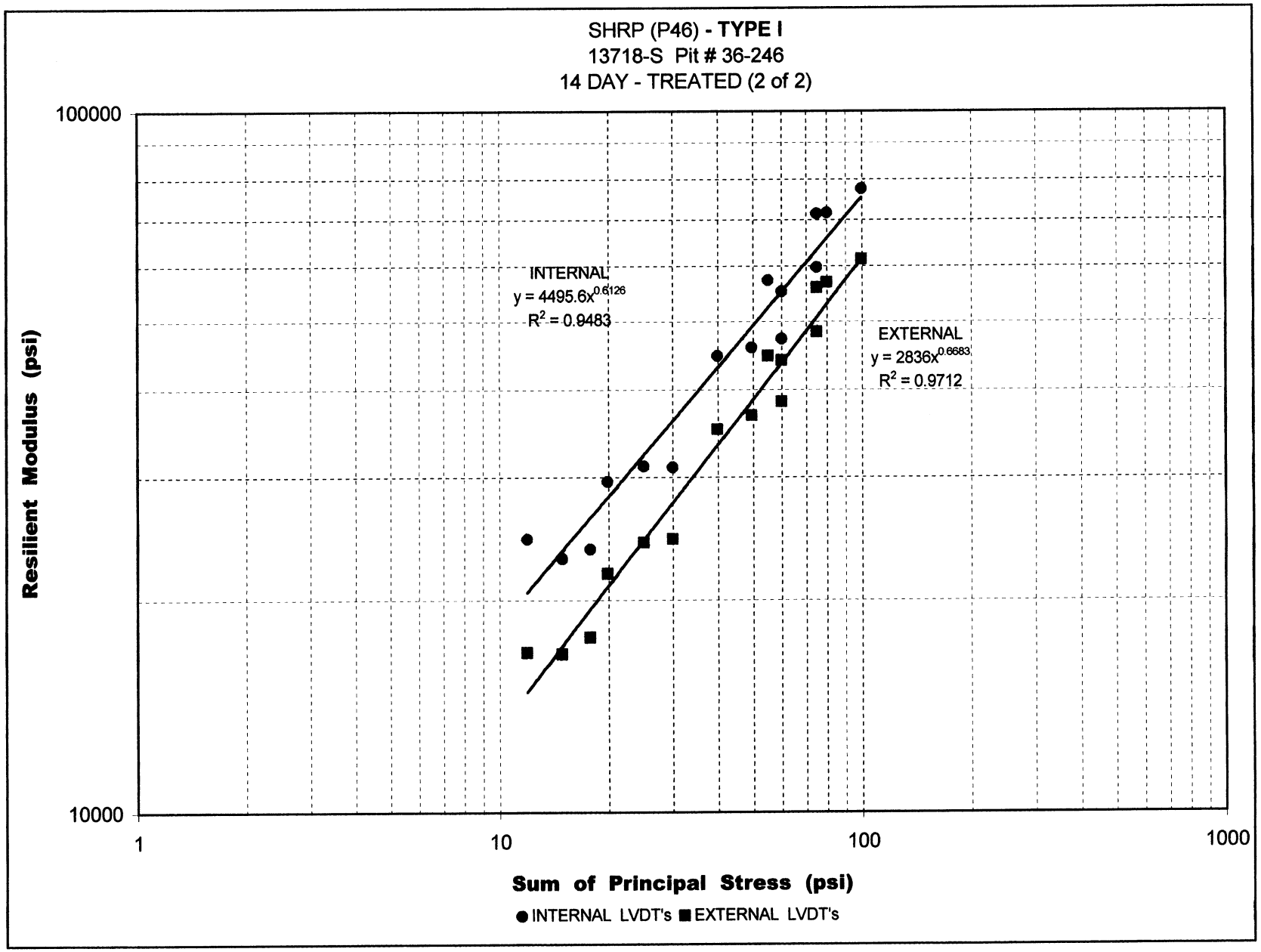
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
11.92 @ 115.9

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00122766	0.00015346	16882
2	3	5.25	0.63	5.88	0.00249883	0.00031235	16806
3	3	7.94	0.87	8.81	0.00358644	0.00044830	17703
4	5	4.40	0.48	4.88	0.00161590	0.00020199	21786
5	5	8.94	1.04	9.98	0.00296679	0.00037085	24119
6	5	13.46	1.52	14.98	0.00441248	0.00055156	24408
7	10	8.90	1.04	9.94	0.00202742	0.00025343	35109
8	10	17.64	1.99	19.64	0.00383765	0.00047971	36778
9	10	26.86	3.02	29.88	0.00558670	0.00069834	38462
10	15	8.94	1.03	9.97	0.00159866	0.00019983	44727
11	15	13.44	1.51	14.95	0.00244108	0.00030514	44050
12	15	26.89	3.02	29.91	0.00444394	0.00055549	48402
13	20	13.45	1.51	14.96	0.00192701	0.00024088	55843
14	20	18.02	1.99	20.01	0.00253760	0.00031720	56796
15	20	35.62	3.98	39.60	0.00464258	0.00058032	61385

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00042400	0.00010600	24440
2	3	5.25	0.63	5.88	0.00091608	0.00022902	22922
3	3	7.94	0.87	8.81	0.00134353	0.00033588	23629
4	5	4.40	0.48	4.88	0.00059463	0.00014866	29602
5	5	8.94	1.04	9.98	0.00114963	0.00028741	31121
6	5	13.46	1.52	14.98	0.00173522	0.00043381	31034
7	10	8.90	1.04	9.94	0.00079500	0.00019875	44767
8	10	17.64	1.99	19.64	0.00153356	0.00038339	46017
9	10	26.86	3.02	29.88	0.00226824	0.00056706	47366
10	15	8.94	1.03	9.97	0.00062437	0.00015609	57260
11	15	13.44	1.51	14.95	0.00097425	0.00024356	55186
12	15	26.89	3.02	29.91	0.00179684	0.00044921	59854
13	20	13.45	1.51	14.96	0.00075320	0.00018830	71435
14	20	18.02	1.99	20.01	0.00100614	0.00025154	71623
15	20	35.62	3.98	39.60	0.00183691	0.00045923	77571


SHRP (P46) - TYPE I
13718-S Pit # 36-246
14 DAY - TREATED (2 of 2)
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 4495.6x^0.6126
R^2 = 0.9483
EXTERNAL
y = 2836x^0.6683
R^2 = 0.9712
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (28 day,#2,Treated) Date of Compaction: 5-19-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

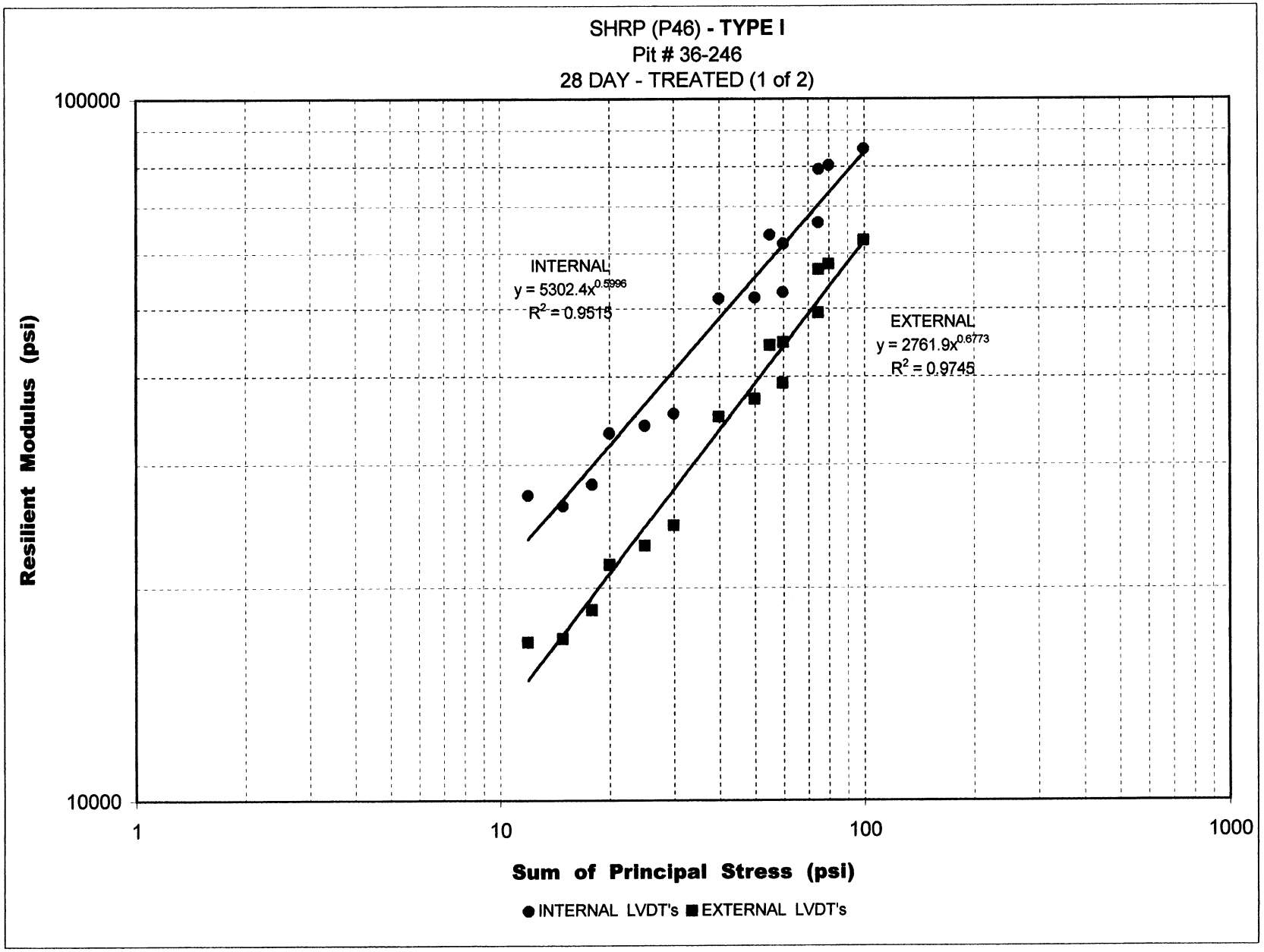
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY: 11.90 @ 115.8

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.93	0.00124360	0.00015545	16782
2	3	5.27	0.64	5.91	0.00248073	0.00031009	16980
3	3	8.02	0.87	8.90	0.00344208	0.00043026	18649
4	5	4.48	0.48	4.96	0.00166072	0.00020759	21591
5	5	8.97	1.04	10.01	0.00312795	0.00039099	22939
6	5	13.51	1.52	15.03	0.00440300	0.00055038	24554
7	10	8.86	1.04	9.90	0.00202354	0.00025294	35039
8	10	17.99	2.00	19.98	0.00387083	0.00048385	37179
9	10	26.84	3.02	29.87	0.00548716	0.00068590	39132
10	15	9.00	1.04	10.04	0.00162452	0.00020307	44319
11	15	13.49	1.52	15.01	0.00241523	0.00030190	44691
12	15	26.76	3.03	29.79	0.00434526	0.00054316	49266
13	20	13.40	1.52	14.92	0.00188392	0.00023549	56893
14	20	18.01	1.99	20.00	0.00248806	0.00031101	57914
15	20	35.71	3.98	39.69	0.00455899	0.00056987	62662

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.93	0.00038393	0.00009598	27179
2	3	5.27	0.64	5.91	0.00080362	0.00020090	26207
3	3	8.02	0.87	8.90	0.00114058	0.00028515	28139
4	5	4.48	0.48	4.96	0.00053862	0.00013466	33286
5	5	8.97	1.04	10.01	0.00105182	0.00026295	34109
6	5	13.51	1.52	15.03	0.00152408	0.00038102	35468
7	10	8.86	1.04	9.90	0.00068598	0.00017150	51680
8	10	17.99	2.00	19.98	0.00138619	0.00034655	51910
9	10	26.84	3.02	29.87	0.00203383	0.00050846	52788
10	15	9.00	1.04	10.04	0.00056361	0.00014090	63871
11	15	13.49	1.52	15.01	0.00087041	0.00021760	62005
12	15	26.76	3.03	29.79	0.00160982	0.00040246	66490
13	20	13.40	1.52	14.92	0.00067435	0.00016859	79471
14	20	18.01	1.99	20.00	0.00089583	0.00022396	80424
15	20	35.71	3.98	39.69	0.00168437	0.00042109	84802


SHRP (P46) - TYPE I
Pit # 36-246
28 DAY - TREATED (1 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 5302.4x^0.5996
R^2 = 0.9515
EXTERNAL
y = 2761.9x^0.6773
R^2 = 0.9745
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 36-246 (28 day, #1, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

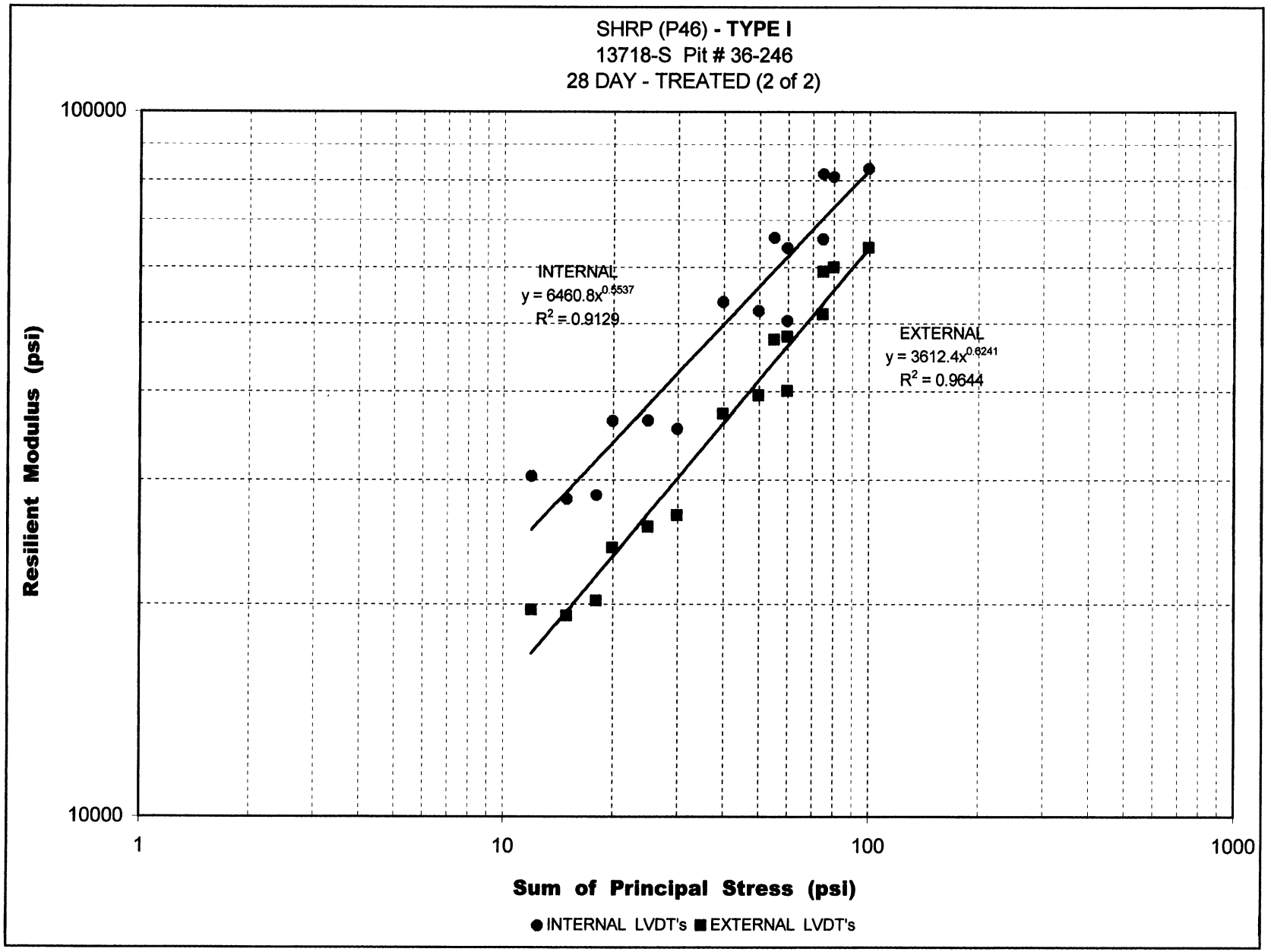
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
11.96 @ 116.1

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.94	0.00106520	0.00013315	19630
2	3	5.30	0.64	5.94	0.00220322	0.00027540	19256
3	3	8.10	0.87	8.98	0.00320336	0.00040042	20240
4	5	4.44	0.49	4.93	0.00147844	0.00018480	24044
5	5	8.83	1.05	9.87	0.00274444	0.00034305	25732
6	5	13.40	1.52	14.92	0.00401346	0.00050168	26705
7	10	8.91	1.04	9.95	0.00191710	0.00023964	37198
8	10	17.93	2.00	19.93	0.00363469	0.00045434	39468
9	10	26.69	3.02	29.72	0.00532643	0.00066580	40093
10	15	8.99	1.04	10.03	0.00151635	0.00018954	47437
11	15	13.36	1.51	14.87	0.00223167	0.00027896	47883
12	15	26.79	3.03	29.82	0.00415954	0.00051994	51534
13	20	13.55	1.52	15.07	0.00183307	0.00022913	59143
14	20	18.07	1.99	20.06	0.00240704	0.00030088	60063
15	20	35.84	3.97	39.81	0.00447798	0.00055975	64025

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.94	0.00034385	0.00008596	30404
2	3	5.30	0.64	5.94	0.00075191	0.00018798	28211
3	3	8.10	0.87	8.98	0.00113498	0.00028375	28563
4	5	4.44	0.49	4.93	0.00048821	0.00012205	36406
5	5	8.83	1.05	9.87	0.00096865	0.00024216	36453
6	5	13.40	1.52	14.92	0.00151158	0.00037790	35453
7	10	8.91	1.04	9.95	0.00066488	0.00016622	53628
8	10	17.93	2.00	19.93	0.00137585	0.00034396	52132
9	10	26.69	3.02	29.72	0.00211570	0.00052892	50469
10	15	8.99	1.04	10.03	0.00054293	0.00013573	66243
11	15	13.36	1.51	14.87	0.00083508	0.00020877	63981
12	15	26.79	3.03	29.82	0.00162534	0.00040633	65942
13	20	13.55	1.52	15.07	0.00066229	0.00016557	81848
14	20	18.07	1.99	20.06	0.00089239	0.00022310	81004
15	20	35.84	3.97	39.81	0.00172186	0.00043047	83254


SHRP (P46) - TYPE I
13718-S Pit # 36-246
28 DAY - TREATED (2 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 6460.8x^0.5537
R^2 = 0.9129
EXTERNAL
y = 3612.4x^0.6241
R^2 = 0.9644
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (1 day,#1, Untreated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

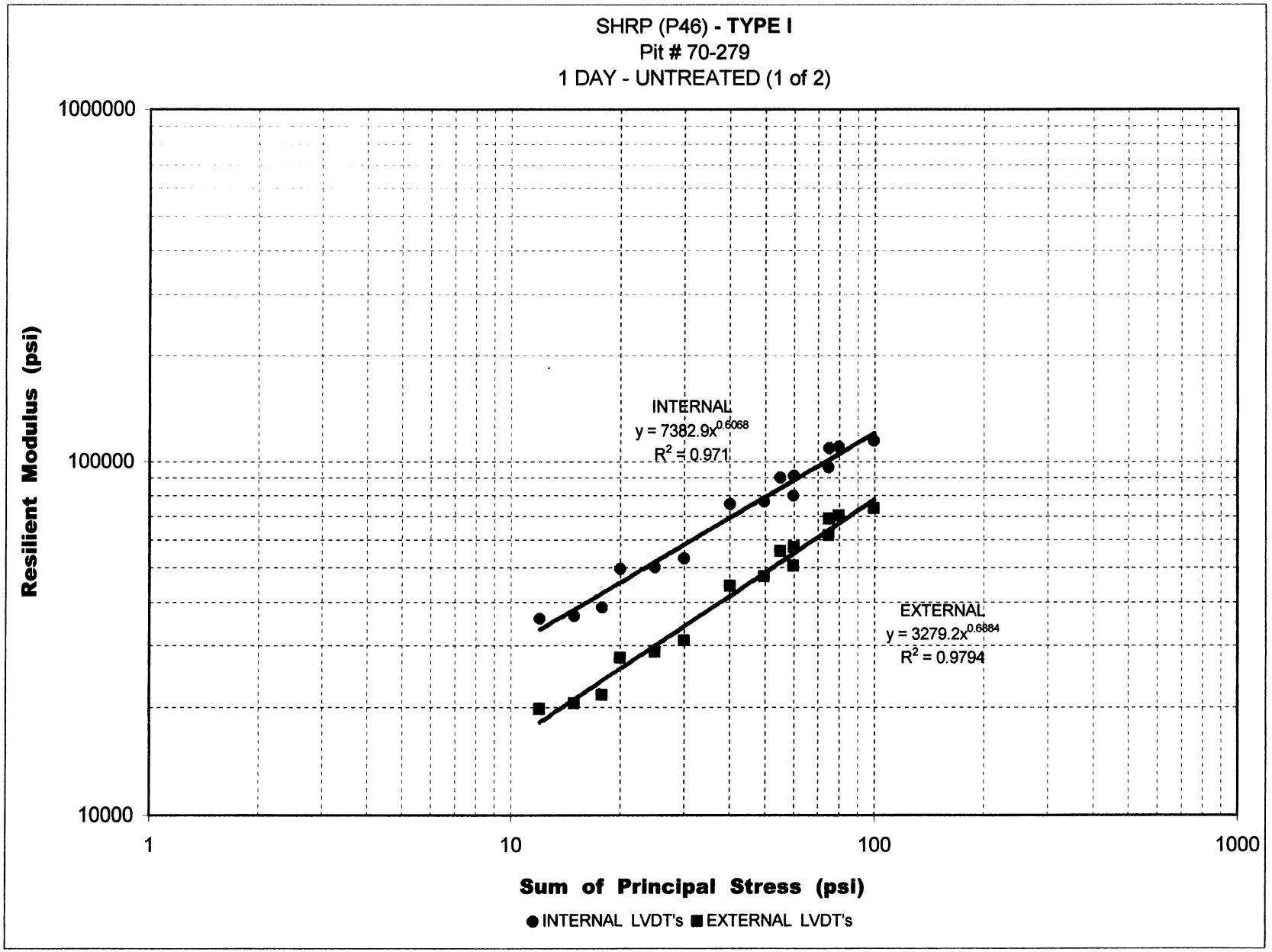
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.07 @ 126.8

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.98	0.00107339	0.00013417	19774
2	3	5.30	0.64	5.93	0.00206749	0.00025844	20491
3	3	7.96	0.88	8.84	0.00293964	0.00036746	21670
4	5	4.50	0.48	4.98	0.00130047	0.00016256	27709
5	5	8.82	1.04	9.86	0.00245531	0.00030691	28730
6	5	13.46	1.52	14.97	0.00347095	0.00043387	31016
7	10	8.98	1.04	10.02	0.00161633	0.00020204	44470
8	10	17.83	2.00	19.83	0.00302324	0.00037790	47187
9	10	26.93	3.02	29.95	0.00426554	0.00053319	50499
10	15	9.01	1.04	10.05	0.00129358	0.00016170	55718
11	15	13.60	1.52	15.12	0.00190590	0.00023824	57087
12	15	26.83	3.02	29.85	0.00347699	0.00043462	61733
13	20	13.46	1.52	14.98	0.00156549	0.00019569	68794
14	20	17.91	2.00	19.91	0.00203948	0.00025493	70254
15	20	35.86	3.98	39.84	0.00389410	0.00048676	73669

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.98	0.00029560	0.00007390	35903
2	3	5.30	0.64	5.93	0.00057999	0.00014500	36523
3	3	7.96	0.88	8.84	0.00082431	0.00020608	38640
4	5	4.50	0.48	4.98	0.00036195	0.00009049	49778
5	5	8.82	1.04	9.86	0.00070236	0.00017559	50217
6	5	13.46	1.52	14.97	0.00101261	0.00025315	53158
7	10	8.98	1.04	10.02	0.00047442	0.00011860	75754
8	10	17.83	2.00	19.83	0.00092686	0.00023171	76957
9	10	26.93	3.02	29.95	0.00134397	0.00033599	80137
10	15	9.01	1.04	10.05	0.00039901	0.00009975	90318
11	15	13.60	1.52	15.12	0.00059593	0.00014898	91288
12	15	26.83	3.02	29.85	0.00111258	0.00027814	96464
13	20	13.46	1.52	14.98	0.00049208	0.00012302	109428
14	20	17.91	2.00	19.91	0.00064764	0.00016191	110619
15	20	35.86	3.98	39.84	0.00124744	0.00031186	114985


SHRP (P46) - TYPE I
Pit # 70-279
1 DAY - UNTREATED (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 7382.9x^0.6068
R^2 = 0.971
EXTERNAL
y = 3279.2x^0.6884
R^2 = 0.9794
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (1 day, #2, Unreated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

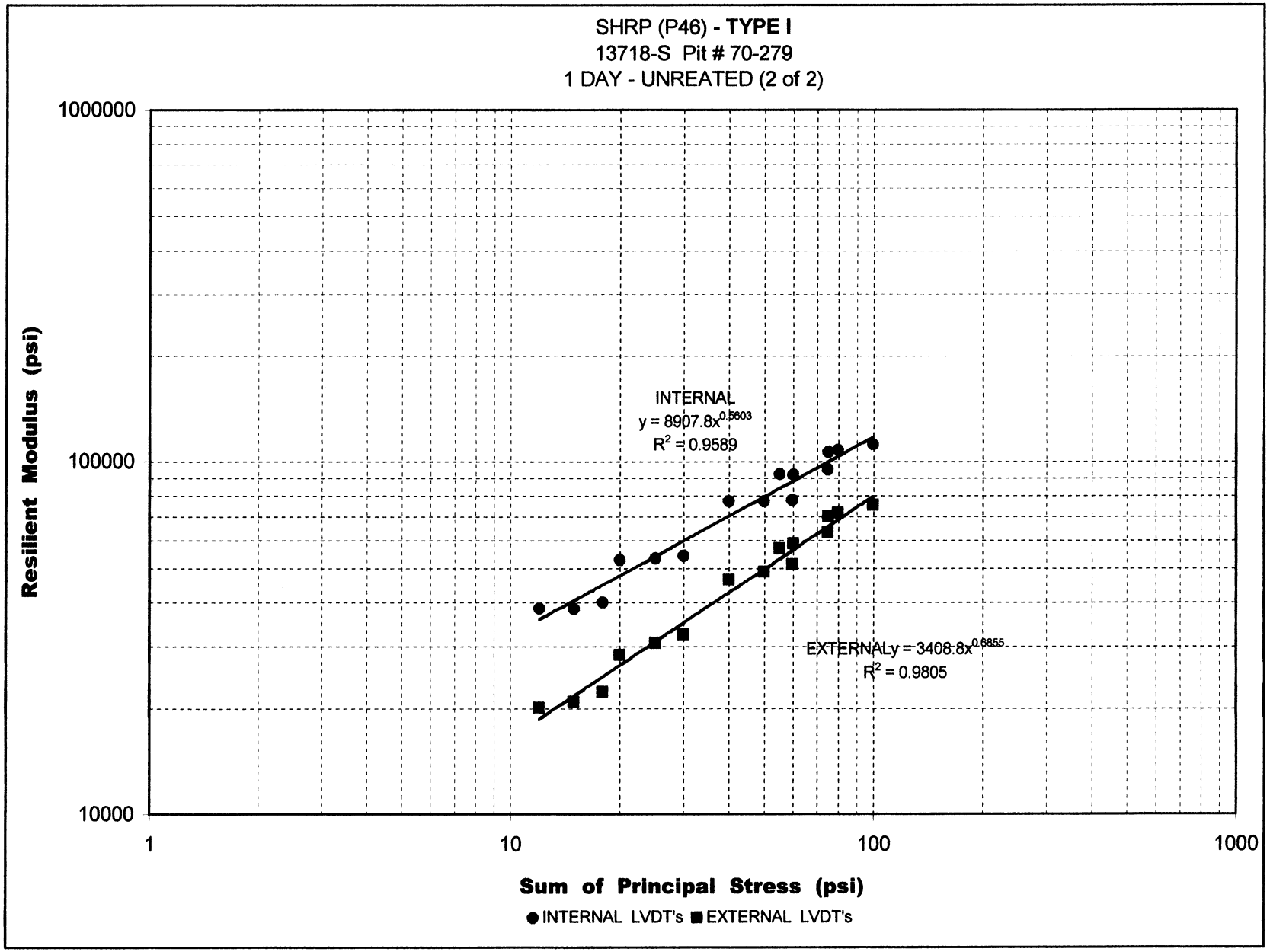
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 118.0
ACTUAL MOISTURE / DENSITY:
7.17 @ 126.6

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.98	0.00105486	0.00013186	20128
2	3	5.29	0.64	5.93	0.00202181	0.00025273	20918
3	3	8.03	0.88	8.90	0.00287802	0.00035975	22315
4	5	4.52	0.48	5.00	0.00127678	0.00015960	28347
5	5	8.99	1.04	10.03	0.00234715	0.00029339	30649
6	5	13.44	1.51	14.95	0.00331798	0.00041475	32412
7	10	8.88	1.04	9.92	0.00153144	0.00019143	46397
8	10	17.97	2.01	19.98	0.00294094	0.00036762	48890
9	10	26.75	3.02	29.77	0.00416902	0.00052113	51331
10	15	9.01	1.04	10.05	0.00126601	0.00015825	56937
11	15	13.55	1.52	15.06	0.00184299	0.00023037	58800
12	15	26.89	3.03	29.91	0.00341450	0.00042681	63000
13	20	13.57	1.51	15.09	0.00154997	0.00019375	70060
14	20	17.95	2.00	19.95	0.00200027	0.00025003	71806
15	20	35.74	3.98	39.72	0.00378810	0.00047351	75476

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.98	0.00027577	0.00006894	38496
2	3	5.29	0.64	5.93	0.00055026	0.00013756	38430
3	3	8.03	0.88	8.90	0.00080146	0.00020037	40066
4	5	4.52	0.48	5.00	0.00034127	0.00008532	53027
5	5	8.99	1.04	10.03	0.00067091	0.00016773	53612
6	5	13.44	1.51	14.95	0.00098761	0.00024690	54446
7	10	8.88	1.04	9.92	0.00045890	0.00011473	77418
8	10	17.97	2.01	19.98	0.00092815	0.00023204	77457
9	10	26.75	3.02	29.77	0.00137111	0.00034278	78039
10	15	9.01	1.04	10.05	0.00038953	0.00009738	92525
11	15	13.55	1.52	15.06	0.00058731	0.00014683	92258
12	15	26.89	3.03	29.91	0.00112722	0.00028181	95418
13	20	13.57	1.51	15.09	0.00050975	0.00012744	106514
14	20	17.95	2.00	19.95	0.00066530	0.00016633	107944
15	20	35.74	3.98	39.72	0.00127674	0.00031919	111969


SHRP (P46) - TYPE I
13718-S Pit # 70-279
1 DAY - UNREATED (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 8907.8x^0.5603
R^2 = 0.9589
EXTERNALy = 3408.8x^0.6855
R^2 = 0.9805
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

LAB # : Mine # 36-246

DATE: May 21, 1998

SAMPLE # : 1 of 2

PROJ. NO.: 1909701A101

LBR :

MATERIAL DESCRIPTION : Tan Limerock

SOIL CLASS :

COMMENTS : Pit # 70-279 (7 day, Untreated) Date of Compaction: 5-20-98

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

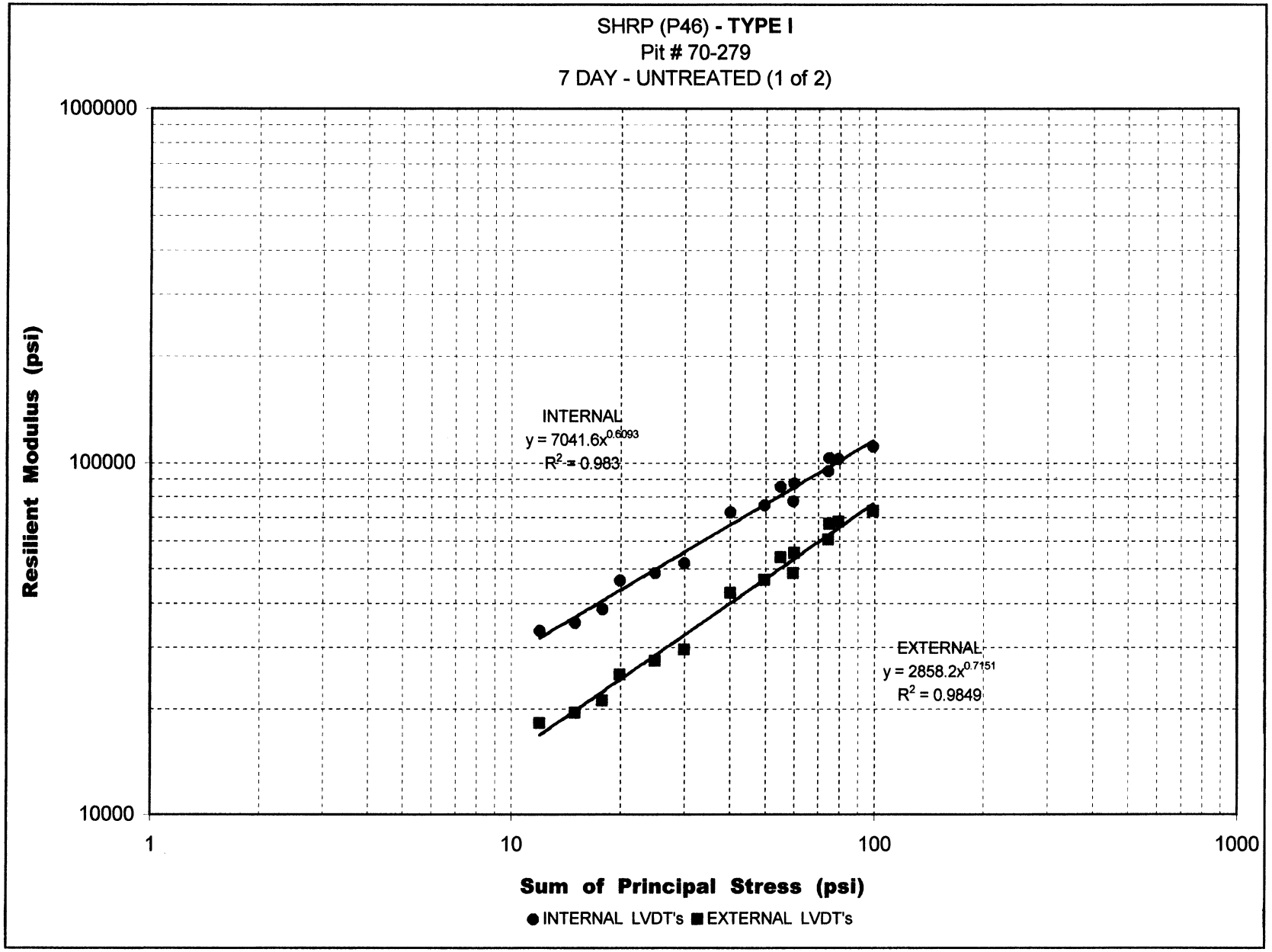
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.15 @ 126.5

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00115569	0.00014446	18201
2	3	5.35	0.63	5.99	0.00219934	0.00027492	19466
3	3	7.93	0.88	8.81	0.00300557	0.00037570	21114
4	5	4.45	0.48	4.93	0.00142026	0.00017753	25070
5	5	8.87	1.04	9.91	0.00258673	0.00032334	27436
6	5	13.44	1.52	14.96	0.00364547	0.00045568	29501
7	10	9.00	1.04	10.04	0.00168226	0.00021028	42786
8	10	17.83	1.99	19.82	0.00307021	0.00038378	46456
9	10	26.69	3.03	29.72	0.00438921	0.00054865	48653
10	15	9.05	1.04	10.10	0.00134313	0.00016789	53932
11	15	13.50	1.52	15.02	0.00194683	0.00024335	55471
12	15	26.62	3.02	29.65	0.00351921	0.00043990	60521
13	20	13.59	1.51	15.10	0.00161978	0.00020247	67126
14	20	17.71	1.99	19.70	0.00208429	0.00026054	67979
15	20	35.28	3.98	39.25	0.00387471	0.00048434	72837

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00031412	0.00007853	33481
2	3	5.35	0.63	5.99	0.00060799	0.00015200	35209
3	3	7.93	0.88	8.81	0.00082344	0.00020586	38533
4	5	4.45	0.48	4.93	0.00038350	0.00009587	46423
5	5	8.87	1.04	9.91	0.00072821	0.00018205	48728
6	5	13.44	1.52	14.96	0.00103286	0.00025821	52061
7	10	9.00	1.04	10.04	0.00049596	0.00012399	72563
8	10	17.83	1.99	19.82	0.00094064	0.00023516	75815
9	10	26.69	3.03	29.72	0.00137326	0.00034332	77751
10	15	9.05	1.04	10.10	0.00042228	0.00010557	85771
11	15	13.50	1.52	15.02	0.00061704	0.00015426	87508
12	15	26.62	3.02	29.65	0.00112291	0.00028073	94836
13	20	13.59	1.51	15.10	0.00052440	0.00013110	103671
14	20	17.71	1.99	19.70	0.00068900	0.00017225	102821
15	20	35.28	3.98	39.25	0.00126425	0.00031606	111617


SHRP (P46) - TYPE I
Pit # 70-279
7 DAY - UNTREATED (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 7041.6x^0.6093
R^2 = 0.983
EXTERNAL
y = 2858.2x^0.7151
R^2 = 0.9849
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

LAB # : 13718-S

DATE: May 21, 1998

SAMPLE # : 2 of 2

PROJ. NO.: 1909701A101-037

LBR :

MATERIAL DESCRIPTION : Tan Limerock

SOIL CLASS :

COMMENTS : Pit # 70-279 (7 day, #4, Unreated) Date of Compaction: 5-20-98

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

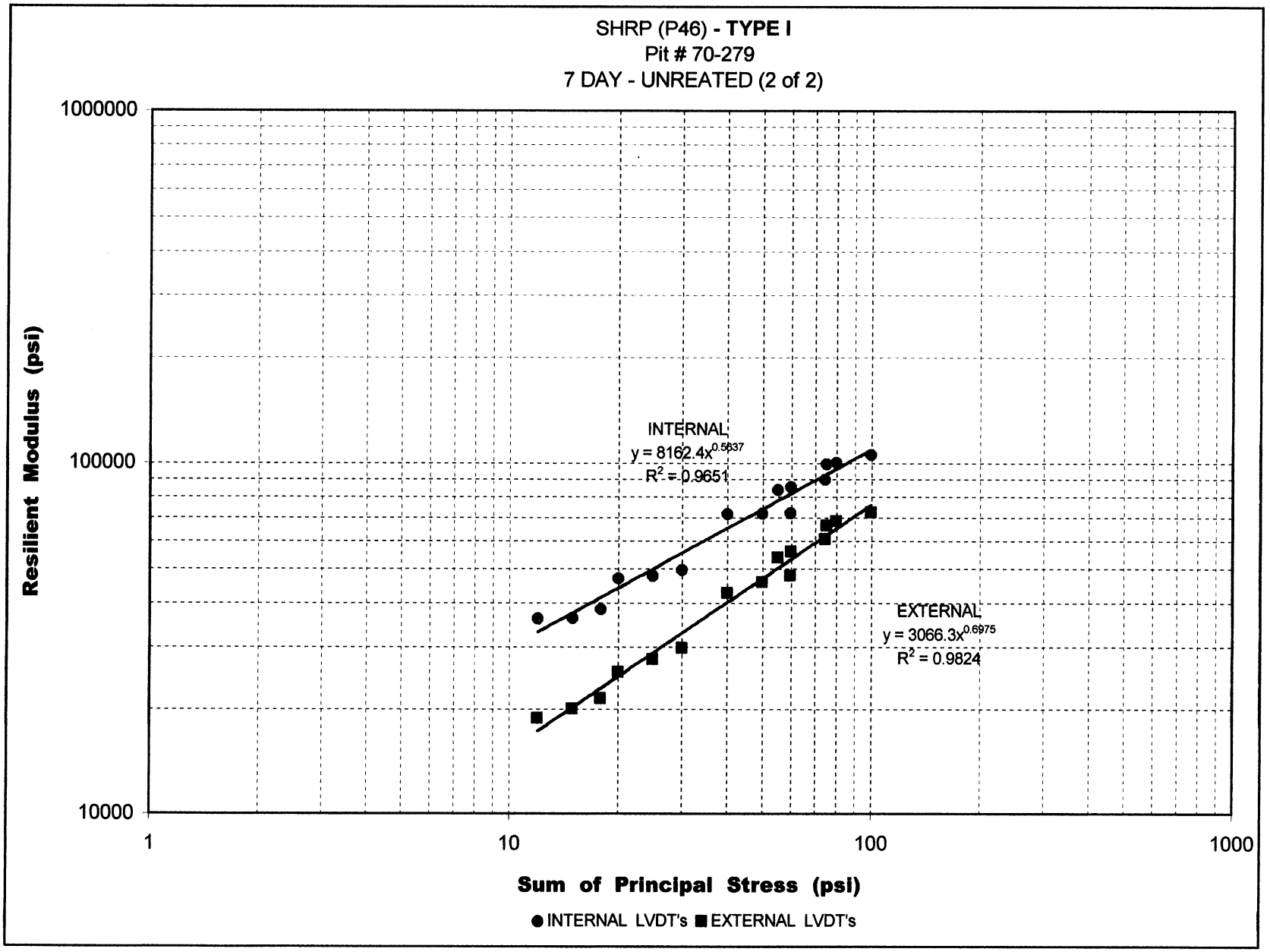
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.12 @ 126.3

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00111390	0.00013924	18878
2	3	5.28	0.64	5.92	0.00211058	0.00026382	20023
3	3	7.97	0.88	8.84	0.00296808	0.00037101	21478
4	5	4.50	0.48	4.98	0.00141682	0.00017710	25419
5	5	8.87	1.04	9.91	0.00256562	0.00032070	27656
6	5	13.43	1.52	14.95	0.00361143	0.00045143	29751
7	10	8.90	1.04	9.94	0.00166674	0.00020834	42718
8	10	17.94	1.99	19.94	0.00312536	0.00039067	45927
9	10	26.61	3.02	29.63	0.00445600	0.00055700	47778
10	15	9.00	1.04	10.04	0.00133538	0.00016692	53915
11	15	13.46	1.51	14.97	0.00192098	0.00024012	56063
12	15	26.40	3.02	29.42	0.00347569	0.00043446	60760
13	20	13.51	1.51	15.02	0.00162883	0.00020360	66357
14	20	17.90	2.00	19.89	0.00209464	0.00026183	68354
15	20	35.70	3.98	39.68	0.00393978	0.00049247	72484

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00029043	0.00007261	36202
2	3	5.28	0.64	5.92	0.00058343	0.00014586	36217
3	3	7.97	0.88	8.84	0.00083077	0.00020769	38368
4	5	4.50	0.48	4.98	0.00038221	0.00009555	47114
5	5	8.87	1.04	9.91	0.00074071	0.00018518	47897
6	5	13.43	1.52	14.95	0.00107939	0.00026985	49771
7	10	8.90	1.04	9.94	0.00049596	0.00012399	71780
8	10	17.94	1.99	19.94	0.00099752	0.00024938	71948
9	10	26.61	3.02	29.63	0.00147453	0.00036863	72193
10	15	9.00	1.04	10.04	0.00042831	0.00010708	84048
11	15	13.46	1.51	14.97	0.00062825	0.00015706	85711
12	15	26.40	3.02	29.42	0.00117591	0.00029398	89795
13	20	13.51	1.51	15.02	0.00054293	0.00013573	99538
14	20	17.90	2.00	19.89	0.00071141	0.00017785	100629
15	20	35.70	3.98	39.68	0.00134827	0.00033707	105902


SHRP (P46) - TYPE I
Pit # 70-279
7 DAY - UNREATED (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 8162.4x^0.5637
R2 = 0.9651
EXTERNAL
y = 3066.3x^0.6975
R2 = 0.9824
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 29, 1998

PROJ. NO.: 24285915201

MATERIAL DESCRIPTION : Light Tan Limerock.70-279,14 day,untreated,#5

COMMENTS : M.P. 293.7

LAB # : 16591-S

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

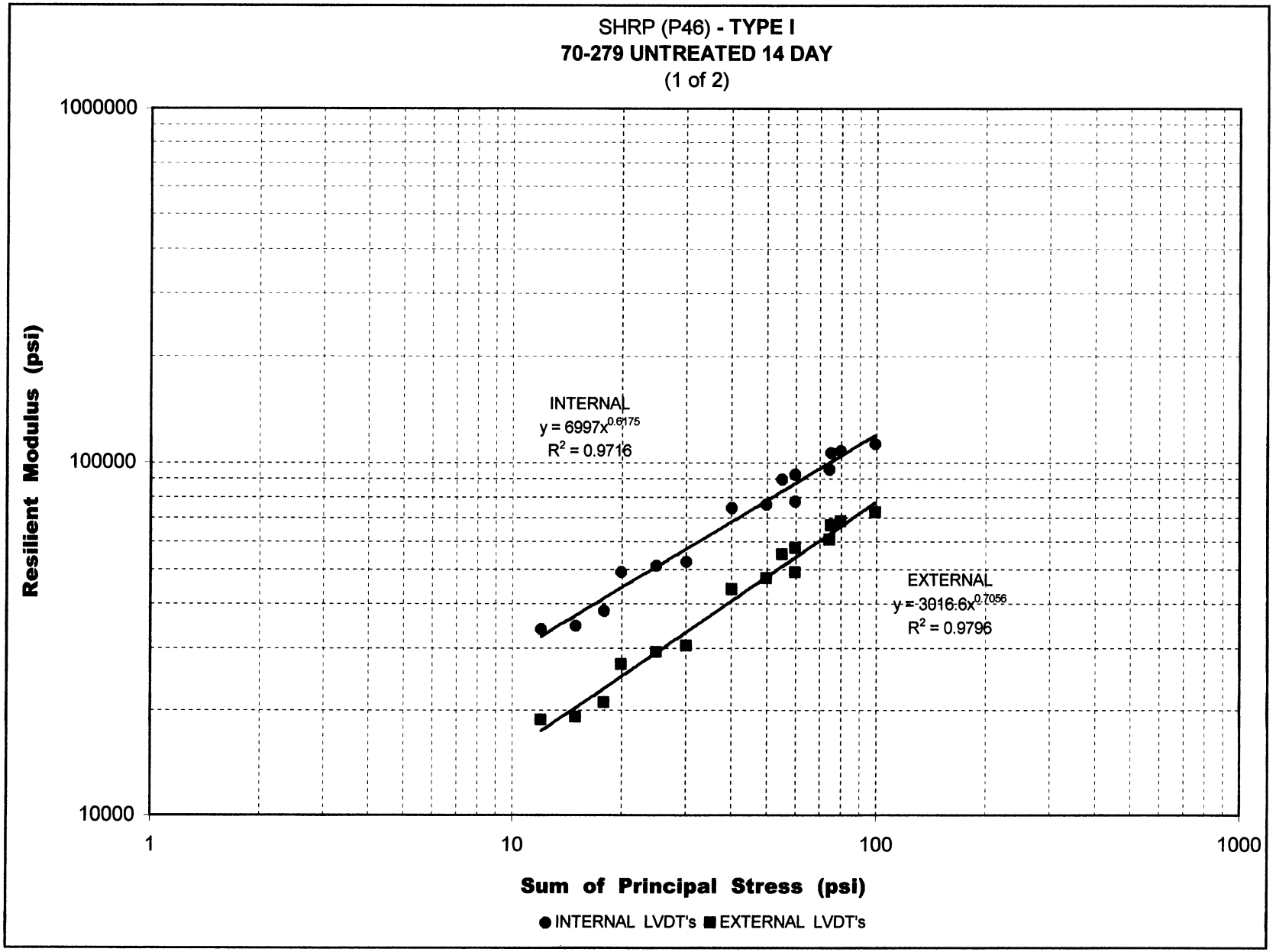
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY: 7.07 @ 126.6

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.97	0.00113242	0.00014155	18726
2	3	5.30	0.64	5.94	0.00222219	0.00027777	19088
3	3	8.01	0.88	8.89	0.00304996	0.00038124	21005
4	5	4.45	0.48	4.93	0.00132073	0.00016509	26960
5	5	8.82	1.04	9.86	0.00241911	0.00030239	29173
6	5	13.50	1.52	15.02	0.00354722	0.00044340	30439
7	10	9.02	1.04	10.06	0.00164347	0.00020543	43904
8	10	17.85	1.99	19.83	0.00303099	0.00037887	47103
9	10	26.83	3.03	29.86	0.00437542	0.00054693	49053
10	15	8.97	1.04	10.02	0.00129918	0.00016240	55255
11	15	13.35	1.52	14.87	0.00185764	0.00023220	57503
12	15	26.34	3.03	29.37	0.00346060	0.00043258	60884
13	20	13.52	1.52	15.04	0.00162020	0.00020253	66755
14	20	17.85	1.99	19.84	0.00208257	0.00026032	68554
15	20	35.59	3.97	39.57	0.00391823	0.00048978	72670

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.97	0.00031196	0.00007799	33988
2	3	5.30	0.64	5.94	0.00060971	0.00015243	34785
3	3	8.01	0.88	8.89	0.00083637	0.00020909	38300
4	5	4.45	0.48	4.93	0.00036238	0.00009060	49128
5	5	8.82	1.04	9.86	0.00068900	0.00017225	51215
6	5	13.50	1.52	15.02	0.00102682	0.00025671	52576
7	10	9.02	1.04	10.06	0.00048217	0.00012054	74823
8	10	17.85	1.99	19.83	0.00093419	0.00023355	76413
9	10	26.83	3.03	29.86	0.00137499	0.00034375	78047
10	15	8.97	1.04	10.02	0.00039987	0.00009997	89762
11	15	13.35	1.52	14.87	0.00057697	0.00014424	92570
12	15	26.34	3.03	29.37	0.00109878	0.00027470	95876
13	20	13.52	1.52	15.04	0.00050587	0.00012647	106901
14	20	17.85	1.99	19.84	0.00065970	0.00016493	108207
15	20	35.59	3.97	39.57	0.00125908	0.00031477	113074


SHRP (P46) - TYPE I
70-279 UNTREATED 14 DAY
(1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 6997x^0.6175
R2 = 0.9716
EXTERNAL
y = 3916.6x^0.7056
R2 = 0.9796
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 30, 1998

PROJ. NO.: 24285915201

MATERIAL DESCRIPTION : 70-279,14 day, untreated.#6

COMMENTS : M.P. 293.7

LAB # : 16591-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

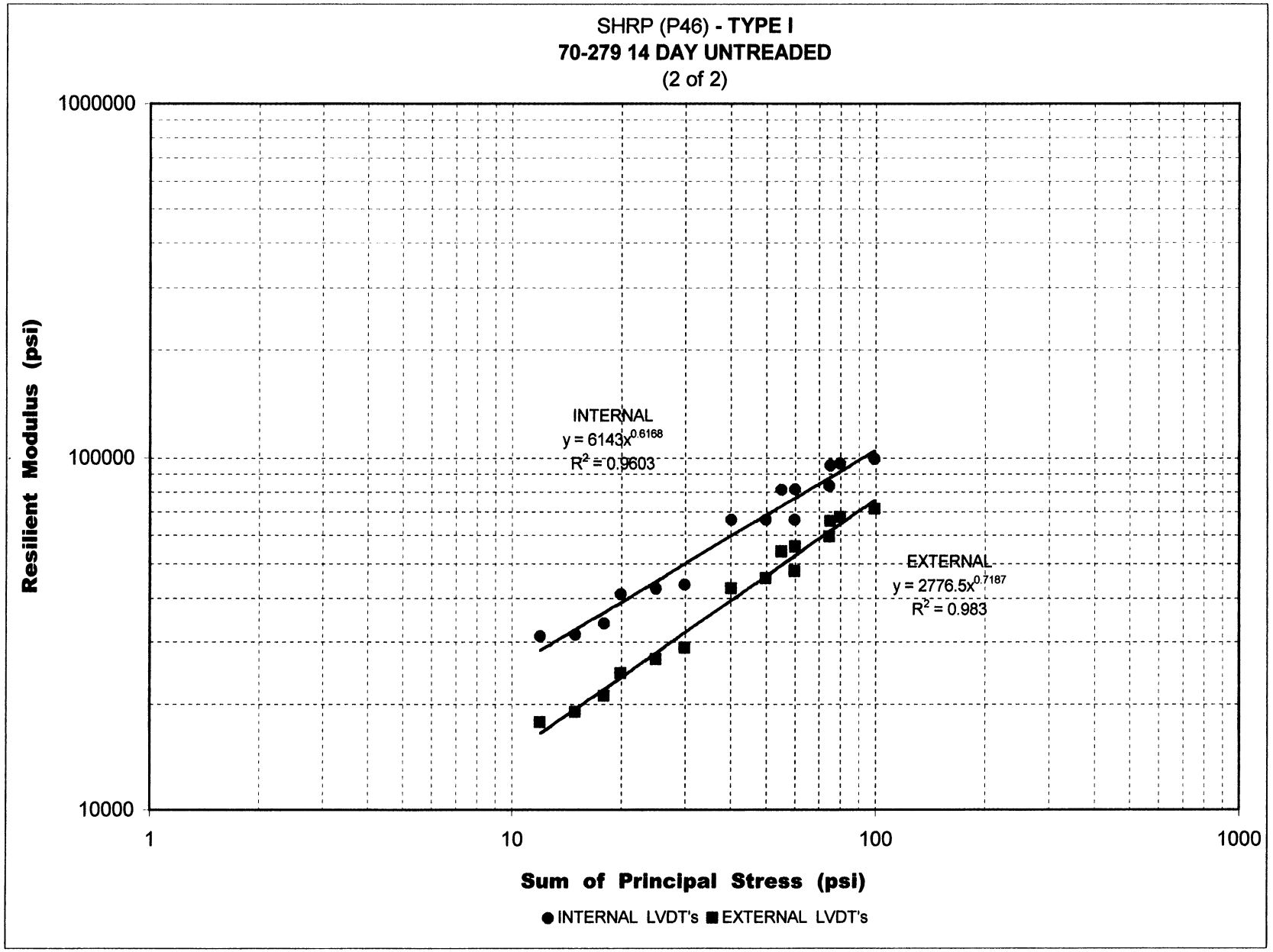
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.18 @ 126.2

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.97	0.00119232	0.00014904	17741
2	3	5.29	0.64	5.92	0.00222434	0.00027804	19011
3	3	8.07	0.88	8.95	0.00305771	0.00038221	21122
4	5	4.44	0.48	4.92	0.00145173	0.00018147	24486
5	5	8.88	1.03	9.92	0.00265352	0.00033169	26780
6	5	13.38	1.52	14.90	0.00370795	0.00046349	28861
7	10	8.97	1.04	10.02	0.00168657	0.00021082	42571
8	10	17.84	2.00	19.84	0.00314001	0.00039250	45461
9	10	26.80	3.03	29.83	0.00450987	0.00056373	47538
10	15	9.06	1.04	10.10	0.00134529	0.00016816	53890
11	15	13.53	1.52	15.05	0.00194511	0.00024314	55645
12	15	26.69	3.03	29.71	0.00359290	0.00044911	59426
13	20	13.44	1.52	14.96	0.00163443	0.00020430	65803
14	20	17.96	1.99	19.95	0.00212480	0.00026560	67604
15	20	35.45	3.98	39.43	0.00397727	0.00049716	71300

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.97	0.00033911	0.00008478	31189
2	3	5.29	0.64	5.92	0.00067047	0.00016762	31535
3	3	8.07	0.88	8.95	0.00095270	0.00023818	33896
4	5	4.44	0.48	4.92	0.00043132	0.00010783	41207
5	5	8.88	1.03	9.92	0.00083378	0.00020845	42614
6	5	13.38	1.52	14.90	0.00122461	0.00030615	43694
7	10	8.97	1.04	10.02	0.00053991	0.00013498	66491
8	10	17.84	2.00	19.84	0.00107293	0.00026823	66522
9	10	26.80	3.03	29.83	0.00161112	0.00040278	66534
10	15	9.06	1.04	10.10	0.00044598	0.00011149	81279
11	15	13.53	1.52	15.05	0.00066444	0.00016611	81448
12	15	26.69	3.03	29.71	0.00128063	0.00032016	83363
13	20	13.44	1.52	14.96	0.00056361	0.00014090	95412
14	20	17.96	1.99	19.95	0.00074200	0.00018550	96795
15	20	35.45	3.98	39.43	0.00142627	0.00035657	99413


SHRP (P46) - TYPE I
70-279 14 DAY UNTREADED
(2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 6143x^0.6168
R2 = 0.9603
EXTERNAL
y = 2776.5x^0.7187
R2 = 0.983
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 29, 1998

PROJ. NO.: 24285915201

MATERIAL DESCRIPTION : 70-279,28day,#7,untreated

COMMENTS : M.P. 293.7

LAB # :

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

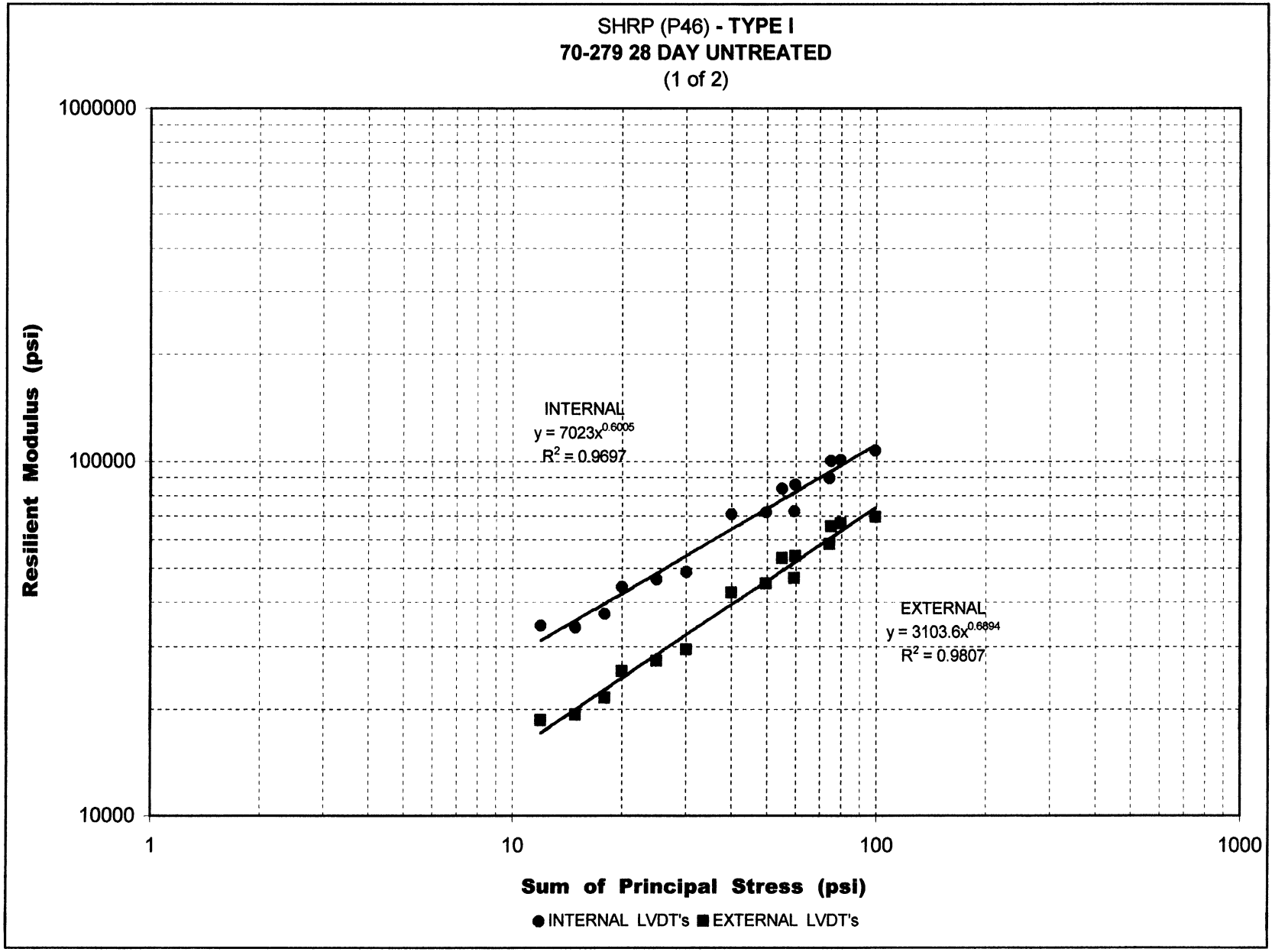
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.17 @ 126.8

