EFFECTS OF STRESS-RELEASE DISTURBANCE ON THE SHEAR BEHAVIOUR OF SIMULATED OFFSHORE CLAYS SUBJECTED TO DRAINED STORAGE

by

SEBASTIAN LUNG-KWONG LAU

A thesis
presented to the University of Manitoba
in partial fulfillment of the requirements for the degree of
Master of Science
in
Civil Engineering

Winnipeg, Manitoba, 1986

ISBN 0-315-34037-1

EFFECTS OF STRESS-RELEASE DISTURBANCE ON THE SHEAR BEHAVIOUR OF SIMULATED OFFSHORE CLAYS SUBJECTED TO DRAINED STORAGE

BY

SEBASTIAN LUNG-KWONG LAU

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

ABSTRACT

The main objectives of this thesis were to examine the effects of stress-release disturbance on normally consolidated and overconsolidated samples of simulated offshore clay, and to search for a laboratory procedure to best recover the in situ undrained shear strength. Seventeen "samples" of illitic clay were consolidated one-dimensionally, offloaded, stored "drained" under three storage times, reconsolidated using three different procedures, and sheared undrained. The results were compared with six control "in situ specimens" that had not been offloaded.

For normally consolidated clay, anisotropic reconsolidation to the in situ stresses was successful in reproducing the in situ shear strength (s_u) only from the 15-minute "sample". It underestimated the s_u by 9% and 14% from the 1-day "sample" and the 1-week "sample" respectively. The isotropic reconsolidation to 0.6x(overburden stress) underestimated the in situ s_u by 18% to 19%, and while isotropic reconsolidation to 1.0x(overburden stress) overestimated the in situ value by 10% to 20% for three storage times.

For the overconsolidated clay, both the anisotropic and the isotropic 0.6x(overburden stress) procedures successfully reproduced the in situ s_u from the 15-minute "samples". They underestimated the in situ value by 18% to 29% from the 1-day and 1-week "samples". The isotropic 1.0x(overburden stress) reconsolidation overestimated the in situ s_u by 21% and 11% from the 15-minute "sample" and the 1-day "sample" respectively, but was successful in recovering the s_u from the 1-week "sample".

The effects of increasing storage time tended to decrease the undrained shear strength, and increase the porewater presssure parameters A_f and m if the "samples" were subjected to identical reconsolidation procedures. All three reconsolidation procedures overestimated the porewater pressure parameters A_f and m, the axial strains at failure. They underestimated the modulus E_{50} from both the normally consolidated "samples" and the overconsolidated "samples".

ACKNOWLEDGEMENTS

The author wishes to express his sincere thanks to his advisor, Dr. J. Graham, for his advice, encourgement and patience throughout the project and especially during the preparation of this thesis.

The author also wishes to thank fellow graduate students, N. Chandler, M. Rahman and B. Sun for their helpful assistance throughout the testing program.

Special thanks is given to the technical staff of the Civil Engineering Department, especially N. Piamsalee, for their technical assistance during the experimental investigation.

Financial assistance, in form of support from the University of Manitoba Graduate Fellowship and NSERC grant are acknowledged.

The author is also deeply indebted to his parents for their continued support and encouragement throughout his graduate studies.

TABLE OF CONTENTS

LIST OF SYMBOLS

A,B	- porewater pressure parameters (after Skempton 1954)
A_f	- value of $A = \Delta u/\Delta q$ at failure
A_{fF}	- in situ value of A_f at field
A_{fS}	- value of A_f for samples during unconsolidated undrained triaxial test in laboratory
A_u	- value of A during undrained shear unloading
c'	- effective cohesion
c_v	- coefficient of consolidation
CAU	- strain-controlled, consolidated anisotropically undrained compression test
CIU	- strain-controlled, consolidated isotropically undrained compression test
CSL	- critical state line
e	- voids ratio
E_{50}	- elastic modulus to 50% of maximum stress in undrained shear
G_{eq},K_{eq}	- shear and bulk moduli
G_s	- specific gravity
I_p	- plasticity index
k	- coefficient of permeability
K	- σ_3'/σ_1'
K_o	- coefficient of earth pressure at rest
LSSV	- length of stress vector
m	- porewater pressure parameter = ($\Delta u/\Delta p$)
NCL	- normal consolidation line
OCR	- overconsolidation ratio
p'	- effective mean principal stress = $(\sigma_1' + \sigma_2' + \sigma_3')/3$

p'_{cons} - value of p' at the end of triaxial consolidation

p'_{iso} - value of p' at yield with isotropic consolidation

q - deviator stress = $(\sigma_1 - \sigma_3)$

q_{max} - maximum deviator stress

s_u - undrained shear strength = $(q_{max}/2)$

s_{uF} - in situ undrained shear strength in field

s_{uS} - undrained shear strength of samples determined by unconsolidated undrained triaxial test

U-U - strain-controlled, unconsolidated undrained compression test

u - porewater pressure

u_f - porewater pressure at failure

u_r - residual porewater pressure

u_{ri} - initial residual porewater pressure

v - volumetric strain

v_c - volumetric strain at the end of triaxial consolidation to σ'_{1c}, σ'_{3c}

V - specific volume = $(1 + e)$

w - moisture content

w_L - liquid limit

w_p - plastic limit

W - strain energy absorbed per unit volume

σ_{cell} - cell pressure (i.e. σ_3)

σ'_{cyl} - vertical effective stress applied during cylinder consolidation

σ'_1, σ'_3 - major and minor principal effective stresses

$\sigma'_{1c}, \sigma'_{3c}$ - σ'_1 and σ'_3 at the end of triaxial consolidation

σ'_{ps} - residual effective stress after perfect sampling

σ'_r - residual effective stress

σ_v	- vertical total stress
σ'_v	- vertical effective stress
σ'_{vc}	- effective preconsolidation pressure
σ'_{vo}	- in situ vertical (overburden) effective stress
σ'_y	- vertical effective stress determined from yield criteria
Φ'	- effective angle of shearing resistance
ϵ_1, ϵ_3	- major and minor principal strains (i.e. axial and lateral strains in triaxial compression test)
ϵ	- shear strain = $2(\epsilon_1 - \epsilon_3)/3$
$\epsilon_{1c}, \epsilon_{3c}$	- ϵ_1 and ϵ_3 at the end of triaxial consolidation to σ'_{1c}, σ'_{3c}
ϵ_{1f}	- axial strain at failure
κ_1	- slope of reload line in ln(p'),V-space during triaxial consolidation
κ_2	- slope of unload line in ln(p'),V-space during triaxial consolidation
λ_1	- slope of normally consolidated line in ln(σ_v),V-space during cylinder consolidation
λ_2	- slope of normally consolidated line in ln(p'),V-space during triaxial consolidation
Δp	- change in total mean principal stress
Δu	- change in porewater pressure
ΔV_{rc}	- volumetric strain during reconsolidation
$\Delta\epsilon_{1rc}, \Delta\epsilon_{3rc}$	- ϵ_1 and ϵ_3 during reconsolidation

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Increasing demand of hydrocarbon recovery has accelerated engineering activities within deep offshore water (McClelland 1974). Of the two principal types of seabed structures used as drilling platforms in the deepwater offshore hydrocarbon recovery, pile-supported structures are believed to be more economical compared with gravity structures. In the shallow water of Canada's East coast, a decision has been made partly because of difficult environmental loadings from waves and icebergs, and partly on socio-economic grounds, to develop large concrete gravity structures. Design engineers must now design larger and longer piles, or larger and heavier footings for greater structural loads (Semple et al. 1982). Kwok (1984) stated that one of the essential requirements for the safe design of offshore platforms is a better understanding of the strength of seabed clays underneath proposed structures.

In practice, both in situ tests and laboratory testing on recovered soil specimens are performed to measure the strength of offshore clays. While in situ measurement of the soil properties seems conceptually attractive, the design, fabrication and deployment of in situ apparatus is a complicated, costly, and time-consuming matter (de Ruiter 1976). Due to the expense and complication of in situ tests and also because of some uncertainty in interpreting their results, significant effort must still go into soil sampling and conventional laboratory tests on high quality specimens (Lunne and Christoffersen 1983, Lee 1985). Soil properties interpreted from in situ tests are most often utilized to complement laboratory testing on recovered specimens (Vyas et al. 1983). Soil specimens are also generally required for routine soil classification tests and structural assessment in a geotechnical investigation. It is desirable to measure the soil properties in the laboratory when soil specimens are available even though they may have experienced some disturbance. A complete offshore geotechnical investigation should therefore consist of both extensive in situ testing and a comprehensive sampling program for laboratory testing (Vyas et al. 1983).

Offshore soil specimens are often of relatively poor quality (de Ruiter 1977). When offshore specimens are brought up from their marine environment to the surface, sampling disturbance induced on the recovered specimens may be classified into mechanical disturbance caused by boring and sampling; and process disturbance due to release of total pressures. The effects of mechanical disturbance depend on the nature of the soils, and the sampling techniques which are used in practice. New sampling technology capable of minimizing the mechanical disturbance has greatly improved the quality of specimens recovered from the field (de Ruiter and Richards 1983). The effects caused by mechanical disturbance can therefore be avoided to a greater or less degree.

However the second type of disturbance, namely the process disturbance due to stress release, generally becomes unavoidable when soil specimens are removed from the seabed. The reduction in total stresses during offshore sample recovery results in the generation of negative porewater pressures, swelling of soil materials out of the end of the core tubes, and gas bubbling phenomena (Fukuoka and Nakase 1973; Broms 1980). These effects become even more pronounced for gassy clays which generally expand in a nonuniform manner in the sampling tubes during recovery, causing various degree of disturbance within soil specimens (Young et al. 1983).

Process disturbance due to stress release can affect the shear strength and deformation properties measured in the laboratory (Broms 1980). The author recently (September-October 1985) took part in a sample collecting cruise on the "CSS Hudson" for the Bedford Institute of Oceanography in The Baffin Island area. Sampling of surficial sediments was carried out by piston coring. It was observed that free water accumulated inside the plastic core liners during the sampling process. Small water channels were also formed between the interface of plastic liners and the core surface when the retrieved cores were stored in the liners. These specimens had a great chance to swell because of their easy access to water in tubes. A large number of these cores were observed to swell longitudinally out of the core tubes when on-board testing was carried out. Therefore it might be concluded that the recovered specimens could not maintain totally undrained conditions in the sampling tubes without any swelling.

This thesis deals specifically with the effects of sampling disturbance due to stress release on specimens of reconstituted illitic clay used to simulate seabed clay. Effects of mechanical disturbance are excluded in this testing program. Techniques developed in the University of Manitoba are capable of producing artificial reconstituted laboratory specimens without mechanical disturbance. This permits comparison between so-called "samples" which undergo offloading processes without any mechanical disturbance; and "in situ specimens" which are tested immediately without either offloading or mechanical disturbance. This procedure has been used to model the "perfect samples" that were defined by Ladd and Lambe (1963) as real soils which have experienced no disturbance during sampling other than that associated with stress release. They can then be compared with "in situ specimens" that simulate the behaviour of offshore clay in the field with no disturbance. Both Kwok (1984) and Ambrosie (1985) performed tests separately to model "samples" which had been immediately sealed upon recovery and had been stored under totally undrained conditions. This investigation is a subsequent but parallel study which tested "samples" that were allowed to be fully drained during storage. Other procedures in the tests were maintained similar to the conditions in the earlier studies. This study therefore permits detailed comparison of the results from two different assumed storage conditions (namely totally drained and totally undrained conditions).

1.2 OBJECTIVES

The main objective of this study is to search for a recommended procedure in the laboratory to recover the "in situ" properties of reconstituted illitic clays which experienced only process disturbance due to stress release, but no mechanical disturbance. "Samples" in this study were stored drained, for various periods of time, and then reconsolidated using the same procedures as Kwok (1984) and Ambrosie (1985) who had used undrained storage. The principal objective of the work is therefore to compare the effects of totally drained and totally undrained storage conditions on the stress-strain behaviour of the illite after reconsolidation.

In addition, other objectives of this investigation include:

(1) continued development in the University of Manitoba of techniques for the preparation of identical one-dimensionally consolidated reconstituted clay specimens,

(2) additional information on the engineering properties and classification of illitic clay from Illinois,

(3) additional data for the strength envelopes proposed by Kwok (1984) and Ambrosie (1985),

(4) a preliminary yield envelope for reconstituted illitic clay when combined with the results obtained by Ambrosie (1985).

The laboratory testing program for studying stress release effects consisted of twenty-three 76 mm diameter specimens of the reconstituted illite. Of these twenty-three specimens, eleven were prepared as normally consolidated specimens for comparison with the results of Ambrosie (1985). Twelve specimens were prepared with an overconsolidation ratio (OCR)* equal to 2.0 for comparison with the results of Kwok (1984). Three control specimens from each group (total of six specimens) were used as "in situ specimens" to model the "in situ" behaviour of the clay. The remaining seventeen specimens were tested as "samples" which were allowed to drain fully after being offloaded. In addition to this work, three further overconsolidated specimens were tested to determine a preliminary yield envelope for the clay. The total number of specimens in this program was twenty-six.

A review of previous published work on stress release behaviour will be presented in Chapter 2. This will be followed by a presentation

* see list of symbols on p. vii

of the testing program in Chapter 3. Chapters 4, 5 and 6 respectively present the results obtained from the consolidation; the stress offloading, storage and reconsolidation; and the undrained shear phases of the tests. Chapters 7 and 8 respectively present a discussion and synthesis of the results, and the conclusions from the project. Finally the latter part of the thesis presents tables, figures and appendices referred to in the text.

CHAPTER 2

A REVIEW OF SAMPLE DISTURBANCE ASSOCIATED WITH STRESS RELEASE

2.1 INTRODUCTION

The undrained shear strength of fine-grained marine soils is perhaps the most important single geotechnical parameter needed for offshore foundation design. However the undrained strength has not been a simple property to measure in hostile marine environments (Lee 1979). The strengths of marine sediments are affected by disturbance that occurs when specimens are taken from the seabed and brought to the surface. Sampling disturbance induced in recovered specimens may originate from the two general sources outlined in Chapter 1, namely mechanical disturbance and process disturbance. Because of this, it is usually necessary to combine a program of sampling and laboratory testing, with a program of in situ testing for major structures.

Factors that affect the mechanical disturbance of specimens have been discussed in detail by Broms (1980) and Young et al. (1983). The effects of mechanical disturbance depend on the nature of soils and the sampling techniques which are used. The introduction over a period of years of improved techniques that use thin-wall samplers and seafloor mounted equipment such as Seaclam (Fugro International) and Stingray (McClelland Engineers Inc.) has largely reduced mechanical disturbance, and has significantly improved the quality of recovered specimens. The research presented in this thesis deals only with the second source of disturbance, process disturbance due to stress release. Mechanical disturbance is excluded from the testing program. A detailed review of mechanical disturbance processes will therefore not be undertaken in this thesis.

2.2 GENERAL REVIEW OF PROCESS DISTURBANCE

This section summarizes the work by various investigators on the effects of stress release. Since only a limited number of publications has been published that deal directly with stress relief for offshore clays, similar research on onshore clays will also be included.

It is commonly believed that effective mean stresses before and after "perfect sampling" can be held constant by the generation of negative porewater pressures. However this is disputed by many researchers. Skempton and Sowa (1963), for example, suggested that even when there was no change in water content during "perfect sampling", the recovered specimen was still subjected to significant changes in stress state.

When an offshore specimen is removed from its natural environment to the surface, the in situ confining pressures are inevitably released. This may result from local consolidation of the thin skin of remoulded clay round the inside of the sampling tube. It may also result from the common practice of extruding samples from the tubes shortly after recovery for visual classification, and geological testing (de Ruiter 1976, Young et al. 1983, Long et al. 1986). This procedure is thought to minimize adhesion between the clay and the tube and to reduce the forces and disturbance which would be experienced with longer storage (Lee 1985). The process clearly leads to total stress unloading just after extrusion. In both cases, the clay tends to swell as the total stresses on the specimen decrease towards zero. If the expansion is prevented as it is when the unloading is undrained, negative porewater pressures or pore suctions (u_r) will be developed within the recovered specimen (Mori 1981a). The in situ effective stresses before sampling are anisotropic in a general case. On the other hand, the residual effective stress after the sampling, which is equal and opposite to the pore suction, is isotropic.

For normally consolidated and lightly overconsolidated clays with the coefficient of earth pressure at rest (K_o) less than one, the magnitude of the residual effective stress after "perfect sampling" (σ'_{ps}) has been given by Ladd and Lambe (1963) as:

$$\sigma'_{ps} = \sigma'_{vo} [K_o + A_u (1 - K_o)]$$

where σ'_{vo} = in situ vertical effective stress

A_u = porewater pressure coefficient from release of ground deviator stress during perfect sampling.

Ladd and Lambe (1963) suggested that the porewater pressure coefficient A_u for most normally consolidated clays varies between -0.1 and 0.3. Noorany and Seed (1965) studied a San Francisco Bay mud with a sensitivity of 8 to 10. In this case, A_u was found to range from 0.16 to 0.24 with an average of 0.20. Kirkpatrick (1982a) also reported average values of A_u for illite and kaolin of 0.20 and 0.25 respectively. Broms (1980) showed that the A_u value in the work of Skempton and Sowa (1963) was negative for a remoulded Weald clay with a sensitivity of 2. Similar results have been reported by Bjerrum (1973a) for a plastic clay from Drammen.

Examination of the previously published A_u values suggests that few natural and remoulded soils are perfectly elastic material in which A_u

would be 0.333 (Skempton and Sowa 1963). This would mean therefore that the effective mean stresses before and after "perfect sampling" cannot be constant. Both Skempton and Sowa (1963) and Ladd and Lambe (1963) observed from their laboratory work that the reduction in residual effective stress might be as high as 20% of the "in situ" mean effective stress. The operation of "perfect sampling" causes therefore not only the change in stress system direction discussed in a previous paragraph, but also a decrease in the magnitude of the stresses.

This view has been challenged recently by Kwok (1984) and Ambrosie (1985) in work at the University of Manitoba. Their tests measured A_u values of 0.37 and 0.33 respectively, suggesting only small deviations from elastic behaviour during undrained unloading of shear stress. These deviations may be due to anisotropy of elastic response (Graham and Houlsby 1983).

Examination of the actual residual effective stresses (σ'_r) in tube samples immediately on unloading always shows an appreciable difference from the value of the residual effective stress after "perfect sampling" (σ'_{ps}). Ladd and Lambe (1963), Lee (1979) and others assumed that the additional reduction was purely caused by mechanical disturbance of the clay structure. This assumption may not be completely true. The work by Kirkpatrick and Rennie (1975) implied that the assumption might only be true for insensitive clays removed from relatively shallow depths. The reasons are that most studies on the effects of stress release have been based on the following assumptions.

(1) The compressibility of the porewater is negligible as compared to that of soil skeleton.

(2) The soil water is capable of carrying all tensions without

cavitation, that is, the dissolution of gases (water vapour, methane etc) in the pore spaces of the specimen, and the specimen remains saturated even after stress release.

(3) The absorption of any free water on the surface of the specimen during sampling is so small that the sample volume remains constant.

When a specimen is taken from its deep ocean floor to the surface, the unloading of the total confining pressures on the specimen causes the porewater to expand. Richards and Parker (1968) estimated that the volumetric strains of sea water for depths of 130m and 3700m were 0.06% and 1.6%, respectively. However Broms (1980) concluded that the effect on the measured strength and the deformation properties due to porewater expansion would be small.

Most laboratory studies on stress release have been carried out under back pressures in the pore fluid, or by removal of only the deviator stress component (e.g. Skempton and Sowa 1963; Ladd and Lambe 1963 and others). The total stresses acting on the soil specimens in the laboratory were therefore never fully reduced to atmospheric pressure. This was done to avoid the experimental problems involved with negative porewater pressures. However Kirkpatrick and Rennie (1975) indicated that residual negative porewater pressures decreased with increasing sample age. They concluded that specimens from deep in situ positions cannot maintain their high pore tensions despite being physically undisturbed.

Both dissolved and undissolved gases are found in offshore clays (Young et al. 1983). The offloading experienced during sampling can cause the dissolved gas to come out of solution as bubbles and undissolved gas to expand within the sample. The released volume, which can be estimated with Boyle's and Henry's laws, may be so large that the effective stresses can be reduced to zero (Broms 1980). The release of gas and its subsequent expansion would also cause the recovered specimens to swell. The sample expansion changes the in situ properties measured in the laboratory. Soil explorations in nearshore areas have revealed that the measured degrees of saturation of marine clays in the laboratory decrease with increasing sampling depths (Fukuoka and Nakase 1973).

When an offshore specimen is taken up to the deck of the drill ship, the clay is often observed to swell rather quickly out the end of the core tube (Emrich 1971, Fukuoka and Nakase 1973). Schjetne (1971) also observed swelling of Norwegian quick clay within the sampling tube. But in this case, the swelling was more gradual. Berre and Bjerrum (1973) have explained that the clay during sampling is subjected to the greatest shear deformations in the outer zone of the specimen due to a variation in stress state. After the sampling, the relatively undisturbed central part of the specimen may suffer from a swelling, as excess water migrates from the remoulded zones towards less disturbed zones. The negative porewater pressure in the specimen is thereby reduced. The change in clay microstructure caused by the shear deformations and subsequent internal swelling will make the stress-strain behaviour of the "sample" different from that of in situ soils (Mori 1981b).

The findings in the four previous paragraphs suggest that the second and third of the listed assumptions (p.10) cannot be fulfilled by the sampling procedures commonly employed for most natural clays. A degree of sampling disturbance due to stress release is therefore inevitable in practice.

2.3 DETAILED REVIEW OF PROCESS DISTURBANCE

It is clear that stress release can cause sampling disturbance. Various reseachers have tried to quantify the effects of stress release on recovered specimens. For example, Skempton and Sowa (1963) conducted tests on remoulded specimens of Weald clay (sensitivity = 2) from Surrey, England. Specimens were loaded anisotropically in a triaxial apparatus to simulate in situ conditions. At the end of the consolidation, one specimen was subjected directly to undrained shearing to measure the "in situ" strength of the clay. A second specimen was disturbed by unloading the shear stress to zero under undrained conditions. The specimen at this stage was subject to an isotropic residual effective stress, σ'_{ps}. No significant change in water content (less than 0.4%) was found. This was followed by undrained shearing to measure the shear strength of the "sample". The authors reported that the unloading caused only a small reduction in the "sample" strength of the order of 1% to 2% even though the resulting stress paths were quite different. However the comparison was made for a relatively insensitive remoulded clay. Since there was little change in water content and microstructure for such insensitive clay during "perfect sampling", the effect on strength reduction was expected to be minimal (Broms 1980; Kirkpatrick and Khan 1984). Skempton and Sowa (1963) further concluded that if two identical specimens of saturated clay were subjected to different changes in total stress without alteration in water content and microstructure, the strength of the two specimens would be practically equal.

Ladd and Lambe (1963) also investigated the effect of stress release on normally consolidated Kawasaki clay and Boston Blue clay. The sensitivities for both clays were approximately 5 to 10. Ladd and Bailey (1964) reported that the initial offloading of shear stress decreased the subsequent unconsolidated undrained (U-U) shear strengths of "samples" by 0% to 15% for two clays when compared to the comparable "in situ" shear strengths.

Noorany and Seed (1965) established a link in terms of Hvorslev strength parameters, c_e and Φ_e, between the "sample" strength and the in situ strength. The in situ strength (s_{uF}) of a normally consolidated clay is given by:

$$s_{uF} = \frac{\sigma'_{vo} \sin\Phi_e \, [K_o + A_{fF} \, (1-K_o)] + c_e \cos\Phi_e}{1 + (2A_{fF} - 1)\sin\Phi_e}$$

where Φ_e = Horslev angle of internal friction

c_e = Horslev cohesion of soil

A_{fF} = porewater pressure coefficient at failure in field.

The shear strength of a "sample" (s_{uS}) measured with unconsolidated undrained triaxial test in laboratory is given by:

$$s_{uS} = \frac{\sigma'_{vo} \sin\Phi_e \, [K_o + A_u \, (1-K_o)] + c_e \cos\Phi_e}{1 + (2A_{fS} - 1)\sin\Phi_e}$$

where A_u = porewater pressure coefficient due to release of deviator stress during sampling operation

A_{fS} = porewater presure coefficient at failure for "samples" during unconsolidated undrained triaxial tests.

Note that s_{uF} and s_{uS} are only equal if porewater pressure coefficients A_{fF}, A_u and A_{fS} are identical.

Noorany and Seed (1965) also conducted a series of tests on a soft saturated clay from the San Francisco Bay areas. The sensitivity of the soil was approximately 8 to 10. Identical specimens were anisotropically consolidated in triaxial cells above their in situ stresses to become laboratory-produced, normally consolidated soils. One specimen was subjected to undrained shearing in order to measure the "in situ" strength (s_{uF}) and the porewater pressure coefficient A_{fF}. A second specimen was subjected to total offloading in undrained conditions. The residual negative pore water pressure was measured to evaluate the porewater pressure coefficient A_u. This was followed by undrained shearing to measure the "sample" strength (s_{uS}) and the porewater pressure coefficient A_{fS}. For the San Francisco Bay mud, reductions of the order of 6% were observed in the "sample" strengths. Average values of the porewater pressure coefficients A_u, A_{fS} and A_{fF} were found to be 0.20, 0.45 and 0.80 respectively. The differences in porewater pressure coefficients can be attributed to the non-reversibility and non-linearity of the relationship between porewater pressure change and deviator stress change. The analysis and its supporting experimental data indicated that for a normally consolidated sensitive clay, the in situ strength and the porewater pressure coefficient at failure are significantly different from those measured from "samples" using unconsolidated undrained triaxial compresion tests.

Davis and Poulos (1967) also performed tests to quantify the effect on the undrained strength due to stress release alone. They indicated that the strength of "samples" was less than in situ value by 18%.

Adams and Radhakrishna (1971) tested normally consolidated glacial lake clays from the St. Clair River, Ontario. Block specimens were obtained in the field, then trimmed and placed in triaxial cells. The specimens were consolidated anisotropically to in situ stresses. At the end of consolidation, one specimen was subjected to undrained shearing for its "in situ" strength. The shear stress on a second specimen was offloaded down to isotropic stress under undrained conditions, and the sample was then sheared undrained. This measured strength compared favorably with the "in situ" strength from the first specimen. A third specimen was unloaded in drained condition. A considerable reduction in strength was found when undrained shearing was performed. The authors concluded that specimens that were allowed to swell showed a significant loss in undrained shear strength.

Preliminary tests reported by Kirkpatrick and Rennie (1975) on the other hand indicated much greater loss than those mentioned above, and brought into consideration the influence of sample age. Berre and Bjerrum (1973) also noticed that older samples tend to give lower strength than those tested at earlier age. Similar results have been reported by Sandegren (1961), Bjerrum (1973a), Arman and McManis (1977) and others.

Recent research by Kirkpatrick (1982a) studied the stress release effects on normally consolidated kaolin and illite. Specimens were prepared by consolidating a slurry at a water content of 1.5 times the liquid limit in a 254 mm diameter odeometer. "In situ specimens" were first consolidated to 276 kPa in the odeometer, then cut and placed in a triaxial apparatus for further K_o anisotropic consolidation. The final vertical stresses ranged from 400 to 800 kPa. The specimens were then back-pressured to 200 kPa and tested undrained to determine the "in situ" strength of the clays.

Normally consolidated specimens used for examining disturbance effects were prepared by consolidating the slurry to a final pressure of 552 kPa in the odeometer to simulate depths greater than 100 m below the seabed. The procedures of sampling were modelled in the laboratory by closing the end drains of the odeometer and rapidly reducing the pressure to zero. These large blocks or "cakes" were then sealed and stored at an even temperature. Sample age or storage time, which was defined as the time elapse between the unloading of the "cakes" and the time of testing, ranged from a few hours to 50 days. As the program required, "samples" were cut from the "cakes" using thin-wall tubes at selected time intervals to study the influence of sample age. These "samples" still experienced mechanical disturbance from the cutting tubes. Estimation of residual porewater pressures was performed in triaxial cells prior to undrained shearing tests.

The illite and kaolin both illustrated a large initial drop in residual negative porewater pressures, and the loss continued gradually for more than 50 days. Comparison of "in situ specimens" and "samples" of various ages of normally consolidated clays showed the "samples" experienced considerable loss in strength, increase in failure strains and appreciable difference in effective stress paths. The effects were more pronounced with increasing sample age, and were relatively greater in kaolin than in the less permeable illite. The processes involved in the loss of the pore suctions were thought to be related to cavitation and diffusion effects. The dissipation rates were found to be better correlated to the coefficient of consolidation (c_v) than the coefficient of permeability (k).

Kirkpatrick (1982b) also studied overconsolidated kaolin and illite. Similar trends of behaviour were observed as previously described for normally consolidated clays. The reductions in both residual porewater pressure and strength were smaller for the overconsolidated "samples" than for normally consolidated "samples". The reason could either be due to the different behaviour of normally consolidated and overconsolidated soils; or simply that the stress release in the case of overconsolidated soils was smaller than for normally consolidated soils.

Kwok (1984) and Ambrosie (1985) respectively have also studied the effects of stress release alone on reconstituted specimens of overconsolidated and normally consolidated illite. Specimens were consolidated one-dimensionally, first in cylinders from a slurry, and then in triaxial cells along an approximate K_0 stress path to a maximum vertical pressure of 160 kPa. Overconsolidated specimens were offloaded to 80 kPa to give an overconsolidation ratio (OCR) equal to two. Back pressure of 500 kPa was applied to simulate the porewater pressure in the field. By this procedure, mechanical disturbance was excluded in the testing programs. "In situ specimens" were subjected to undrained shearing without any offloading. "Samples" were unloaded under undrained conditions to simulate stress-release during the sampling process. The offloading of shear stress was carried out with porewater pressure changes that results in essentially constant p'. Negative porewater pressures caused by release of total pressures were monitored throughout different storage periods. At the end of storage, each "sample" was subjected to reconsolidation at one of three stress levels prior to undrained shearing. Kwok (1984) observed that the reductions in negative porewater pressures for overconsolidated illite were 0 to

3.2 kPa for "samples" subjected to 15-minute and 1-day storage periods, and 7.4 to 21.2 kPa for 1-week "samples". A similar but more marked trend of behaviour, one of residual negative porewater pressure decreases with increasing sample age, was also observed by Ambrosie (1985) for normally consolidated illite. Graham et al. (1986) suggested that the relaxation of the residual negative porewater pressure was due to internal creep straining caused by soil particle reorientation towards more stable isotropic microstructure. They concluded that the full negative porewater pressures u_{ri} could not be retained in the "samples" for periods longer than 1 to 2 days.

In summary, with increasing storage time, "samples" experience gradual loss in the residual effective stress due to cavitation and diffusion effects and/or creep reorganization of soil structures. This means that conventional unconsolidated undrained compression tests in the laboratory cannot reproduce the strengths or stress-strain behaviour of in situ soil.

2.4 RECOVERING IN SITU STRENGTH

As previously shown, "samples" recovered from deep sea environment are inevitably subjected to process disturbance, which reduces the strength measured with U-U tests in the laboratory. This section briefly describes the previous work by various researchers to recover the in situ strength of the clay in the laboratory. There are two common approaches:

(1) to correct the unconsolidated undrained strengths with an empirically determined multiplication factor,

(2) to employ an appropriate laboratory reconsolidation procedure.

The use of correction factors to adjust "sample" strength to in situ strength is very empirical. Researchers such as Ladd and Lambe (1963), Noorany and Seed (1965), and others tried to quantify the degree of disturbance. However most of these researchers also included the effects of mechanical disturbance. This work has been reviewed in detail by Kwok (1984) and will not be repeated here.

Many researchers have also tried to develop appropriate reconsolidation procedures to recover the in situ strength in the laboratory. The most common reconsolidation procedure is to reconsolidate "samples" isotropically to in situ vertical stresses (e.g. Casagrande and Rutledge 1947; Bishop and Bjerrum 1960; Ladd and Lambe 1963). Other procedures include isotropic reconsolidation to 0.5-0.75 of the in situ vertical stresses (Raymond et al. 1971), K_o reconsolidation to in situ stresses (Davis and Poulous 1967; Bjerrum 1973b) and the SHANSEP method (Ladd and Foott 1974). However the value of these proposals is limited at best because the actual in situ strengths that the laboratory studies attempted to recover were in fact unknown.

Kirkpatrick (1982a), and Kirkpatrick and Khan (1984) studied the reliability of these reconsolidation procedures for normally consolidated kaolin and illite. Some swelling occurred during storage even though the average water contents were kept constant. Three types of reconsolidation were examinated in their study:

(a) anisotropic reconsolidation to "in situ" effective stresses either by a progressive incremental method or by a two-step method,

(b) isotropic reconsolidation to the "in situ" vertical effective stress,

(c) isotropic reconsolidation to the residual effective stress (σ'_{ps}) of the "sample" immediately on unloading.

They drew the following conclusions from their reconsolidation tests.

(1) Method (a) reproduced good simulation of "in situ" strength, stress-strain behaviour and stress paths.

(2) Methods (b) and (c) using isotropic reconsolidation were found respectively to overestimate and underestimate the failure stresses. Neither tests reproduced similar stress paths when compared to "in situ specimens".

(3) Sample ages up to one month had little or no effect on behaviour of consolidated undrained tests as long as the moisture contents were maintained constant.

Kwok (1984) and Ambrosie (1985) also investigated the validity of various reconsolidation procedures in recovering the "in situ" strength of reconstituted illite. "Samples" were "stored" undrained, and the effects of mechanical disturbance were removed from the test. Reconsolidation procedures examined in their studies included the following methods.

(a) Isotropic reconsolidation to 0.6 of the "in situ" vertical effective stress.

(b) Isotropic reconsolidation to the "in situ" vertical effective stress.

(c) Anistropic reconsolidation to the "in situ" effective stresses.

For overconsolidated illite, Kwok (1984) found that methods (a) and (c) were both successful in reproducing the "in situ" strength. Method (b) overestimated the "in situ" value. On the other hand, Ambrosie

(1985) found that none of these methods could recover the "in situ" strength of the normally consolidated illite. Both investigators also found that all three methods overestimated and underestimated respectively the axial strain at failure (ϵ_{1f}) and the modulus (E_{50}). The "sample" strengths were unaffected by the duration of the undrained storage period if identical reconsolidation procedures were used (Graham et al. 1986).

Although research by Kirkpatrick and Khan (1984) provided an improved understanding of the influence of stress release on recovered specimens, the effects on mechanical disturbance were not entirely excluded in their testing program. The tests by Kwok (1984) and Ambrosie (1985) were based on the assumption that the recovered specimens remained totally undrained during stress release and the storage periods. Because the time during which the field stresses are released is relatively short in comparision with the drainage time of low-permeability clays (Bishop and Henkel 1962; Chaney et al. 1984), the sampling process can be assumed to be under totally undrained conditions. The porewater behaviour of the specimens at various stages after sampling is complex and relatively unknown. Observations such as those by Emrich (1971), Schjetne (1971) and Fukuoka and Nakase (1973), however, suggested that recovered specimens did swell after the sampling. The author's personal experience from a sample collecting cruise near Baffin Island confirmed that specimens could not maintain totally undrained conditions without any swelling, even when the samples were stored in sampling tubes. This finding has led to the present testing program in which, in contrast with the earlier programs of Kwok

(1984) and Ambrosie (1985), full drainage is allowed during the various storage periods.