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00113458	0.00014182	18580
2	3	5.28	0.63	5.91	0.00218987	0.00027373	19280
3	3	8.04	0.87	8.92	0.00298661	0.00037333	21541
4	5	4.47	0.48	4.95	0.00139958	0.00017495	25530
5	5	8.84	1.04	9.88	0.00259147	0.00032393	27289
6	5	13.51	1.52	15.03	0.00367693	0.00045962	29390
7	10	8.91	1.04	9.95	0.00166847	0.00020856	42705
8	10	17.73	2.00	19.73	0.00313743	0.00039218	45215
9	10	26.50	3.02	29.52	0.00451719	0.00056465	46924
10	15	9.00	1.04	10.04	0.00135003	0.00016875	53349
11	15	13.43	1.52	14.95	0.00199208	0.00024901	53949
12	15	26.31	3.03	29.34	0.00360453	0.00045057	58383
13	20	13.55	1.52	15.07	0.00165597	0.00020700	65440
14	20	17.94	1.99	19.93	0.00214592	0.00026824	66877
15	20	35.36	3.98	39.34	0.00405655	0.00050707	69730

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00030637	0.00007659	34404
2	3	5.28	0.63	5.91	0.00062135	0.00015534	33975
3	3	8.04	0.87	8.92	0.00086653	0.00021663	37122
4	5	4.47	0.48	4.95	0.00040246	0.00010061	44392
5	5	8.84	1.04	9.88	0.00075924	0.00018981	46572
6	5	13.51	1.52	15.03	0.00110697	0.00027674	48811
7	10	8.91	1.04	9.95	0.00050199	0.00012550	70969
8	10	17.73	2.00	19.73	0.00098503	0.00024626	72008
9	10	26.50	3.02	29.52	0.00146505	0.00036626	72341
10	15	9.00	1.04	10.04	0.00042917	0.00010729	83909
11	15	13.43	1.52	14.95	0.00062437	0.00015609	86064
12	15	26.31	3.03	29.34	0.00117161	0.00029290	89810
13	20	13.55	1.52	15.07	0.00053862	0.00013465	100597
14	20	17.94	1.99	19.93	0.00070925	0.00017731	101171
15	20	35.36	3.98	39.34	0.00131725	0.00032931	107368


SHRP (P46) - TYPE I
70-279 28 DAY UNTREATED
(1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 7023x^0.6005
R² = 0.9697
EXTERNAL
y = 3103.6x^0.6894
R² = 0.9807
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 30, 1998

PROJ. NO.: 24285915201

MATERIAL DESCRIPTION : 70-279,28day,untreated,#8

COMMENTS : M.P. 293.7

LAB # : 16591-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

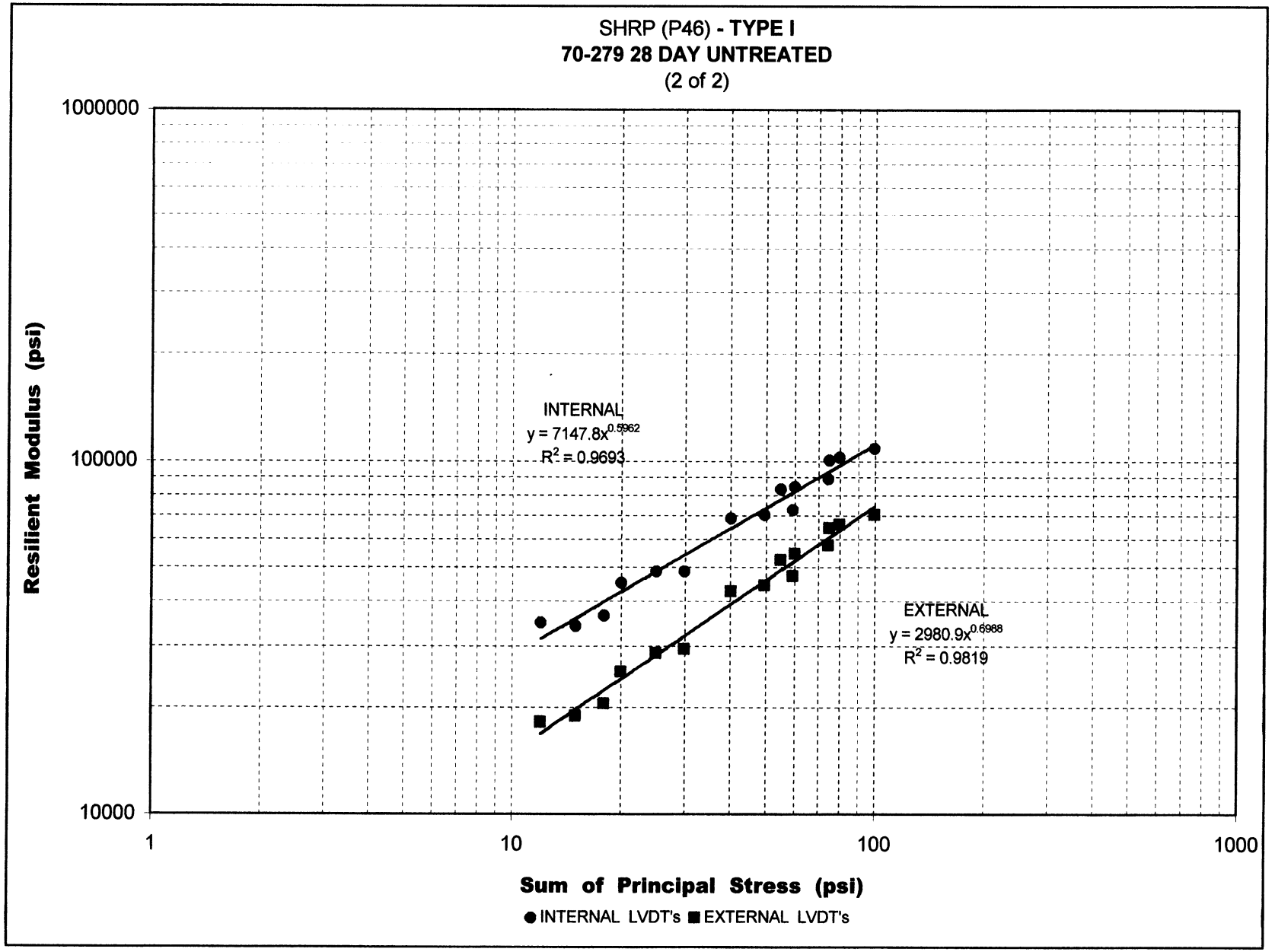
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
6.99 @ 126.8

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.67	0.32	2.99	0.00117379	0.00014672	18184
2	3	5.35	0.64	5.98	0.00226010	0.00028251	18926
3	3	8.06	0.88	8.94	0.00314907	0.00039363	20474
4	5	4.52	0.48	5.00	0.00142415	0.00017802	25386
5	5	8.91	1.04	9.94	0.00248762	0.00031095	28645
6	5	13.34	1.52	14.86	0.00362866	0.00045358	29407
7	10	8.99	1.04	10.04	0.00168786	0.00021098	42625
8	10	17.60	1.99	19.60	0.00317018	0.00039627	44420
9	10	26.27	3.03	29.30	0.00445600	0.00055700	47166
10	15	8.93	1.04	9.97	0.00136253	0.00017032	52425
11	15	13.49	1.52	15.01	0.00197312	0.00024664	54698
12	15	26.40	3.02	29.42	0.00365365	0.00045671	57796
13	20	13.36	1.52	14.88	0.00165382	0.00020673	64645
14	20	17.79	1.99	19.78	0.00215324	0.00026915	66090
15	20	35.76	3.98	39.73	0.00405052	0.00050632	70619

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.67	0.32	2.99	0.00030550	0.00007638	34933
2	3	5.35	0.64	5.98	0.00062523	0.00015631	34207
3	3	8.06	0.88	8.94	0.00088247	0.00022062	36530
4	5	4.52	0.48	5.00	0.00039901	0.00009975	45304
5	5	8.91	1.04	9.94	0.00073209	0.00018302	48668
6	5	13.34	1.52	14.86	0.00109620	0.00027405	48671
7	10	8.99	1.04	10.04	0.00052095	0.00013024	69050
8	10	17.60	1.99	19.60	0.00099924	0.00024981	70462
9	10	26.27	3.03	29.30	0.00144350	0.00036088	72800
10	15	8.93	1.04	9.97	0.00042788	0.00010697	83470
11	15	13.49	1.52	15.01	0.00063600	0.00015900	84847
12	15	26.40	3.02	29.42	0.00118367	0.00029592	89201
13	20	13.36	1.52	14.88	0.00053086	0.00013272	100696
14	20	17.79	1.99	19.78	0.00069288	0.00017322	102693
15	20	35.76	3.98	39.73	0.00131208	0.00032802	109004


SHRP (P46) - TYPE I
70-279 28 DAY UNTREATED
(2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 7147.8x^0.5962
R2 = 0.9693
EXTERNAL
y = 2980.9x^0.6988
R2 = 0.9819
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (1 day,#1,Treated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

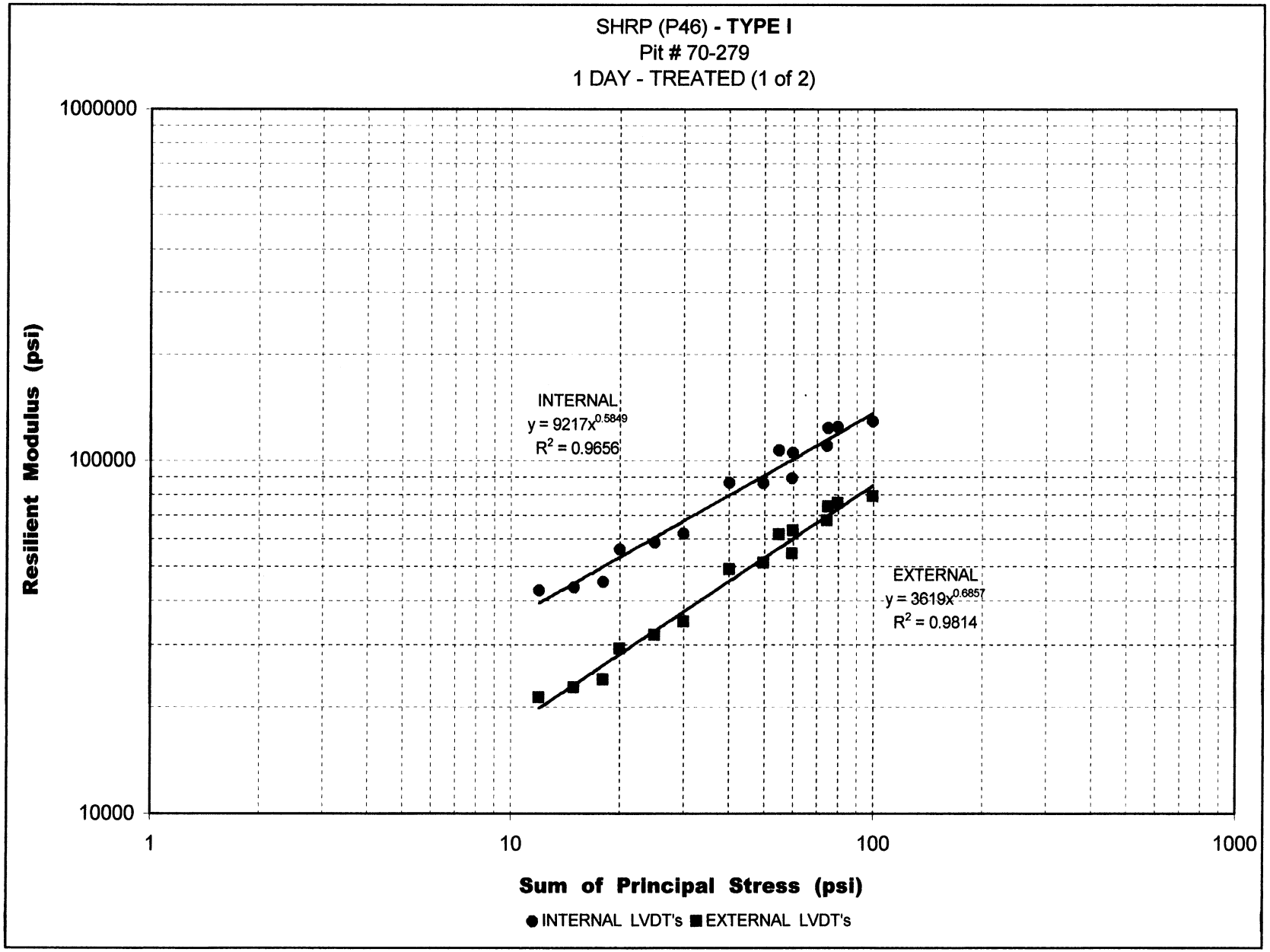
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.99 @ 127.4

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00099195	0.00012399	21292
2	3	5.30	0.64	5.94	0.00186841	0.00023355	22713
3	3	8.10	0.88	8.98	0.00271213	0.00033902	23901
4	5	4.48	0.48	4.96	0.00122636	0.00015330	29249
5	5	8.90	1.04	9.94	0.00222304	0.00027788	32031
6	5	13.44	1.51	14.95	0.00307840	0.00038480	34935
7	10	9.00	1.04	10.04	0.00146853	0.00018357	49049
8	10	17.83	1.99	19.82	0.00278452	0.00034806	51225
9	10	26.78	3.02	29.80	0.00394021	0.00049253	54372
10	15	8.93	1.04	9.97	0.00115871	0.00014484	61647
11	15	13.48	1.51	15.00	0.00170509	0.00021314	63265
12	15	26.58	3.02	29.60	0.00314519	0.00039315	67597
13	20	13.45	1.52	14.97	0.00145086	0.00018136	74179
14	20	17.98	1.99	19.97	0.00189469	0.00023684	75915
15	20	35.89	3.98	39.87	0.00361660	0.00045207	79394

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00024604	0.00006151	42920
2	3	5.30	0.64	5.94	0.00048562	0.00012140	43695
3	3	8.10	0.88	8.98	0.00071658	0.00017914	45231
4	5	4.48	0.48	4.96	0.00032059	0.00008015	55944
5	5	8.90	1.04	9.94	0.00060670	0.00015168	58683
6	5	13.44	1.51	14.95	0.00086567	0.00021642	62116
7	10	9.00	1.04	10.04	0.00041495	0.00010374	86793
8	10	17.83	1.99	19.82	0.00082344	0.00020586	86610
9	10	26.78	3.02	29.80	0.00120005	0.00030001	89262
10	15	8.93	1.04	9.97	0.00033222	0.00008306	107504
11	15	13.48	1.51	15.00	0.00051061	0.00012765	105631
12	15	26.58	3.02	29.60	0.00096348	0.00024087	110331
13	20	13.45	1.52	14.97	0.00043434	0.00010859	123892
14	20	17.98	1.99	19.97	0.00057611	0.00014403	124834
15	20	35.89	3.98	39.87	0.00110956	0.00027739	129393


SHRP (P46) - TYPE I
Pit # 70-279
1 DAY - TREATED (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9217x^0.5849
R2 = 0.9656
EXTERNAL
y = 3619x^0.6857
R2 = 0.9814
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (1 day, #2, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

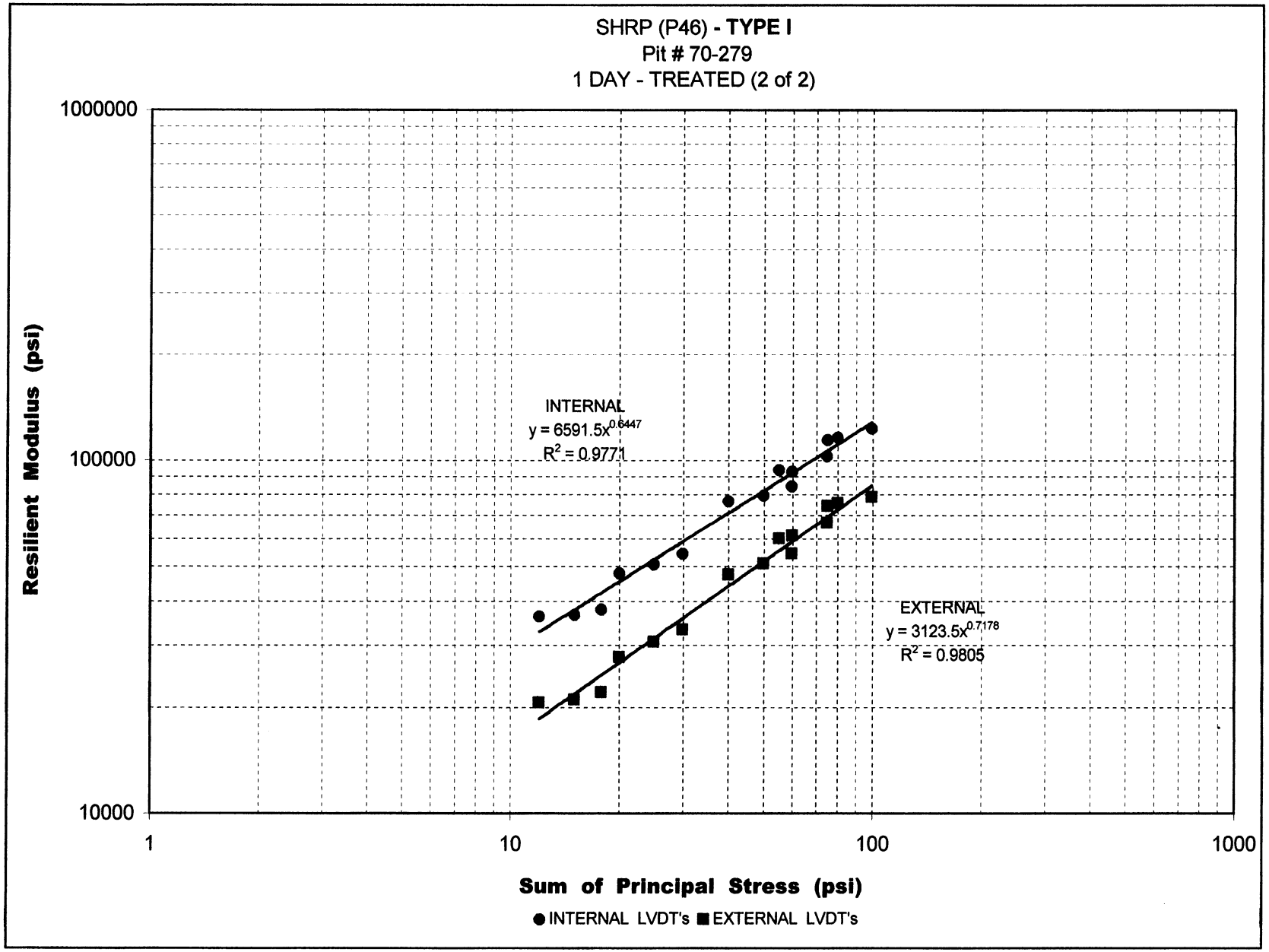
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
8.08 @ 127.5

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.33	2.97	0.00102814	0.00012852	20612
2	3	5.38	0.63	6.01	0.00204810	0.00025601	21013
3	3	7.94	0.88	8.82	0.00287717	0.00035965	22079
4	5	4.51	0.48	4.99	0.00129875	0.00016234	27786
5	5	8.87	1.04	9.90	0.00231353	0.00028919	30659
6	5	13.32	1.52	14.84	0.00320853	0.00040107	33212
7	10	8.89	1.04	9.93	0.00149438	0.00018680	47592
8	10	17.97	1.99	19.96	0.00282115	0.00035264	50959
9	10	26.75	3.02	29.78	0.00392814	0.00049102	54482
10	15	9.01	1.04	10.05	0.00119921	0.00014990	60119
11	15	13.45	1.52	14.96	0.00175724	0.00021966	61219
12	15	26.73	3.02	29.76	0.00320681	0.00040085	66694
13	20	13.51	1.52	15.03	0.00145517	0.00018190	74271
14	20	18.01	1.99	20.01	0.00189858	0.00023732	75905
15	20	35.57	3.98	39.56	0.00361358	0.00045170	78757

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.33	2.97	0.00029258	0.00007314	36217
2	3	5.38	0.63	6.01	0.00058774	0.00014694	36612
3	3	7.94	0.88	8.82	0.00083637	0.00020909	37977
4	5	4.51	0.48	4.99	0.00037660	0.00009415	47911
5	5	8.87	1.04	9.90	0.00069719	0.00017430	50868
6	5	13.32	1.52	14.84	0.00097943	0.00024486	54400
7	10	8.89	1.04	9.93	0.00046235	0.00011559	76912
8	10	17.97	1.99	19.96	0.00090488	0.00022622	79437
9	10	26.75	3.02	29.78	0.00126683	0.00031671	84468
10	15	9.01	1.04	10.05	0.00038350	0.00009587	93997
11	15	13.45	1.52	14.96	0.00057654	0.00014413	93295
12	15	26.73	3.02	29.76	0.00103889	0.00025972	102935
13	20	13.51	1.52	15.03	0.00047226	0.00011807	114426
14	20	18.01	1.99	20.01	0.00061877	0.00015469	116451
15	20	35.57	3.98	39.56	0.00115437	0.00028859	123268


SHRP (P46) - TYPE I
Pit # 70-279
1 DAY - TREATED (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 6591.5x^0.6447
R2 = 0.9771
EXTERNAL
y = 3123.5x^0.7178
R2 = 0.9805
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (7day,#3,Treated) Date of Compaction: 5-20-98

LAB # : Mine # 36-246

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

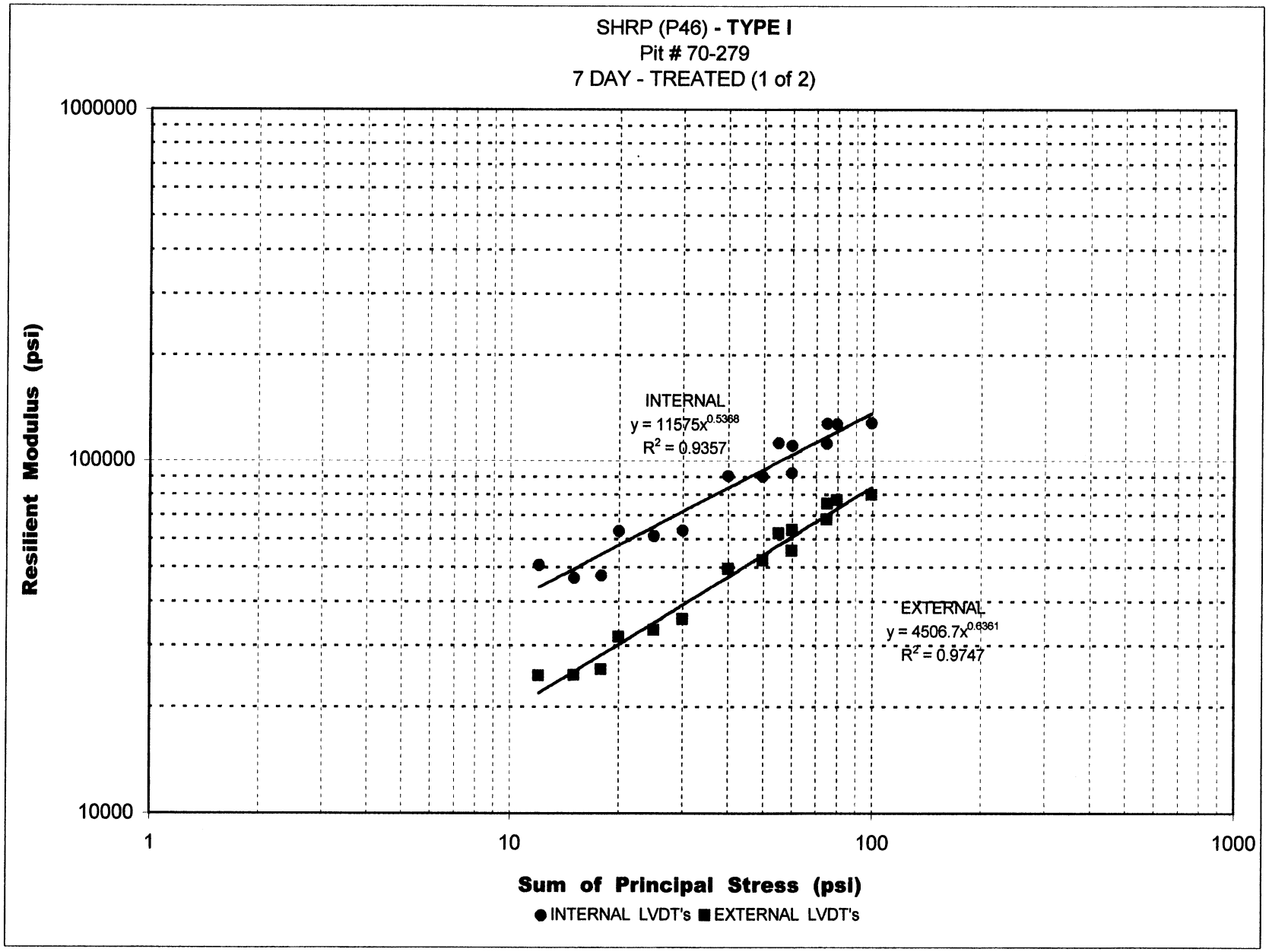
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.95 @ 127.5

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.68	0.32	3.00	0.00087388	0.00010923	24545
2	3	5.39	0.64	6.03	0.00175120	0.00021890	24636
3	3	7.98	0.88	8.86	0.00249107	0.00031138	25636
4	5	4.48	0.48	4.95	0.00112768	0.00014096	31756
5	5	8.90	1.04	9.95	0.00214204	0.00026775	33248
6	5	13.47	1.52	14.98	0.00302108	0.00037764	35665
7	10	8.92	1.04	9.96	0.00144052	0.00018006	49554
8	10	17.83	2.00	19.83	0.00272333	0.00034042	52378
9	10	26.85	3.03	29.88	0.00386222	0.00048278	55612
10	15	9.00	1.04	10.04	0.00115526	0.00014441	62292
11	15	13.59	1.51	15.11	0.00170596	0.00021324	63751
12	15	26.79	3.03	29.82	0.00314949	0.00039369	68056
13	20	13.55	1.51	15.06	0.00143406	0.00017926	75567
14	20	17.89	1.99	19.88	0.00185333	0.00023167	77211
15	20	35.40	3.96	39.35	0.00353688	0.00044211	80068

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.68	0.32	3.00	0.00021071	0.00005268	50898
2	3	5.39	0.64	6.03	0.00046063	0.00011516	46830
3	3	7.98	0.88	8.86	0.00067133	0.00016783	47563
4	5	4.48	0.48	4.95	0.00028310	0.00007078	63247
5	5	8.90	1.04	9.95	0.00058042	0.00014510	61352
6	5	13.47	1.52	14.98	0.00084887	0.00021222	63466
7	10	8.92	1.04	9.96	0.00039341	0.00009835	90725
8	10	17.83	2.00	19.83	0.00078854	0.00019714	90448
9	10	26.85	3.03	29.88	0.00116127	0.00029032	92479
10	15	9.00	1.04	10.04	0.00031930	0.00007982	112691
11	15	13.59	1.51	15.11	0.00048993	0.00012248	110992
12	15	26.79	3.03	29.82	0.00095400	0.00023850	112339
13	20	13.55	1.51	15.06	0.00042271	0.00010568	128182
14	20	17.89	1.99	19.88	0.00056060	0.00014015	127630
15	20	35.40	3.96	39.35	0.00110180	0.00027545	128513


SHRP (P46) - TYPE I
Pit # 70-279
7 DAY - TREATED (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 11575x^0.5368
R^2 = 0.9357
EXTERNAL
y = 4506.7x^0.6361
R^2 = 0.9747
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101-037

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (7 day, #4, Treated) Date of Compaction: 5-20-98

LAB # : 13718-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

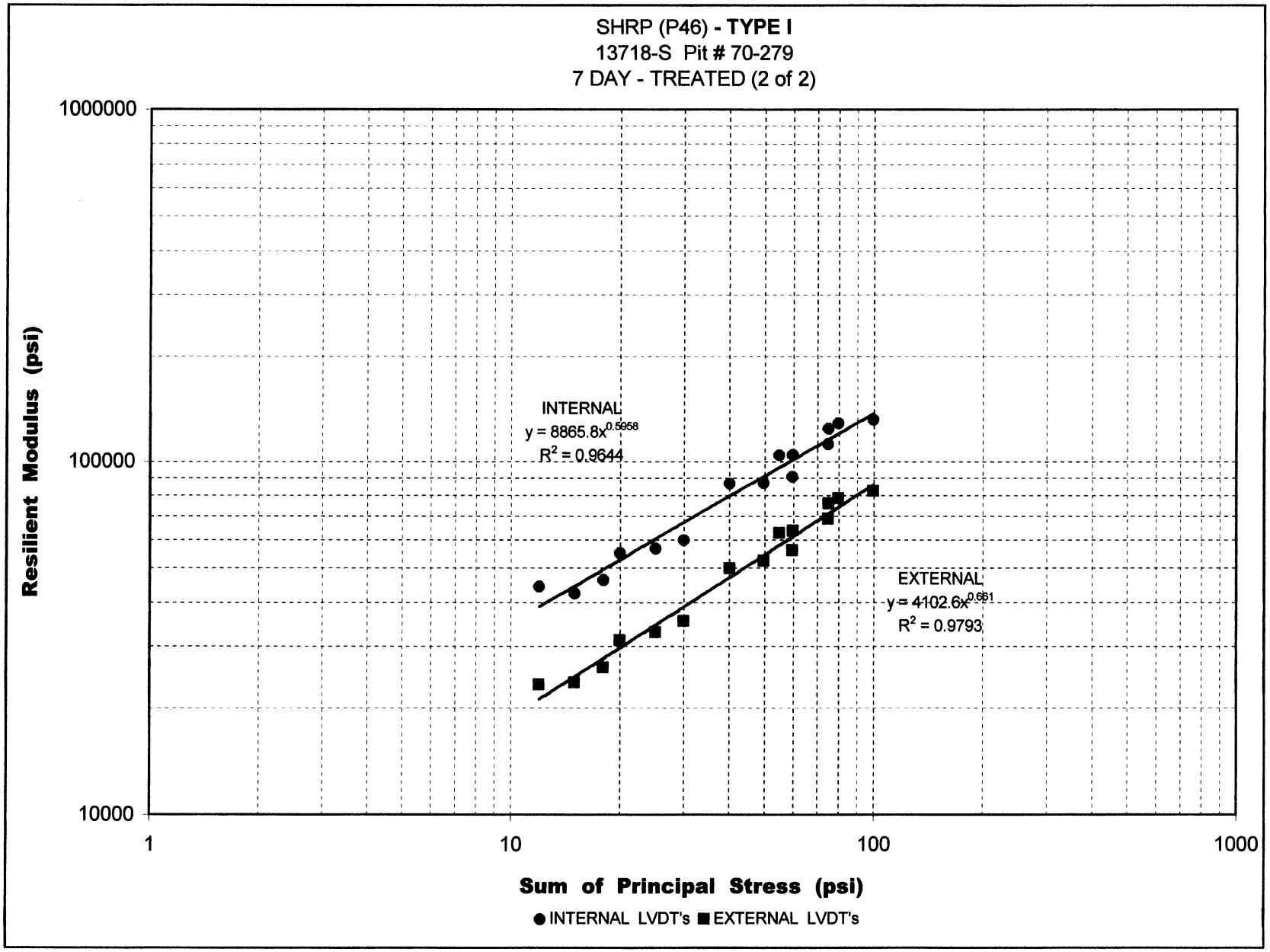
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.54 @ 127.8

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.97	0.00090835	0.00011354	23345
2	3	5.35	0.64	5.98	0.00181110	0.00022639	23614
3	3	8.10	0.88	8.97	0.00248288	0.00031036	26084
4	5	4.51	0.48	4.99	0.00115742	0.00014468	31156
5	5	8.97	1.03	10.01	0.00218555	0.00027319	32849
6	5	13.41	1.51	14.92	0.00303143	0.00037893	35381
7	10	8.97	1.04	10.01	0.00143966	0.00017996	49863
8	10	17.81	2.00	19.81	0.00272333	0.00034042	52325
9	10	26.68	3.02	29.71	0.00381740	0.00047718	55920
10	15	8.95	1.03	9.98	0.00114104	0.00014263	62728
11	15	13.38	1.52	14.90	0.00167925	0.00020991	63757
12	15	26.85	3.03	29.87	0.00311933	0.00038992	68858
13	20	13.51	1.52	15.03	0.00142156	0.00017770	76055
14	20	17.84	1.99	19.83	0.00181541	0.00022693	78635
15	20	35.91	3.97	39.88	0.00349034	0.00043629	82302

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.97	0.00023872	0.00005968	44416
2	3	5.35	0.64	5.98	0.00050415	0.00012604	42415
3	3	8.10	0.88	8.97	0.00069935	0.00017484	46303
4	5	4.51	0.48	4.99	0.00032748	0.00008187	55058
5	5	8.97	1.03	10.01	0.00063256	0.00015814	56748
6	5	13.41	1.51	14.92	0.00089540	0.00022385	59892
7	10	8.97	1.04	10.01	0.00041409	0.00010352	86678
8	10	17.81	2.00	19.81	0.00081784	0.00020446	87118
9	10	26.68	3.02	29.71	0.00117548	0.00029387	90800
10	15	8.95	1.03	9.98	0.00034170	0.00008543	104734
11	15	13.38	1.52	14.90	0.00050975	0.00012744	105015
12	15	26.85	3.03	29.87	0.00095228	0.00023807	112777
13	20	13.51	1.52	15.03	0.00043348	0.00010837	124708
14	20	17.84	1.99	19.83	0.00055198	0.00013799	129312
15	20	35.91	3.97	39.88	0.00108500	0.00027125	132379


SHRP (P46) - TYPE I
13718-S Pit # 70-279
7 DAY - TREATED (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 8865.8x^0.5958
R² = 0.9644
EXTERNAL
y = 4102.6x^0.661
R² = 0.9793
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: May 21, 1998

PROJ. NO.: 1909701A101

MATERIAL DESCRIPTION : Tan Limerock

COMMENTS : Pit # 70-279 (14 day,#5,Treated) Date of Compaction: 5-20-98

LAB # :

SAMPLE # : 1 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

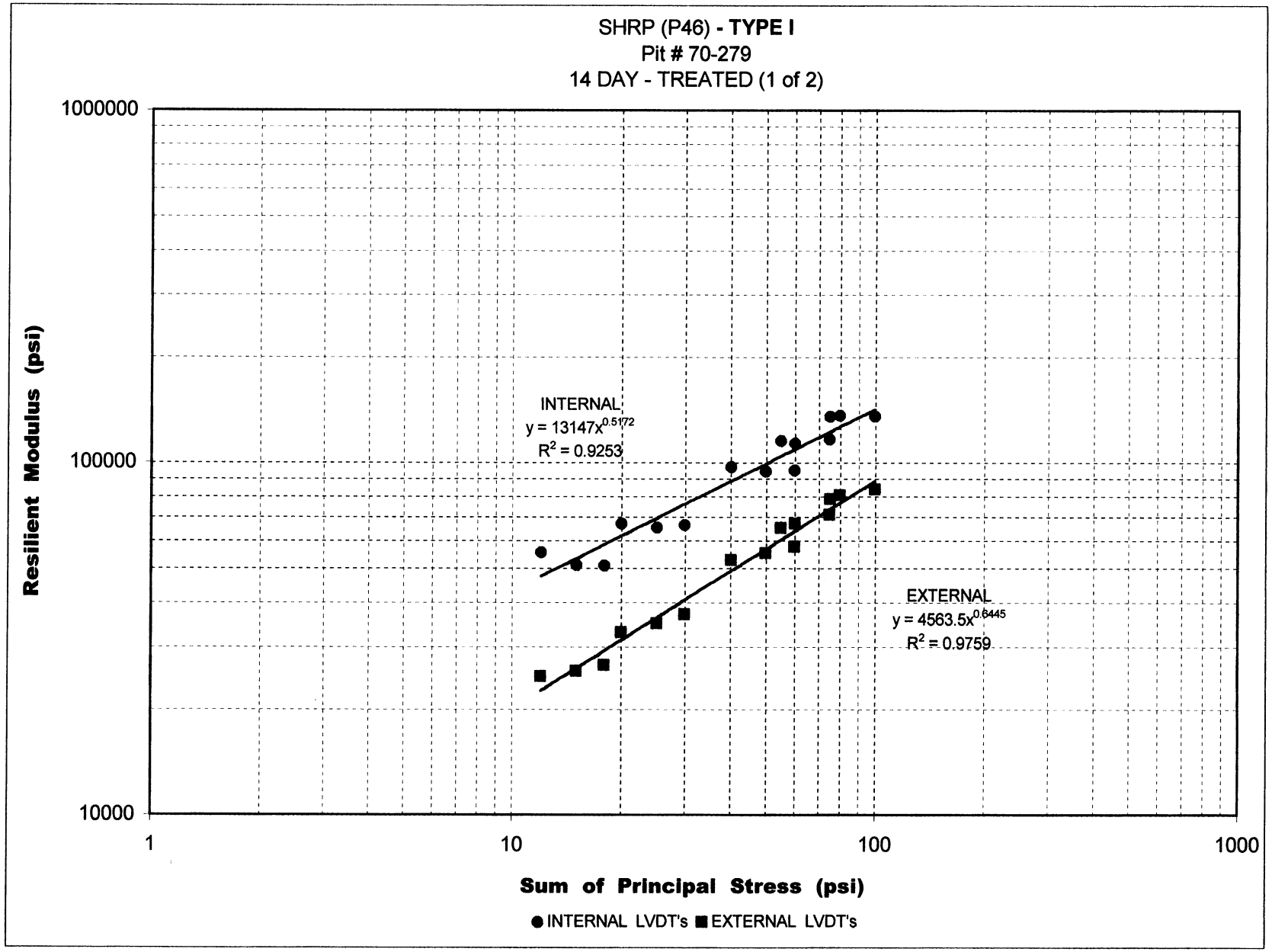
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.91 @ 127.7

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.99	0.00086009	0.00010751	24778
2	3	5.38	0.64	6.02	0.00167752	0.00020969	25651
3	3	8.06	0.88	8.94	0.00241394	0.00030174	26698
4	5	4.47	0.48	4.95	0.00108373	0.00013547	33014
5	5	8.97	1.03	10.00	0.00204766	0.00025596	35051
6	5	13.36	1.52	14.88	0.00287975	0.00035997	37116
7	10	9.01	1.04	10.04	0.00136253	0.00017032	52874
8	10	17.89	2.00	19.89	0.00259147	0.00032393	55241
9	10	26.89	3.02	29.91	0.00373036	0.00046629	57671
10	15	8.92	1.04	9.96	0.00109579	0.00013697	65156
11	15	13.51	1.52	15.02	0.00160987	0.00020123	67118
12	15	26.85	3.02	29.88	0.00302108	0.00037764	71104
13	20	13.52	1.52	15.04	0.00137114	0.00017139	78890
14	20	17.76	1.99	19.76	0.00175508	0.00021939	80959
15	20	35.78	3.99	39.77	0.00340804	0.00042600	83998

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.99	0.00019132	0.00004783	55695
2	3	5.38	0.64	6.02	0.00042099	0.00010525	51107
3	3	8.06	0.88	8.94	0.00063169	0.00015792	51012
4	5	4.47	0.48	4.95	0.00026629	0.00006657	67178
5	5	8.97	1.03	10.00	0.00054853	0.00013713	65423
6	5	13.36	1.52	14.88	0.00080492	0.00020123	66395
7	10	9.01	1.04	10.04	0.00036928	0.00009232	97546
8	10	17.89	2.00	19.89	0.00075709	0.00018927	94545
9	10	26.89	3.02	29.91	0.00112809	0.00028202	95353
10	15	8.92	1.04	9.96	0.00030895	0.00007724	115548
11	15	13.51	1.52	15.02	0.00047442	0.00011860	113878
12	15	26.85	3.02	29.88	0.00092126	0.00023031	116586
13	20	13.52	1.52	15.04	0.00039772	0.00009943	135989
14	20	17.76	1.99	19.76	0.00051923	0.00012981	136827
15	20	35.78	3.99	39.77	0.00105440	0.00026360	135749


SHRP (P46) - TYPE I
Pit # 70-279
14 DAY - TREATED (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 13147x^0.5172
R^2 = 0.9253
EXTERNAL
y = 4563.5x^0.6445
R^2 = 0.9759
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 30, 1998

PROJ. NO.: 24285915201

MATERIAL DESCRIPTION : Light Tan Limerock,70-279,14day,Treated

COMMENTS : M.P. 293.7

LAB # : 16591-S

SAMPLE # : (2 of 2)

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

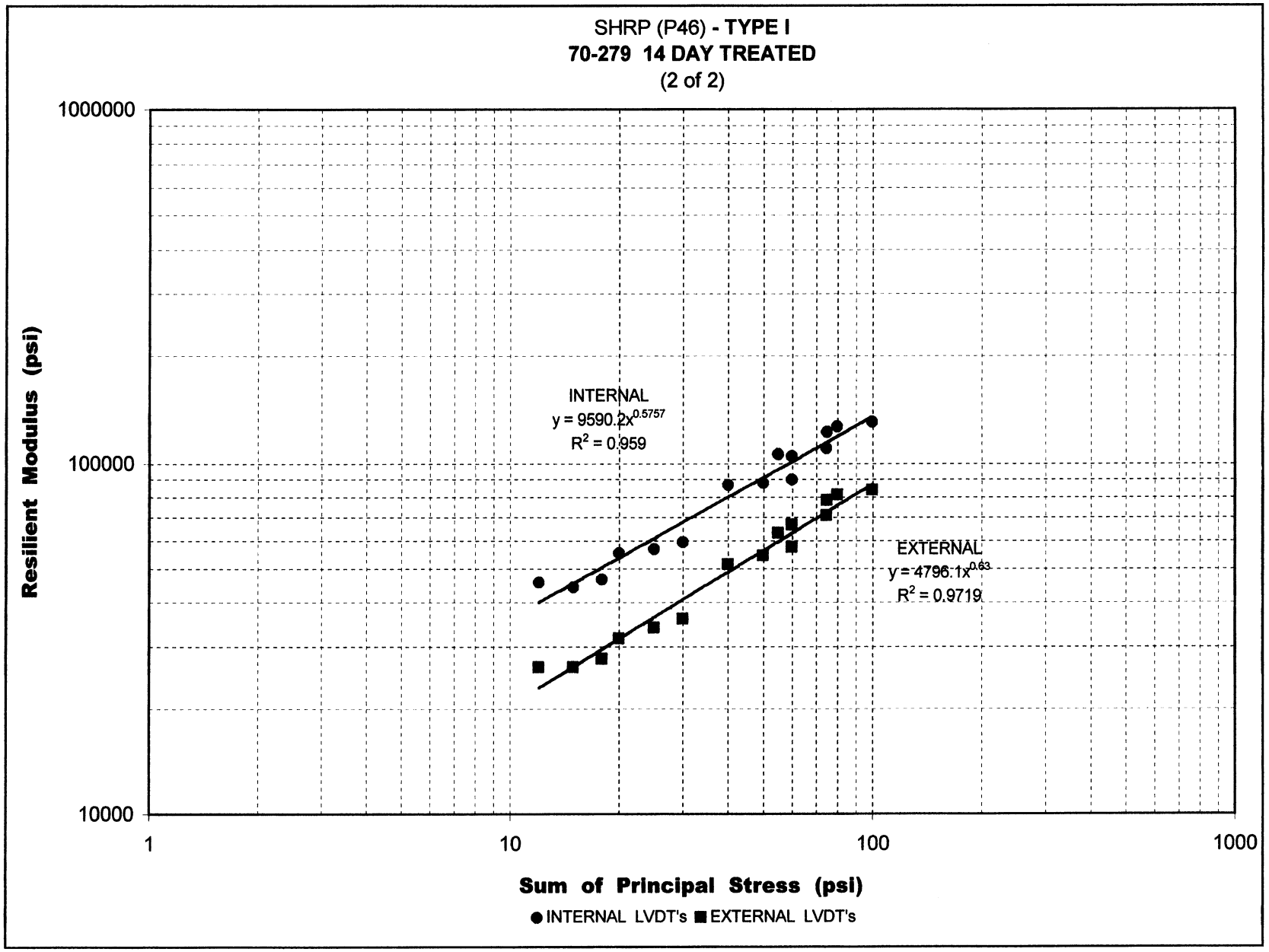
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
8.08 @ 127.6

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.99	0.00081054	0.00010132	26276
2	3	5.31	0.64	5.95	0.00161676	0.00020210	26285
3	3	8.07	0.88	8.95	0.00232560	0.00029070	27772
4	5	4.48	0.48	4.96	0.00113113	0.00014139	31671
5	5	8.89	1.04	9.93	0.00209248	0.00026156	33992
6	5	13.45	1.52	14.96	0.00298489	0.00037311	36038
7	10	8.93	1.04	9.96	0.00138924	0.00017366	51412
8	10	17.90	2.00	19.89	0.00262723	0.00032840	54492
9	10	26.86	3.02	29.88	0.00372949	0.00046619	57607
10	15	8.89	1.04	9.93	0.00112337	0.00014042	63304
11	15	13.42	1.52	14.94	0.00160944	0.00020118	66714
12	15	26.58	3.02	29.60	0.00299308	0.00037413	71045
13	20	13.38	1.52	14.90	0.00136468	0.00017059	78424
14	20	17.81	2.00	19.81	0.00175077	0.00021885	81384
15	20	35.78	3.99	39.77	0.00341278	0.00042660	83875

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.99	0.00023268	0.00005817	45767
2	3	5.31	0.64	5.95	0.00047829	0.00011957	44426
3	3	8.07	0.88	8.95	0.00069030	0.00017257	46781
4	5	4.48	0.48	4.96	0.00032274	0.00008068	55500
5	5	8.89	1.04	9.93	0.00062308	0.00015577	57077
6	5	13.45	1.52	14.96	0.00090187	0.00022547	59637
7	10	8.93	1.04	9.96	0.00041064	0.00010266	86966
8	10	17.90	2.00	19.89	0.00081353	0.00020338	87989
9	10	26.86	3.02	29.88	0.00119100	0.00029775	90195
10	15	8.89	1.04	9.93	0.00033351	0.00008338	106613
11	15	13.42	1.52	14.94	0.00051018	0.00012755	105230
12	15	26.58	3.02	29.60	0.00096004	0.00024001	110748
13	20	13.38	1.52	14.90	0.00043520	0.00010880	122958
14	20	17.81	2.00	19.81	0.00055887	0.00013972	127475
15	20	35.78	3.99	39.77	0.00109146	0.00027287	131131


SHRP (P46) - TYPE I
70-279 14 DAY TREATED
(2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9590.2x^0.5757
R2 = 0.959
EXTERNAL
y = 4796.1x^0.63
R2 = 0.9719
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 29, 1998
PROJ. NO.: 24285915201
MATERIAL DESCRIPTION : 70-279,treated,28day,#7
COMMENTS : M.P. 293.7

LAB # : 16591-S
SAMPLE # : 1 of 2
LBR :
SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

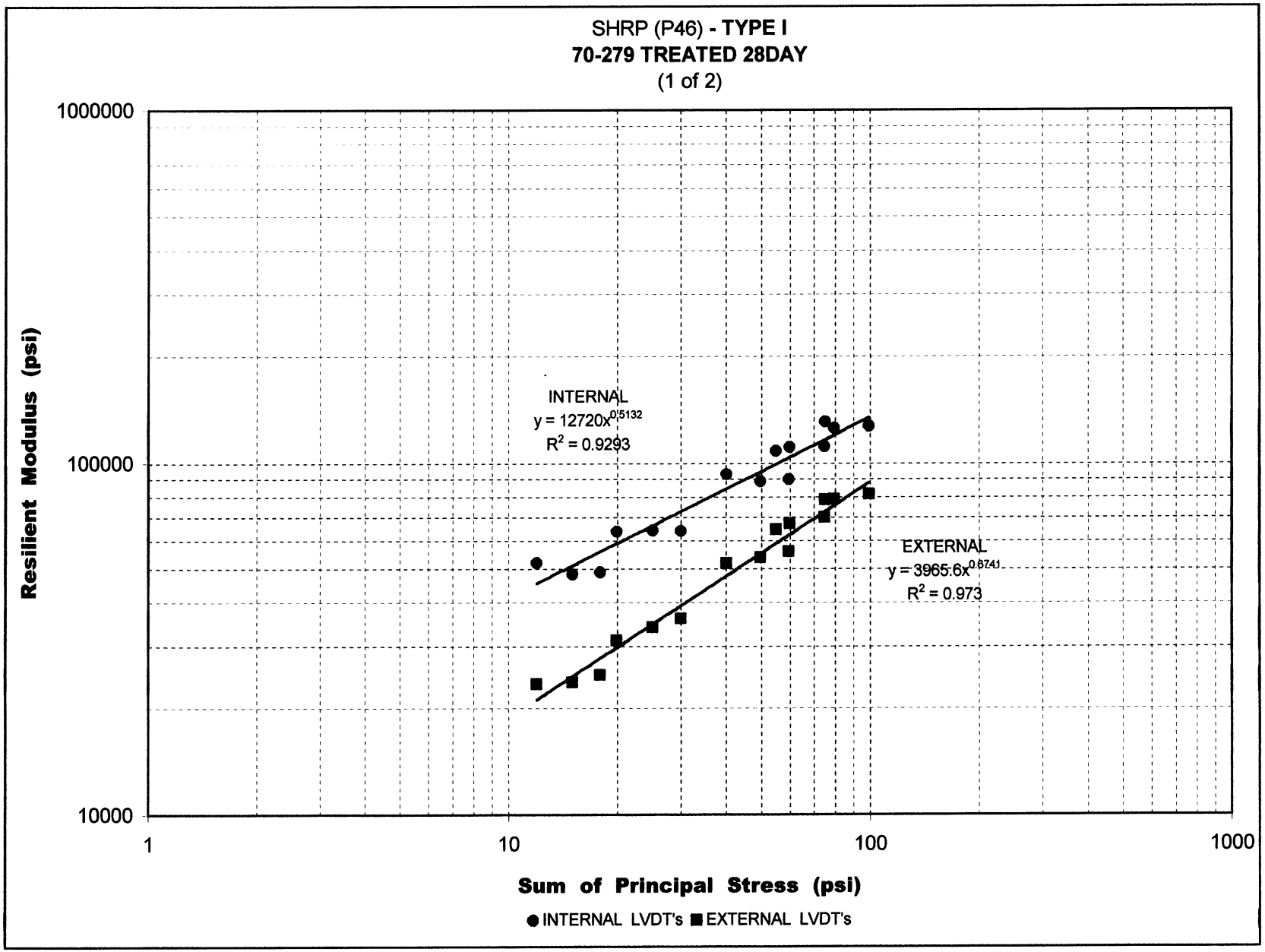
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.95 @ 127.5

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00090275	0.00011284	23351
2	3	5.37	0.64	6.01	0.00181584	0.00022698	23676
3	3	8.04	0.88	8.91	0.00258759	0.00032345	24845
4	5	4.45	0.48	4.93	0.00114190	0.00014274	31170
5	5	8.99	1.04	10.03	0.00211403	0.00026425	34016
6	5	13.41	1.52	14.93	0.00297972	0.00037246	35997
7	10	9.02	1.04	10.06	0.00139183	0.00017398	51823
8	10	17.71	2.00	19.70	0.00263111	0.00032889	53836
9	10	26.44	3.02	29.46	0.00378594	0.00047324	55860
10	15	8.97	1.04	10.01	0.00111131	0.00013891	64596
11	15	13.41	1.52	14.92	0.00159608	0.00019951	67194
12	15	26.80	3.03	29.82	0.00305685	0.00038211	70134
13	20	13.45	1.52	14.97	0.00136683	0.00017085	78729
14	20	17.75	1.99	19.74	0.00179818	0.00022477	78968
15	20	35.52	3.97	39.50	0.00348991	0.00043624	81429

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00020209	0.00005052	52156
2	3	5.37	0.64	6.01	0.00044468	0.00011117	48339
3	3	8.04	0.88	8.91	0.00065582	0.00016396	49014
4	5	4.45	0.48	4.93	0.00027750	0.00006937	64132
5	5	8.99	1.04	10.03	0.00055715	0.00013929	64535
6	5	13.41	1.52	14.93	0.00083465	0.00020866	64255
7	10	9.02	1.04	10.06	0.00038651	0.00009663	93307
8	10	17.71	2.00	19.70	0.00079543	0.00019886	89038
9	10	26.44	3.02	29.46	0.00117549	0.00029387	89956
10	15	8.97	1.04	10.01	0.00033093	0.00008273	108462
11	15	13.41	1.52	14.92	0.00048088	0.00012022	111512
12	15	26.80	3.03	29.82	0.00095918	0.00023979	111757
13	20	13.45	1.52	14.97	0.00041021	0.00010255	131163
14	20	17.75	1.99	19.74	0.00056491	0.00014123	125682
15	20	35.52	3.97	39.50	0.00111559	0.00027890	127367


SHRP (P46) - TYPE I
70-279 TREATED 28DAY
(1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 12720x^0.5132
R² = 0.9293
EXTERNAL
y = 3965.6x^0.6741
R² = 0.973
1
10
100
1000
Sum of Principal Stress (psi)
● INTERNAL LVDT's ■ EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE: July 30, 1998

PROJ. NO.: 24285915201

MATERIAL DESCRIPTION : 70-279,treated,28day,#8

COMMENTS : M.P. 293.7

LAB # : 16591-S

SAMPLE # : 2 of 2

LBR :

SOIL CLASS :

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

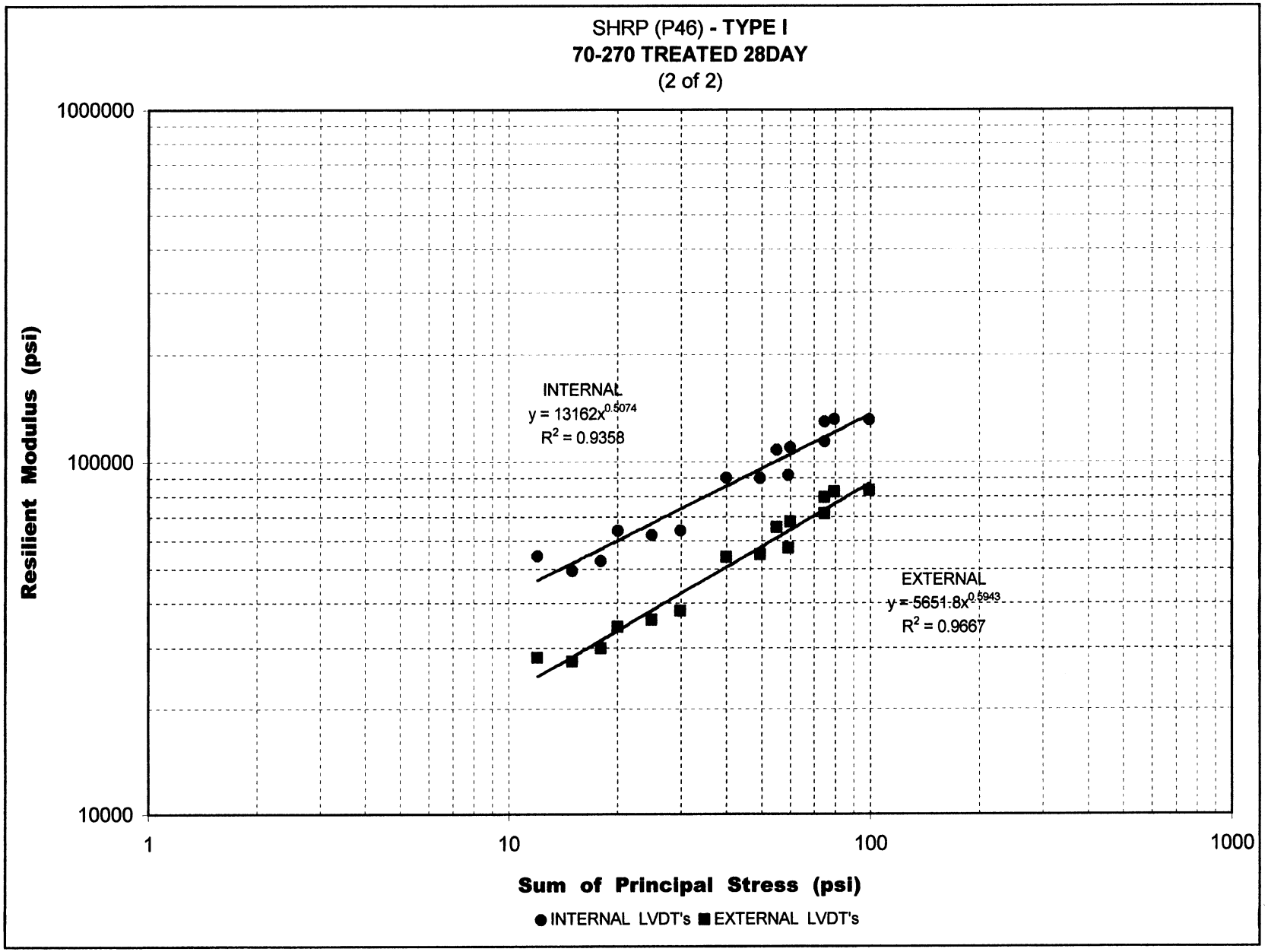
INSITU or TARGET MOIST. / DENSITY:
ACTUAL MOISTURE / DENSITY:
7.95 @ 127.1

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.69	0.32	3.01	0.00076573	0.00009572	28064
2	3	5.34	0.64	5.98	0.00155729	0.00019466	27416
3	3	8.08	0.88	8.96	0.00216703	0.00027088	29840
4	5	4.54	0.48	5.02	0.00105787	0.00013223	34337
5	5	8.87	1.04	9.91	0.00197786	0.00024723	35875
6	5	13.38	1.52	14.90	0.00281813	0.00035227	37991
7	10	8.94	1.04	9.98	0.00132504	0.00016563	53978
8	10	17.64	2.00	19.64	0.00257079	0.00032135	54889
9	10	26.37	3.03	29.40	0.00368641	0.00046080	57226
10	15	9.00	1.04	10.03	0.00109967	0.00013746	65447
11	15	13.50	1.51	15.01	0.00159220	0.00019902	67817
12	15	26.83	3.02	29.85	0.00299954	0.00037494	71555
13	20	13.38	1.51	14.89	0.00134529	0.00016816	79564
14	20	17.68	1.99	19.68	0.00172018	0.00021502	82238
15	20	35.50	3.98	39.47	0.00341278	0.00042660	83206

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.69	0.32	3.01	0.00019692	0.00004923	54562
2	3	5.34	0.64	5.98	0.00043133	0.00010783	49492
3	3	8.08	0.88	8.96	0.00061274	0.00015318	52767
4	5	4.54	0.48	5.02	0.00028267	0.00007067	64253
5	5	8.87	1.04	9.91	0.00056792	0.00014198	62470
6	5	13.38	1.52	14.90	0.00083292	0.00020823	64269
7	10	8.94	1.04	9.98	0.00039556	0.00009889	90406
8	10	17.64	2.00	19.64	0.00078380	0.00019595	90016
9	10	26.37	3.03	29.40	0.00115050	0.00028762	91681
10	15	9.00	1.04	10.03	0.00033222	0.00008305	108319
11	15	13.50	1.51	15.01	0.00049165	0.00012291	109812
12	15	26.83	3.02	29.85	0.00093763	0.00023441	114456
13	20	13.38	1.51	14.89	0.00041237	0.00010309	129783
14	20	17.68	1.99	19.68	0.00053474	0.00013369	132272
15	20	35.50	3.98	39.47	0.00107767	0.00026942	131748


SHRP (P46) - TYPE I
70-270 TREATED 28DAY
(2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 13162x^0.5074
R2 = 0.9358
EXTERNAL
y = 5651.8x^0.5943
R2 = 0.9667
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock [redacted]

COMMENTS : [redacted]

LAB # : 14222-S

SAMPLE # : [redacted]

LBR : 91.0

SOIL CLASS :

FINAL % (w) : 12.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

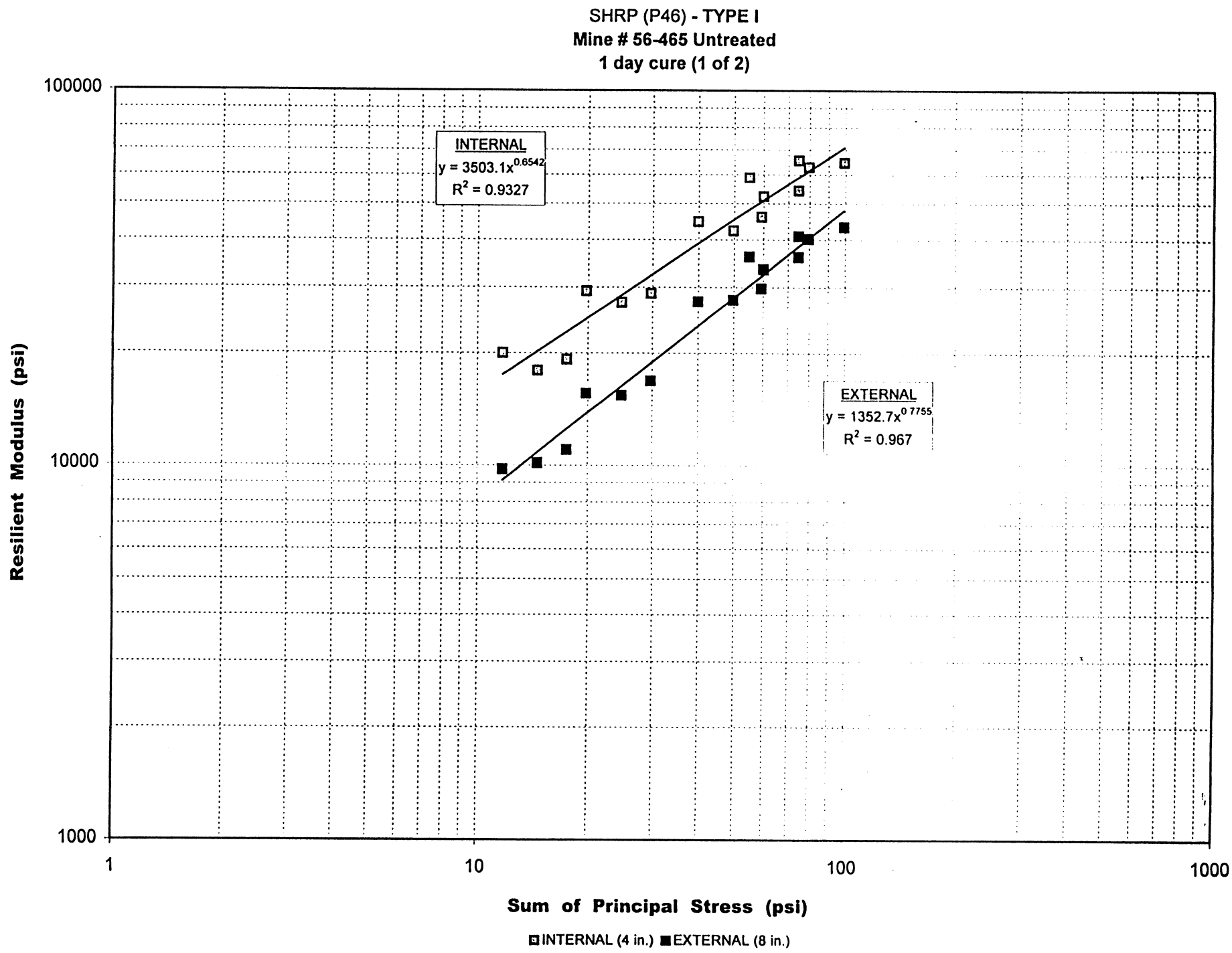
INSITU or TARGET MOIST. / DENSITY:
11.8 @ 121.4
ACTUAL MOISTURE / DENSITY:
12.4 @ 120.2

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.39	0.32	2.71	0.00196106	0.00024513	9745
2	3	4.95	0.63	5.58	0.00390875	0.00048859	10127
3	3	7.65	0.87	8.53	0.00558024	0.00069753	10971
4	5	4.33	0.48	4.80	0.00222563	0.00027820	15551
5	5	8.70	1.04	9.74	0.00452969	0.00056621	15364
6	5	13.18	1.51	14.70	0.00626366	0.00078296	16839
7	10	8.89	1.04	9.92	0.00259190	0.00032399	27424
8	10	17.80	1.99	19.79	0.00513770	0.00064221	27715
9	10	26.25	3.02	29.27	0.00705265	0.00088158	29773
10	15	8.93	1.04	9.96	0.00198131	0.00024766	36052
11	15	13.47	1.52	14.98	0.00322663	0.00040333	33389
12	15	26.71	3.02	29.73	0.00594306	0.00074288	35953
13	20	13.24	1.52	14.75	0.00259147	0.00032393	40861
14	20	17.65	1.99	19.64	0.00351318	0.00043915	40182
15	20	35.40	3.97	39.38	0.00655323	0.00081915	43218

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.39	0.32	2.71	0.00047829	0.00011957	19978
2	3	4.95	0.63	5.58	0.00110266	0.00027567	17950
3	3	7.65	0.87	8.53	0.00159216	0.00039804	19225
4	5	4.33	0.48	4.80	0.00059119	0.00014780	29273
5	5	8.70	1.04	9.74	0.00127588	0.00031897	27272
6	5	13.18	1.51	14.70	0.00182873	0.00045718	28838
7	10	8.89	1.04	9.92	0.00079629	0.00019907	44632
8	10	17.80	1.99	19.79	0.00168524	0.00042131	42247
9	10	26.25	3.02	29.27	0.00228590	0.00057148	45928
10	15	8.93	1.04	9.96	0.00060756	0.00015189	58784
11	15	13.47	1.52	14.98	0.00103070	0.00025768	52263
12	15	26.71	3.02	29.73	0.00197092	0.00049273	54206
13	20	13.24	1.52	14.75	0.00080879	0.00020220	65462
14	20	17.65	1.99	19.64	0.00112464	0.00028116	62761
15	20	35.40	3.97	39.38	0.00219154	0.00054788	64616


SHRP (P46) - TYPE I
Mine # 56-465 Untreated
1 day cure (1 of 2)
INTERNAL
y = 3503.1x^0.6542
R² = 0.9327
EXTERNAL
y = 1352.7x^0.7755
R² = 0.967
Resilient Modulus (psi)
100000
10000
1000
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock [redacted]

COMMENTS : [redacted]

LAB # : 14222-S

SAMPLE # : [redacted]

LBR : 91.0

SOIL CLASS :

FINAL % (w) : 12.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

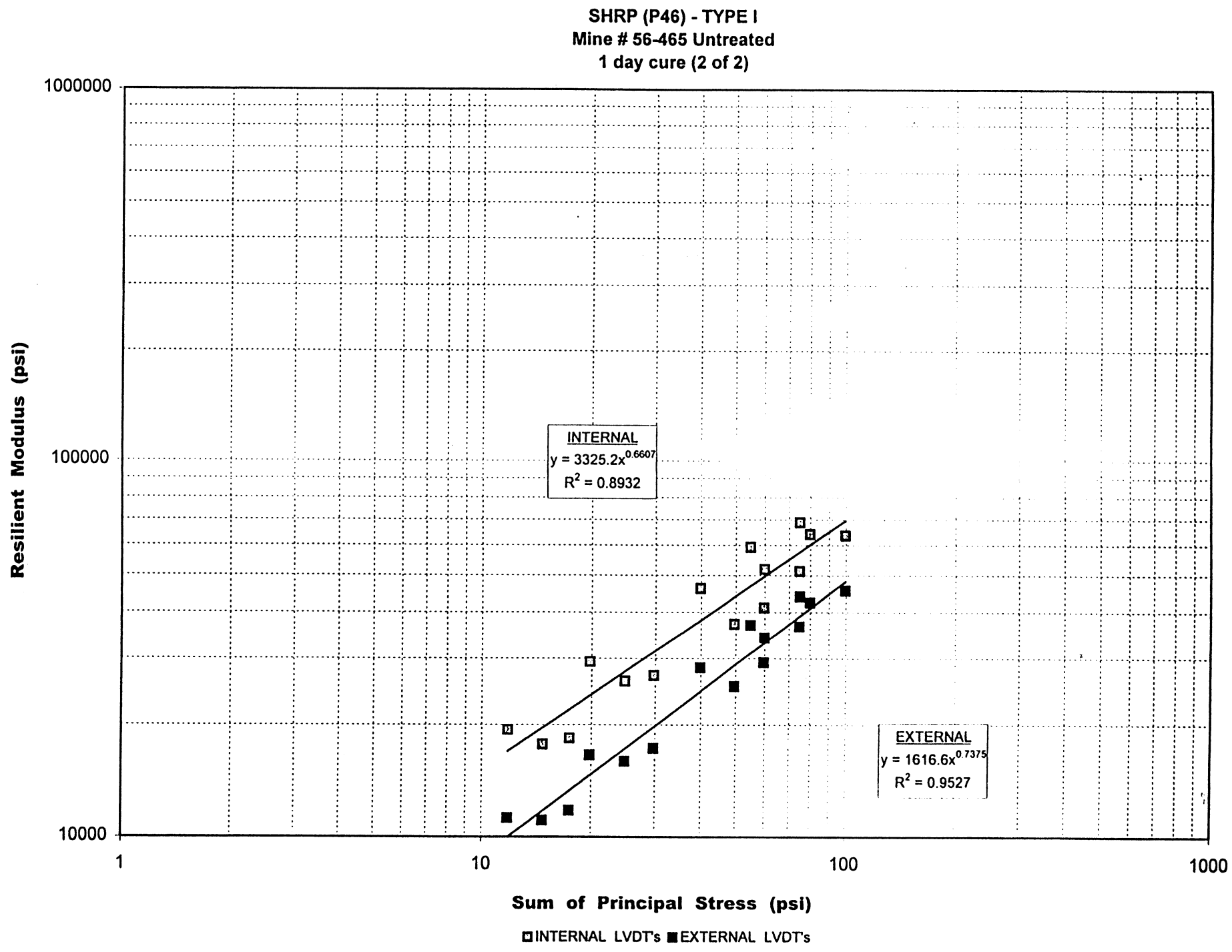
INSITU or TARGET MOIST. / DENSITY:
11.8 @ 121.4
ACTUAL MOISTURE / DENSITY:
12.4 @ 120.8

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.48	0.32	2.79	0.00176198	0.00022025	11246
2	3	5.07	0.63	5.70	0.00365753	0.00045719	11086
3	3	7.57	0.87	8.44	0.00513425	0.00064178	11793
4	5	4.33	0.47	4.81	0.00208990	0.00026124	16587
5	5	8.66	1.03	9.70	0.00434698	0.00054337	15943
6	5	13.21	1.51	14.72	0.00611284	0.00076410	17291
7	10	8.84	1.03	9.87	0.00249624	0.00031203	28327
8	10	17.53	1.99	19.52	0.00554921	0.00069365	25269
9	10	26.63	3.02	29.65	0.00728059	0.00091007	29259
10	15	8.83	1.03	9.86	0.00191409	0.00023926	36888
11	15	13.37	1.51	14.88	0.00313355	0.00039169	34129
12	15	26.65	3.01	29.66	0.00582628	0.00072829	36596
13	20	13.38	1.51	14.90	0.00243635	0.00030454	43949
14	20	17.86	1.99	19.85	0.00337400	0.00042175	42347
15	20	35.80	3.97	39.77	0.00628994	0.00078624	45537

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.48	0.32	2.79	0.00051147	0.00012787	19371
2	3	5.07	0.63	5.70	0.00114489	0.00028622	17708
3	3	7.57	0.87	8.44	0.00164688	0.00041172	18382
4	5	4.33	0.47	4.81	0.00059033	0.00014758	29360
5	5	8.66	1.03	9.70	0.00133017	0.00033254	26050
6	5	13.21	1.51	14.72	0.00195885	0.00048971	26980
7	10	8.84	1.03	9.87	0.00076699	0.00019175	46097
8	10	17.53	1.99	19.52	0.00188775	0.00047194	37141
9	10	26.63	3.02	29.65	0.00259399	0.00064850	41061
10	15	8.83	1.03	9.86	0.00059550	0.00014887	59284
11	15	13.37	1.51	14.88	0.00103199	0.00025800	51814
12	15	26.65	3.01	29.66	0.00208252	0.00052063	51192
13	20	13.38	1.51	14.90	0.00077863	0.00019466	68759
14	20	17.86	1.99	19.85	0.00111473	0.00027868	64087
15	20	35.80	3.97	39.77	0.00225488	0.00056372	63512


SHRP (P46) - TYPE I
Mine # 56-465 Untreated
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 3325.2x^0.6607
R^2 = 0.8932
EXTERNAL
y = 1616.6x^0.7375
R^2 = 0.9527
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock (56-465)

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14222-S

SAMPLE # : 1 of 2

LBR : 91.0

SOIL CLASS :

FINAL % (w) : 12.4

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

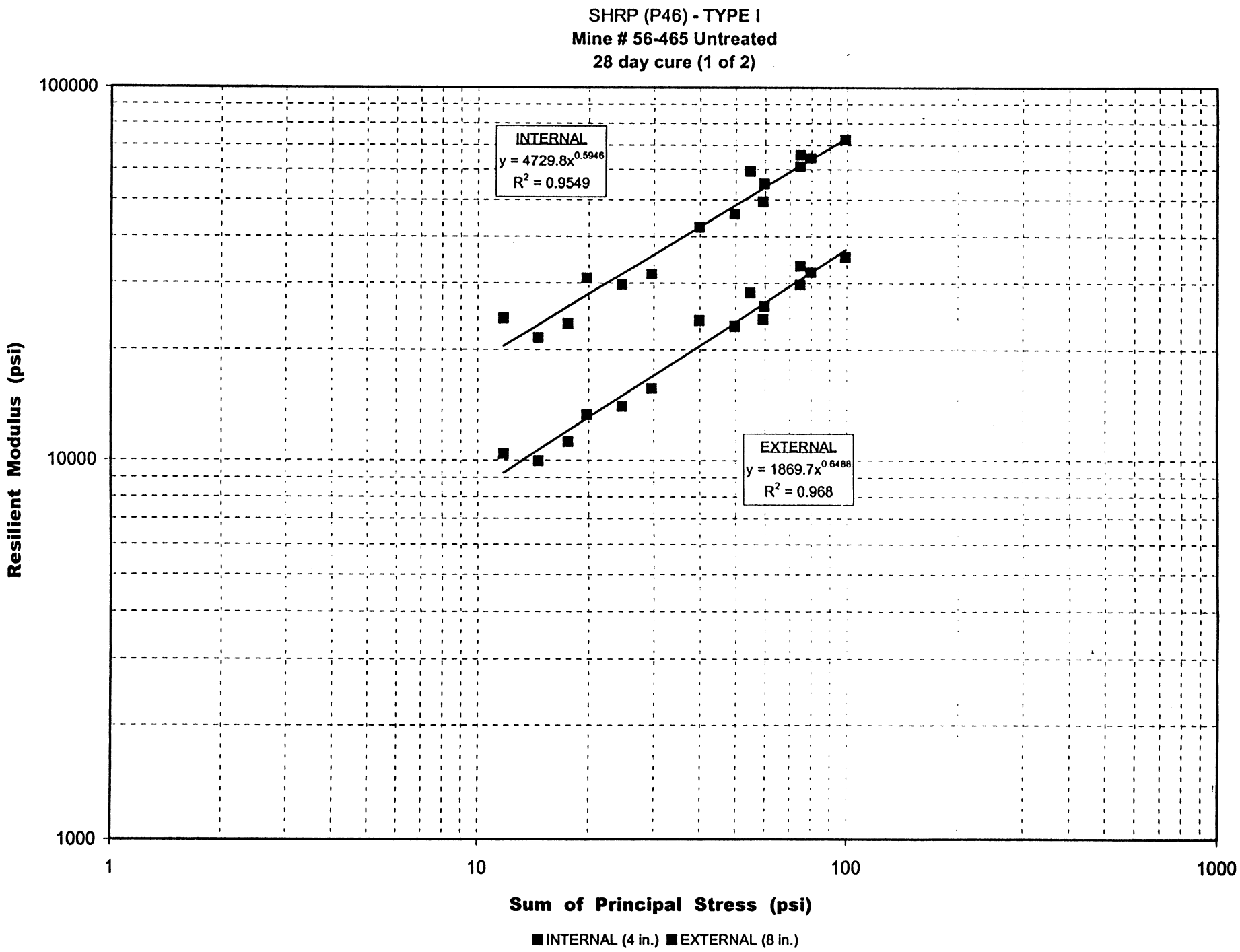
INSITU or TARGET MOIST. / DENSITY:
11.8 @ 121.4
ACTUAL MOISTURE / DENSITY:
12.1 @ 120.3

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.45	0.32	2.76	0.00188392	0.00023549	10389
2	3	4.98	0.63	5.61	0.00400528	0.00050066	9946
3	3	7.72	0.87	8.59	0.00550914	0.00068864	11204
4	5	4.29	0.48	4.77	0.00259061	0.00032383	13246
5	5	8.58	1.03	9.62	0.00491879	0.00061485	13958
6	5	13.13	1.52	14.65	0.00671524	0.00083941	15645
7	10	8.86	1.03	9.90	0.00296333	0.00037042	23931
8	10	17.82	1.99	19.81	0.00616196	0.00077024	23134
9	10	26.36	3.02	29.38	0.00873663	0.00109208	24137
10	15	8.80	1.03	9.83	0.00249495	0.00031187	28226
11	15	13.33	1.50	14.83	0.00409879	0.00051235	26016
12	15	26.81	3.02	29.82	0.00722070	0.00090259	29698
13	20	13.41	1.51	14.92	0.00321672	0.00040209	33345
14	20	17.89	1.99	19.87	0.00445772	0.00055721	32103
15	20	35.19	3.98	39.17	0.00798987	0.00099873	35238

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.45	0.32	2.76	0.00040418	0.00010105	24212
2	3	4.98	0.63	5.61	0.00092428	0.00023107	21550
3	3	7.72	0.87	8.59	0.00131553	0.00032888	23461
4	5	4.29	0.48	4.77	0.00055457	0.00013864	30939
5	5	8.58	1.03	9.62	0.00115438	0.00028859	29738
6	5	13.13	1.52	14.65	0.00165766	0.00041442	31689
7	10	8.86	1.03	9.90	0.00083896	0.00020974	42265
8	10	17.82	1.99	19.81	0.00155856	0.00038964	45732
9	10	26.36	3.02	29.38	0.00213725	0.00053431	49334
10	15	8.80	1.03	9.83	0.00059335	0.00014834	59343
11	15	13.33	1.50	14.83	0.00096995	0.00024249	54969
12	15	26.81	3.02	29.82	0.00175418	0.00043855	61123
13	20	13.41	1.51	14.92	0.00081612	0.00020403	65714
14	20	17.89	1.99	19.87	0.00110870	0.00027717	64537
15	20	35.19	3.98	39.17	0.00194378	0.00048594	72424


SHRP (P46) - TYPE I
Mine # 56-465 Untreated
28 day cure (1 of 2)
INTERNAL
y = 4729.8x^0.5946
R^2 = 0.9549
EXTERNAL
y = 1869.7x^0.6488
R^2 = 0.968
Resilient Modulus (psi)
100000
10000
1000
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock (56-465)

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14222-S

SAMPLE # : 2 of 2

LBR : 91.0

SOIL CLASS :

FINAL % (w) : 13.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

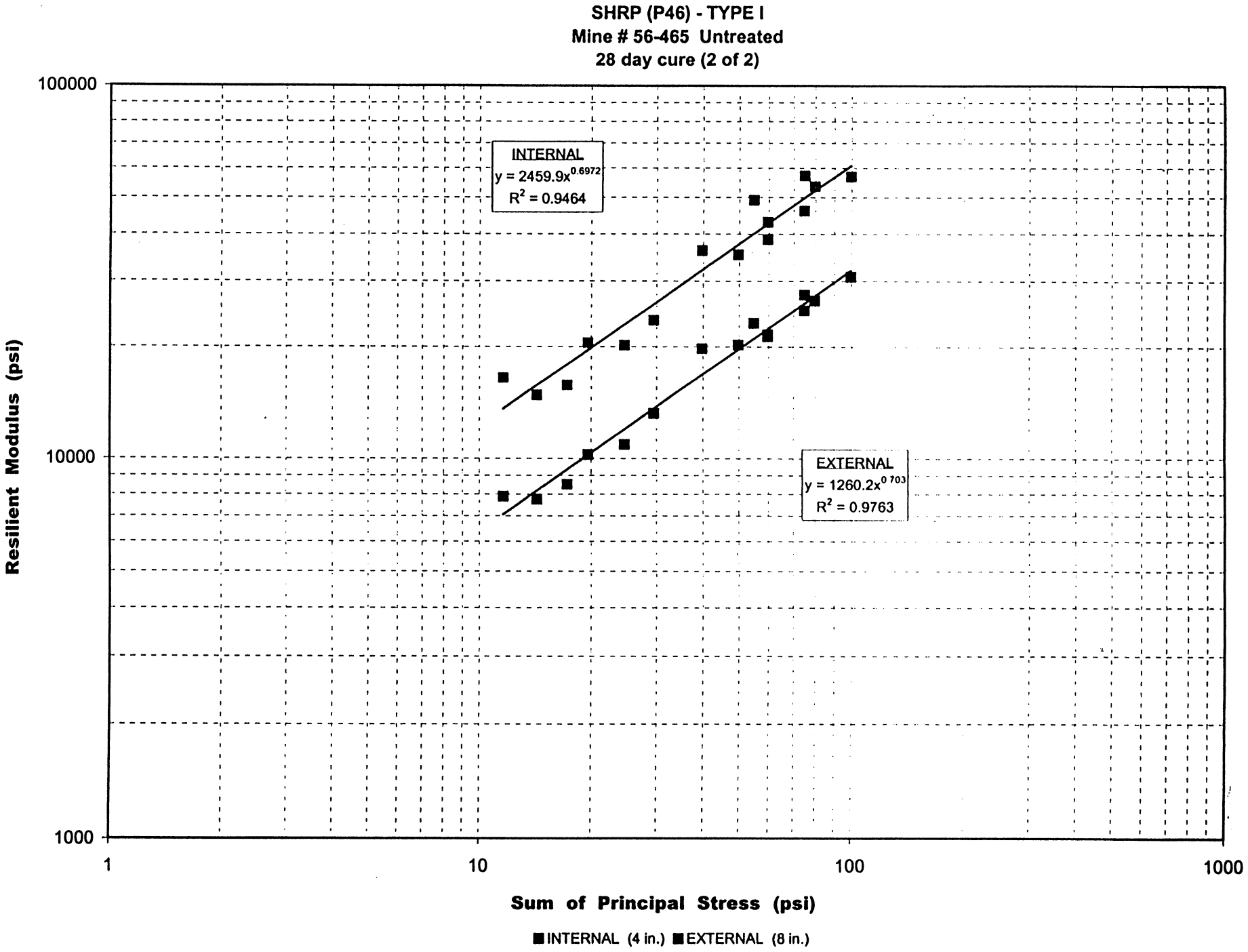
INSITU or TARGET MOIST. / DENSITY:
11.8 @ 121.4
ACTUAL MOISTURE / DENSITY:
12.4 @ 120.3

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.27	0.32	2.59	0.00230751	0.00028844	7882
2	3	4.63	0.64	5.27	0.00478048	0.00059756	7750
3	3	7.35	0.88	8.22	0.00691303	0.00086413	8500
4	5	4.08	0.48	4.56	0.00319216	0.00039902	10228
5	5	8.50	1.03	9.53	0.00624297	0.00078037	10895
6	5	12.92	1.51	14.43	0.00783215	0.00097902	13199
7	10	8.67	1.03	9.70	0.00350930	0.00043866	19765
8	10	17.68	1.98	19.66	0.00699189	0.00087399	20231
9	10	26.58	3.01	29.59	0.00986345	0.00123293	21558
10	15	8.70	1.04	9.73	0.00300730	0.00037591	23137
11	15	13.09	1.51	14.59	0.00491147	0.00061393	21316
12	15	26.68	3.01	29.68	0.00851859	0.00106482	25051
13	20	13.30	1.51	14.80	0.00385963	0.00048245	27560
14	20	17.75	1.98	19.73	0.00533549	0.00066694	26611
15	20	35.64	3.98	39.62	0.00926707	0.00115838	30770

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.27	0.32	2.59	0.00055327	0.00013832	16437
2	3	4.63	0.64	5.27	0.00125606	0.00031402	14748
3	3	7.35	0.88	8.22	0.00187095	0.00046774	15704
4	5	4.08	0.48	4.56	0.00079759	0.00019940	20467
5	5	8.50	1.03	9.53	0.00168523	0.00042131	20181
6	5	12.92	1.51	14.43	0.00219498	0.00054875	23549
7	10	8.67	1.03	9.70	0.00096089	0.00024022	36092
8	10	17.68	1.98	19.66	0.00201013	0.00050253	35185
9	10	26.58	3.01	29.59	0.00275299	0.00068825	38619
10	15	8.70	1.04	9.73	0.00070925	0.00017731	49051
11	15	13.09	1.51	14.59	0.00122030	0.00030507	42896
12	15	26.68	3.01	29.68	0.00232166	0.00058042	45959
13	20	13.30	1.51	14.80	0.00093159	0.00023290	57091
14	20	17.75	1.98	19.73	0.00132888	0.00033222	53423
15	20	35.64	3.98	39.62	0.00251471	0.00062868	56696


SHRP (P46) - TYPE I
Mine # 56-465 Untreated
28 day cure (2 of 2)
INTERNAL
y = 2459.9x^0.6972
R² = 0.9464
EXTERNAL
y = 1260.2x^0.703
R² = 0.9763
Resilient Modulus (psi)
100000
10000
1000
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock [redacted]

COMMENTS : [redacted]

LAB # : 14222-S

SAMPLE # : [redacted]

LBR : 116.0

SOIL CLASS :

FINAL % (w) : 13.1

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

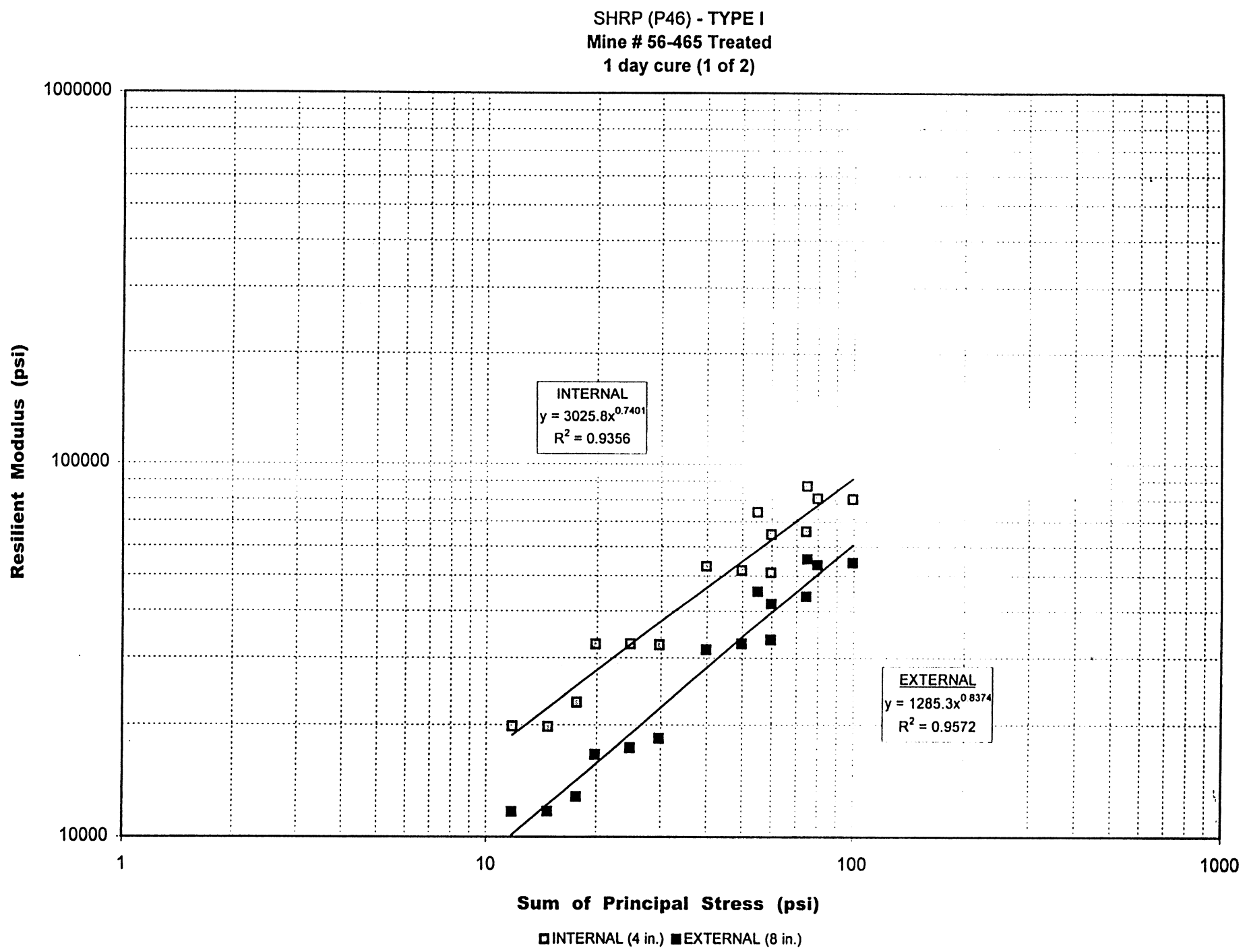
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 119.1
ACTUAL MOISTURE / DENSITY:
13.7 @ 117.2

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.44	0.32	2.76	0.00167407	0.00020926	11676
2	3	5.07	0.63	5.70	0.00345975	0.00043247	11712
3	3	7.75	0.87	8.62	0.00482658	0.00060332	12849
4	5	4.33	0.48	4.81	0.00208085	0.00026011	16659
5	5	8.63	1.04	9.67	0.00397554	0.00049694	17373
6	5	13.13	1.51	14.64	0.00570391	0.00071299	18412
7	10	8.80	1.04	9.83	0.00223684	0.00027960	31459
8	10	17.78	1.99	19.77	0.00435819	0.00054477	32641
9	10	26.64	3.02	29.66	0.00637612	0.00079702	33425
10	15	8.92	1.03	9.95	0.00157712	0.00019714	45250
11	15	13.28	1.51	14.79	0.00253804	0.00031725	41859
12	15	26.30	3.02	29.32	0.00479383	0.00059923	43884
13	20	13.36	1.52	14.87	0.00192658	0.00024082	55459
14	20	17.88	1.99	19.87	0.00267421	0.00033428	53498
15	20	35.50	3.96	39.46	0.00523551	0.00065444	54245

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.44	0.32	2.76	0.00049295	0.00012324	19825
2	3	5.07	0.63	5.70	0.00102554	0.00025638	19756
3	3	7.75	0.87	8.62	0.00135603	0.00033901	22867
4	5	4.33	0.48	4.81	0.00053302	0.00013325	32517
5	5	8.63	1.04	9.67	0.00105958	0.00026489	32591
6	5	13.13	1.51	14.64	0.00161974	0.00040494	32419
7	10	8.80	1.04	9.83	0.00066358	0.00016590	53023
8	10	17.78	1.99	19.77	0.00137585	0.00034396	51697
9	10	26.64	3.02	29.66	0.00208942	0.00052235	51001
10	15	8.92	1.03	9.95	0.00048131	0.00012033	74136
11	15	13.28	1.51	14.79	0.00082215	0.00020554	64611
12	15	26.30	3.02	29.32	0.00159647	0.00039912	65886
13	20	13.36	1.52	14.87	0.00061273	0.00015318	87188
14	20	17.88	1.99	19.87	0.00088549	0.00022137	80783
15	20	35.50	3.96	39.46	0.00176581	0.00044145	80417


SHRP (P46) - TYPE I
Mine # 56-465 Treated
1 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 3025.8x^0.7401
R^2 = 0.9356
EXTERNAL
y = 1285.3x^0.8374
R^2 = 0.9572
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock [redacted]

COMMENTS : [redacted]

LAB # : 14222-S

SAMPLE # : [redacted]

LBR : 116.0

SOIL CLASS :

FINAL % (w) : 12.9

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

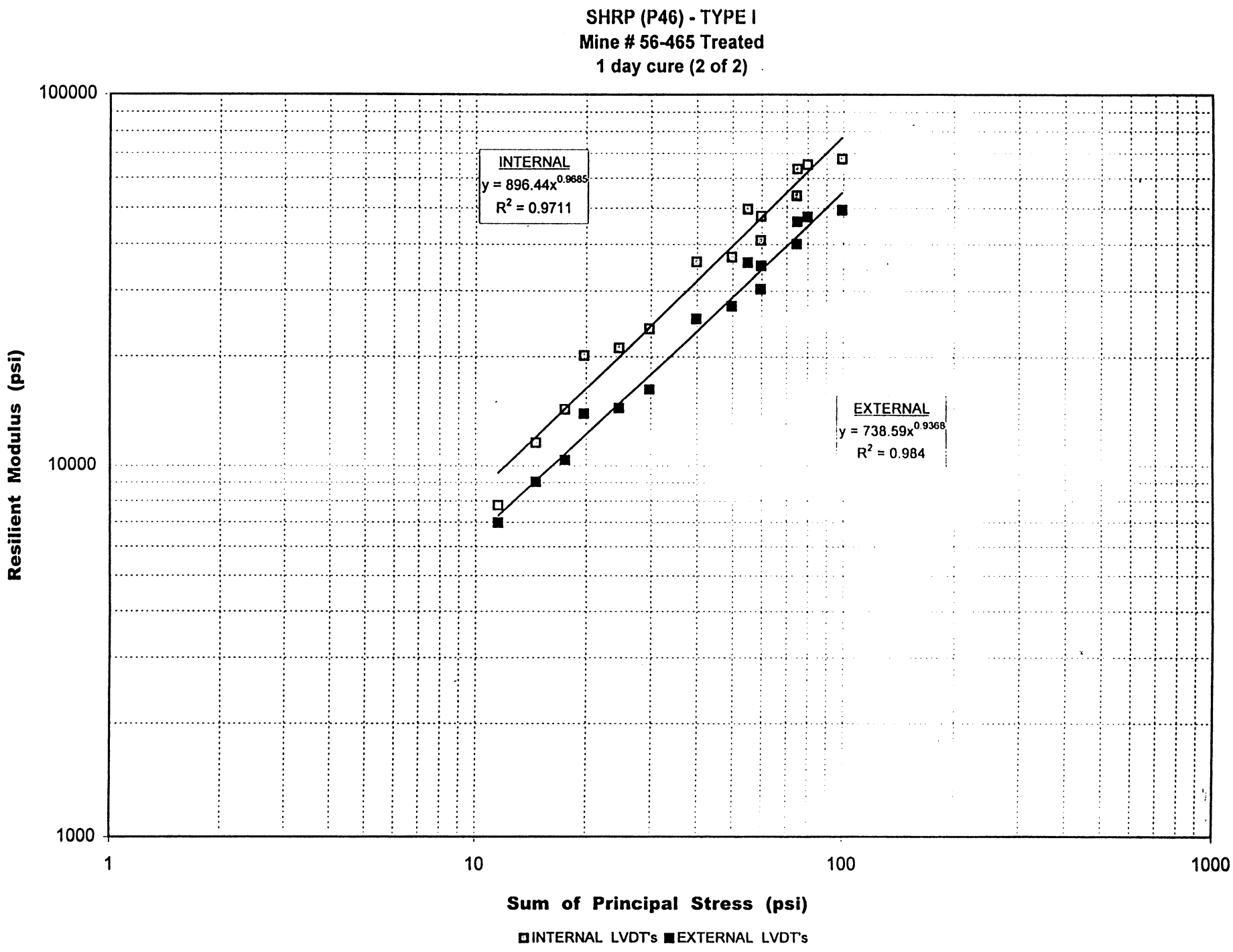
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 119.1
ACTUAL MOISTURE / DENSITY:
13.4 @ 118.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.19	0.32	2.51	0.00251477	0.00031435	6966
2	3	4.95	0.63	5.58	0.00438059	0.00054757	9035
3	3	7.64	0.87	8.51	0.00588015	0.00073502	10388
4	5	4.27	0.48	4.75	0.00245358	0.00030670	13913
5	5	8.54	1.04	9.58	0.00474514	0.00059314	14401
6	5	13.21	1.52	14.73	0.00651229	0.00081404	16231
7	10	8.80	1.04	9.84	0.00278883	0.00034860	25252
8	10	17.72	1.99	19.71	0.00519328	0.00064916	27298
9	10	26.57	3.02	29.59	0.00700869	0.00087609	30332
10	15	8.88	1.03	9.91	0.00198950	0.00024869	35705
11	15	13.21	1.52	14.73	0.00302324	0.00037790	34962
12	15	26.50	3.02	29.51	0.00529196	0.00066150	40054
13	20	13.37	1.51	14.88	0.00232733	0.00029092	45960
14	20	17.91	1.99	19.90	0.00302367	0.00037796	47374
15	20	35.21	3.97	39.18	0.00570391	0.00071299	49383

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.19	0.32	2.51	0.00112636	0.00028159	7776
2	3	4.95	0.63	5.58	0.00170721	0.00042680	11592
3	3	7.64	0.87	8.51	0.00213768	0.00053442	14287
4	5	4.27	0.48	4.75	0.00084714	0.00021179	20149
5	5	8.54	1.04	9.58	0.00161845	0.00040461	21111
6	5	13.21	1.52	14.73	0.00222342	0.00055586	23769
7	10	8.80	1.04	9.84	0.00098244	0.00024561	35840
8	10	17.72	1.99	19.71	0.00192007	0.00048002	36917
9	10	26.57	3.02	29.59	0.00259442	0.00064861	40969
10	15	8.88	1.03	9.91	0.00071529	0.00017882	49655
11	15	13.21	1.52	14.73	0.00111214	0.00027804	47521
12	15	26.50	3.02	29.51	0.00196919	0.00049230	53820
13	20	13.37	1.51	14.88	0.00084326	0.00021082	63423
14	20	17.91	1.99	19.90	0.00109835	0.00027459	65208
15	20	35.21	3.97	39.18	0.00208812	0.00052203	67447


SHRP (P46) - TYPE I
Mine # 56-465 Treated
1 day cure (2 of 2)
INTERNAL
y = 896.44x^0.9685
R² = 0.9711
EXTERNAL
y = 738.59x^0.9368
R² = 0.984
Resilient Modulus (psi)
100000
10000
1000
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock (56-465)

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14222-S

SAMPLE # : 1 of 2

LBR : 116.0

SOIL CLASS :

FINAL % (w) : 13.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
13.0 @ 119.1
ACTUAL MOISTURE / DENSITY:
13.3 @ 118.3

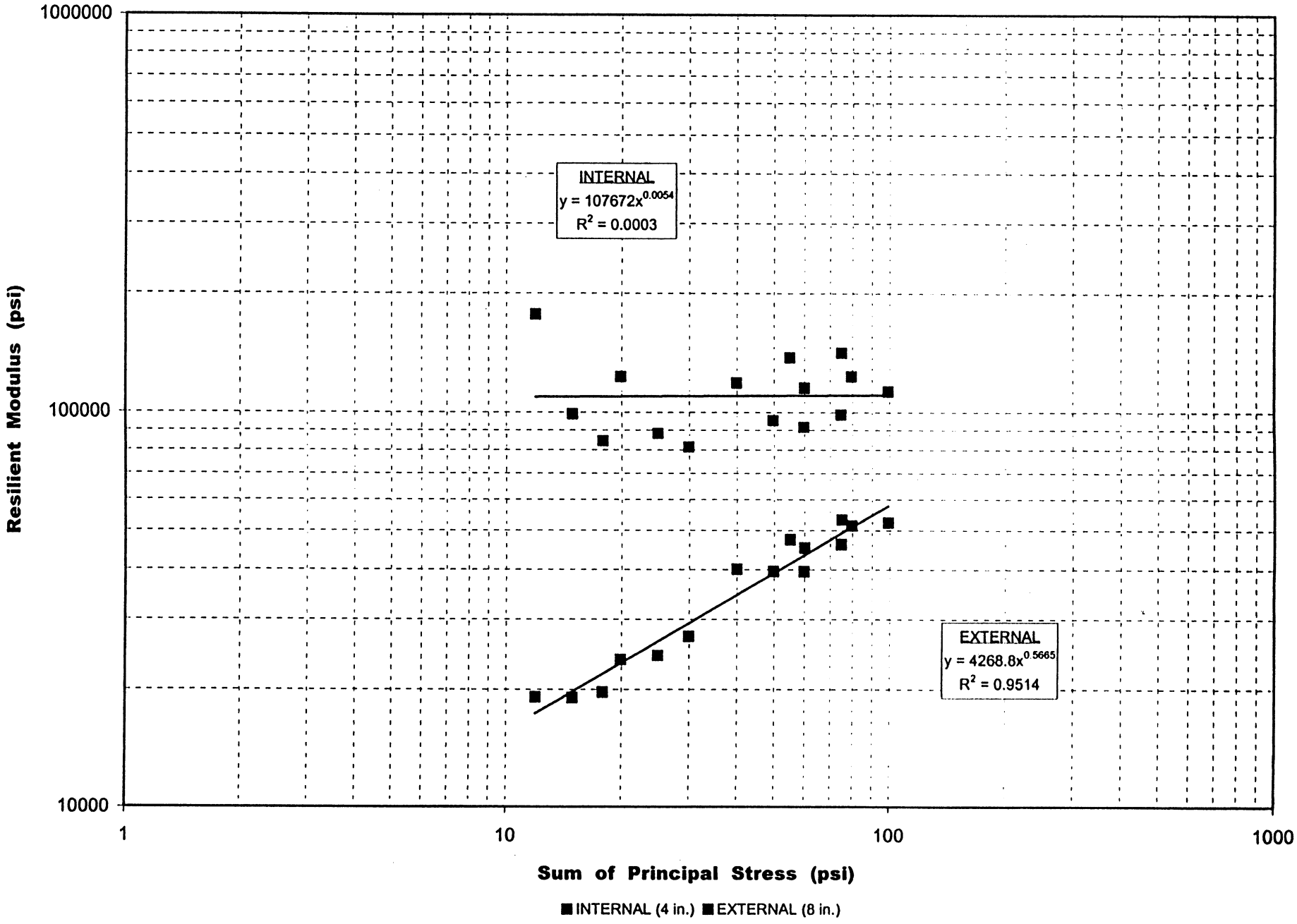
EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.92	0.00109019	0.00013627	19125
2	3	5.26	0.63	5.90	0.00220926	0.00027616	19063
3	3	7.99	0.87	8.85	0.00324817	0.00040602	19671
4	5	4.41	0.47	4.88	0.00148480	0.00018560	23759
5	5	8.79	1.03	9.83	0.00289267	0.00036158	24322
6	5	13.39	1.51	14.90	0.00395099	0.00049387	27118
7	10	8.92	1.03	9.95	0.00178137	0.00022267	40047
8	10	17.74	1.99	19.73	0.00358557	0.00044820	39582
9	10	26.75	3.02	29.77	0.00541736	0.00067717	39502
10	15	8.97	1.04	10.00	0.00151162	0.00018895	47455
11	15	13.50	1.52	15.02	0.00238593	0.00029824	45265
12	15	26.77	3.02	29.78	0.00463827	0.00057978	46171
13	20	13.52	1.51	15.03	0.00203000	0.00025375	53269
14	20	17.60	1.99	19.59	0.00273884	0.00034235	51420
15	20	35.16	3.97	39.13	0.00537685	0.00067211	52310

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.92	0.00005903	0.00001476	176596
2	3	5.26	0.63	5.90	0.00021286	0.00005322	98925
3	3	7.99	0.87	8.85	0.00037876	0.00009469	84346
4	5	4.41	0.47	4.88	0.00014392	0.00003598	122557
5	5	8.79	1.03	9.83	0.00039901	0.00009975	88164
6	5	13.39	1.51	14.90	0.00065841	0.00016460	81364
7	10	8.92	1.03	9.95	0.00030163	0.00007541	118255
8	10	17.74	1.99	19.73	0.00074588	0.00018647	95139
9	10	26.75	3.02	29.77	0.00116859	0.00029215	91561
10	15	8.97	1.04	10.00	0.00026112	0.00006528	137355
11	15	13.50	1.52	15.02	0.00046925	0.00011731	115076
12	15	26.77	3.02	29.78	0.00108586	0.00027146	98610
13	20	13.52	1.51	15.03	0.00038264	0.00009566	141305
14	20	17.60	1.99	19.59	0.00057309	0.00014327	122870
15	20	35.16	3.97	39.13	0.00124744	0.00031186	112735

SHRP (P46) - **TYPE I**
Mine # 56-465 Treated
28 day cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 20, 1999

PROJECT NO. : 19106618101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Dark Gray Limerock (56-465)

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14222-S

SAMPLE # : 2 of 2

LBR : 116.0

SOIL CLASS :

FINAL % (w) : 12.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

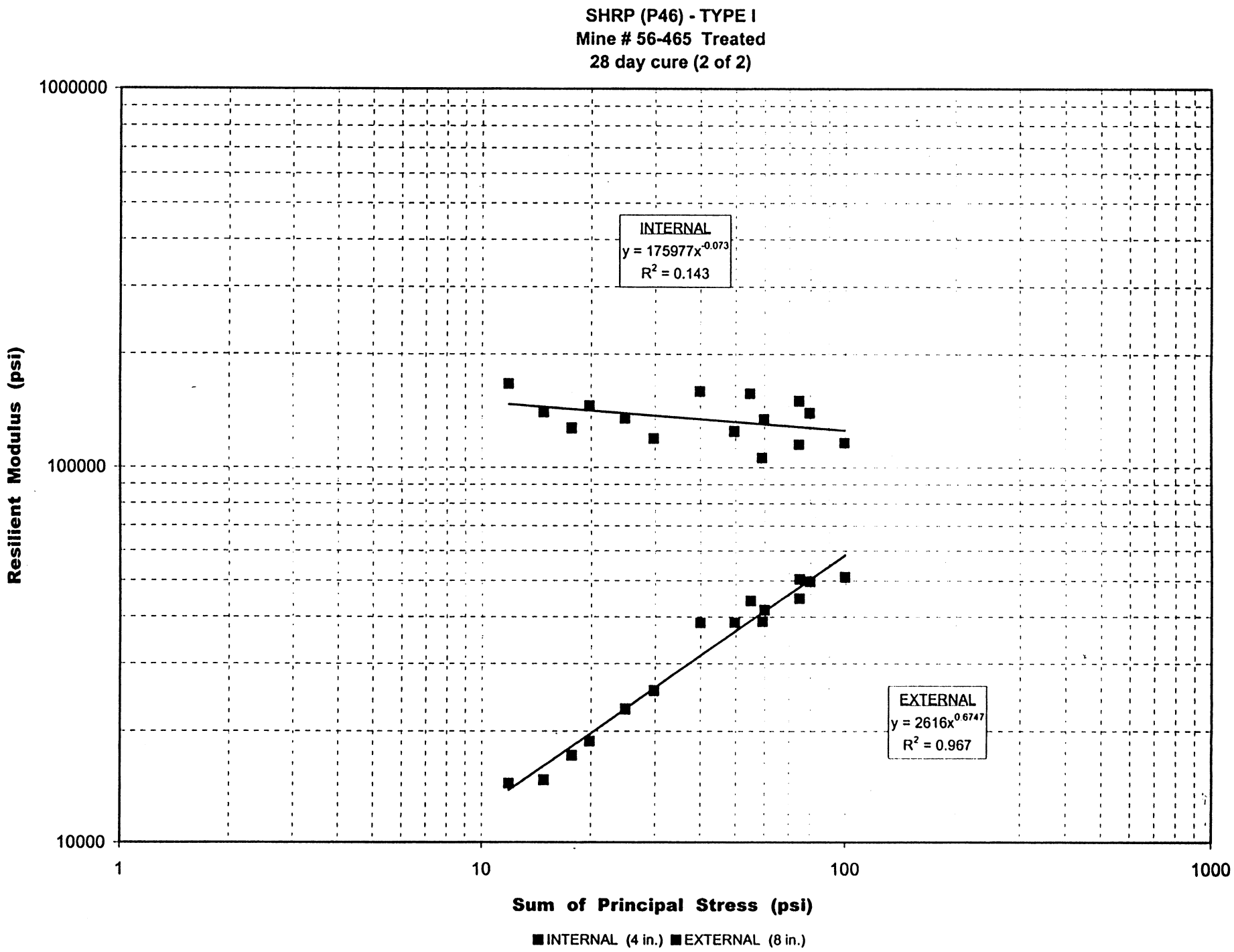
INSITU or TARGET MOIST. / DENSITY:
13.0 @ 119.1
ACTUAL MOISTURE / DENSITY:
13.0 @ 118.1

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00141510	0.00017689	14492
2	3	5.21	0.63	5.85	0.00281641	0.00035205	14804
3	3	7.85	0.87	8.72	0.00364589	0.00045574	17236
4	5	4.35	0.48	4.83	0.00185161	0.00023145	18792
5	5	8.80	1.04	9.83	0.00308357	0.00038545	22829
6	5	13.26	1.52	14.77	0.00416342	0.00052043	25476
7	10	8.90	1.03	9.93	0.00184988	0.00023124	38482
8	10	17.69	1.99	19.68	0.00367262	0.00045908	38526
9	10	26.22	3.02	29.23	0.00540788	0.00067598	38784
10	15	8.93	1.04	9.97	0.00162193	0.00020274	44057
11	15	13.45	1.51	14.96	0.00257984	0.00032248	41704
12	15	26.76	3.01	29.78	0.00478392	0.00059799	44754
13	20	13.30	1.51	14.81	0.00211187	0.00026398	50396
14	20	17.90	1.99	19.89	0.00288234	0.00036029	49674
15	20	35.59	3.98	39.57	0.00557636	0.00069705	51063

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00006161	0.00001540	166417
2	3	5.21	0.63	5.85	0.00014866	0.00003716	140231
3	3	7.85	0.87	8.72	0.00024690	0.00006173	127257
4	5	4.35	0.48	4.83	0.00011979	0.00002995	145241
5	5	8.80	1.04	9.83	0.00026026	0.00006506	135243
6	5	13.26	1.52	14.77	0.00044382	0.00011095	119495
7	10	8.90	1.03	9.93	0.00022406	0.00005602	158854
8	10	17.69	1.99	19.68	0.00056619	0.00014155	124949
9	10	26.22	3.02	29.23	0.00098847	0.00024712	106093
10	15	8.93	1.04	9.97	0.00022794	0.00005698	156745
11	15	13.45	1.51	14.96	0.00040073	0.00010018	134242
12	15	26.76	3.01	29.78	0.00092944	0.00023236	115177
13	20	13.30	1.51	14.81	0.00035463	0.00008866	150060
14	20	17.90	1.99	19.89	0.00051319	0.00012830	139495
15	20	35.59	3.98	39.57	0.00122331	0.00030583	116384


SHRP (P46) - TYPE I
Mine # 56-465 Treated
28 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 175977x^-0.073
R2 = 0.143
EXTERNAL
y = 2616x^0.6747
R2 = 0.967
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 1, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Untreated. 1 Day Cure

LAB # : 14214-S

SAMPLE # : 1 of 2

LBR : 140.0

SOIL CLASS :

FINAL % (w) : 9.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
8.6 @ 129.5
ACTUAL MOISTURE / DENSITY:
9.3 @ 126.4

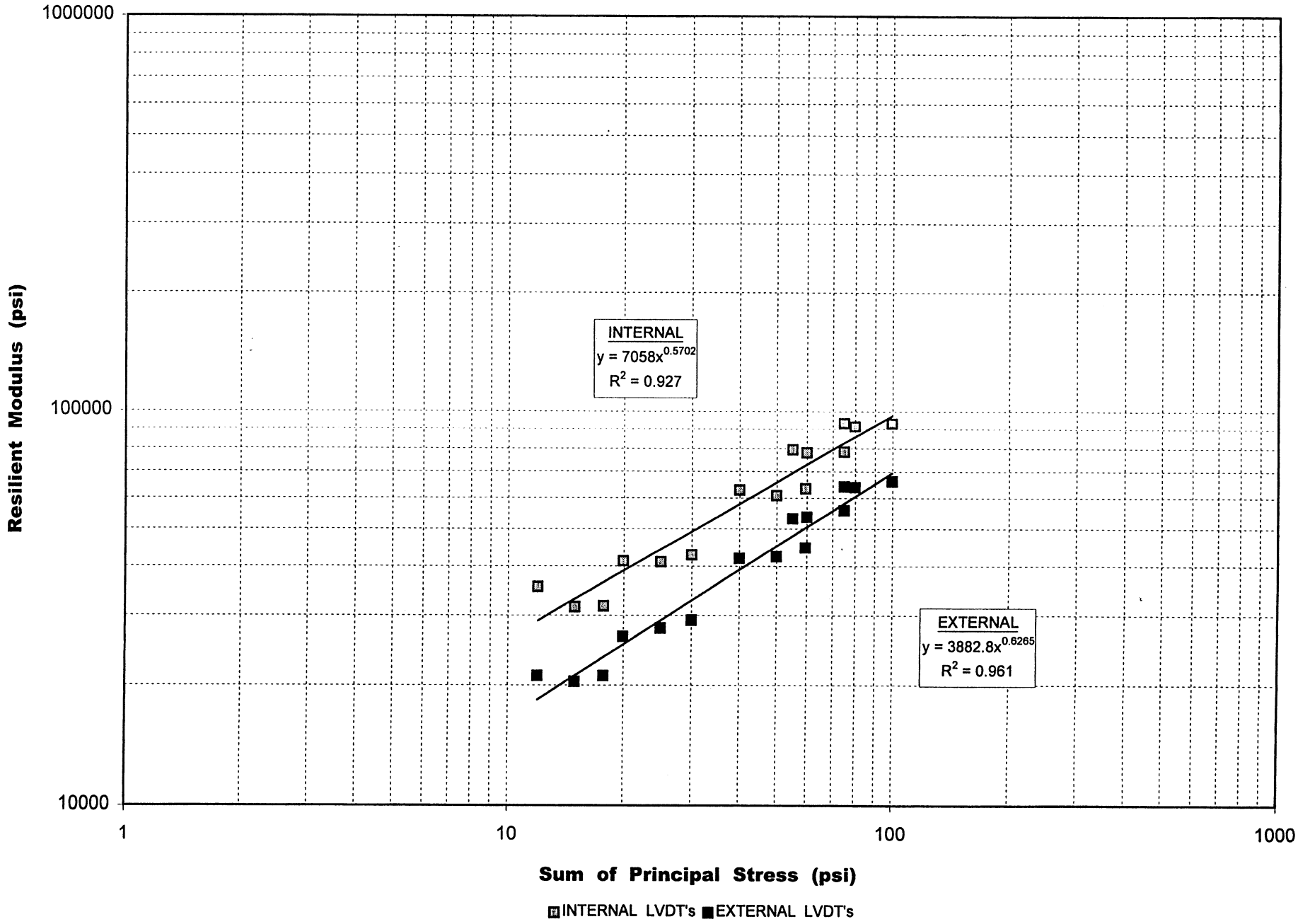
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00099927	0.00012491	21122
2	3	5.31	0.63	5.94	0.00208086	0.00026011	20423
3	3	7.87	0.87	8.74	0.00298187	0.00037273	21116
4	5	4.48	0.48	4.96	0.00135089	0.00016886	26524
5	5	8.93	1.04	9.96	0.00256045	0.00032006	27890
6	5	13.46	1.51	14.97	0.00368813	0.00046102	29192
7	10	8.94	1.04	9.98	0.00170897	0.00021362	41851
8	10	17.93	1.99	19.92	0.00338864	0.00042358	42324
9	10	26.50	3.02	29.52	0.00475204	0.00059400	44613
10	15	9.00	1.03	10.03	0.00135607	0.00016951	53107
11	15	13.52	1.51	15.03	0.00201837	0.00025230	53589
12	15	26.86	3.02	29.88	0.00385876	0.00048235	55694
13	20	13.44	1.51	14.95	0.00167967	0.00020996	64015
14	20	17.92	1.99	19.91	0.00224631	0.00028079	63832
15	20	35.78	3.97	39.75	0.00433621	0.00054203	66015

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00029861	0.00007465	35342
2	3	5.31	0.63	5.94	0.00067565	0.00016891	31449
3	3	7.87	0.87	8.74	0.00099580	0.00024895	31615
4	5	4.48	0.48	4.96	0.00043520	0.00010880	41165
5	5	8.93	1.04	9.96	0.00087128	0.00021782	40980
6	5	13.46	1.51	14.97	0.00126037	0.00031509	42711
7	10	8.94	1.04	9.98	0.00056965	0.00014241	62778
8	10	17.93	1.99	19.92	0.00117980	0.00029495	60782
9	10	26.50	3.02	29.52	0.00167532	0.00041883	63273
10	15	9.00	1.03	10.03	0.00045330	0.00011333	79436
11	15	13.52	1.51	15.03	0.00069288	0.00017322	78053
12	15	26.86	3.02	29.88	0.00136983	0.00034246	78444
13	20	13.44	1.51	14.95	0.00057828	0.00014457	92970
14	20	17.92	1.99	19.91	0.00078595	0.00019649	91219
15	20	35.78	3.97	39.75	0.00154003	0.00038501	92938

SHRP (P46) - **TYPE I**
Pit # 17-091 (Untreated)
1 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 1, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Untreated. 1 Day Cure

LAB # : 14214-S

SAMPLE # : 2 of 2

LBR : 140.0

SOIL CLASS :

FINAL % (w) : 9.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
8.6 @ 129.5
ACTUAL MOISTURE / DENSITY:
9.5 @ 126.2

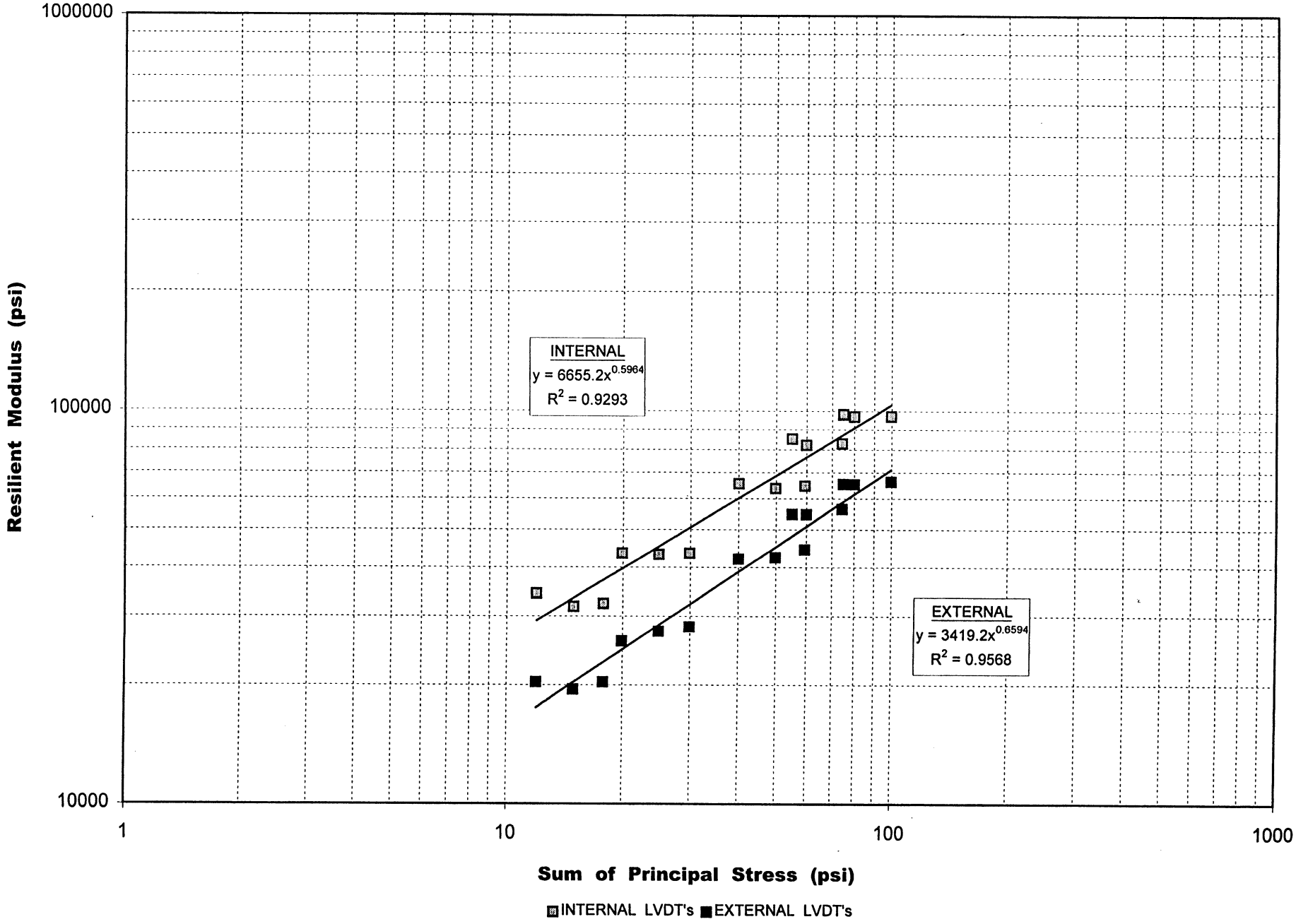
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00103158	0.00012895	20339
2	3	5.30	0.63	5.93	0.00217823	0.00027228	19471
3	3	7.97	0.86	8.83	0.00313571	0.00039196	20334
4	5	4.45	0.48	4.93	0.00137718	0.00017215	25845
5	5	8.83	1.03	9.86	0.00257940	0.00032243	27399
6	5	13.36	1.51	14.88	0.00379801	0.00047475	28149
7	10	8.99	1.03	10.02	0.00171198	0.00021400	41993
8	10	17.85	1.99	19.84	0.00336882	0.00042110	42389
9	10	26.40	3.01	29.42	0.00475893	0.00059487	44385
10	15	9.03	1.03	10.06	0.00132288	0.00016536	54614
11	15	13.52	1.51	15.03	0.00198390	0.00024799	54537
12	15	26.44	3.01	29.44	0.00375492	0.00046937	56325
13	20	13.44	1.51	14.95	0.00164692	0.00020587	65272
14	20	17.98	1.99	19.96	0.00220625	0.00027578	65189
15	20	35.76	3.97	39.73	0.00431768	0.00053971	66252

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00030637	0.00007659	34243
2	3	5.30	0.63	5.93	0.00066875	0.00016719	31710
3	3	7.97	0.86	8.83	0.00098848	0.00024712	32253
4	5	4.45	0.48	4.93	0.00041021	0.00010255	43384
5	5	8.83	1.03	9.86	0.00081913	0.00020478	43139
6	5	13.36	1.51	14.88	0.00123193	0.00030798	43392
7	10	8.99	1.03	10.02	0.00054939	0.00013735	65428
8	10	17.85	1.99	19.84	0.00112249	0.00028062	63609
9	10	26.40	3.01	29.42	0.00163611	0.00040903	64552
10	15	9.03	1.03	10.06	0.00042443	0.00010611	85110
11	15	13.52	1.51	15.03	0.00065927	0.00016482	82057
12	15	26.44	3.01	29.44	0.00127589	0.00031897	82883
13	20	13.44	1.51	14.95	0.00054810	0.00013702	98064
14	20	17.98	1.99	19.96	0.00074286	0.00018572	96803
15	20	35.76	3.97	39.73	0.00147453	0.00036863	97000