CHAPTER 3

TESTING PROGRAM: DESIGN AND PROCEDURES

3.1 INTRODUCTION

Specimens recovered in practice are found to swell to a greater or less degree after sampling. The "samples" used in this study were allowed totally free drainage to atmospheric pressure conditions during storage. In contrast, and to provide the other bound of behaviour that can be experienced in practice, "samples" were examined under totally undrained storage conditions in preceding studies by Kwok (1984) and Ambrosie (1985). The specimens tested in the present investigation included both normally consolidated clay and overconsolidated clay with an OCR of 2. Figure 3.1 shows the equivalent field conditions of both groups of specimens that were modelled in the laboratory. The normally consolidated specimens simulated soil elements 20 m below the seabed, with 30 m of water overlying the seabed. It was assumed that the clay was fully saturated with an "in situ" stress state:

vertical effective stress, σ'_{1c} = 160 kPa

porewater pressure, u = 500 kPa

horizontal effective stress, σ'_{3c} = 84.8 kPa (= 0.53 σ'_{1c})

For the overconsolidated specimens, an "in situ" stress state corresponding to 10 m of soil depth with an OCR of 2.0, and a 40 m water depth was modelled in the laboratory. The "in situ" stress state of the soil was assumed to be:

vertical effective stress, σ'_{1c} = 80 kPa

porewater pressure, u = 500 kPa

horizontal effective stress, σ'_{3c} = 42.4 kPa

This again assumed $K = \sigma'_{3c}/\sigma'_{1c} = 0.53$ despite the change in K_o that accompanies overconsolidation (Brooker and Ireland 1965; Mayne and Kulhawy 1982). The effective stresses and porewater pressure imposed on the specimens in this study modelled soils under moderately deep sea conditions.

The following sections provide a description of the design of the test program, of the soil classification properties, and of specimen preparation and test procedures.

3.2 DESIGN OF TESTING PROGRAM

The purpose of this investigation was to study the effects of sampling disturbance due to stress release only, with no influence from mechanically induced disturbance. This was achieved by comparing the shear strengths of reconstituted "samples" with those of simulated "in situ specimens". It was therefore necessary that the present testing program reproduced as closely as possible in the laboratory the conditions that would exist for the recovered specimens during and after the sampling process in the field. The following sections will provide the background leading to the selection of variables being studied and an overview of the testing program.

3.2.1 Modelling Sampling Procedures

When an offshore soil specimen is lifted out of its marine environment and extruded for inspection, classification, etc., the total confining pressures on the recovered specimen are inevitably removed. The stress release associated with the field sampling process was modelled in the laboratory by unloading the external pressures on artificial specimens made by anisotropic triaxial consolidation and back pressuring. Two choices were available when these "samples" were offloaded in the triaxial cells. Firstly they could be unloaded under totally undrained conditions with porewater pressure measurements. Secondly they could be unloaded with drainage permitted. In this case measurements of volume changes could be taken while the "samples" swelled because of the release of stress. As mentioned in Chapter 2, the total stresses are typically released in practice in times that are relatively short in comparison of the drainage time of low-permeability clay in the field. The coefficient of consolidation (c_v) of illite reported by Kirkpatrick and Khan (1984) was of the order of 10^{-8} m^2/s. During the offloading process the "samples" in the laboratory program are therefore best assumed to be under totally undrained conditions. Besides, it is helpful to know the effective stress path during unloading (Graham et al. 1986), and this can only be obtained by keeping the "samples" undrained and measuring the resulting decrease in porewater pressures. This undrained condition during unloading was also assumed in the earlier studies by Kwok (1984) and Ambrosie (1985).

3.2.2 Modelling Storage

Kwok (1984) and Ambrosie (1985) both assumed that after sampling, the recovered specimens were stored under totally undrained conditions. However in the author's opinion, this assumption is not completely valid. As mentioned in Chapter 2, the author's personal experience showed that the recovered specimens were always observed to swell to some degree even when they were stored in sampling tubes. Graham et al. (1986) showed that the negative porewater pressures relaxed with time, causing decreased value of mean effective stress p'. The mechanism is unclear. They suggested that the change from anistropic to isotropic effective stress states can cause internal creep straining at constant volume and particle reorientation towards more stable isotropic microstructure. For these reasons, the "samples" in the present study were allowed to swell during various periods of storage in the laboratory. This procedure also provides an alternative limit to the practice defined in the previous studies in which the samples were kept totally undrained.

The selected storage periods model the time delays that occur in practice between specimen recovery from the seabed and actual testing in the laboratory. In order to investigate the effects of the duration of storage time between sampling and testing on undrained shear strength, Kwok (1984) and Ambrosie (1985) chose three storage periods to represent the potential variation of sample disturbance. The same storage periods were applied to the "samples" in this investigation. The three storage periods were:

(1) "Instantaneous" (15 minutes) - this represents ship-board testing on recovered specimens of the highest quality.

(2) 1 day - this models onshore testing on high quality soil specimens which are transferred immediately to onshore laboratories after recovery.

(3) 1 week - this represents average practice of onshore testing on recovered specimens with long storage periods.

In actual cases, recovered specimens might be stored for longer periods than one week. However due to time constraints on the research, one week was chosen to be the longest storage time in this study. This has been subsequently justified by volume measurements during storage.

During the early stage of this study, two "samples" (T732 and T733) were allowed to have drainage from the top of the "sample" through the top cap, and at the same time porewater pressures were monitored from the cell pedestal for storage periods of 2 hours and 1 week respectively. These required the elimination of the circumferential filter strips around the "sample", but with filter stones placed both at the top and bottom of the "sample". (No facilities exist in the University of Manitoba to measure the negative porewater pressures from the bottom of the "sample" with the hypodermic needles). These two "samples" were allowed to have both top and bottom drainage but no side drainage during the earlier triaxial consolidation phase of testing. However this arrangement caused different drainage boundary conditions when compared to the earlier studies of Kwok (1984) and Ambrosie (1985). Difficulty was therefore anticipated in comparing results from the previous "undrained storage" programs, and the present "drained storage" program. Drainage from one end only, without side drains, also greatly increased the duration of the tests.

In order to obtain uniform set of data for comparison with the earlier studies, it was therefore decided that the drainage conditions in the rest of the "samples" would be maintained from the bottom of the "sample" only, and that circumferential filter strips would be used. Besides, the use of top drainage was always prone to additional problems of leakage and bubble formation within the drainage lines (Graham et al. 1985).

3.2.3 Procedures for Recovering the In situ Strength of "Samples"

As discussed in Section 2.4, different reconsolidation procedures have been investigated by various researchers to recover the in situ strengths of recovered specimens. To facilitate comparisons, the following reconsolidation procedures used by Kwok (1984) and Ambrosie (1985) were also adopted in the present study:

(1) isotropic reconsolidation to 0.6 times the "in situ" vertical effective stress,

(2) isotropic reconsolidation to 1.0 times the "in situ" vertical effective stress,

(3) anistropic reconsolidation to "in situ" effective stresses.

The isotropic reconsolidation procedures were emphasized in previous work due to their relative simplicity. The anisotropic reconsolidation was due to its apparent success in the recovery of "in situ" behaviour (Kirkpatrick and Khan 1984).

3.2.4 Overview of the Testing Program

A summary of the testing program in this research project is given in Table 1. A total of seventeen normally consolidated and overconsolidated "samples" (T732-T739, T751-T759 respectively) of reconstituted illite were tested under the influence of stress release, and compared with a total of six normally consolidated and overconsolidated "in situ specimens" (T740-T742, T760-T762 respectively). The "in situ specimens" underwent the same consolidation processes as the corresponding disturbed "samples", but were not subjected to an offloading and reloading cycle. The "samples" were allowed fully open drainage to atmospheric pressure during the various storage periods.

3.3 SOIL PROPERTIES

The tests specimens in this study were prepared from reconstituted illitic clay from Grundy County, Illinois, similar to the grundite used by Wu et al. (1983). The advantange of using reconstituted clay rather than natural clays is that slurry consolidation can produce specimens with good consistency in their water contents so that better quality control can be maintained in the testing program. The clay was received at the University of Manitoba in burlap sacks with water content of 21% (Ambrosie 1985). Standard classification tests and X-ray diffraction tests were performed on the clay, and the results were reviewd by Kwok (1984). The major minerals presented in the clay are quartz, illite and kaolinite with the proportion of illite to kaolinite more than 5:1. A summary of classification test results is given in Table 2. The illitic clay in this study had a clay fraction (less than 0.002 mm) of 66% with a specific gravity 2.74. The liquid limit (w_L) and plasticity index (I_p) were determined to be 59.5% and 33.6% respectively. These agree closely with the values reported by Graham et al. (1986).

3.4 SAMPLE PREPARATION AND TEST PROCEDURES

The following sections will describe briefly the techniques that have been used in the present study for preparing and testing the reconstituted illite specimens. The procedures were given in detail by Kwok (1984).

3.4.1 Slurry Consolidation

The illitic clay was first oven-dried, pulverized and mixed with deaired, distilled water in a mechanical mixer for five 30-minute periods over a duration of 2 days under vacuum. The water-clay ratio by weight chosen for this research project was approximately twice the liquid limit of illite ($2xw_L$), which is very common in research work using slurry consolidation (e.g. Lewin and Burland 1970; Li 1983). The resulting slurry was poured carefully into a 256 mm diameter consolidation cylinder with top and bottom drainage.

The cylinder was then transferred to a newly designed loading frame for one-dimensional consolidation (Figure. 3.2). These procedures were newly developed for this thesis. They were felt necessary to overcome some of the variability between "samples" that was observed in previous programs. A vertical load was applied to the slurry through an air-pressure controlled hydraulic jack (booster), and was monitored with a load cell placed between the cylinder and the jack. The initial vertical stress used in this test was 14 kPa. The slurry was then allowed to stabilize for three days under this stress level due its high initial porewater pressure. Five successive consolidation stresses were applied using 24-hour periods each with a load ratio of 1.38 to a final vertical stress of 70 kPa. Vertical displacement was monitored with time throughout this compression process. When the final vertical stress of 70 kPa was attained, all "cakes" were allowed to reach porewater pressure equilibrium. This was monitored by plotting a log time-displacement curve, and this condition was interpreted as the "cake" entering the secondary consolidation (Figure 3.3). The equilibrium procedure was time-consuming, often taking more than one week to complete. At this stage, a "cake" of 256 mm diameter was produced inside the consolidation cylinder. It was then ready for extrusion from the cylinder, and for cutting into three identical "pie slices" that could be used to form "samples". More complete details of preparing the "cakes" from slurry consolidation are included in Appendix A.

During the earliest stage of this study, there was considerable difficulty in maintaining the required vertical loads for slurry "cake" 732-733. The loads observed from the load cell fluctuated with time especially during the load application of first stress level (Figure 3.4 a). This occurred due to the mechanical inability of the booster to maintain constant pressure to the hydraulic jack. Deviations from desired stress levels (in percent) were computed by comparing the actual load cell reading and required vertical load in each increment (Figure 3.4 b). The average vertical stress in each increment was calculated by assuming the area bounded by the curve in Figure 3.4 b equal to that in Figure 3.4 c. The inadequate booster was subsequently replaced. Graphs for the slurry consolidation of the slurry "cake" 737-739 are presented in Figure 3.5, and much better control in vertical loading is observed. There were only two "samples" (T732 and T733) available from the "cake" 732-733. It had been allowed to reach porewater pressure equilibrium at an average initial stress level of 12.9 kPa as well as at 70 kPa.

Towards the end of the program, a lever-loading system was developed to provide better load control on the consolidating "cakes". It is also described in Appendix A.

3.4.2 Extrusion, Trimming and Building-in of Reconstituted Specimens

The loading frame was also designed for extrusion of the "cake" and cutting it into three "pie slices" which could then be trimmed into three identical specimens for the subsequent triaxial tests (Appendix A). The trimming and building-in of three specimens usually lasted two days. While the "pies" were waiting for the trimming, they were wrapped with Saran wrap, sealed with wax, and stored in a cool, humid sample room to minimize changes in moisture content.

The importance of high quality sampling and testing techniques has been emphasized by several investigators (e.g. Graham 1974; Crooks and Graham 1976; Tavenas and Leroueil 1977). Although mechanical disturbance due to sampling is avoided in laboratory consolidated clay, disturbance associated with specimen preparation and testing should be nevertheless minimized. The approach used by Graham et al. (1986) was to trim specimens from the "cakes" that had been consolidated one-dimensionally to σ'_{1c} = 70 kPa, and then to further consolidate them anisotropically in triaxial cells to σ'_{1c} = 160 kPa. They argued that normal (virgin) consolidation from 70 kPa to 160 kPa would remove any influence of the trimming disturbance (see also, Ladd and Foott 1974).

Triaxial tests were done on 76 mm diameter specimens that were carefully trimmed from the "pie slices". Equipment and testing procedures aimed at reducing disturbance during trimming and building-in of triaxial specimens are well developed at the University of Manitoba. The most important feature of the equipment is that the top of the triaxial specimen is supported throughout the processes so that minimum disturbance is ensured. The trimming and building-in procedures were carefully described in detail by Lew (1981). They can be outlined as follows:

The cell pedestal was deaired by flushing water through it by means of two burettes to the pedestal drainage leads. The base plate of the trimming equipment was placed on the cell base and was adjusted until the inverted cutting cylinder was accurately centred over the pedestal. The trimming table was then attached to the base plate. The trimming equipment was lubricated with silicone oil to facilitate smooth sliding. A slightly oiled cutting cylinder with a sharp leading edge was pushed carefully into the soil to a depth of about 1 cm. The excess soil outside the cutting edge was removed by trimming wire. This process was repeated until 2 to 3 cm soil protruded the top of the cylinder. The top and the bottom of the specimen were then carefully trimmed with a cutting wire. The cutting cylinder with specimen inside was then removed from the uprights, and weighed.

A saturated de-aired filter stone was placed on the pedestal. The cutting cylinder containing the specimen was then lowered to the top of the filter stone. The top cap was located firmly by a central rod and the cylinder was removed. The height and the diameter of the specimen were measured. The average diameter of the specimen was 76.15 cm with height varying between 130 mm and 135 mm. A thin coat of silicone stopcock grease was applied to the sides of the pedestal and the top cap. Lateral drainage filter strips were applied longitudinally around the specimen's surface. (For specimens T732 and T733 with no lateral filter strips, filter stones were placed both at the top and the bottom of the specimens.) Two membranes separated by a coating of silicone oil were placed around the specimen with four sealing rings on the bottom pedestal and two sealing rings on the top cap to seal the specimen from cell water. The top of the triaxial cell was carefully placed over the specimen and the piston lowered to touch the top cap and clamped. The cell was then filled with deaired distilled water until the top of specimen was covered. A 2 cm thick layer of viscous oil was applied on the top of the water through the top of the cell to reduce leakage of cell water and friction between the piston and the rotating bush. Initial readings of the axial dial gauge and volume change burettes were taken carefully, and loading was ready to start.

3.4.3 Triaxial Consolidation

The triaxial consolidation tests were performed in triaxial cells supported on a steel loading frame, the general arrangement of which is shown in Figure 3.6. Cell pressure was applied through deaired water in the cell, using compressed air to pressurize an external air water tank.

The cell pressures and the porewater pressures at the bottom the specimens were monitored by pressure transducers, which were rezeroed before each load increment to atmospheric pressure at mid-height of the specimen. Axial load was applied through the piston by a hanger and a dead weight system. Dial gauges and burettes were used to monitor vertical displacements and volume changes of the specimens.

The specimens were subjected to anisotropic consolidation with $\sigma'_{3c} = K \times (\sigma'_{1c})$ in the triaxial cells. The first axial stress applied to the specimens was 50 kPa. All specimens in this study were tested with a K value of 0.53, which was chosen in the earlier programs by Kwok (1984) and Ambrosie (1985) to remove one of the potential variables in the test series. The specimens were loaded for 24-hour periods between successive load increments with a load ratio of 1.15. Before each loading increment, water was flushed through the drainage leads to remove air that might have been trapped in the cell base. After the application of a new load, the readings of the axial dial gauge and volume change burette were recorded using "standard" time intervals (that is 1,2,4,8,15,30 min, 1,2,4,8 hr etc). When the maximum vertical stress of 160 kPa was reached, the normally consolidated specimens were allowed to stabilize for standardized periods of four days to reach porewater pressure equilibrium. The overconsolidated specimens were unloaded to an axial stress of 80 kPa in one step to give an OCR of 2 after being at the maximum stress of 160 kPa for one day. The 4-day stabilization period then resumed at the vertical stress of 80 kPa with K = 0.53.

3.4.4 Back Pressuring

Backpressuring of the specimens after triaxial consolidation simulated the high porewater pressure experienced in the seabed. In this investigation, the effective stresses and back pressuring imposed on the normally consolidated specimens a stress state representative of 30 m of water and 20 m of saturated soil (Fig. 3.1). The overconsolidated specimens with an OCR of 2 represented a stress state of 40 m of water and 10 m of soil. These stresses brought the normally consolidated specimens and overconsolidated specimens to "in situ" vertical total stresses of 660 kPa and 580 kPa respectively, with a porewater pressure of 500 kPa. The backpressure of 500 kPa modelled a soil specimen under moderately deep sea conditions of 30 m to 40 m depth.

Before back pressuring, the drainage system was flushed to ensure that any trapped air was removed. The piston was clamped before the hanger and dead weights were removed. The cell pressure, burettes, axial dial gauge, and transducers lines were all kept in place. The triaxial cell was then carefully transferred from the consolidation frame to the compression frame. The axial load at the end of the triaxial consolidation was re-established by means of a proving ring. The specimens were then subjected to ten increments of 50 kPa in both cell pressure and porewater pressure. The procedure took about 10 minutes with the specimens undergoing negligible axial strain (less than 0.1%). The specimens were then allowed to stabilize for a period of 24 hours before any further testing.

The "in situ specimens" (T740-T742, T750-T752) were then subjected immediately to undrained shearing as described in Section 3.4.8 without any further offloading and reloading cycle. Sections 3.4.5 to 3.4.7 inclusive are applicable only to "samples" (T732-T739, T751-T759) which were subjected to a sequence of unloading, storage and reconsolidation.

3.4.5 Unloading

This section describes the procedure used in the laboratory to model the stress release associated with sampling from the field. As mentioned in Section 3.2.1, the confining pressures on recovered specimens are released in a relative short time compared to the drainage time of low-permeability clay. The unloading in the laboratory was chosen to be under totally undrained conditions. Techniques used for unloading were outlined by Kwok (1984) and will be briefly reviewed as follows:

Unloading was accomplished in two stages, namely shear unloading and isotropic unloading. During shear unloading, the shear load was removed in six steps by means of adjusting the proving ring force while the cell pressure was maintained constant. At the end of this stage, The "sample" was under an isotropic total stress condition. It was then subjected to isotropic unloading by reducing the cell pressure, in increments of 50 kPa until a cell pressure of about 5 kPa was reached. (The 5 kPa cell pressure was used to ensure contact between membrane and the clay, and to control volume readings in the burettes). The proving force was of course adjusted to compensate for the decreases in cell pressure. The total time for the unloading processes lasted for about 15 minutes. The porewater pressures and the axial displacements of the "sample" were monitored during the whole unloading processes. The results are presented in Section 5.2.

3.4.6 Storage

As mentioned in Section 3.2.2, three different storage periods of 15 minutes, 1 day or 1 week under totally free drainage conditions were selected to simulate various time delays between the field sampling and laboratory testing. This was achieved by opening the bottom drainage lead at the end of the unloading period, and by carefully monitoring the volume changes during the various chosen storage periods. The cell pressure was kept at around 5 kPa during storage. Results will be shown in Section 5.3. "Samples" stored under totally undrained conditions have been studied by Kwok (1984) and Ambrosie (1985).

3.4.7 Reconsolidation

In order to recover the in situ shear strength of seabed clays, specimens recovered from site investigation are usually subjected to reconsolidation prior to undrained shear test. Otherwise "loss of suction" leads to considerable reduction in shear strength (Kirkpatrick and Khan 1984). As described in Section 4.2.4, three reconsolidation procedures were selected for this investigation, namely isotropic reconsolidation (1) to 0.6 and (2) to 1.0 times "in situ" vertical effective stress, and (3) anistropic reconsolidation to "in situ" effective stresses. The main objective in this study is to determine which reconsolidation procedure can best recover the "in situ" strength of the clay.

For both isotropic and anisotropic reconsolidation, the cell pressures were first increased in one step to the required stress levels. The "samples" to be consolidated isotropically were then allowed to reach porewater pressure equilibrium before any further testing. For "samples" to be consolidated anisotropically, the extra axial loads were usually established by increasing the proving ring force after the "samples" had been consolidated isotropically for 24 hours. This represented a slightly different procedure from that used by Kwok (1984) and Ambrosie (1985) who added the required cell pressures and axial loads almost simultaneously. Drainage during storage caused the "samples" to behave differently, and to require different treatment during reconsolidation. It agrees with technique currently in use in the Norwegian Geotechnical Institute (personal comm. S. Lacasse to J. Graham). Axial strains and volume strains experienced by the "samples" during reconsolidation varied with the reconsolidation procedures and the storage periods. This will be further discussed in Section 5.4.

Measurements of volume change versus time were taken during reconsolidation which allowed free drainage of the "sample" to atmospheric pressure. Equilibrium was usually reached after 3 to 4 days. Upon reaching porewater pressure equilibrium, the "samples" were subjected to a back pressure of 200 kPa which is used commonly in commercial and research laboratories to achieve high levels of saturation . The 200 kPa back pressure was applied in four increments of 50 kPa. The "samples" at this stage were then allowed to stabilize for 24 hours. Before undrained shear testing, the "samples" were checked that their saturation was acceptable, B-values greater than 0.98.

3.4.8 Undrained Shear

Undrained shear test procedures have been outlined by Kwok (1984). These procedures followed techniques developed at the University of Manitoba over several years (e.g. Graham et al. 1983). The rate of testing used in this study was approxiately 0.5% per hour, with readings taken of time, axial displacement, proving ring, porewater pressure, and cell pressure at regular intervals. "Samples" T732 and T733 with no side drains were subjected to a lower shear strain rate of 0.2% per hour due to their slow response of porewater pressures. Shearing usually continued overnight until an axial strain of 12% was reached. After shearing was completed, the failed specimens were removed from the triaxial cells weighed and cut into six layers for determination of moisture contents. This was done to check the variability of water content along the length of the specimens, and the uniformity of the specimens. Chapter 7 will present and discuss the moisture content profiles across the failed specimens.

CHAPTER 4

CONSOLIDATION TEST RESULTS

4.1 INTRODUCTION

As described in Chapter 3, reconstituted specimens for triaxial testing were prepared by consolidating slurry in a consolidation cylinder until a "cake" with adequate strength for trimming was produced. A total of eight "cakes" were produced in the present program. Each "cake" was extruded from the cylinder and cut into three identical "pie slices", each of which was subsequently trimmed into a specimen for triaxial testing. (As mentioned in Chapter 3, only two specimens (T732 and T733) were available from the first "cake" during the earliest stage of the program). A total of twenty-three reconstituted specimens was then subjected to closely similar anisotropic consolidation procedures in triaxial cells to produce the consistent set of specimens required for the present study. This chapter reports and briefly discusses the results during the slurry consolidation and the triaxial consolidation phases of the tests.

4.2 ONE-DIMENSIONAL SLURRY CONSOLIDATION (λ_1-VALUES)

The consolidation of clay in first-time loading is commonly characterized by straight relationships in log(pressure) versus compression space expressed as changes in moisture content, voids ratio, or specific volume. The straight line portions of these graphs represent the critical state parameter λ, which indicates the compressibility of clay. It is expressed as the slope of voids ratio versus the natural logarithm of vertical stress, $\Delta e/\ln(\sigma'_{v2}/\sigma'_{v1})$.

Values of compression index (λ_1) during slurry consolidation as outlined in Section 3.4.1 were obtained by plotting the logarithm of vertical stresses versus the moisture contents (Figure 4.1). The compression index (λ_1) has been used in this thesis to describe the parameter originating from slurry consolidation in the cylinder. Due to time constraints in the present investigation, complete porewater pressure dissipation in the slurry was not attempted during each of the loading increments. The "cakes" were therefore underconsolidated except at the end of the final stabilization period at the maximum vertical stress of 70 kPa. The λ_1-values obtained in Figure 4.1 were simply the measured slopes of the graphs in $\ln(\sigma'_v)$,e-space. They do not give the proper λ_1-values that would be measured if complete consolidation was allowed in each load increment (Kwok 1984). Values of λ_1 are summarized in Table 3. They varied over a narrow range from 0.501 to 0.533 with an average of 0.513 and a standard deviation of 0.012. This suggests a high level of consistency in the observations that were taken.

As mentioned in Section 3.4.1, the slurry "cake" 732-733 was treated slightly differently from the rest of the specimens. During the first stage of the testing program, it was compressed with a slightly lower average initial vertical stress of 12.9 kPa, and it was allowed to reach complete porewater pressure equilibrium before the next increment was applied. This initial stabilization lasted for 6 days (Figure 4.1 a). The rest of the slurries were allowed to sit for only 3 days due to time constraints. Compressions during this first stage of loading show as the initial vertical sections on the graphs in Figure 4.1. When the final stress of 70 kPa was reached, the resulting "cakes" were allowed to reach equilibrium and undergo some aging before extrusion and specimen trimming. This is shown as the final vertical sections in Figure 4.1. It was observed that the "cake" 732-733 seemed to experience two λ_1-values during the slurry consolidation (Figure 4.1 a). The first λ_1-value was calculated from the results from the average initial stress of 12.9 kPa to an intermediate stress of 50 kPa. The value for this phase of slurry consolidation was 0.327. This was significantly lower than the other values given in Table 3, and has not been included in the above statistical analysis giving a mean λ_1=0.513. This low value in "cake" 732-733 was partly due to the effects of aging (Bjerrum 1967). During the initial 6-day equilibrium period (which was longer than the other slurries), some additional resistance was built up in the clay structure to resist further loading. A pseudo-preconsolidation pressure of about 50 kPa can be approximately determined from Figure 4.1 a. After the vertical stress exceeded 50 kPa, the λ_1-value for the second phase was 0.504. This compared very well with the general range of λ_1-values from the other tests.

The mean and standard deviation of λ_1-values (0.513 and 0.012 respectively) from the present program showed lower values than those obtained from the two previous programs (0.621 and 0.055 respectively from Kwok (1984); 0.689 and 0.067 respectively from Ambrosie (1985)). The lower average λ_1-value in the present tests was due to the longer initial loading period (3 days) used in the present program rather than the 24 hours that both Kwok and Ambrosie used in their testing programs. Laboratory plots showed that the larger part of the initial high porewater pressures caused by the initial loading had dissipated at the end of 3 days. The degree of consolidation obtained in the present study was therefore higher than those experienced in the two previous programs. Less excess porewater pressure was carried over from the initial loading to subsequent loading stages in the present program. The compressions of the "cakes" occurring during subsequent loading were therefore smaller. This means that the slope λ_1 of the compressibility line in $\ln(\sigma_v')$,e-space would be less steep.

It is evident from Figure 4.1 that the drainage conditions in the "cakes" were not exactly identical during slurry consolidation although they were closely similar. Table 3 shows a range of moisture contents calculated in the specimens at 24 hours after the final load application of 70 kPa. The moisture contents at this stage ranged from 55.4% to 59.4% with a standard deviation of 1.3%. This variation compared favorably than those from two previous programs (5.2% from Kwok 1984; 6.4% from Ambrosie 1985) and reflects the improved sample preparation techniques introduced in the present project. Even though there were relatively small differences in moisture content after 24 hours in the present tests, different "cakes" underwent different changes in moisture contents during the remainder of the stabilization period at 70 kPa. Different straining rates during secondary consolidation and aging in fact produced specimens with smaller range of moisture contents at the end of consolidation (Table 3) than at the 24-hour stage. The moisture contents calculated from height changes during slurry consolidation varied from only 49.1% to 50.5% with a standard deviation of 0.5%. The range was less variable than the equivalent ranges obtained from the two previous programs (2.0% from Kwok 1984; 3.29% from Ambrosie 1985) and again represents the improvements effected by detailed procedural differences in the present program. Table 3 also shows the average moisture contents measured from the trimming of specimens during the building-in process. There was a good agreement between the measured and calculated moisture contents. The maximum difference was only 1%, which compared very favorably with the 3% reported by Kwok (1984). Slurry consolidation in the present study can be considered to give good control in producing uniform moisture contents among specimens.

4.3 TRIAXIAL CONSOLIDATION

4.3.1 Overview of Program

After slurry consolidation, each "cake" was extruded from the cylinder and trimmmed into three identical specimens. The specimens were then carefully transferred into triaxial cells and were subjected to the uniform anisotropic consolidation procedures described in Section 3.4.3. Drainage volumes were measured carefully during this phase of testing. Drainage conditions in the two "samples" T732 and T733 were slightly different from the rest (Section 3.2.2). For "sample" T732, there was also a leakage at the top drainage, but this was not discovered until the reconsolidation phase of the tests. On the basis of results from T733, the volume change of this "sample" during triaxial consolidation was estimated by taking the top and bottom drainage volumes to be equal.

4.3.2 Linear and Volumetric Strains

All specimens were subjected to closely similar anisotropic consolidation with a stress ratio of K=0.53. During the triaxial consolidation, volume changes and axial deflections of the specimens were measured. These measurements enabled calculation of axial strains and volumetric strains at any stage of the triaxial consolidation. Air trapped in the specimens during the building-in process was flushed out before each load increment was applied. This was excluded from the calculation of volume changes. Lateral strains were computed from the measured volumetric strains and axial strains on the basis of common assumption that the specimens remained cylindrical during deformation.

Linear and volumetric strains for normally consolidated specimens are presented in Table 4. The axial strains (ϵ_{1c}) varied from 11.15% to 15.97% and the volumetric strains (v_c) ranged from 10.49% to 12.79%. The lateral strains (ϵ_{3c}) varied from -1.27% to 0.65% with a mean of -0.25% and a standard deviation of 0.70%. The axial and volumetric strains were comparable to those reported by Ambrosie (1985). The absolute values of the $\epsilon_{1c}/\epsilon_{3c}$ ratio in Table 4 varied from 9.7 to 149. Ambrosie (1985) found this ratio varied in his tests from 2.68 to 22.76.

For the overconsolidated specimens with OCR=2, results of the linear and volumetric strains during consolidation are shown in Table 5. The axial strains (ϵ_{1c}) ranged from 9.74% to 12.57% and the volumetric strains (v_c) ranged from 9.50% to 10.76%. The lateral strains (ϵ_{3c}) varied from -1.14% to 0.02% with a mean of -0.54% and a standard deviation of 0.38%. The absolute values of the $\epsilon_{1c}/\epsilon_{3c}$ ratio were found to vary from 10.4 to 518. Kwok (1984) reported this ratio varied in his tests from 5.8 to 48.5.

Under fully K_0 conditions, the cross sectional areas of the specimens should remain constant by definition, with zero lateral strains. With the test facilities available at the University of Manitoba, zero lateral strain could not be controlled. They were held to small values by carefully choosing the imposed K value. As mentioned earlier, a K value of 0.53 was used in all specimens of the present study to permit comparison with previous studies. This came from the value K_0=0.95-sinΦ' proposed by Brooker and Ireland (1965) for normally consolidated clays with the value of $\Phi'=25^0$ suggested by Ambrosie (1985). Kwok (1984) and Ambrosie (1985) both determined K_0=0.46 empirically from very limited testing. Graham et al. (1986) suggested K_0=0.50 from examining the results at the end of their testing programs. The specimens in the present study were subject to a small degree of lateral straining from their "in situ" condition. The overall average $\epsilon_{1c}/\epsilon_{3c}$ was 62.9. The higher $\epsilon_{1c}/\epsilon_{3c}$ ratio in this series indicated that the consolidation at the chosen value of K=0.53 was closer to the zero lateral strain condition than in the previous series. The adopted K value was virtually constant in the present program, and there was therefore no systematic relationship between K and $\epsilon_{1c}/\epsilon_{3c}$.

4.3.3 κ_1-values

When specimens were transferred from from one-dimensional cylinder consolidation to the triaxial cells, disturbance due to stress release inevitably occurred. There were also varying degrees of mechanical disturbance caused by the extrusion, cutting, trimming and building-in processes although the equipment used and the procedures adopted were aimed at reducing the disturbance as much as possible. The approach used by Graham et al. (1986) was to consolidate reconstituted specimens anisotropically in triaxial cells to σ'_{1c}=160 kPa, 2.3 times larger than the maximum stress in the one-dimensional cylinder. They argued on the published evidence that normal (virgin) consolidation from 70 kPa to 160 kPa would remove any influence of mechanical disturbance during trimming. Values for the recompression index (κ_1) during the early stages of triaxial consolidation were calculated from the reload portion of the log(p') versus V plots in the stress range of 50 kPa to 70 kPa (Figures 4.2-4.7). Values of κ_1 are presented in Tables 4 and 5. They were found to range between 0.082 and 0.124 with a mean of 0.102 and a standard deviation of 0.013. Similar results were reported by Kwok (1984) and Ambrosie (1985), with mean values of 0.103 and 0.105 respectively.

4.3.4 λ_2-values

The values of the compression index (λ_2) during the later stages of triaxial consolidation were calculated from the graphs of log(p') versus V for the stress range from approximately 70 kPa to 160 kPa (Figures 4.2-4.7). The λ_2-values represented by the linear section of virgin compression lines varied from 0.169 to 0.263 with an average of 0.234 and a standard deviation of 0.019. Results of λ_2-values are summarized in Tables 4 and 5. Mean λ_2-values reported by Kwok (1984) and Ambrosie (1985) were 0.226 and 0.237 respectively. The mean λ_2=0.234 in the present study falls well between these two values.

"Samples" T732 and T733 exhibited λ_2-values at the lower end of the range (0.169 and 0.209 respectively). The reason is thought to be due to the different drainage condition used in these tests during the earliest phase of the program. As mentioned earlier, both "samples" (T732 and T733) were allowed to drain only from the top and bottom of the "samples" but with no side filter drains. The remaining specimens in the program were given lateral filter drains as well as bottom drainage. Daily loading increments were applied throughout the whole triaxial consolidation phase of the tests. "Samples" T732 and T733 with only end drainage would experience smaller daily volume changes than those with bottom drainage and lateral drainage due to their lower degree of consolidation resulting from the different boundary conditions (Bishop and Henkel 1962). This would make the slope of the normal consolidation line in ln(p'),V-space become less steep because the measurement values did not represent complete consolidation.

The parameter λ_2 was observed to be much lower than the value of λ_1 from slurry consolidation. The mean λ_1/λ_2 ratio was found to be 2.2 as compared to the higher value of approximately 3.0 obtained by Kwok (1984) and Ambrosie (1985). Kwok(1984) suggested that the variation in λ_1 and λ_2 may be due to the difference in load ratios during slurry consolidation and triaxial consolidation (1.38 and 1.15 respectively). However changes in load ratio would normally be expected only to move the consolidation line in $\ln(\sigma_v')$,e-space, but not to change its slope (Leonards and Altschaeffl 1964). Ambrosie (1985) suggested that the higher λ_1-values may be due to the higher porewater pressures developed during the slurry consolidation and dissipated subsequently.

The mean λ_2/κ_1 ratio was found to be 2.3 in the present study. A value of 2.2 was reported by Graham et al. (1986) for the same clay and by Graham et al. (1983) for natural Winnipeg clay. Li (1983) reported the λ_2/κ_1 ratio was 2.1 for remoulded Winnipeg clay.