SHRP (P46) - **TYPE I**
Pit # 17-091 (Untreated)
1 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 28, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Unteated. 28 Day Cure

LAB # : 14214-S

SAMPLE # : 1 of 2

LBR : 140.0

SOIL CLASS :

FINAL % (w) : 10.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
8.6 @ 129.5
ACTUAL MOISTURE / DENSITY:
9.4 @ 126.5

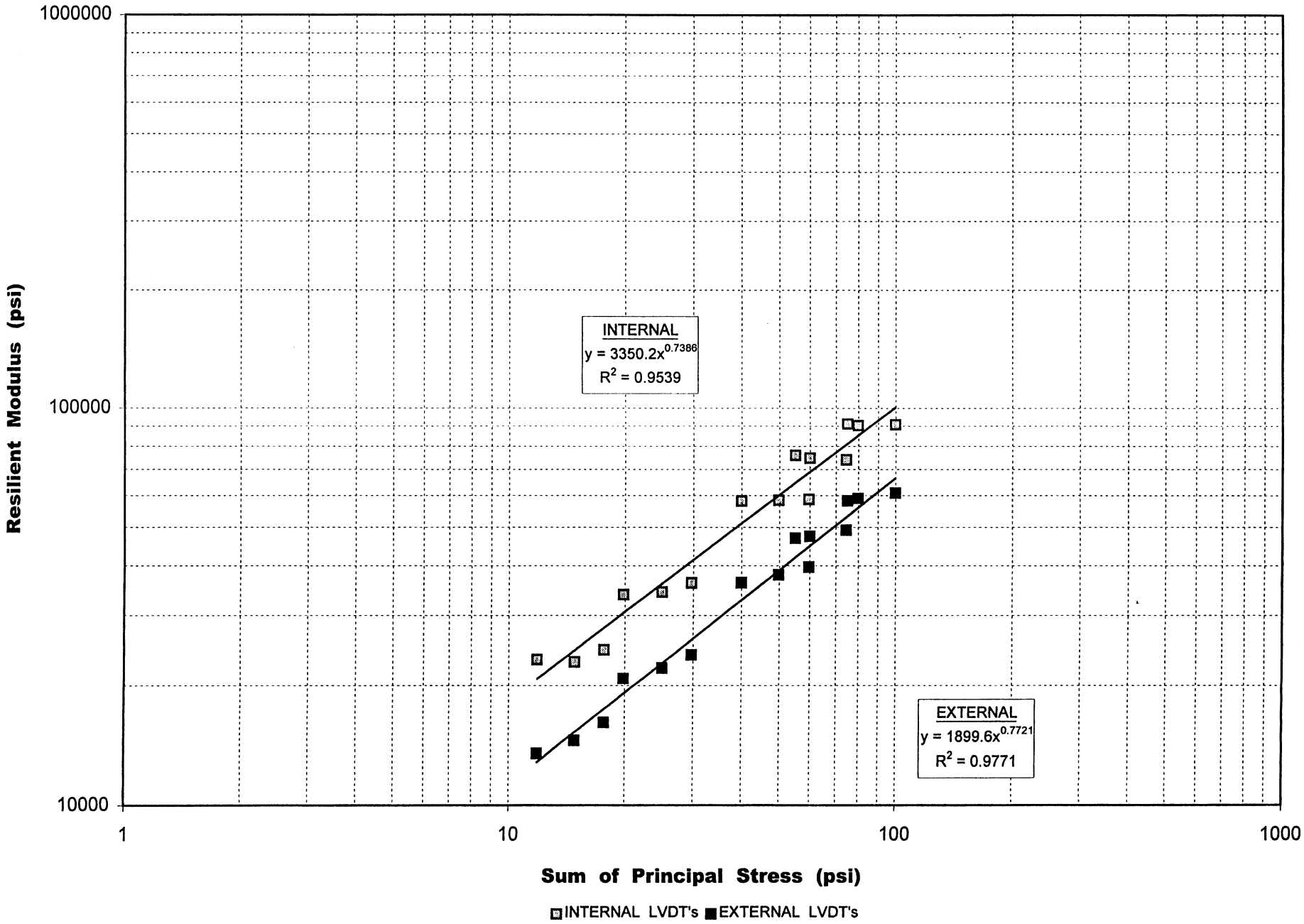
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.53	0.32	2.85	0.00150430	0.00018804	13466
2	3	5.20	0.63	5.83	0.00286466	0.00035808	14522
3	3	7.82	0.87	8.68	0.00387687	0.00048461	16127
4	5	4.36	0.48	4.84	0.00167665	0.00020958	20820
5	5	8.92	1.03	9.95	0.00322016	0.00040252	22162
6	5	13.20	1.52	14.72	0.00442196	0.00055275	23884
7	10	8.95	1.03	9.98	0.00197527	0.00024691	36229
8	10	17.82	1.99	19.81	0.00376052	0.00047006	37911
9	10	26.67	3.02	29.69	0.00538504	0.00067313	39627
10	15	8.99	1.03	10.02	0.00153446	0.00019181	46847
11	15	13.46	1.52	14.97	0.00227432	0.00028429	47330
12	15	26.39	3.02	29.41	0.00429786	0.00053723	49118
13	20	13.52	1.51	15.03	0.00185893	0.00023237	58182
14	20	17.83	1.99	19.82	0.00242083	0.00030260	58907
15	20	35.86	3.97	39.83	0.00471110	0.00058889	60889

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.53	0.32	2.85	0.00043564	0.00010891	23250
2	3	5.20	0.63	5.83	0.00090703	0.00022676	22933
3	3	7.82	0.87	8.68	0.00127072	0.00031768	24602
4	5	4.36	0.48	4.84	0.00051621	0.00012905	33812
5	5	8.92	1.03	9.95	0.00104018	0.00026005	34304
6	5	13.20	1.52	14.72	0.00146074	0.00036518	36151
7	10	8.95	1.03	9.98	0.00061618	0.00015405	58069
8	10	17.82	1.99	19.81	0.00122288	0.00030572	58290
9	10	26.67	3.02	29.69	0.00182011	0.00045503	58622
10	15	8.99	1.03	10.02	0.00047399	0.00011850	75830
11	15	13.46	1.52	14.97	0.00072132	0.00018033	74615
12	15	26.39	3.02	29.41	0.00142842	0.00035710	73894
13	20	13.52	1.51	15.03	0.00059420	0.00014855	91010
14	20	17.83	1.99	19.82	0.00079070	0.00019767	90176
15	20	35.86	3.97	39.83	0.00158096	0.00039524	90721

SHRP (P46) - **TYPE I**
Pit # 17-091 (Untreated)
28 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 28, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Untreated. 28 Day Cure

LAB # : 14214-S

SAMPLE # : 2 of 2

LBR : 140.0

SOIL CLASS :

FINAL % (w) : 10.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
8.6 @ 129.5
ACTUAL MOISTURE / DENSITY:
9.2 @ 127.2

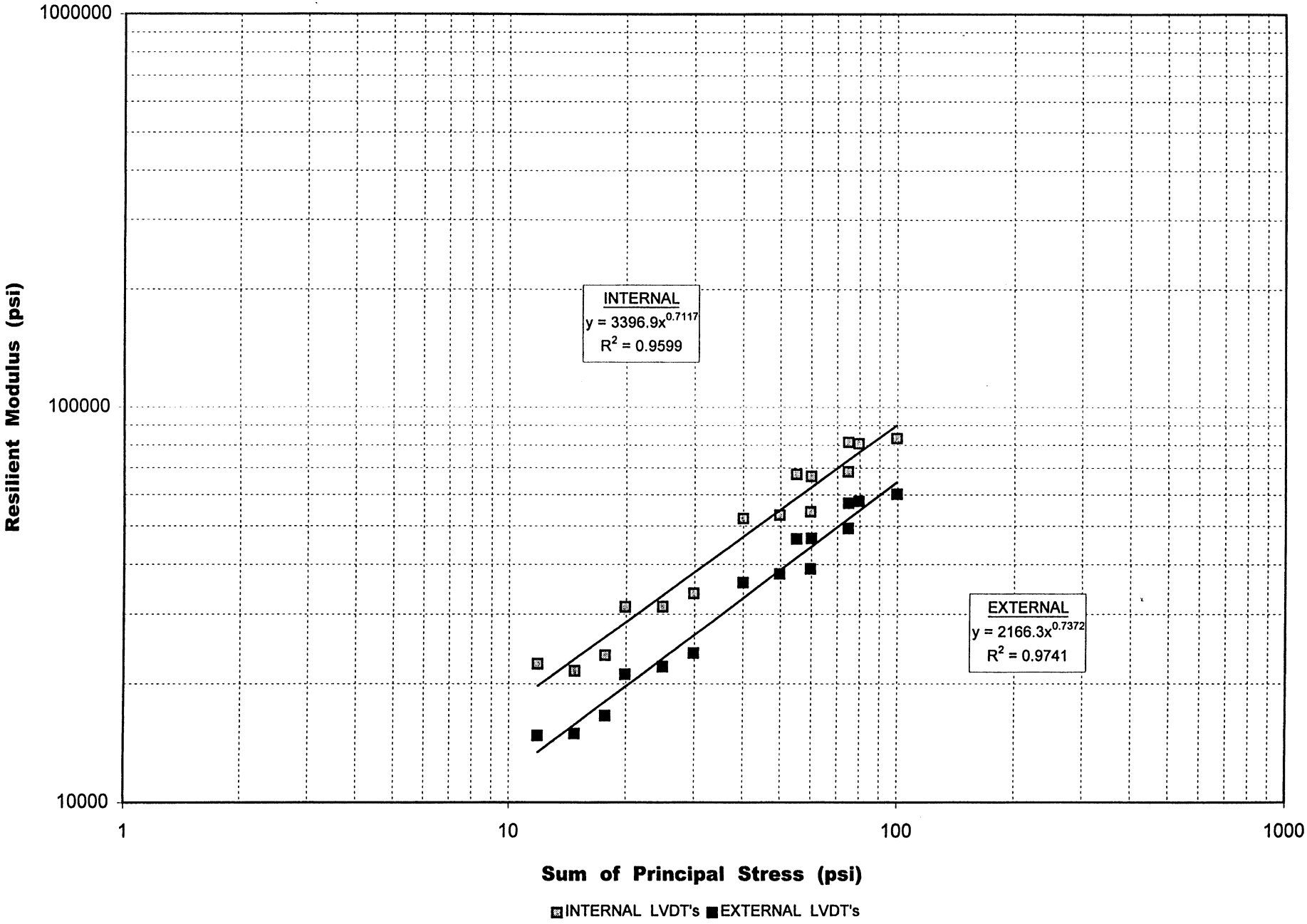
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00138881	0.00017360	14771
2	3	5.13	0.63	5.77	0.00274444	0.00034306	14966
3	3	7.82	0.87	8.69	0.00377000	0.00047125	16588
4	5	4.44	0.47	4.91	0.00168054	0.00021007	21113
5	5	8.79	1.03	9.83	0.00318741	0.00039843	22073
6	5	13.36	1.51	14.87	0.00447798	0.00055975	23871
7	10	8.92	1.03	9.95	0.00198648	0.00024831	35915
8	10	17.72	1.99	19.71	0.00374759	0.00046845	37822
9	10	26.63	3.02	29.65	0.00546820	0.00068353	38955
10	15	8.95	1.04	9.99	0.00154523	0.00019315	46329
11	15	13.49	1.51	15.00	0.00232215	0.00029027	46477
12	15	26.70	3.02	29.72	0.00433837	0.00054230	49236
13	20	13.35	1.50	14.85	0.00187186	0.00023398	57059
14	20	17.68	1.99	19.67	0.00245229	0.00030654	57678
15	20	35.82	3.97	39.79	0.00476668	0.00059584	60125

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00045718	0.00011429	22436
2	3	5.13	0.63	5.77	0.00095271	0.00023818	21556
3	3	7.82	0.87	8.69	0.00132673	0.00033168	23568
4	5	4.44	0.47	4.91	0.00056792	0.00014198	31238
5	5	8.79	1.03	9.83	0.00112464	0.00028116	31280
6	5	13.36	1.51	14.87	0.00158182	0.00039545	33788
7	10	8.92	1.03	9.95	0.00068426	0.00017107	52132
8	10	17.72	1.99	19.71	0.00133234	0.00033308	53192
9	10	26.63	3.02	29.65	0.00196359	0.00049090	54241
10	15	8.95	1.04	9.99	0.00053130	0.00013282	67372
11	15	13.49	1.51	15.00	0.00081008	0.00020252	66614
12	15	26.70	3.02	29.72	0.00156200	0.00039050	68376
13	20	13.35	1.50	14.85	0.00065625	0.00016406	81376
14	20	17.68	1.99	19.67	0.00087644	0.00021911	80692
15	20	35.82	3.97	39.79	0.00172315	0.00043079	83161

SHRP (P46) - **TYPE I**
Pit # 17-091 (Untreated)
28 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 1, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Treated w / 1% Lime. 1 Day Cure

LAB # : 14214-S

SAMPLE # : 1 of 2

LBR : 133.0

SOIL CLASS :

FINAL % (w) : 10.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
9.8 @ 127.6
ACTUAL MOISTURE / DENSITY:
10.4 @ 125.2

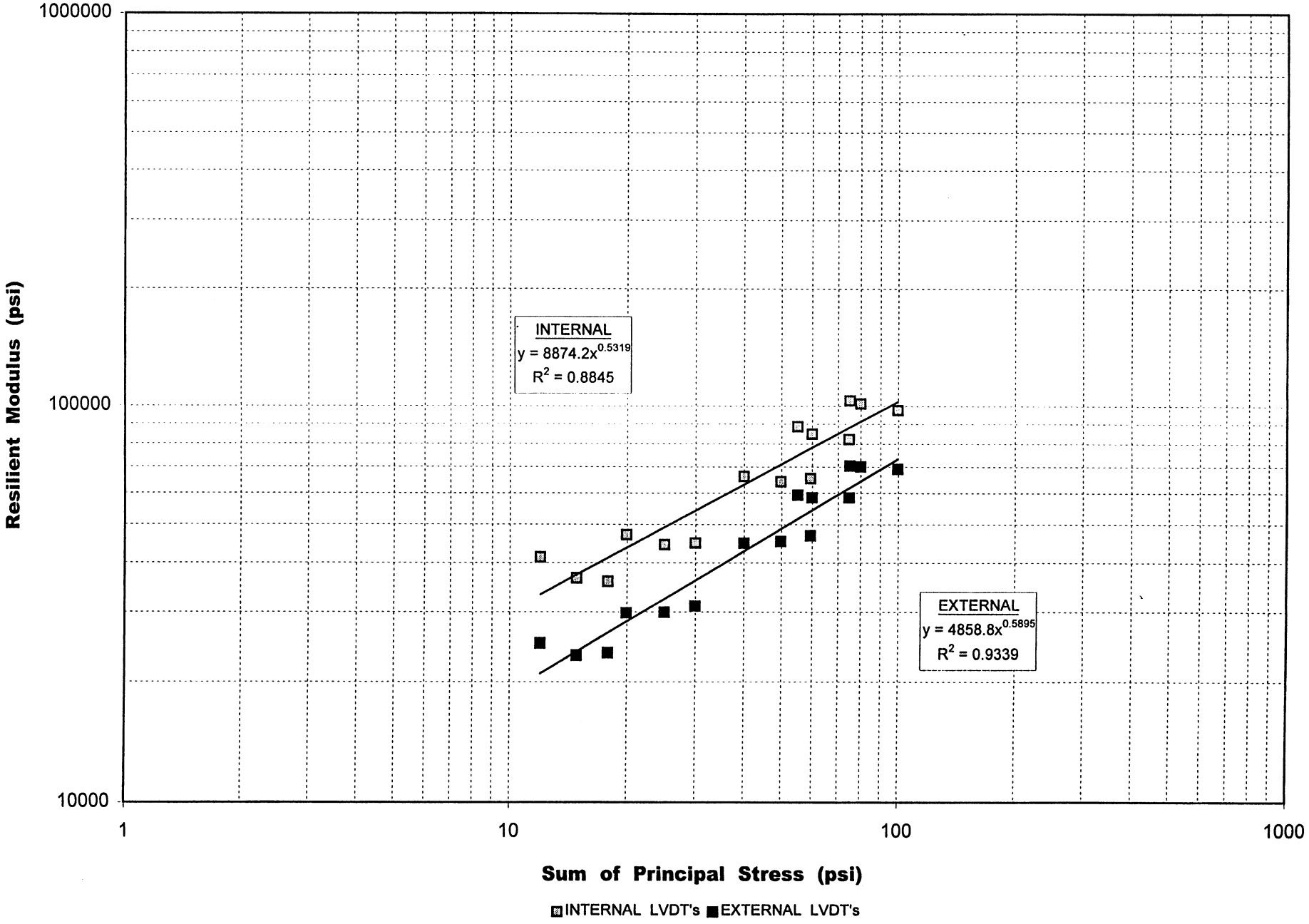
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.98	0.00085018	0.00010627	25028
2	3	5.26	0.63	5.89	0.00180205	0.00022526	23352
3	3	8.04	0.86	8.90	0.00271342	0.00033918	23695
4	5	4.48	0.47	4.95	0.00120050	0.00015006	29830
5	5	8.96	1.03	9.99	0.00239240	0.00029905	29945
6	5	13.43	1.51	14.94	0.00345932	0.00043242	31048
7	10	8.97	1.03	10.00	0.00160168	0.00020021	44786
8	10	17.80	1.99	19.79	0.00314734	0.00039342	45244
9	10	26.44	3.01	29.45	0.00452193	0.00056524	46777
10	15	9.02	1.03	10.05	0.00121818	0.00015227	59264
11	15	13.51	1.50	15.01	0.00185204	0.00023151	58363
12	15	26.70	3.01	29.72	0.00365969	0.00045746	58376
13	20	13.57	1.51	15.08	0.00154221	0.00019278	70392
14	20	17.96	1.99	19.95	0.00205241	0.00025655	70007
15	20	35.75	3.97	39.72	0.00414057	0.00051757	69066

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.98	0.00025810	0.00006453	41220
2	3	5.26	0.63	5.89	0.00057568	0.00014392	36550
3	3	8.04	0.86	8.90	0.00089626	0.00022407	35869
4	5	4.48	0.47	4.95	0.00038134	0.00009533	46954
5	5	8.96	1.03	9.99	0.00080750	0.00020187	44360
6	5	13.43	1.51	14.94	0.00119746	0.00029936	44847
7	10	8.97	1.03	10.00	0.00054250	0.00013562	66114
8	10	17.80	1.99	19.79	0.00110956	0.00027739	64170
9	10	26.44	3.01	29.45	0.00161844	0.00040461	65348
10	15	9.02	1.03	10.05	0.00040763	0.00010191	88555
11	15	13.51	1.50	15.01	0.00063773	0.00015943	84747
12	15	26.70	3.01	29.72	0.00129958	0.00032490	82195
13	20	13.57	1.51	15.08	0.00052526	0.00013132	103337
14	20	17.96	1.99	19.95	0.00070926	0.00017731	101292
15	20	35.75	3.97	39.72	0.00146591	0.00036648	97541

SHRP (P46) - **TYPE I**
Pit # 17-091 (Treated)
1 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 1, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Treated w / 1% Lime. 1 Day Cure

LAB # : 14214-S

SAMPLE # : 2 of 2

LBR : 133.0

SOIL CLASS :

FINAL % (w) : 10.2

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
9.8 @ 127.6
ACTUAL MOISTURE / DENSITY:
10.2 @ 125.9

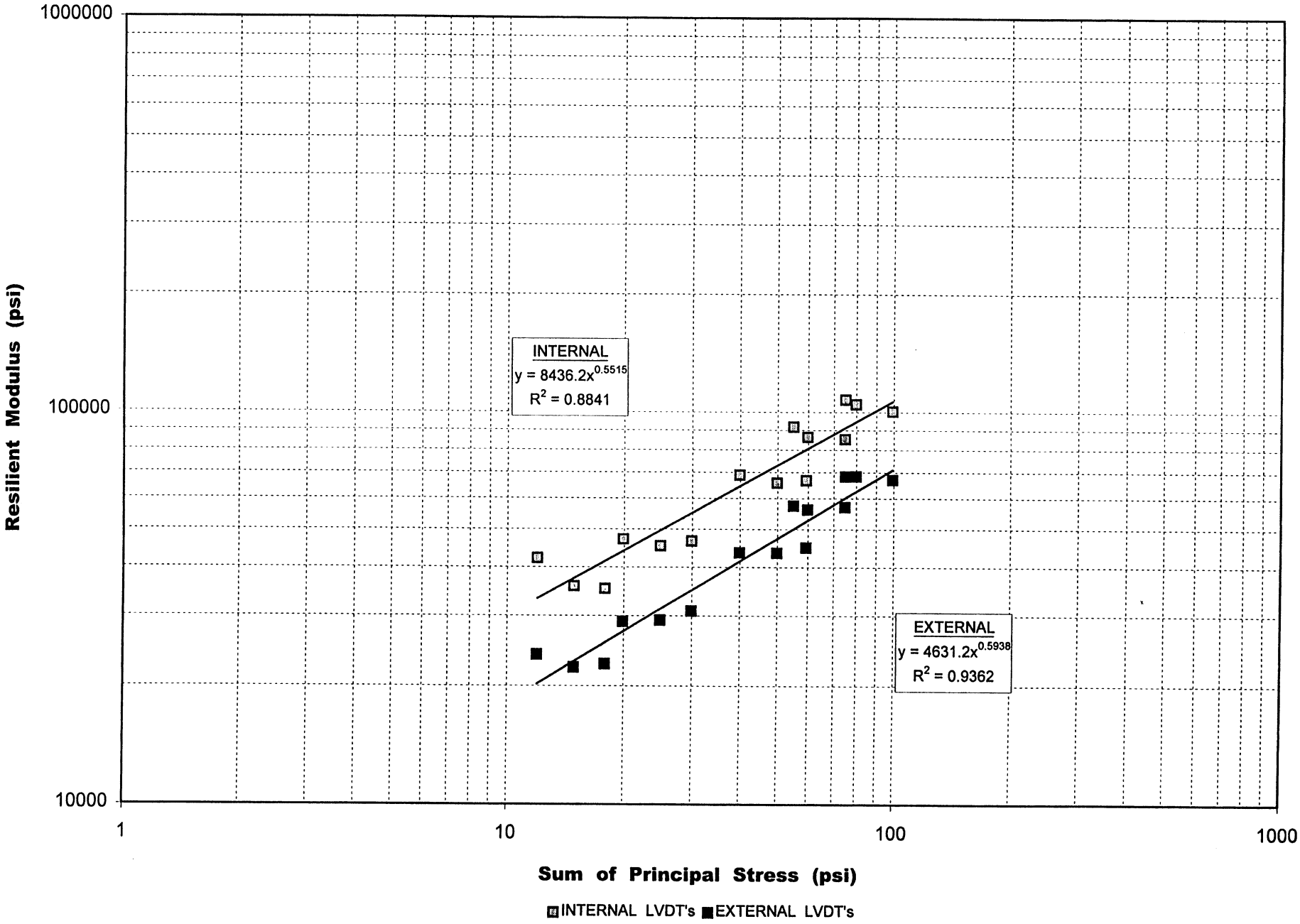
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00087991	0.00010999	23950
2	3	5.27	0.63	5.90	0.00189469	0.00023684	22249
3	3	8.00	0.89	8.89	0.00281941	0.00035243	22711
4	5	4.43	0.48	4.91	0.00122420	0.00015303	28967
5	5	8.80	1.04	9.84	0.00241178	0.00030147	29197
6	5	13.38	1.52	14.89	0.00347181	0.00043398	30828
7	10	8.89	1.04	9.93	0.00163700	0.00020463	43462
8	10	17.85	1.99	19.84	0.00328954	0.00041119	43421
9	10	26.30	3.02	29.31	0.00469343	0.00058668	44821
10	15	8.94	1.03	9.98	0.00124704	0.00015588	57375
11	15	13.30	1.51	14.81	0.00189600	0.00023700	56103
12	15	26.81	3.02	29.83	0.00376828	0.00047103	56921
13	20	13.48	1.51	14.99	0.00158099	0.00019762	68232
14	20	17.86	1.99	19.86	0.00209162	0.00026145	68330
15	20	35.38	3.96	39.34	0.00422590	0.00052824	66973

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.63	0.32	2.95	0.00025035	0.00006259	42089
2	3	5.27	0.63	5.90	0.00059033	0.00014758	35704
3	3	8.00	0.89	8.89	0.00091091	0.00022773	35147
4	5	4.43	0.48	4.91	0.00037703	0.00009426	47027
5	5	8.80	1.04	9.84	0.00077777	0.00019444	45268
6	5	13.38	1.52	14.89	0.00115049	0.00028762	46515
7	10	8.89	1.04	9.93	0.00051751	0.00012938	68740
8	10	17.85	1.99	19.84	0.00108715	0.00027179	65692
9	10	26.30	3.02	29.31	0.00157708	0.00039427	66694
10	15	8.94	1.03	9.98	0.00039039	0.00009760	91637
11	15	13.30	1.51	14.81	0.00061618	0.00015405	86315
12	15	26.81	3.02	29.83	0.00125822	0.00031455	85238
13	20	13.48	1.51	14.99	0.00050199	0.00012550	107445
14	20	17.86	1.99	19.86	0.00068254	0.00017064	104697
15	20	35.38	3.96	39.34	0.00140903	0.00035226	100431

SHRP (P46) - **TYPE I**
Pit # 17-091 (Treated)
1 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 28, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Treated w / 1% lime. 28 Day Cure

LAB # : 14214-S

SAMPLE # : 1 of 2

LBR : 133.0

SOIL CLASS :

FINAL % (w) : 11.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
9.8 @ 127.6
ACTUAL MOISTURE / DENSITY:
10.4 @ 125.2

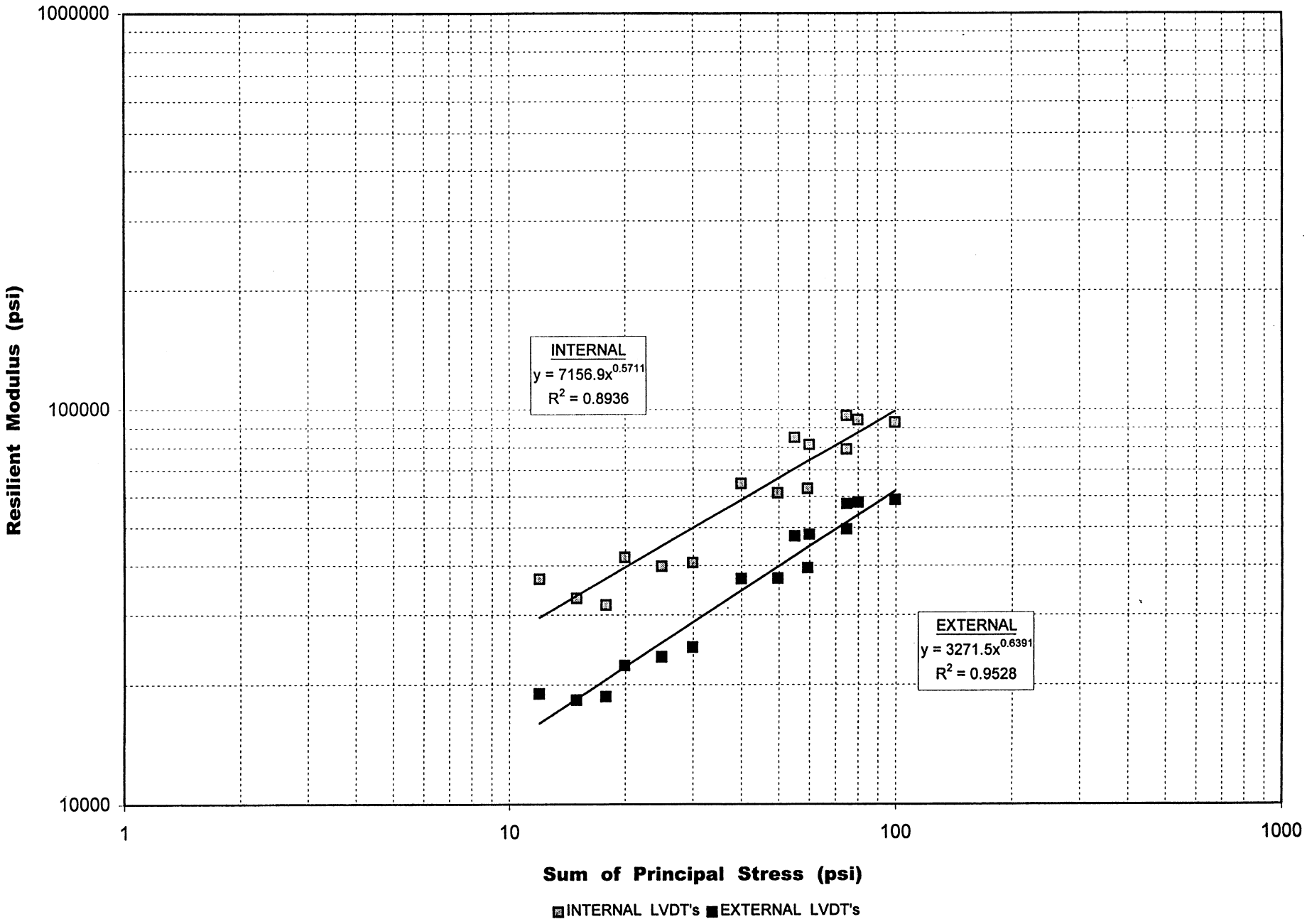
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00111346	0.00013918	18986
2	3	5.29	0.63	5.92	0.00231483	0.00028935	18296
3	3	7.94	0.87	8.81	0.00340329	0.00042541	18658
4	5	4.44	0.48	4.91	0.00158919	0.00019865	22347
5	5	8.83	1.03	9.86	0.00300902	0.00037613	23472
6	5	13.40	1.51	14.91	0.00431509	0.00053939	24848
7	10	8.90	1.04	9.93	0.00192658	0.00024082	36943
8	10	17.64	1.99	19.63	0.00380878	0.00047610	37058
9	10	26.29	3.01	29.30	0.00533721	0.00066715	39409
10	15	8.92	1.03	9.95	0.00150386	0.00018798	47458
11	15	13.47	1.51	14.98	0.00224804	0.00028100	47924
12	15	26.66	3.02	29.68	0.00431251	0.00053906	49451
13	20	13.35	1.51	14.86	0.00185850	0.00023231	57455
14	20	17.95	1.98	19.94	0.00247987	0.00030998	57916
15	20	35.81	3.97	39.78	0.00486795	0.00060849	58846

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00028655	0.00007164	36887
2	3	5.29	0.63	5.92	0.00064161	0.00016040	33005
3	3	7.94	0.87	8.81	0.00100054	0.00025014	31732
4	5	4.44	0.48	4.91	0.00042357	0.00010589	41922
5	5	8.83	1.03	9.86	0.00088721	0.00022180	39802
6	5	13.40	1.51	14.91	0.00131940	0.00032985	40632
7	10	8.90	1.04	9.93	0.00055026	0.00013756	64673
8	10	17.64	1.99	19.63	0.00115351	0.00028838	61182
9	10	26.29	3.01	29.30	0.00167446	0.00041861	62806
10	15	8.92	1.03	9.95	0.00042012	0.00010503	84940
11	15	13.47	1.51	14.98	0.00066229	0.00016557	81336
12	15	26.66	3.02	29.68	0.00134612	0.00033653	79212
13	20	13.35	1.51	14.86	0.00055370	0.00013843	96424
14	20	17.95	1.98	19.94	0.00076312	0.00019078	94104
15	20	35.81	3.97	39.78	0.00154476	0.00038619	92719

SHRP (P46) - **TYPE I**
Pit # 17-091 (Treated)
28 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 28, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 17-091 (Gray Bank-Run Shell)

COMMENTS : Treated w 1% lime. 28 Day Cure

LAB # : 14214-S

SAMPLE # : 2 of 2

LBR : 133.0

SOIL CLASS :

FINAL % (w) : 11.2

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
9.8 @ 127.6
ACTUAL MOISTURE / DENSITY:
10.1 @ 125.1

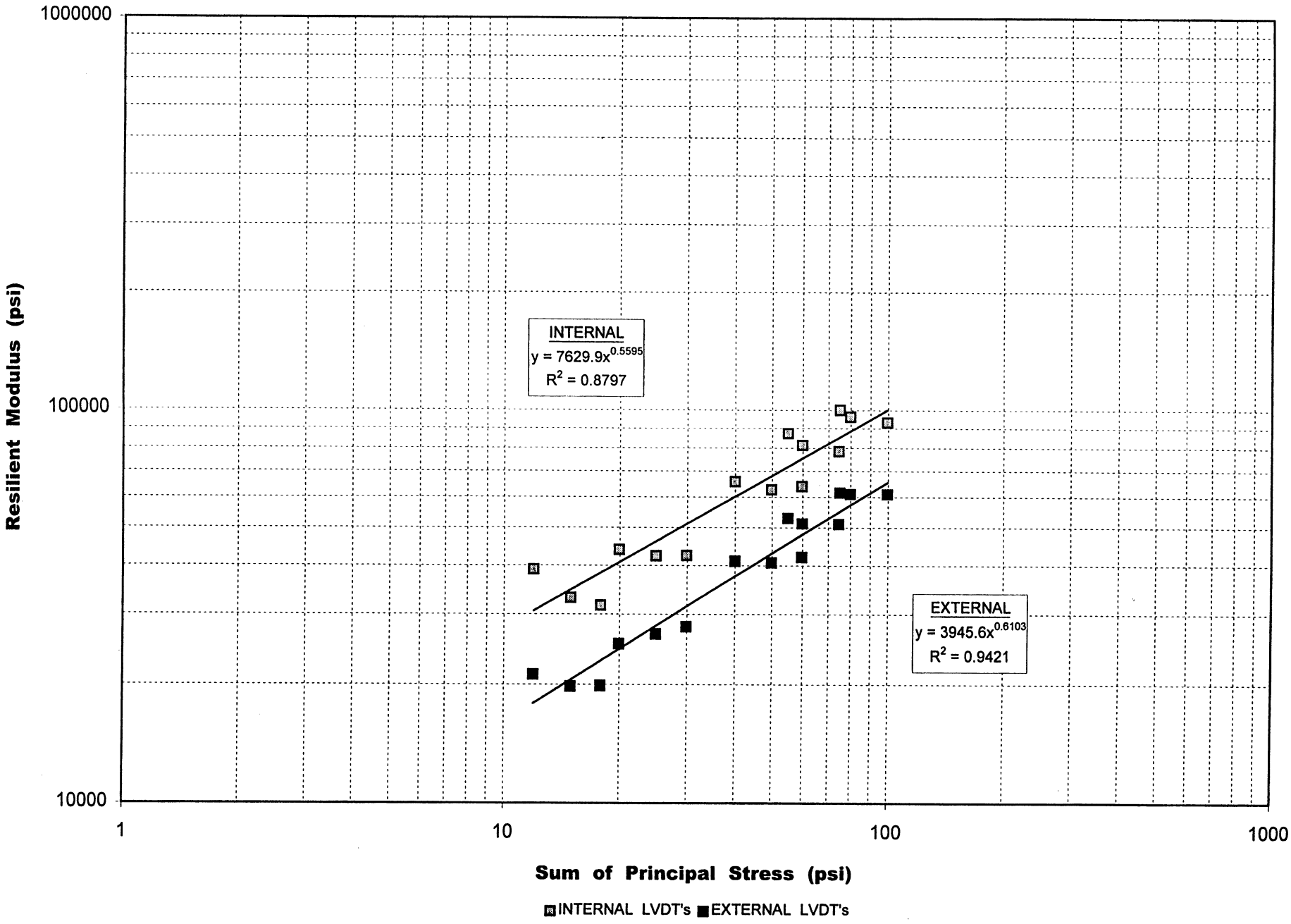
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00098979	0.00012372	21185
2	3	5.29	0.63	5.93	0.00214247	0.00026781	19765
3	3	7.99	0.87	8.86	0.00321758	0.00040220	19856
4	5	4.47	0.47	4.94	0.00141596	0.00017700	25267
5	5	8.83	1.03	9.86	0.00263930	0.00032991	26755
6	5	13.34	1.51	14.85	0.00382860	0.00047858	27878
7	10	8.93	1.04	9.97	0.00174517	0.00021815	40949
8	10	17.86	1.99	19.85	0.00351533	0.00043942	40645
9	10	26.73	3.02	29.75	0.00509590	0.00063699	41968
10	15	8.96	1.03	9.99	0.00135822	0.00016978	52776
11	15	13.43	1.51	14.94	0.00210239	0.00026280	51109
12	15	26.47	3.01	29.48	0.00415006	0.00051876	51020
13	20	13.55	1.51	15.07	0.00176283	0.00022035	61511
14	20	17.88	1.99	19.86	0.00234628	0.00029329	60955
15	20	35.68	3.98	39.66	0.00468352	0.00058544	60942

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00026888	0.00006722	38993
2	3	5.29	0.63	5.93	0.00064246	0.00016062	32956
3	3	7.99	0.87	8.86	0.00101303	0.00025326	31533
4	5	4.47	0.47	4.94	0.00040806	0.00010201	43839
5	5	8.83	1.03	9.86	0.00083594	0.00020898	42236
6	5	13.34	1.51	14.85	0.00125994	0.00031499	42357
7	10	8.93	1.04	9.97	0.00054379	0.00013595	65709
8	10	17.86	1.99	19.85	0.00114101	0.00028525	62611
9	10	26.73	3.02	29.75	0.00167489	0.00041872	63844
10	15	8.96	1.03	9.99	0.00041108	0.00010277	87187
11	15	13.43	1.51	14.94	0.00066099	0.00016525	81280
12	15	26.47	3.01	29.48	0.00135000	0.00033750	78420
13	20	13.55	1.51	15.07	0.00054250	0.00013563	99938
14	20	17.88	1.99	19.86	0.00074373	0.00018593	96150
15	20	35.68	3.98	39.66	0.00153485	0.00038371	92981

SHRP (P46) - **TYPE I**
Pit # 17-091 (Treated)
28 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : UNTREATED, 1-DAY CURE (lost specimen following sequence # 12)

LAB # : 14230-S

SAMPLE # : 102

LBR : 179.0

SOIL CLASS :

FINAL % (w) : 8.4

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

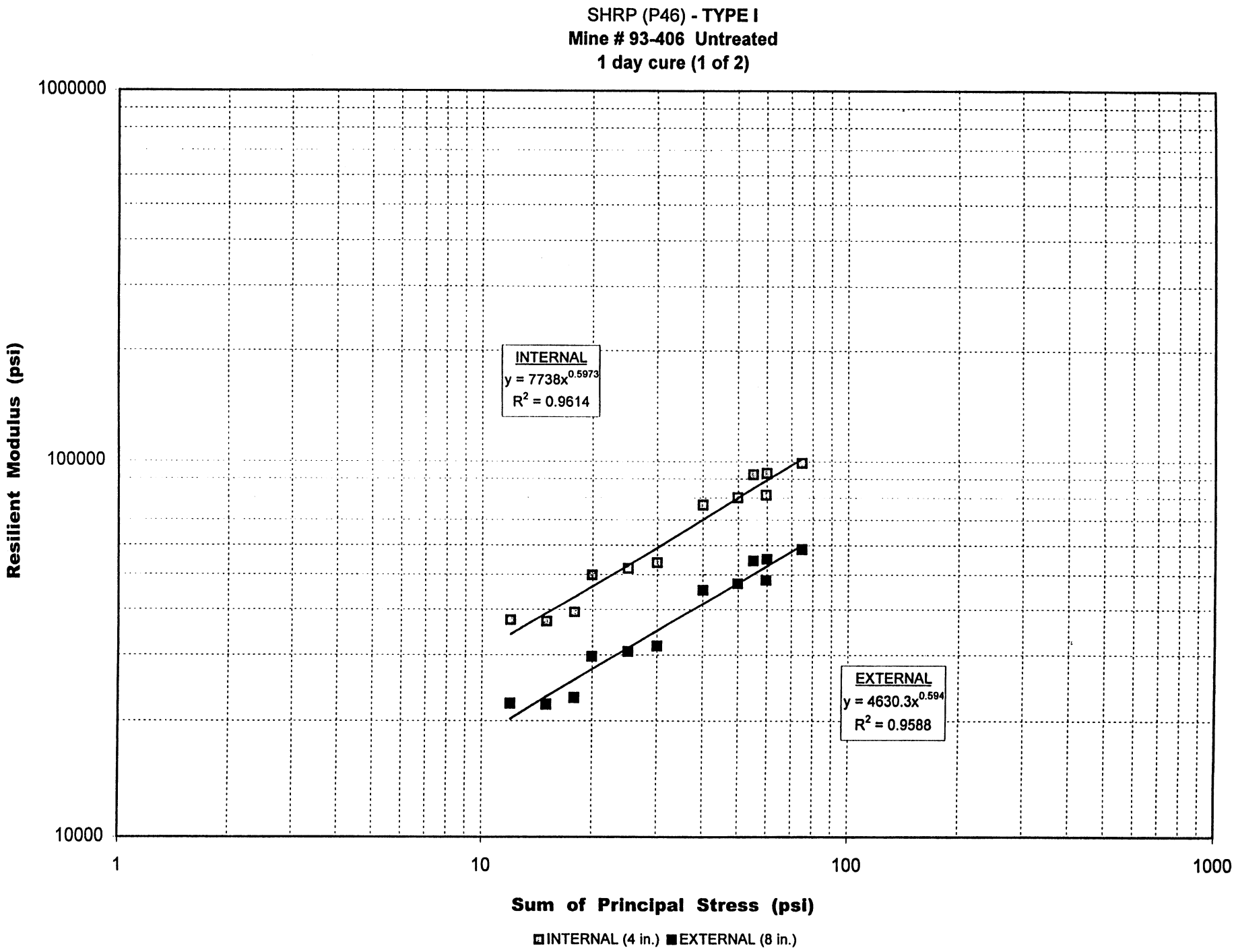
INSITU or TARGET MOIST. / DENSITY:
7.6 @ 129.0
ACTUAL MOISTURE / DENSITY:
7.3 @ 128.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.97	0.00095532	0.00011941	22177
2	3	5.37	0.63	6.01	0.00194727	0.00024341	22081
3	3	7.98	0.87	8.86	0.00278021	0.00034753	22975
4	5	4.48	0.48	4.96	0.00120869	0.00015109	29682
5	5	8.96	1.04	10.00	0.00234198	0.00029275	30612
6	5	13.45	1.52	14.97	0.00339296	0.00042412	31721
7	10	8.97	1.04	10.01	0.00158487	0.00019811	45265
8	10	17.86	1.99	19.85	0.00303013	0.00037877	47155
9	10	26.63	3.02	29.65	0.00442412	0.00055301	48158
10	15	8.99	1.03	10.03	0.00132159	0.00016520	54447
11	15	13.47	1.51	14.98	0.00195761	0.00024470	55058
12	15	26.65	3.02	29.67	0.00364719	0.00045590	58464
13	20	0.00	1.52	1.52	0.00174431	0.00021804	0
14	20	0.00	1.99	1.99	0.00227691	0.00028461	0
15	20	0.00	3.98	3.98	0.00377000	0.00047125	0

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.65	0.32	2.97	0.00028396	0.00007099	37304
2	3	5.37	0.63	6.01	0.00058171	0.00014543	36958
3	3	7.98	0.87	8.86	0.00081396	0.00020349	39237
4	5	4.48	0.48	4.96	0.00036066	0.00009017	49737
5	5	8.96	1.04	10.00	0.00069116	0.00017279	51865
6	5	13.45	1.52	14.97	0.00099968	0.00024992	53832
7	10	8.97	1.04	10.01	0.00046838	0.00011710	76582
8	10	17.86	1.99	19.85	0.00089239	0.00022310	80059
9	10	26.63	3.02	29.65	0.00131035	0.00032759	81298
10	15	8.99	1.03	10.03	0.00038996	0.00009749	92263
11	15	13.47	1.51	14.98	0.00057955	0.00014489	92986
12	15	26.65	3.02	29.67	0.00107595	0.00026899	99089
13	20	0.00	1.52	1.52	0.00052699	0.00013175	0
14	20	0.00	1.99	1.99	0.00069805	0.00017451	0
15	20	0.00	3.98	3.98	0.00124787	0.00031197	0


SHRP (P46) - TYPE I
Mine # 93-406 Untreated
1 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 7738x^0.5973
R^2 = 0.9614
EXTERNAL
y = 4630.3x^0.594
R^2 = 0.9588
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 UF Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14230-S

SAMPLE # : 2 of 2

LBR : 179.0

SOIL CLASS :

FINAL % (w) : 7.9

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

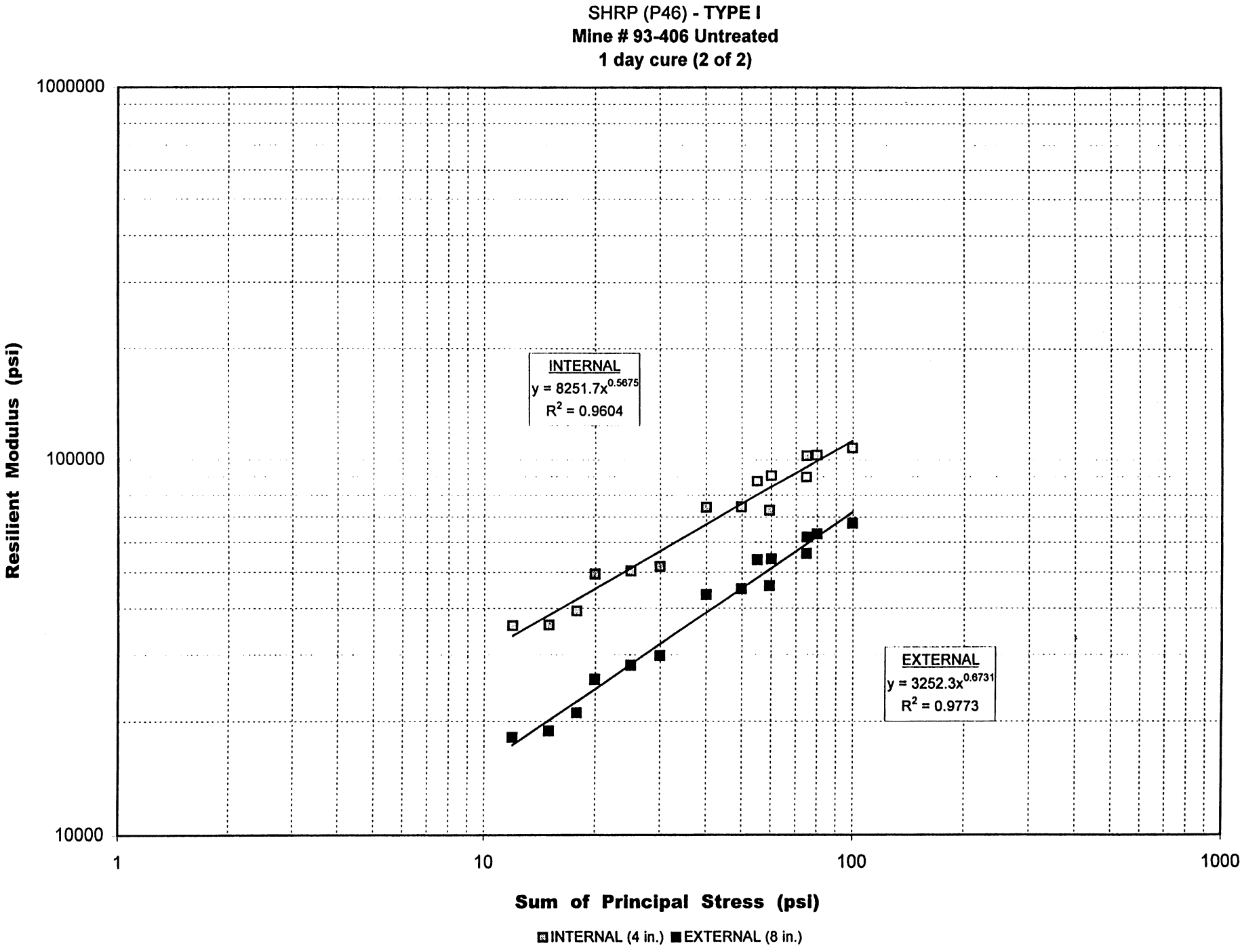
INSITU or TARGET MOIST. / DENSITY:
7.6 @ 129.0
ACTUAL MOISTURE / DENSITY:
7.0 @ 128.1

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.93	0.00115440	0.00014430	18107
2	3	5.34	0.63	5.97	0.00226915	0.00028364	18827
3	3	7.96	0.87	8.83	0.00302195	0.00037774	21067
4	5	4.46	0.47	4.94	0.00137976	0.00017247	25887
5	5	8.93	1.03	9.96	0.00253286	0.00031661	28196
6	5	13.42	1.51	14.93	0.00359850	0.00044981	29829
7	10	8.91	1.04	9.95	0.00163874	0.00020484	43496
8	10	17.83	1.99	19.83	0.00316587	0.00039573	45065
9	10	26.29	3.02	29.31	0.00457838	0.00057230	45942
10	15	8.97	1.04	10.01	0.00133193	0.00016649	53886
11	15	13.53	1.51	15.05	0.00199983	0.00024998	54139
12	15	26.83	3.02	29.85	0.00383291	0.00047911	55992
13	20	13.50	1.52	15.01	0.00174431	0.00021804	61900
14	20	17.94	1.99	19.93	0.00227691	0.00028461	63027
15	20	35.81	3.97	39.79	0.00425305	0.00053163	67363

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.93	0.00029129	0.00007282	35880
2	3	5.34	0.63	5.97	0.00059291	0.00014823	36026
3	3	7.96	0.87	8.83	0.00080965	0.00020241	39315
4	5	4.46	0.47	4.94	0.00036152	0.00009038	49400
5	5	8.93	1.03	9.96	0.00070925	0.00017731	50347
6	5	13.42	1.51	14.93	0.00103846	0.00025961	51682
7	10	8.91	1.04	9.95	0.00048045	0.00012011	74179
8	10	17.83	1.99	19.83	0.00095918	0.00023979	74371
9	10	26.29	3.02	29.31	0.00144522	0.00036131	72770
10	15	8.97	1.04	10.01	0.00041107	0.00010277	87299
11	15	13.53	1.51	15.05	0.00059852	0.00014963	90448
12	15	26.83	3.02	29.85	0.00119789	0.00029947	89580
13	20	13.50	1.52	15.01	0.00052699	0.00013175	102443
14	20	17.94	1.99	19.93	0.00069805	0.00017451	102790
15	20	35.81	3.97	39.79	0.00133061	0.00033265	107657


SHRP (P46) - TYPE I
Mine # 93-406 Untreated
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 8251.7x^0.5675
R^2 = 0.9604
EXTERNAL
y = 3252.3x^0.6731
R^2 = 0.9773
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14230-S

SAMPLE # : [redacted]

LBR : 179.0

SOIL CLASS :

FINAL % (w) : 9.9

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

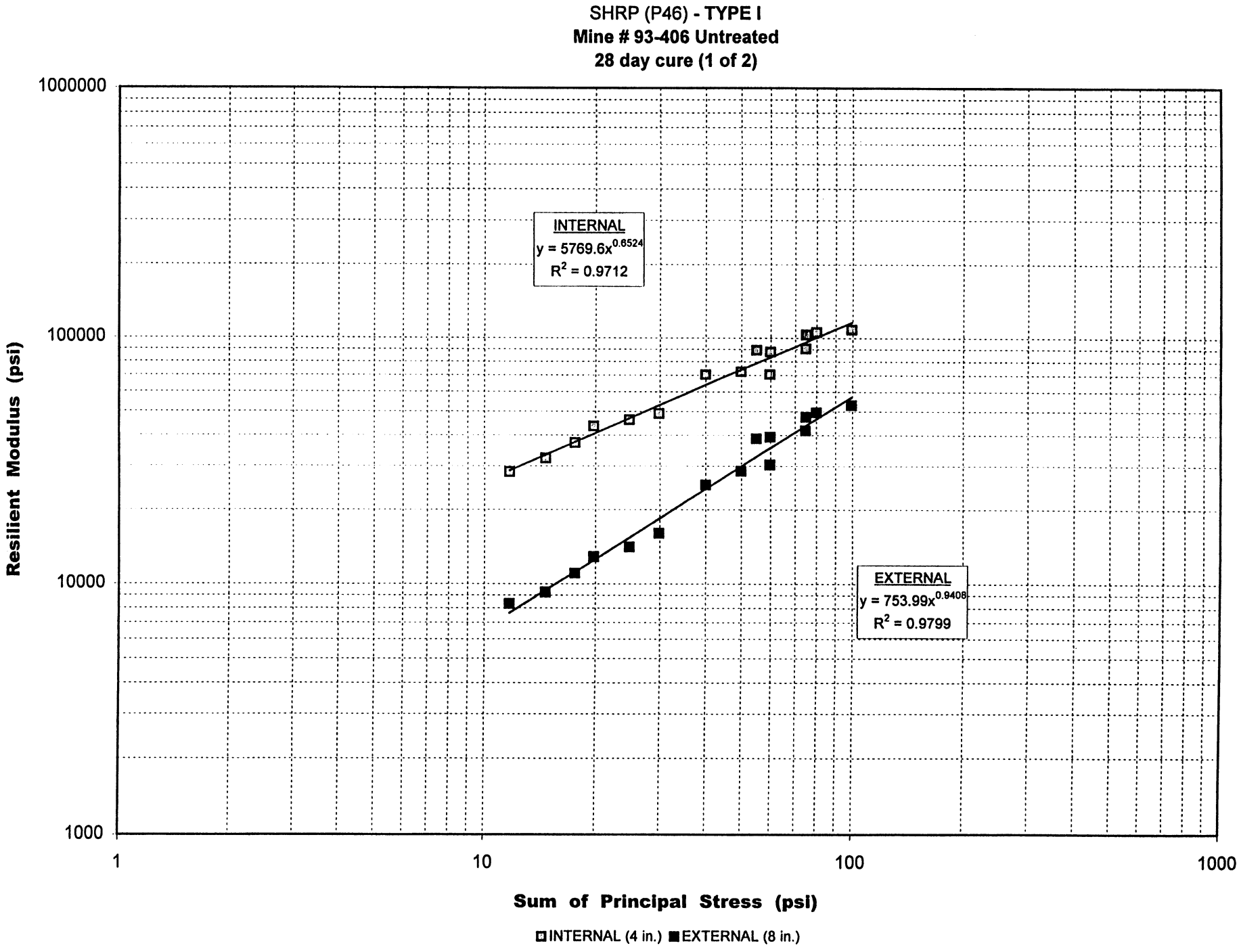
INSITU or TARGET MOIST. / DENSITY:
7.6 @ 129.0
ACTUAL MOISTURE / DENSITY:
7.3 @ 128.1

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.39	0.32	2.71	0.00229673	0.00028709	8318
2	3	5.02	0.63	5.65	0.00434354	0.00054294	9255
3	3	7.73	0.87	8.60	0.00558498	0.00069812	11066
4	5	4.31	0.48	4.78	0.00267033	0.00033379	12905
5	5	8.69	1.03	9.73	0.00492354	0.00061544	14128
6	5	13.29	1.51	14.81	0.00661441	0.00082680	16076
7	10	8.88	1.03	9.91	0.00282588	0.00035324	25128
8	10	17.92	1.99	19.91	0.00501403	0.00062675	28584
9	10	26.75	3.02	29.76	0.00706126	0.00088266	30301
10	15	8.91	1.03	9.95	0.00184126	0.00023016	38723
11	15	13.39	1.51	14.90	0.00272721	0.00034090	39289
12	15	26.69	3.02	29.71	0.00511830	0.00063979	41722
13	20	13.37	1.51	14.88	0.00225623	0.00028203	47423
14	20	17.96	1.98	19.94	0.00291164	0.00036395	49344
15	20	35.50	3.97	39.47	0.00536134	0.00067017	52968

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.39	0.32	2.71	0.00033739	0.00008435	28312
2	3	5.02	0.63	5.65	0.00062437	0.00015609	32191
3	3	7.73	0.87	8.60	0.00083163	0.00020791	37159
4	5	4.31	0.48	4.78	0.00039642	0.00009911	43464
5	5	8.69	1.03	9.73	0.00075450	0.00018862	46096
6	5	13.29	1.51	14.81	0.00108715	0.00027179	48904
7	10	8.88	1.03	9.91	0.00050372	0.00012593	70485
8	10	17.92	1.99	19.91	0.00098891	0.00024723	72465
9	10	26.75	3.02	29.76	0.00151374	0.00037843	70673
10	15	8.91	1.03	9.95	0.00039987	0.00009997	89152
11	15	13.39	1.51	14.90	0.00061058	0.00015265	87743
12	15	26.69	3.02	29.71	0.00118109	0.00029527	90402
13	20	13.37	1.51	14.88	0.00051923	0.00012981	103034
14	20	17.96	1.98	19.94	0.00067996	0.00016999	105647
15	20	35.50	3.97	39.47	0.00131208	0.00032802	108218


SHRP (P46) - TYPE I
Mine # 93-406 Untreated
28 day cure (1 of 2)
1000000
100000
10000
1000
Resilient Modulus (psi)
INTERNAL
y = 5769.6x^0.6524
R^2 = 0.9712
EXTERNAL
y = 753.99x^0.9408
R^2 = 0.9799
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : UNTREATED, 28-DAY CURE (lost data for Sequence #1)

LAB # : 14230-S

SAMPLE # : [redacted]

LBR : 179.0

SOIL CLASS :

FINAL % (w) : 9.8

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

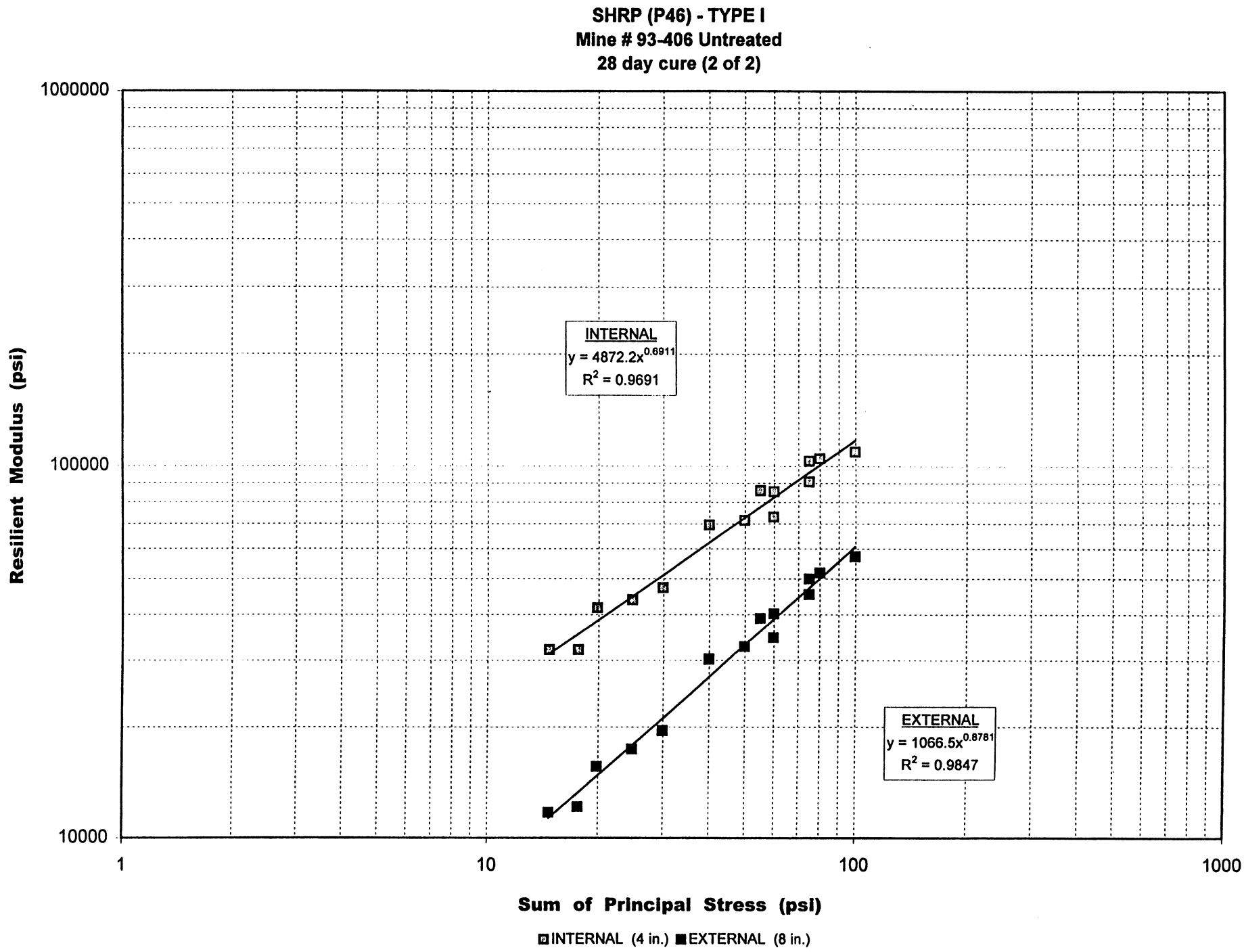
INSITU or TARGET MOIST. / DENSITY:
7.6 @ 129.0
ACTUAL MOISTURE / DENSITY:
7.2 @ 127.7