4.3.5 κ_2-values

Twelve specimens (T751-T762) were overconsolidated by reducing stresses from σ_{1c}'=160 kPa to σ_{1c}'=80 kPa following the original stress path to give an OCR of 2.0 (Figures 4.5-4.7). The change in K_o which would normally accompany overconsolidation had not been modelled in these tests. The offloading was done in one step due to time constraints. The specimens were then allowed to stabilize for a period of four days after unloading. The κ_2-values for the swelling phase are also presented in Table 5. They ranged between 0.036 and 0.054 with a mean of 0.047 and a standard deviation of 0.005. They were the least variable among all the λ and κ values reported. Kwok (1984) and Ambrosie (1985) reported that the mean κ_2-values were 0.048 and 0.05 respectively. The average κ_1/κ_2 ratio was 2.2, which was also observed by Kwok (1984). Kwok suggested that the difference in κ_1 and κ_2 might be due to different load ratios used during the reloading phase and during the unloading (swelling) phase (1.15 and 0.5 respectively). The author suggests it is more likely due to the difference in slope between loading and unloading in the overconsolidated range. Leonards and Altschaeffl (1964) showed that the reload line is always observed to be steeper than the swelling line within the range of vertical pressures in this study.

4.3.6 Yield Determination

The preconsolidation pressure from slurry consolidation, (that is, the highest pressure reached in the cylinder, σ'_{cyl}=70 kPa) was compared to the vertical yield stresses (σ'_y) interpreted from the triaxial tests. The triaxial consolidation data were analysized using the computer program TXCEP which was developed by Lew (1981) at the University of Manitoba. The program produced printouts of the results and seven different stress-strain plots. The plots included:

1. log(p') versus V
2. p' versus v
3. q versus ϵ
4. σ'_1 versus ϵ_1
5. σ'_3 versus ϵ_3
6. p' versus ϵ_1

7. W versus LSSV

The stresses at which yielding took place have been interpreted using the bilinear plotting techniques described by Graham et al. (1983). Graphs of various yield curves are presented in Figures 4.2-4.7 and in Appendix B. The plot of σ_3' versus ϵ_3 was omitted from the interpretation because specimens were loaded along an approximate K_0-line with small lateral strains. Some problems were encountered with the interpretation of the yield stresses on some of the p' versus v plots where bilinear behaviour was not observed. For comparison purposes, stresses at yield determined from the various plots for each specimen were expressed in terms of a common variable, namely the vertical effective stress (Table 6). An average vertical yield stress (σ_y') was also calculated for each specimen from the various plots. It was found to vary from 70.6 kPa to 73.9 kPa, and averaged only 3.0% higher than the 70 kPa applied in the slurry consolidation. It was comparable to 2.6% obtained by Ambrosie (1985) and 3.3% obtained by Kwok (1984).

4.3.7 Elastic Parameters

According to Graham and Houlsby (1983), five elastic parameters are required to describe the cross-anisotropic elasticity of clays inside their state boundary surface. However this requires specimens stressed along stress paths in widely different directions in p',q-space. All specimens in the present program were tested only along a stress path with K=0.53. This meant that the full range of elastic parameters could not be obtained. Equivalent isotropic pseudo-elastic bulk and shear moduli (K_{eq}, G_{eq}) close to the K_0-condition were calculated from the linear reload sections of the p' versus v and q versus ϵ plots respectively (Appendix B) before yielding occurred. Results are summarized in Tables 4 and 5. Values of K_{eq} and G_{eq} varied from 772 kPa to 1126 kPa and from 376 kPa to 893 kPa respectively. Since the stiffness of lightly overconsolidated clay depends on the preconsolidation pressures, normalized values of K_{eq}/σ'_{cyl} and G_{eq}/σ'_{cyl} are also shown in Tables 4 and 5. The values of K_{eq}/σ'_{cyl} were observed to vary from 11.0 to 16.0 with an average of 13.5. The values of G_{eq}/σ'_{cyl} ranged between 5.3 and 12.8 with a mean of 8.8. The mean value of G_{eq}/σ'_{cyl} in the present program was lower than the results reported by Kwok (1984) (G_{eq}/σ'_{cyl}=13.2) and Ambrosie (1985) (G_{eq}/σ'_{cyl}= 15.5) for the same clay, and Li (1983) (G_{eq}/σ'_{cyl}=13.6) for reconstituted Winnipeg clay. The reasons are unclear this time. On the other hand, a much lower value of G_{eq}/σ'_{cyl}=4.5 was reported by Graham et al. (1983) for natural Winnipeg clay. Wroth et al. (1979) reported G_{eq}/σ'_{cyl} values of many clays to be about 11.

CHAPTER 5

RESULTS: UNLOADING, STORAGE AND RECONSOLIDATION

5.1 INTRODUCTION

As described in Section 3.4.3, all specimens at the end of triaxial consolidation were allowed to stabilize for a period of 4 days that was the same as was used in the previous programs by Kwok (1984) and Ambrosie (1985). They were then backpressured with 500 kPa to simulate high porewater pressures experienced in the seabed, and were allowed to stabilize for a period of 24 hours. "Samples" T732-T739 and T751-T759 were subsequently subjected to the total stress unloading procedures described earlier to model the field sampling process. "Samples" were then allowed to swell for various periods of time to simulate totally drained storage of recovered samples from a site investigation. At the end of various storage periods, all "samples" were subjected to one of the chosen reconsolidation procedures prior to undrained shear tests. The following sections will present the results of "samples" during the unloading, storage and reconsolidation phases of the tests. The "in situ specimens" (T740-T742, T760-T762) were subjected immediately to undrained shearing without an offloading and reloading cycle. The results during shearing will be presented in Chapter 6.

5.2 UNLOADING BEHAVIOUR

5.2.1 Unloading of Shear Stress

As described in Section 3.4.5, the consolidation shear stresses on the "samples" were first offloaded quickly in a period of about 5 minutes while the cell pressures maintained constant. The porewater pressures of the disturbed "samples" during shear unloading were monitored from the cell pedestals with pressure transducers. Graphs of porewater pressures versus deviator stress for the normally consolidated "samples" (T732-T739) and the overconsolidated "samples" (T751-T759) are shown in Figures 5.1-5.3 and Figures 5.4-5.6 respectively. The porewater pressure typically shows an initial non-linear relationship with deviator stress, and then a subsequent linear relationship. Similar porewater pressure behaviour was observed by Noorany and Seed (1965). Some differences in detail compared with the results of Kwok (1984) and Ambrosie (1985) will be discussed later.

The porewater pressure parameter ($A_u = \Delta u/\Delta q$) based on the total unloading of shear stress for the normally consolidated "samples" T732-T739 ranged from 0.26 to 0.49 with an average of 0.37 and a standard deviation of 0.08. For the overconsolidated "samples" T751-T759, A_u varied between 0.36 to 0.47 with a mean of 0.42 and a standard deviation of 0.05. Since these two mean A_u-values are greater than 0.333, the "samples" generally experienced higher mean effective stress immediately following shear unloading than their in situ values. These values are somewhat higher than what Graham et al. (1986) found in their studies. Their mean A_u-values for normally consolidated "samples" and overconsolidated "samples" of the same clay were 0.33 and 0.37 respectively. This means that their mean effective stresses remained essentially constant or increased just slightly immediately after unloading the shear stress to zero.

Unusual behaviour was observed in "sample" T732 (Figure 5.1), in which porewater pressures increased slightly with decreasing deviator stress during the first two decrements of shear stress. This might be due to a minor leakage at the top drainage connections of the "sample". In this case, A_u was found to be negative in this range.

The stress paths of the normally consolidated and overconsolidated "samples" during unloading in p',q-space are also presented in Figures 5.7-5.8 and Figures 5.9-5.11 respectively. The stress paths in p',q-space first move downwards to the left instead of being vertical as would be expected from a linear elastic isotropic soil. Behaviour similar to the present study was reported by Kwok (1984) and Ambrosie (1985). The mechanism is unclear. They both attributed the occurrence to be caused by the "samples" not being at porewater pressure equilibrium before unloading. (To permit comparison, "samples" in the present study were consolidated for the same time duration as in the previous program). Alternatively, the leftwards movement may be caused by a small amount aging of the "samples" at the end of triaxial consolidation and backpressuring, or to a delay in porewater pressure equalization between the "sample" and the sensing element in the transducer.

After two to three decrements of shear stress, Figures 5.7-5.11 show a tendency to move to the right as well as downwards. Kwok (1984) and Ambrosie (1985) both observed similar but less marked behaviour during the last decrement in their tests. They suggested this behaviour was perhaps due to slow equalization of porewater pressures between the "samples" and the porewater pressure transducer. The shear unloading procedure was completed in all studies within 5 minutes, and did not allow the readings to fully stabilize during unloading. This occurrence was more systematic in the present study than the two previous programs. The behaviour might simply be due to the inherent anisotropy of the "samples" (Graham and Houslby 1983). This would explain a straight unloading in p',q-space with $A_u \neq 0.333$, but would not explain the observed non-linear behaviour.

5.2.2 Unloading of Cell Presssure

All "samples" were subjected to isotropic unloading following the unloading of the shear stress. The isotropic unloading lasted for a further period of 10 minutes. Porewater pressure changes that accompanied the removal of cell pressure for normally consolidated "samples" and overconsolidated "samples" are shown in Figures 5.12-5.14 and Figures 5.15-5.17 respectively.

For normally consolidated "samples" (Figure 5.12-5.14), the B-values (= $\Delta u/\Delta\sigma_{cell}$) during isotropic unloading were 96% to 99%. The initial residual porewater pressure immediately following the isotropic unloading reached an average value of -88 kPa. The stress paths for normally consolidated "samples" during isotropic unloading in p',q-space are also shown in Figures 5.7-5.8. Following the combined processes of shear and isotropic unloadings, the normally consolidated "samples" had been unloaded from an "in situ" p'=109.9 kPa (σ'_{1c}=160 kPa, K=0.53) to an average p'=93.0 kPa. The loss in p' averaged 15%. This is lower than the 20% reported by Skempton and Sowa (1963) and Ladd and Lambe (1963). It should also be noted on these tests that the shear unloading phase with $A_u > 0.333$ actually led to small increases in p' before cell pressure reduction.

Exceptions to the general pattern were the normally consolidated "samples" T733 and T736 in Figures 5.12 and 5.13 respectively. The porewater pressures in both "samples" were observed to deviate from an approximate 1:1 relationship with the cell pressure during isotropic unloading. This is more evident in the negative pressure range for the "sample" T736 (Figure 5.13). It was probably associated with the presence of air coming out of solution into the system and inhibiting the development of high negative porewater pressures (Okumura 1971). (It was confirmed during the later reconsolidation phase of testing that both "samples" had air in their drainage systems). The initial residual porewater pressures immediately following isotropic unloading for both "samples" T733 and T736 were -44 kPa and -45 kPa respectively, about half of what was experienced by other normally consolidated "samples". This caused a total loss of 55% in p' as the mean effective stress dropped to about 50 kPa.

For overconsolidated "samples, the B-values during the isotropic unloading were 99% to 100% (Figures 5.15-5.17). They were higher than those obtained for normally consolidated "samples" as discussed in one of the earlier paragraphs. It can be observed that the deviation from the 1:1 relationship was much less obvious in the overconsolidated "samples". The initial residual porewater pressures immediately following the isotropic unloading ranged from -45.3 kPa to -51.6 kPa with an average value of -47.5 kPa. Figures 5.9-5.11 also show the stress paths of the overconsolidated "samples" in p',q-space during isotropic unloading. The residual effective stress immediately following the shear and isotropic unloadings reached an average value of 52.7 kPa, which compared favorably to the "in situ" mean effective stress of 54.9 kPa (σ'_{1c}=80 kPa, K=0.53). The loss in p' was only 3.8%, which is much less than the 15% from the normally consolidated "samples". The mean effective stress of the overconsolidated "samples" can be considered to remain approximately constant immediately before and after the unloading processes, especially for "samples" T751, T752, T756 and T759 where the differences were usually of the the order of 2 to 3 kPa. A similar conclusion was drawn for overconsolidated "samples" of the clay by Graham et al. (1986).

5.3 STORAGE

All "samples" after being unloaded were subjected to different periods of swelling to model various storage periods imposed on the recovered samples. The selected durations of the storage periods were 15 minutes, 1 day and 1 week. The background leading to the selection of these storage periods was discussed in Section 3.2.2. Section 3.4.6 described the test procedure during the storage phase of testing.

Figures 5.18 to 5.20 show the swelling behaviour of the normally consolidated "samples" T733-T739 with respect to the storage time. The final volumetric strains measured during this phase are summarized in Table 7. The swelling curve for "sample" T732 is not available due to leakage at the top drainage connection. "Sample" T733 was allowed to have drainage from the top of the "sample" through the top cap (Figure 5.18 a), and at the same time negative porewater pressures were monitored from the cell pedestal (Figure 5.18 b) during a storage period of 1 week (Section 3.2.2). It was observed in Figure 5.18 b that the negative residual porewater pressure stayed almost constant at a value of about -55 to -57 kPa for some time, and then a loss of negative porewater pressure started at a time ranging from 10 hours to 1 day. (This relatively sudden breakdown phenomenon was not so obvious at the corresponding section of the swelling curve in Figure 5.18 a but the curves have the same general shape). The drop of porewater pressure continued in an approximately linear relationship with log(storage time). This gradually caused decreased values of the mean effective stress p'. Similar porewater pressure behaviour was also observed by both Kwok (1984) and Ambrosie (1985), (Graham et al. 1986). The mechanism is unclear. They suggested that some may be due to slow reorientation of clay particles. This could develop as the anisotropic in situ stress changed to isotropic effective stresses controlled by negative porewater pressures. The remainder may result from diffusion through the double membranes, or past the sealing rings under the low cell pressure of 5 kPa during this stage of testing. Kirkpatrick and Khan (1984) attributed the loss of pore suction with increasing storage time to the effects of cavitation. The occurrence may result from a combination of all these factors to varying degrees. Further work is needed on the effects of cavitation in these samples.

After the "sample" T733 had been stored for about 4 to 5 days, the linear relationship (Figure 5.18 b) of porewater pressure with respect to log(time) tended to slow down. This is also reflected at the corresponding section of the swelling curve in Figure 5.18 a. At the end of the 1-week storage time, the residual porewater pressure (u_r) at the bottom of T733 dropped to -7.5 kPa, and the u_r/u_{ri} ratio decreased to 14%. The final volumetric strain (expansion) for T733 was 5.92%.

Two other 1-week normally consolidated "samples" (T736 and T739) also show swelling curves with a shape similar to a conventionally S-shaped consolidation curve with large load increment ratios (Figures 5.19-5.20). The swelling of the "samples" resulted from the dissipation of negative porewater pressures. The volume increases of the "samples" were observed to take place more gradually than the losses in negative porewater pressure.

A typical swelling curve in log(time) space consists of an initial non-linear section followed by a second linear section and a third less steep linear line. The time where the two linear sections meet may be interpreted as the equilibrium time, and was observed to range from about to 1 to 2 days in T736, about 3 to 4 days in T739, and about 5 days in the one-end drainage "sample" T733 (Figure 5.18 a). At the end of the 1-week storage period, both "samples" T736 and T739 had final volumetric strains of 7.46% and 7.76% respectively. These strains were higher than the 5.92% from "sample" T733. The lower strain in T733 was probably due to the partially drained condition imposed on the "sample", where lateral filter paper drains had not been used. Ambrosie (1985) reported the volumetric strain of the same clay after a storage period of 1 week was 1.7%. Re-examination of the original laboratory data shows that this figure should be corrected to 6.95%.

The 1-day storage "samples" T735 and T738 exhibited only the first linear relationship without any subsequent slow-down during the storage period. The final volumetric strain of "sample" T738 after 1-day storage was 5.20%. "Sample" T735 had an unusually high volumetric strain of 8.11% probably because its membranes were accidentally overexpanded for a short time at the end of unloading when the "sample" was under low cell pressure with high applied porewater pressure. After its "in situ" stresses (σ'_{1c}=160 kPa, σ'_{3c}=84.8 kPa) had been re-established, the drainage system was flushed to ensure that any trapped air was removed. The "sample" was then allowed to stabilize for

24 hours under a backpressure of 500 kPa. The unloading procedure was subsequently repeated. The soil structure at end of the backpressuring might be different from that at its "in situ" state despite the rescue procedure. However the most important thing is that the shape of this swelling curve during the first 2-hour storage period is identical to the corresponding stage of "sample" T736.

The 15-minute "samples" T734 and T737 had volumetric strains of 0.54% and 0.46% respectively. These strains were small when compared to those obtained from "samples" after a storage period of 1 day or 1 week. However their swelling behaviour did show the initial shape of a 1-week swelling curve, especially for "sample" T737.

The swelling curves for the overconsolidated "samples" T751-T759 during various storage periods are presented in Figures 5.21-5.23. Similar trends of swelling behaviour were observed as previously described for the normally consolidated "samples". Equilibrium times usually occurred at times ranging from 2 to 3 days after the drainage leads were opened. This was in the same range as the normally consolidated samples but the results appeared to be more consistent. The reason may be due to the smaller magnitude of stress release in the case of overconsolidated "samples" than normally consolidated "samples".

Table 8 summarizes the final volumetric strains measured during swelling for the overconsolidated "samples". The volumetric strains for the 1-week "samples" varied from 6.49% to 6.75%. The 1-day "samples" and 15-minute "samples" show volumetric strains of 4.13% to 5.29%, and 0.28% to 0.37% respectively. These strains are only slightly lower than the corresponding values from the normally consolidated "samples". This may be due to the marked non-linearity of swelling behaviour during unloading. Figure 5.21 shows a sudden jump in the results for "sample" T752 after it has been drained for a period of 2 hours. This was because of a sudden loss of the cell pressure during the early stages of the test.

5.4 RECONSOLIDATION

At the end of various selected storage periods, all "samples" prior to undrained shearing were subjected to reconsolidation at one of the various stress levels chosen in Section 3.2.2. The main objective in this study is to determine which reconsolidation procedure can best reproduce the "in situ" strength of reconstituted illite clay. Section 3.4.7 described the test procedure during this phase of testing.

Reconsolidation was usually complete after 3 to 4 days. Axial strains and volumetric strains measured during this stage for the normally consolidated "samples" T732-T739 are summarized in Table 7. Lateral strains were also computed in Table 7 from the measured volumetric strains and axial strains assuming that the "samples" remained cylindrical during deformation. Test results for "sample" T732 were not available due to leakage at top drainage connection.

It was observed that reconsolidation strains experienced by the normally consolidated "samples" varied with the reconsolidation procedures and the storage periods. The volume changes in term of volumetric strains experienced by the "samples" during this reconsolidation phase are also plotted against log(storage time) in Figure 5.24. There is an approximately linear and parallel relationship between the volumetric reconsolidation strain and the storage time of the "sample" in log space. The "samples" which had been subjected to longer periods of drained storage experienced larger subsequent volume decreases when they were subjected to identical reconsolidation procedures. The volumetric strains were usually the highest for the "samples" stored for 1 week. Table 7 also shows similar relationships in the measured axial strains.

As well as this influence of storage time, "samples" which had been subjected to identical period of storage experienced larger volume decreases resulting from $1.0x\sigma'_{1c}$-iso reconsolidation than those from $1.0x\sigma'_{1c}$-aniso reconsolidation. (These symbols will be used again later to refer to the reconsolidation procedures. "$1.0x\sigma'_{1c}$-iso" means "isotropic reconsolidation to σ'_1=$1.0x\sigma'_{1c}$; "aniso" means "anisotropic reconsolidation to σ'_1=$1.0x\sigma'_{1c}$".) These larger volume decreases are due to the higher imposed mean stress level of p'=160 kPa in the $1.0x\sigma'_{1c}$-iso reconsolidation compared with p'=109.9 kPa in the $1.0x\sigma'_{1c}$-aniso reconsolidation. Of the three 1-week normally consolidated "samples" (T733, T736 and T739), "sample" T733 which was subjected to the $0.6x\sigma'_{1c}$-iso reconsolidation procedure gave the lowest volumetric strain. This is probably because it had the lowest p' value of 96 kPa of the three "samples". Results of the $0.6x\sigma'_{1c}$-iso reconsolidation for normally consolidated "samples" with other storage times are not available as explained in an earlier section.

Reconsolidation strains for the overconsolidated "samples" T751-T759 are summarized in Table 8. Volumetric reconsolidation strains are plotted against log(storage time) in Figure 5.25. Similar trends of reconsolidation behaviour were observed to those described earlier for normally consolidated "samples", but the results appear to be more consistent. The volume decreases experienced by overconsolidated "samples" during this stage were smaller than corresponding values from normally consolidated "samples". The reason is probably due to the smaller magnitude of the reconsolidation stress levels in the case of overconsolidated "samples" compared with the normally consolidated "samples".

Unusual behaviour was observed in "sample" T751 which experienced a small volume expansion instead of volume compression during the $0.6x\sigma'_{1c}$-iso reconsolidation (Table 8). "Sample" T751 was not able to swell fully during the short imposed storage period of 15 minutes. The mean effective stress of the "sample" at the end of storage period therefore dropped only slightly lower than the initial value of p'=53 kPa immediately following the total stress unloading, and was still higher than the value of p'=48 kPa that was applied during $0.6x\sigma'_{1c}$-iso reconsolidation. This explains why swelling still continued during the reconsolidation phase of the tests. Swelling is also seen in the results of axial strain for T751 (Table 8). On the other hand, the 1-day and 1-week "samples" (T752 and T753 respectively) had released their negative porewater pressures, and the p' values were therefore lower than the reconsolidation value p'=48 kPa. These samples experienced volume decreases during the $0.6x\sigma'_{1c}$-iso reconsolidation.

CHAPTER 6

UNDRAINED SHEAR TEST RESULTS

6.1 INTRODUCTION

After triaxial consolidation, all specimens were transferred from the consolidation frame to a strain-controlled compression test frame. They were then subjected to a backpressure of 500 kPa for a 24-hr period before any further testing. Seventeen specimens (T732-T739 and T751-T759) now referred to as "samples" were subsequently subjected to processes of unloading, swelling and reconsolidation before undrained shearing was performed. On the other hand, six control "in situ specimens" (T740-T742 and T760-T762) were sheared undrained immediately following the backpressuring without the unloading and reloading steps. This chapter presents the undrained shear test results for both the normally consolidated specimens (T732-T742) in Table 9 and the overconsolidated specimens (T751-T762) in Table 10.

Properties examined from the results of the undrained shear tests include the undrained shear strength, s_u; the porewater pressure parameters, A_f and m; and the "elastic" modulus, E_{50}. In each case, the results from the "in situ specimens" will be identified first, and then the results from various reconsolidation procedures will be presented.

6.2 STRESS-STRAIN RELATIONSHIPS

Graphs of $(\sigma_1-\sigma_3)/2\sigma'_{vc}$, σ'_1/σ'_3 and $\Delta u/\sigma'_{vc}$ versus ϵ_1 have been plotted for all specimens during undrained shearing. Eight representative sets of these graphs differentiated in terms of the reconsolidation procedures and their overconsolidation ratio are given in Figures 6.1-6.8. The remaining graphs from the test program have been included in Appendix C for further reference.

The stress-strain curves from the undrained shear tests are all rather similar, showing a variety of slightly strain softening behaviour that depends (1) on the overconsolidation history of the specimens; (2) on the duration of storage; and (3) on the reconsolidation procedures. In general, all tests exhibited an initial stiff section on $(\sigma_1-\sigma_3)/2\sigma'_{vc}$ versus ϵ_1 plots, followed by a more flexible stress-strain response. A small amount of strain softening behaviour was usually observed after a maximum deviator stress had been reached. The reduction in the shear resistance between the maximum deviator stress and the end of the test at large strain, was not as large as observed for example by Li (1983) in remoulded Winnipeg Clay. The stress-strain curves in the present study were examined using the maximum deviator stress for determining failure. This failure criterion differed from the yield failure criterion used by Kwok (1984) and Ambrosie (1985), in which a yield point was identified with some difficulty as the stress at which their samples had maximum curvature in stress-strain behaviour.

For normally consolidated soil, the "in situ specimens" T740-T742 failed at axial strains ranging from 0.56% to 0.75%. The isotropically reconsolidated "samples" T732-T736 failed at markedly larger axial strains (4.39% to 5.37%) than the anisotropically reconsolidated "samples" T737-T739 (0.82% to 1.37%).

In the case of overconsolidated soil, the failure of the "in situ specimens" T760-T762 occurred at axial strains ranging from 0.97% to 1.39%, larger than the corresponding values from the normally consolidated soil. The failure strains of the isotropically reconsolidated "samples" T750-T756 ranged between 2.73% and 4.11%. The anisotropically reconsolidated "samples" T757-T759 failed at slightly lower strains of 1.38% to 2.50% than the isotropically consolidated "samples", and at slightly larger strains than the control specimens.

In general, the reconsolidated "samples" of the normally consolidated and the overconsolidated illite usually failed at higher axial strains than the control "in situ specimens". The failure strains observed from the anistropically reconsolidated "samples" were also closer to the "in situ" values when compared to the isotropically reconsolidated "samples". Similar results were reported by Okumura (1971), Kirkpatrick and Khan (1984), and Graham et al. (1986). However no systematic relationship was observed between the failure strains and storage time (Tables 9 and 10).

6.3 EFFECTIVE STRESS PATHS

6.3.1 Normally Consolidated Soil

The effective stress paths in p',q-space of normally consolidated specimens are presented in Figures 6.9-6.12. "Samples" subjected to identical reconsolidation procedures are plotted in the same graphs to show comparisons regarding the storage periods. The results from the different reconsolidation procedures will be discussed separately in the following paragraphs. The influence of normal consolidation is clearly demonstrated in all effective stress paths, with some differences due to the different reconsolidation procedures. They generally rise fairly steeply and then move to the left as the specimens try to compress during undrained shear.

The three normally consolidated "in situ specimens" T740, T741 and T742 rose steeply at the beginning of the test (Figure 6.9), and then moved sharply to the left with some strain softening once failure had been reached. This behaviour indicated breakdown of the soil microstructure that had been developed during anisotropic consolidation. The "in situ specimens" failed at almost identical shear stresses (Figure 6.9; Table 9).

The $0.6x\sigma'_{1c}$-iso reconsolidated "samples" T732 and T733 exhibited slightly different effective paths in p',q-space (Figure 6.10) although they were reconsolidated to identical reconsolidation stresses. (They were also quite different from the control "specimens" in Figure 6.9). "Sample" T732 shifted first slightly to the right and then back to the left as it moved upwards. It then reached maximum shear stress and continued to the left with a small amount of strain softening. "Sample" T733, on the other hand, moved upwards to the left at the start of shearing, and then ran approximately parallel to T732. Its maximum shear stress, and post-failure behaviour were very similar to those in T732.

The stress paths of the $1.0x\sigma'_{1c}$-iso reconsolidated "samples" T734, T735 and T736 in Figure 6.11 are again similar to each other but different from the other series. They first moved upwards to the left until reaching failure, and continued to the left with some strain softening at large strains. However the pre-failure stress path of the 15-minute "sample" (T734) rose more steeply than the 1-day and 1-week "samples" (T735 and T736 respectively). The maximum shear stresses of these reconsolidated "samples" decreased with increasing storage time.

The stress paths of the $1.0x\sigma'_{1c}$-aniso "samples" T737, T738 and T739 are shown in Figure 6.12. They exhibited generally similar shapes of effective stress paths to the "in situ specimens" (Figure 6.9). The 15-minute "sample" T737 moved upwards steeply until reaching the failure. The effective stress paths of "samples" T738 and T739 (with storage times of 1 day and 1 week respectively) deviated more to the left during the pre-failure stage. The duration of storage seemed to have similar effects on the stress paths as described in the previous paragraph for $1.0x\sigma'_{1c}$-iso reconsolidated "samples". That is, the maximum shear stress decreased with increasing storage time.

6.3.2 Overconsolidated Soil

The effective stress paths in p',q-space for the overconsolidated illite are presented in Figures 6.13-6.16. The effective stress paths generally moved upwards either almost vertically or slightly to the left at the beginning of shear. They then moved slowly to the right and subsequently failed as the lightly overconsolidated clay tended to dilate, producing decreasing porewater pressures. They generally continued to move to the right with some strain softening. Some exception to this general behaviour are shown in Figure 6.15. The shapes of the pre-failure stress paths of the $1.0x\sigma'_{1c}$-iso "samples" T754, T755 and T756 in Figure 6.15 are very similar to those from other overconsolidated specimens (Figures 6.13, 6.14 and 6.16). However after the $1.0x\sigma'_{1c}$-iso "samples" reached failure, they moved to the left instead of to the right, and showed the expected strain softening. With the increase of p' to 80 kPa during reconsolidation, these "samples" tended to compress during the later stages of shear, producing increasing porewater pressures.

The duration of storage seemed to have similar effects on the effective stress paths of the overconsolidated "samples" to those described earlier for the $1.0x\sigma'_{1c}$ isotropically and anisotropically reconsolidated "samples" that were normally consolidated. The deviation of the pre-failure effective stress paths from the vertical to the left (Figures 6.14 and 6.15) increased with increasing storage time. The 15-minute "samples" usually exhibited the highest shear strength.

6.4 POREWATER PRESSURE GENERATION

6.4.1 Normally Consolidated Soil

The relationships between normalized changes in porewater pressure ($\Delta u/\sigma'_{vc}$) and axial strains (ϵ_1) for all the normally consolidated specimens during the undrained shearing phase of the tests are presented in Figures 6.1-6.4 and in Appendix C. The porewater pressures continued to increase after the failure was reached. These increases in porewater pressures are characteristic of normal consolidation as the soil tends to compress under undrained shearing.

The porewater pressure parameter $A_f = \Delta u_f/\Delta(\sigma_1-\sigma_3)_f$ was obtained from each test and results are summarized in Table 9. The reconsolidated "samples" usually failed at higher A_f-values (0.51 to 0.79) than the control "in situ specimens" (0.37 to 0.42). They also showed the A_f-values increased with increasing storage time. For "samples" subjected to identical periods of storage, the $0.6x\sigma'_{1c}$-iso reconsolidation gave the best estimates of the "in situ" A_f. This view was also reflected in the results of Ambrosie (1985). On the other hand, the anisotropic reconsolidation was the least successful method for estimating the "in situ" value except from the 15-minute sample (Table 9).

The porewater pressure behaviour was also examined using the normalized change in porewater pressure $\Delta u/\sigma'_{vc}$ versus normalized change in octahedral total mean stress $\Delta p/\sigma'_{vc}$. The graphs shown in Figures 6.17-6.20 are presented in groups according to reconsolidation procedures. The shapes of these graphs for the anisotropically reconsolidated "samples" T737, T738 and T739 (Figure 6.20) are quite similar to those obtained from the control "in situ specimens" T740, T741 and T742 (Figure 6.17). The specimens generally exhibited remarkably linear initial relationships until close to failure. When the porewater pressures suddenly increased, the normalized changes in octahedral total mean stress $\Delta p/\sigma'_{vc}$ remained almost constant. The slopes of the initial linear sections represent the m-values summarized in Table 9. The m-values of the "in situ specimens" ranged between 1.21 and 1.42 with an average of 1.29. This average is close to the m-value of 1.26 reported by Ambrosie (1985) and represents anisotropic particle structure in the specimens (Graham and Houlsby 1983). The m-values of the anisotropically reconsolidated "samples" were usually slightly higher than the "in situ specimens" and had larger variability from 1.37 to 1.88.

The relationships between $\Delta u/\sigma'_{vc}$ versus $\Delta p/\sigma'_{vc}$ for the isotropically reconsolidated "samples" (Figures 6.18 and 6.19) were slightly different from the anisotropically reconsolidated specimens shown in Figure 6.20. The initial linear section was more pronounced for the isotropically reconsolidated "samples", and the transition to non-linear behaviour was not as sudden as in the anisotropically reconsolidated "samples". A similar observation was made by Ambrosie (1985). Despite these differences, the isotropic "samples" exhibited a similar range of m-values (1.56 to 1.86) when compared to that from anisotropic "samples" (1.37 to 1.88). However the anisotropic reconsolidation generally tended to give the best estimates of the "in situ" m-value compared with the isotropic reconsolidations if identical periods of storage were imposed to the "samples". There was exception for the case of the 1-week "samples" (Table 9).

Overall, the reconsolidated "samples" generally exhibited higher m-values than the control "in situ specimens". The m-values also increased with increasing storage time (Table 9). The $1.0x\sigma'_{1c}$-aniso reconsolidation generally gave the best estimate of its "in situ" m-value.

6.4.2 Overconsolidated Soil

The relationships between $\Delta u/\sigma'_{vc}$ and ϵ_1 for the overconsolidated samples during undrained shearing are given in Figures 6.5-6.8 and in Appendix C. The porewater presssures rose to maximum before failure was reached, and then decreased as the specimens tended to dilate and strain soften to the end of the test at axial strains of about 12%.

Figures 6.21-6.24 group the plots of $\Delta u/\sigma'_{vc}$ versus $\Delta p/\sigma'_{vc}$ according to the reconsolidation procedures. For specimens except the $1.0\sigma'_{1c}$-iso reconsolidated "samples" (T754-T756; Figure 6.23), the initial relationship was approximately linear and suddenly showed a decrease in $\Delta u/\sigma'_{vc}$, with an increase in $\Delta p/\sigma'_{vc}$ hooking the curve to the right. This indicated the dilative behaviour of lightly overconsolidated soils. The subsequent Δu versus Δp behaviour is complex and will be discussed further in Chapter 7. There is close general agreement between the "in situ specimens" in Figure 6.21 and the $1.0x\sigma'_{1c}$-aniso "samples" in Figure 6.24. The initial porewater pressure responses shown in Figures

6.21 and 6.24 seemed to be less certain and less linear when compared to those of the $0.6x\sigma'_{1c}$-iso reconsolidated "samples" (Figure 6.22).

The porewater pressures of the $1.0x\sigma'_{1c}$-iso reconsolidated "samples" T754, T755 and T756 (Figure 6.23) are slightly different in detail, although they show similar trends. They increased slightly more quickly during the early stages of the tests than other overconsolidated specimens. In this case, the "loop" in the porewater pressure curves shown in Figures 6.21, 6.22 and 6.24 have degenerated into simply a marked discontinuity and a sudden change of direction. The $1.0x\sigma'_{1c}$-iso reconsolidated "samples" at this stage tended to compress and behaved more like normally consolidated soils. This behaviour was also observed by Kwok (1984) in his $1.0x\sigma'_{1c}$-iso reconsolidated "samples".

The A_f-values of the overconsolidated samples are summarized in Table 10. The control "in situ specimens" T761 and T762 had A_f-values of 0.12 and 0.18 respectively. These compare with values of 0.19 and 0.20 reported by Kwok (1984) at smaller axial strains defining his "yield stress". The control specimen T760 showed an unusually low A_f-value of 0.03. This is possibly due to a saturation problem encountered at the end of triaxial consolidation. The B-value = 0.97 reported in Table 10 was obtained only after efforts to increase the saturation. For the reconsolidated "samples", the measured A_f-values varied considerably from 0.11 to 0.50. It was observed that A_f-values increased with increasing storage time when "samples" had been subjected to identical reconsolidation procedures. Kwok (1984) also reported that the 1-week storage "samples" showed the highest A_f-values. The anisotropically reconsolidated "samples" seemed to give the best estimates of "in situ" A_f-value compared with the isotropically reconsolidated "samples" when they had been subjected to identical duration of storage. Graham et al. (1986) also drew the same conclusion.