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	[redacted]						
2	3	5.07	0.63	5.70	0.00346793	0.00043349	11702
3	3	7.75	0.87	8.62	0.00510796	0.00063850	12132
4	5	4.36	0.48	4.84	0.00223640	0.00027955	15606
5	5	8.71	1.04	9.74	0.00399623	0.00049953	17433
6	5	13.39	1.51	14.90	0.00547381	0.00068423	19571
7	10	8.89	1.03	9.93	0.00235103	0.00029388	30256
8	10	17.87	1.99	19.87	0.00438059	0.00054757	32644
9	10	26.70	3.01	29.71	0.00618178	0.00077272	34552
10	15	8.94	1.04	9.98	0.00183480	0.00022935	38974
11	15	13.43	1.51	14.94	0.00267593	0.00033449	40145
12	15	26.75	3.02	29.77	0.00472360	0.00059045	45310
13	20	13.44	1.51	14.95	0.00215626	0.00026953	49875
14	20	17.96	1.98	19.94	0.00277504	0.00034688	51770
15	20	35.74	3.97	39.71	0.00499507	0.00062438	57238

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	[redacted]						
2	3	5.07	0.63	5.70	0.00063385	0.00015846	32011
3	3	7.75	0.87	8.62	0.00096779	0.00024195	32016
4	5	4.36	0.48	4.84	0.00041883	0.00010471	41666
5	5	8.71	1.04	9.74	0.00079457	0.00019864	43838
6	5	13.39	1.51	14.90	0.00113455	0.00028364	47212
7	10	8.89	1.03	9.93	0.00051233	0.00012808	69421
8	10	17.87	1.99	19.87	0.00100011	0.00025003	71492
9	10	26.70	3.01	29.71	0.00146375	0.00036594	72961
10	15	8.94	1.04	9.98	0.00041581	0.00010395	85987
11	15	13.43	1.51	14.94	0.00062911	0.00015728	85379
12	15	26.75	3.02	29.77	0.00117807	0.00029452	90838
13	20	13.44	1.51	14.95	0.00052095	0.00013024	103219
14	20	17.96	1.98	19.94	0.00068512	0.00017128	104845
15	20	35.74	3.97	39.71	0.00130777	0.00032694	109310


SHRP (P46) - TYPE I
Mine # 93-406 Untreated
28 day cure (2 of 2)
Resilient Modulus (psi)
1000000
100000
10000
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL
y = 4872.2x^0.6911
R^2 = 0.9691
EXTERNAL
y = 1066.5x^0.8781
R^2 = 0.9847
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 UF Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14230-S

SAMPLE # : [redacted]

LBR : 220.0

SOIL CLASS :

FINAL % (w) : 8.2

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

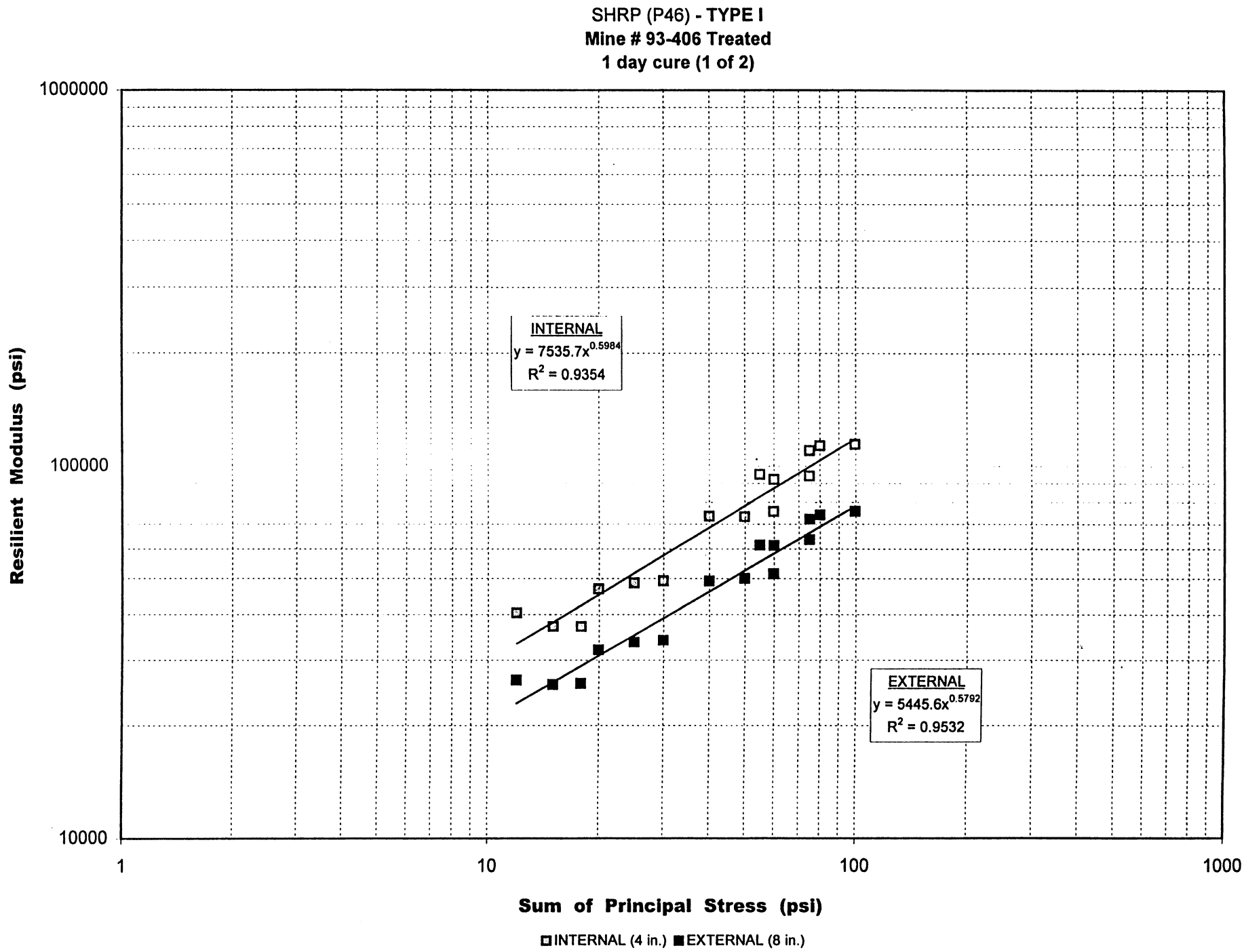
INSITU or TARGET MOIST. / DENSITY:
8.4 @ 130.0
ACTUAL MOISTURE / DENSITY:
7.0 @ 126.6

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00079718	0.00009965	26494
2	3	5.36	0.63	5.99	0.00166459	0.00020807	25768
3	3	8.00	0.87	8.87	0.00246565	0.00030821	25943
4	5	4.47	0.47	4.94	0.00111863	0.00013983	31954
5	5	8.89	1.04	9.93	0.00211920	0.00026490	33563
6	5	13.42	1.52	14.94	0.00316329	0.00039541	33950
7	10	8.94	1.04	9.98	0.00145301	0.00018163	49205
8	10	17.91	1.99	19.90	0.00286811	0.00035851	49959
9	10	26.80	3.02	29.82	0.00416902	0.00052113	51424
10	15	8.91	1.03	9.94	0.00115914	0.00014489	61470
11	15	13.49	1.51	15.01	0.00176198	0.00022025	61264
12	15	26.77	3.02	29.79	0.00337271	0.00042159	63500
13	20	13.43	1.51	14.94	0.00148749	0.00018594	72210
14	20	17.94	1.98	19.92	0.00193865	0.00024233	74037
15	20	35.68	3.98	39.65	0.00377000	0.00047125	75704

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.64	0.32	2.96	0.00026155	0.00006539	40374
2	3	5.36	0.63	5.99	0.00057912	0.00014478	37032
3	3	8.00	0.87	8.87	0.00086309	0.00021577	37057
4	5	4.47	0.47	4.94	0.00038135	0.00009534	46867
5	5	8.89	1.04	9.93	0.00073209	0.00018302	48578
6	5	13.42	1.52	14.94	0.00109060	0.00027265	49236
7	10	8.94	1.04	9.98	0.00048691	0.00012173	73418
8	10	17.91	1.99	19.90	0.00097856	0.00024464	73214
9	10	26.80	3.02	29.82	0.00141764	0.00035441	75615
10	15	8.91	1.03	9.94	0.00037488	0.00009372	95035
11	15	13.49	1.51	15.01	0.00058559	0.00014640	92168
12	15	26.77	3.02	29.79	0.00113800	0.00028450	94098
13	20	13.43	1.51	14.94	0.00048734	0.00012184	110202
14	20	17.94	1.98	19.92	0.00063298	0.00015825	113378
15	20	35.68	3.98	39.65	0.00124787	0.00031197	114356


SHRP (P46) - TYPE I
Mine # 93-406 Treated
1 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 7535.7x^0.5984
R^2 = 0.9354
EXTERNAL
y = 5445.6x^0.5792
R^2 = 0.9532
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14230-S

SAMPLE # : 2 of 2

LBR : 220.0

SOIL CLASS :

FINAL % (w) : 8.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

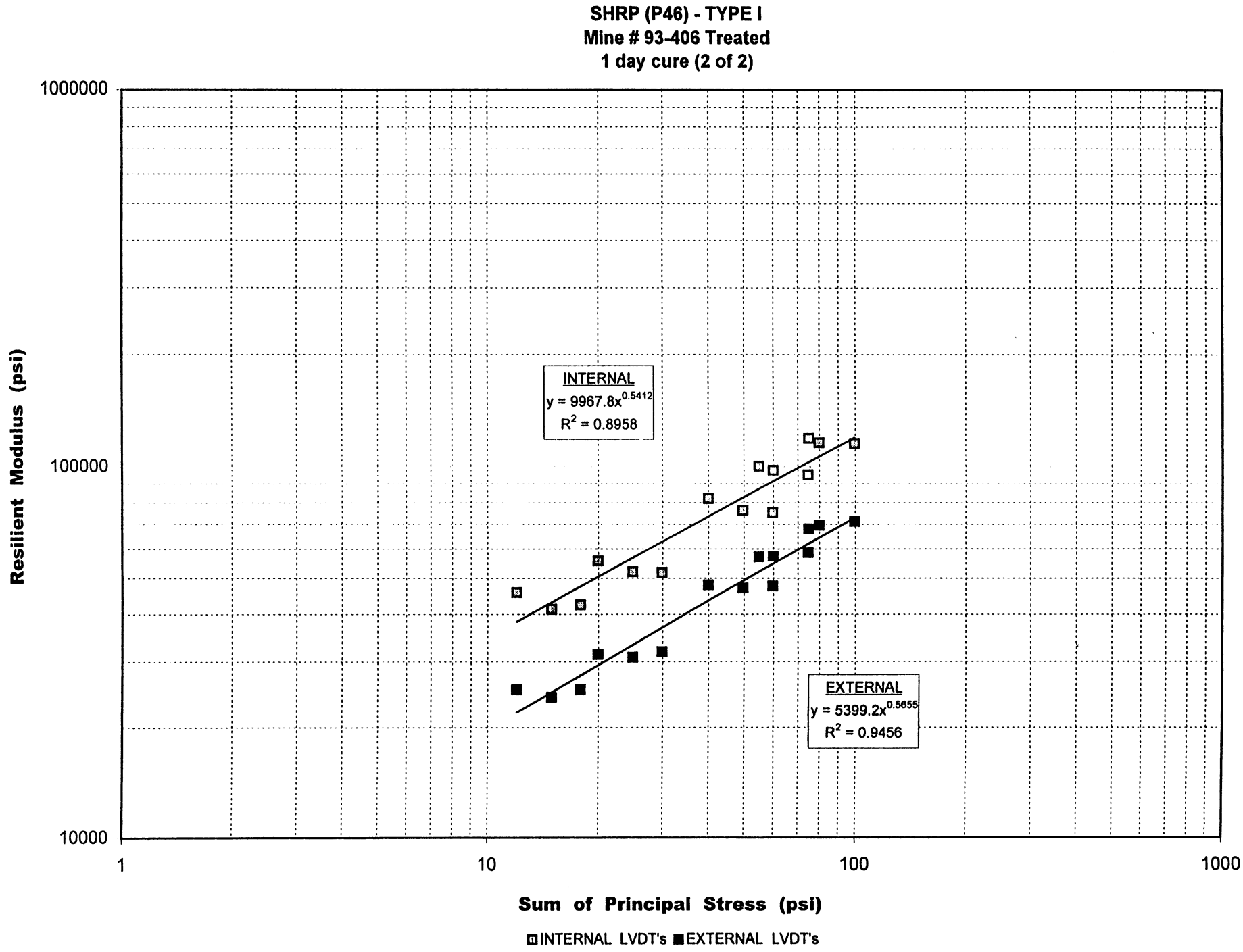
INSITU or TARGET MOIST. / DENSITY:
8.4 @ 130.0
ACTUAL MOISTURE / DENSITY:
7.1 @ 126.0

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.67	0.32	2.99	0.00084285	0.00010536	25300
2	3	5.28	0.63	5.92	0.00175034	0.00021879	24151
3	3	8.01	0.87	8.88	0.00253373	0.00031672	25301
4	5	4.49	0.47	4.97	0.00114751	0.00014344	31316
5	5	8.86	1.03	9.90	0.00230277	0.00028785	30788
6	5	13.39	1.51	14.91	0.00336323	0.00042040	31853
7	10	8.93	1.04	9.97	0.00149309	0.00018664	47845
8	10	17.74	1.99	19.73	0.00302152	0.00037769	46969
9	10	26.78	3.02	29.80	0.00450685	0.00056336	47532
10	15	8.87	1.04	9.91	0.00124532	0.00015567	56983
11	15	13.49	1.51	15.00	0.00188521	0.00023565	57249
12	15	26.57	3.02	29.59	0.00363125	0.00045391	58543
13	20	13.36	1.52	14.88	0.00157367	0.00019671	67917
14	20	17.94	1.99	19.94	0.00206706	0.00025838	69444
15	20	35.67	3.97	39.64	0.00401476	0.00050184	71071

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.67	0.32	2.99	0.00023354	0.00005839	45654
2	3	5.28	0.63	5.92	0.00051319	0.00012830	41186
3	3	8.01	0.87	8.88	0.00075795	0.00018949	42288
4	5	4.49	0.47	4.97	0.00032360	0.00008090	55525
5	5	8.86	1.03	9.90	0.00068211	0.00017053	51968
6	5	13.39	1.51	14.91	0.00103631	0.00025908	51688
7	10	8.93	1.04	9.97	0.00043564	0.00010891	81991
8	10	17.74	1.99	19.73	0.00093203	0.00023301	76134
9	10	26.78	3.02	29.80	0.00142282	0.00035571	75279
10	15	8.87	1.04	9.91	0.00035377	0.00008844	100296
11	15	13.49	1.51	15.00	0.00055241	0.00013810	97687
12	15	26.57	3.02	29.59	0.00111904	0.00027976	94985
13	20	13.36	1.52	14.88	0.00044684	0.00011171	119594
14	20	17.94	1.99	19.94	0.00061662	0.00015415	116398
15	20	35.67	3.97	39.64	0.00123107	0.00030777	115888


SHRP (P46) - TYPE I
Mine # 93-406 Treated
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9967.8x^0.5412
R^2 = 0.8958
EXTERNAL
y = 5399.2x^0.5655
R^2 = 0.9456
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14230-S

SAMPLE # : [redacted]

LBR : 220.0

SOIL CLASS :

FINAL % (w) : 10.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

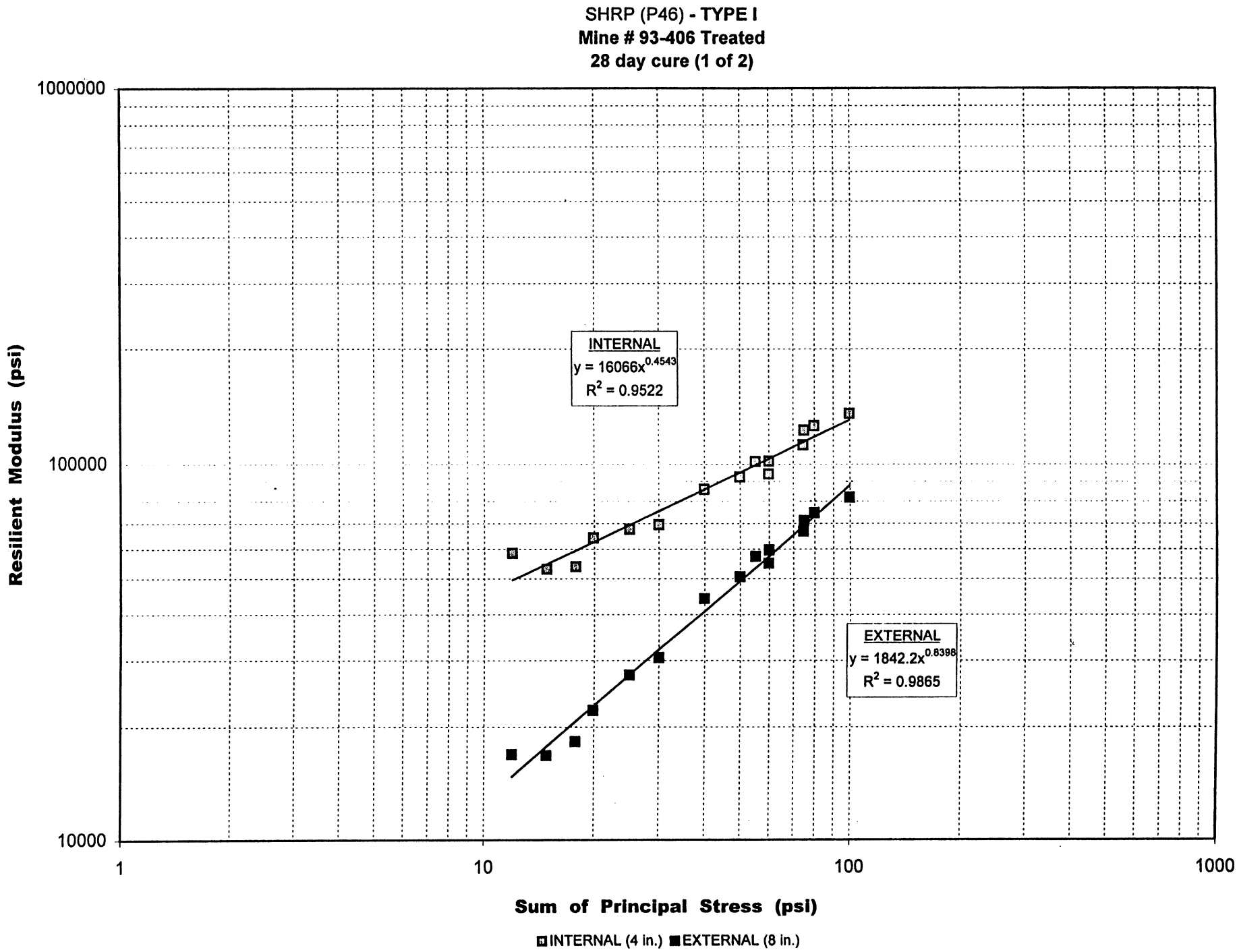
INSITU or TARGET MOIST. / DENSITY:
8.4 @ 130.0
ACTUAL MOISTURE / DENSITY:
7.1 @ 125.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00123153	0.00015394	16903
2	3	5.22	0.63	5.85	0.00248504	0.00031063	16810
3	3	7.95	0.87	8.82	0.00347914	0.00043489	18282
4	5	4.41	0.48	4.89	0.00159738	0.00019967	22105
5	5	8.93	1.04	9.97	0.00260569	0.00032571	27423
6	5	13.50	1.51	15.02	0.00354420	0.00044303	30477
7	10	8.91	1.04	9.94	0.00161547	0.00020193	44102
8	10	17.90	1.99	19.90	0.00283709	0.00035464	50485
9	10	26.82	3.01	29.83	0.00390660	0.00048832	54914
10	15	9.05	1.03	10.08	0.00126385	0.00015798	57279
11	15	13.46	1.51	14.97	0.00180722	0.00022590	59566
12	15	26.53	3.02	29.55	0.00317923	0.00039740	66769
13	20	13.42	1.51	14.93	0.00150989	0.00018874	71104
14	20	17.92	1.98	19.90	0.00192400	0.00024050	74502
15	20	35.69	3.97	39.66	0.00349163	0.00043645	81781

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00017796	0.00004449	58487
2	3	5.22	0.63	5.85	0.00039384	0.00009846	53032
3	3	7.95	0.87	8.82	0.00059119	0.00014780	53793
4	5	4.41	0.48	4.89	0.00027534	0.00006884	64120
5	5	8.93	1.04	9.97	0.00052871	0.00013218	67577
6	5	13.50	1.51	15.02	0.00077776	0.00019444	69441
7	10	8.91	1.04	9.94	0.00041538	0.00010385	85759
8	10	17.90	1.99	19.90	0.00077432	0.00019358	92487
9	10	26.82	3.01	29.83	0.00114015	0.00028504	94079
10	15	9.05	1.03	10.08	0.00035678	0.00008920	101452
11	15	13.46	1.51	14.97	0.00052914	0.00013229	101721
12	15	26.53	3.02	29.55	0.00094711	0.00023678	112064
13	20	13.42	1.51	14.93	0.00043951	0.00010988	122134
14	20	17.92	1.98	19.90	0.00057094	0.00014273	125531
15	20	35.69	3.97	39.66	0.00105699	0.00026425	135077


SHRP (P46) - TYPE I
Mine # 93-406 Treated
28 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 16066x^0.4543
R^2 = 0.9522
EXTERNAL
y = 1842.2x^0.8398
R^2 = 0.9865
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Grayish Shelly Limerock (93-406)

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14230-S

SAMPLE # : [redacted]

LBR : 220.0

SOIL CLASS :

FINAL % (w) : 9.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

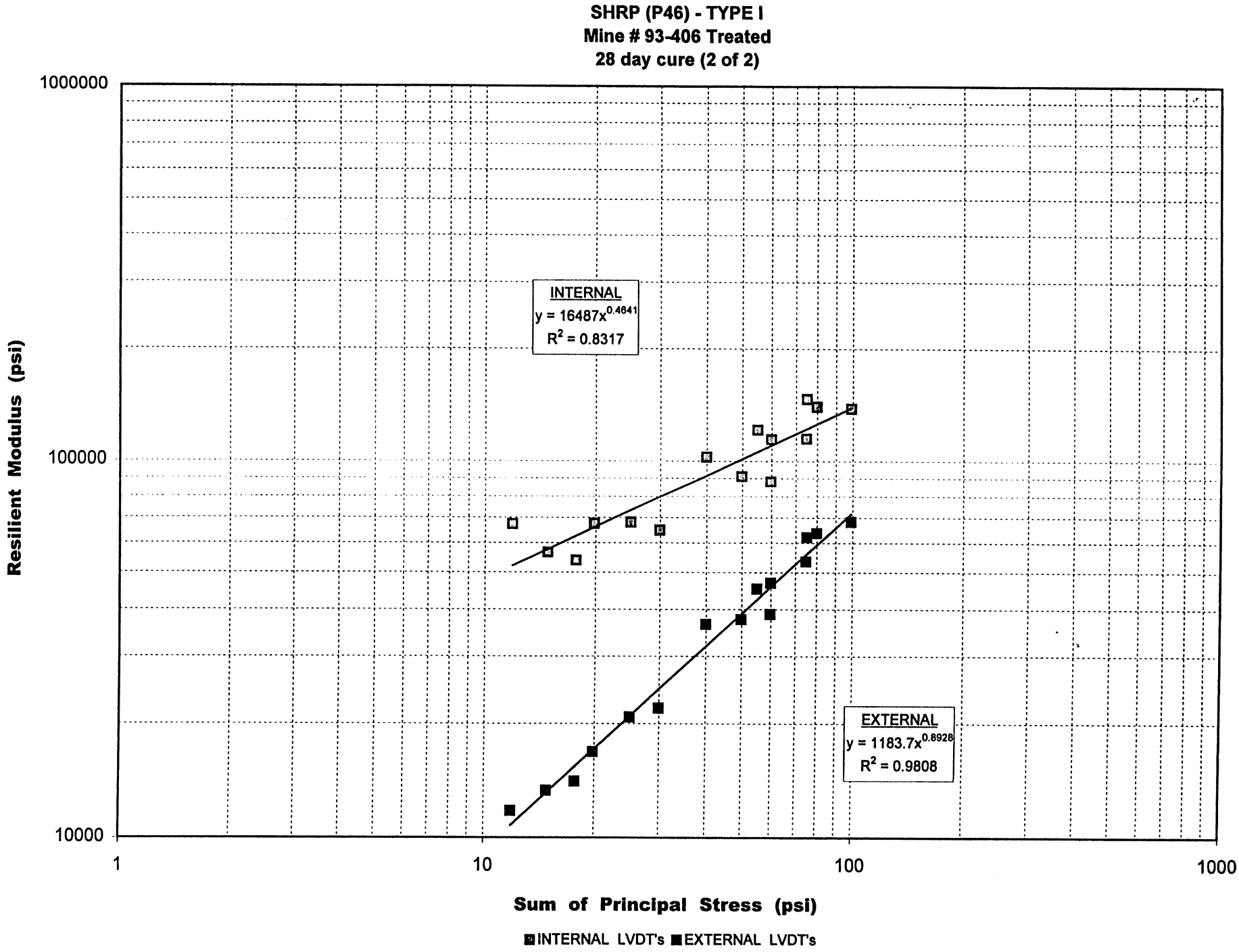
INSITU or TARGET MOIST. / DENSITY:
8.4 @ 130.0
ACTUAL MOISTURE / DENSITY:
6.9 @ 126.7

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.53	0.32	2.85	0.00171975	0.00021497	11764
2	3	5.17	0.63	5.80	0.00310726	0.00038841	13316
3	3	7.85	0.87	8.73	0.00446030	0.00055754	14089
4	5	4.36	0.47	4.84	0.00207265	0.00025908	16839
5	5	8.90	1.03	9.93	0.00342657	0.00042832	20773
6	5	13.40	1.52	14.91	0.00488648	0.00061081	21936
7	10	8.89	1.04	9.93	0.00195029	0.00024379	36480
8	10	17.88	1.99	19.87	0.00381050	0.00047631	37529
9	10	26.71	3.02	29.73	0.00551302	0.00068913	38766
10	15	8.94	1.03	9.97	0.00158272	0.00019784	45185
11	15	13.40	1.51	14.91	0.00228768	0.00028596	46854
12	15	26.70	3.02	29.72	0.00400097	0.00050012	53397
13	20	13.46	1.51	14.98	0.00173483	0.00021685	62090
14	20	17.87	1.99	19.86	0.00224675	0.00028084	63641
15	20	35.15	3.96	39.11	0.00412033	0.00051504	68255

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.53	0.32	2.85	0.00015038	0.00003760	67265
2	3	5.17	0.63	5.80	0.00036626	0.00009157	56486
3	3	7.85	0.87	8.73	0.00058516	0.00014629	53695
4	5	4.36	0.47	4.84	0.00025897	0.00006474	67385
5	5	8.90	1.03	9.93	0.00052354	0.00013088	67980
6	5	13.40	1.52	14.91	0.00082732	0.00020683	64780
7	10	8.89	1.04	9.93	0.00034730	0.00008683	102428
8	10	17.88	1.99	19.87	0.00078639	0.00019660	90926
9	10	26.71	3.02	29.73	0.00121340	0.00030335	88065
10	15	8.94	1.03	9.97	0.00029474	0.00007368	121322
11	15	13.40	1.51	14.91	0.00046882	0.00011720	114318
12	15	26.70	3.02	29.72	0.00093031	0.00023258	114821
13	20	13.46	1.51	14.98	0.00036756	0.00009189	146529
14	20	17.87	1.99	19.86	0.00051061	0.00012765	140014
15	20	35.15	3.96	39.11	0.00101605	0.00025401	138396


SHRP (P46) - TYPE I
Mine # 93-406 Treated
28 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 16487x^0.4641
R^2 = 0.8317
EXTERNAL
y = 1183.7x^0.8928
R^2 = 0.9808
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 3, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Untreated. 1 Day Cure

LAB # : 14078-S

SAMPLE # : 1 of 2

LBR : 120.0

SOIL CLASS :

FINAL % (w) : 11.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 119.4
ACTUAL MOISTURE / DENSITY:
12.1 @ 115.9

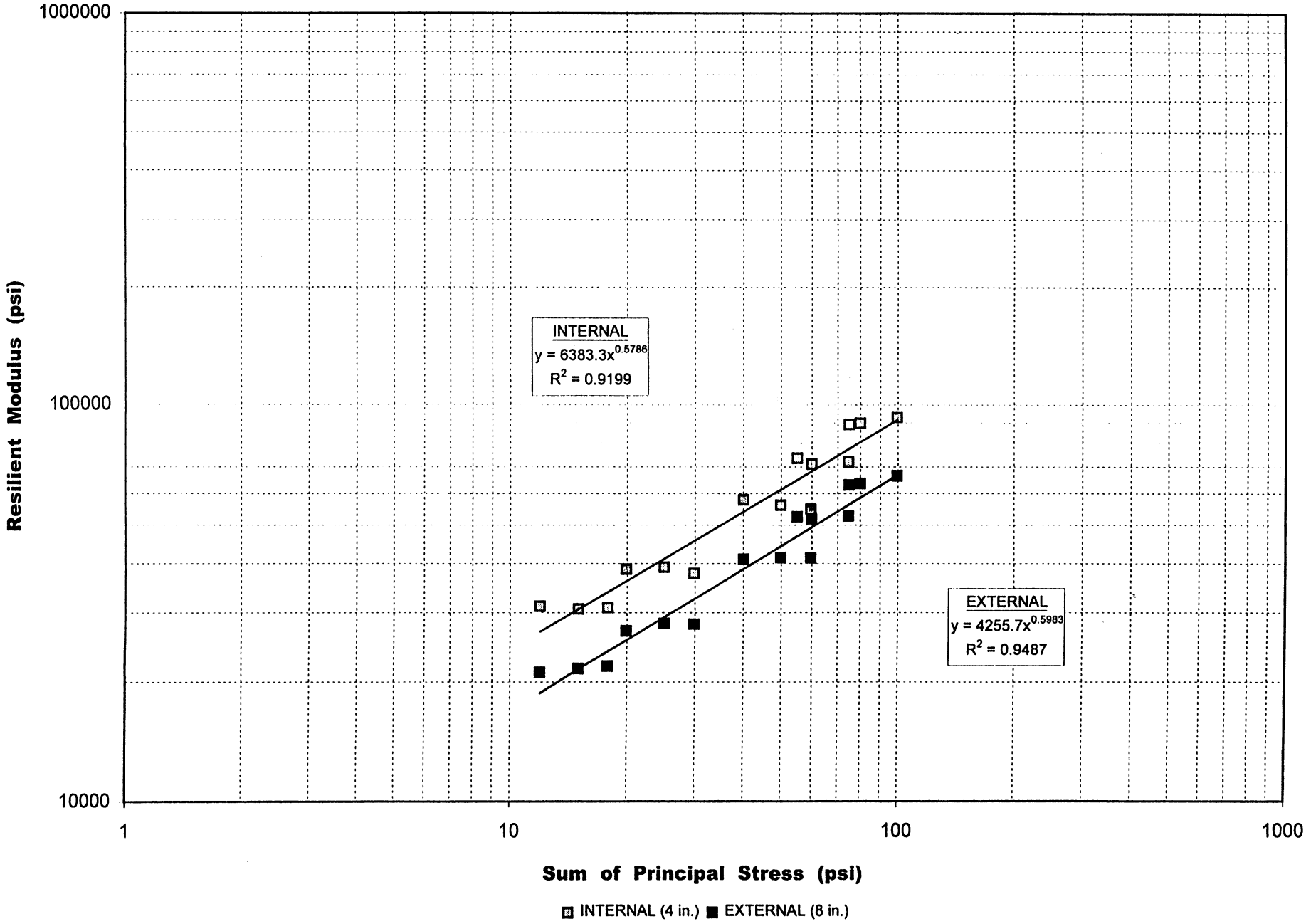
EXTERNAL LVDT's (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00099324	0.00012416	21105
2	3	5.38	0.63	6.02	0.00199640	0.00024955	21571
3	3	8.00	0.87	8.88	0.00292585	0.00036573	21887
4	5	4.44	0.48	4.91	0.00131814	0.00016477	26918
5	5	8.96	1.04	10.00	0.00254622	0.00031828	28149
6	5	13.31	1.51	14.82	0.00380533	0.00047567	27974
7	10	8.97	1.04	10.00	0.00175249	0.00021906	40940
8	10	17.91	1.99	19.91	0.00347052	0.00043382	41295
9	10	26.68	3.02	29.70	0.00517346	0.00064668	41262
10	15	9.00	1.04	10.04	0.00137459	0.00017182	52372
11	15	13.48	1.52	15.00	0.00208645	0.00026081	51686
12	15	26.62	3.02	29.64	0.00404707	0.00050588	52616
13	20	13.45	1.51	14.96	0.00170768	0.00021346	63000
14	20	17.94	1.99	19.93	0.00225967	0.00028246	63519
15	20	35.64	3.98	39.62	0.00429484	0.00053686	66390

INTERNAL LVDT's (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00033696	0.00008424	31105
2	3	5.38	0.63	6.02	0.00070279	0.00017570	30638
3	3	8.00	0.87	8.88	0.00103760	0.00025940	30859
4	5	4.44	0.48	4.91	0.00045847	0.00011462	38695
5	5	8.96	1.04	10.00	0.00091695	0.00022924	39083
6	5	13.31	1.51	14.82	0.00141118	0.00035280	37717
7	10	8.97	1.04	10.00	0.00062092	0.00015523	57774
8	10	17.91	1.99	19.91	0.00127890	0.00031972	56031
9	10	26.68	3.02	29.70	0.00195239	0.00048810	54668
10	15	9.00	1.04	10.04	0.00048993	0.00012248	73470
11	15	13.48	1.52	15.00	0.00075881	0.00018970	71058
12	15	26.62	3.02	29.64	0.00148056	0.00037014	71912
13	20	13.45	1.51	14.96	0.00060412	0.00015103	89042
14	20	17.94	1.99	19.93	0.00080018	0.00020004	89688
15	20	35.64	3.98	39.62	0.00153615	0.00038404	92808

SHRP (P46) - **TYPE I**
Pit # 26-001 Untreated
1 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 3, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Untreated. 1 Day Cure

LAB # : 14078-S

SAMPLE # : 2 of 2

LBR : 120.0

SOIL CLASS :

FINAL % (w) : 12.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 119.4
ACTUAL MOISTURE / DENSITY:
12.0 @ 115.7

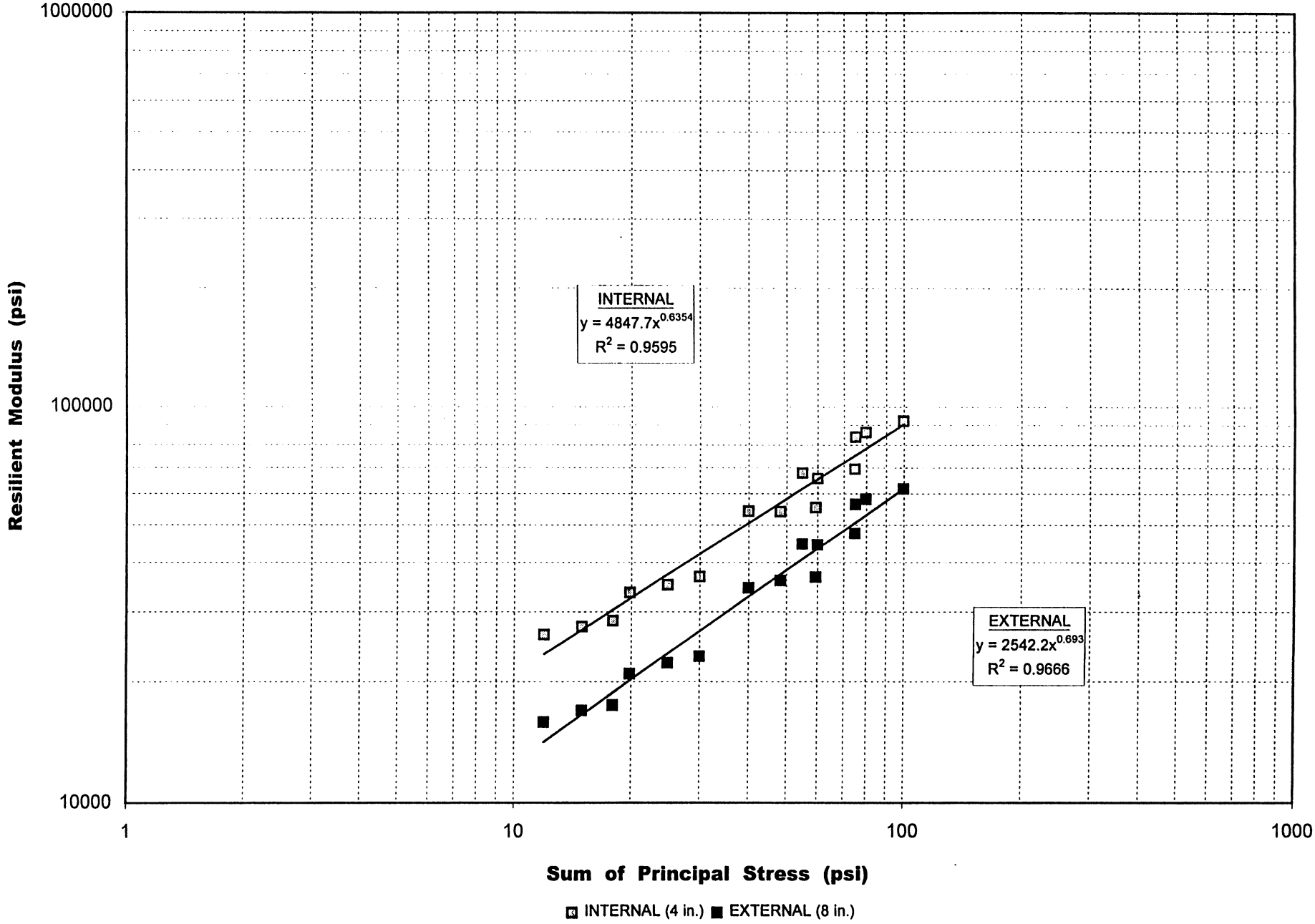
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.94	0.00131858	0.00016482	15857
2	3	5.31	0.63	5.94	0.00250270	0.00031284	16967
3	3	8.06	0.87	8.93	0.00368296	0.00046037	17506
4	5	4.39	0.47	4.86	0.00167709	0.00020964	20925
5	5	8.77	1.04	9.81	0.00315165	0.00039396	22267
6	5	13.43	1.51	14.94	0.00464086	0.00058011	23146
7	10	8.96	1.03	10.00	0.00208473	0.00026059	34396
8	10	16.18	1.99	18.17	0.00360453	0.00045057	35907
9	10	26.35	3.01	29.37	0.00575519	0.00071940	36633
10	15	8.90	1.03	9.94	0.00159824	0.00019978	44557
11	15	13.49	1.51	15.01	0.00243117	0.00030390	44398
12	15	26.65	3.02	29.67	0.00448789	0.00056099	47502
13	20	13.53	1.51	15.04	0.00191882	0.00023985	56394
14	20	17.74	1.99	19.73	0.00244324	0.00030540	58073
15	20	35.79	3.98	39.77	0.00463871	0.00057984	61720

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.94	0.00039772	0.00009943	26286
2	3	5.31	0.63	5.94	0.00077216	0.00019304	27497
3	3	8.06	0.87	8.93	0.00113153	0.00028288	28490
4	5	4.39	0.47	4.86	0.00052397	0.00013099	33487
5	5	8.77	1.04	9.81	0.00100269	0.00025067	34995
6	5	13.43	1.51	14.94	0.00146160	0.00036540	36747
7	10	8.96	1.03	10.00	0.00066229	0.00016557	54136
8	10	16.18	1.99	18.17	0.00119832	0.00029958	54004
9	10	26.35	3.01	29.37	0.00190499	0.00047625	55337
10	15	8.90	1.03	9.94	0.00052569	0.00013142	67733
11	15	13.49	1.51	15.01	0.00082301	0.00020575	65576
12	15	26.65	3.02	29.67	0.00153442	0.00038360	69467
13	20	13.53	1.51	15.04	0.00064462	0.00016116	83932
14	20	17.74	1.99	19.73	0.00082301	0.00020575	86199
15	20	35.79	3.98	39.77	0.00155510	0.00038878	92052

SHRP (P46) - **TYPE I**
Pit # 26-001 Untreated
1 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 30, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Untreated. 28 Day Cure

LAB # : 14078-S

SAMPLE # : 1 of 2

LBR : 120.0

SOIL CLASS :

FINAL % (w) : 13.2

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 119.4
ACTUAL MOISTURE / DENSITY:
12.0 @ 116.0

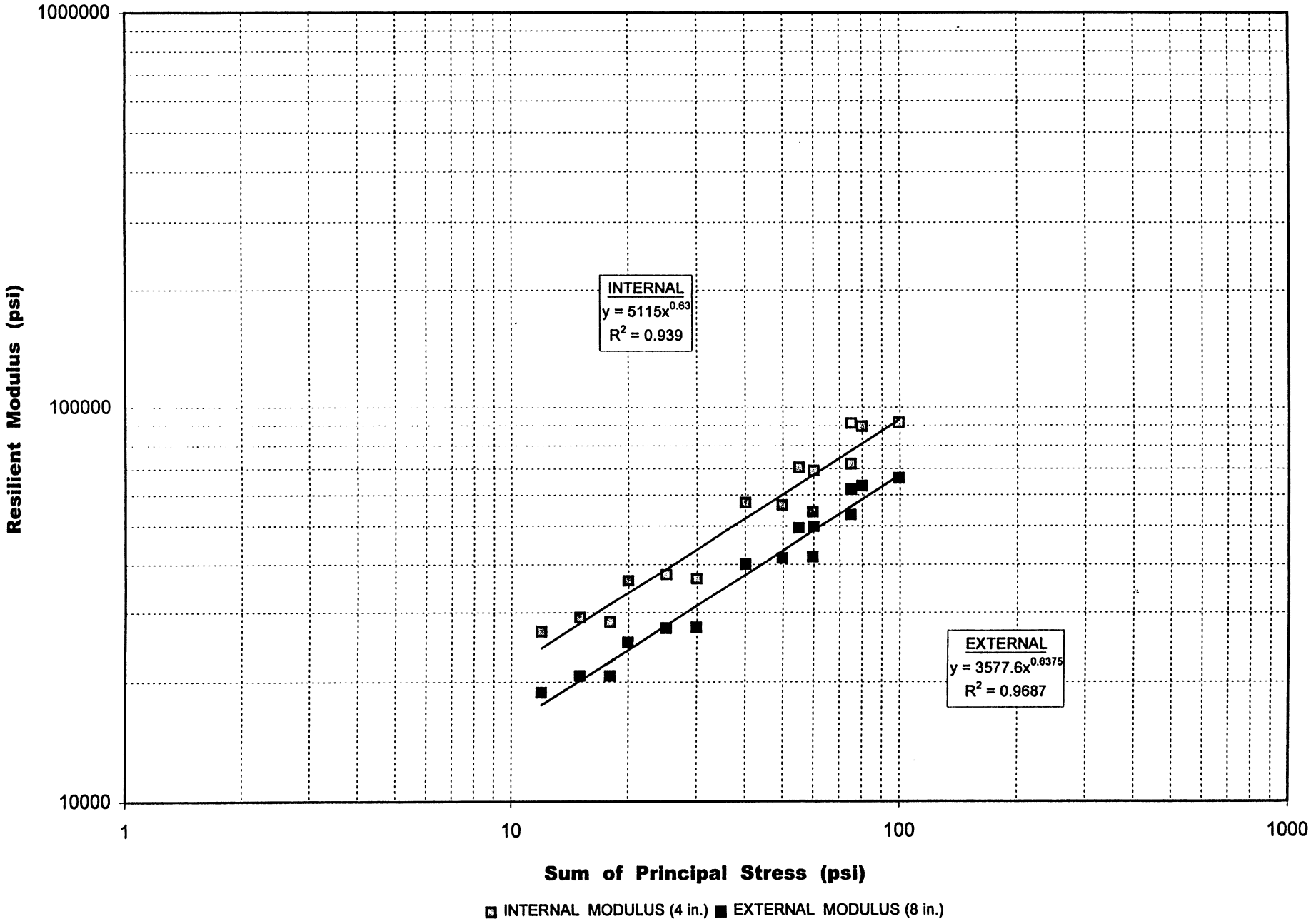
EXTERNAL LVDT's (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.98	0.00113199	0.00014150	18774
2	3	5.39	0.63	6.02	0.00208214	0.00026027	20717
3	3	8.09	0.87	8.96	0.00312235	0.00039029	20733
4	5	4.50	0.48	4.97	0.00142673	0.00017834	25220
5	5	8.98	1.03	10.01	0.00262250	0.00032781	27396
6	5	13.40	1.52	14.92	0.00389841	0.00048730	27507
7	10	8.97	1.04	10.01	0.00179214	0.00022402	40027
8	10	17.86	1.99	19.86	0.00344596	0.00043074	41475
9	10	26.69	3.02	29.71	0.00511098	0.00063887	41784
10	15	9.04	1.04	10.08	0.00146508	0.00018314	49367
11	15	13.58	1.52	15.09	0.00218039	0.00027255	49822
12	15	26.83	3.02	29.85	0.00401734	0.00050217	53423
13	20	13.40	1.51	14.91	0.00172923	0.00021615	61982
14	20	17.91	1.99	19.90	0.00226527	0.00028316	63254
15	20	35.52	3.98	39.50	0.00429269	0.00053659	66204

INTERNAL LVDT's (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.66	0.32	2.98	0.00039513	0.00009878	26892
2	3	5.39	0.63	6.02	0.00074028	0.00018507	29135
3	3	8.09	0.87	8.96	0.00113972	0.00028493	28400
4	5	4.50	0.48	4.97	0.00049596	0.00012399	36275
5	5	8.98	1.03	10.01	0.00095314	0.00023829	37689
6	5	13.40	1.52	14.92	0.00146031	0.00036508	36716
7	10	8.97	1.04	10.01	0.00062566	0.00015641	57326
8	10	17.86	1.99	19.86	0.00126424	0.00031606	56524
9	10	26.69	3.02	29.71	0.00196661	0.00049165	54296
10	15	9.04	1.04	10.08	0.00051363	0.00012841	70407
11	15	13.58	1.52	15.09	0.00078639	0.00019660	69070
12	15	26.83	3.02	29.85	0.00149133	0.00037283	71956
13	20	13.40	1.51	14.91	0.00058947	0.00014737	90914
14	20	17.91	1.99	19.90	0.00080190	0.00020047	89344
15	20	35.52	3.98	39.50	0.00155467	0.00038867	91399

SHRP (P46) - **TYPE I**
Pit # 26-001 Untreated
28 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 30, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Untreated. 28 Day Cure

LAB # : 14078-S

SAMPLE # : 2 of 2

LBR : 120.0

SOIL CLASS :

FINAL % (w) : 13.1

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 119.4
ACTUAL MOISTURE / DENSITY:
12.0 @ 116.0

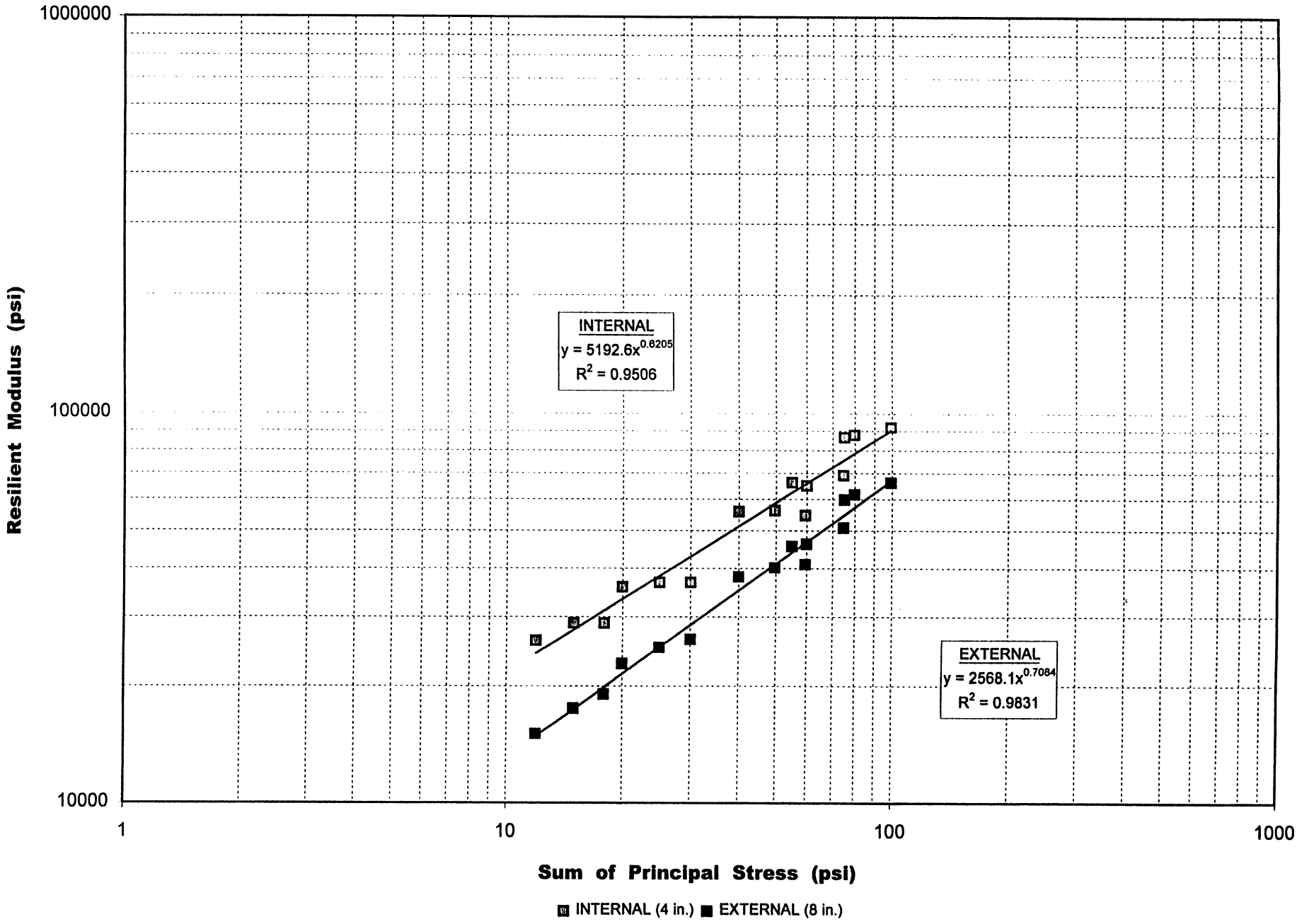
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00137847	0.00017231	15073
2	3	5.28	0.64	5.92	0.00240963	0.00030120	17543
3	3	8.03	0.88	8.90	0.00336969	0.00042121	19063
4	5	4.49	0.48	4.97	0.00157798	0.00019725	22740
5	5	8.87	1.04	9.91	0.00283881	0.00035485	24988
6	5	13.52	1.51	15.03	0.00412334	0.00051542	26233
7	10	8.93	1.04	9.97	0.00188392	0.00023549	37937
8	10	17.65	1.99	19.64	0.00351964	0.00043996	40116
9	10	26.45	3.02	29.47	0.00516872	0.00064609	40940
10	15	8.95	1.03	9.98	0.00157281	0.00019660	45529
11	15	13.45	1.51	14.96	0.00232905	0.00029113	46189
12	15	26.66	3.02	29.68	0.00420220	0.00052527	50752
13	20	13.57	1.51	15.09	0.00181670	0.00022709	59778
14	20	17.73	1.99	19.72	0.00230276	0.00028785	61581
15	20	35.33	3.99	39.32	0.00427675	0.00053459	66093

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00039858	0.00009964	26064
2	3	5.28	0.64	5.92	0.00073166	0.00018292	28888
3	3	8.03	0.88	8.90	0.00111258	0.00027814	28868
4	5	4.49	0.48	4.97	0.00050200	0.00012550	35740
5	5	8.87	1.04	9.91	0.00096693	0.00024173	36681
6	5	13.52	1.51	15.03	0.00147453	0.00036863	36679
7	10	8.93	1.04	9.97	0.00064031	0.00016008	55809
8	10	17.65	1.99	19.64	0.00125649	0.00031412	56186
9	10	26.45	3.02	29.47	0.00193860	0.00048465	54578
10	15	8.95	1.03	9.98	0.00054121	0.00013530	66156
11	15	13.45	1.51	14.96	0.00082818	0.00020705	64948
12	15	26.66	3.02	29.68	0.00154390	0.00038597	69069
13	20	13.57	1.51	15.09	0.00062738	0.00015685	86548
14	20	17.73	1.99	19.72	0.00080750	0.00020187	87806
15	20	35.33	3.99	39.32	0.00153744	0.00038436	91927

SHRP (P46) - **TYPE I**
Pit # 26-001 Untreated
28 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 3, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Treated w / 1% Lime. 1 Day Cure

LAB # : 14078-S

SAMPLE # : 1 of 2

LBR : 160.0

SOIL CLASS :

FINAL % (w) : 11.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 118.1
ACTUAL MOISTURE / DENSITY:
11.9 @ 115.6

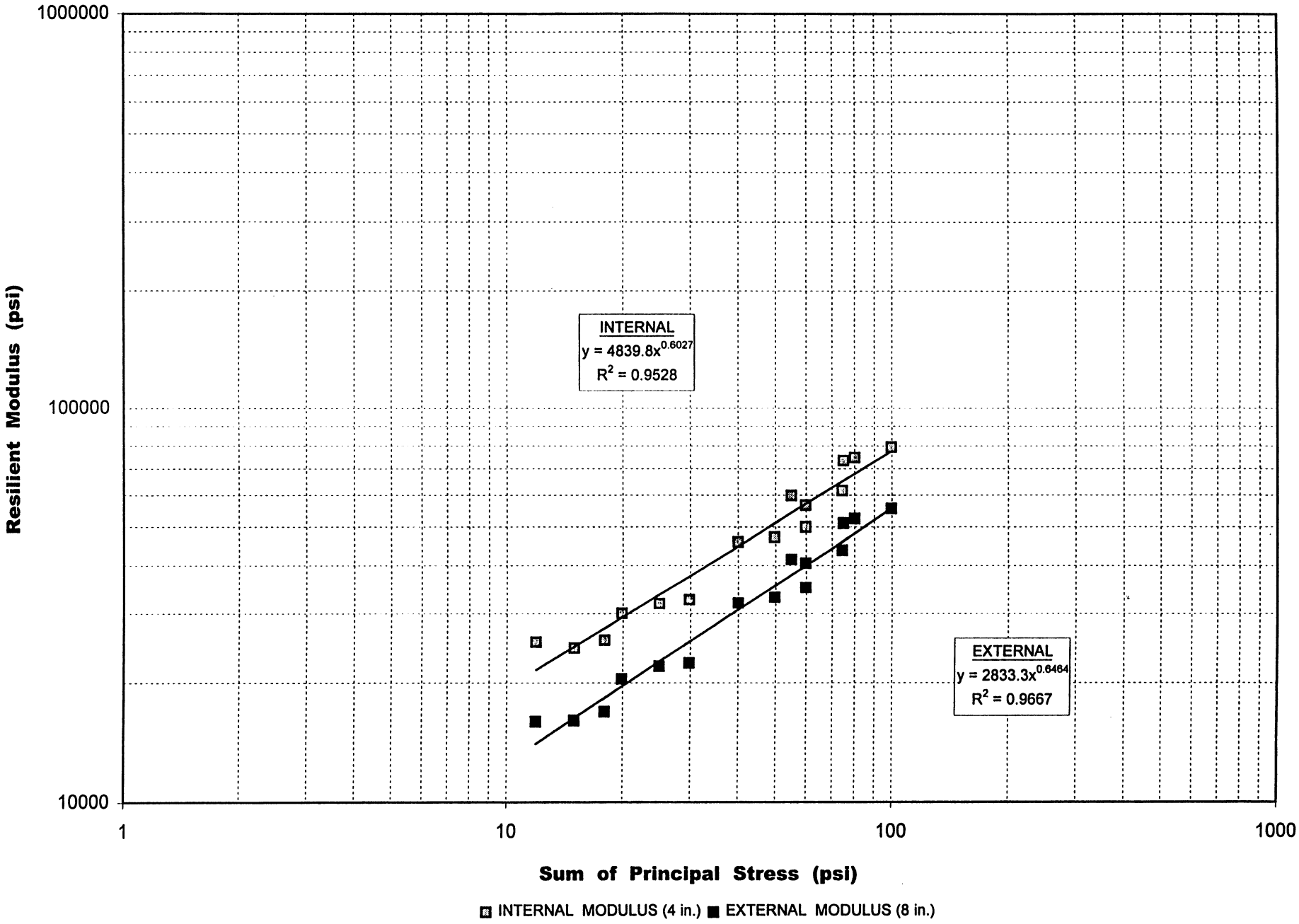
EXTERNAL LVDT's (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.58	0.32	2.91	0.00129617	0.00016202	15949
2	3	5.34	0.63	5.97	0.00265869	0.00033234	16064
3	3	8.06	0.87	8.93	0.00381697	0.00047712	16886
4	5	4.41	0.48	4.89	0.00172492	0.00021561	20451
5	5	8.89	1.04	9.93	0.00323180	0.00040397	21998
6	5	13.28	1.52	14.80	0.00473480	0.00059185	22438
7	10	8.92	1.04	9.96	0.00223641	0.00027955	31901
8	10	17.69	2.00	19.68	0.00428278	0.00053535	33039
9	10	26.86	3.02	29.88	0.00614042	0.00076755	34997
10	15	8.92	1.03	9.96	0.00172276	0.00021535	41440
11	15	13.37	1.52	14.89	0.00263930	0.00032991	40537
12	15	26.42	3.01	29.44	0.00483778	0.00060472	43697
13	20	13.39	1.51	14.90	0.00210153	0.00026269	50955
14	20	18.04	1.99	20.03	0.00275737	0.00034467	52336
15	20	35.80	3.98	39.79	0.00517131	0.00064641	55389

INTERNAL LVDT's (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.58	0.32	2.91	0.00040720	0.00010180	25383
2	3	5.34	0.63	5.97	0.00087127	0.00021782	24509
3	3	8.06	0.87	8.93	0.00125606	0.00031401	25657
4	5	4.41	0.48	4.89	0.00058688	0.00014672	30055
5	5	8.89	1.04	9.93	0.00111602	0.00027900	31852
6	5	13.28	1.52	14.80	0.00163008	0.00040752	32587
7	10	8.92	1.04	9.96	0.00077863	0.00019466	45814
8	10	17.69	2.00	19.68	0.00150167	0.00037542	47113
9	10	26.86	3.02	29.88	0.00215448	0.00053862	49872
10	15	8.92	1.03	9.96	0.00059679	0.00014920	59812
11	15	13.37	1.52	14.89	0.00094668	0.00023667	56508
12	15	26.42	3.01	29.44	0.00171884	0.00042971	61494
13	20	13.39	1.51	14.90	0.00072951	0.00018238	73394
14	20	18.04	1.99	20.03	0.00096736	0.00024184	74589
15	20	35.80	3.98	39.79	0.00180287	0.00045072	79438

SHRP (P46) - **TYPE I**
Pit # 26-001 Treated
1 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 3, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Treated w / 1% Lime. 1 Day Cure

LAB # : 14078-S

SAMPLE # : 2 of 2

LBR : 160.0

SOIL CLASS :

FINAL % (w) : 11.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

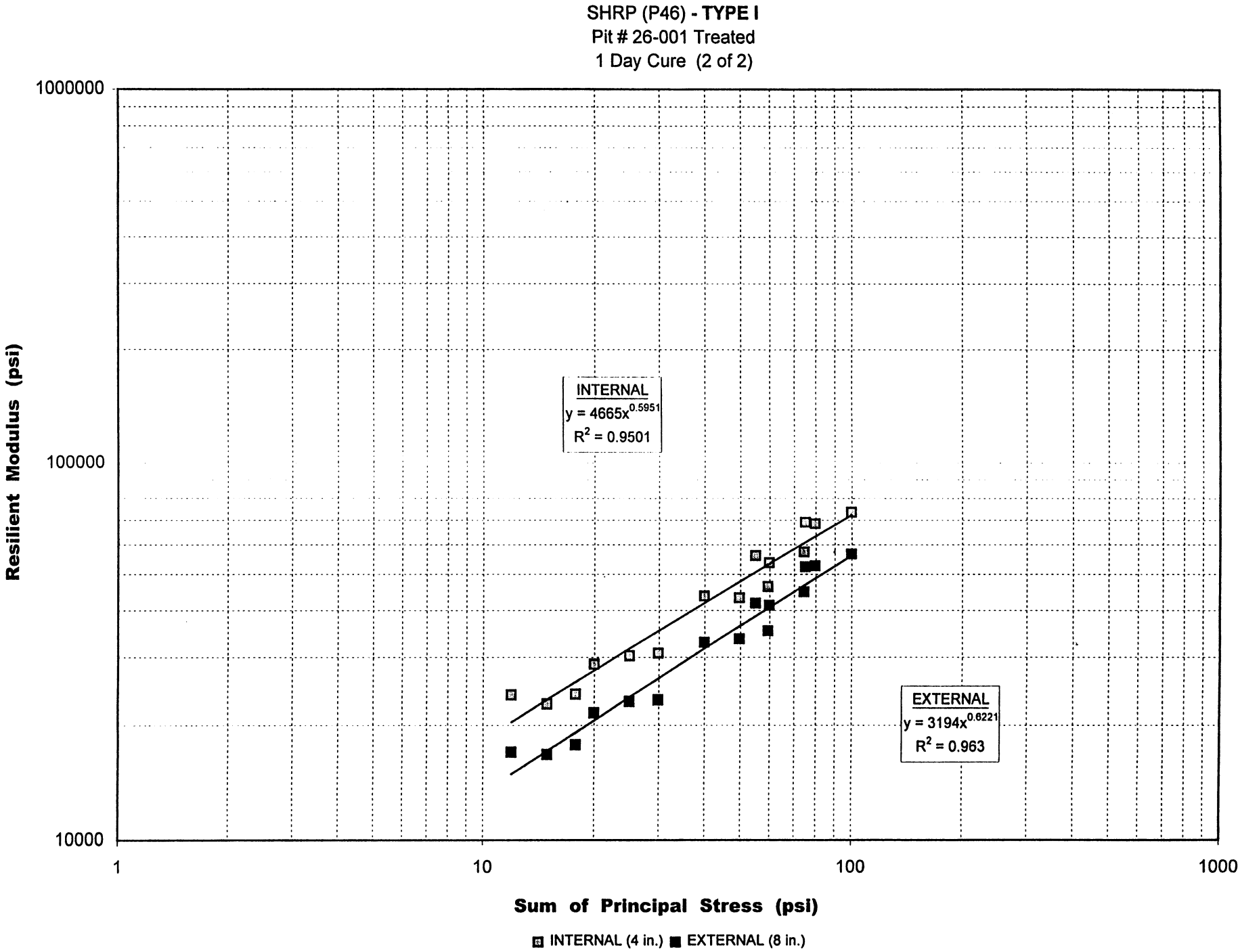
INSITU or TARGET MOIST. / DENSITY:
11.9 @ 118.1
ACTUAL MOISTURE / DENSITY:
11.7 @ 115.8

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00121860	0.00015233	17067
2	3	5.30	0.63	5.93	0.00252382	0.00031548	16804
3	3	7.95	0.87	8.83	0.00357222	0.00044653	17814
4	5	4.50	0.48	4.98	0.00167148	0.00020894	21551
5	5	8.92	1.03	9.95	0.00309693	0.00038712	23048
6	5	13.36	1.51	14.87	0.00459906	0.00057488	23243
7	10	8.85	1.03	9.89	0.00215712	0.00026964	32833
8	10	17.66	1.99	19.66	0.00421125	0.00052641	33551
9	10	26.32	3.04	29.36	0.00597236	0.00074655	35259
10	15	8.86	1.04	9.90	0.00169648	0.00021206	41783
11	15	13.31	1.52	14.83	0.00258027	0.00032253	41263
12	15	26.38	3.02	29.40	0.00470981	0.00058873	44808
13	20	13.54	1.52	15.06	0.00207223	0.00025903	52276
14	20	17.70	1.99	19.69	0.00269446	0.00033681	52556
15	20	35.91	3.96	39.87	0.00507953	0.00063494	56550

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00043391	0.00010848	23965
2	3	5.30	0.63	5.93	0.00093375	0.00023344	22710
3	3	7.95	0.87	8.83	0.00132371	0.00033093	24037
4	5	4.50	0.48	4.98	0.00062566	0.00015642	28787
5	5	8.92	1.03	9.95	0.00118022	0.00029506	30239
6	5	13.36	1.51	14.87	0.00173824	0.00043456	30749
7	10	8.85	1.03	9.89	0.00081094	0.00020274	43668
8	10	17.66	1.99	19.66	0.00163353	0.00040838	43248
9	10	26.32	3.04	29.36	0.00227341	0.00056835	46314
10	15	8.86	1.04	9.90	0.00063299	0.00015825	55991
11	15	13.31	1.52	14.83	0.00099321	0.00024830	53599
12	15	26.38	3.02	29.40	0.00184165	0.00046041	57295
13	20	13.54	1.52	15.06	0.00078466	0.00019617	69028
14	20	17.70	1.99	19.69	0.00103501	0.00025875	68409
15	20	35.91	3.96	39.87	0.00195454	0.00048864	73482


SHRP (P46) - TYPE I
Pit # 26-001 Treated
1 Day Cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL
y = 4665x^0.5951
R^2 = 0.9501
EXTERNAL
y = 3194x^0.6221
R^2 = 0.963
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 30, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Treated w / 1% Lime. 28 Day Cure

LAB # : 14078-S

SAMPLE # : 1 of 2

LBR : 160.0

SOIL CLASS :

FINAL % (w) : 12.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 118.1
ACTUAL MOISTURE / DENSITY:
11.8 @ 115.5

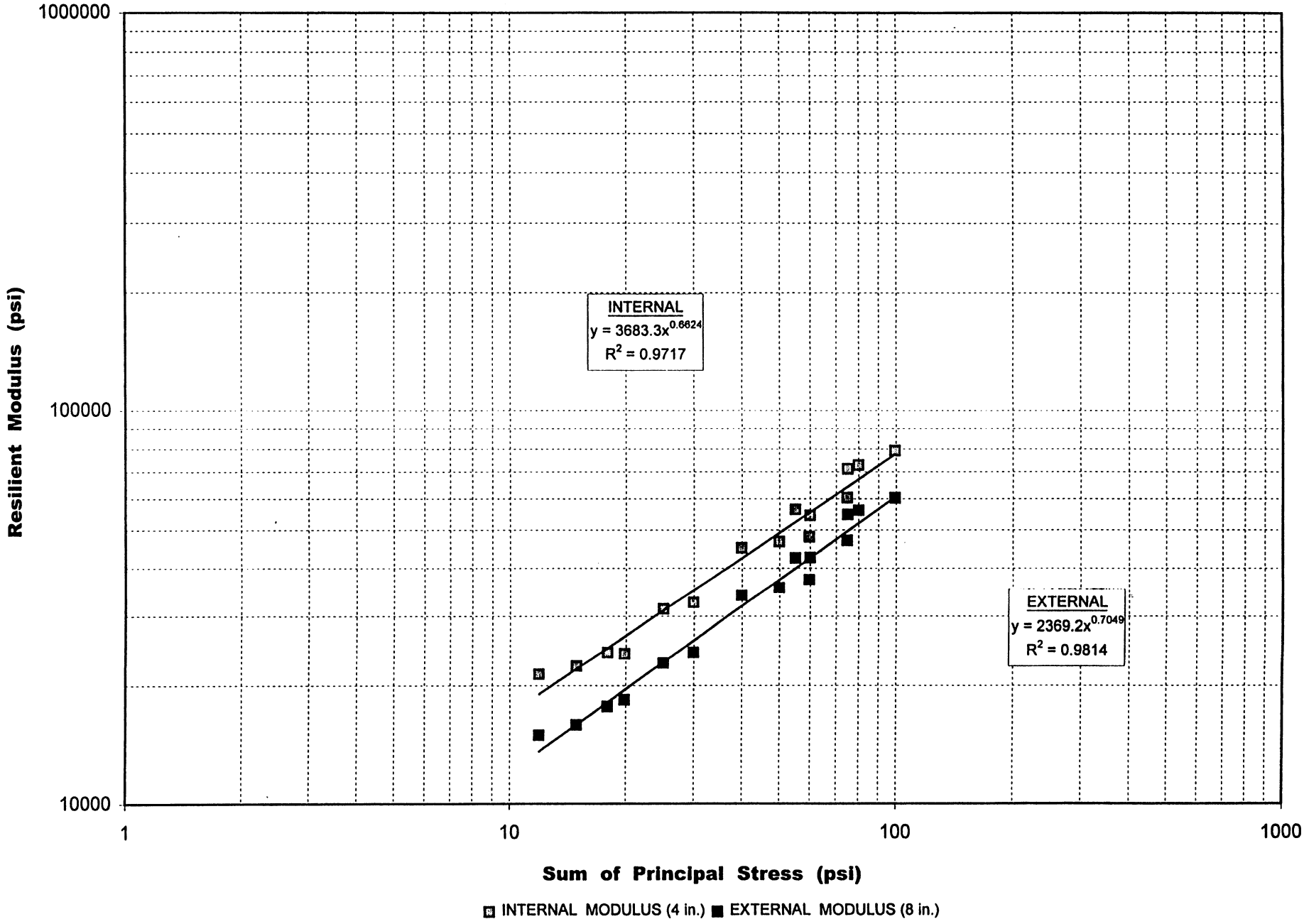
EXTERNAL LVDT's (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00138665	0.00017333	14936
2	3	5.26	0.63	5.89	0.00265008	0.00033126	15875
3	3	8.06	0.87	8.93	0.00364331	0.00045541	17687
4	5	4.36	0.48	4.84	0.00189728	0.00023716	18396
5	5	8.98	1.04	10.02	0.00315122	0.00039390	22801
6	5	13.38	1.51	14.89	0.00441421	0.00055178	24241
7	10	8.88	1.03	9.91	0.00209550	0.00026194	33902
8	10	17.91	1.99	19.90	0.00402768	0.00050346	35568
9	10	26.67	3.02	29.69	0.00571813	0.00071477	37316
10	15	8.97	1.04	10.01	0.00169088	0.00021136	42431
11	15	13.51	1.52	15.03	0.00253933	0.00031742	42564
12	15	26.69	3.02	29.72	0.00454305	0.00056788	47008
13	20	13.54	1.52	15.06	0.00198088	0.00024761	54700
14	20	17.97	2.00	19.97	0.00256648	0.00032081	56011
15	20	35.54	3.98	39.52	0.00471756	0.00058970	60275

INTERNAL LVDT's (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00048519	0.00012130	21344
2	3	5.26	0.63	5.89	0.00093935	0.00023484	22393
3	3	8.06	0.87	8.93	0.00132845	0.00033211	24254
4	5	4.36	0.48	4.84	0.00072476	0.00018119	24078
5	5	8.98	1.04	10.02	0.00114791	0.00028698	31297
6	5	13.38	1.51	14.89	0.00164344	0.00041086	32555
7	10	8.88	1.03	9.91	0.00078940	0.00019735	44997
8	10	17.91	1.99	19.90	0.00153442	0.00038360	46681
9	10	26.67	3.02	29.69	0.00222127	0.00055532	48030
10	15	8.97	1.04	10.01	0.00063643	0.00015911	56366
11	15	13.51	1.52	15.03	0.00099322	0.00024830	54411
12	15	26.69	3.02	29.72	0.00177055	0.00044264	60309
13	20	13.54	1.52	15.06	0.00076182	0.00019046	71115
14	20	17.97	2.00	19.97	0.00098847	0.00024712	72713
15	20	35.54	3.98	39.52	0.00179727	0.00044932	79106

SHRP (P46) - **TYPE I**
Pit # 26-001 Treated
28 Day Cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : December 30, 1998

PROJECT NO. : 1910661B101

MATERIAL DESCRIPTION : PIT NO. 26-001 (Light Yellow Limerock)

COMMENTS : Treated w / 1% Lime. 28 Day Cure

LAB # : 14078-S

SAMPLE # : 2 of 2

LBR : 160.0

SOIL CLASS :

FINAL % (w) : 12.5

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.9 @ 118.1
ACTUAL MOISTURE / DENSITY:
11.8 @ 115.5

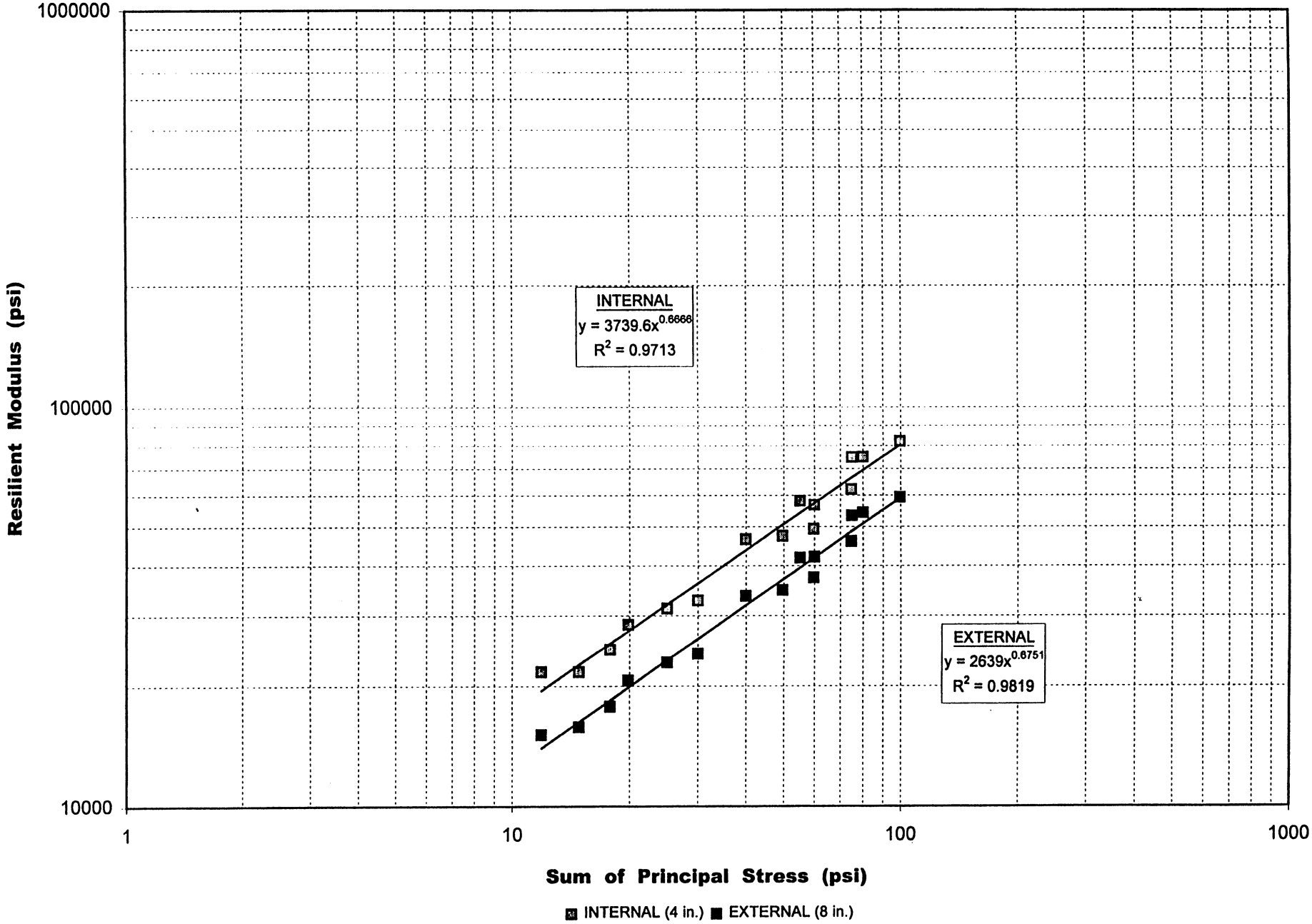
2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.57	0.32	2.89	0.00135779	0.00016972	15152
2	3	5.23	0.63	5.86	0.00263629	0.00032954	15863
3	3	7.97	0.87	8.84	0.00357437	0.00044680	17833
4	5	4.37	0.49	4.86	0.00169303	0.00021163	20638
5	5	8.97	1.04	10.01	0.00313657	0.00039207	22880
6	5	13.46	1.52	14.97	0.00447453	0.00055932	24057
7	10	8.87	1.04	9.91	0.00211489	0.00026436	33560
8	10	17.65	1.99	19.64	0.00406646	0.00050831	34713
9	10	26.70	3.03	29.73	0.00572416	0.00071552	37321
10	15	9.01	1.04	10.05	0.00172319	0.00021540	41831
11	15	13.48	1.52	15.00	0.00256476	0.00032059	42047
12	15	26.70	3.03	29.73	0.00464991	0.00058124	45943
13	20	13.47	1.52	14.99	0.00202440	0.00025305	53244
14	20	17.97	2.00	19.97	0.00265352	0.00033169	54188
15	20	35.67	3.98	39.65	0.00481667	0.00060208	59247

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.57	0.32	2.89	0.00047441	0.00011860	21683
2	3	5.23	0.63	5.86	0.00096391	0.00024098	21692
3	3	7.97	0.87	8.84	0.00129441	0.00032360	24622
4	5	4.37	0.49	4.86	0.00061360	0.00015340	28472
5	5	8.97	1.04	10.01	0.00114834	0.00028708	31248
6	5	13.46	1.52	14.97	0.00164645	0.00041161	32689
7	10	8.87	1.04	9.91	0.00076398	0.00019099	46452
8	10	17.65	1.99	19.64	0.00148961	0.00037240	47382
9	10	26.70	3.03	29.73	0.00216654	0.00054164	49302
10	15	9.01	1.04	10.05	0.00062178	0.00015545	57965
11	15	13.48	1.52	15.00	0.00095142	0.00023785	56674
12	15	26.70	3.03	29.73	0.00172229	0.00043057	62020
13	20	13.47	1.52	14.99	0.00072132	0.00018033	74716
14	20	17.97	2.00	19.97	0.00096090	0.00024023	74820
15	20	35.67	3.98	39.65	0.00173910	0.00043477	82046

SHRP (P46) - **TYPE I**
Pit # 26-001 Treated
28 Day Cure (2 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : August 4, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14223-S

SAMPLE # : 1 of 2

LBR : 202.0

SOIL CLASS :

FINAL % (w) : 9.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

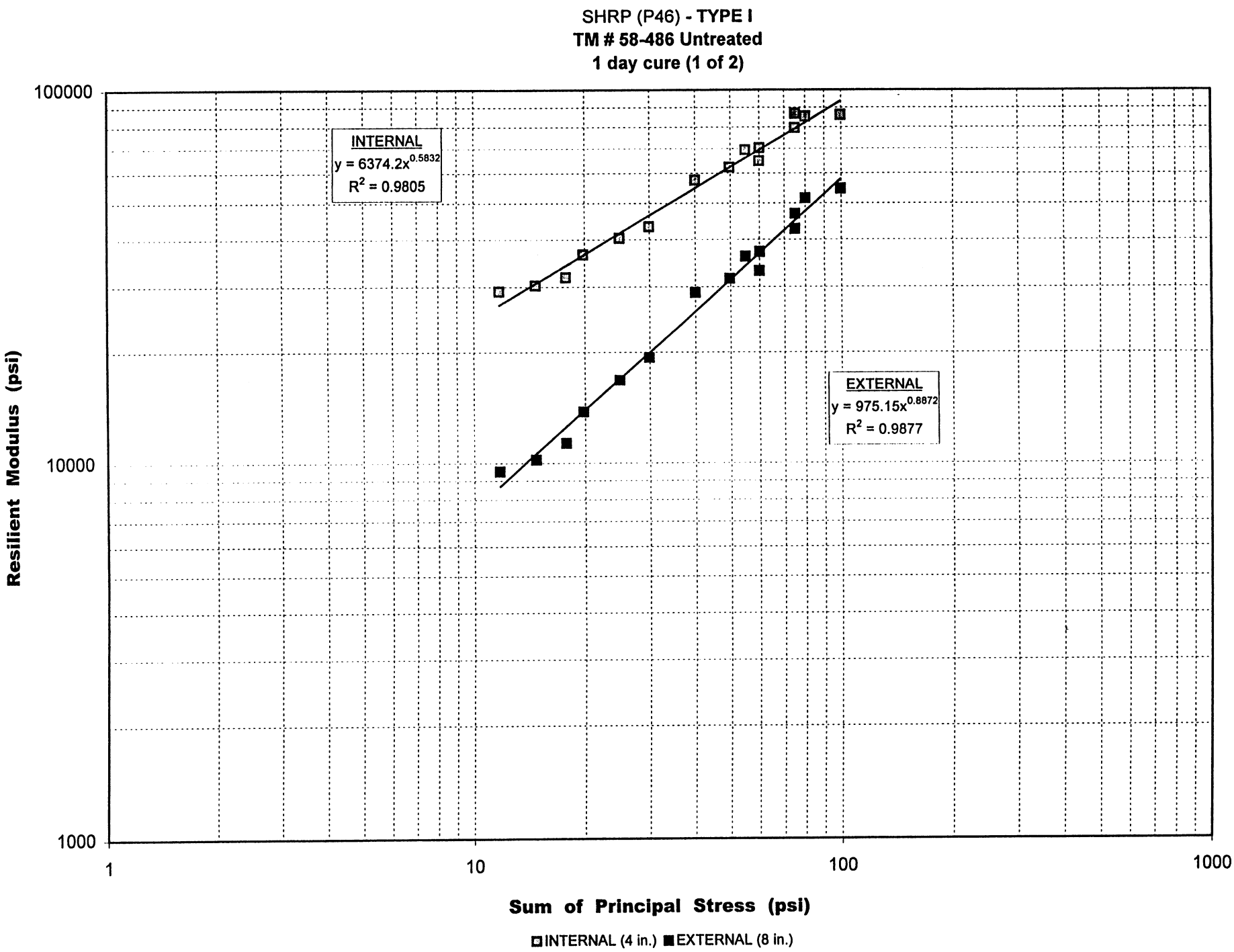
INSITU or TARGET MOIST. / DENSITY:
10.0 @ 123.0
ACTUAL MOISTURE / DENSITY:
11.5 @ 119.6

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.43	0.32	2.74	0.00204249	0.00025531	9499
2	3	5.09	0.63	5.72	0.00398631	0.00049829	10208
3	3	7.90	0.87	8.77	0.00559316	0.00069915	11295
4	5	4.34	0.48	4.82	0.00253028	0.00031629	13728
5	5	8.84	1.04	9.88	0.00422805	0.00052851	16735
6	5	13.42	1.51	14.94	0.00556214	0.00069527	19308
7	10	8.94	1.03	9.97	0.00247384	0.00030923	28922
8	10	17.70	1.99	19.69	0.00449134	0.00056142	31526
9	10	26.87	3.02	29.89	0.00650410	0.00081301	33048
10	15	8.91	1.03	9.94	0.00197485	0.00024686	36083
11	15	13.54	1.51	15.05	0.00292025	0.00036503	37089
12	15	26.90	3.02	29.92	0.00504979	0.00063122	42616
13	20	13.49	1.51	15.01	0.00230664	0.00028833	46789
14	20	18.03	1.99	20.02	0.00279874	0.00034984	51546
15	20	35.75	3.97	39.72	0.00523939	0.00065492	54582

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.43	0.32	2.74	0.00033265	0.00008316	29161
2	3	5.09	0.63	5.72	0.00067263	0.00016816	30249
3	3	7.90	0.87	8.77	0.00099365	0.00024841	31790
4	5	4.34	0.48	4.82	0.00047528	0.00011882	36544
5	5	8.84	1.04	9.88	0.00087731	0.00021933	40327
6	5	13.42	1.51	14.94	0.00124185	0.00031046	43239
7	10	8.94	1.03	9.97	0.00062222	0.00015555	57495
8	10	17.70	1.99	19.69	0.00113757	0.00028439	62236
9	10	26.87	3.02	29.89	0.00166154	0.00041538	64684
10	15	8.91	1.03	9.94	0.00051363	0.00012841	69368
11	15	13.54	1.51	15.05	0.00077131	0.00019283	70211
12	15	26.90	3.02	29.92	0.00135431	0.00033858	79450
13	20	13.49	1.51	15.01	0.00062265	0.00015566	86666
14	20	18.03	1.99	20.02	0.00084757	0.00021189	85104
15	20	35.75	3.97	39.72	0.00166326	0.00041582	85969


SHRP (P46) - TYPE I
TM # 58-486 Untreated
1 day cure (1 of 2)
INTERNAL
y = 6374.2x^0.5832
R2 = 0.9805
EXTERNAL
y = 975.15x^0.8872
R2 = 0.9877
Resilient Modulus (psi)
100000
10000
1000
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : August 4, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14223-S

SAMPLE # : 2 of 2

LBR : 202.0

SOIL CLASS :

FINAL % (w) : 10.0

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

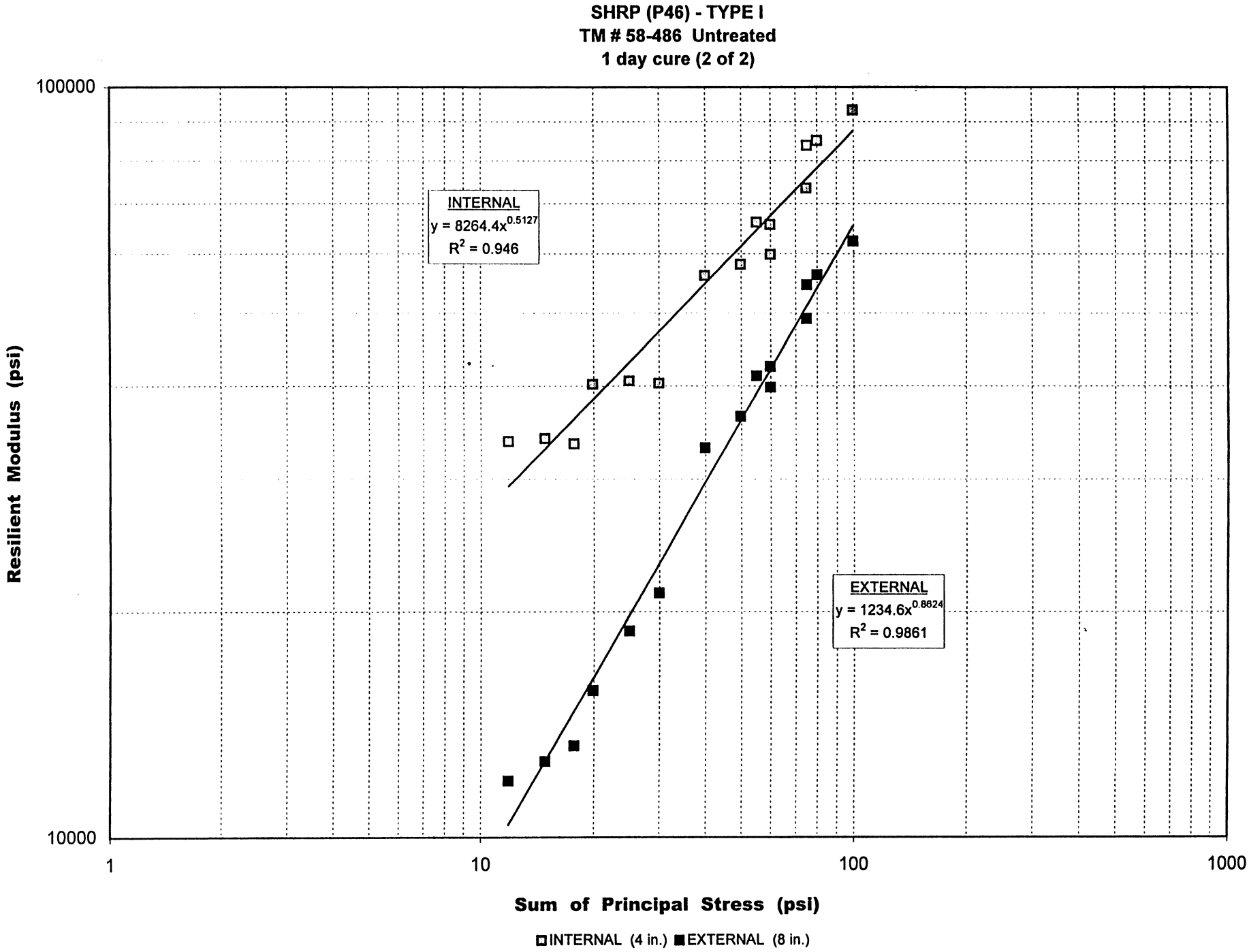
INSITU or TARGET MOIST. / DENSITY:
10.0 @ 123.0
ACTUAL MOISTURE / DENSITY:
13.1 @ 119.3

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.51	0.32	2.83	0.00169002	0.00021125	11893
2	3	5.22	0.63	5.86	0.00330893	0.00041362	12628
3	3	7.85	0.87	8.72	0.00474083	0.00059260	13243
4	5	4.41	0.48	4.89	0.00224718	0.00028090	15707
5	5	8.90	1.04	9.94	0.00377991	0.00047249	18838
6	5	13.46	1.51	14.97	0.00508125	0.00063516	21187
7	10	8.87	1.04	9.90	0.00214720	0.00026840	33040
8	10	17.78	1.99	19.77	0.00390919	0.00048865	36386
9	10	26.84	3.01	29.85	0.00539366	0.00067421	39811
10	15	8.93	1.04	9.97	0.00173224	0.00021653	41247
11	15	13.32	1.52	14.84	0.00250917	0.00031365	42469
12	15	26.87	3.02	29.89	0.00437457	0.00054682	49135
13	20	13.56	1.51	15.07	0.00198992	0.00024874	54518
14	20	18.01	1.99	20.01	0.00256303	0.00032038	56220
15	20	35.77	3.97	39.74	0.00458872	0.00057359	62361

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.51	0.32	2.83	0.00029818	0.00007454	33703
2	3	5.22	0.63	5.86	0.00061446	0.00015361	34002
3	3	7.85	0.87	8.72	0.00093806	0.00023452	33463
4	5	4.41	0.48	4.89	0.00043908	0.00010977	40194
5	5	8.90	1.04	9.94	0.00087644	0.00021911	40622
6	5	13.46	1.51	14.97	0.00133535	0.00033384	40310
7	10	8.87	1.04	9.90	0.00063212	0.00015803	56115
8	10	17.78	1.99	19.77	0.00122460	0.00030615	58076
9	10	26.84	3.01	29.85	0.00179339	0.00044835	59866
10	15	8.93	1.04	9.97	0.00054034	0.00013509	66115
11	15	13.32	1.52	14.84	0.00081181	0.00020295	65633
12	15	26.87	3.02	29.89	0.00146419	0.00036605	73400
13	20	13.56	1.51	15.07	0.00064764	0.00016191	83755
14	20	18.01	1.99	20.01	0.00084757	0.00021189	85003
15	20	35.77	3.97	39.74	0.00153571	0.00038393	93167


SHRP (P46) - TYPE I
TM # 58-486 Untreated
1 day cure (2 of 2)
100000
10000
1
10
100
1000
Resilient Modulus (psi)
Sum of Principal Stress (psi)
INTERNAL
y = 8264.4x^0.5127
R^2 = 0.946
EXTERNAL
y = 1234.6x^0.8624
R^2 = 0.9861
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : August 4, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14223-S

SAMPLE # : 1 of 2

LBR : 202.0

SOIL CLASS :

FINAL % (w) : 10.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
10.0 @ 123.0
ACTUAL MOISTURE / DENSITY:
12.1 @ 118.2

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00145689	0.00018211	14212
2	3	5.24	0.63	5.87	0.00288966	0.00036121	14515
3	3	7.92	0.87	8.80	0.00399881	0.00049985	15850
4	5	4.40	0.47	4.87	0.00185936	0.00023242	18934
5	5	8.92	1.03	9.96	0.00312666	0.00039083	22835
6	5	13.31	1.51	14.81	0.00415049	0.00051881	25646
7	10	9.03	1.03	10.06	0.00196321	0.00024540	36790
8	10	17.66	2.00	19.66	0.00348129	0.00043516	40590
9	10	26.81	3.02	29.84	0.00508728	0.00063591	42166
10	15	8.99	1.03	10.02	0.00160599	0.00020075	44773
11	15	13.54	1.51	15.06	0.00230147	0.00028768	47075
12	15	26.95	3.02	29.96	0.00397683	0.00049710	54206
13	20	13.58	1.52	15.10	0.00189469	0.00023684	57348
14	20	17.79	1.99	19.79	0.00238894	0.00029862	59588
15	20	35.62	3.97	39.60	0.00435129	0.00054391	65491

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.91	0.00021545	0.00005386	48051
2	3	5.24	0.63	5.87	0.00044080	0.00011020	47576
3	3	7.92	0.87	8.80	0.00063471	0.00015868	49929
4	5	4.40	0.47	4.87	0.00031197	0.00007799	56424
5	5	8.92	1.03	9.96	0.00056102	0.00014026	63631
6	5	13.31	1.51	14.81	0.00077604	0.00019401	68581
7	10	9.03	1.03	10.06	0.00040332	0.00010083	89542
8	10	17.66	2.00	19.66	0.00076613	0.00019153	92221
9	10	26.81	3.02	29.84	0.00115652	0.00028913	92738
10	15	8.99	1.03	10.02	0.00034342	0.00008586	104688
11	15	13.54	1.51	15.06	0.00051535	0.00012884	105114
12	15	26.95	3.02	29.96	0.00092513	0.00023128	116507
13	20	13.58	1.52	15.10	0.00042142	0.00010535	128919
14	20	17.79	1.99	19.79	0.00053819	0.00013455	132253
15	20	35.62	3.97	39.60	0.00103544	0.00025886	137608

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : August 4, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14223-S

SAMPLE # : 2 of 2

LBR : 202.0

SOIL CLASS :

FINAL % (w) : 10.9

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

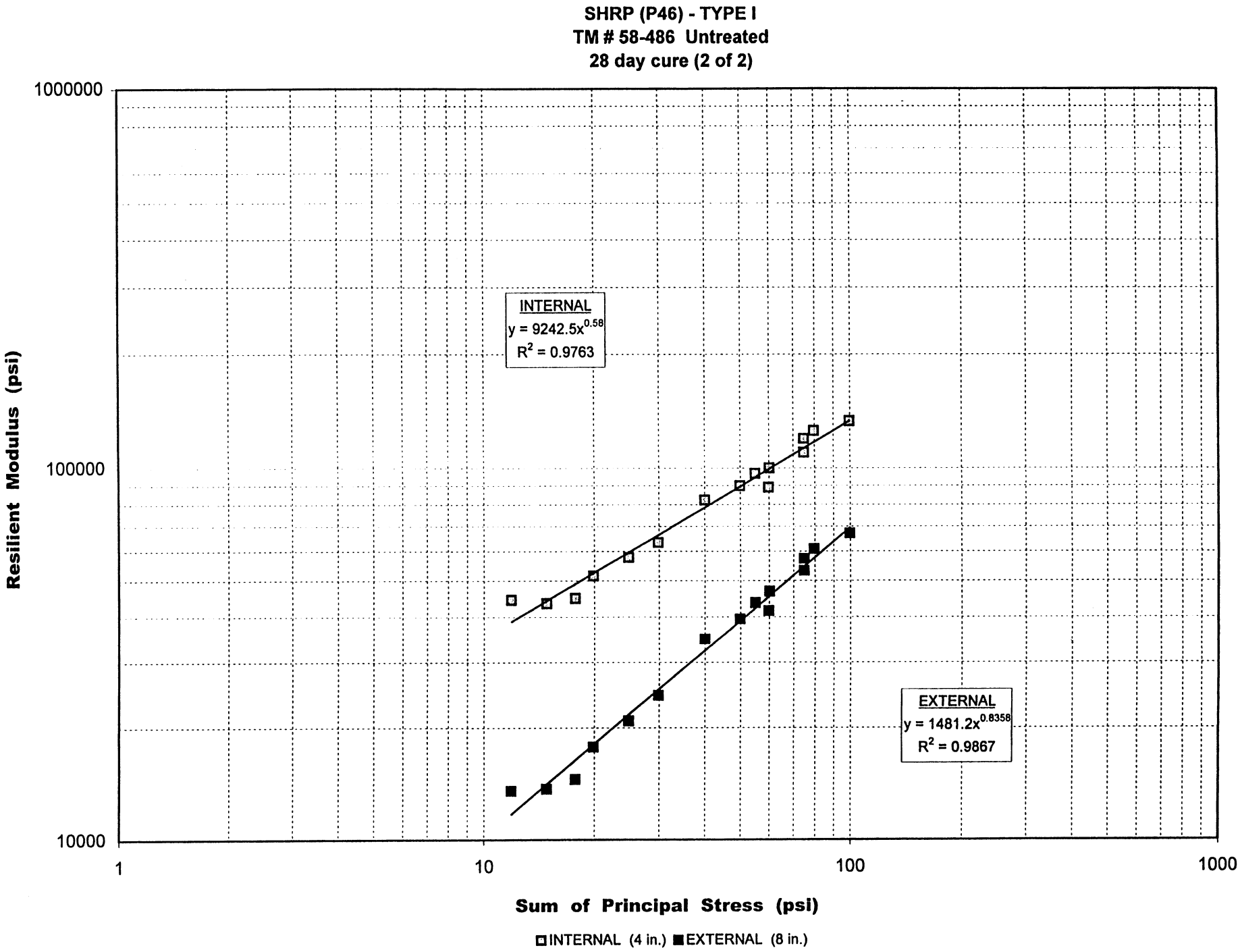
INSITU or TARGET MOIST. / DENSITY:
10.0 @ 123.0
ACTUAL MOISTURE / DENSITY:
11.5 @ 119.9

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.89	0.00151550	0.00018944	13536
2	3	5.22	0.63	5.85	0.00304737	0.00038092	13708
3	3	7.87	0.87	8.74	0.00433190	0.00054149	14532
4	5	4.42	0.48	4.89	0.00198820	0.00024852	17766
5	5	8.79	1.04	9.83	0.00337098	0.00042137	20859
6	5	13.35	1.52	14.87	0.00437586	0.00054698	24414
7	10	9.01	1.04	10.05	0.00207611	0.00025951	34726
8	10	17.91	1.99	19.90	0.00363297	0.00045412	39430
9	10	26.78	3.02	29.80	0.00516355	0.00064544	41487
10	15	8.93	1.04	9.96	0.00163788	0.00020473	43599
11	15	13.60	1.51	15.12	0.00232862	0.00029108	46735
12	15	26.80	3.02	29.82	0.00403975	0.00050497	53070
13	20	13.32	1.52	14.83	0.00186238	0.00023280	57201
14	20	17.69	1.99	19.68	0.00232905	0.00029113	60747
15	20	35.82	3.98	39.79	0.00428191	0.00053524	66917

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.89	0.00023096	0.00005774	44410
2	3	5.22	0.63	5.85	0.00048045	0.00012011	43473
3	3	7.87	0.87	8.74	0.00070193	0.00017548	44842
4	5	4.42	0.48	4.89	0.00034342	0.00008586	51428
5	5	8.79	1.04	9.83	0.00060929	0.00015232	57704
6	5	13.35	1.52	14.87	0.00084369	0.00021092	63312
7	10	9.01	1.04	10.05	0.00043865	0.00010966	82179
8	10	17.91	1.99	19.90	0.00079888	0.00019972	89657
9	10	26.78	3.02	29.80	0.00120478	0.00030120	88903
10	15	8.93	1.04	9.96	0.00036928	0.00009232	96690
11	15	13.60	1.51	15.12	0.00054422	0.00013605	99986
12	15	26.80	3.02	29.82	0.00097425	0.00024356	110027
13	20	13.32	1.52	14.83	0.00044511	0.00011128	119665
14	20	17.69	1.99	19.68	0.00056318	0.00014079	125611
15	20	35.82	3.98	39.79	0.00107638	0.00026909	133100


SHRP (P46) - TYPE I
TM # 58-486 Untreated
28 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9242.5x^0.58
R^2 = 0.9763
EXTERNAL
y = 1481.2x^0.8358
R^2 = 0.9867
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : July 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14223-S

SAMPLE # : 1 of 2

LBR : 235.0

SOIL CLASS :

FINAL % (w) : 11.2

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
11.0 @ 125.0
ACTUAL MOISTURE / DENSITY:
12.0 @ 120.2

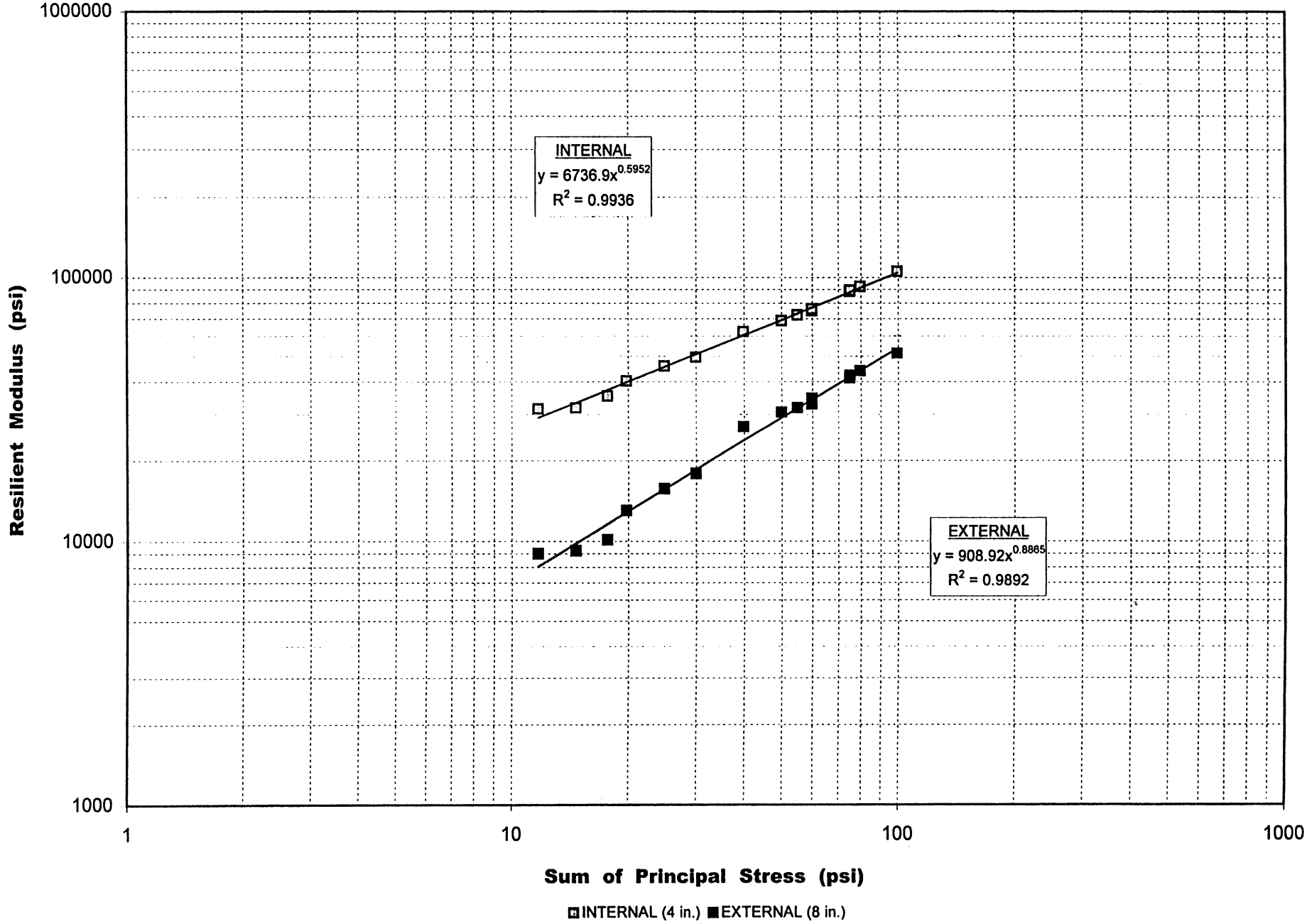
EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.39	0.32	2.71	0.00213040	0.00026630	8983
2	3	5.02	0.63	5.65	0.00435431	0.00054429	9224
3	3	7.79	0.87	8.67	0.00616498	0.00077062	10114
4	5	4.33	0.47	4.80	0.00266516	0.00033314	12999
5	5	8.73	1.04	9.77	0.00444566	0.00055571	15710
6	5	13.44	1.51	14.95	0.00600856	0.00075107	17896
7	10	8.80	1.03	9.83	0.00262034	0.00032754	26873
8	10	17.95	1.99	19.94	0.00470033	0.00058754	30555
9	10	26.82	3.01	29.82	0.00652608	0.00081576	32872
10	15	8.86	1.03	9.89	0.00222692	0.00027837	31842
11	15	13.35	1.51	14.86	0.00308658	0.00038582	34591
12	15	26.84	3.01	29.85	0.00519802	0.00064975	41305
13	20	13.47	1.51	14.98	0.00255355	0.00031919	42198
14	20	17.65	1.99	19.64	0.00321370	0.00040171	43929
15	20	35.30	3.96	39.27	0.00549793	0.00068724	51370

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.39	0.32	2.71	0.00030292	0.00007573	31588
2	3	5.02	0.63	5.65	0.00063126	0.00015781	31813
3	3	7.79	0.87	8.67	0.00088290	0.00022073	35311
4	5	4.33	0.47	4.80	0.00043003	0.00010751	40282
5	5	8.73	1.04	9.77	0.00076139	0.00019035	45865
6	5	13.44	1.51	14.95	0.00108370	0.00027093	49613
7	10	8.80	1.03	9.83	0.00056447	0.00014112	62373
8	10	17.95	1.99	19.94	0.00104492	0.00026123	68722
9	10	26.82	3.01	29.82	0.00143272	0.00035818	74867
10	15	8.86	1.03	9.89	0.00049122	0.00012281	72177
11	15	13.35	1.51	14.86	0.00070107	0.00017527	76145
12	15	26.84	3.01	29.85	0.00121383	0.00030346	88441
13	20	13.47	1.51	14.98	0.00060282	0.00015070	89376
14	20	17.65	1.99	19.64	0.00076441	0.00019110	92342
15	20	35.30	3.96	39.27	0.00133965	0.00033491	105411

SHRP (P46) - **TYPE I**
TM # 58-486 Treated
1 day cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : July 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14223-S

SAMPLE # : 2 of 2

LBR : 235.0

SOIL CLASS :

FINAL % (w) : 10.9

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

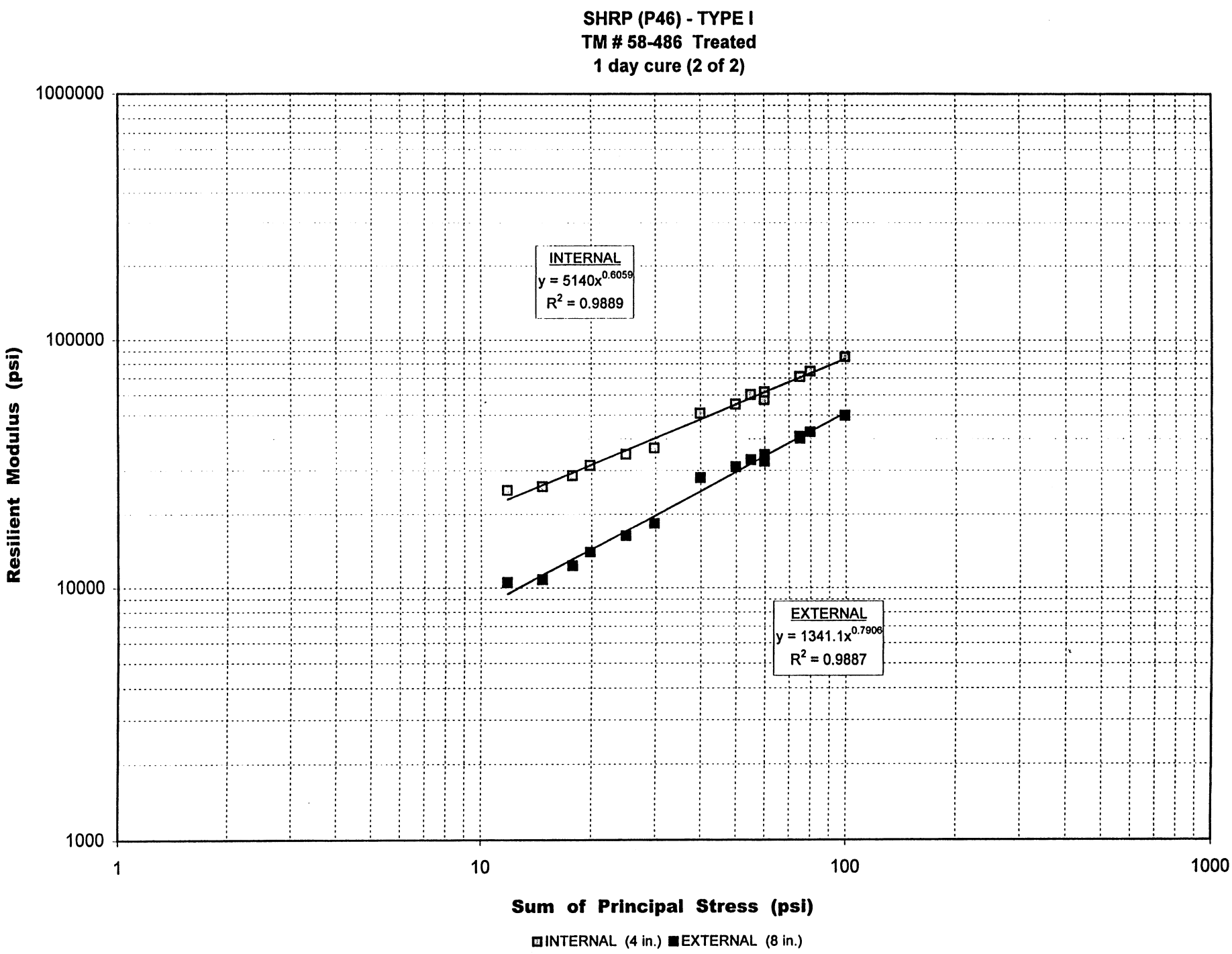
INSITU or TARGET MOIST. / DENSITY:
11.0 @ 125.0
ACTUAL MOISTURE / DENSITY:
12.4 @ 119.8

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.49	0.32	2.81	0.00190030	0.00023754	10490
2	3	5.09	0.63	5.73	0.00378336	0.00047292	10773
3	3	7.88	0.87	8.76	0.00514976	0.00064372	12247
4	5	4.36	0.48	4.84	0.00250271	0.00031284	13927
5	5	8.84	1.04	9.87	0.00434397	0.00054300	16280
6	5	13.26	1.51	14.77	0.00580172	0.00072522	18286
7	10	8.88	1.04	9.92	0.00253589	0.00031699	28007
8	10	17.89	2.00	19.89	0.00462621	0.00057828	30943
9	10	26.89	3.02	29.91	0.00661096	0.00082637	32537
10	15	8.92	1.04	9.96	0.00216099	0.00027012	33021
11	15	13.48	1.51	15.00	0.00312450	0.00039056	34523
12	15	26.75	3.03	29.78	0.00521828	0.00065228	41010
13	20	13.45	1.52	14.97	0.00268455	0.00033557	40092
14	20	18.00	1.99	19.99	0.00337443	0.00042180	42674
15	20	35.72	3.98	39.70	0.00574700	0.00071837	49726

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.49	0.32	2.81	0.00039858	0.00009964	25007
2	3	5.09	0.63	5.73	0.00078811	0.00019703	25858
3	3	7.88	0.87	8.76	0.00110266	0.00027567	28599
4	5	4.36	0.48	4.84	0.00055586	0.00013896	31353
5	5	8.84	1.04	9.87	0.00101649	0.00025412	34786
6	5	13.26	1.51	14.77	0.00144307	0.00036077	36758
7	10	8.88	1.04	9.92	0.00069978	0.00017494	50746
8	10	17.89	2.00	19.89	0.00129743	0.00032436	55167
9	10	26.89	3.02	29.91	0.00187440	0.00046860	57379
10	15	8.92	1.04	9.96	0.00059334	0.00014834	60132
11	15	13.48	1.51	15.00	0.00087558	0.00021890	61597
12	15	26.75	3.03	29.78	0.00150943	0.00037736	70888
13	20	13.45	1.52	14.97	0.00076096	0.00019024	70720
14	20	18.00	1.99	19.99	0.00096736	0.00024184	74429
15	20	35.72	3.98	39.70	0.00167705	0.00041926	85201


SHRP (P46) - TYPE I
TM # 58-486 Treated
1 day cure (2 of 2)
1000000
100000
10000
1000
Resilient Modulus (psi)
INTERNAL
y = 5140x^0.6059
R^2 = 0.9889
EXTERNAL
y = 1341.1x^0.7906
R^2 = 0.9887
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : July 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14223-S

SAMPLE # : 1 of 2

LBR : 235.0

SOIL CLASS :

FINAL % (w) : 11.5

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

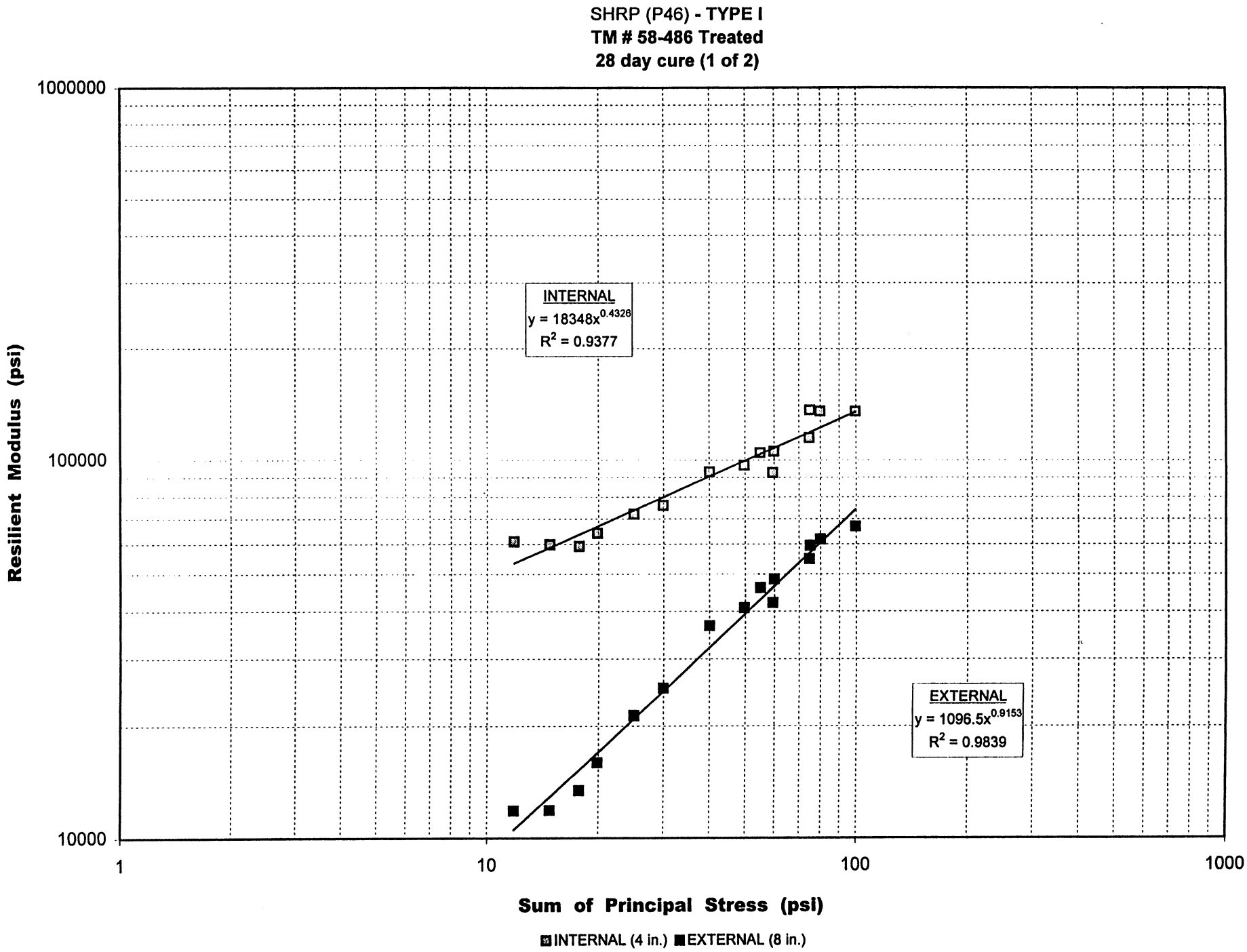
INSITU or TARGET MOIST. / DENSITY:
11.0 @ 125.0
ACTUAL MOISTURE / DENSITY:
12.9 @ 119.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.50	0.32	2.82	0.00168915	0.00021114	11840
2	3	5.12	0.63	5.76	0.00345156	0.00043145	11877
3	3	7.86	0.87	8.73	0.00468654	0.00058582	13413
4	5	4.38	0.48	4.86	0.00219934	0.00027492	15932
5	5	8.96	1.04	10.00	0.00337142	0.00042143	21269
6	5	13.45	1.51	14.96	0.00427890	0.00053486	25149
7	10	8.97	1.04	10.00	0.00195890	0.00024486	36619
8	10	17.76	1.99	19.75	0.00348259	0.00043532	40796
9	10	26.43	3.02	29.45	0.00502351	0.00062794	42088
10	15	9.03	1.03	10.06	0.00156850	0.00019606	46036
11	15	13.52	1.51	15.03	0.00222822	0.00027853	48525
12	15	26.65	3.02	29.67	0.00389151	0.00048644	54782
13	20	13.51	1.52	15.02	0.00181799	0.00022725	59434
14	20	18.00	1.99	19.99	0.00233379	0.00029172	61702
15	20	35.80	3.97	39.77	0.00428622	0.00053578	66820

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.50	0.32	2.82	0.00016418	0.00004104	60910
2	3	5.12	0.63	5.76	0.00034256	0.00008564	59836
3	3	7.86	0.87	8.73	0.00053044	0.00013261	59252
4	5	4.38	0.48	4.86	0.00027319	0.00006830	64130
5	5	8.96	1.04	10.00	0.00049812	0.00012453	71978
6	5	13.45	1.51	14.96	0.00070926	0.00017731	75861
7	10	8.97	1.04	10.00	0.00038609	0.00009652	92898
8	10	17.76	1.99	19.75	0.00073382	0.00018345	96806
9	10	26.43	3.02	29.45	0.00114231	0.00028558	92546
10	15	9.03	1.03	10.06	0.00034515	0.00008629	104604
11	15	13.52	1.51	15.03	0.00051234	0.00012808	105520
12	15	26.65	3.02	29.67	0.00092815	0.00023204	114843
13	20	13.51	1.52	15.02	0.00039729	0.00009932	135985
14	20	18.00	1.99	19.99	0.00053432	0.00013358	134752
15	20	35.80	3.97	39.77	0.00106345	0.00026586	134659


SHRP (P46) - TYPE I
TM # 58-486 Treated
28 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 18348x^0.4326
R^2 = 0.9377
EXTERNAL
y = 1096.5x^0.9153
R^2 = 0.9839
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : July 20, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Crushed Concrete TM# 58-486

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14223-S

SAMPLE # : 2 of 2

LBR : 235.0

SOIL CLASS :

FINAL % (w) : 11.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

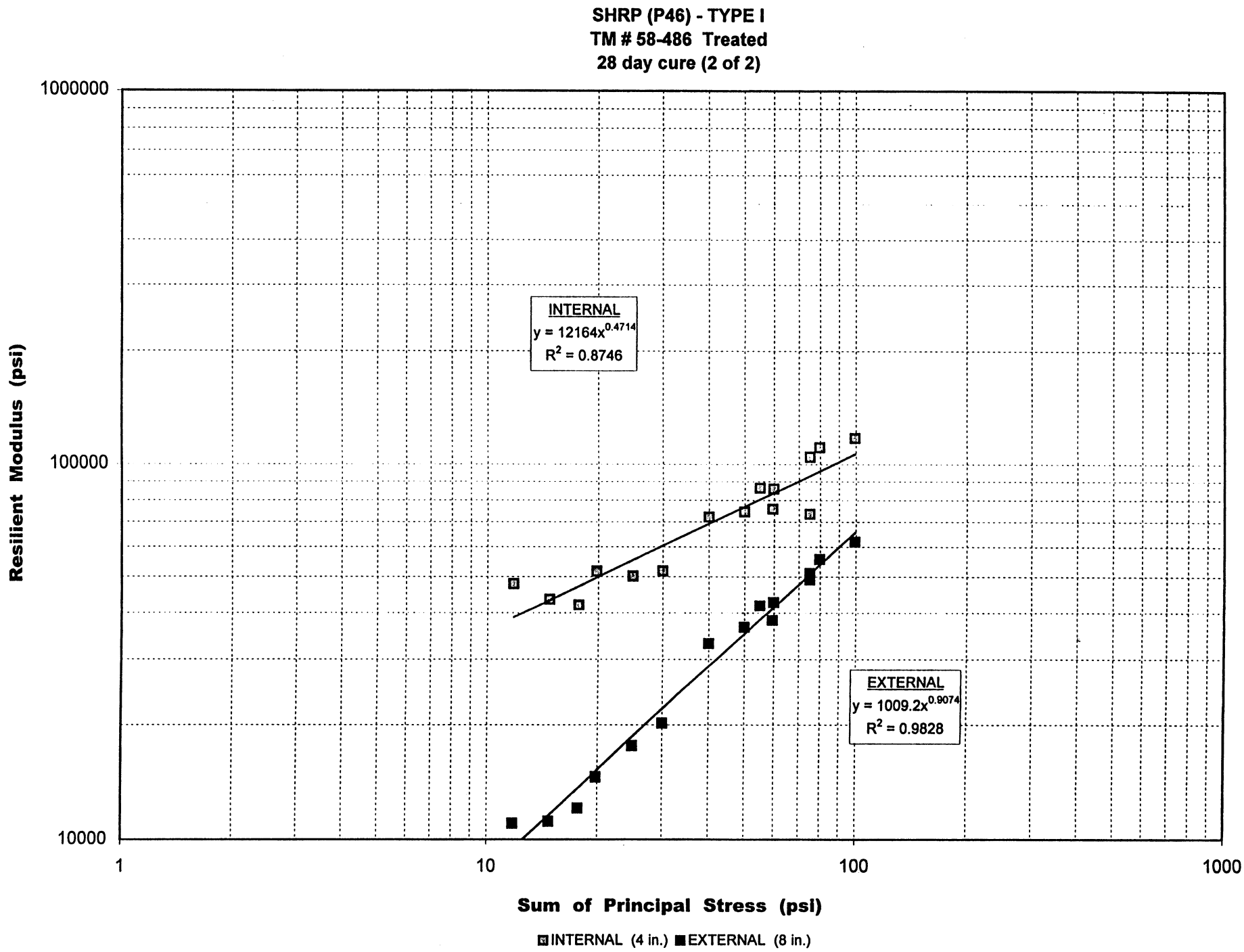
INSITU or TARGET MOIST. / DENSITY:
11.0 @ 125.0
ACTUAL MOISTURE / DENSITY:
12.4 @ 120.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.46	0.32	2.78	0.00178051	0.00022256	11037
2	3	5.11	0.63	5.74	0.00365667	0.00045708	11182
3	3	7.81	0.87	8.69	0.00516140	0.00064517	12111
4	5	4.33	0.48	4.81	0.00237041	0.00029630	14629
5	5	8.82	1.04	9.85	0.00400139	0.00050017	17626
6	5	13.46	1.51	14.98	0.00532988	0.00066624	20207
7	10	8.93	1.03	9.96	0.00216057	0.00027007	33049
8	10	17.94	1.99	19.93	0.00392513	0.00049064	36573
9	10	26.43	3.02	29.46	0.00553973	0.00069247	38175
10	15	8.98	1.04	10.02	0.00171889	0.00021486	41805
11	15	13.30	1.50	14.80	0.00249194	0.00031149	42689
12	15	26.87	3.02	29.89	0.00437457	0.00054682	49135
13	20	13.49	1.51	15.01	0.00211791	0.00026474	50959
14	20	17.73	1.99	19.72	0.00255097	0.00031887	55592
15	20	35.50	3.96	39.46	0.00459131	0.00057391	61856