The m-values for the overconsolidated specimens are given in Table 10. All specimens except T760 and T762 have m-values higher than 1.0. The m-values of the "in situ specimens" varied considerably from 0.86 to 1.34. The reason is unclear, but the same difficulty was encountered by Kwok (1984) in his overconsolidated "in situ specimens".

For "samples" subjected to identical periods of storage, the isotropic "samples" generally exhibited higher m-values than the anisotropic "samples", which usually gave results closer to the "in situ" m-values. This view is also reflected in the results of A_f-values which have just been discussed. The m-values also tended to increase with increasing storage time although the tendency was not as consistent as in the case of the normally consolidated "samples".

6.5 ELASTIC MODULUS

In the present study, the non-linearity of the $(\sigma_1-\sigma_3)/2\sigma'_{vc}$ versus ϵ_1 curves from undrained shear testing has been approximated by a secant modulus E_{50}. This E_{50}-value was obtained as the slope of a stress-strain curve between start of shearing and 50% of the maximum deviator stress (Graham 1974). Table 9 and Table 10 summarize the results for the normally consolidated specimens and the overconsolidated specimens respectively. The relative stiffnesses E_{50}/s_u and E_{50}/σ'_{vc} are also included in Table 9 and Table 10 for comparison.

For the normally consolidated specimens, the E_{50}-values of the "in situ specimens" T740 and T741 were 63.5 mPa and 70.6 mPa respectively. "In situ specimens" T762 showed a comparatively low value of 25.4 mPa that has been excluded from the analysis. There was no systematic variation of stiffness with storage time. This means that the effectiveness of the reconsolidation procedures can be examined in terms of the average E_{50} values. These were calculated from Table 9 to be (1) 67.1 mPa for the control "in situ specimens", (2) 11.4 mPa for the $0.6x\sigma'_{1c}$-iso "samples", (3) 17.4 mPa for the $1.0x\sigma'_{1c}$-iso "samples" and (4) 37.4 mPa for the $1.0x\sigma'_{1c}$-aniso "samples". This shows that the reconsolidated "samples" generally exhibit much lower E_{50}-values than the "in situ specimens". Similar results were found by Atkinson and Kubba (1981); and by Kirkpatrick and Khan (1984). Although there was considerable scatter among the measured E_{50}-values (as is usual in estimating clay stiffnesses in the laboratory), the $1.0x\sigma'_{1c}$-aniso "samples" usually gave closer results to "in situ" values than the isotropic "samples". This contrasted with what Graham et al. (1986) found, namely that the $1.0x\sigma'_{1c}$-aniso reconsolidation procedure was actually the least successful method in recovering the elastic modulus E_{50}.

The E_{50} values for the overconsolidated specimens varied considerably (Table 10) so no firm interpretations can be made. The "samples" subjected to a storage period of 15 minutes usually showed the highest E_{50}-values if identical reconsolidation procedures were applied. This indicated that the 15-minute "samples" were subjected to less disturbance due to offloading and storage than other "samples". If some apparently divergent results are discarded, it can be suggested tentatively that both isotropic reconsolidation procedures underestimate the "in situ" soil stiffness, and a better estimate is obtained from

$1.0 \times \sigma'_{1c}$-aniso reconsolidation procedure. This view was also reflected in the last paragraph for the normally consolidated "samples". Further discussion of the soil stiffnesses will be undertaken in Chapter 7.

CHAPTER 7

GENERAL DISCUSSION

7.1 INTRODUCTION

This investigation studied the effects of stress-release disturbance on the shear behaviour of simulated offshore clay samples. It was aimed at searching for laboratory procedures which can best recover the "in situ" strength and stress-strain behaviour of the clay. The design program and test procedures for this study were outlined in Chapter 3. Chapters 4, 5 and 6 presented the results in detail from the consolidation; the unloading, storage and reconsolidation; and the undrained shear phases of tests. They also contained some preliminary discussion of the results as they were being presented. This chapter will discuss more general topics raised by the research.

7.2 BASIC SOIL PROPERTIES AND GENERAL DISCUSSION ON MOISTURE CONTENTS

7.2.1 Basic Soil Properties

General classification tests, including Atterberg limits, grain size distribution and specific gravity tests, were performed on the illitic clay used in this investigation. The average index properties were compared in Table 2 with results reported by Ambrosie (1985), Kwok (1984) and Wu et al. (1983) on similar clay. Relatively good agreement was found between these four sets of results. Atterberg limits were performed on all specimens used for the present stress release study. The range of plasticity index (Tables 11 and 12) was from 28.4% to 37.3% with a mean of 33.6% and a standard deviation of 4.7%. There was no systematic variation of the Atterberg limits with time during the course of the testing program.

7.2.2 Moisture Contents at Various Stages During Testing

Tables 11 and 12 present six sets of moisture contents at different stages during testing. These six sets of moisture contents were obtained as follows:

(1) from slurry at the beginning of one-dimensional consolidation.

(2) from soil trimmings at the beginning of triaxial consolidation.

(3) from measured volume changes at the end of triaxial consolidation.

(4) from volume changes at the end of unloading and storage.

(5) from volume changes at the end of reconsolidation and immediately before undrained shear testing.

(6) from trimmings of failed specimens after undrained shear testing.

The moisture contents during the above six stages of testing will be discussed in the following paragraphs.

The moisture content of each slurry was measured after the initial slurry mixing and before it was poured into the cylinder for one-dimensional consolidation. The moisture contents of all slurries were within 1% of the intended value of 114.4% (twice of the liquid limit used by Kwok 1984) except for specimens T740-T742 in which the moisture contents were around 5% higher (Table 11).

At the end of one-dimensional consolidation (stage 2) , moisture contents measured directly from the trimmings of specimens during the building-in process varied from 49.0% to 51.5% with a mean of 50.2% and a standard deviation of 0.7% (Tables 11 and 12). Standard deviations of

3.4% and 2.0% were obtained by Ambrosie (1984) and Kwok (1985) respectively. The results obtained from the present program thus compare favourably with those from the two previous programs and justify the extra effort and attention that was given to them.

Moisture contents of normally consolidated samples at the end of triaxial consolidation (stage 3) were calculated from the observed volume changes during triaxial consolidation based on the known moisture contents measured from stage 2 above. They varied from 38.3% to 39.1% with a mean of 38.8% and a standard deviation of 0.5% (Table 11). "Samples" T732 and T733 with higher moisture contents of 41.0% and 39.7% respectively were excluded from the above statistical analysis due to their different drainage conditions and leakage problems during testing (Section 4.3).

The moisture contents of overconsolidated samples at the end of triaxial consolidation (stage 3) varied from 41.3% to 42.7% with a mean of 42.0% and a standard devaiation of 0.4% (Table 12). Kwok (1984) and Ambrosie (1985) had the standard deviations of 1.3% and 3.3% respectively at this stage. The variations in moisture contents at this phase of testing in the present program were much less when compared to the two previous programs. This again indicated that much better control in moisture contents was achieved in the present study.

The changes in moisture contents of the normally consolidated "samples" during their storage can be obtained by comparing the moisture contents between stages 3 and 4 in Table 11. The changes depended upon the duration of storage time. The 1-week "samples" (T733, T736 and T739) generally experienced the largest increases in moisture contents (4.5%, 5.6% and 5.8% respectively). "Sample" T733 exhibited the lowest moisture increase of 4.5% among these three "samples" because only top drainage with no side filter drains was allowed (Section 3.2.2). The 1-day "samples" T735 and T738 experienced increases of 6.1% and 3.9% respectively. The moisture increase in T735 was unusually high due to the unusual unloading and rescue procedures previously mentioned in Section 5.3. The 15-minute "samples" T734 and T737 experienced the smallest moisture increase in the range 0.3% to 0.4%.

The increases in moisture contents of the overconsolidated "samples" during their storage periods can be obtained from Table 12. The increases from stage 3 to stage 4 were similar but slightly lower than in normally consolidated "samples" with identical storage times. However the results seemed to be more consistent in this case of the overconsolidated soils. Despite some scatter, the rather obvious conclusion can be drawn that during "drained" storage, "samples" experience increasing moisture contents (volumes) with increasing storage times.

The net changes of moisture contents resulting from the combined "drained" storage and the reconsolidation process for the normally consolidated "samples" can be obtained from Table 11 by comparing moisture contents at stages 3 and 5. These net changes depend very much on the reconsolidated procedures, but not so much on the storage periods. That is, the two processes tended to counteract one another to some extent. "Sample" T733 ($0.6x\sigma'_{1c}$-iso group) gave a result of 0.1% loss in moisture content from stage 3 to stage 5 even though the mean pressure p'=110 kPa during initial triaxial consolidation decreased to p'=96 kPa during subsequent reconsolidation. It is therefore suggested that a change must have occurred in the microstructure of the clay during the unloading, storage and reconsolidation (see also, Graham et al. 1986).

The 1.0xσ'_{1c}-iso samples (T734-T736) showed net losses of 2.0% to 2.9% in moisture contents (that is, volume decrease) between stages 3 and 5. There was no systematic relationship observed between the net moisture changes and the storage times. Although the "samples" swelled during the various storage periods, more moisture was lost during the reconsolidation period. Therefore there were net volume decreases in the "samples" at the end of reconsolidation. These losses in moisture contents were expected due to an overall increase in p' from 110 kPa at the end of triaxial consolidation to 160 kPa at the end of reconsolidation. Since the 1.0xσ'_{1c}-iso "samples" undergo additional volumetric straining, changes in the measured properties can be expected.

Table 11 showed that the 1.0xσ'_{1c}-aniso set of "samples" (T737-T739) underwent reconsolidation back to their "in situ" anisotropic stresses after the "drained" storage periods. Net decreases in moisture contents in the range of 0.5% to 0.7% still occurred between stages 3 and 5. However these losses were relatively small when compared to those from 1.0xσ'_{1c}-iso "samples". No consistent relationship was observed between the decreases of moisture contents and the storage times.

On the other hand, the differences in moisture contents between stage 3 and stage 5 for the overconsolidated "samples" were clearly affected by the duration of storage as well as the subsequent reconsolidation procedures (Table 12). The 0.6xσ'_{1c}-iso "samples" (T751-T753) experienced 0.3% to 1.5% net increases in moisture contents because p' was decreased from about 55 kPa at the end of triaxial consolidation to 48 kPa at the end of reconsolidation. The gains tended to increase with increasing storage times. This tendency was not observed in the case of the normally consolidated "samples". For "samples" in the $1.0x\sigma'_{1c}$-iso reconsolidation (T754-T756), the p' values increased from about 55 kPa to 80 kPa at the end of reconsolidation. This was accompanied by a net loss of 0.4% to 1.1% in moisture content. The loss in this case tended to decrease with increasing storage times. Although the $1.0x\sigma'_{1c}$-aniso "samples" (T757-T759) were reconsolidated to "in situ" anisotropic stresses, they still experienced small net gains of 0.1% to 0.9% in moisture contents. The tendency of increasing moisture contents with increasing storage times was again observed.

All the above observations indicate that "samples" subjected to longer storage periods experience higher degrees of sample disturbance during their "drained" storage. Although "samples" within the same reconsolidation group were subsequently reconsolidated to identical stress levels, they behaved slightly differently during the reconsolidation and the undrained shear stages due to the different durations of storage that had been previously imposed. None of the reconsolidation procedures in this thesis could fully recover the moisture contents immediate before the unloading, swelling and reconsolidation cycle.

Finally, the moisture contents measured from the trimmings at the end of undrained shearing tests (stage 6) were compared to calculated moisture contents at the end of reconsolidation (stage 5). Since the specimens were sheared undrained, the moisture contents before and after shearing should be the same. Tables 11 and 12 show that these two sets of values are comparable in most cases. The percentage differences between measured and calculated moisture contents range from 0% to 2.7% for the normally consolidated soils, and 0% to 2.1% for the overconsolidated soils. Although these differences are slightly higher than the values of 0% to 1.2% obtained by Kwok (1984), they show much better consistency than the values of 0% to 4.1% obtained by Ambrosie (1985).

7.2.3 Moisture Content Profiles across Failed Samples

There was intially some concern regarding possible variations of moisture content along the length of the failed samples. Each sample was cut into six transverse slices along its height at the end of undrained shear testing. Two moisture determination were carried out on each slice. Figures 7.1 and 7.2 show the moisture content profiles across six randomly selected samples. Observations drawn from these figures were as follows:

(1) The difference between the two moisture content determinations from each slice generally varied from 0% to 0.9% with an average of 0.3%.

(2) The moisture content differences across the whole sample were in the range of 1.3% to 1.7%.

(3) There is a tendency for the moisture contents to be slightly lower in the middle of the samples compared with the top and the bottom.

Similar results and observation were obtained by Kwok (1984).

7.3 UNDRAINED SHEARING BEHAVIOUR

7.3.1 Normally Consolidated and Overconsolidated Failure Envelopes

The tests conducted in this investigation permit an evaluation of both normally consolidated and the overconsolidated rupture envelopes of illite at a preconsolidation pressure of 160 kPa. The stress states at which maximum deviator stresses occurred in the present study were plotted as the data points in Figure 7.3. The composite strength envelopes obtained from the two previous programs of Kwok (1984) for overconsolidated samples and Ambrosie (1985) for normally consolidated samples were also included in line form in the figure for comparison. Using an assumption of zero cohesion for the normally consolidated samples (c'_{nc}=0), Ambrosie (1985) found that the effective friction angle (Φ'_{nc}) was equal to 25°. The data from the present program were observed to fall on the same envelope.

The overconsolidated envelope with c'_{oc}=16 kPa, Φ'_{oc}=18° was obtained by Kwok (1984) for his "samples" stored "undrained". Failure in his "samples" was clearly affected by the reconsolidation procedures and was apparently unaffected by the storage times. His "samples" were stored under "undrained" conditions so that there were losses only in the negative porewater pressures, but not in the volumes or moisture contents. On the other hand, the "samples" stored under "drained" conditions in the present program were allowed to have moisture changes as well as dissipation of negative porewater pressures. Failure in these "samples" was seen to depend upon the duration of storage as well as the subsequent reconsolidation procedures. Figure 7.3 shows that the 15-minute overconsolidated "samples" gave the same strength envelope obtained by Kwok (1984). This was because the 15 minutes of storage time was so short that the degrees of sample disturbance introduced from both the "drained" and the "undrained" storage were small (0.2% to 0.3% of moisture content increase (Table 12) or a drop of 0 to 3.2 kPa in p'

(Kwok 1984)). Therefore it did not really matter whether the "samples" were stored "drained" or "undrained" in this case, and the subsequent reconsolidation procedures dominate the undrained shear behaviour. However the "samples" with longer "drained" storage periods develop higher mosture contents and larger volume changes and these were not overcome by the subsequent reconsolidation procedures. Lower strength envelopes could therefore be expected. This can be seen in Figure 7.3, where the 1-week storage data produce an envelope (c'_{oc}=11 kPa and Φ'_{oc}=18°) shown dotted below the overconsolidated envelope from Kwok (1984). There is more scatter however in the 1-day data.

7.3.2 Influence of Storage Times and Reconsolidation Procedures on Undrained Shear Strength

The effects of two test parameters, namely duration of storage and reconsolidation procedures, on the undrained shear strength of "samples" were investigated in this study. Six control "in situ specimens" were sheared undrained immediately at the end of triaxial consolidation under a backpressure of 500 kPa to model the undrained shear behaviour of the "in situ " soils. The results were compared to those of the seventeen "samples" which had undergone unloading, storage and reconsolidation befor shearing. Test results for "samples" during the unloading, storage and reconsolidation stages were given in detail in Chapter 5. Chapter 6 described the undrained shearing behaviour for all specimens, and the results were summarized in Tables 9 and 10. The stress paths in p',q-space during the undrained shearing for all control "in situ specimens" and "samples" are presented in Figures 6.9 to 6.16.

7.3.2.1 Normally Consolidated Soil

As shown in Figure 6.9, the stress paths of the three control "in situ specimens" exhibit similar behaviour in p',q-space. The undrained shear strengths (s_u) of these specimens (T740-T742) are also in relatively good agreement with values of 55.3 kPa, 56.3 kPa and 54.7 kPa respectively. Ambrosie (1984) found that the undrained shear strength of his control specimens were 54.4 kPa and 54.6 kPa. In conjunction with Ambrosie's results, the average value of the "in situ" shear strength for comparison purposes will be taken as 55.0 kPa.

Table 9 showed that "samples" T732 and T733 ($0.6x\sigma'_{1c}$-iso group) had shear strengths of 81.6% and 81.1% of the average "in situ" value respectively. These two "samples" also showed that the s_u tended to decrease with increasing storage times although the difference was small (only 0.5%). The strength losses of 18.4% and 18.9% from these two "samples" compared well with the loss of 18% reported by Ambrosie (1985) for his 15-minute "samples" (T703). They were however about 6% lower than the 25% loss he reported for his 1-week "sample" (T707). The unloading procedures and drainage boundaries used in his program were slightly different. The bottom drainage lead was open throughout the unloading and storage phases of the tests, and the samples were placed with lateral filter paper drains. A higher degree of disturbance could therefore be expected from his 1-week "sample" (T707) with lateral filter drains, than from the 1-week "sample" (T733) without lateral drains in the present program. Work done by Adams and Radhakrishna (1971) also showed that a considerable decrease in strength can be expected during undrained shearing on samples that had been allowed to swell.

"Samples" from $1.0x\sigma'_{1c}$-iso reconsolidation experienced net volume and moisture reductions due to an overall increase in p' from triaxial consolidation (p'=110 kPa) to reconsolidation (p'=160 kPa). These associated volume decreases cause increases in undrained shear strength. Table 9 showed that "samples" T734, T735 and T736 had undrained shear strength of 119.8%, 114.2% and 109.8% of the average "in situ" shear strength respectively. The tendency that s_u decreased with increasing storage times was clearly observed. A conclusion that the $1.0x\sigma'_{1c}$-iso reconsolidation generally overestimates the "in situ" shear strength of soil has been frequently drawn by researchers such as Bishop and Bjerrum (1960), Ladd and Lambe (1963), and Kirkpatrick and Khan (1984).

"Samples" T737, T738, and T739 ($1.0x\sigma'_{1c}$-aniso group) provided effective stress paths in Figure 6.12 similar to those of the "in situ specimens" in Figure 6.9. However they had only 97.1%, 91.3% and 86.5% of the average "in situ" shear strength respectively. The tendency of decreasing s_u with increasing storage times was observed again as in the two other sets of samples".

Generally, none of the adopted reconsolidation procedures could successfully recover the "in situ" shear strength of the normally consolidated soils. For "samples" with 15 minutes "drained" storage time, the best estimate of s_u was obtained from the $1.0x\sigma'_{1c}$-aniso reconsolidation procedure.

7.3.2.2 Overconsolidated Soil

Figure 6.13 presented the effective stress paths in p',q-space of three control "in situ specimens" (T760-T762) in the present study. They exhibited similar behaviour during the undrained shear test even though there was some scatter in the values of undrained shear strength ranging from 35.5 kPa to 39.9 kPa (Table 10). The "in situ" shear strength found by Kwok (1984) was 39.0 kPa. When this result was taken in conjunction with the results in the present program, the average "in situ" s_u-value was taken as 37.6 kPa for comparison purposes.

Table 10 showed that "samples" T751, T752 and T753 had shear strength of 99.7%, 72.3% and 75.2% of the average "in situ" value respectively. Thus $0.6x\sigma'_{1c}$-iso reconsolidation underestimated the "in situ" strength from the 1-day and 1-week "samples" but, in the author's opinion, recovered the "in situ" value from the 15-minute "sample" within experimental error. Although the tendency that "samples" decrease in shear strength with increasing storage times is not as obvious as in the normally consolidated soils, the 15-minute "sample" does show the the highest s_u among the three "samples".

All "samples" in $1.0x\sigma'_{1c}$-iso reconsolidation group (T754-T756) behave in an almost normally consolidated manner during undrained shear even though the original clay was overconsolidated with OCR=2.0. This was due to an overall increase of p' from triaxial consolidation (p'=55 kPa) to the reconsolidation pressure p'=96 kPa. Effective stress paths in p',q-space were shown in Figure 6.15. There were generally reductions in moisture contents and sample volumes associated with the isotropic reconsolidation to the "in situ" vertical effective stress (Table 12). In this case, "samples" T754, T755 and T756 had shear strengths of 121.3%, 110.6% and 101.1% of the average "in situ" value respectively. Therefore $1.0x\sigma'_{1c}$-iso reconsolidation overestimated the "in situ" s_u from the 15-minute and 1-day "samples", and might be considered to recover the "in situ" from the 1-week "sample" within experimental error. The tendency of decreasing s_u with increasing storage times was clearly observed in this set of "samples".

Although the $1.0x\sigma'_{1c}$-aniso "samples" showed rather similar shapes of stress paths in Figure 6.16, they exhibited different maximum deviator stresses due to their different durations of storage time. "Samples" T757, T758 and T759 had s_u of 39.9kPa, 26.9 kPa and 31.0 kPa respectively (Table 10). This showed that the 15-minute "sample" again exhibited the highest s_u among the three "samples". The $1.0x\sigma'_{1c}$-aniso reconsolidation underestimated the "in situ" s_u from the 1-day and 1-week "samples", but recovered the "in situ" s_u in the upper bound value from the 15-minute "sample".

Overall, it can be concluded that both $0.6x\sigma'_{1c}$-iso and $1.0x\sigma'_{1c}$-aniso reconsolidation procedures were successful in reproducing the "in situ" shear strength only from the 15-minutes "samples". The $1.0x\sigma'_{1c}$-iso reconsolidation procedure gave the best estimate only from the 1-week "sample".

As shown in Chapter 6 (Figures 6.9 to 6.16), the shapes of the q,p'-stress paths were much better recovered by anisotropic reconsolidation than by either of the isotropic reconsolidations.

7.3.3 Failure Axial Strains and Elastic Modulus

The behaviour of the vertical strains at failure was examined in Section 6.2. Since there was no systematic relationship observed between the failure axial strains and the storage time, the failure strains were grouped according to the reconsolidation procedures. The average failure strain for each group of the normally consolidated samples in Table 9 was (1) 0.66% for control "in situ specimens", (2) 4.52% for $0.6x\sigma'_{1c}$-iso "samples", (3) 4.98% for the $1.0x\sigma'_{1c}$-iso "samples" and (4) 1.18% for the $1.0x\sigma'_{1c}$-aniso "samples". The corresponding average failure strains for the four groups of the overconsolidated samples were 1.17%, 3.36%, 3.49% and 1.83% respectively (Table 10).

This showed that both the normally consolidated and the overconsolidated "samples" usually failed at higher axial strains than the "in situ specimens", and that the $1.0x\sigma'_{1c}$-aniso reconsolidation procedure gave the best estimates of the "in situ" failure strains.

Values of secant modulus (E_{50}) and the relative stiffness (E_{50}/s_u) were presented in Tables 9 and 10. Since they were discussed in Section 6.5, they will only briefly be reviewed here. The $0.6x\sigma'_{1c}$-iso and $1.0x\sigma'_{1c}$-iso reconsolidation procedures both underestimated the average "in situ" E_{50}-value of the normally consolidated illite by greater amounts than "samples" from the $1.0x\sigma'_{1c}$-aniso group. The average values were 17%, 26% and 56% respectively of the "in situ" values. For the overconsolidated illite, the ranges of variation of the secant moduli and relative stiffness were quite high among each group. Therefore firm interpretation was difficult. However if some apparently divergent results were discarded, the $1.0x\sigma'_{1c}$-aniso reconsolidation procedure again seemed to give the best estimate of the "in situ" stiffness.

7.3.4 Porewater Pressure Generation

The results of porewater pressure generation during undrained shear were presented in Section 6.4. The values of porewater pressure parameters A_f and m-values are given in Tables 9 and 10. The A_f-values from the reconsolidated "samples" were 30% to 100% higher than the average "in situ" A_f of the normally consolidated illite (0.40), and 30% to 230% higher than the average "in situ" A_f of the overconsolidated illite (0.15). Although the $1.0x\sigma'_{1c}$-aniso again gave the best agreement in overconsolidated "samples", none of the presently adopted reconsolidation procedures could successfully reproduce the "in situ" A_f-values from "samples" that had been stored "drained". Kirkpatrick

(1982) also found that the A_f-values of the "samples" reconsolidated to "in situ" stresses were about two times larger than the "in situ" A_f-values. This indicates the unloading, storage and reconsolidation processes cause particle reorientation towards a larger porewater pressure generation, leading to a larger A_f-value for "samples" compared to in situ " soils. This view is also supported by Graham and Au (1984) for the "freeze-thaw", "softened" and "undisturbed" Winnipeg clay they tested, and by Graham et al. (1986) in discussing the results of the test programs preceding the author's.

Tables 9 and 10 also showed that the A_f-values tended to increase with increasing storage time. This is expected because longer storage time can cause higher degree of disturbance to the "samples".

Porewater pressure behaviour during shearing was also examined in terms of $\Delta u/\sigma'_{vc}$ versus $\Delta p/\sigma'_{vc}$ (Figures 6.17-6.24) in this study. The slopes m of the intial linear section of these graphs were summarized in Tables 9 and 10. The average "in situ" m-value of the normally consolidated illite (1.29) was overestimated by all reconsolidated "samples" with m-values ranging 1.37 to 1.88. There was considerable scatter of m-values (ranging from 0.86 to 1.34) among the overconsolidated "in situ specimens". Kwok (1984) had a similar interpretation problem in which his control specimens gave m-values between 0.82 and 1.25. However the overconsolidated "samples" in the present study with m-values ranging from 1.09 to 1.77 seemed to overestimate the "in situ" value in most cases, especially for the "samples" with long storage duration. As in the case of A_f-values discussed in the last paragraph, there was the tendency that m-values increased with increasing storage time for both normally consolidated and overconsolidated soils. This occurred due to the increasing degree of sample disturbance imposed to the "samples" as storage duration increased.

7.4 SYNTHESIS OF DATA

Figure 7.4 shows a plot of specific volume ($V = 1+e$) versus mean effective stress p' in natural logarithm space at the end of the consolidation or reconsolidation. These results come from all the tests in the present program. The specific volumes were calculated in this case from final moisture contents measured after the undrained shear tests were completed. The data in Figure 7.3 are shown separately for different overconsolidation histories and reconsolidation procedures. The normal consolidation line from the triaxial consolidation tests for one-dimensional compression (1-D NCL) was drawn with slope λ_2 through the data for the normally consolidated "in situ specimens" and the $1.0x\sigma'_{1c}$-aniso "samples". The isotropic NCL with slope λ_2 was obtained by best fit through the data from the normally consolidated $0.6x\sigma'_{1c}$-iso and $1.0x\sigma'_{1c}$-iso "samples".

All the overconsolidated "in situ specimens" and "samples" were located to the left-hand side of the 1-D NCL. The overconsolidated "in situ specimens" were obtained by unloading to p'=55 kPa (σ'_1=80 kPa, σ'_3=42.4 kPa) after they had reached p'=110 kPa (σ'_1=160 kPa, σ'_3=84.8 kPa) for 1 day. The normally consolidated "in situ specimens", on the other hand, were allowed to age for a total of 5 days at p'=110 kPa. Therefore the line joining the two sets of control specimens has a slope different to the κ_2-values in Section 4.3.5 for unloading. This is due to the different durations of creep allowed to these two sets of specimens at p'=110 kPa. The overconsolidated, isotropic ($0.6x\sigma'_{1c}$-iso and $1.0x\sigma'_{1c}$-iso) data were observed to locate more or less on the "unload" line in Figure 7.4.

The peak failure state of the samples have also been examined in the V,ln(p')-space shown in Figure 7.5. Storage times are represented by numbers labelled beside the failure points. The consolidation data from Figure 7.4 were also included in this figure to show the stress paths in V,ln(p')-space during undrained shear tests. For the normally consolidated samples, each test moved horizontally from the isotropic NCL or 1-D NCL to the left depending on the type of reconsolidation. The samples then failed towards unique failure envelopes for each of the storage times, although the data from the $0.6x\sigma'_{1c}$-iso reconsolidation seemed to be anomalous. This might be due to the different drainage conditions (no radial drainage) and strain rate imposed to these two "samples" during the undrained shearing. The two failure envelopes for normally consolidated samples with slope=λ_2 from triaxial consolidation are shown parallel in Figure 7.5. It should be remembered that this is different from the results in p',q-space where only one failure envelope was obtained for the normally consolidated samples (Figure 7.3). When Figures 7.4 and 7.5 are compared, the 1-D NCL and the 15-minute failure line for normally consolidated samples are coincident although they are different in Figure 7.3. This can be interpreted from the relationship between p'_{cons} and p'_{iso} in these tests.

Figure 7.5 also shows that the overconsolidated samples generally tended to move to the right before they failed. However there were some tests from $0.6x\sigma'_{1c}$-iso reconsolidation that were observed to move to the left. There was a tendency for m= $\Delta u/\Delta p$ to increase with storage time, and this would indicate a time-dependent transition towards more anisotropic behaviour. This is surprising, and will require further attention. The overconsolidated samples exhibited three distinct failure envelopes for different storage times in V,ln(p')-space in a clearer way than the results in p',q-space (Figure 7.3). The 1-day "samples" were also more consistent in this V - ln(p') plot (Figure 7.5) than in Figure 7.3.

The states of samples in V,ln(p')-space at the end of the undrained shear tests were also examined, and are shown in Figure 7.6. The states were interpreted from the measured data at the end of the testing. They can be considered in this program (see for example Figures 6.1-6.8) to be only a fair approximation to the classical definition of critical state where $\delta u/\delta \epsilon_1 = \delta q/\delta \epsilon_1 = \delta p/\delta \epsilon_1 = 0$. These formal conditions were clearly not totally met by the samples in the present study. However it can be shown that the data in Figure 7.6 correspond to what would be interpreted as a "Critical State Model" (Wroth and Houlsby 1980). The line shown in the figure is a best-fit line with slope λ_2=0.234 that was measured from anisotropic consolidation of the triaxial samples before unloading, storage, reconsolidation and shearing. The agreement is good. In fact, regression analysis through the end-of-shear data points in Figure 7.6 gives a slope of 0.213 compared with 0.234 from consolidation.

A composite plot of the isotropic NCL, 1-D NCL and CSL for a Critical State Model of this sample behaviour is shown in Figure 7.7. It is interesting to note that the separation of the isotropic NCL to the CSL was calculated to be 1.67 compared to the value of 2.0 that would be expected from the Modified Cam Clay Model. The conclusion that can be drawn from this work is that the Critical State Model permits good understanding of the particular processes that have been explored in the testing program.

CHAPTER 8

CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

8.1 CONCLUSIONS

Based on the results for reconstituted illite presented in this thesis, the following conclusions can be drawn:

1. The one-dimensional consolidation using a large cylinder to provide three test specimens was successful in providing good quality control of tested specimens. The average moisture content measured at the end of consolidation was 50.2% with a standard deviation of 0.7%.
2. Under identical loading schedules, the λ_1-values for one-dimensional cylinder consolidation varied from 0.501 to 0.533 with an average of 0.513 and a standard deviation of 0.012.
3. The λ_2-values for the triaxial consolidation varied from 0.169 to 0.263 with an average of 0.234 and a standard deviation of 0.019. The mean λ_2 (0.234) during triaxial consolidation was about 2.2 times smaller than the mean λ_1-value (0.513) for cylinder consolidation.
4. During triaxial consolidation, the κ_1-values for reloading varied from 0.082 to 0.124 with an average of 0.102 and a standard deviation of 0.013. The mean κ_1-value (0.102) during reloading in overconsolidation region was about 2.3 times smaller than the mean λ_2-value (0.234) during loading in the normal consolidation line.
5. During triaxial consolidation, the κ_2-values for unloading varied from 0.036 to 0.054 with an average of 0.047 and a standard

deviation of 0.005. The mean κ_2-value (0.047) for unloading was about 2.2 times smaller than the mean κ_1-value (0.102) for reloading.

6. The average one-dimensional yield stress measured during triaxial consolidation using bilinear plotting techniques was 3.0% higher than the actual preconsolidation pressure of 70 kPa.

7. The values of K_{eq}/σ'_{vc} during triaxial consolidation varied from 11.0 to 16.0 with an average of 13.5. Corresponding values of G_{eq}/σ'_{vc} varied from 5.3 to 12.8 with a mean of 8.8.

8. The non-vertical stress paths of the "samples" in p',q-space during undrained shear unloading indicated the anisotropic behaviour of the reconstituted illite. The mean values of the porewater pressure parameter A_u for shear unloading of the normally consolidated "samples" and the overconsolidated "samples" were 0.37 and 0.42 respectively.

9. During isotropic unloading, the porewater pressures decreased by 96% to 99% and 99% to 100% of the corresponding total stress decreases for normally consolidated "samples" and overconsolidated "samples" respectively.

10. "Samples" subjected to storage periods of 15 minutes under fully "drained" conditions experienced small volume increases (0.2% to 0.5%). "Samples" with storage periods of 1 day and 1 week exhibited much greater volume increases from 4.1% to 5.3% and 6.5% to 7.8%, respectively. The normally consolidated "samples" swelled slightly more than the overconsolidated "samples" when they were both subjected to identical periods of "drained" storage.

11. Assuming that c'_{nc}=0, the effective friction angle (Φ'_{nc}) of the

normally consolidated samples was 25°. A failure envelope with c'_{oc}=16 kPa and Φ'_{oc}=18° was obtained for the 15-minute storage overconsolidated samples. The 1-week overconsolidated samples had a failure envelope with slightly lower c'_{oc}=11 kPa and Φ'_{oc}=18°.

12. If identical reconsolidation procedures were used, samples subjected to increasing storage time generally tended to have decreased undrained shear strength (s_u), and increased porewater pressure parameters A_f and m. This is because longer duration of storage caused higher degrees of sample disturbance due to stress-release.
13. For normally consolidated "samples", the $1.0x\sigma'_{1c}$-aniso reconsolidation procedure was successful in reproducing the "in situ" shear strength only from the 15-minute "sample". It underestimated the s_u by 9% and 14% from the 1-day "sample" and the 1-week "sample" respectively. The $0.6x\sigma'_{1c}$-iso reconsolidation underestimated the "in situ" s_u by 18% to 19% and the $1.0x\sigma'_{1c}$-iso reconsolidation overestimated the "in situ" value by 10% to 20%.
14. For the overconsolidated "samples", both $1.0x\sigma'_{1c}$-aniso and $0.6x\sigma'_{1c}$-iso reconsolidation procedures successfully reproduced the "in situ" s_u from the 15-minute "samples". They underestimated the "in situ" value by 18% to 29% from the 1-day and 1-week "samples". The $1.0x\sigma'_{1c}$-iso reconsolidation overestimated the in situ" s_u by 21% and 11% from the 15-minute "sample" and the 1-day "sample" respectively, but was successful in recovering the s_u from the 1-week "sample".
15. All three reconsolidation procedures overestimated the axial strains at failure, ϵ_{1f}; porewater pressure parameters, A_f and m; and underestimated the secant modulus, E_{50} from both the normally

consolidated "samples" and the overconsolidated "samples".

16. The moisture content difference across the whole sample after the undrained shearing was generally less than 1.7%. There wass a tendency for the moisture contents to be slightly lower in the middle of the sample compared with the top and bottom.

17. The data from the present program seemed to fit into a generalized Critical State Model which permits good understanding of the soil behaviour.

8.2 SUGGESTIONS FOR FURTHER RESEARCH

1. A better understanding of the generation of air bubbles within samples is required. It is recommended that negative porewater pressures be measured within the samples with hypodermic needles during unloading and storage periods.