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.46	0.32	2.78	0.00020554	0.00005139	47803
2	3	5.11	0.63	5.74	0.00047054	0.00011764	43450
3	3	7.81	0.87	8.69	0.00074459	0.00018615	41977
4	5	4.33	0.48	4.81	0.00033610	0.00008402	51588
5	5	8.82	1.04	9.85	0.00070409	0.00017602	50085
6	5	13.46	1.51	14.98	0.00104191	0.00026048	51685
7	10	8.93	1.03	9.96	0.00049553	0.00012388	72048
8	10	17.94	1.99	19.93	0.00096392	0.00024098	74463
9	10	26.43	3.02	29.46	0.00139524	0.00034881	75785
10	15	8.98	1.04	10.02	0.00041668	0.00010417	86228
11	15	13.30	1.50	14.80	0.00061920	0.00015480	85899
12	15	26.87	3.02	29.89	0.00146419	0.00036605	73400
13	20	13.49	1.51	15.01	0.00051708	0.00012927	104361
14	20	17.73	1.99	19.72	0.00064118	0.00016029	110588
15	20	35.50	3.96	39.46	0.00121384	0.00030346	116985


SHRP (P46) - TYPE I
TM # 58-486 Treated
28 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 12164x^0.4714
R2 = 0.8746
EXTERNAL
y = 1009.2x^0.9074
R2 = 0.9828
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-411)

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14242-S

SAMPLE # : 1b2

LBR : 174.0

SOIL CLASS :

FINAL % (w) : 8.1

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

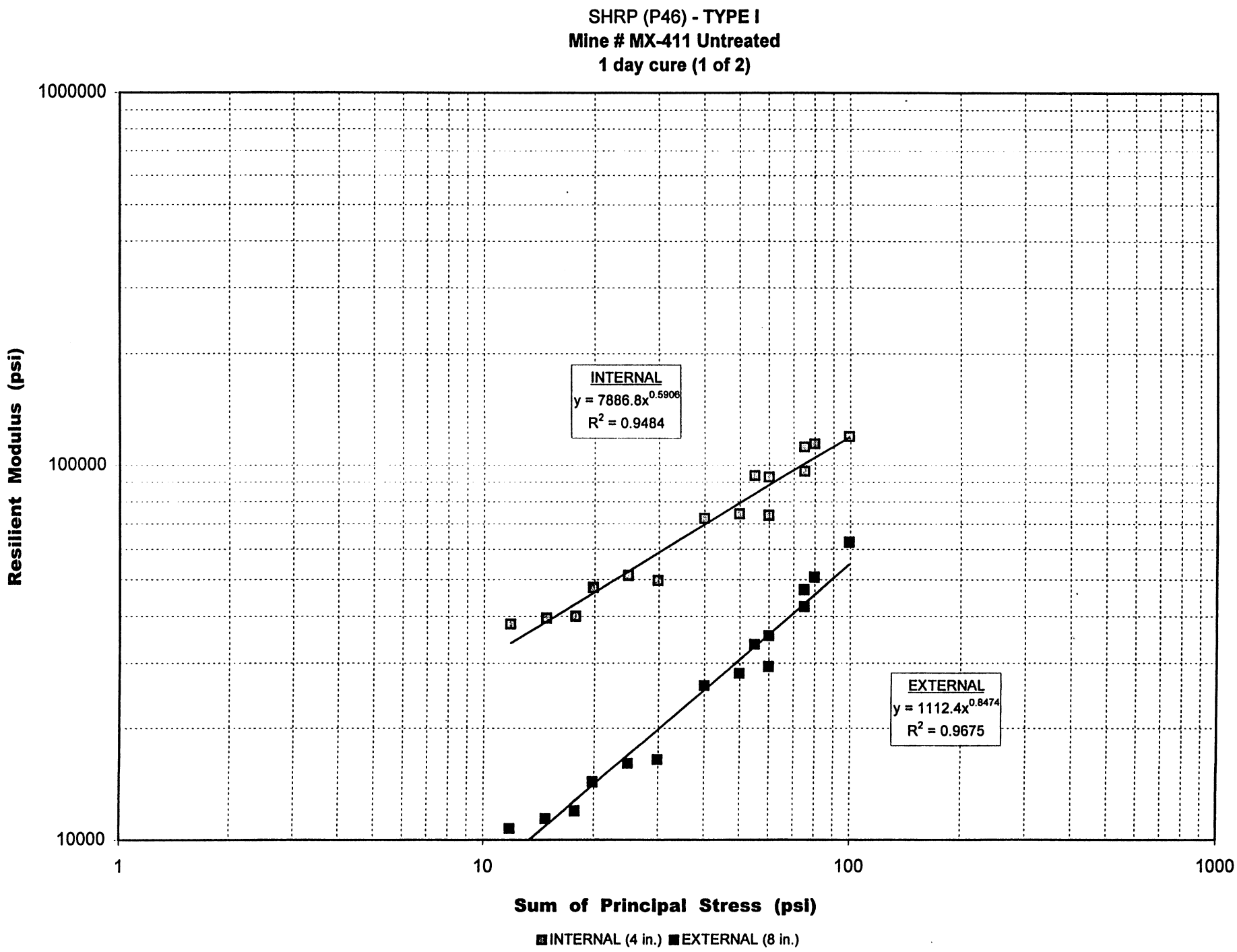
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
7.9 @ 125.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.49	0.32	2.81	0.00185936	0.00023242	10721
2	3	5.13	0.63	5.77	0.00360281	0.00045035	11401
3	3	7.87	0.87	8.74	0.00526783	0.00065848	11946
4	5	4.36	0.48	4.83	0.00244195	0.00030524	14274
5	5	8.72	1.04	9.76	0.00435733	0.00054467	16009
6	5	13.31	1.51	14.82	0.00649376	0.00081172	16395
7	10	8.92	1.04	9.96	0.00274100	0.00034262	26046
8	10	17.86	1.99	19.86	0.00508470	0.00063559	28108
9	10	26.86	3.02	29.88	0.00732972	0.00091621	29316
10	15	8.83	1.03	9.87	0.00210412	0.00026301	33585
11	15	13.45	1.52	14.97	0.00303789	0.00037974	35429
12	15	26.94	3.02	29.96	0.00508512	0.00063564	42382
13	20	13.34	1.51	14.86	0.00227260	0.00028407	46974
14	20	17.91	1.99	19.90	0.00283019	0.00035377	50638
15	20	35.37	3.97	39.34	0.00452538	0.00056567	62526

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.49	0.32	2.81	0.00026156	0.00006539	38107
2	3	5.13	0.63	5.77	0.00051966	0.00012991	39520
3	3	7.87	0.87	8.74	0.00078811	0.00019703	39926
4	5	4.36	0.48	4.83	0.00036583	0.00009146	47638
5	5	8.72	1.04	9.76	0.00068167	0.00017042	51166
6	5	13.31	1.51	14.82	0.00107250	0.00026812	49633
7	10	8.92	1.04	9.96	0.00049381	0.00012345	72286
8	10	17.86	1.99	19.86	0.00096133	0.00024033	74335
9	10	26.86	3.02	29.88	0.00145944	0.00036486	73616
10	15	8.83	1.03	9.87	0.00037747	0.00009437	93606
11	15	13.45	1.52	14.97	0.00057956	0.00014489	92855
12	15	26.94	3.02	29.96	0.00112033	0.00028008	96184
13	20	13.34	1.51	14.86	0.00047614	0.00011904	112103
14	20	17.91	1.99	19.90	0.00062652	0.00015663	114373
15	20	35.37	3.97	39.34	0.00118195	0.00029549	119698


SHRP (P46) - TYPE I
Mine # MX-411 Untreated
1 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL
y = 7886.8x^0.5906
R^2 = 0.9484
EXTERNAL
y = 1112.4x^0.8474
R^2 = 0.9675
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 10, 1999

PROJECT NO. :

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-41)

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14242-S

SAMPLE # : 2012

LBR : 174.0

SOIL CLASS :

FINAL % (w) : 7.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

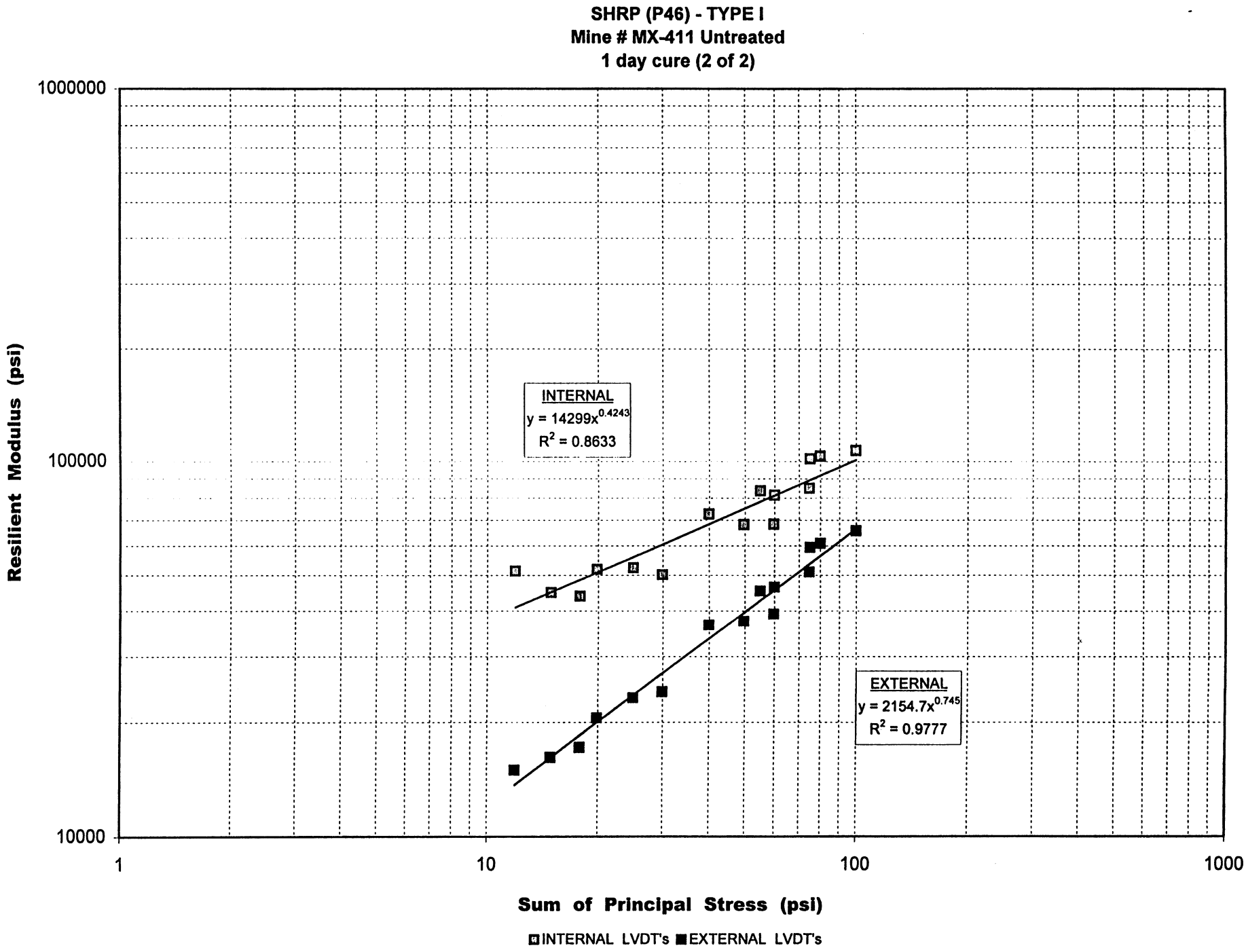
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
7.9 @ 127.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.90	0.00138451	0.00017306	14941
2	3	5.25	0.63	5.88	0.00260095	0.00032512	16152
3	3	8.00	0.87	8.87	0.00372950	0.00046619	17160
4	5	4.40	0.48	4.87	0.00171328	0.00021416	20533
5	5	8.90	1.03	9.93	0.00305814	0.00038227	23269
6	5	13.39	1.52	14.91	0.00443618	0.00055452	24144
7	10	8.91	1.04	9.94	0.00194684	0.00024335	36599
8	10	17.66	1.99	19.65	0.00376698	0.00047087	37501
9	10	26.73	3.02	29.75	0.00545441	0.00068180	39203
10	15	8.94	1.04	9.98	0.00157970	0.00019746	45284
11	15	13.47	1.51	14.98	0.00232431	0.00029054	46363
12	15	26.61	3.01	29.62	0.00417031	0.00052129	51044
13	20	13.51	1.51	15.02	0.00181843	0.00022730	59431
14	20	17.94	1.99	19.94	0.00235835	0.00029479	60870
15	20	35.82	3.98	39.80	0.00436336	0.00054542	65675

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.59	0.32	2.90	0.00020166	0.00005041	51288
2	3	5.25	0.63	5.88	0.00046838	0.00011710	44845
3	3	8.00	0.87	8.87	0.00072994	0.00018248	43839
4	5	4.40	0.48	4.87	0.00033911	0.00008478	51868
5	5	8.90	1.03	9.93	0.00068038	0.00017010	52294
6	5	13.39	1.52	14.91	0.00106862	0.00026716	50116
7	10	8.91	1.04	9.94	0.00049079	0.00012270	72590
8	10	17.66	1.99	19.65	0.00103587	0.00025897	68187
9	10	26.73	3.02	29.75	0.00156329	0.00039082	68391
10	15	8.94	1.04	9.98	0.00042788	0.00010697	83593
11	15	13.47	1.51	14.98	0.00066229	0.00016557	81355
12	15	26.61	3.01	29.62	0.00125520	0.00031380	84795
13	20	13.51	1.51	15.02	0.00053172	0.00013293	101623
14	20	17.94	1.99	19.94	0.00069590	0.00017397	103142
15	20	35.82	3.98	39.80	0.00134181	0.00033545	106783


SHRP (P46) - TYPE I
Mine # MX-411 Untreated
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL
y = 14299x^0.4243
R^2 = 0.8633
EXTERNAL
y = 2154.7x^0.745
R^2 = 0.9777
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-411)

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14242-S

SAMPLE # : 1 of 2

LBR : 174.0

SOIL CLASS :

FINAL % (w) : 8.5

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

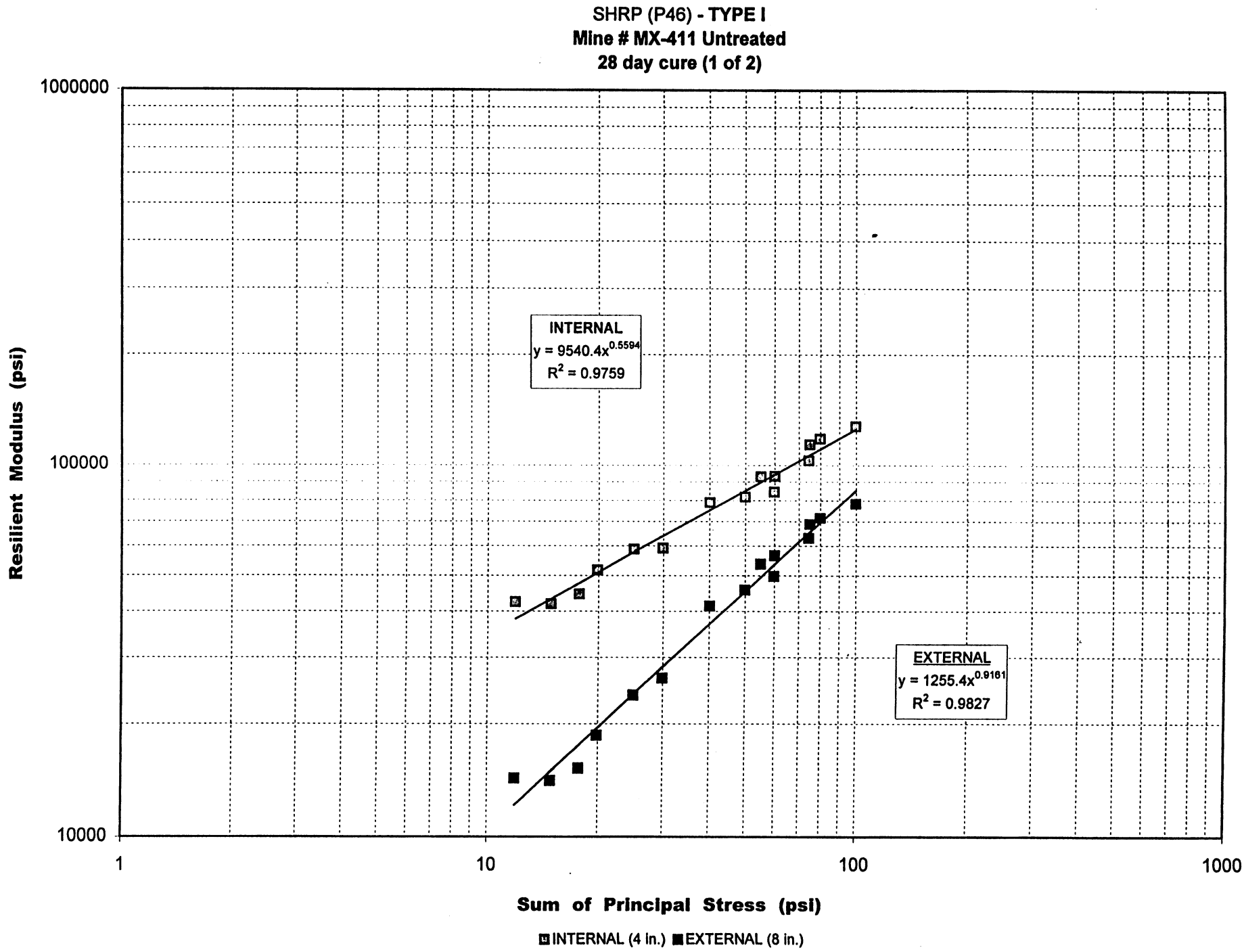
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
8.4 @ 127.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.58	0.32	2.90	0.00144138	0.00018017	14310
2	3	5.26	0.63	5.89	0.00298532	0.00037317	14090
3	3	7.86	0.88	8.74	0.00414101	0.00051763	15185
4	5	4.39	0.48	4.87	0.00189039	0.00023630	18599
5	5	8.94	1.04	9.98	0.00300945	0.00037618	23772
6	5	13.40	1.52	14.92	0.00406603	0.00050825	26363
7	10	9.03	1.04	10.06	0.00174819	0.00021852	41304
8	10	17.94	1.99	19.93	0.00314131	0.00039266	45692
9	10	26.84	3.02	29.85	0.00431941	0.00053993	49704
10	15	9.01	1.04	10.04	0.00134486	0.00016811	53584
11	15	13.55	1.51	15.06	0.00191840	0.00023980	56488
12	15	26.34	3.02	29.35	0.00334814	0.00041852	62932
13	20	13.44	1.51	14.95	0.00156548	0.00019569	68705
14	20	17.91	1.99	19.90	0.00200457	0.00025057	71494
15	20	35.80	3.97	39.77	0.00365797	0.00045725	78297

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.58	0.32	2.90	0.00024345	0.00006086	42361
2	3	5.26	0.63	5.89	0.00050242	0.00012561	41860
3	3	7.86	0.88	8.74	0.00070624	0.00017656	44517
4	5	4.39	0.48	4.87	0.00034084	0.00008521	51577
5	5	8.94	1.04	9.98	0.00060971	0.00015243	58669
6	5	13.40	1.52	14.92	0.00090746	0.00022687	59063
7	10	9.03	1.04	10.06	0.00045718	0.00011429	78971
8	10	17.94	1.99	19.93	0.00087773	0.00021943	81763
9	10	26.84	3.02	29.85	0.00127157	0.00031789	84420
10	15	9.01	1.04	10.04	0.00038781	0.00009695	92911
11	15	13.55	1.51	15.06	0.00058085	0.00014521	93284
12	15	26.34	3.02	29.35	0.00102337	0.00025584	102947
13	20	13.44	1.51	14.95	0.00047269	0.00011817	113771
14	20	17.91	1.99	19.90	0.00060713	0.00015178	118027
15	20	35.80	3.97	39.77	0.00112205	0.00028051	127626


SHRP (P46) - TYPE I
Mine # MX-411 Untreated
28 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9540.4x^0.5594
R2 = 0.9759
EXTERNAL
y = 1255.4x^0.9161
R2 = 0.9827
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-411)

COMMENTS : UNTREATED, 28-DAY CURE

LAB # : 14242-S

SAMPLE # : 2 of 2

LBR : 174.0

SOIL CLASS :

FINAL % (w) : 8.5

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

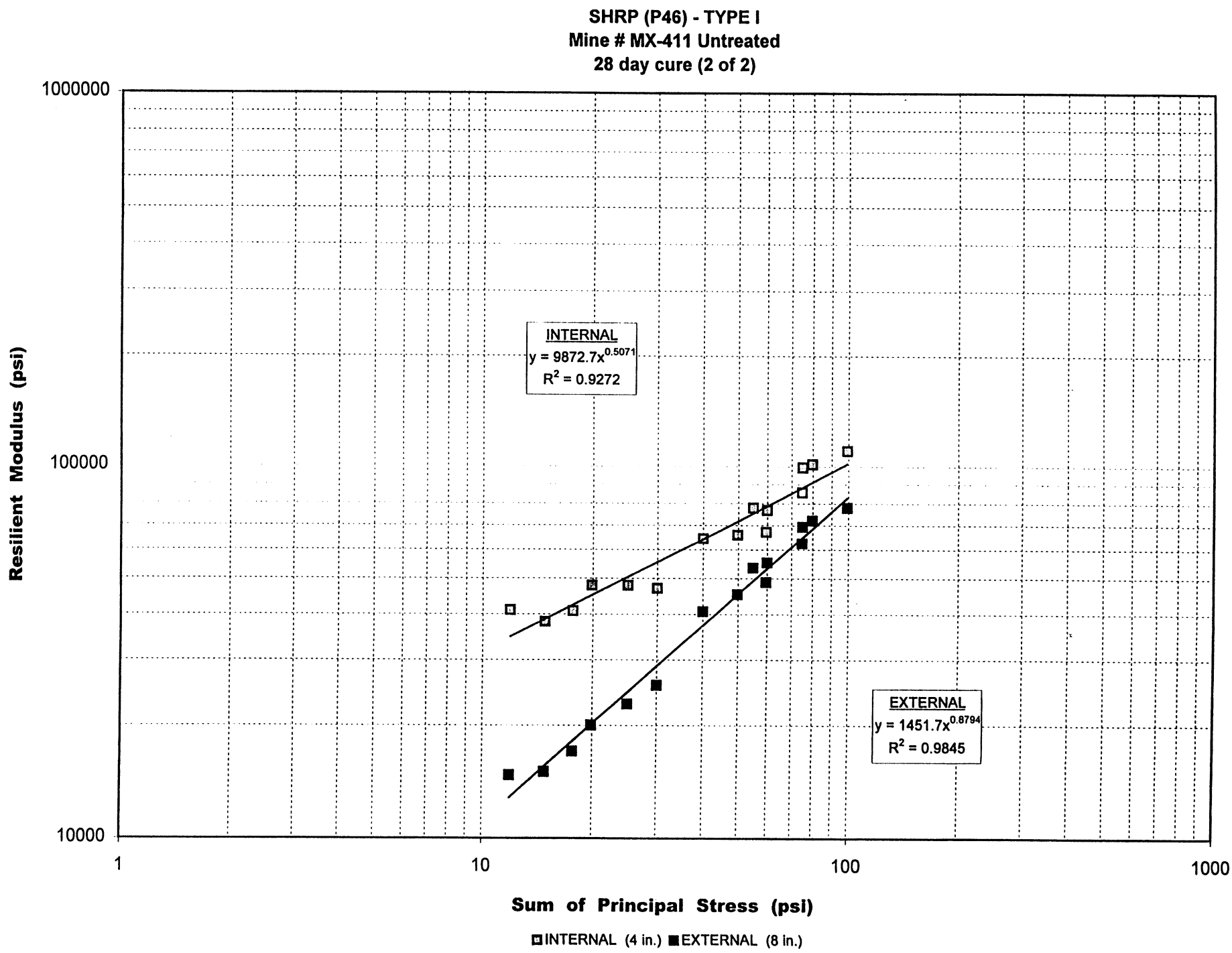
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
7.9 @ 126.3

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.58	0.32	2.90	0.00139958	0.00017495	14742
2	3	5.20	0.63	5.83	0.00276685	0.00034586	15038
3	3	7.80	0.87	8.67	0.00366184	0.00045773	17042
4	5	4.43	0.47	4.90	0.00176930	0.00022116	20017
5	5	8.87	1.03	9.90	0.00310942	0.00038868	22826
6	5	13.49	1.51	15.00	0.00420823	0.00052603	25642
7	10	8.94	1.03	9.97	0.00175896	0.00021987	40658
8	10	17.81	1.99	19.80	0.00315466	0.00039433	45166
9	10	26.57	3.02	29.59	0.00435819	0.00054477	48778
10	15	8.89	1.04	9.92	0.00133279	0.00016660	53337
11	15	13.50	1.51	15.01	0.00195588	0.00024449	55224
12	15	26.83	3.02	29.84	0.00343993	0.00042999	62385
13	20	13.52	1.51	15.03	0.00155988	0.00019498	69324
14	20	17.81	1.99	19.80	0.00197958	0.00024745	71991
15	20	35.29	3.97	39.26	0.00362306	0.00045288	77920

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.58	0.32	2.90	0.00025165	0.00006291	40995
2	3	5.20	0.63	5.83	0.00054594	0.00013649	38107
3	3	7.80	0.87	8.67	0.00076527	0.00019132	40773
4	5	4.43	0.47	4.90	0.00037100	0.00009275	47729
5	5	8.87	1.03	9.90	0.00074330	0.00018582	47744
6	5	13.49	1.51	15.00	0.00114963	0.00028741	46931
7	10	8.94	1.03	9.97	0.00055586	0.00013896	64329
8	10	17.81	1.99	19.80	0.00108241	0.00027060	65818
9	10	26.57	3.02	29.59	0.00158527	0.00039632	67050
10	15	8.89	1.04	9.92	0.00045675	0.00011419	77819
11	15	13.50	1.51	15.01	0.00070322	0.00017581	76797
12	15	26.83	3.02	29.84	0.00125391	0.00031348	85573
13	20	13.52	1.51	15.03	0.00054336	0.00013584	99508
14	20	17.81	1.99	19.80	0.00070322	0.00017581	101327
15	20	35.29	3.97	39.26	0.00128320	0.00032080	110001


SHRP (P46) - TYPE I
Mine # MX-411 Untreated
28 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9872.7x^0.5071
R^2 = 0.9272
EXTERNAL
y = 1451.7x^0.8794
R^2 = 0.9845
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-411)

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14242-S

SAMPLE # : 1 of 2

LBR : 225.0

SOIL CLASS :

FINAL % (w) : 6.9

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

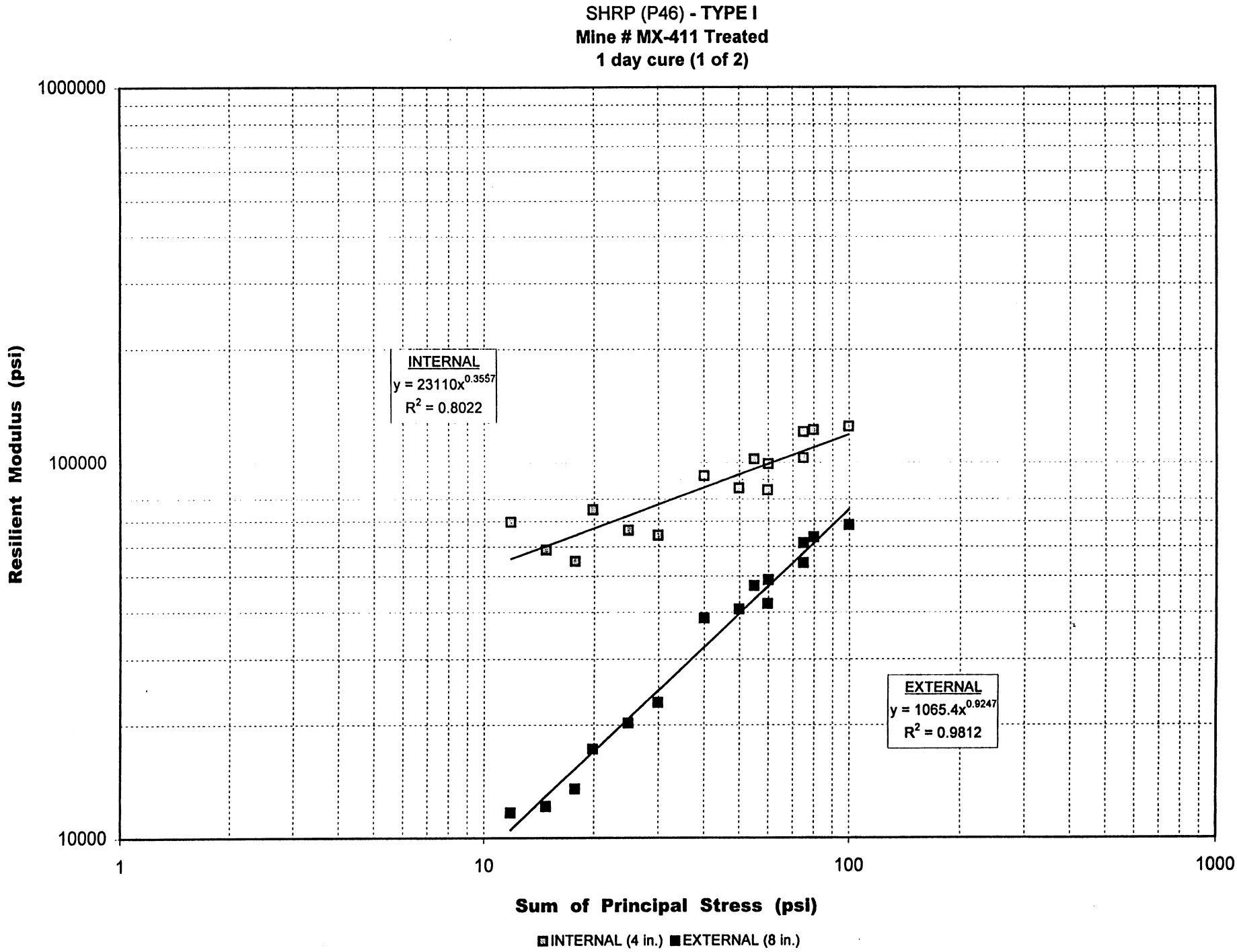
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
8.0 @ 127.0

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.51	0.32	2.82	0.00172578	0.00021572	11620
2	3	5.12	0.63	5.76	0.00339942	0.00042493	12058
3	3	7.87	0.87	8.74	0.00468913	0.00058614	13422
4	5	4.37	0.48	4.85	0.00202784	0.00025348	17240
5	5	8.79	1.03	9.82	0.00348086	0.00043511	20207
6	5	13.39	1.51	14.90	0.00467060	0.00058382	22938
7	10	8.91	1.04	9.95	0.00185117	0.00023140	38501
8	10	17.88	1.99	19.87	0.00351576	0.00043947	40689
9	10	26.69	3.02	29.71	0.00507306	0.00063413	42092
10	15	8.87	1.03	9.91	0.00150860	0.00018858	47056
11	15	13.45	1.51	14.97	0.00220667	0.00027583	48772
12	15	26.74	3.02	29.76	0.00395055	0.00049382	54157
13	20	13.43	1.52	14.95	0.00175293	0.00021912	61287
14	20	17.91	1.99	19.90	0.00225838	0.00028230	63445
15	20	35.74	3.98	39.72	0.00418367	0.00052296	68340

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.51	0.32	2.82	0.00014392	0.00003598	69667
2	3	5.12	0.63	5.76	0.00034859	0.00008715	58791
3	3	7.87	0.87	8.74	0.00057438	0.00014360	54788
4	5	4.37	0.48	4.85	0.00023311	0.00005828	74986
5	5	8.79	1.03	9.82	0.00053086	0.00013272	66248
6	5	13.39	1.51	14.90	0.00083421	0.00020855	64214
7	10	8.91	1.04	9.95	0.00038694	0.00009674	92096
8	10	17.88	1.99	19.87	0.00083766	0.00020941	85388
9	10	26.69	3.02	29.71	0.00126511	0.00031628	84393
10	15	8.87	1.03	9.91	0.00034773	0.00008693	102074
11	15	13.45	1.51	14.97	0.00054293	0.00013573	99113
12	15	26.74	3.02	29.76	0.00104104	0.00026026	102757
13	20	13.43	1.52	14.95	0.00044511	0.00011128	120679
14	20	17.91	1.99	19.90	0.00058645	0.00014661	122161
15	20	35.74	3.98	39.72	0.00114446	0.00028612	124911


SHRP (P46) - TYPE I
Mine # MX-411 Treated
1 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 23110x^0.3557
R^2 = 0.8022
EXTERNAL
y = 1065.4x^0.9247
R^2 = 0.9812
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-411)

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14242-S

SAMPLE # : 262

LBR : 225.0

SOIL CLASS :

FINAL % (w) : 7.4

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

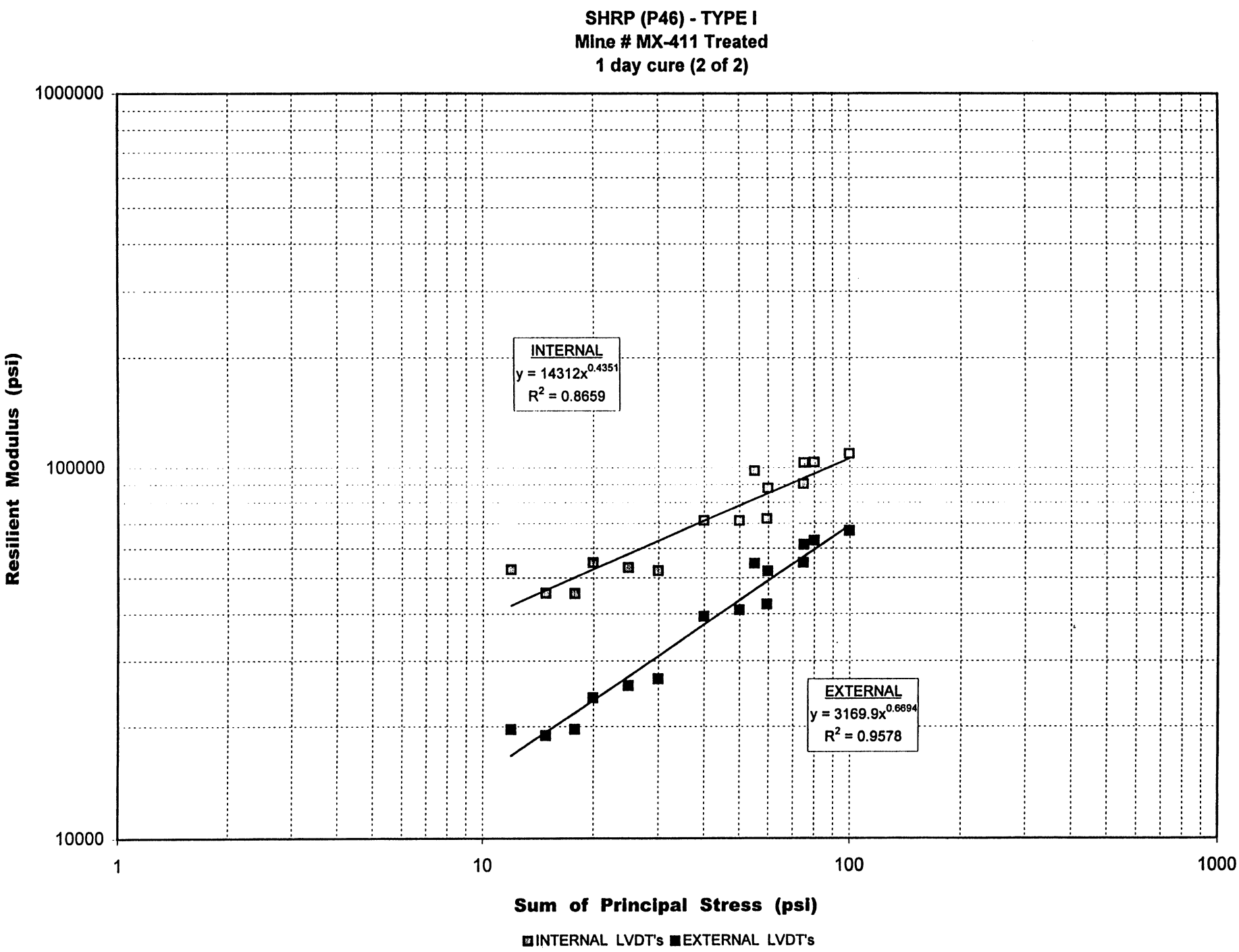
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
7.7 @ 125.1

2 EXTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00106563	0.00013320	19646
2	3	5.21	0.63	5.84	0.00220495	0.00027562	18891
3	3	7.93	0.87	8.80	0.00323051	0.00040381	19634
4	5	4.47	0.48	4.95	0.00149481	0.00018685	23935
5	5	8.84	1.04	9.87	0.00274142	0.00034268	25792
6	5	13.42	1.52	14.94	0.00399321	0.00049915	26889
7	10	8.90	1.04	9.94	0.00181239	0.00022655	39303
8	10	17.90	1.99	19.89	0.00349939	0.00043742	40920
9	10	26.37	3.02	29.38	0.00497525	0.00062191	42395
10	15	8.96	1.04	9.99	0.00131211	0.00016401	54610
11	15	13.29	1.51	14.80	0.00204422	0.00025553	51993
12	15	26.78	3.02	29.79	0.00390315	0.00048789	54882
13	20	13.49	1.51	15.00	0.00175508	0.00021939	61475
14	20	17.96	1.99	19.95	0.00228381	0.00028548	62903
15	20	35.74	3.97	39.72	0.00427416	0.00053427	66902

2 INTERNAL LVDT's

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.62	0.32	2.94	0.00019907	0.00004977	52583
2	3	5.21	0.63	5.84	0.00045847	0.00011462	45427
3	3	7.93	0.87	8.80	0.00070021	0.00017505	45291
4	5	4.47	0.48	4.95	0.00032576	0.00008144	54914
5	5	8.84	1.04	9.87	0.00066401	0.00016600	53241
6	5	13.42	1.52	14.94	0.00102941	0.00025735	52152
7	10	8.90	1.04	9.94	0.00049940	0.00012485	71318
8	10	17.90	1.99	19.89	0.00100571	0.00025143	71192
9	10	26.37	3.02	29.38	0.00146289	0.00036572	72092
10	15	8.96	1.04	9.99	0.00036540	0.00009135	98049
11	15	13.29	1.51	14.80	0.00060498	0.00015124	87843
12	15	26.78	3.02	29.79	0.00118625	0.00029656	90289
13	20	13.49	1.51	15.00	0.00052268	0.00013067	103212
14	20	17.96	1.99	19.95	0.00069374	0.00017344	103538
15	20	35.74	3.97	39.72	0.00130734	0.00032683	109364


SHRP (P46) - TYPE I
Mine # MX-411 Treated
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 14312x^0.4351
R^2 = 0.8659
EXTERNAL
y = 3169.9x^0.6694
R^2 = 0.9578
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL LVDT's
EXTERNAL LVDT's

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock (MX-11)

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14242-S

SAMPLE # : [redacted]

LBR : 225.0

SOIL CLASS :

FINAL % (w) : 8.5

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

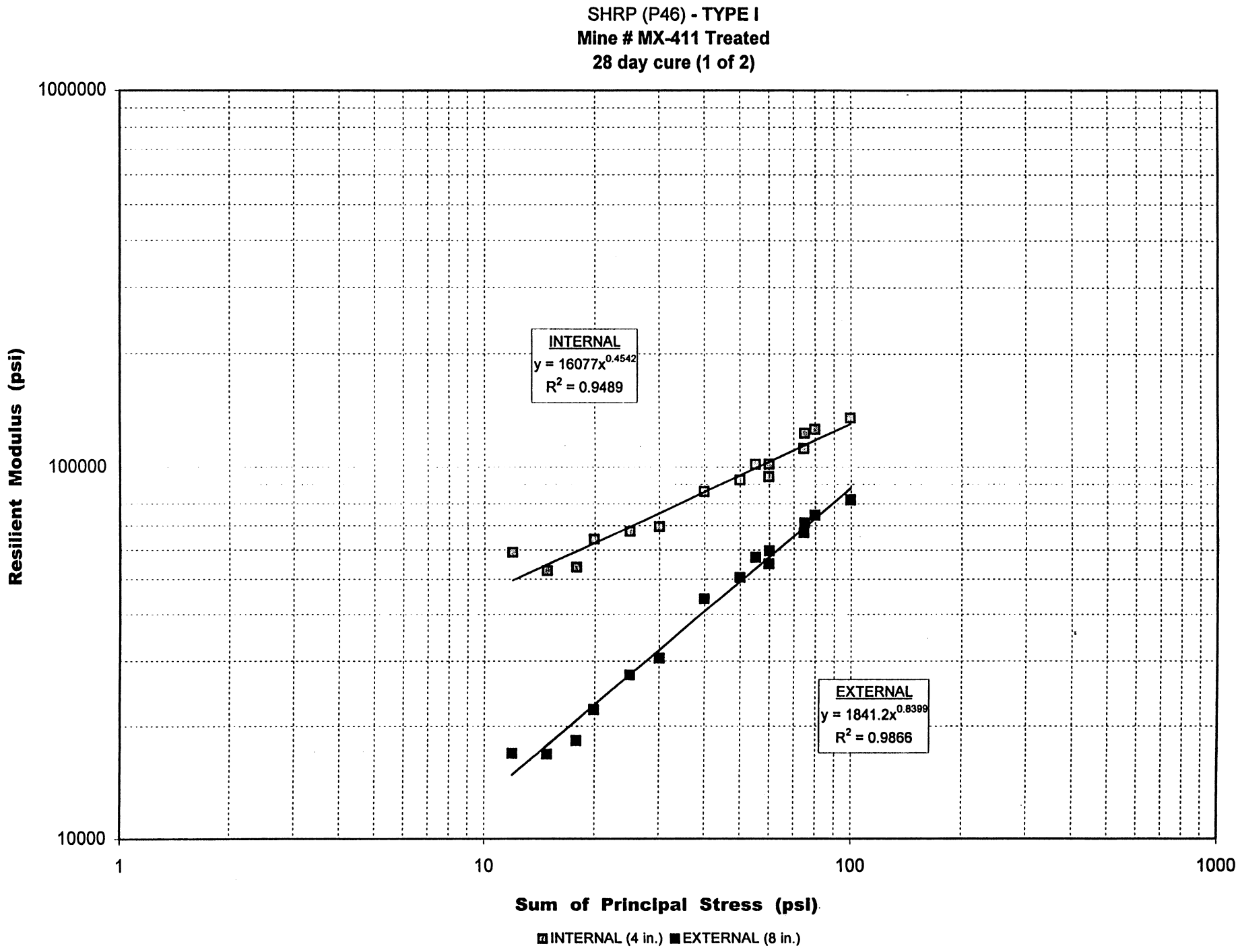
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
7.7 @ 126.3

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00123196	0.00015399	16892
2	3	5.22	0.63	5.85	0.00248504	0.00031063	16810
3	3	7.95	0.87	8.82	0.00347698	0.00043462	18283
4	5	4.42	0.47	4.89	0.00159867	0.00019983	22099
5	5	8.93	1.04	9.97	0.00260526	0.00032566	27423
6	5	13.50	1.51	15.02	0.00354420	0.00044303	30477
7	10	8.91	1.04	9.94	0.00161417	0.00020177	44138
8	10	17.91	1.99	19.90	0.00283881	0.00035485	50461
9	10	26.82	3.01	29.83	0.00390574	0.00048822	54926
10	15	9.05	1.03	10.08	0.00126471	0.00015809	57245
11	15	13.45	1.51	14.97	0.00180765	0.00022596	59545
12	15	26.54	3.01	29.55	0.00317966	0.00039746	66771
13	20	13.42	1.51	14.93	0.00150947	0.00018868	71133
14	20	17.92	1.98	19.90	0.00192443	0.00024055	74485
15	20	35.69	3.97	39.66	0.00349034	0.00043629	81798

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.60	0.32	2.92	0.00017624	0.00004406	59041
2	3	5.22	0.63	5.85	0.00039686	0.00009921	52629
3	3	7.95	0.87	8.82	0.00059119	0.00014780	53765
4	5	4.42	0.47	4.89	0.00027534	0.00006884	64156
5	5	8.93	1.04	9.97	0.00053000	0.00013250	67399
6	5	13.50	1.51	15.02	0.00077776	0.00019444	69441
7	10	8.91	1.04	9.94	0.00041409	0.00010352	86027
8	10	17.91	1.99	19.90	0.00077561	0.00019390	92346
9	10	26.82	3.01	29.83	0.00113929	0.00028482	94150
10	15	9.05	1.03	10.08	0.00035635	0.00008909	101584
11	15	13.45	1.51	14.97	0.00052914	0.00013229	101708
12	15	26.54	3.01	29.55	0.00094926	0.00023732	111828
13	20	13.42	1.51	14.93	0.00043736	0.00010934	122751
14	20	17.92	1.98	19.90	0.00057008	0.00014252	125721
15	20	35.69	3.97	39.66	0.00105828	0.00026457	134890


SHRP (P46) - TYPE I
Mine # MX-411 Treated
28 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 16077x^0.4542
R^2 = 0.9489
EXTERNAL
y = 1841.2x^0.8399
R^2 = 0.9866
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : May 12, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Orange-Brown Limerock [redacted]

COMMENTS : [redacted]

LAB # : 14242-S

SAMPLE # : [redacted]

LBR : 225.0

SOIL CLASS :

FINAL % (w) : 7.4

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

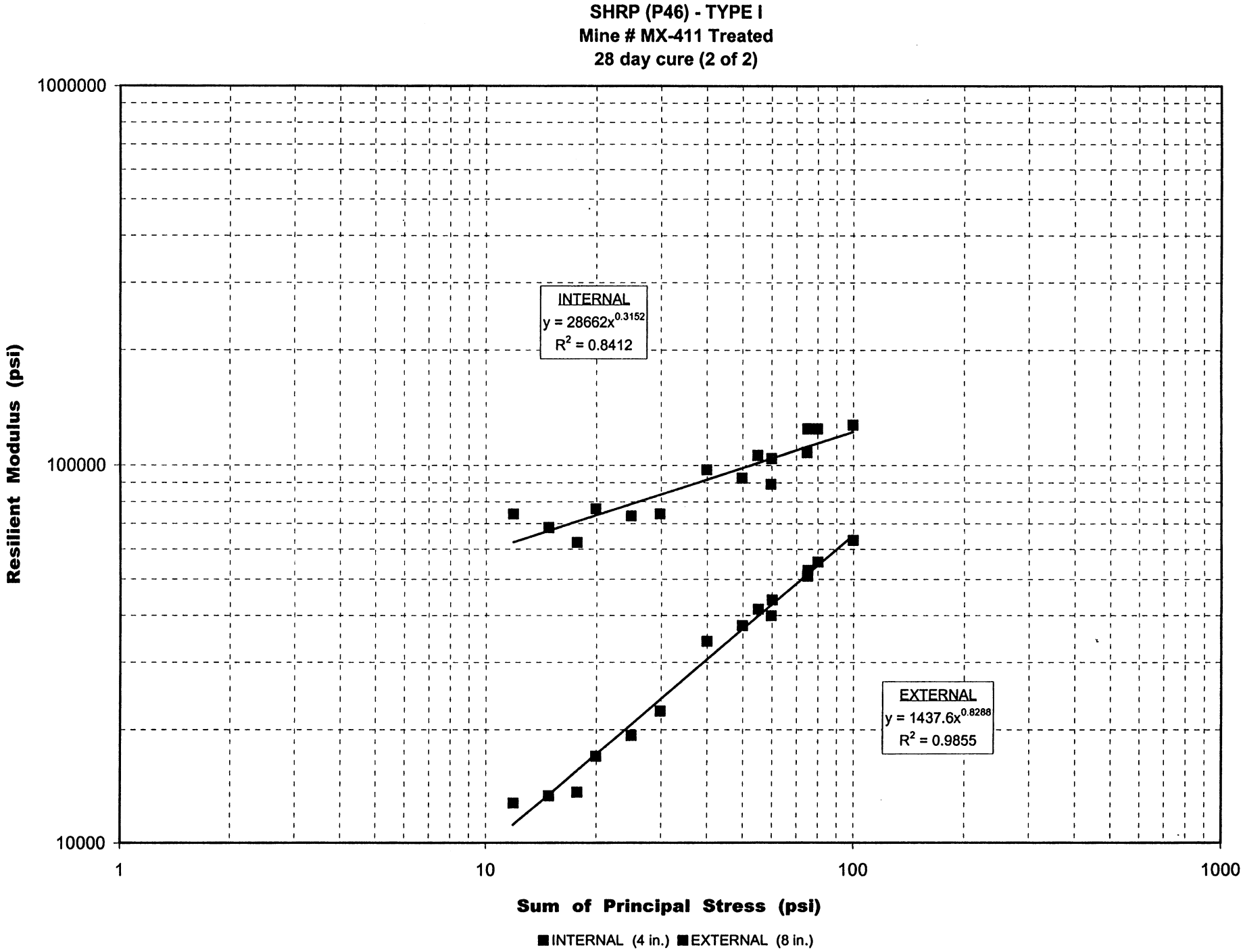
INSITU or TARGET MOIST. / DENSITY:
9.0 @ 127.0
ACTUAL MOISTURE / DENSITY:
7.7 @ 125.1

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00159867	0.00019983	12795
2	3	5.18	0.64	5.82	0.00309994	0.00038749	13369
3	3	7.81	0.87	8.69	0.00456890	0.00057111	13679
4	5	4.42	0.48	4.89	0.00208041	0.00026005	16982
5	5	8.81	1.03	9.84	0.00365107	0.00045638	19299
6	5	13.26	1.51	14.78	0.00474815	0.00059352	22347
7	10	8.84	1.03	9.87	0.00207524	0.00025941	34061
8	10	17.76	1.99	19.75	0.00378939	0.00047367	37502
9	10	26.63	3.02	29.64	0.00534281	0.00066785	39869
10	15	8.92	1.04	9.96	0.00171931	0.00021491	41511
11	15	13.44	1.51	14.95	0.00244668	0.00030584	43936
12	15	26.84	3.01	29.86	0.00422374	0.00052797	50842
13	20	13.54	1.51	15.05	0.00205500	0.00025687	52718
14	20	17.91	1.99	19.90	0.00258501	0.00032313	55436
15	20	35.76	3.97	39.74	0.00452408	0.00056551	63243

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.56	0.32	2.88	0.00013789	0.00003447	74171
2	3	5.18	0.64	5.82	0.00030335	0.00007584	68308
3	3	7.81	0.87	8.69	0.00050027	0.00012507	62464
4	5	4.42	0.48	4.89	0.00023053	0.00005763	76627
5	5	8.81	1.03	9.84	0.00048045	0.00012011	73329
6	5	13.26	1.51	14.78	0.00071443	0.00017861	74261
7	10	8.84	1.03	9.87	0.00036324	0.00009081	97298
8	10	17.76	1.99	19.75	0.00076872	0.00019218	92433
9	10	26.63	3.02	29.64	0.00119616	0.00029904	89040
10	15	8.92	1.04	9.96	0.00033653	0.00008413	106040
11	15	13.44	1.51	14.95	0.00051665	0.00012916	104034
12	15	26.84	3.01	29.86	0.00099537	0.00024884	107872
13	20	13.54	1.51	15.05	0.00043521	0.00010880	124463
14	20	17.91	1.99	19.90	0.00057567	0.00014392	124464
15	20	35.76	3.97	39.74	0.00112335	0.00028084	127350


SHRP (P46) - TYPE I
Mine # MX-411 Treated
28 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 28662x^0.3152
R^2 = 0.8412
EXTERNAL
y = 1437.6x^0.8288
R^2 = 0.9855
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 15, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Aggregate Base - crushed (AL-149)

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14321-S

SAMPLE # : 1 of 2

LBR : 210.0

SOIL CLASS :

FINAL % (w) : 4.4

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

INSITU or TARGET MOIST. / DENSITY:
5.7 @ 141.5
ACTUAL MOISTURE / DENSITY:
5.7 @ 142.4

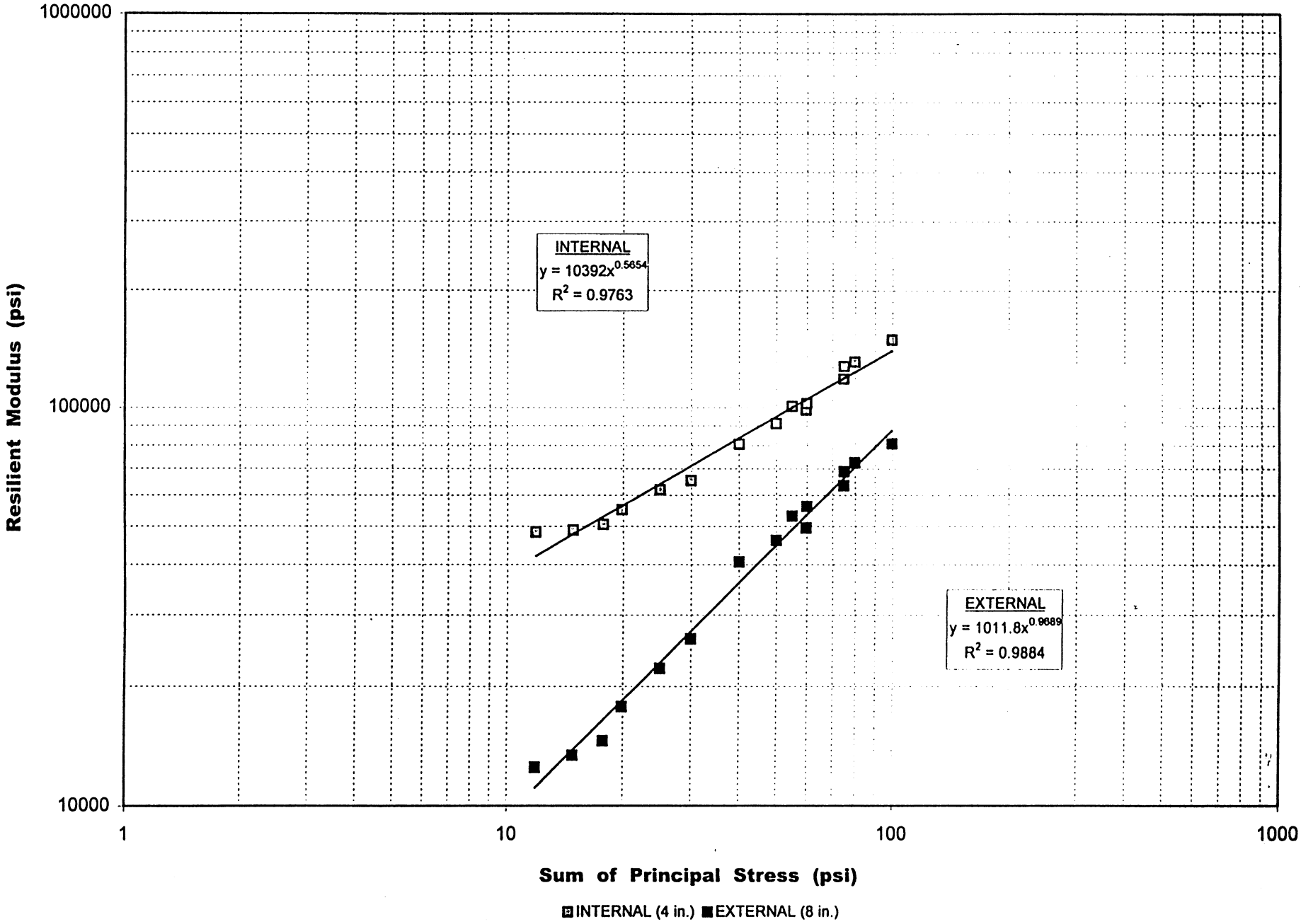
EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.54	0.32	2.86	0.00162926	0.00020366	12490
2	3	5.21	0.63	5.84	0.00311114	0.00038889	13391
3	3	7.90	0.87	8.77	0.00433577	0.00054197	14569
4	5	4.39	0.47	4.87	0.00198045	0.00024756	17743
5	5	8.90	1.04	9.93	0.00321585	0.00040198	22128
6	5	13.42	1.52	14.94	0.00410869	0.00051359	26135
7	10	8.97	1.03	10.00	0.00176628	0.00022079	40631
8	10	17.97	1.99	19.96	0.00312019	0.00039002	46067
9	10	26.71	3.02	29.73	0.00431337	0.00053917	49545
10	15	8.99	1.03	10.02	0.00135563	0.00016945	53041
11	15	13.47	1.51	14.98	0.00191926	0.00023991	56130
12	15	26.82	3.02	29.83	0.00338606	0.00042326	63358
13	20	13.44	1.52	14.96	0.00156376	0.00019547	68768
14	20	17.89	1.99	19.88	0.00197614	0.00024702	72443
15	20	35.76	3.98	39.74	0.00353731	0.00044216	80883

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.54	0.32	2.86	0.00021071	0.00005268	48287
2	3	5.21	0.63	5.84	0.00042616	0.00010654	48879
3	3	7.90	0.87	8.77	0.00062523	0.00015631	50517
4	5	4.39	0.47	4.87	0.00031929	0.00007982	55026
5	5	8.90	1.04	9.93	0.00057524	0.00014381	61852
6	5	13.42	1.52	14.94	0.00082301	0.00020575	65235
7	10	8.97	1.03	10.00	0.00044469	0.00011117	80693
8	10	17.97	1.99	19.96	0.00078897	0.00019724	91091
9	10	26.71	3.02	29.73	0.00108370	0.00027093	98599
10	15	8.99	1.03	10.02	0.00035678	0.00008920	100768
11	15	13.47	1.51	14.98	0.00052569	0.00013142	102463
12	15	26.82	3.02	29.83	0.00090445	0.00022611	118599
13	20	13.44	1.52	14.96	0.00042056	0.00010514	127852
14	20	17.89	1.99	19.88	0.00054508	0.00013627	131317
15	20	35.76	3.98	39.74	0.00095831	0.00023958	149278

SHRP (P46) - TYPE I
Mine # AL-149 Untreated
1 day cure (1 of 2)



RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 15, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Aggregate Base - crushed (AL149)

COMMENTS : UNTREATED, 1-DAY CURE

LAB # : 14321-S

SAMPLE # : 2 of 2

LBR : 210.0

SOIL CLASS :