2. The actual value of K_0 should be determined either by using a load cell attached to an oedometer similar to Kirkpatrick (1984) or by using a servomechanism suggested by Kwok (1984).

3. Further research should be conducted on samples subjected to higher stress levels and higher OCR, which are now common in offshore geotechnical practice.

4. Further work is needed to compare the effects of sample disturbance due to stress-release on real offshore clay samples.

REFERENCES

Adams, J.I. and Radhakrishna, H.S. 1971. "Loss of Strength due to Sampling in a Glacial Lake Deposit". Sampling of Soil and Rock, ASTM STP 483, pp. 109-120.

Ambrosie, A.W. 1985. "Effects of Stress-release Disturbance on the Shear Behaviour of Simulated Offshore Normally-consolidated Clay Samples". M.Sc. Thesis, University of Manitoba, Winnipeg, Manitoba.

Arman, A. and McManis, K.L. 1977. "The Effects of Conventional Soil Sampling Methods on the Engineering Properties of Cohesive Soils in Louisiana". Engineering Research Bullitin No. 117, Louisiana State University, Division of Engineering Research, Baton Rouge, Louisiana.

Atkinson, J.H. and Kubba, L.M. 1981. "Some Effects of Sample Disturbance on Soft Clay". Proc. 10th Int. Conf. on Soil Mech. and Found. Eng., Stockholm, Vol. 2, pp. 423-426.

Berre, T. and Bjerrum, L. 1973. "Shear Strength of Normally Consolidated Clays". Proc. 8th Int. Conf. on Soil Mech. and Found. Eng., Moscow, Vol. 1, pp. 34-49.

Bishop, A.W. and Bjerrum, L. 1960. "The Relevance of the Triaxial Test to the Solution of Stability Problems". Proc. ASCE Spec. Conf. on Shear Strength of Cohesive Soils, Boulder, Colorado, pp. 34-49.

Bishop, W.W. and Henkel, D.J. 1962. "The Measurement of Soil Properties in the Triaxial Test". 2nd Ed., Edward Arnold, Ltd. London.

Bjerrum, L. 1967. "Engineering Geology of Norwegian Normally Consolidated Marine Clays as Related to Settlements of Buildings". Geotechnique 17, No. 2, pp. 81-118.

Bjerrum, L. 1973a. "Geotechnical Problems Involved in Foundation of Structures North Sea". Geotechnique 23, No. 3, pp. 319-358.

Bjerrum, L. 1973b. "Problems of Soil Mechanics and Construction of Soft Clays and Structurally Unstable Soils". State-of-the-Art report at Session 4, Proc. 8th Int. Conf. on Soil Mech. and Found. Eng., Moscow, Vol. 3, pp. 111-159.

Broms, B.B. 1980. "Soil Sampling in Europe: State-of-The-Art". Journal of The Geotechnical Engineering Division, Proc. of American Society of Civil Engineers, Vol. 106, No. GT1, pp. 65-98.

Brooker, E.W. and Ireland, H.O. 1965. "Earth Pressures at Rest Related to Stress History". Canadian Geotechnical Journal, Vol. 2, No. 1, pp. 1-15.

Casagrande, A. and Rutledge, P.C. 1947. "Co-operative Triaxial Shear Research". Waterways Experiment Station, Vicksburg, Mississippi.

Crooks, J.H.A. and Graham, J. 1976. "Geotechnical Properties of the Estuarine Deposits". Geotechnique 26, No. 2, pp. 293-315.

Chaney, R.C., Demars, K.R. and Fang, H.-Y. 1985. "Toward a Unified Approach to Soil Property Characterization: In situ Versus Laboratory". Strength Testing of Marine Sediments: Laboratory and In situ Measurements, ASTM STP 883, R.C. Chaney and K.R. Demars, Eds., American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 425-439.

Davis, E.H. and Poulos, H.G. 1967. "Laboratory Investigation of the Effects of Sampling". Civ. Eng. Transactions, Instn. of Engrs. Australia, CE9, No. 1, pp. 86-94.

de Ruiter, J. 1976. "North Sea Site Investigations - The Role of The Geotechnical Consultant". Offshore Soil Mechanics. Philip George and David Wood, Eds., Cambridge University Engineering Department, Cambridge, England, pp. 62-78.

de Ruiter, J. 1977. Workshop on Specialty Session 7-Geotechnical Problems in Ocean Engineering. Proc. 9th Int. Conf. on Soil Mech. and Found. Eng., Tokyo, Vol. 3, pp. 513-523.

de Ruiter, J. and Richards, A.F. 1983. "Marine Geotechnical Investigation, A Mature Technology State". State-of-The-Art Paper, Proc. of the Conf. on Geotechnical Practice in Offshore Engineering, University of Texas at Austin, Austin, Texas, pp. 1-24.

Emrich, W.J. 1971. "Performance Study of Soil Sample for Deep-Penetration Marine Borings". Sampling of Soil and Rock, ASTM STP 483, American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 30-50.

Fukuoka, M. and Nakase, A. 1973. "Problems of Soil Mechanics of the Ocean Floor". Special Lecture, Proc. 8th Int. Conf. on Soil Mech. and Found. Eng., Moscow, Vol. 4.2, pp. 205-222.

Graham, J. 1974. "Laboratory Studies of Sensitive Clay from Lyndhurst, Ontario". Civil Engineering Research Report CE74-2, Royal Military College, Kingston, Ontario.

Graham, J. and Houlsby, G.T. 1983. "Anisotropic Elasticity of a Natural Clay". Geotechnique 33, No. 2, pp. 165-180.

Graham, J., Noonan, M.L. and Lew, K.V. 1983. "Yield States Stress-Strain Relationships in a Natural Plastic Clay". Canadian Geotechnical Journal, Vol. 20, No. 3, pp. 502-516.

Graham, J. and Au, V.C.S. 1984. "Influence of Freeze-Thaw and Softening on a Natural Clay at Low Stresses". Canadian Geotechnical Journal, Vol. 22, No. 1, pp. 69-78.

Graham, J., Shields, D.H. and Sun B.C.-C. 1985. "Stress-Strain Relationship in Sand-Clay Buffer Materials". Proc. 19th Information Meeting on the Nuclear Fuel Waste Management Program, Toronto, Ontario, May 1985, AECL Technical Report TR-350, Vol. 3, pp. 745-760.

Graham, J., Kwok, C.K. and Ambrosie, R.W. 1986. "Reconsolidation procedures to Offset Stress-Realease Effects in Simulated Offshore Clays". Third Canadian Conference on Marine Geotechnical Engineering, St. John's, Newfoundland, Vol. 2, pp. 637-653.

Kirkpatrick, W.M. 1982a. "Stress Relief Effects on the Undrained Behaviour of Clays". Normally Consolidated Clays. Report No. CESM 82/01, Department of Civil Engineering, University of Strathclyde, Glasgow.

Kirkpatrick, W.M. 1982b. "Stress Relief Effects on the Undrained Behaviour of Clays". Overconsolidated Clays. Report No. CESM 82/02, Department of Civil Engineering, University of Strathclyde, Glasgow.

Kirkpatrick, W.M. and Rennie, I.A. 1972. "Stress Relief Effects in Deep Sampling Operations". Proc. Conf. Offshore Engineering, Cardiff.

Kirkpatrick, W.M. and Khan, A.J. 1984. "The Reaction of Clays to Sampling Stress Relief". Geotechnique 34, No. 1, pp. 29-42.

Kwok, C.K. 1984. "Effects of Stress-Release Disturbance on the hear Behaviour of Simulated Over-Consolidated Clay Samples". M.Sc. Thesis, University of Manitoba, Winnipeg, Manitoba.

Ladd, C.C. and Lambe, T.W. 1963. "The Strength of Undrained Clay Determined from Undrained Tests". ASTM-NRC Symposium on Laboratory Shear Testing of Soils, Ottawa, Canada, ASTM STP 361, pp. 342-371.

Ladd, C.C. and Bailey, W.A. 1964. Correspondence on "The Behaviour of Saturated Clays During Sampling and Testing" by Skempton, A.W. and Sowa, V.A., Geotechnique 14, No. 4, pp. 353-358.

Ladd, C.C. and Foott, R. 1974. "New Design Procedures for Stability of Soft Clays". Journal of the Geotechnical Engineering Division, Proc. of American Society of Civil Engineers, Vol. 100, No. GT7, pp. 763-786.

Lee, H.J. 1979. "Offshore Soil Sampling and Geotechnical Parameter Determination". Proc. 11th Offshore Technology Conf., Houston, Texas, OTC Paper 4524, pp. 1449-1457.

Lee, H.J. 1985. "State of The Art: Laboratory Determination of the Strength of Marine Soils". Strength Testing of Marine Sediments: Laboratory and In situ Measurements, ASTM STP 883, R.C. Chaney and K.R. Demars, Eds., American Society for Testing and Materials, Philadelphia, Pennsylvania, pp. 181-250.

Leonards, G.A. and Altschaeffl, A.G. 1964. "Compressibility of Clay". Journal of the Soil Mechanics and Foundation Division, Proc. of American Society of Civil Engineers, Vol. 90, No. SM5, pp. 133-156.

Lew, K.V. 1981. "Yielding and Limit State in a Winnipeg Clay". M.Sc. Thesis, University of Manitoba, Winnipeg, Manitoba.

Lewin, P.I. and Burland, J.B. 1970. "Stress-Probe Experiments on Saturated Normally Consolidated Clay". Geotechnique 20, No. 1, pp. 38-56.

Li, E.C.C. 1983. "A Geotechnical Study of Remoulded Winnipeg Clay". M.Sc. Thesis, University of Manitoba, Winnipeg, Manitoba.

Long, L.G., Thompson, G.R., Brown, J.D. and Rivette, C.A. 1986. "Hibernia Site Geotechnical Characterization". 3rd Canadian Conf. on Marine Geotechnical Engineering, St. John, Newfoundland, Vol. 1, pp. 99-116.

Lunne, T. and Christoffersen, H.P. 1983. "Interpretation of Cone Penetrometer Data for Offshore Sands". Proc. 15th Offshore Technology Conf., Houston, Texas, OTC Paper 4464, pp. 181-192.

Marsland, A. 1971. "Laboratory and In situ Measurements of the Deformation Modulus of London Clay". Proceedings of the Symposium on the Interaction of Structure and Foundation, The Midland Soil Mechanics and Foundation Engineering Society, pp. 7-17.

Mayne,P.W. and Kulhawy, F.H. 1982. "K_o-OCR Relatioship in Soil". Journal of the Geotechnical Engineering Division, Proc. of American Society of Civil Engineers, Vol. 108, No. GT6, pp. 851-872.

McClelland, B. 1974. "Design of Deep Penetration Piles for Ocean Structures". Journal of the Geotechnical Engineering Division, Proc. of American Society of Civil Engineers, Vol. 100, No. GT7, pp. 705-747.

Mori, H. 1981a. "Soil Sampling in Site Investigation for Coastal Structure". Proceedings of the Symposium on Geotechnical Aspects of Coastal and Offshore Structures, Bangkok, pp. 1-10.

Mori, H. 1981b. General report on Session 7 - Soil Exploration and Sampling. Proc. 10th Int. Conf. on Soil Mech. and Found. Eng., Stockholm, Vol. 4, pp. 399-413.

Noorany, I. and Seed, H.B. 1965. "In situ Strength Characteristics of Soft Clays". Journal of the Soil Mechanics and Foundation Division, Proc. of American Society of Civil Engineers, Vol. 91, No. SM2, pp. 49-80.

Okumura, T. 1971. "The Variation of Mechanical Properties of Clay Samples Depending on Its Degree of Disturbance". Proceedings of the Specialty Session on Quality in Soil Sampling, 4th Asian Conf., International Society for Soil Mechanics and Foundation Engineering, pp. 73-81.

Raymond, G.P., Townsend, D.L. and Lojkocek, M.J. 1971. "The Effect of Sampling on the Undrained Soil Properties of Leda Soil". Canadian Geotechnical Journal, Vol. 8, No. 4, pp. 546-557.

Richards, A.F. and Parker, H.W. 1968. "Surface Coring for Shear Strength Measurements". Civil Engineering in the Ocean, American Society of Civil Engineers, N.Y., pp. 445-489.

Sandegren, E. 1961. "Sample Transportation Problems". Proc. of the Swedish Geotechnical Institute, Linkoping, Sweden, No. 19, pp.35-37.

Schjetne, K. 1971. "The Measurement of Pore Pressure During Sampling". 4th Asia Conf., International Society on Soil Mechanics and Foundation Engineering Proceedings of Specialty Session 1, Quality in Soil Sampling, pp. 12-16.

Semple, R.M., St. John, H.D. and Toolan, F.E. 1982. "Statement of Research Needs in Offshore Foundation Design". Geotechnical Committee, Society for Underwater Technology, London, England.

Skempton, A.W. 1954. "The Pore Pressure Coefficient A and B". Geotechnique 4, No. 4, pp. 143-147.

Skempton, A.W. and Sowa, V.A. 1963. "The Behaviour of Saturated Clays During Sampling and Testing". Geotechnique 13, No. 4, pp. 269-290.

Tavenas, F. and Leroueil, S. 1977. "The Effects of Stresses and Time on Yielding of Clays". Proc. 9th Int. Conf. on Soil Mech. and Found. Eng., Tokyo, Vol. 1, pp. 319-326.

Vyas, Y.K., Angemmer, J., Murff, J.D., Neuberger, C.A., McNeilan, T. and Klejbuk Jr., L.W. 1983. "Deepwater Geotechnical Site Investigation: Santa Ynez Unit, Offshore California". Proc. 15th Offshore Technology Conf., Houston, Texas, Vol. 1, pp. 217-226.

Wroth, C.P., Randolph, M.F., Houlsby, G.T. and Fahey, M. 1979. "A Review of the Engineering Properties of Soils with Particular Reference to Shear Modulus". Internal Report CVED/D-Soils TR75, Cambridge University Engineering Department, Cambridge, England.

Wroth, C.P. and Houslby, G.T. 1980. "A Critical State Model for Predicting the Behaviour of Clays". Proc. of Workshop on Limit Equilibrium, Plasticity and Generalized Stress-Strain in Geotechnical Engineering, McGill University, Montreal, Quebec, pp. 592-627.

Wu, T.H., Hsu, J.R. and Ali, E.M. 1983. "Plastic Deformation of an Embankment on Clay". Canadian Geotechnical Journal, Vol.20, No. 3, pp. 437-452.

Young, A.G., Quiros, G.W. and Ehlers, C.J. 1983. "Effects of Offshore Sampling and Testing on Undrained Soil Shear Strength". Proc. 15th Offshore Technology Conf., Houston, Texas, Vol. 1, pp. 193-216.

SAMPLE NO.	T732	T733	T734	T735	T736	T737	T738	T739	T740	T741	T742
OVERCONSOLIDATION RATIO	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
STORAGE PERIOD (hours)	2	168	0.25	24	168	0.25	24	168	-	-	-
RECONSOLIDATION TYPE	CIU	CIU	CIU	CIU	CIU	CAU	CAU	CAU	-	-	-
RECONSOLIDATION LEVEL (*σ'_c)	0.6	0.6	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-

SAMPLE NO.	T751	T752	T753	T754	T755	T756	T757	T758	T759	T760	T761	T762
OVERCONSOLIDATION RATIO	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
STORAGE PERIOD (hours)	0.25	24	168	0.25	24	168	0.25	24	168	-	-	-
RECONSOLIDATION TYPE	CIU	CIU	CIU	CIU	CIU	CIU	CAU	CAU	CAU	-	-	-
RECONSLIDATION LEVEL (*σ'_c)	0.6	0.6	0.6	1.0	1.0	1.0	1.0	1.0	1.0	-	-	-

\- not applicable to control samples

TABLE 1 SUMMARY OF TEST PROGRAM

	W_L	W_P	I_P	Clay Fraction (%)	G_s
Author	59.5 (11)	25.9 (11)	33.6 (11)	66.0 (1)	2.74 (1)
Ambrosie (1985)	57.9 (7)	25.1 (7)	32.8 (7)	61.0 (1)	2.73 (1)
Kwok (1984)	57.2 (8)	25.7 (8)	31.5 (8)	61.0 (1)	2.73 (1)
Wu et al. (1983)	54.4	26.1	28.3	53.0	-

Numbers in parentheses represent the number of tests

TABLE 2 INDEX PROPERTIES OF ILLITE

SAMPLE NO.	T732	T733	T734	T735	T736	T737	T738	T739	T740	T741	T742
MOISTURE CONTENT OF SLURRY (%)	114.4	114.4	114.2	114.2	114.2	113.7	113.7	113.7	120.5	120.5	120.5
PERIOD UNDER 70 kPa (DAYS)	19	19	13	13	13	10	10	10	14	14	14
MOISTURE CONTENT AT 70 kPa AFTER 24 HOURS (%)	58.5	58.5	57.7	57.7	57.7	55.4	55.4	55.4	56.6	56.6	56.6
MEASURED MOISTURE CONTENT AFTER CONSOLIDATION (%)	50.1	50.8	49.4	49.7	49.8	49.0	49.1	49.3	49.5	49.5	49.9
CALCULATED MOISTURE CONTENT AFTER CONSOLIDATION (%)	49.9	49.9	49.3	49.3	49.3	49.1	49.1	49.1	49.5	49.5	49.5
λ_1	0.504	0.504	0.503	0.503	0.503	0.533	0.533	0.533	0.523	0.523	0.523

SAMPLE NO.	T751	T752	T753	T754	T755	T756	T757	T758	T759	T760	T761	T762
MOISTURE CONTENT OF SLURRY (%)	114.4	114.4	114.4	113.6	113.6	113.6	114.3	114.3	114.3	116.0	116.0	116.0
PERIOD UNDER 70 kPa (DAYS)	12	12	12	8	8	8	12	12	12	9	9	9
MOISTURE CONTENT AT 70 kPa AFTER 24 HOURS (%)	58.2	58.2	58.2	56.3	56.3	56.3	57.6	57.6	57.6	59.4	59.4	59.4
MEASURED MOISTURE CONTENT AFTER CONSOLIDATION (%)	50.0	50.5	51.0	50.6	50.6	50.8	50.4	50.5	50.9	51.0	51.5	51.4
CALCULATED MOISTURE CONTENT AFTER CONSOLIDATION (%)	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.5	50.5	50.5
λ_1	0.501	0.501	0.501	0.521	0.521	0.521	0.513	0.513	0.513	0.502	0.502	0.502

TABLE 3 SUMMARY OF ONE-DIMENSIONAL SLURRY CONSOLIDATION

SAMPLE NO.	T732	T733	T734	T735	T736	T737	T738	T739	T740	T741	T742
σ'_{cyl} (kPa)	71.2	71.2	70.4	70.4	70.4	70.0	70.0	70.0	70.0	70.0	70.0
σ'_y (kPa) ¤	73.8	73.7	71.1	70.9	71.1	73.1	73.0	72.6	72.3	70.6	71.0
σ'_{vc} (kPa)	156.1	158.3	160.0	159.7	159.7	159.9	159.7	158.3	160.0	159.6	159.9
σ'_{1c} (kPa)	156.1	158.3	160.0	159.7	159.7	159.9	159.7	158.3	160.0	159.6	159.9
$\sigma'_{3c}/\sigma'_{1c}$	.543	.536	.530	.531	.531	.530	.531	.536	.530	.531	.530
ϵ_{1c} (%) †	11.74	15.97	11.15	12.78	13.45	11.33	12.57	15.33	11.56	13.58	12.21
ϵ_{3c} (%) †	-0.62	-1.65	0.65	-0.17	-0.09	0.42	-0.10	-1.27	0.31	-0.40	0.17
v_c (%) †	10.49	12.68	12.45	12.44	13.27	12.17	12.38	12.79	12.18	12.79	12.54
$\epsilon_{1c}/\epsilon_{3c}$	-18.9	-9.7	17.2	-75.2	-149	27.0	-126	-12.1	37.3	-34.0	71.8
λ_1 #	.504	.504	.503	.503	.503	.533	.533	.533	.523	.523	.523
κ_1	.087	.100	.096	.082	.113	.099	.100	.121	.099	.106	.106
λ_2	.169	.209	.230	.228	.211	.227	.227	.230	.234	.239	.238
K_{eq} (kPa)	1081	1020	978	1126	816	945	954	827	937	864	901
K_{eq}/σ'_{cyl}	15.2	14.3	13.9	16.0	11.6	13.5	13.6	11.8	13.4	12.3	12.9
G_{eq} (kPa)	463	376	668	498	563	703	650	805	594	684	559
G_{eq}/σ'_{cyl}	6.5	5.3	9.5	7.1	8.0	10.0	9.3	11.5	8.5	9.8	8.0

¤ from TABLE 6
† positive compression, negative expansion
# from TABLE 3

TABLE 4 TRIAXIAL CONSOLIDATION TEST RESULTS FOR NORMALLY CONSOLIDATED SAMPLES

SAMPLE NO.	T751	T752	T753	T754	T755	T756	T757	T758	T759	T760	T761	T762
$\sigma'cyl$ (kPa)	70	70	70	70	70	70	70	70	70	70	70	70
$\sigma'y$ (kPa) ¤	73.0	72.6	72.4	71.7	71.0	72.4	73.6	72.0	73.7	71.8	71.9	71.4
$\sigma'vc$ (kPa)	159.3	158.8	159.5	159.3	159.5	159.1	159.6	159.5	159.5	159.1	159.1	159.6
σ'_1c (kPa)	80.3	79.9	80.2	79.9	79.9	79.9	79.8	79.7	79.8	80.1	79.3	80.1
σ'_3c/σ'_1c	.528	.528	.531	.533	.531	.531	.533	.532	.532	.529	.528	.532
ϵ_1c (%) †	10.83	10.87	10.37	10.56	10.95	12.07	9.74	11.10	10.30	11.78	12.57	12.33
ϵ_3c (%) †	-0.42	-0.66	0.02	-0.44	-0.12	-0.87	-0.12	-0.78	-0.22	-1.14	-0.95	-0.78
vc (%) †	9.99	9.55	10.41	9.68	10.71	10.33	9.49	9.54	9.86	9.50	10.66	10.76
ϵ_1c/ϵ_3c	-25.8	-16.5	518	-24.0	-91.3	-13.9	-78.5	-14.3	-46.4	-10.4	-13.2	-15.8
λ_1 #	.501	.501	.501	.521	.521	.521	.513	.513	.513	.502	.502	.502
κ_1	.089	.090	.095	.100	.124	.121	.093	.086	.093	.104	.122	.118
λ_2	.236	.228	.246	.242	.243	.252	.243	.244	.245	.252	.257	.263
κ_2	.042	.036	.054	.045	.051	.048	.049	.052	.049	.046	.049	.041
Keq (kPa)	1065	1061	977	960	772	788	1002	1108	1012	914	794	819
Keq/$\sigma'cyl$	15.2	15.2	14.0	13.7	11.0	11.3	14.3	15.8	14.5	13.1	11.3	11.7
Geq (kPa)	893	892	617	652	518	495	737	662	688	564	498	473
Geq/$\sigma'cyl$	12.8	12.7	8.8	9.3	7.4	7.1	10.5	9.5	9.8	8.1	7.1	6.8

¤ from TABLE 6
† positive compression,negative expansion
# from TABLE 3

TABLE 5 TRIAXIAL CONSOLIDATION TEST RESULTS FOR OVERCONSOLIDATED SAMPLES (OCR = 2)

SAMPLE NO.	T732	T733	T734	T735	T736	T737	T738	T739	T740	T741	T742
σ'_3/σ'_1 AT YIELD	.538	.530	.530	.530	.530	.530	.529	.530	.529	.529	.530
log(p)-v	73.7	74.2	72.8	72.8	71.4	73.6	72.9	74.3	72.9	72.1	71.4
p-v	*	74.2	69.2	71.3	*	72.8	74.3	72.6	72.9	69.2	69.9
q-ϵ	74.7	74.5	70.6	70.7	72.3	72.3	73.3	72.3	71.2	71.2	72.3
σ'_1-ϵ_1	75.0	74.0	71.0	69.0	71.0	74.0	72.5	72.0	70.0	70.0	70.5
p-ϵ_1	73.7	73.5	71.4	70.6	70.7	73.6	73.6	72.6	71.4	69.2	71.4
W-LSSV	72.0	71.9	71.6	71.1	70.1	72.6	71.7	71.7	75.6	72.1	70.8
AVERAGE σ'_y	73.8	73.7	71.1	70.9	71.1	73.1	73.0	72.6	72.3	70.6	71.0
σ'_{cyl}	71.2	71.2	70.4	70.4	70.4	70.0	70.0	70.0	70.0	70.0	70.0
% DIFFERENCE WITH σ'_{cyl}	-3.6	-3.5	-1.0	-0.7	-1.0	-4.4	-4.3	-3.7	-3.3	-0.9	-1.4

SAMPLE NO.	T751	T752	T753	T754	T755	T756	T757	T758	T759	T760	T761	T762
σ'_3/σ'_1 AT YIELD	.529	.529	.530	.530	.530	.530	.530	.530	.529	.529	.529	.530
log(p)-v	73.6	72.9	72.8	72.1	72.1	72.8	72.1	75.9	76.3	72.9	72.9	71.4
p-v	71.4	72.1	71.4	72.8	70.6	72.8	72.8	69.2	72.1	71.4	73.6	72.1
q-ϵ	71.2	73.3	73.4	72.3	71.2	72.3	77.6	73.4	74.4	72.3	71.2	72.3
σ'_1-ϵ_1	76.5	71.0	71.0	71.0	70.0	71.0	75.0	70.5	73.5	71.0	71.0	72.0
p-ϵ_1	76.0	72.9	72.8	72.1	70.6	72.8	72.8	70.6	72.9	70.7	70.7	69.9
W-LSSV	74.9	73.2	72.9	70.0	71.7	72.4	71.7	72.0	72.9	72.4	72.0	70.8
AVERAGE σ'_y	73.9	72.6	72.4	71.7	71.0	72.4	73.6	72.0	73.7	71.8	71.9	71.4
σ'_{cyl}	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
% DIFFERENCE WITH σ'_{cyl}	-5.6	-3.7	-3.4	-2.5	-1.4	-3.4	-5.1	-2.9	-5.3	-2.5	-2.7	-2.0

* not available

TABLE 6 SUMMARY OF YIELD STRESSES FROM DIFFERENT CRITERIA (vertical stress in kPa)

	$0.6 \times \sigma'_{1c}$ ISOTROPIC		$1.0 \times \sigma'_{1c}$ ISOTROPIC			$1.0 \times \sigma'_{1c}$ ANISOTROPIC		
SAMPLE NO.	T732	T733	T734	T735	T736	T737	T738	T739
STORAGE TIME (hr)	2	168	0.25	24	168	0.25	24	168
VOLUMETRIC SWELLING (%)	*	5.92	0.54	8.11	7.46	0.46	5.20	7.75
RECONSOLIDATION TYPE	CIU	CIU	CIU	CIU	CIU	CAU	CAU	CAU
RECON. σ'_1 (kPa)	96	96	160	160	160	160	160	160
RECON. σ'_3 (kPa)	96	96	160	160	160	84.8	84.8	84.8
$\Delta\epsilon_1 rc$(%) #	*	2.17	0.13	3.27	3.40	1.56	8.50	8.25
$\Delta\epsilon_3 rc$ (%) #	*	1.95	1.99	3.75	4.00	-0.26	-1.20	0.06
Δvrc (%) #	*	6.06	4.11	10.76	11.39	1.04	6.10	8.37

* not available due to leakage at top drainage connection
# positive compression; negative expansion

TABLE 7 SUMMARY OF TEST RESULTS DURING STORAGE AND RECONSOLIDATION FOR NORMALLY CONSOLIDATED SAMPLES

	0.6xσ'_{1c} ISOTROPIC			1.0xσ'_{1c} ISOTROPIC			1.0xσ'_{1c} ANISOTROPIC		
SAMPLE NO.	T751	T752	T753	T754	T755	T756	T757	T758	T759
STORAGE TIME (hr)	0.25	24	168	0.25	24	168	0.25	24	168
VOLUMETRIC SWELLING (%)	0.30	4.74	6.75	0.28	5.29	6.57	0.37	4.13	6.49
RECONSOLIDATION TYPE	CIU	CIU	CIU	CIU	CIU	CIU	CAU	CAU	CAU
RECON. σ'_1 (kPa)	48	48	48	80	80	80	80	80	80
RECON. σ'_3 (kPa)	48	48	48	80	80	80	42.4	42.4	42.4
$\Delta\epsilon_1 rc$ (%) #	-0.33	-0.07	1.47	0.02	1.50	2.22	0.57	1.98	2.81
$\Delta\epsilon_3 rc$ (%) #	0.11	1.76	1.67	0.79	2.24	2.55	-0.13	0.71	1.26
Δvrc (%) #	-0.12	3.47	4.80	1.59	5.77	7.32	0.31	3.39	5.33

positive compression; negative expansion

TABLE 8 SUMMARY OF TEST RESULTS DURING STORAGE AND RECONSOLIDATION FOR OVERCONSOLIDATED SAMPLES (OCR = 2)

	$0.6x\sigma'_{1c}$ ISOTROPIC		$1.0x\sigma'_{1c}$ ISOTROPIC			$1.0x\sigma'_{1c}$ ANISOTROPIC			CONTROL SPECIMENS		
SAMPLE NO.	T732	T733	T734	T735	T736	T737	T738	T739	T740	T741	T742
TEST TYPE	CIU	CIU	CIU	CIU	CIU	CAU	CAU	CAU	CAU	CAU	CAU
RECON. σ'_1 (kPa)	96	96	160	160	160	160	160	160	--	--	--
RECON. σ'_3 (kPa)	96	96	160	160	160	84.8	84.8	84.8	--	--	--
STORAGE TIME (hr)	2	168	0.25	24	168	0.25	24	168	--	--	--
$\sigma'vc$ (kPa)	156.1	158.3	160.0	159.7	159.7	159.9	159.7	158.3	160.0	159.6	159.9
σ'_1c (kPa)	156.1	158.3	160.0	159.7	159.7	159.9	159.7	158.3	160.0	159.6	159.9
OCR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
σ'_3c/σ'_1c	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.54	0.53	0.53	0.53
qmax/2 (kPa)	44.9	44.6	65.9	62.8	60.4	53.4	50.2	47.6	55.3	56.3	54.7
qmax/2σ'vc	0.287	0.282	0.412	0.392	0.378	0.334	0.314	0.299	0.345	0.352	0.342
ϵ_1 at qmax (%)	4.39	4.64	5.04	5.37	4.54	1.34	1.37	0.82	0.68	0.75	0.56
p' at qmax (kPa)	79.7	78.3	123.6	115.9	116.7	102.6	100.5	100.1	108.4	107.2	106.9
Af at qmax	0.51	0.54	0.60	0.69	0.69	0.53	0.71	0.79	0.37	0.40	0.42
B (%)	98	100	100	100	100	99	99	98	99	100	99
m	1.64	1.73	1.56	1.81	1.86	1.37	1.47	1.88	1.21	1.26	1.42
E_{50} (mPa) ¤	13.5	9.29	18.3	13.5	20.5	42.6	19.9	49.8	63.5	70.6	25.4
E_{50}/s_u ¤	300	208	277	215	339	799	396	1045	1148	1253	464
$E_{50}/\sigma'vc$ ¤	86.3	58.7	114	84.3	128	267	124	312	397	442	159
$G/\sigma'vc$ ¤	28.8	19.6	38.0	28.1	42.8	88.9	41.4	104	132	147	52.9

-- not applicable to control samples
¤ calculated using qmax

TABLE 9 SUMMARY OF UNDRAINED SHEAR TEST RESULTS FOR NORMALLY CONSOLIDATED SAMPLES

SAMPLE NO.	$0.6x\sigma'_{1c}$ ISOTROPIC			$1.0x\sigma'_{1c}$ ISOTROPIC			$1.0x\sigma'_{1c}$ ANISOTROPIC			CONTROL SPECIMENS		
	T751	T752	T753	T754	T755	T756	T757	T758	T759	T760	T761	T762
TEST TYPE	CIU	CIU	CIU	CIU	CIU	CIU	CAU	CAU	CAU	CAU	CAU	CAU
RECON. σ'_1 (kPa)	48	48	48	80	80	80	80	80	80	CAU	CAU	CAU
RECON. σ'_3 (kPa)	48	48	48	80	80	80	42.4	42.4	42.4	--	--	--
STORAGE TIME (hr)	0.25	24	168	0.25	24	168	0.25	24	168	--	--	--
$\sigma'vc$ (kPa)	159.3	158.8	159.5	159.3	159.5	159.1	159.6	159.5	159.5	159.1	159.1	159.6
σ'_1c (kPa)	80.3	79.9	80.2	79.9	79.9	79.9	79.8	79.7	79.8	80.1	79.3	80.1
OCR	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
σ'_3c/σ'_1c	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53	0.53
qmax/2 (kPa)	37.5	27.2	28.3	45.6	41.6	38.0	39.9	26.9	31.0	39.9	36.1	35.5
qmax/2σ'vc	0.236	0.171	0.178	0.286	0.261	0.239	0.250	0.168	0.194	0.251	0.227	0.222
ϵ_1 at qmax (%)	2.76	4.05	3.26	2.73	4.11	3.63	1.61	1.38	2.50	0.97	1.39	1.14
p' at qmax (kPa)	58.5	46.2	43.3	79.9	72.9	70.7	64.5	55.5	54.7	67.8	60.0	62.9
Af at qmax	0.20	0.39	0.42	0.35	0.43	0.50	0.11	0.27	0.33	0.03	0.18	0.12
B (%)	98	98	100	98	99	99	97	99	100	97	100	100
m	1.25	1.76	1.61	1.73	1.68	1.77	1.09	1.21	1.39	0.86	1.34	0.98
E_{50} (mPa) ¤	12.9	5.64	7.55	35.8	9.31	8.85	27.9	20.0	6.72	44.0	19.7	19.1
E_{50}/S_u ¤	343	207	267	784	224	233	700	743	217	1103	544	539
E_{50}/σ'vc ¤	80.7	35.5	47.3	224	58.4	55.6	175	125	42.1	277	124	120
G/σ'vc ¤	26.9	11.8	15.8	74.8	19.5	18.5	58.3	41.8	14.0	92.2	41.2	40.0

-- not applicable to control samples
¤ calculated using qmax

TABLE 10 SUMMARY OF UNDRAINED SHEAR TEST RESULTS FOR OVERCONSOLIDATED SAMPLES (OCR = 2)