FINAL % (w) : 4.3

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

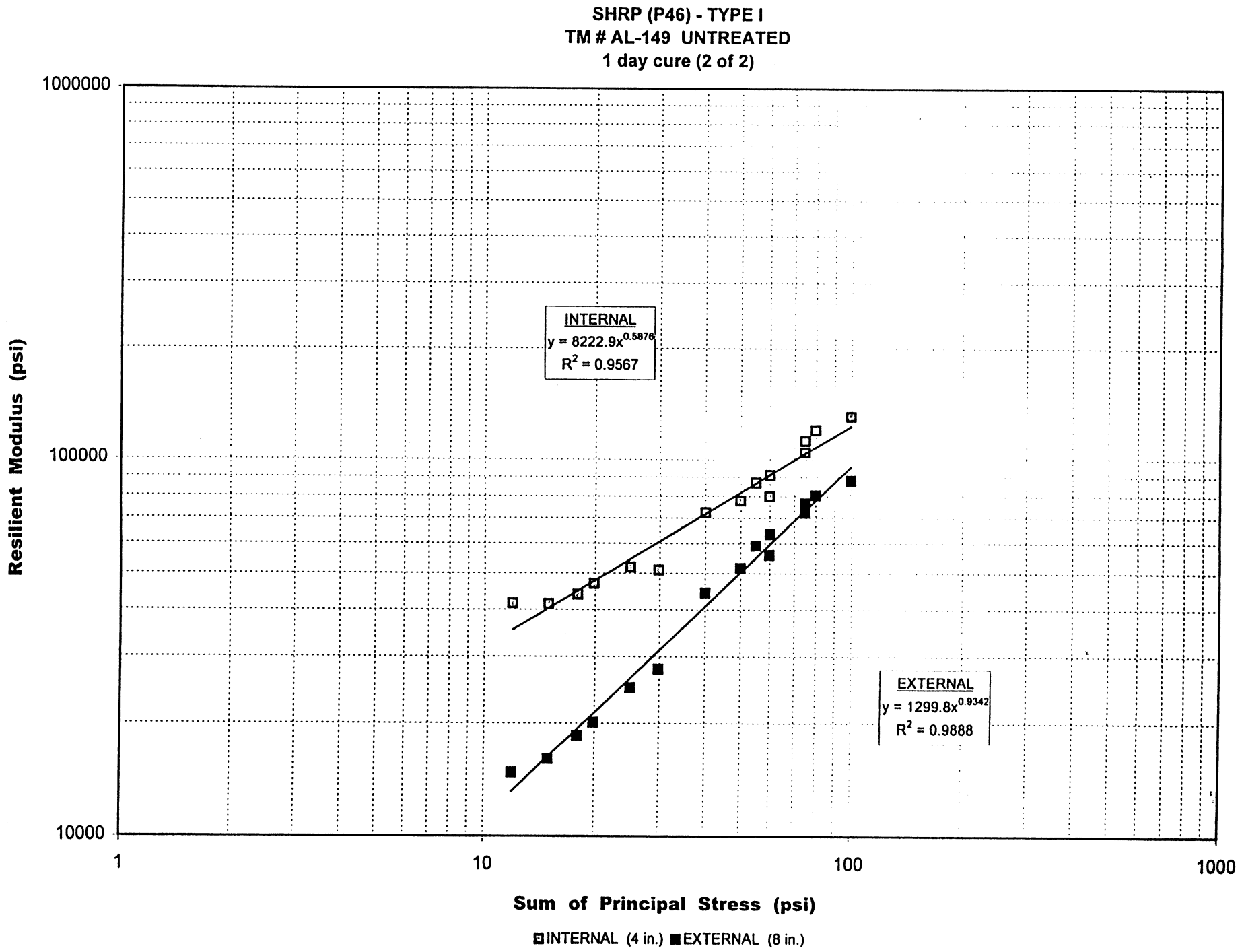
INSITU or TARGET MOIST. / DENSITY:
5.7 @ 141.5
ACTUAL MOISTURE / DENSITY:
5.9 @ 141.6

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.92	0.00141251	0.00017656	14770
2	3	5.34	0.63	5.97	0.00266516	0.00033314	16029
3	3	8.07	0.87	8.94	0.00348214	0.00043527	18546
4	5	4.40	0.48	4.88	0.00175378	0.00021922	20085
5	5	8.94	1.04	9.98	0.00288017	0.00036002	24844
6	5	13.33	1.51	14.84	0.00383550	0.00047944	27799
7	10	9.01	1.03	10.04	0.00162711	0.00020339	44289
8	10	17.93	1.99	19.93	0.00278107	0.00034763	51589
9	10	26.78	3.02	29.80	0.00384196	0.00048024	55759
10	15	8.94	1.04	9.98	0.00121214	0.00015152	59005
11	15	13.53	1.52	15.05	0.00170811	0.00021351	63373
12	15	26.85	3.02	29.87	0.00297067	0.00037133	72317
13	20	13.51	1.52	15.02	0.00140863	0.00017608	76707
14	20	17.99	2.00	19.99	0.00178826	0.00022353	80496
15	20	35.70	3.97	39.68	0.00324429	0.00040554	88038

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.61	0.32	2.92	0.00025121	0.00006280	41525
2	3	5.34	0.63	5.97	0.00051665	0.00012916	41345
3	3	8.07	0.87	8.94	0.00073726	0.00018432	43796
4	5	4.40	0.48	4.88	0.00037574	0.00009394	46873
5	5	8.94	1.04	9.98	0.00069073	0.00017268	51797
6	5	13.33	1.51	14.84	0.00104751	0.00026188	50893
7	10	9.01	1.03	10.04	0.00049769	0.00012442	72398
8	10	17.93	1.99	19.93	0.00092212	0.00023053	77795
9	10	26.78	3.02	29.80	0.00134095	0.00033524	79878
10	15	8.94	1.04	9.98	0.00041237	0.00010309	86722
11	15	13.53	1.52	15.05	0.00059507	0.00014877	90955
12	15	26.85	3.02	29.87	0.00102726	0.00025681	104565
13	20	13.51	1.52	15.02	0.00048131	0.00012033	112246
14	20	17.99	2.00	19.99	0.00059981	0.00014995	119994
15	20	35.70	3.97	39.68	0.00109448	0.00027362	130483


SHRP (P46) - TYPE I
TM # AL-149 UNTREATED
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 8222.9x^0.5876
R^2 = 0.9567
EXTERNAL
y = 1299.8x^0.9342
R^2 = 0.9888
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 15, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Aggregate Base - crushed (AL-149)

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14321-S

SAMPLE # : 1 of 2

LBR : 240.0

SOIL CLASS :

FINAL % (w) : 4.7

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

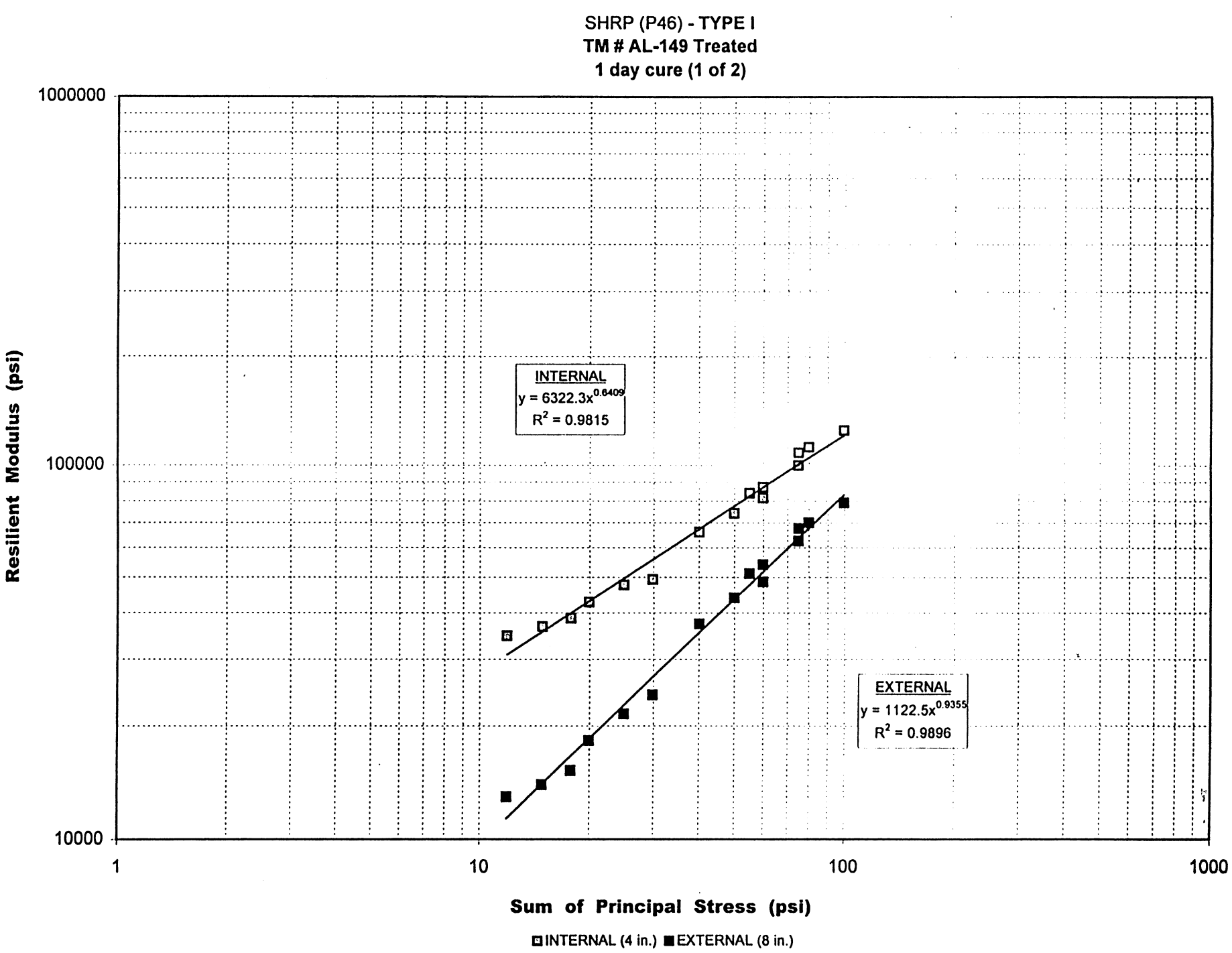
INSITU or TARGET MOIST. / DENSITY:
6.2 @ 142.6
ACTUAL MOISTURE / DENSITY:
5.8 @ 142.3

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.54	0.32	2.86	0.00157109	0.00019639	12927
2	3	5.20	0.63	5.83	0.00298661	0.00037333	13916
3	3	7.90	0.87	8.77	0.00416213	0.00052027	15179
4	5	4.44	0.48	4.91	0.00194597	0.00024325	18237
5	5	8.83	1.04	9.87	0.00328308	0.00041038	21522
6	5	13.31	1.51	14.82	0.00441119	0.00055140	24135
7	10	9.00	1.03	10.03	0.00192917	0.00024115	37317
8	10	17.93	1.99	19.93	0.00326886	0.00040861	43893
9	10	26.88	3.02	29.90	0.00443101	0.00055388	48528
10	15	8.96	1.03	9.99	0.00140389	0.00017549	51068
11	15	13.39	1.52	14.91	0.00198346	0.00024793	54014
12	15	26.85	3.02	29.87	0.00343691	0.00042961	62492
13	20	13.55	1.51	15.06	0.00160642	0.00020080	67471
14	20	17.97	2.00	19.97	0.00205585	0.00025698	69945
15	20	35.73	3.98	39.72	0.00361358	0.00045170	79107

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.54	0.32	2.86	0.00029301	0.00007325	34657
2	3	5.20	0.63	5.83	0.00056577	0.00014144	36730
3	3	7.90	0.87	8.77	0.00081569	0.00020392	38725
4	5	4.44	0.48	4.91	0.00041495	0.00010374	42761
5	5	8.83	1.04	9.87	0.00074287	0.00018572	47558
6	5	13.31	1.51	14.82	0.00108026	0.00027007	49277
7	10	9.00	1.03	10.03	0.00054465	0.00013616	66088
8	10	17.93	1.99	19.93	0.00096737	0.00024184	74160
9	10	26.88	3.02	29.90	0.00131898	0.00032975	81513
10	15	8.96	1.03	9.99	0.00042702	0.00010675	83947
11	15	13.39	1.52	14.91	0.00061489	0.00015372	87118
12	15	26.85	3.02	29.87	0.00107595	0.00026899	99808
13	20	13.55	1.51	15.06	0.00050027	0.00012507	108329
14	20	17.97	2.00	19.97	0.00064074	0.00016019	112210
15	20	35.73	3.98	39.72	0.00114662	0.00028665	124653


SHRP (P46) - TYPE I
TM # AL-149 Treated
1 day cure (1 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 6322.3x^0.6409
R² = 0.9815
EXTERNAL
y = 1122.5x^0.9355
R² = 0.9896
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 15, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Aggregate Base - crushed (AL149)

COMMENTS : TREATED, 1-DAY CURE

LAB # : 14321-S

SAMPLE # : 2 of 2

LBR : 240.0

SOIL CLASS :

FINAL % (w) : 4.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

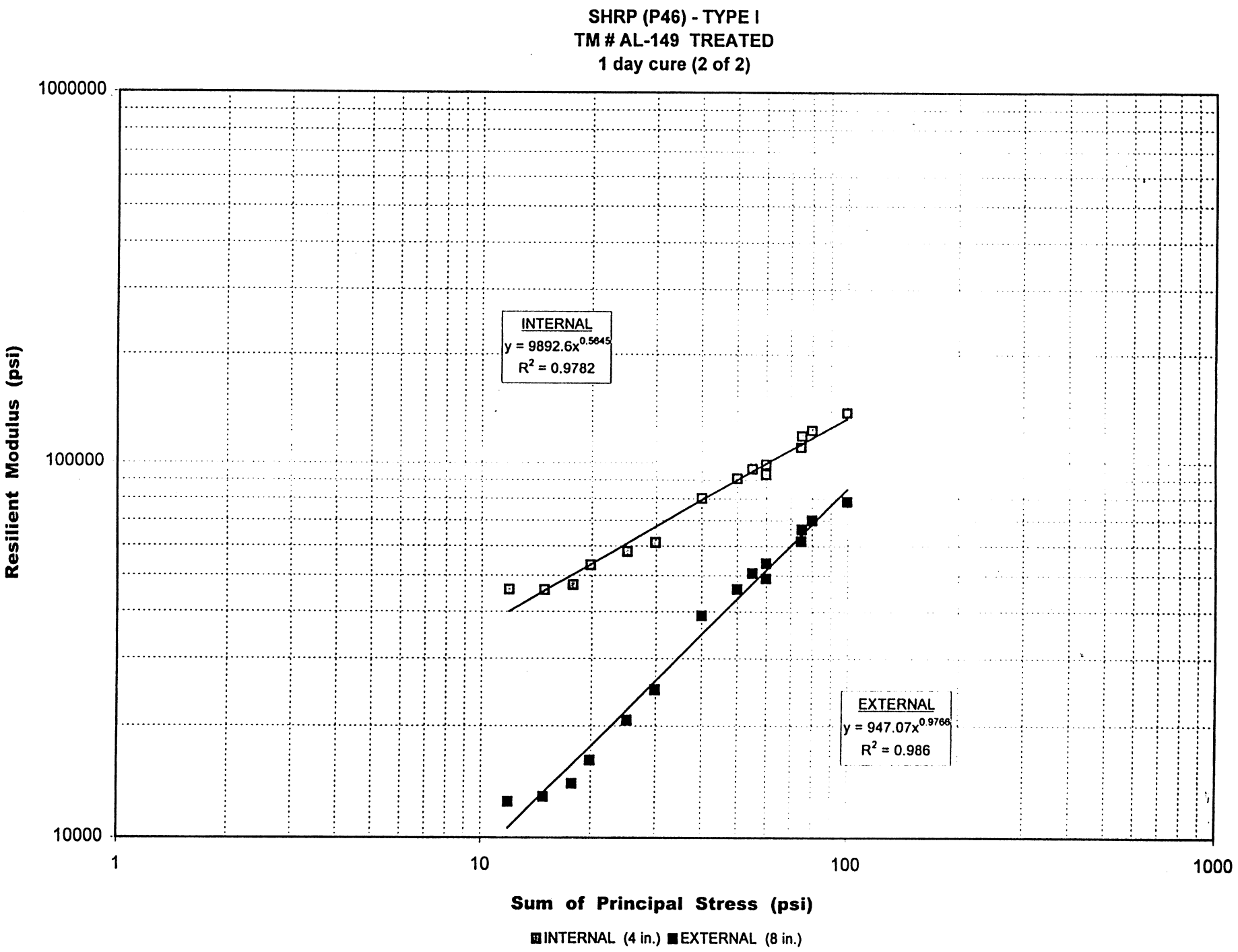
INSITU or TARGET MOIST. / DENSITY:
6.2 @ 142.6
ACTUAL MOISTURE / DENSITY:
6.3 @ 140.2

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.55	0.32	2.87	0.00163356	0.00020419	12481
2	3	5.24	0.63	5.87	0.00325808	0.00040726	12872
3	3	7.89	0.87	8.77	0.00451891	0.00056486	13976
4	5	4.39	0.47	4.86	0.00216961	0.00027120	16178
5	5	9.00	1.03	10.03	0.00348302	0.00043538	20682
6	5	13.34	1.51	14.85	0.00429096	0.00053637	24874
7	10	8.98	1.04	10.01	0.00184212	0.00023027	38980
8	10	17.97	1.99	19.96	0.00313959	0.00039245	45790
9	10	26.88	3.03	29.91	0.00438835	0.00054854	49001
10	15	8.97	1.03	10.00	0.00141725	0.00017716	50614
11	15	13.48	1.51	15.00	0.00200242	0.00025030	53868
12	15	26.74	3.02	29.76	0.00346362	0.00043295	61759
13	20	13.50	1.51	15.02	0.00162840	0.00020355	66342
14	20	17.93	1.99	19.92	0.00204853	0.00025607	70037
15	20	35.74	3.98	39.72	0.00363987	0.00045498	78556

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.55	0.32	2.87	0.00022277	0.00005569	45761
2	3	5.24	0.63	5.87	0.00045977	0.00011494	45607
3	3	7.89	0.87	8.77	0.00067005	0.00016751	47128
4	5	4.39	0.47	4.86	0.00032920	0.00008230	53309
5	5	9.00	1.03	10.03	0.00062221	0.00015555	57887
6	5	13.34	1.51	14.85	0.00087257	0.00021814	61161
7	10	8.98	1.04	10.01	0.00044813	0.00011203	80117
8	10	17.97	1.99	19.96	0.00079242	0.00019810	90712
9	10	26.88	3.03	29.91	0.00115480	0.00028870	93105
10	15	8.97	1.03	10.00	0.00037229	0.00009307	96339
11	15	13.48	1.51	15.00	0.00054379	0.00013595	99180
12	15	26.74	3.02	29.76	0.00096693	0.00024173	110612
13	20	13.50	1.51	15.02	0.00045373	0.00011343	119048
14	20	17.93	1.99	19.92	0.00058214	0.00014554	123229
15	20	35.74	3.98	39.72	0.00103501	0.00025875	138130


SHRP (P46) - TYPE I
TM # AL-149 TREATED
1 day cure (2 of 2)
1000000
100000
10000
Resilient Modulus (psi)
INTERNAL
y = 9892.6x^0.5645
R^2 = 0.9782
EXTERNAL
y = 947.07x^0.9766
R^2 = 0.986
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 15, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Aggregate Base - crushed (AL-149)

COMMENTS : TREATED, 28-DAY CURE

LAB # : 14321-S

SAMPLE # : 1 of 2

LBR : 240.0

SOIL CLASS :

FINAL % (w) : 4.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

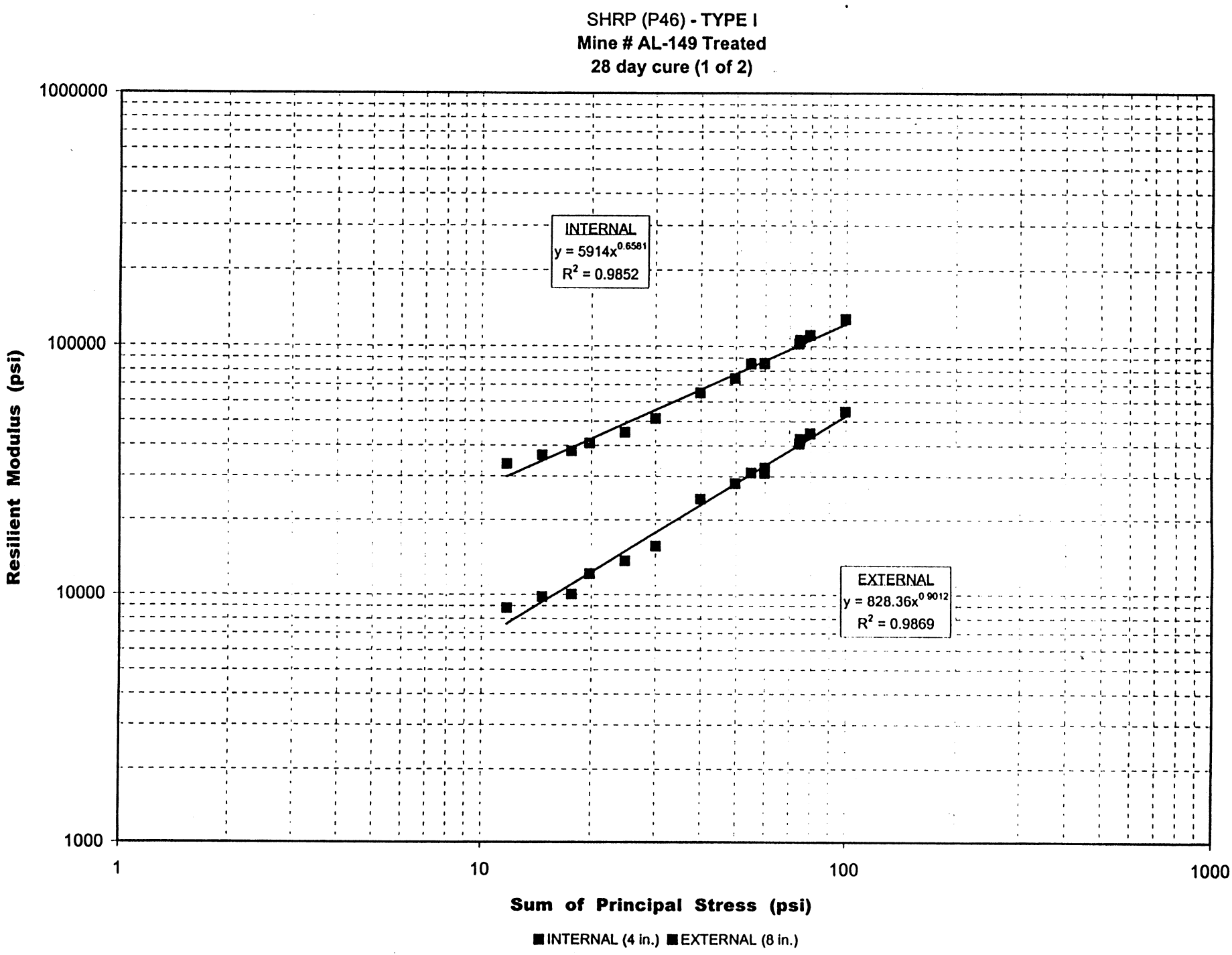
INSITU or TARGET MOIST. / DENSITY:
6.2 @ 142.6
ACTUAL MOISTURE / DENSITY:
5.7 @ 142.2

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.40	0.32	2.72	0.00217565	0.00027196	8811
2	3	5.03	0.63	5.66	0.00411171	0.00051396	9778
3	3	7.78	0.87	8.65	0.00620376	0.00077547	10028
4	5	4.30	0.48	4.78	0.00283881	0.00035485	12127
5	5	8.70	1.04	9.74	0.00509245	0.00063656	13671
6	5	13.54	1.51	15.05	0.00692251	0.00086531	15643
7	10	8.86	1.03	9.89	0.00292112	0.00036514	24268
8	10	17.76	1.98	19.75	0.00505884	0.00063236	28093
9	10	26.82	3.02	29.84	0.00695095	0.00086887	30866
10	15	8.96	1.04	10.00	0.00230837	0.00028855	31055
11	15	13.43	1.51	14.94	0.00330764	0.00041345	32476
12	15	26.39	3.02	29.41	0.00518811	0.00064851	40691
13	20	13.40	1.52	14.92	0.00252813	0.00031602	42416
14	20	17.83	1.99	19.83	0.00319517	0.00039940	44645
15	20	35.72	3.97	39.69	0.00523077	0.00065385	54628

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.40	0.32	2.72	0.00028483	0.00007121	33652
2	3	5.03	0.63	5.66	0.00055069	0.00013767	36504
3	3	7.78	0.87	8.65	0.00081957	0.00020489	37955
4	5	4.30	0.48	4.78	0.00042271	0.00010568	40722
5	5	8.70	1.04	9.74	0.00077217	0.00019304	45080
6	5	13.54	1.51	15.05	0.00105872	0.00026468	51141
7	10	8.86	1.03	9.89	0.00054595	0.00013649	64924
8	10	17.76	1.98	19.75	0.00095745	0.00023936	74216
9	10	26.82	3.02	29.84	0.00125822	0.00031456	85258
10	15	8.96	1.04	10.00	0.00042185	0.00010546	84968
11	15	13.43	1.51	14.94	0.00062695	0.00015674	85668
12	15	26.39	3.02	29.41	0.00103200	0.00025800	102282
13	20	13.40	1.52	14.92	0.00050845	0.00012711	105451
14	20	17.83	1.99	19.83	0.00064592	0.00016148	110424
15	20	35.72	3.97	39.69	0.00111645	0.00027911	127971


SHRP (P46) - TYPE I
Mine # AL-149 Treated
28 day cure (1 of 2)
1000000
100000
10000
1000
Resilient Modulus (psi)
INTERNAL
y = 5914x^0.6581
R² = 0.9852
EXTERNAL
y = 828.36x^0.9012
R² = 0.9869
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.)
EXTERNAL (8 in.)

RESILIENT MODULUS TEST RESULTS

FOUNDATIONS LABORATORY - STATE MATERIALS OFFICE

PROCEDURE : SHRP (P46) - TYPE I

DATE : June 15, 1999

PROJECT NO. : 1910661B101 U of F Lime Treated Base Study

MATERIAL DESCRIPTION : Aggregate Base - crushed (AL149)

COMMENTS : TREATED, 28-DAY CURE

LAB # :	14321-S
SAMPLE # :	2 of 2
LBR :	240.0
SOIL CLASS :	
FINAL % (w) :	4.6

CONDITIONING INFORMATION:
REPETITIONS = 200
σ DEVIATOR = 15 psi
σ CONFINING = 15 psi

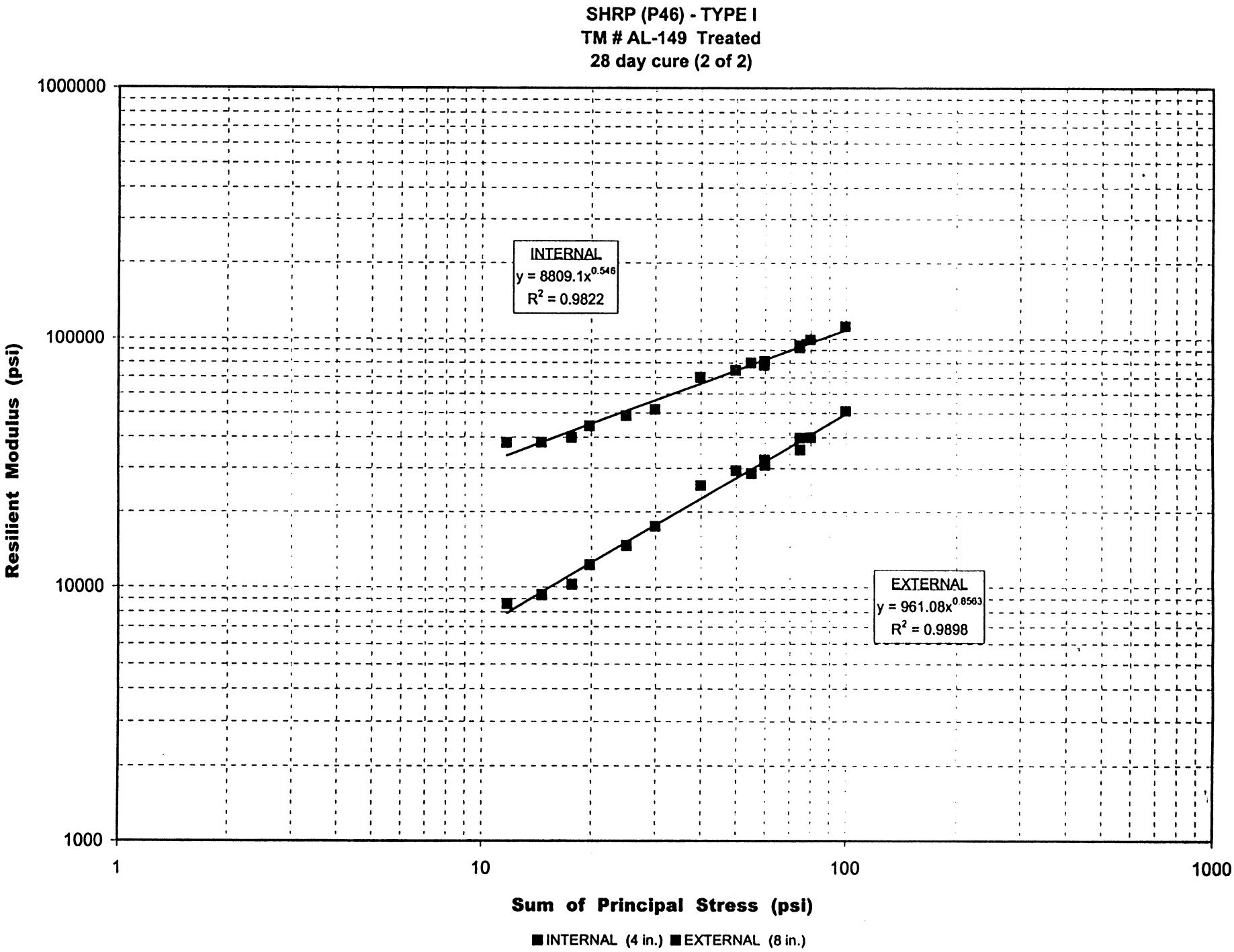
INSITU or TARGET MOIST. / DENSITY:
6.2 @ 142.6
ACTUAL MOISTURE / DENSITY:
5.7 @ 141.9

EXTERNAL (8")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.41	0.32	2.72	0.00223770	0.00027971	8599
2	3	4.95	0.63	5.59	0.00425865	0.00053233	9306
3	3	7.80	0.87	8.67	0.00609086	0.00076136	10249
4	5	4.31	0.48	4.78	0.00281511	0.00035189	12241
5	5	8.91	1.04	9.94	0.00487743	0.00060968	14607
6	5	13.42	1.52	14.94	0.00615033	0.00076879	17459
7	10	8.92	1.03	9.95	0.00279658	0.00034957	25504
8	10	17.94	1.99	19.93	0.00488949	0.00061119	29354
9	10	26.80	3.02	29.82	0.00658683	0.00082335	32551
10	15	8.94	1.04	9.97	0.00250141	0.00031268	28580
11	15	13.44	1.51	14.95	0.00348517	0.00043565	30852
12	15	26.62	3.02	29.64	0.00535186	0.00066898	39799
13	20	13.29	1.51	14.80	0.00298273	0.00037284	35642
14	20	17.96	1.99	19.95	0.00359850	0.00044981	39929
15	20	35.68	3.97	39.66	0.00559747	0.00069968	51001

INTERNAL (4")

TEST SEQ. #	CONFINING STRESS (psi)	CYCLIC STRESS (psi)	CONTACT STRESS (psi)	MAX. AXIAL STRESS (psi)	RESILIENT DEFORMATION (in)	RESILIENT STRAIN (in/in)	RESILIENT MODULUS (psi)
1	3	2.41	0.32	2.72	0.00025337	0.00006334	37974
2	3	4.95	0.63	5.59	0.00052052	0.00013013	38069
3	3	7.80	0.87	8.67	0.00078294	0.00019573	39866
4	5	4.31	0.48	4.78	0.00038953	0.00009738	44233
5	5	8.91	1.04	9.94	0.00073166	0.00018292	48687
6	5	13.42	1.52	14.94	0.00103760	0.00025940	51744
7	10	8.92	1.03	9.95	0.00051061	0.00012765	69843
8	10	17.94	1.99	19.93	0.00095918	0.00023979	74817
9	10	26.80	3.02	29.82	0.00136810	0.00034202	78360
10	15	8.94	1.04	9.97	0.00044727	0.00011182	79917
11	15	13.44	1.51	14.95	0.00066272	0.00016568	81124
12	15	26.62	3.02	29.64	0.00113154	0.00028288	94120
13	20	13.29	1.51	14.80	0.00057740	0.00014435	92061
14	20	17.96	1.99	19.95	0.00072304	0.00018076	99361
15	20	35.68	3.97	39.66	0.00126727	0.00031682	112635


SHRP (P46) - TYPE I
TM # AL-149 Treated
28 day cure (2 of 2)
1000000
100000
10000
1000
Resilient Modulus (psi)
INTERNAL
y = 8809.1x^0.546
R² = 0.9822
EXTERNAL
y = 961.08x^0.8563
R² = 0.9898
1
10
100
1000
Sum of Principal Stress (psi)
INTERNAL (4 in.) EXTERNAL (8 in.)

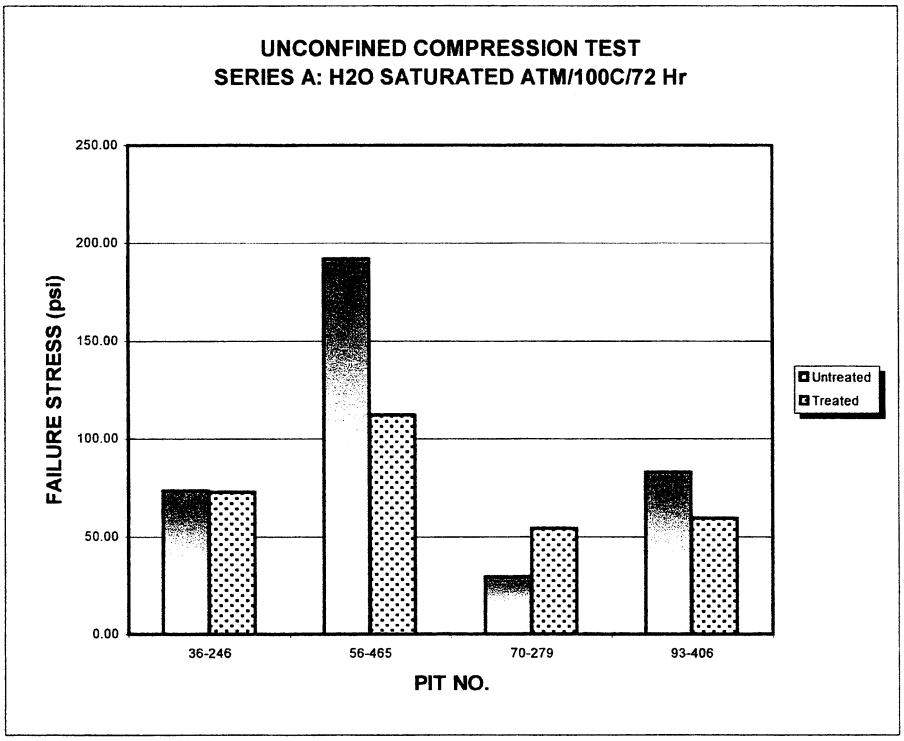
APPENDIX F: RESULTS FROM UNCONFINED COMPRESSION TESTS

Unconfined Compression Test (UCT)

Series A: H_2O Saturated Atmosphere/100C/72 Hr

(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

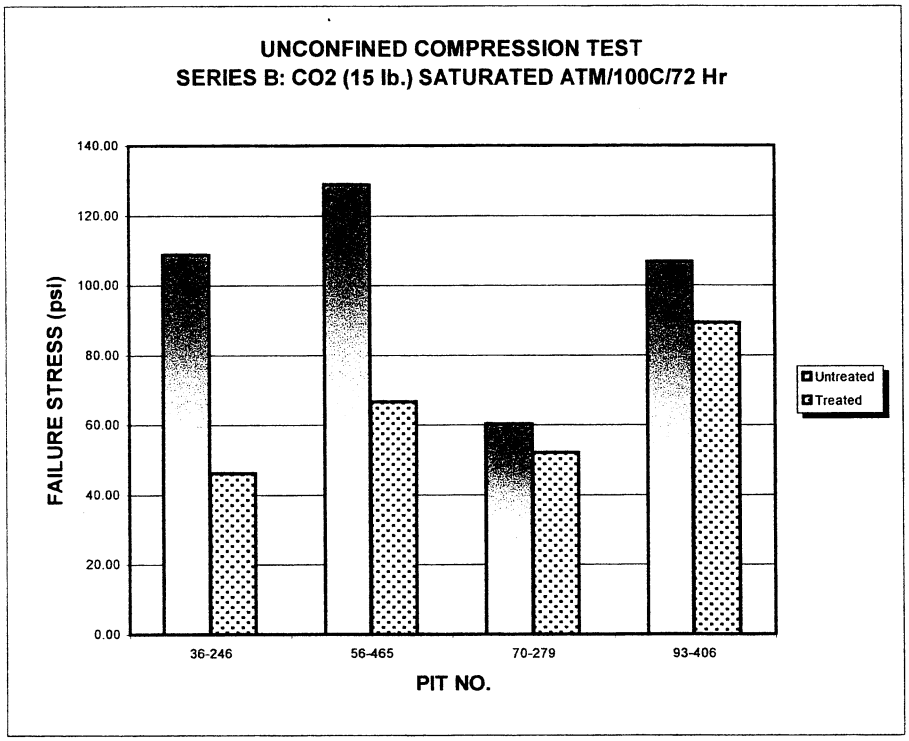
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	49.09	73.24
		2	U	97.38	
		1	T	65.46	72.84
		2	T	80.21	
56-465	high $CaCO_3$	1	U	150.22	192.11
		2	U	233.99	
		1	T	137.48	112.10
		2	T	86.71	
70-279	low $CaCO_3$	1	U	31.92	29.48
		2	U	27.03	
		1	T	62.97	53.99
		2	T	45.00	
93-406	low $CaCO_3$	1	U	92.48	82.66
		2	U	72.83	
		1	T	62.97	59.32
		2	T	55.66	



Unconfined Compression Test (UCT)

Series B: CO2 (15 lb.) Saturated Atmosphere/100C/72 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

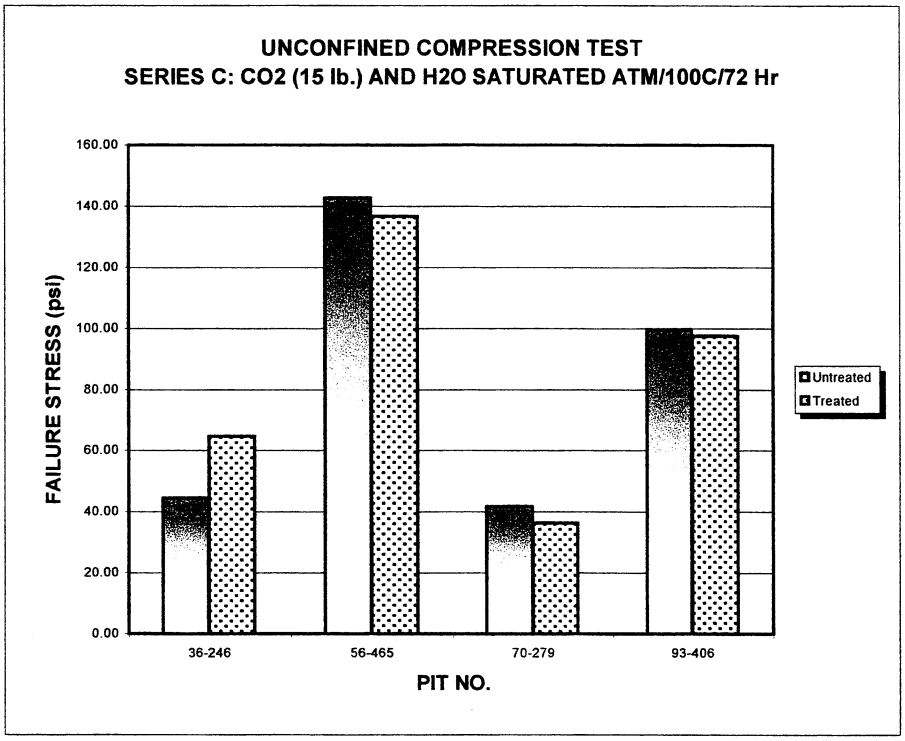
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	88.42	108.86
		2	U	129.29	
		1	T	42.50	46.21
		2	T	49.91	
56-465	high $CaCO_3$	1	U	118.62	128.84
		2	U	139.06	
		1	T	62.93	66.64
		2	T	70.34	
70-279	low $CaCO_3$	1	U	63.83	60.17
		2	U	56.50	
		1	T	62.20	51.95
		2	T	41.69	
93-406	low $CaCO_3$	1	U	99.00	106.78
		2	U	114.55	
		1	T	86.71	89.25
		2	T	91.78	



Unconfined Compression Test (UCT)

Series C: CO2 (15 lb.) and H2O Saturated Atmosphere/100C/72 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

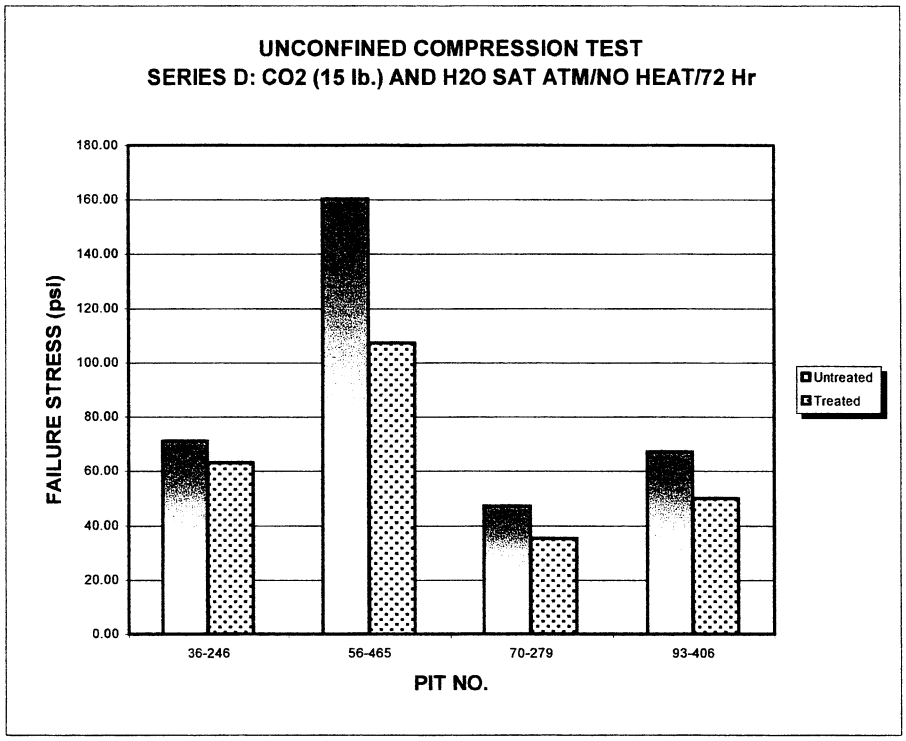
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	40.14	44.50
		2	U	48.85	
		1	T	71.16	64.62
		2	T	58.08	
56-465	high $CaCO_3$	1	U	188.99	142.78
		2	U	96.57	
		1	T	136.61	136.61
		2	T	136.61	
70-279	low $CaCO_3$	1	U	38.43	41.72
		2	U	45.00	
		1	T	42.52	36.39
		2	T	30.25	
93-406	low $CaCO_3$	1	U	107.17	99.39
		2	U	91.61	
		1	T	99.79	97.35
		2	T	94.90	



Unconfined Compression Test (UCT)

Series D: CO2 (15 lb.) and H2O Saturated Atmosphere/No Heat/72 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

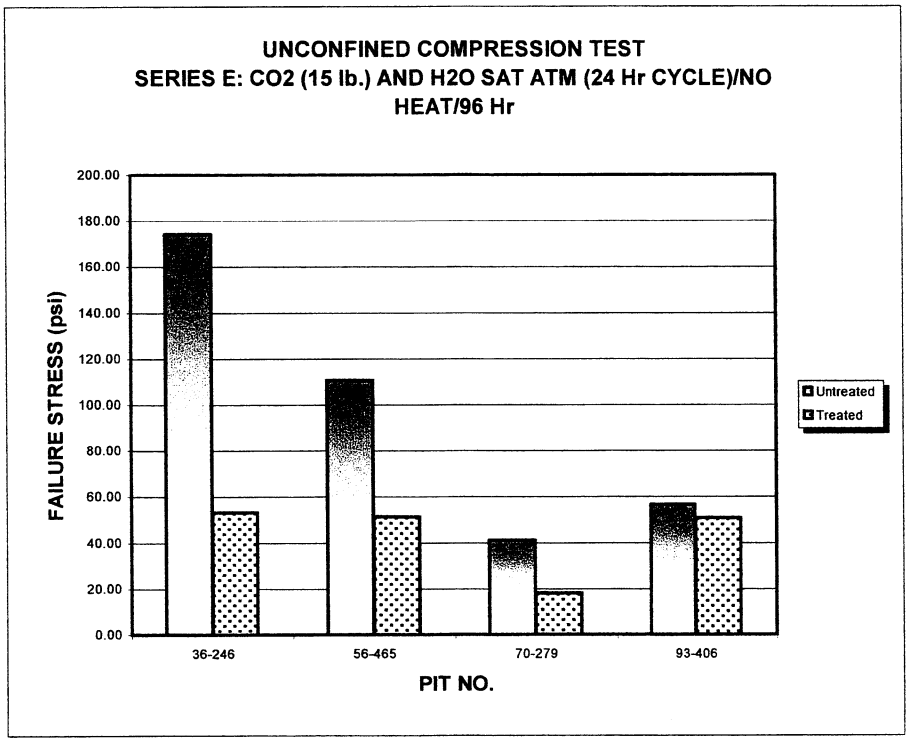
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	85.08	71.04
		2	U	56.99	
		1	T	49.91	63.02
		2	T	76.13	
56-465	high $CaCO_3$	1	U	152.98	160.31
		2	U	167.63	
		1	T	115.36	107.18
		2	T	99.00	
70-279	low $CaCO_3$	1	U	45.02	47.06
		2	U	49.09	
		1	T	45.84	35.18
		2	T	24.51	
93-406	low $CaCO_3$	1	U	73.60	67.09
		2	U	60.57	
		1	T	45.84	49.91
		2	T	53.98	



Unconfined Compression Test (UCT)

Series E: CO2 (15 lb.) and H2O Sat. Atmosphere (24 Hr Cycle)/No Heat/96 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

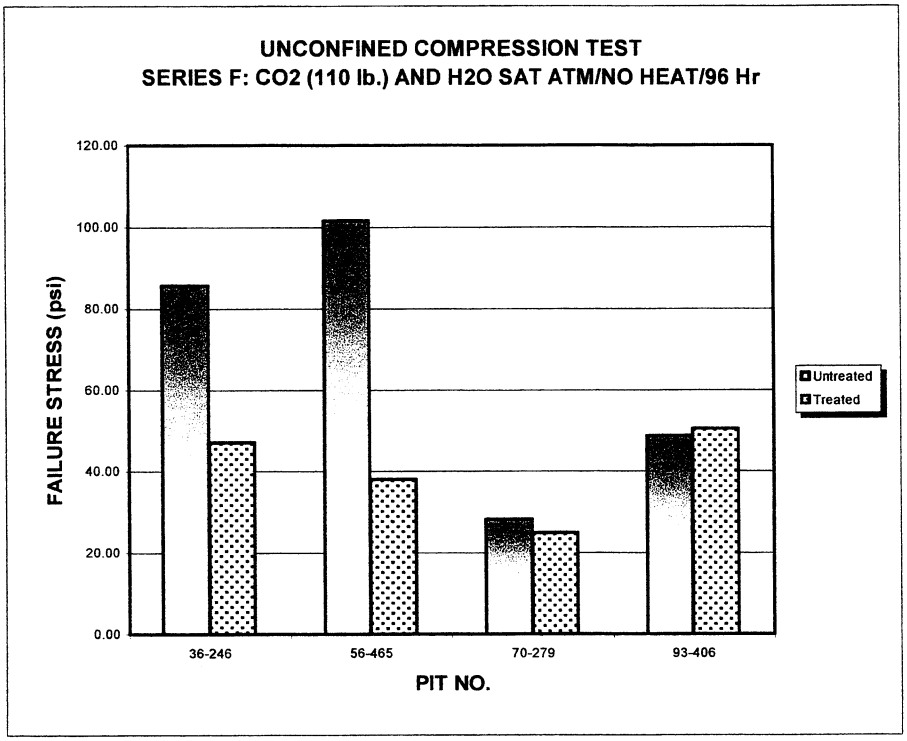
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	186.57	174.30
		2	U	162.03	
		1	T	57.27	53.18
		2	T	49.09	
56-465	high $CaCO_3$	1	U	112.94	110.46
		2	U	107.97	
		1	T	58.88	51.14
		2	T	43.39	
70-279	low $CaCO_3$	1	U	45.81	40.91
		2	U	36.01	
		1	T	0.00	18.01
		2	T	36.01	
93-406	low $CaCO_3$	1	U	61.36	56.47
		2	U	51.57	
		1	T	49.90	50.74
		2	T	51.57	



Unconfined Compression Test (UCT)

Series F: CO2 (110 lb.) and H2O Saturated Atmosphere/No Heat/96 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

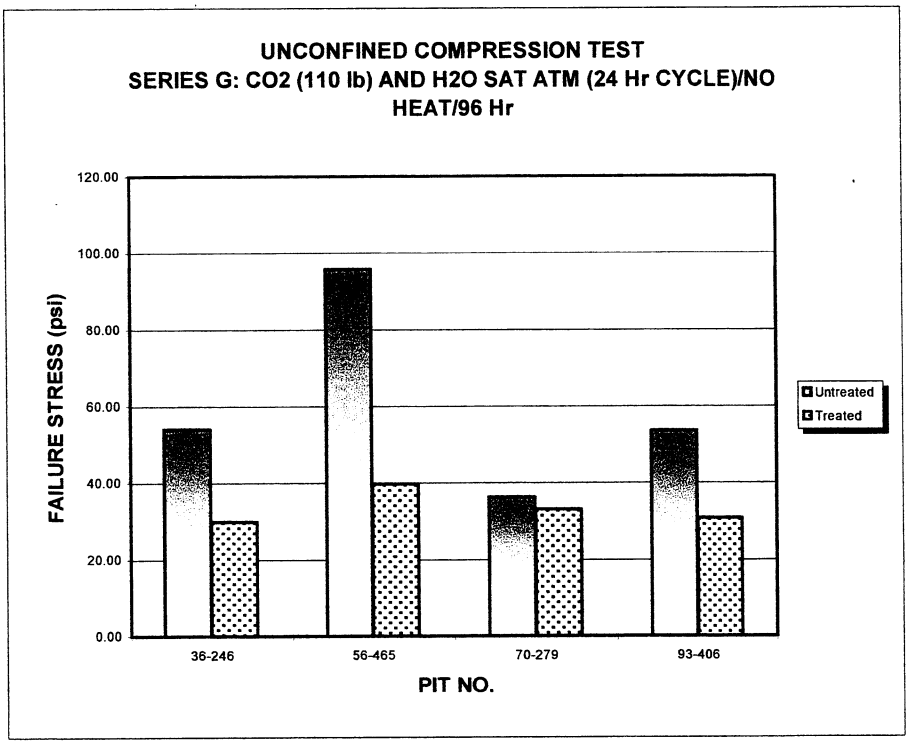
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	106.36	85.51
		2	U	64.65	
		1	T	49.09	47.05
		2	T	45.00	
56-465	high $CaCO_3$	1	U	100.66	101.47
		2	U	102.27	
		1	T	35.21	38.06
		2	T	40.91	
70-279	low $CaCO_3$	1	U	31.12	28.24
		2	U	25.35	
		1	T	28.64	24.95
		2	T	21.26	
93-406	low $CaCO_3$	1	U	54.79	48.66
		2	U	42.52	
		1	T	49.09	50.33
		2	T	51.57	



Unconfined Compression Test (UCT)

Series G: CO_2 (110 lb.) and H_2O Sat. Atmosphere (24 Hr Cycle)/No Heat/96 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

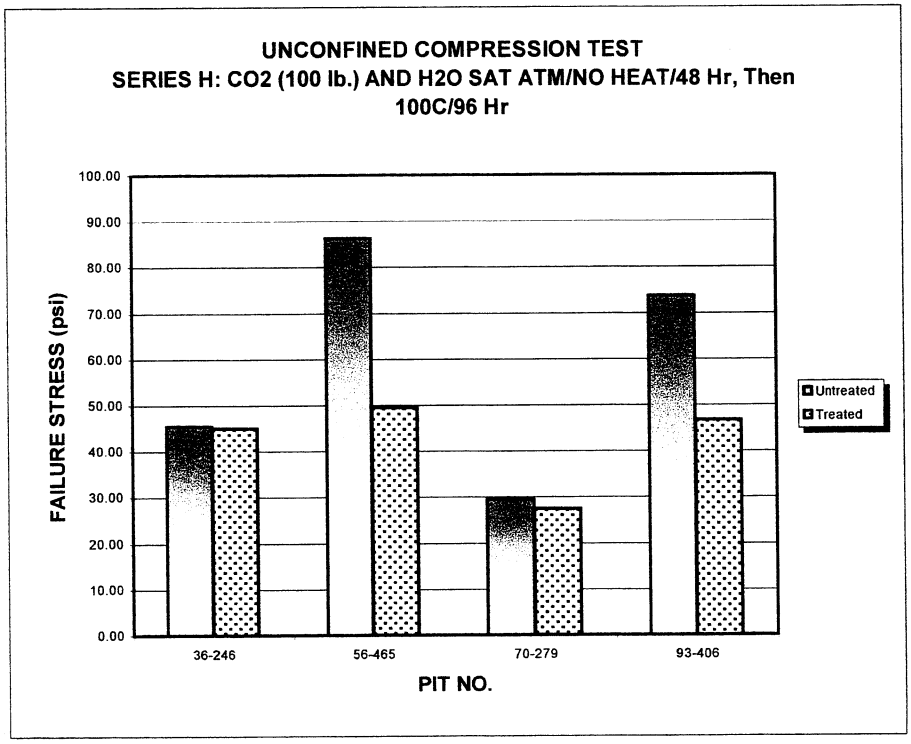
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	54.79	53.99
		2	U	53.18	
		1	T	27.83	29.88
		2	T	31.92	
56-465	high $CaCO_3$	1	U	81.82	95.74
		2	U	109.65	
		1	T	36.82	39.67
		2	T	42.52	
70-279	low $CaCO_3$	1	U	31.12	36.31
		2	U	41.50	
		1	T	33.53	33.13
		2	T	32.73	
93-406	low $CaCO_3$	1	U	53.18	53.59
		2	U	53.99	
		1	T	34.34	30.69
		2	T	27.03	



Unconfined Compression Test (UCT)

Series H: CO2 (100 lb.) and H2O Sat. Atm./No Heat/48 Hr, Then 100C/96 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

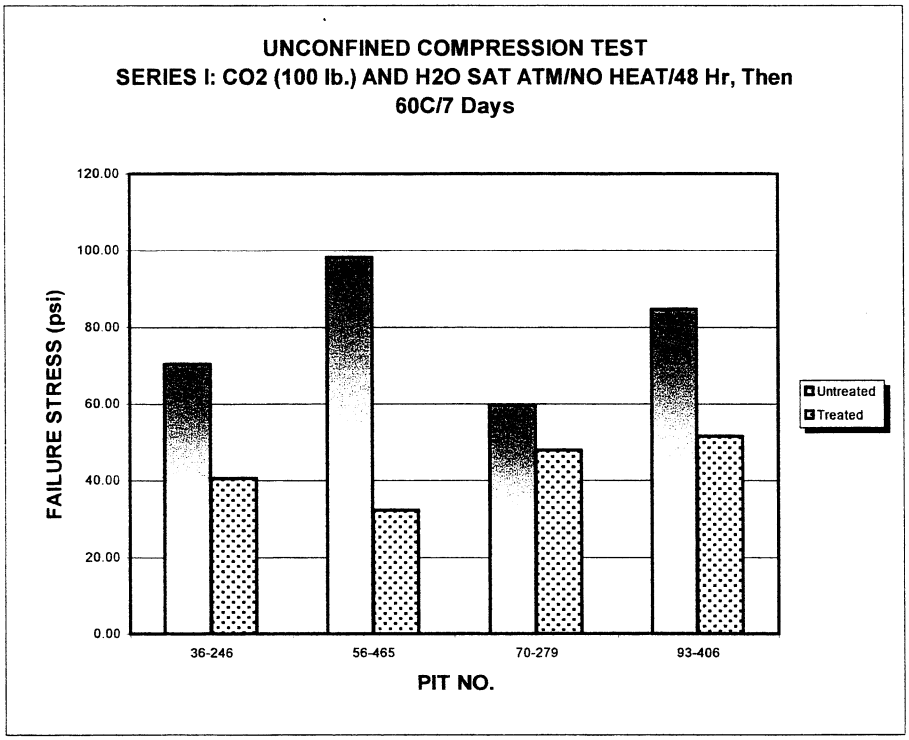
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	47.48	45.44
		2	U	43.39	
		1	T	47.48	45.00
		2	T	42.52	
56-465	high $CaCO_3$	1	U	93.29	86.32
		2	U	79.34	
		1	T	48.29	49.50
		2	T	50.70	
70-279	low $CaCO_3$	1	U	22.94	29.48
		2	U	36.01	
		1	T	32.73	27.40
		2	T	22.06	
93-406	low $CaCO_3$	1	U	53.18	73.64
		2	U	94.09	
		1	T	52.38	46.65
		2	T	40.91	



Unconfined Compression Test (UCT)

Series I: CO2 (100 lb.) and H2O Sat. Atm./No Heat/48 Hr, Then 60C/7 Days
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

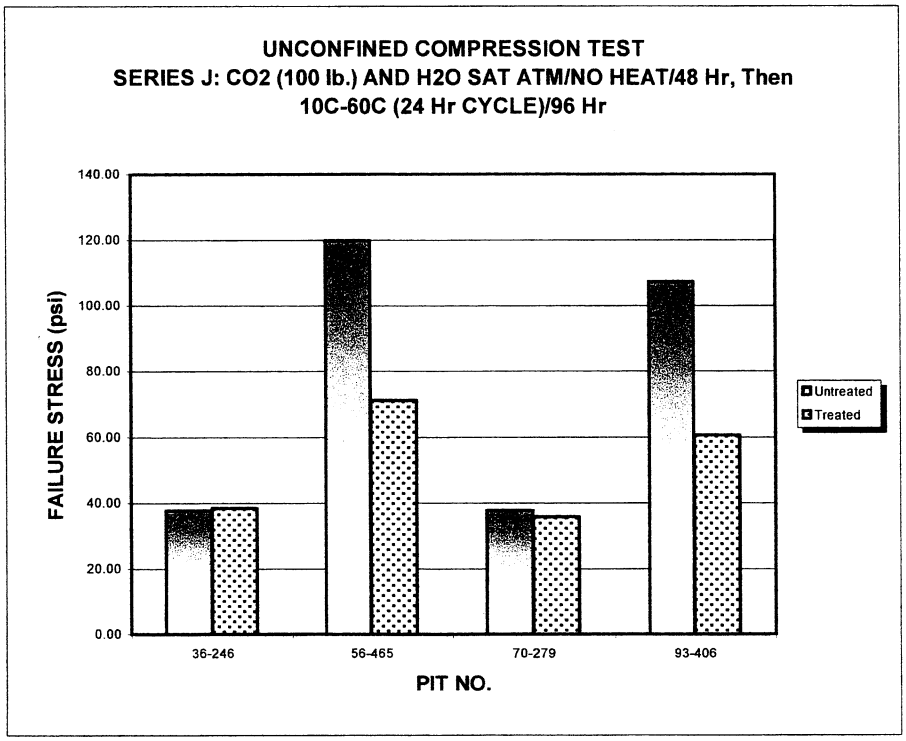
Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	59.75	70.38
		2	U	81.01	
		1	T	30.25	40.48
		2	T	50.70	
56-465	high $CaCO_3$	1	U	99.79	98.18
		2	U	96.57	
		1	T	40.91	32.33
		2	T	23.74	
70-279	low $CaCO_3$	1	U	68.74	59.72
		2	U	50.70	
		1	T	43.39	47.89
		2	T	52.38	
93-406	low $CaCO_3$	1	U	70.35	84.67
		2	U	98.99	
		1	T	56.47	51.54
		2	T	46.61	



Unconfined Compression Test (UCT)

Series J: CO2 (100 lb.) and H2O Sat. Atm./No Heat/48 Hr,
Then 10C-60C (24 Hr Cycle)/96 Hr
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	38.50	37.53
		2	U	36.55	
		1	T	39.30	38.43
		2	T	37.56	
56-465	high $CaCO_3$	1	U	120.25	119.85
		2	U	119.44	
		1	T	76.12	71.19
		2	T	66.26	
70-279	low $CaCO_3$	1	U	27.83	37.66
		2	U	47.48	
		1	T	35.21	35.61
		2	T	36.01	
93-406	low $CaCO_3$	1	U	113.74	107.20
		2	U	100.66	
		1	T	51.57	60.56
		2	T	69.55	



Unconfined Compression Test (UCT)

Series K: CO2 (100 lb.) and H2O Sat. Atm./No Heat/72 Hr,
Then Dessicator/7 Days/Natural Barometric Pressure
(U = untreated, T = treated with 1% hydrated lime -- $Ca(OH)_2$)

Pit No.	Limestone Type	Trial No.	T/U	Failure Stress (psi)	Avg. Failure Stress (psi)
36-246	high $CaCO_3$	1	U	61.36	65.05
		2	U	68.74	
		1	T	42.52	42.52
		2	T	42.52	
56-465	high $CaCO_3$	1	U	102.27	94.09
		2	U	85.91	
		1	T	55.66	58.11
		2	T	60.56	
70-279	low $CaCO_3$	1	U	66.26	65.99
		2	U	65.72	
		1	T	52.38	46.65
		2	T	40.91	
93-406	low $CaCO_3$	1	U	57.72	53.41
		2	U	49.09	
		1	T	40.10	33.57
		2	T	27.03	