		$0.6x\sigma'_{1c}$ ISOTROPIC		$1.0x\sigma'_{1c}$ ISOTROPIC			$1.0x\sigma'_{1c}$ ANISOTROPIC			CONTROL SPECIMENS		
SAMPLE NO.		T732	T733	T734	T735	T736	T737	T738	T739	T740	T741	T742
LIQUID LIMIT (%)		53.7	53.7	56.8	56.8	56.8	63.5	63.5	63.5	60.0	60.0	60.0
PLASTIC LIMIT (%)		25.3	25.3	26.5	26.5	26.5	26.2	26.2	26.2	25.5	25.5	25.5
PLASTICITY INDEX (%)		28.4	28.4	30.3	30.3	30.3	37.3	37.3	37.3	34.5	34.5	34.5
STORAGE TIME (HOURS)		2	168	0.25	24	168	0.25	24	168	-	-	-
RECON. σ'_1 (kPa)		96	96	160	160	160	160	160	160	-	-	-
RECON. σ'_3 (kPa)		96	96	160	160	160	84.8	84.8	84.8	-	-	-
BEFORE CYLINDER CONSOLIDATION (MEASURED)	(1)	114.4	114.4	114.2	114.2	114.2	113.7	113.7	113.7	120.5	120.5	120.5
BEFORE TRIAXIAL CONSOLIDATION (MEASURED)	(2)	50.1	50.8	49.4	49.7	49.9	49.0	49.1	49.3	49.5	49.5	49.9
AFTER TRIAXIAL CONSOLIDATION	(3)	# 41.0	39.7	38.7	39.0	38.4	38.6	38.5	38.3	39.1	38.3	39.1
AFTER STORAGE SWELLING	(4)	*	44.2	39.1	45.1	44.0	38.9	42.4	44.1	-	-	-
BEFORE SHEARING	(5)	*	39.6	36.0	37.0	35.5	38.1	37.8	37.8	39.1	38.3	39.1
AFTER SHEARING (MEASURED)	(6)	43.5	42.3	38.0	37.3	37.4	39.8	38.9	38.7	39.4	38.4	39.1

- not applicable to control samples
only approximation taken due to leakage at top drainage coonection
* not available

TABLE 11 BASIC SOIL PROPERTIES AND MOISTURE CONTENTS (%) AT VARIOUS STAGES FOR NORMALLY CONSOLIDATED SAMPLES

		$0.6x\sigma'_{1c}$ ISOTROPIC			$1.0x\sigma'_{1c}$ ISOTROPIC			$1.0x\sigma'_{1c}$ ANISOTROPIC			CONTROL SPECIMENS		
SAMPLE NO.		T751	T752	T753	T754	T755	T756	T757	T758	T759	T760	T761	T762
LIQUID LIMIT (%)		61.5	61.5	61.5	63.8	63.8	63.8	60.4	60.4	60.4	65.0	65.0	65.0
PLASTIC LIMIT (%)		25.4	25.4	25.4	26.4	26.4	26.4	25.6	25.6	25.6	26.5	26.5	26.5
PLASTICITY INDEX (%)		36.1	36.1	36.1	37.4	37.4	37.4	34.8	34.8	34.8	38.5	38.5	38.5
STORAGE TIME (HOURS)		0.25	24	168	0.25	24	168	0.25	24	168	-	-	-
RECON. σ'_1 (kPa)		48	48	48	80	80	80	80	80	80	-	-	-
RECON. σ'_3 (kPa)		48	48	48	80	80	80	42.4	42.4	42.4	-	-	-
BEFORE CYLINDER CONSOLIDATION (MEASURED)	(1)	114.4	114.4	114.4	113.6	113.6	113.6	114.3	114.3	114.3	116.0	116.0	116.0
BEFORE TRIAXIAL CONSOLIDATION (MEASURED)	(2)	50.0	50.5	51.0	50.6	50.6	50.8	50.4	50.5	50.9	51.0	51.5	51.4
AFTER TRIAXIAL CONSOLIDATION	(3)	41.4	42.2	41.9	42.2	41.3	41.8	42.1	42.2	42.3	42.7	42.1	42.0
AFTER STORAGE SWELLING	(4)	41.6	45.9	47.2	42.4	45.4	46.9	42.4	45.4	47.4	-	-	-
BEFORE SHEARING	(5)	41.7	43.2	43.4	41.1	40.9	41.2	42.2	42.8	43.2	42.7	42.1	42.0
AFTER SHEARING (MEASURED)	(6)	43.8	44.4	44.4	41.6	41.4	41.2	42.7	42.7	43.7	43.4	42.9	42.3

- not applicable to control samples

TABLE 12 BASIC SOIL PROPERTIES AND MOISTURE CONTENTS (%) AT VARIOUS STAGES FOR OVERCONSOLIDATED SAMPLES (OCR =2)

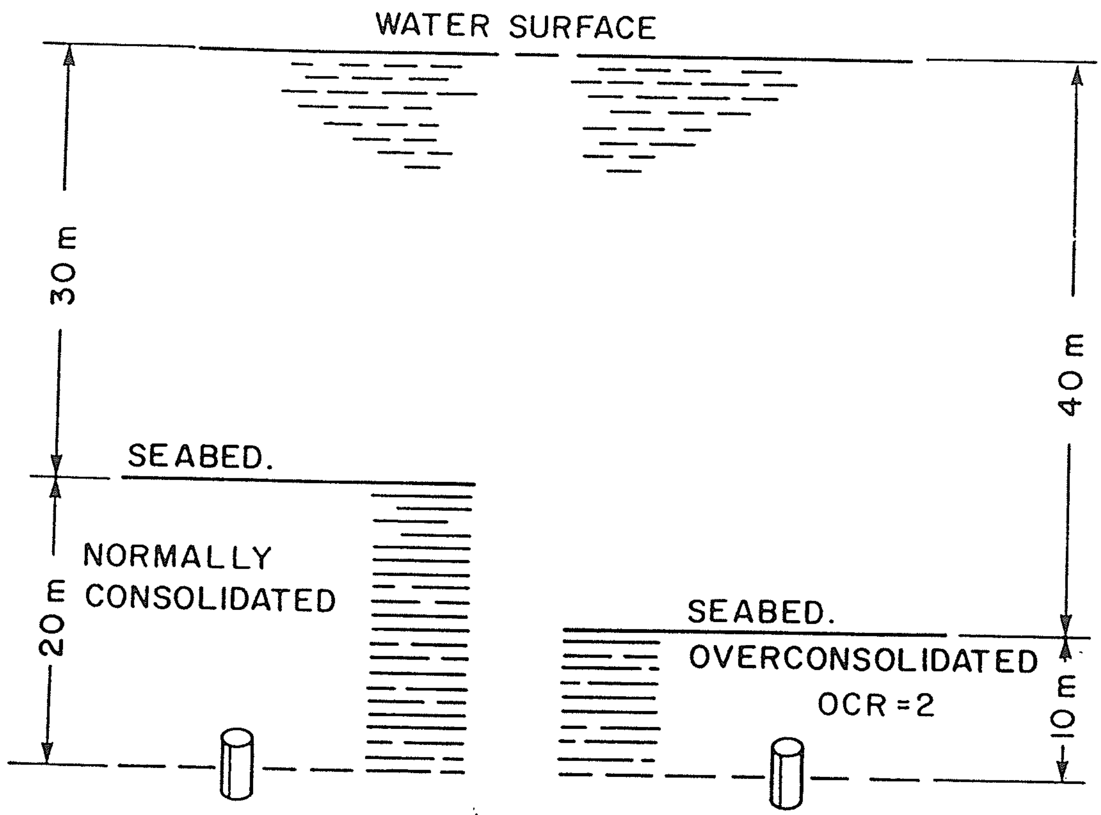


FIGURE 3.1 SCHMATIC DIAGRAM OF MODELLED CONDITIONS

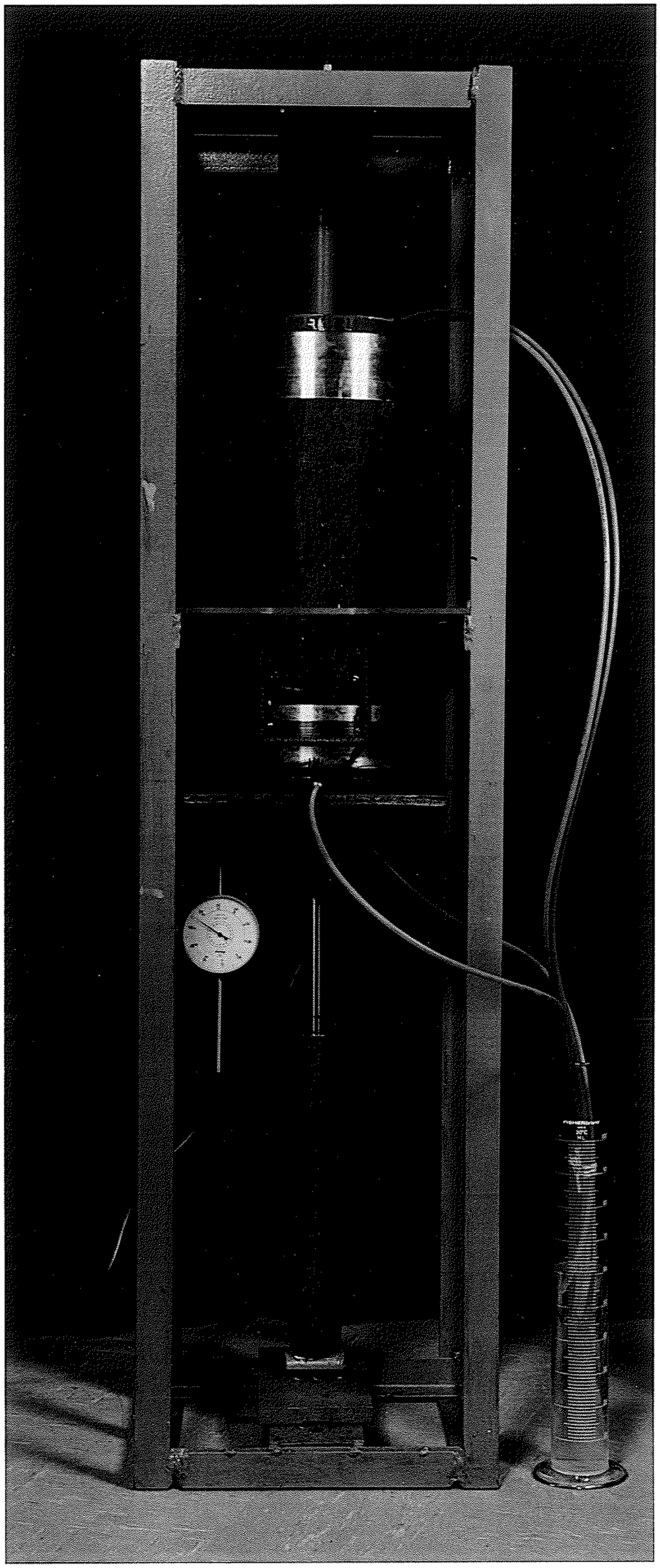


FIGURE 3.2 GENERAL SET-UP DURING ONE-DIMENAIONAL SLURRY CONSOLIDATION

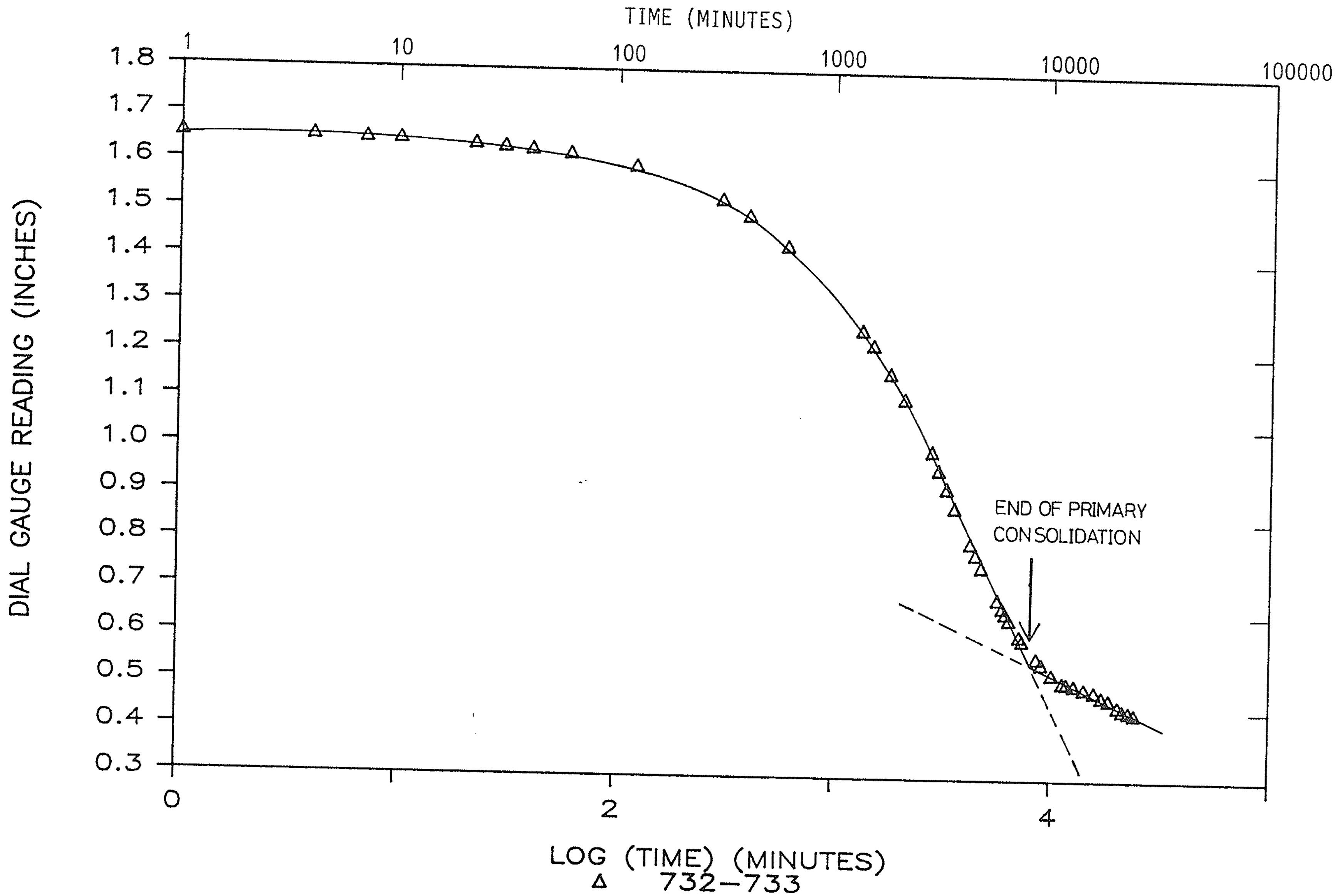


FIGURE 3.3 TIME-DISPLACEMENT CURVE DURING LAST LOAD INCREMENT OF ONE-DIMENSIONAL SLURRY CONSOLIDATION 732-733

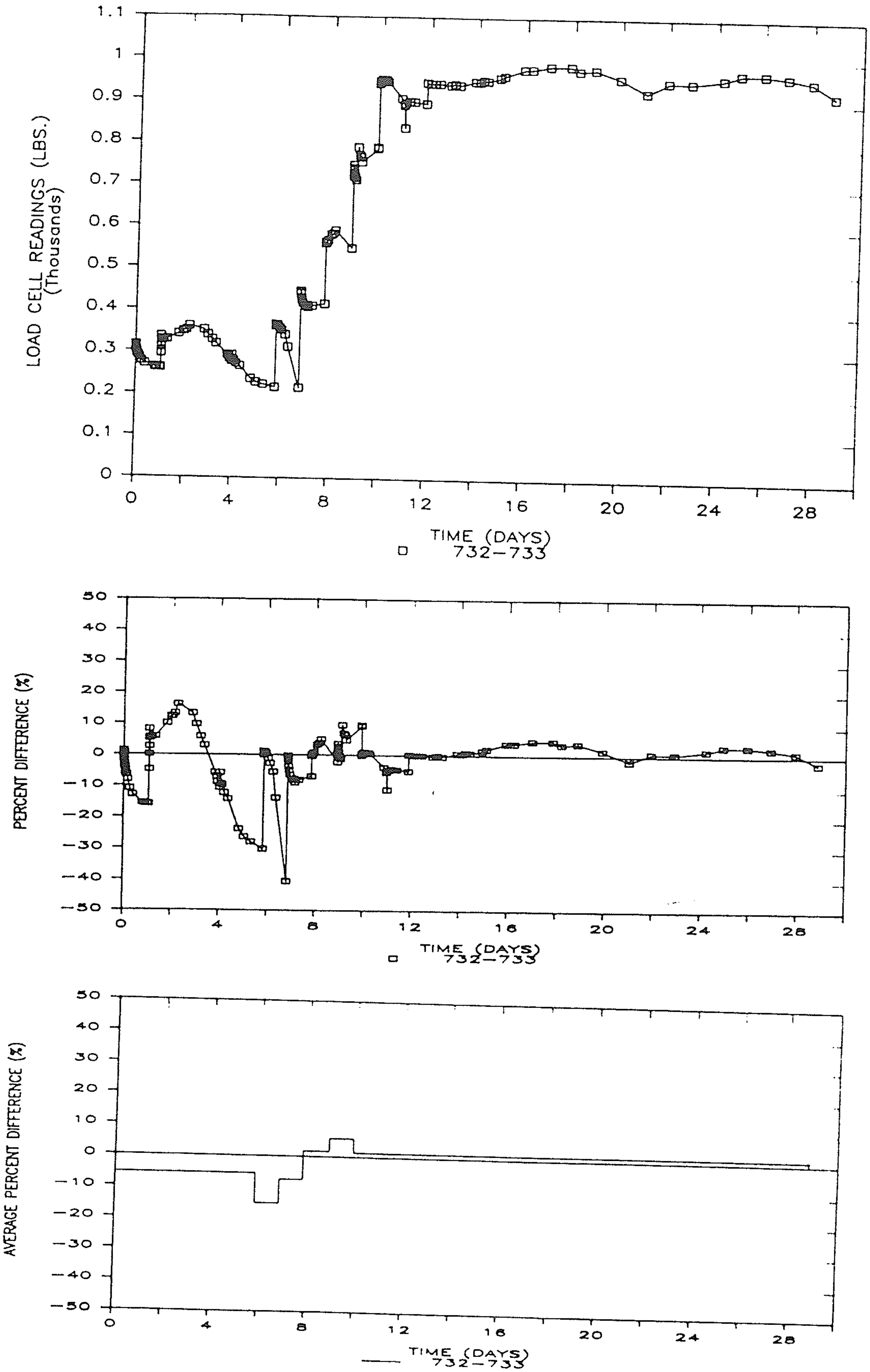


FIGURE 3.4 a,b,c LOADING AND DEVIATION CURVES DURING ONE-DIMENSIONAL SLURRY CONSOLIDATION 732-733

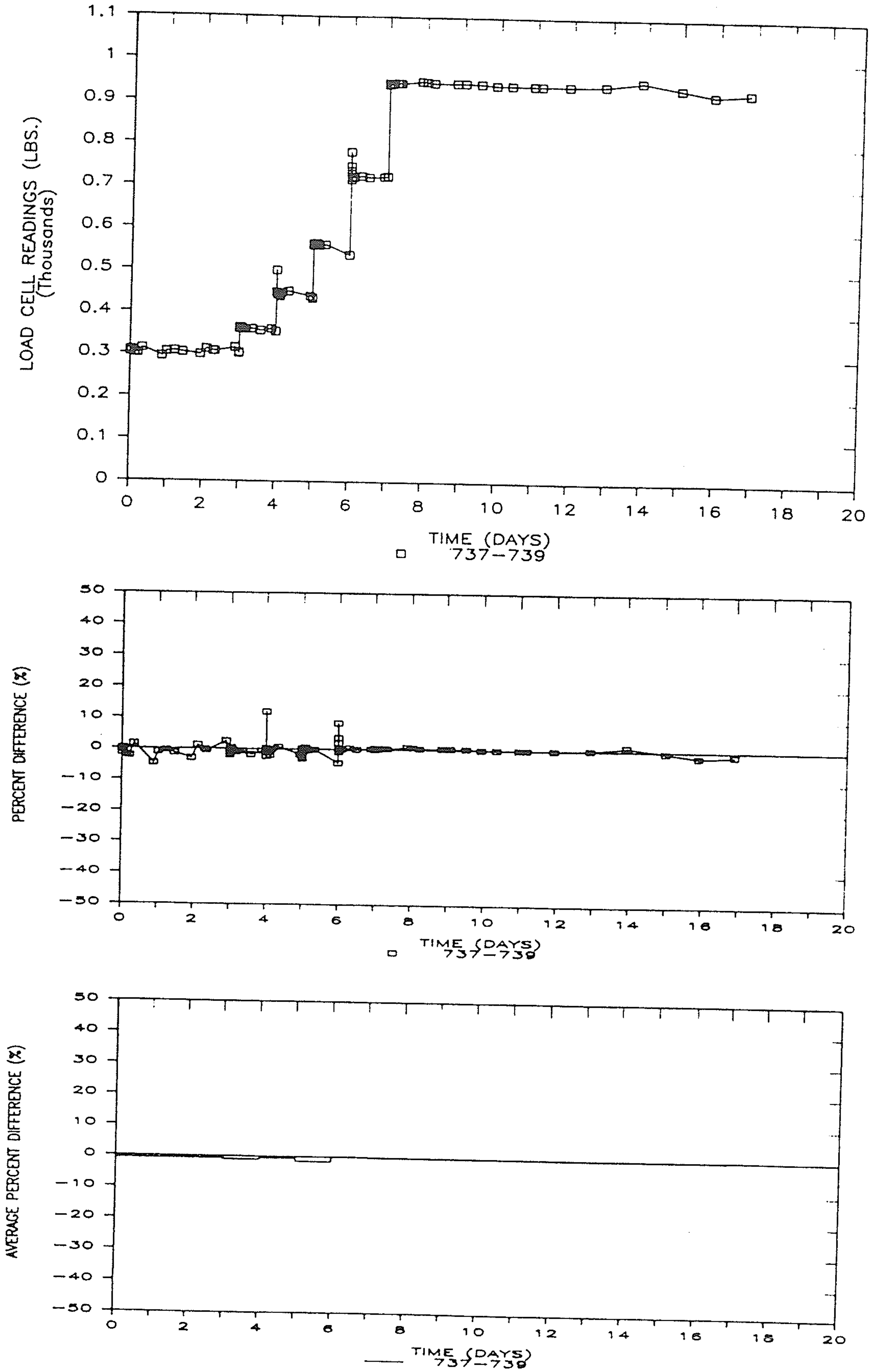


FIGURE 3.5 a,b,c LOADING AND DEVIATION CURVES DURING ONE-DIMENSIONAL SLURRY CONSOLIDATION 737-739

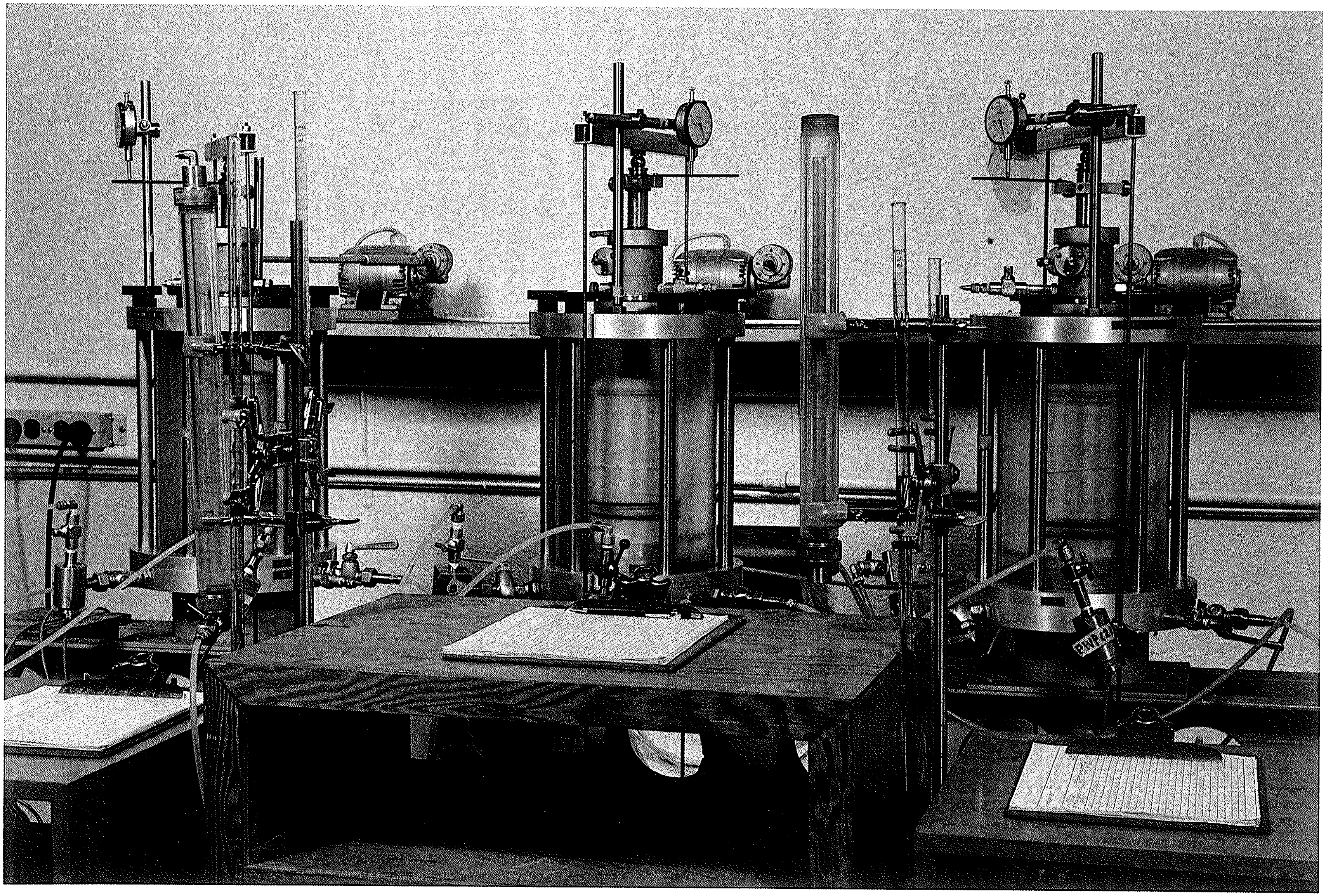
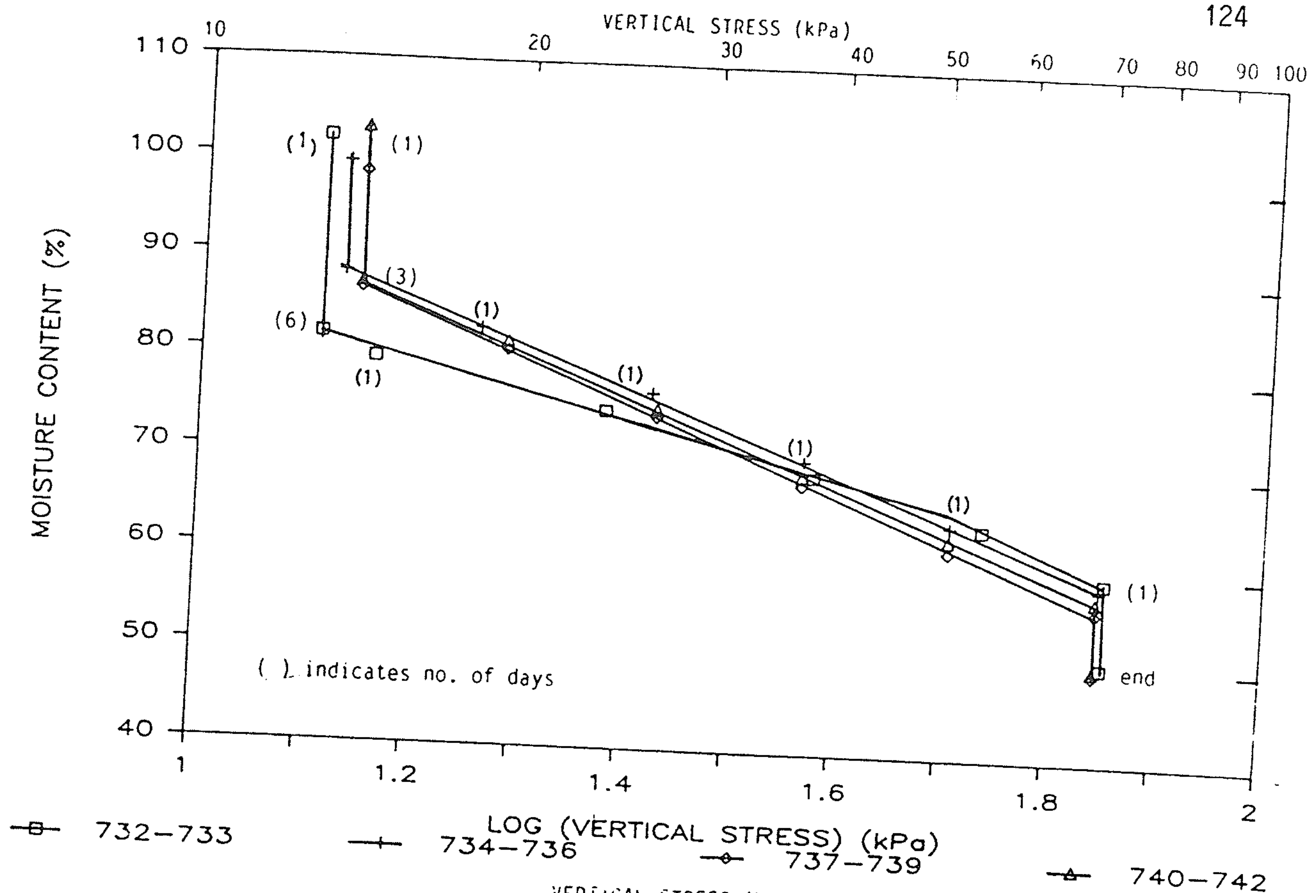


FIGURE 3.6 GENERAL SET-UP DURING TRIAXIAL CONSOLIDATION TESTS



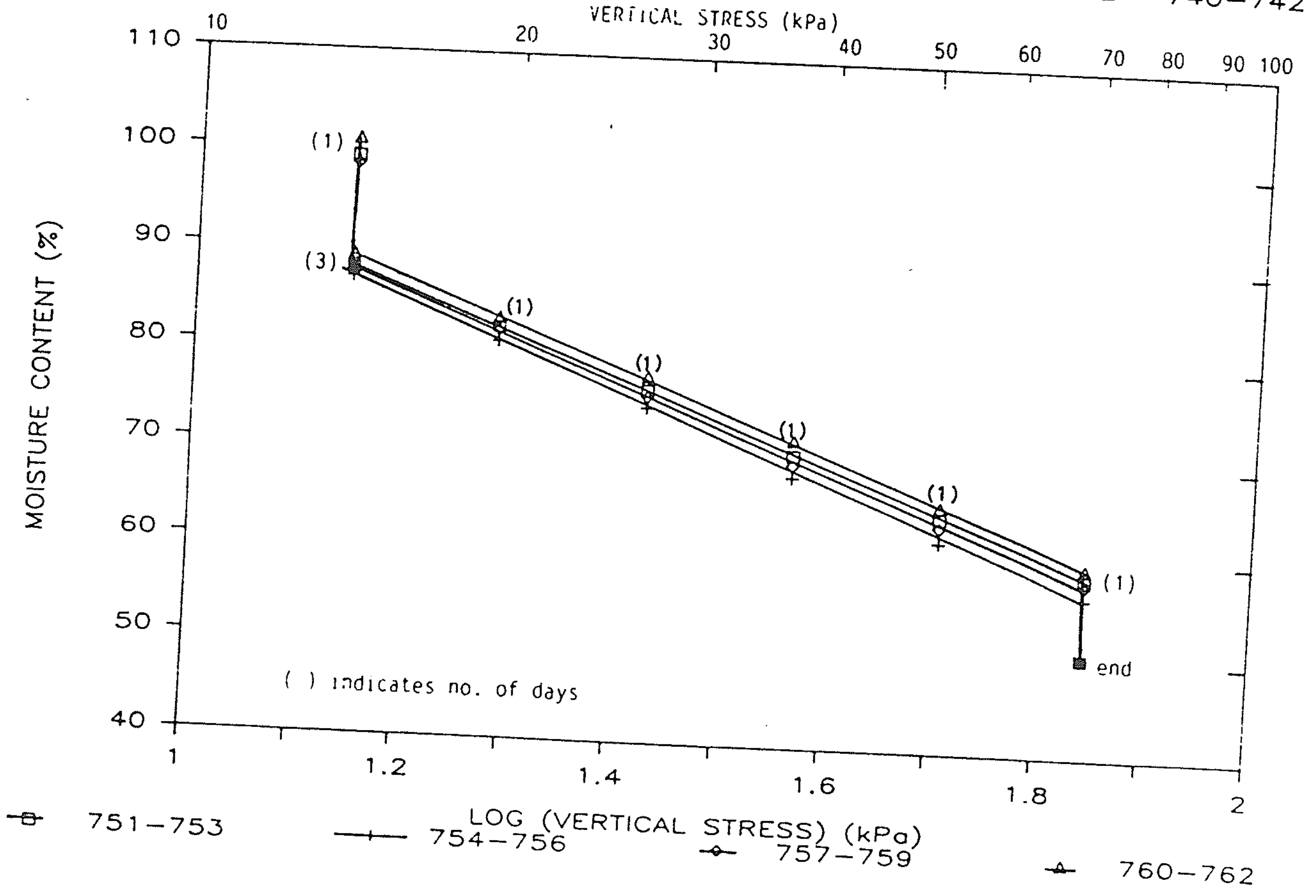


FIGURE 4.1 a,b ONE-DIMENSIONAL SLURRY CONSOLIDATION
LOG (σ_v) VS. W

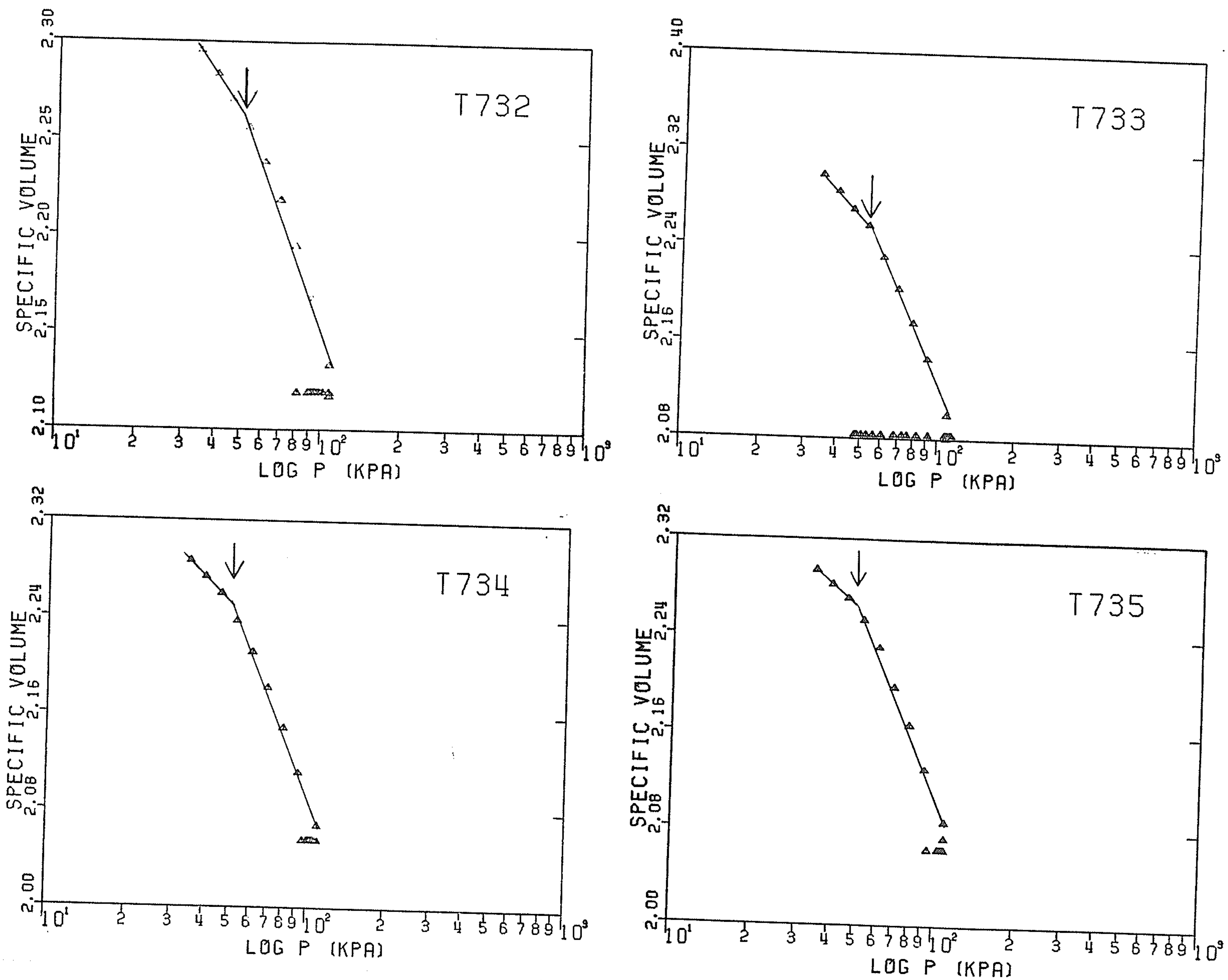


FIGURE 4.2 a,b,c,d TRIAXIAL CONSOLIDATION AND YIELD DETERMINATION—LOG (p') vs. V
NORMALLY CONSOLIDATED SAMPLES T732, T733, T734, T735

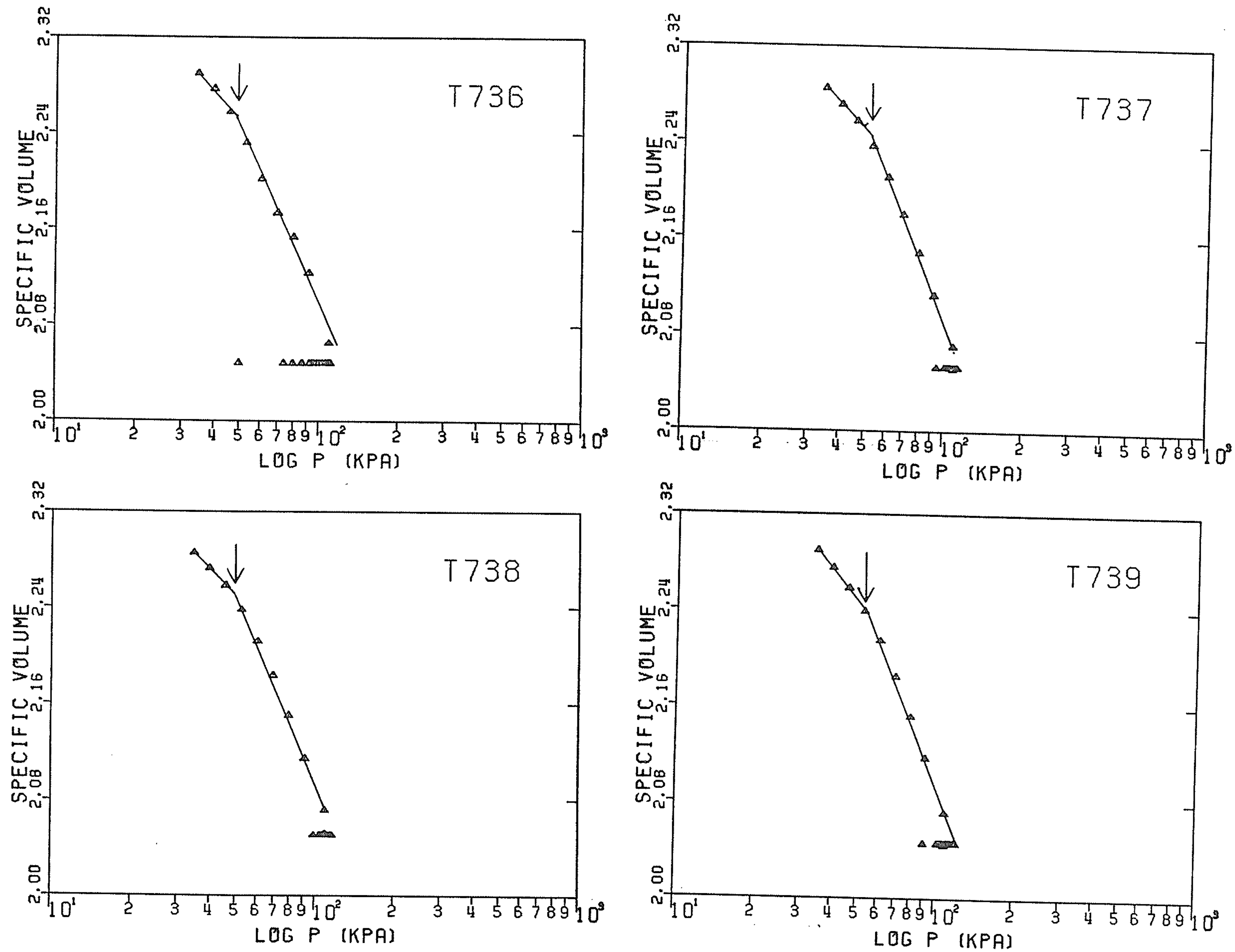


FIGURE 4.3 a,b,c,d TRIAXIAL CONSOLIDATION AND YIELD DETERMINATION—LOG (p') vs. V

NORMALLY CONSOLIDATED SAMPLES T736, T737, T738, T739

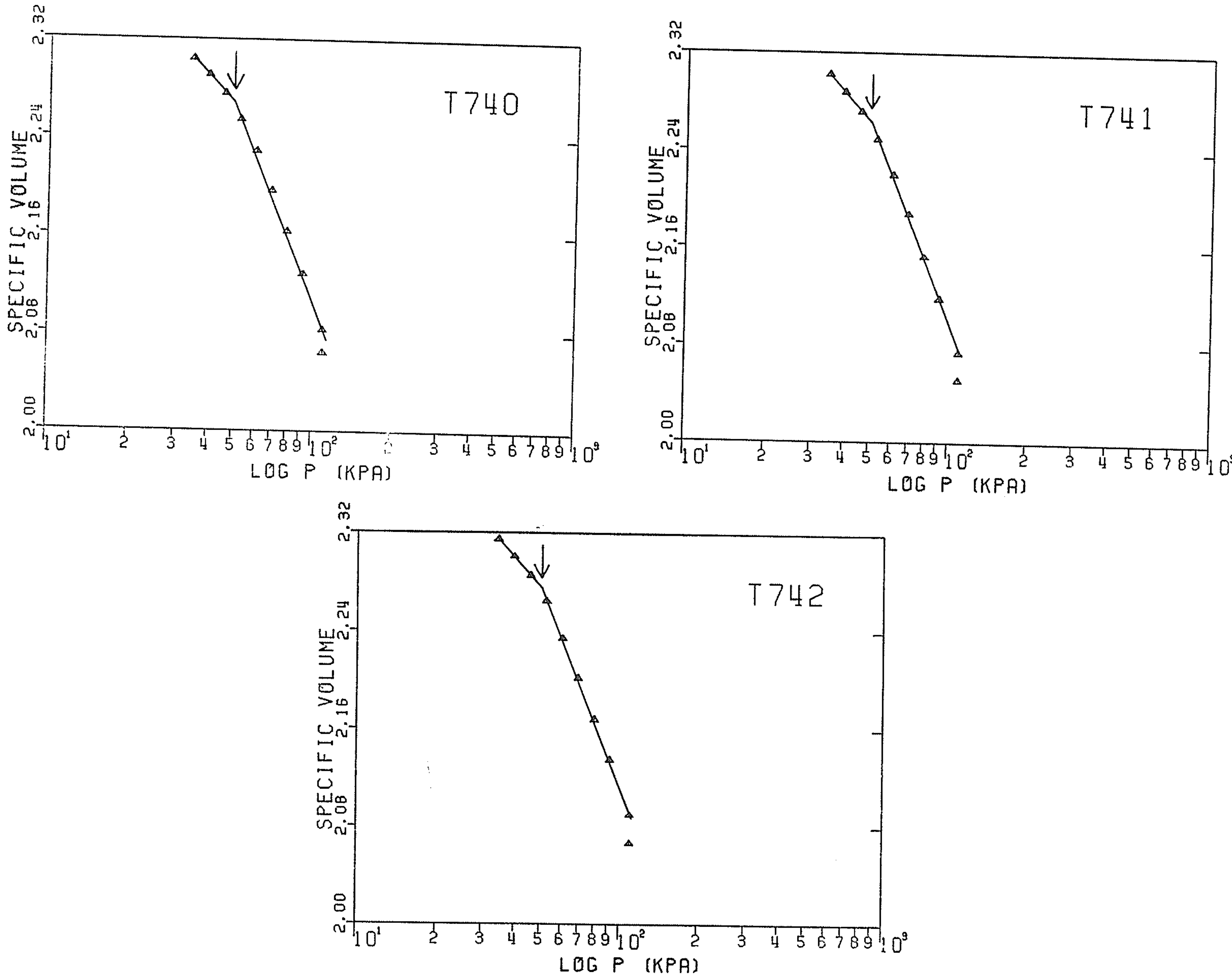


FIGURE 4.4 a,b,c TRIAXIAL CONSOLIDATION AND YIELD DETERMINATION—LOG (p') vs. V
NORMALLY CONSOLIDATED SAMPLES T740, T741, T742

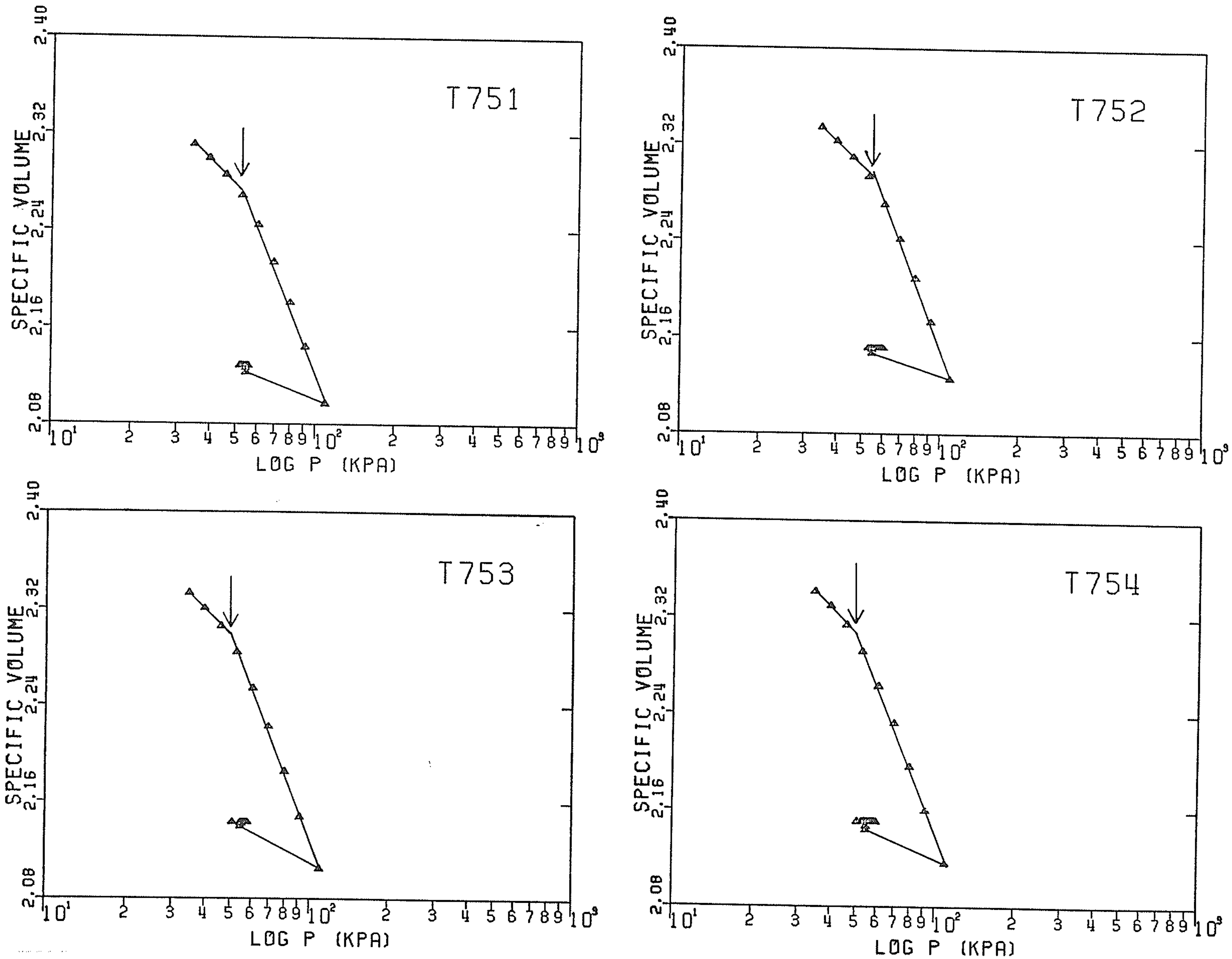


FIGURE 4.5 a,b,c,d TRIAXIAL CONSOLIDATION AND YIELD DETERMINATION—LOG (p') vs. V
OVERCONSOLIDATED SAMPLES T751,T752,T753,T754

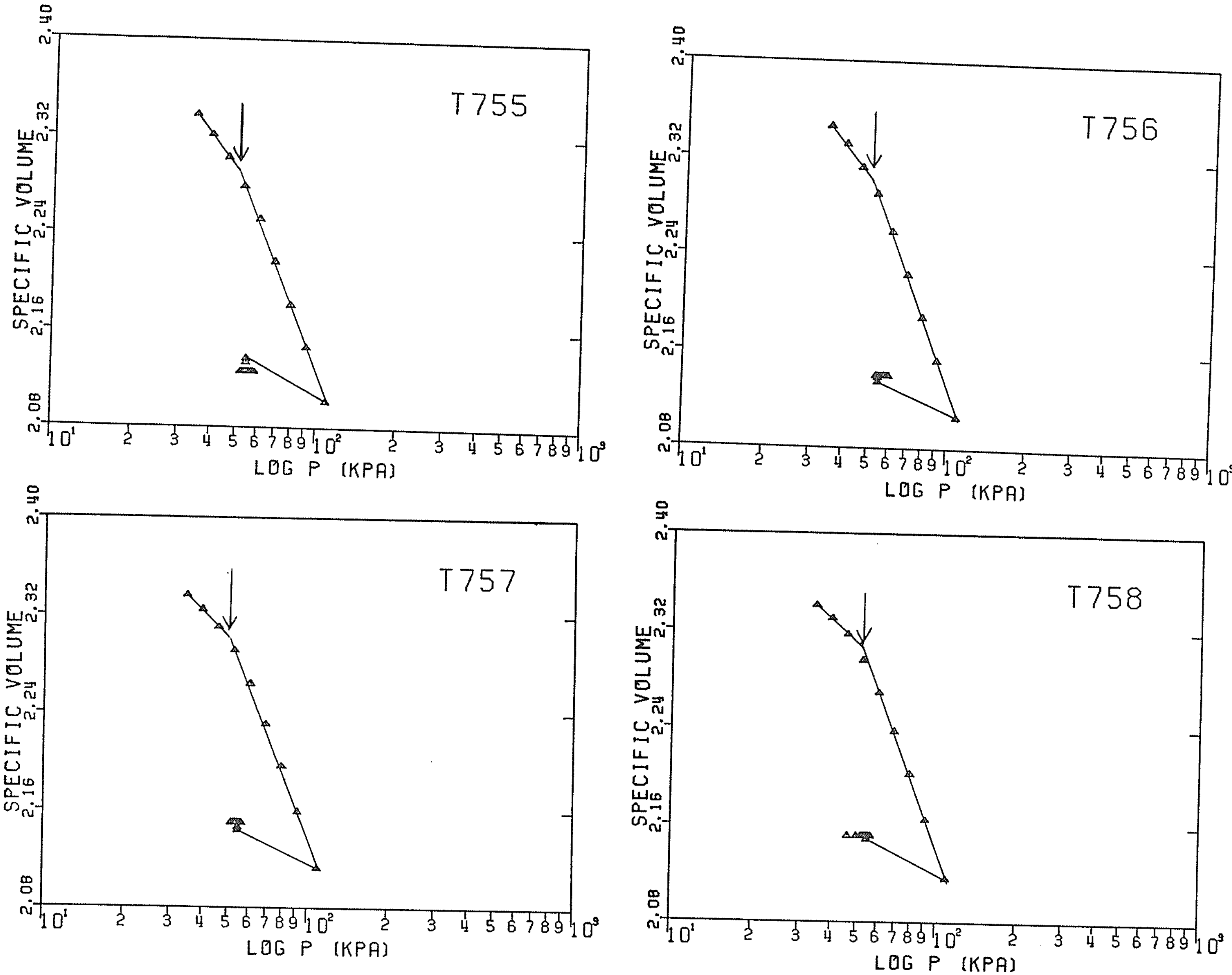


FIGURE 4.6 a,b,c,d TRIAXIAL CONSOLIDATION AND YIELD DETERMINATION—LOG (p') vs. V

OVERCONSOLIDATED SAMPLES T755, T756, T757, T758

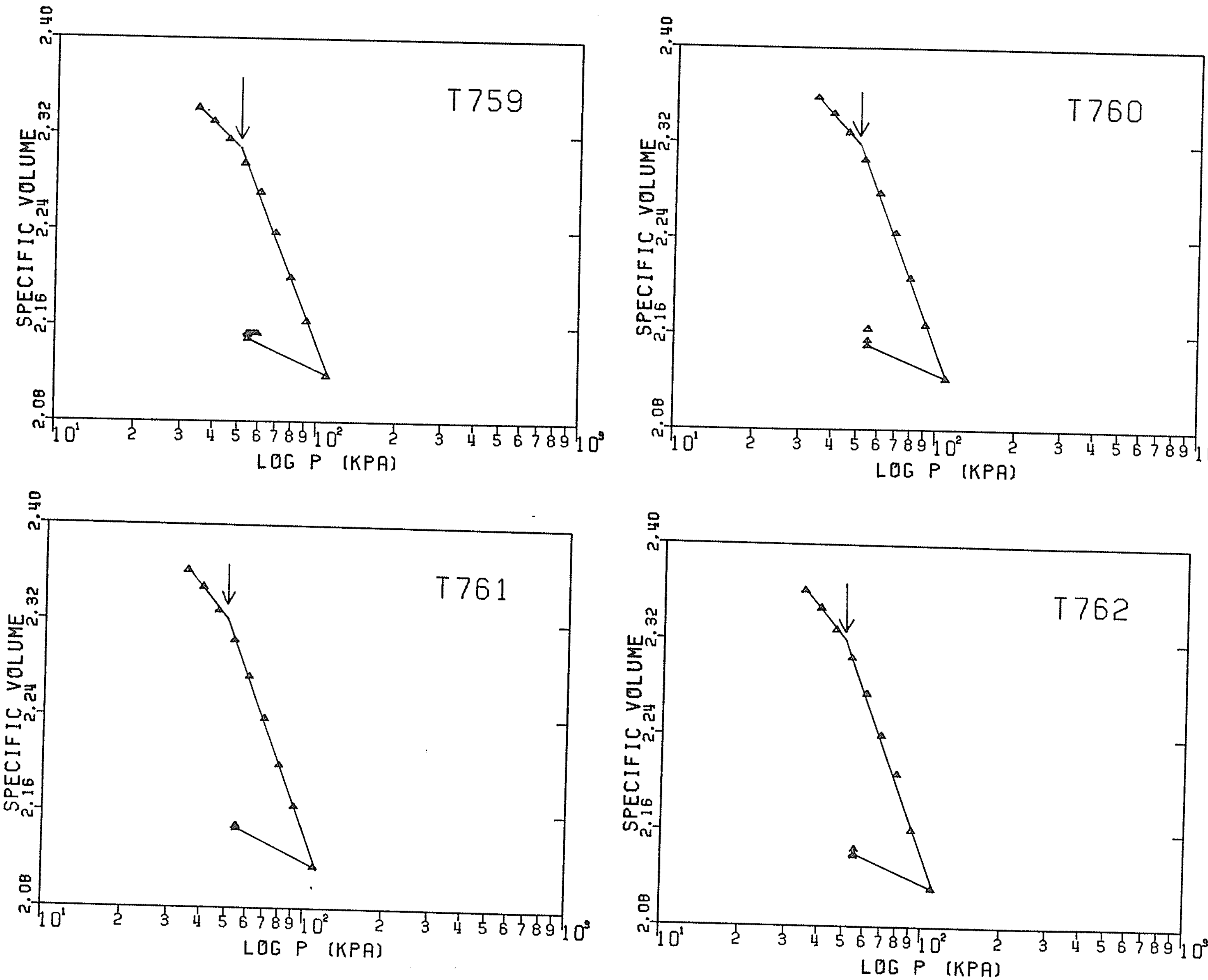


FIGURE 4.7 a,b,c,d TRIAXIAL CONSOLIDATION AND YIELD DETERMINATION—LOG (p') vs. V
OVERCONSOLIDATED SAMPLES T759, T760, T761, T762

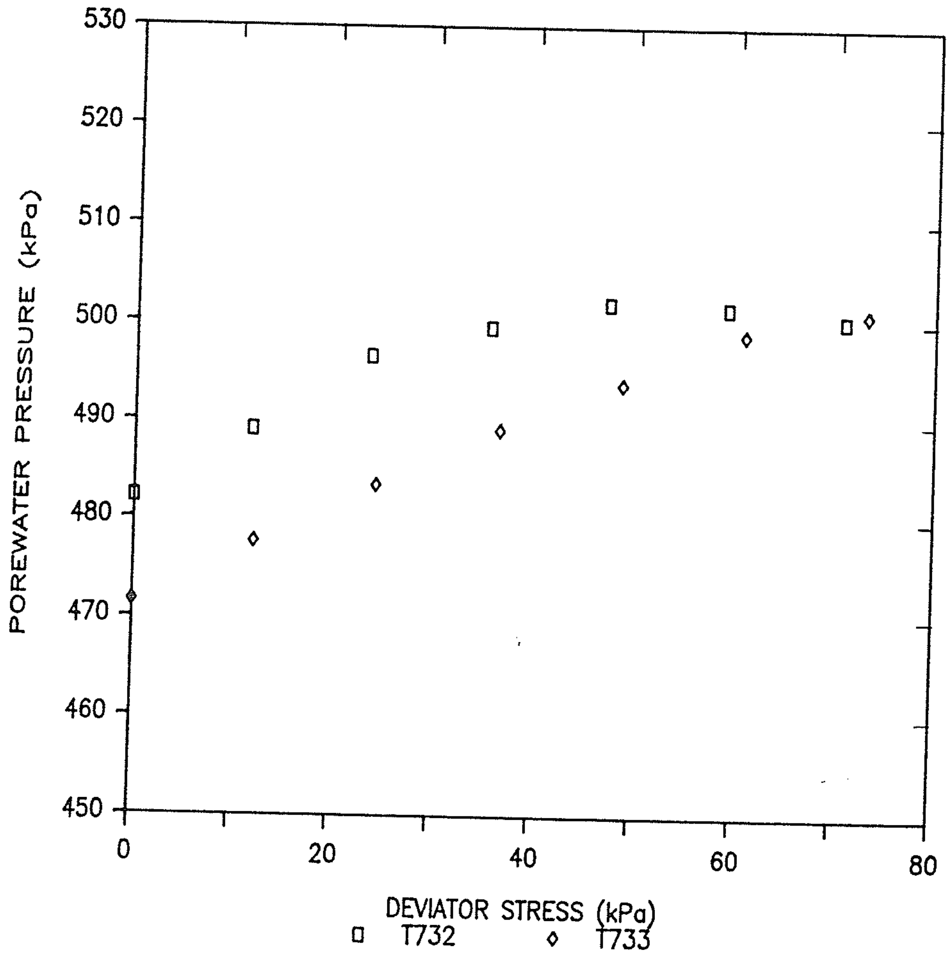


FIGURE 5.1 POREWATER PRESSURE BEHAVIOUR DURING SHEAR UNLOADING NORMALLY CONSOLIDATED SAMPLES T732, T733

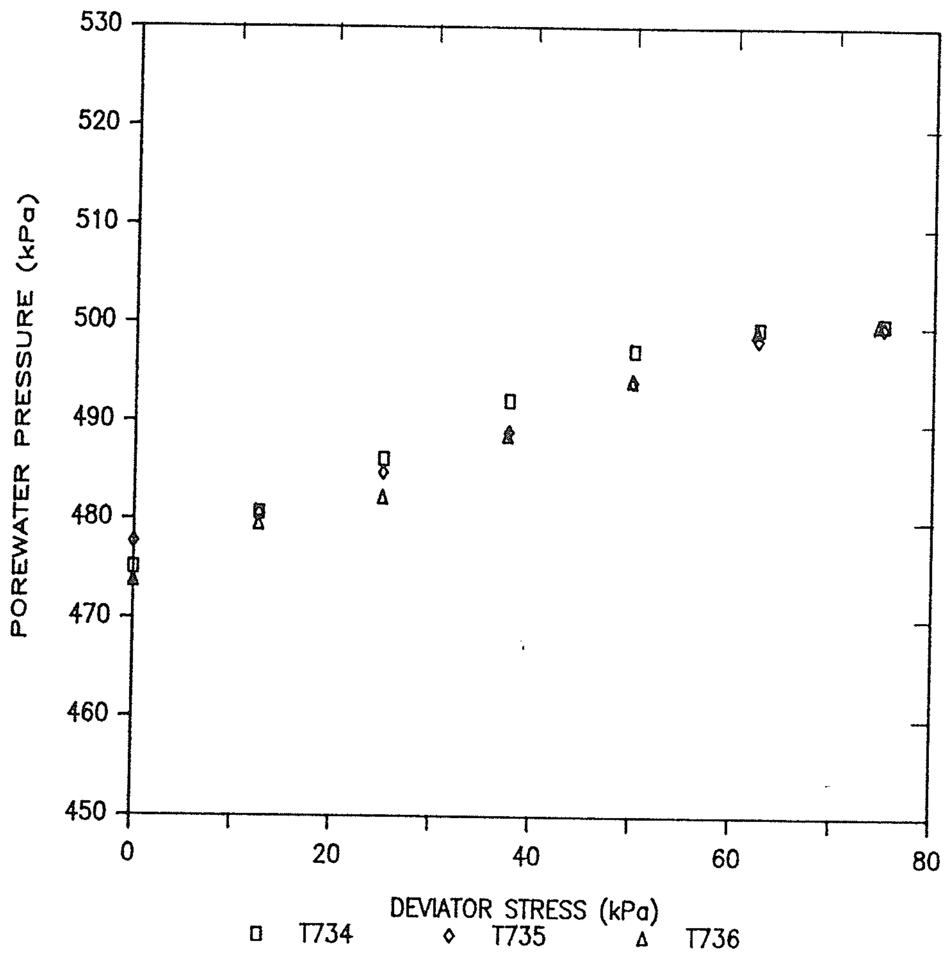


FIGURE 5.2 POREWATER PRESSURE BEHAVIOUR DURING SHEAR UNLOADING
NORMALLY CONSOLIDATED SAMPLES T734, T735, T736

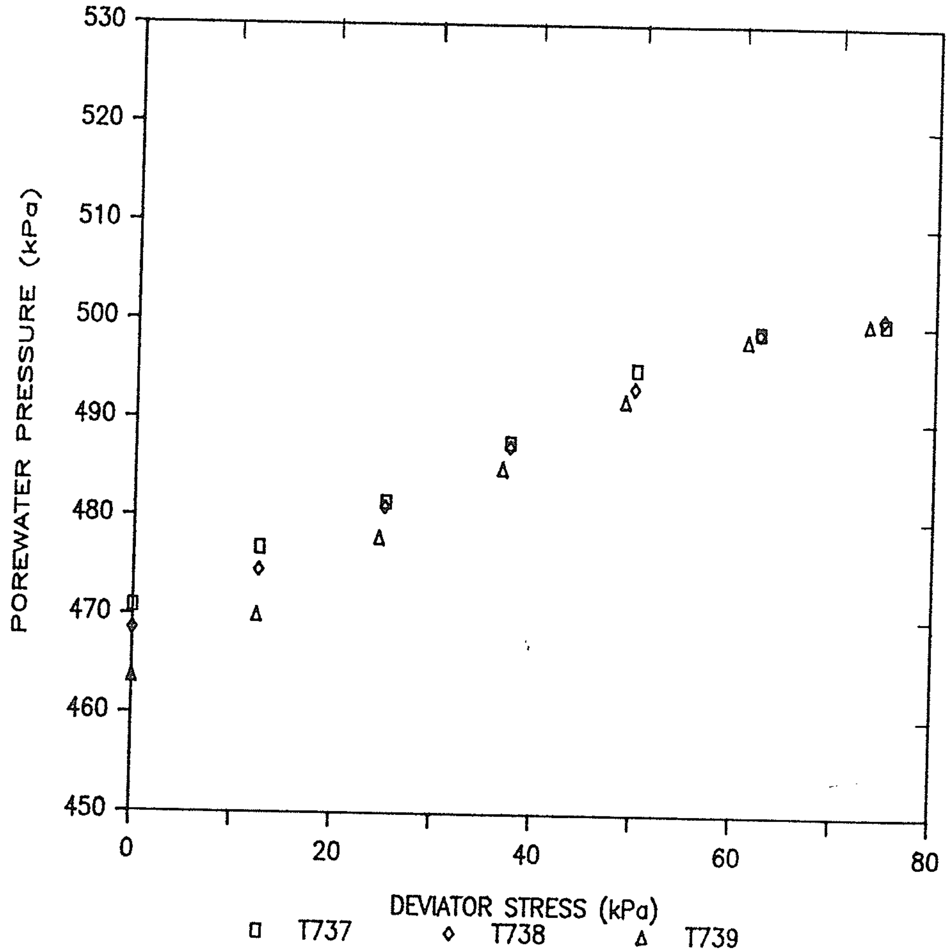


FIGURE 5.3 POREWATER PRESSURE BEHAVIOUR DURING SHEAR UNLOADING NORMALLY CONSOLIDATED SAMPLES T737, T738, T739

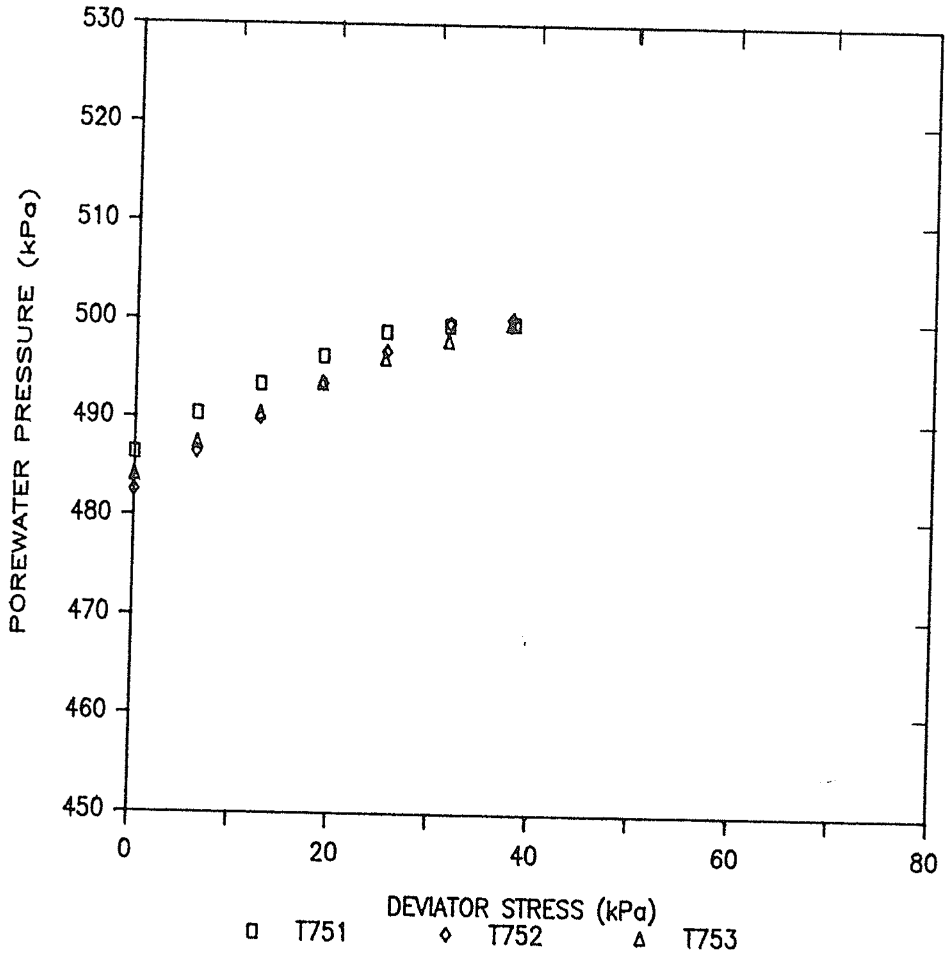


FIGURE 5.4 POREWATER PRESSURE BEHAVIOUR DURING SHEAR UNLOADING OVERCONSOLIDATED SAMPLES T751, T752, T753

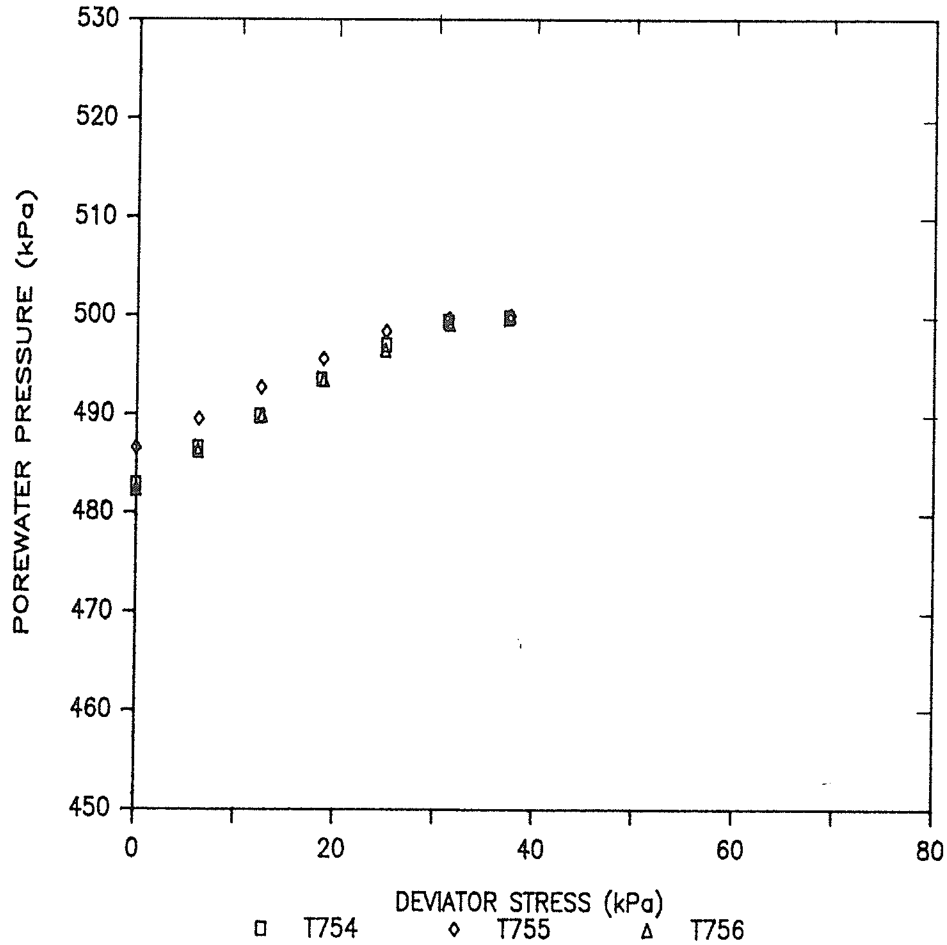


FIGURE 5.5 POREWATER PRESSURE BEHAVIOUR DURING SHEAR UNLOADING
OVERCONSOLIDATED SAMPLES T754, T755, T756

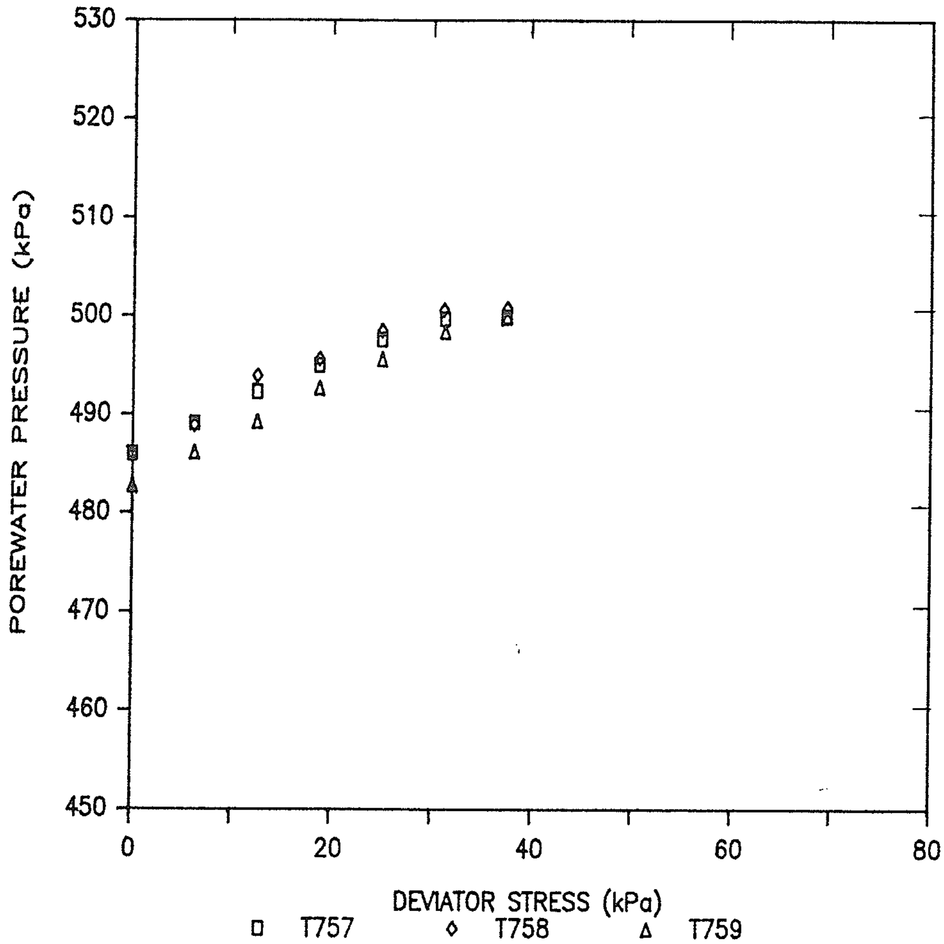


FIGURE 5.6 POREWATER PRESSURE BEHAVIOUR DURING SHEAR UNLOADING OVERCONSOLIDATED SAMPLES T757, T758, T759

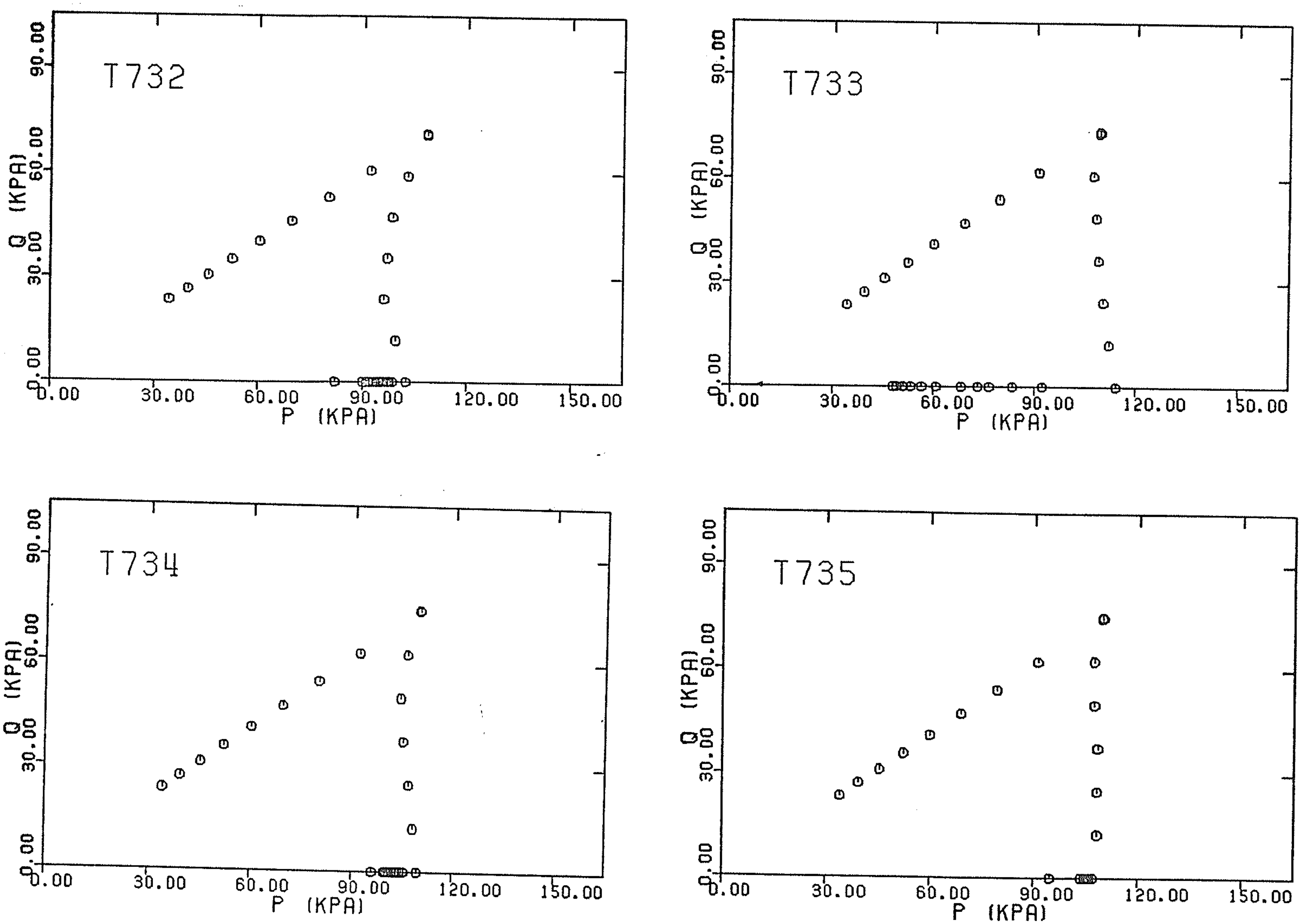


FIGURE 5.7 a,b,c,d STRESS PATHS FOR TRIAXIAL CONSOLIDATION, SHEAR UNLOADING AND ISOTROPIC UNLOADING NORMALLY CONSOLIDATED SAMPLES T732, T733, T734, T735

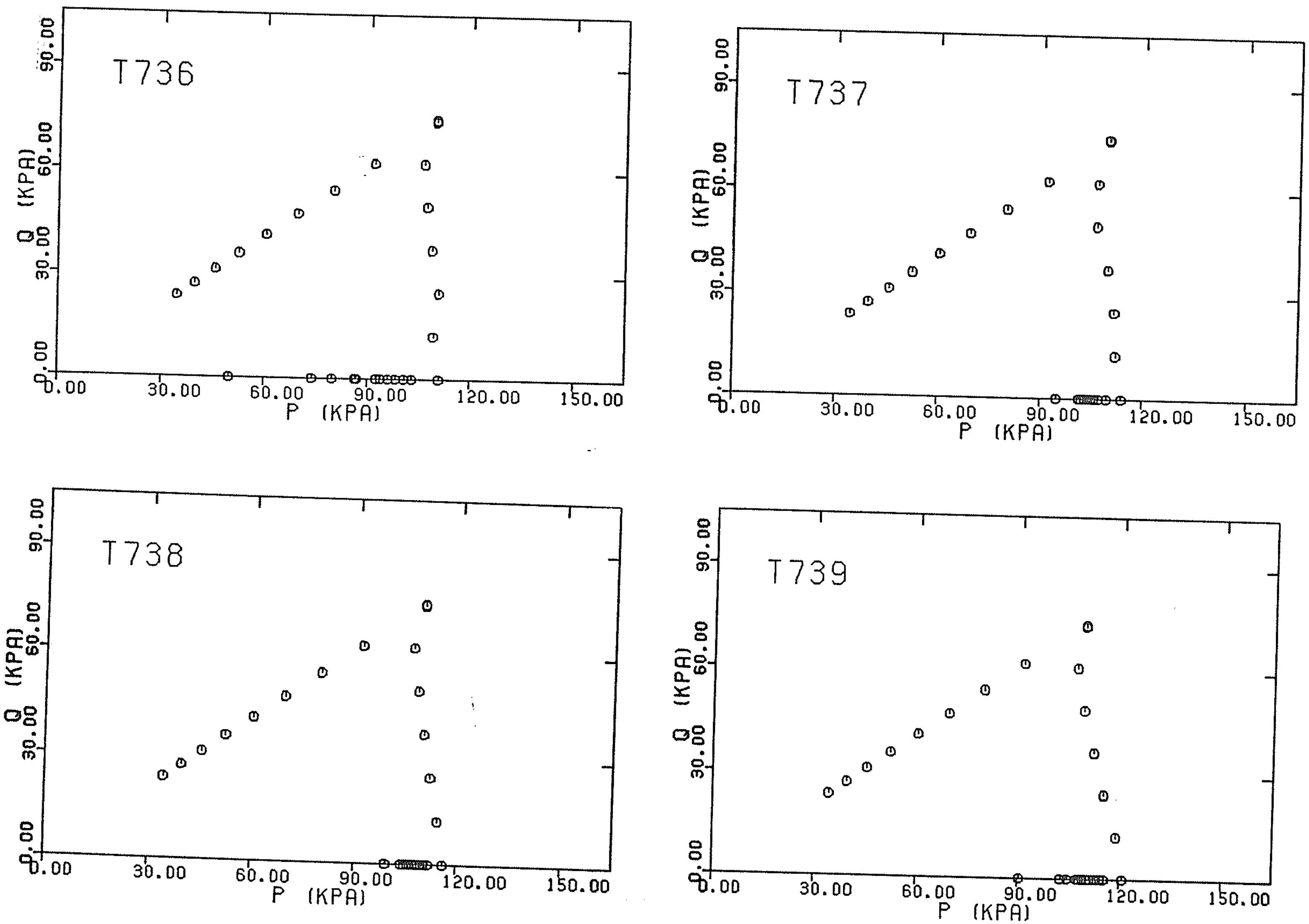


FIGURE 5.8 a,b,c,d STRESS PATHS FOR TRIAXIAL CONSOLIDATION, SHEAR UNLOADING AND ISOTROPIC UNLOADING NORMALLY CONSOLIDATED SAMPLES T736, T737, T738, T739

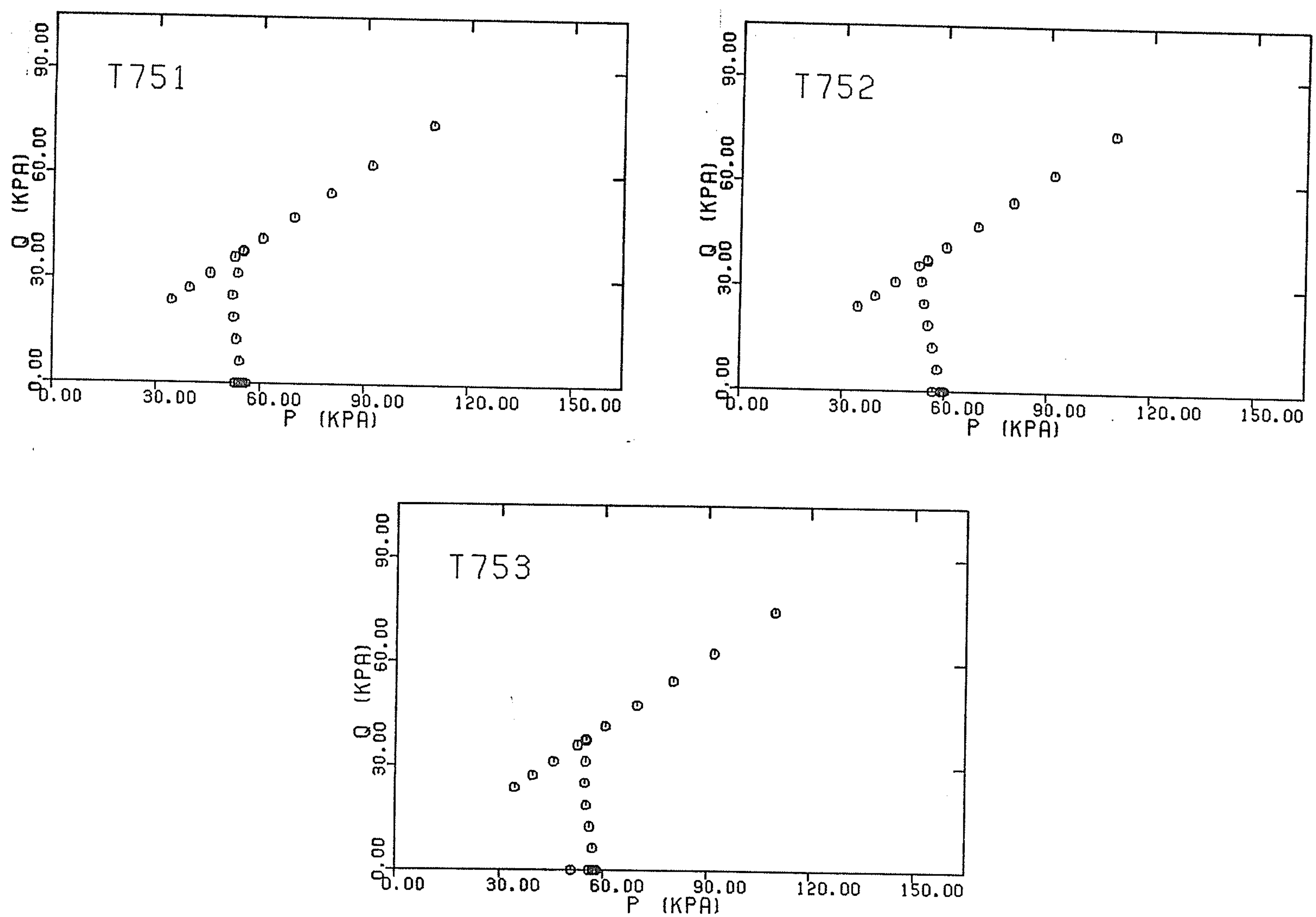


FIGURE 5.9 a,b,c STRESS PATHS FOR TRIAXIAL CONSOLIDATION, SHEAR UNLOADING AND ISOTROPIC UNLOADING OVERCONSOLIDATED SAMPLES T751, T752, T753

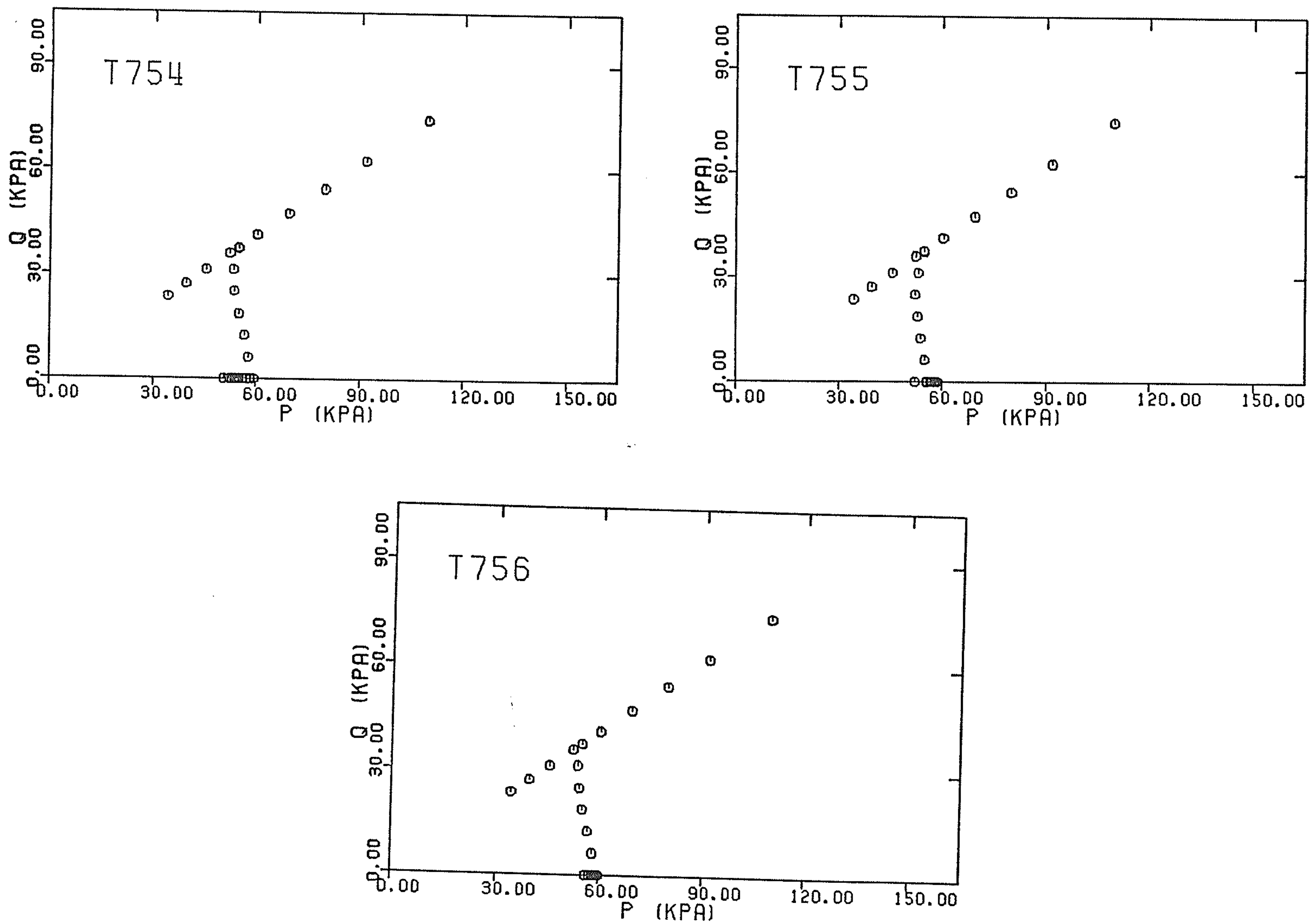
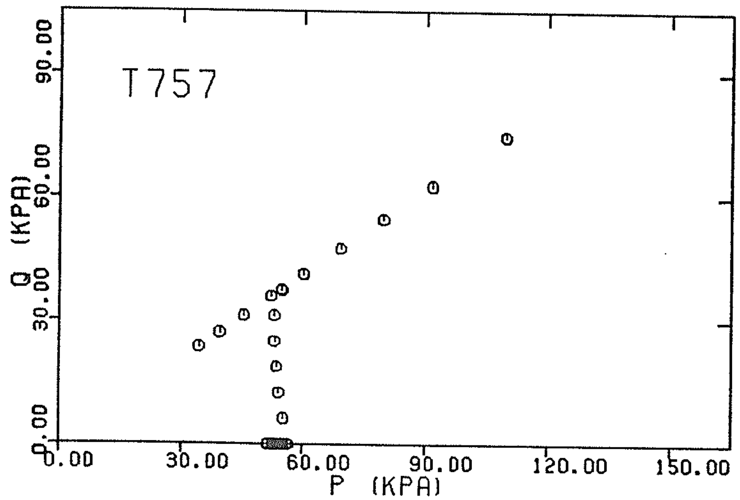
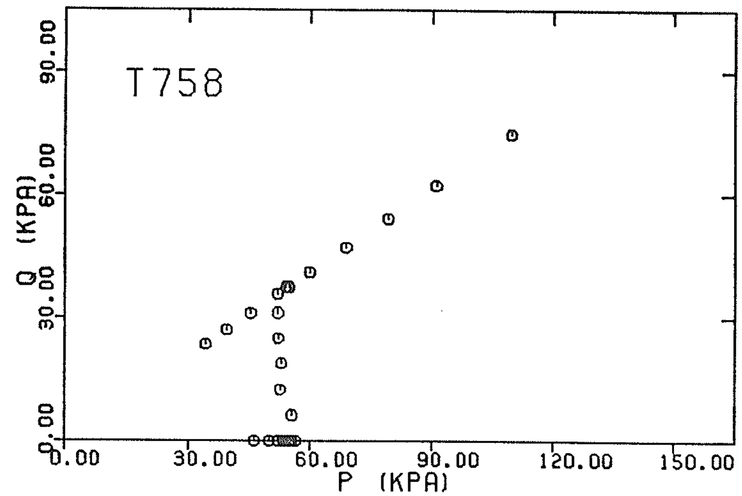


FIGURE 5.10 a,b,c STRESS PATHS FOR TRIAXIAL CONSOLIDATION, SHEAR UNLOADING AND ISOTROPIC UNLOADING OVERCONSOLIDATED SAMPLES T754, T755, T756





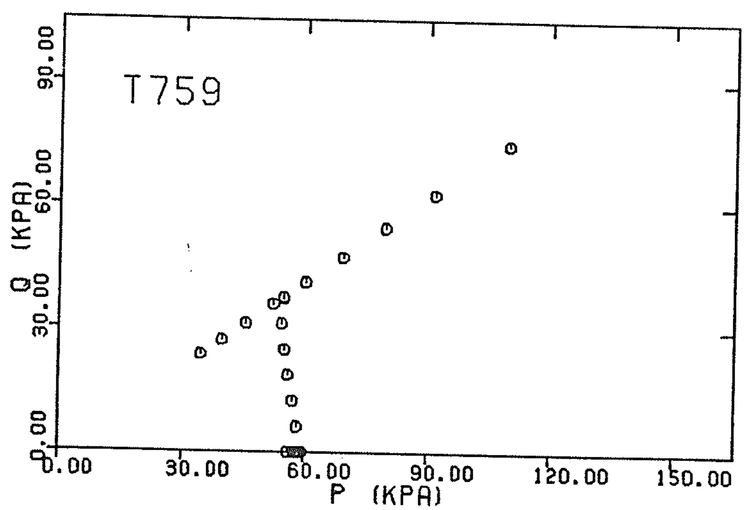


FIGURE 5.11 a,b.c STRESS PATHS FOR TRIAXIAL CONSOLIDATION, SHEAR UNLOADING AND ISOTROPIC UNLOADING OVERCONSOLIDATED SAMPLES T757, T758, T759

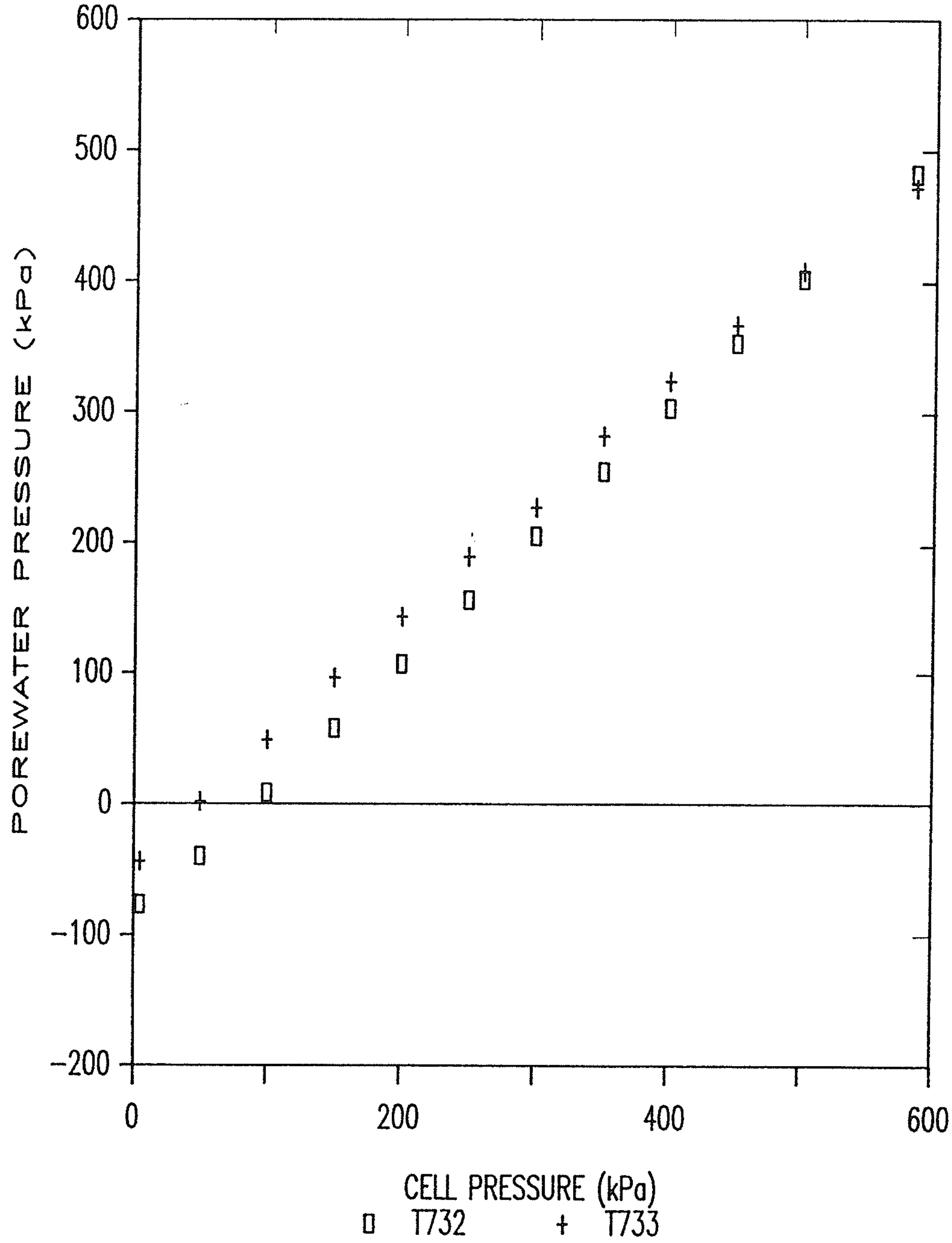


FIGURE 5.12 POREWATER PRESSURE BEHAVIOUR DURING ISOTROPIC UNLOADING NORMALLY CONSOLIDATED SAMPLES T732, T733

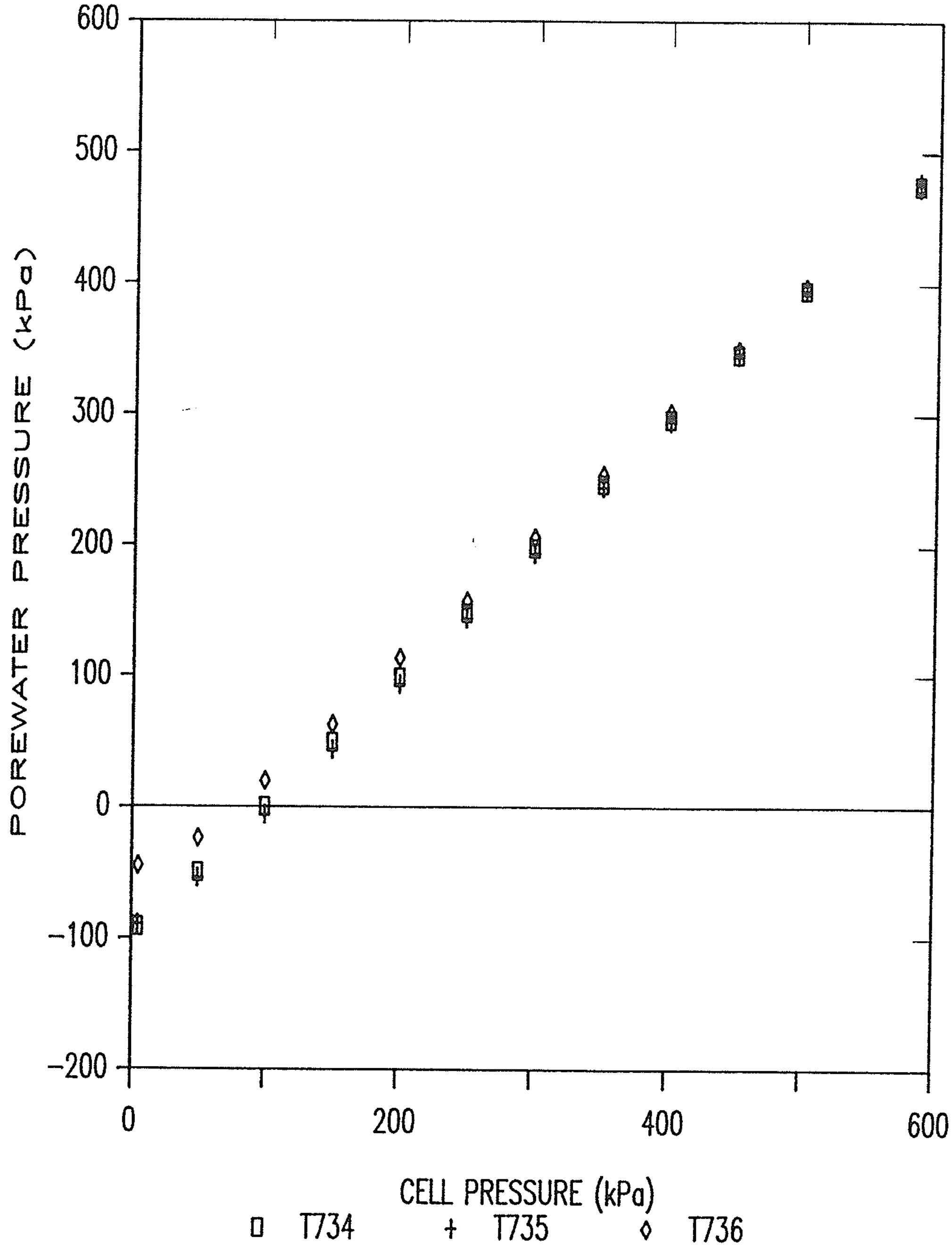


FIGURE 5.13 POREWATER PRESSURE BEHAVIOUR DURING ISOTROPIC UNLOADING NORMALLY CONSOLIDATED SAMPLES T734, T735, T736

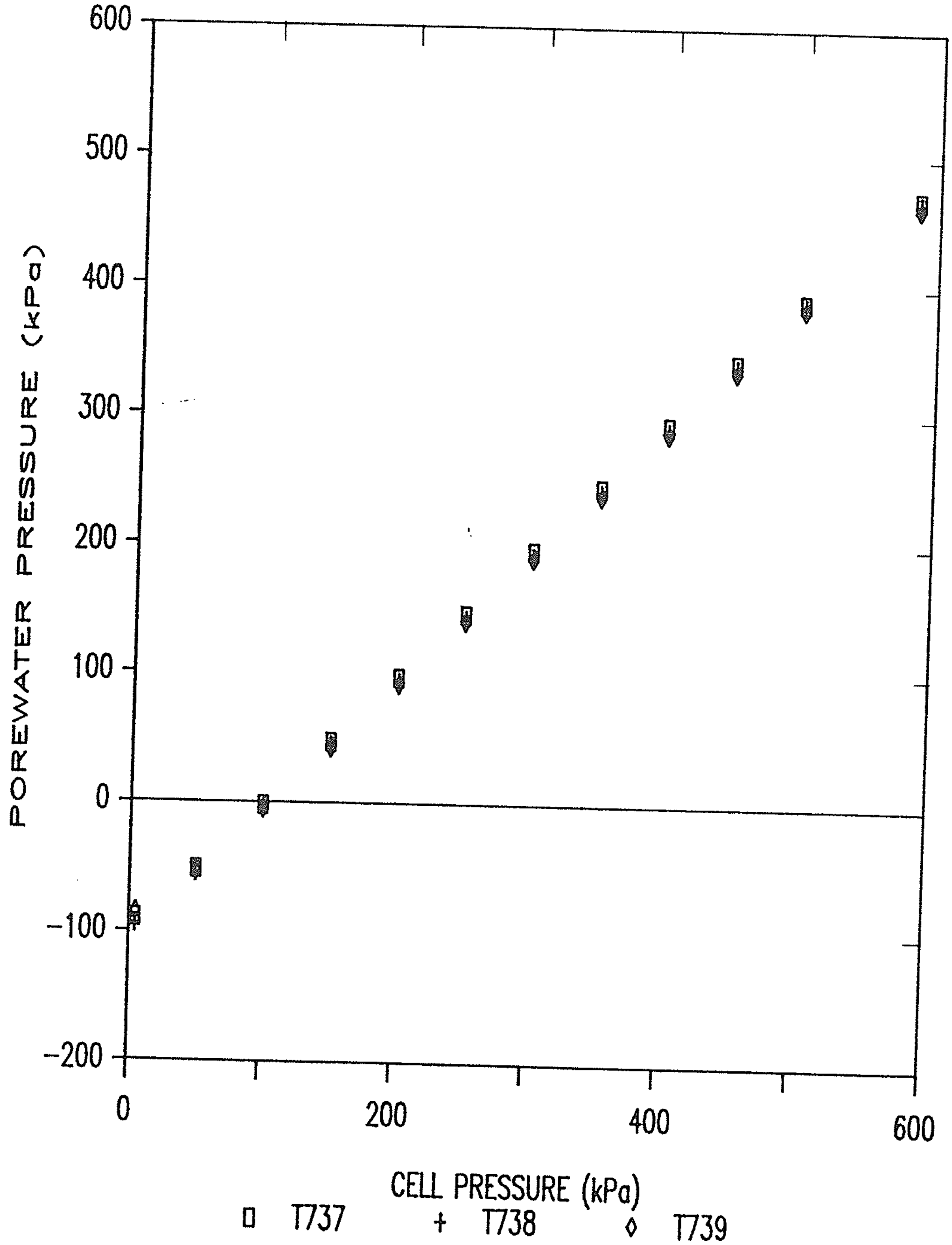


FIGURE 5.14 POREWATER PRESSURE BEHAVIOUR DURING ISOTROPIC UNLOADING NORMALLY CONSOLIDATED SAMPLES T737, T738, T739

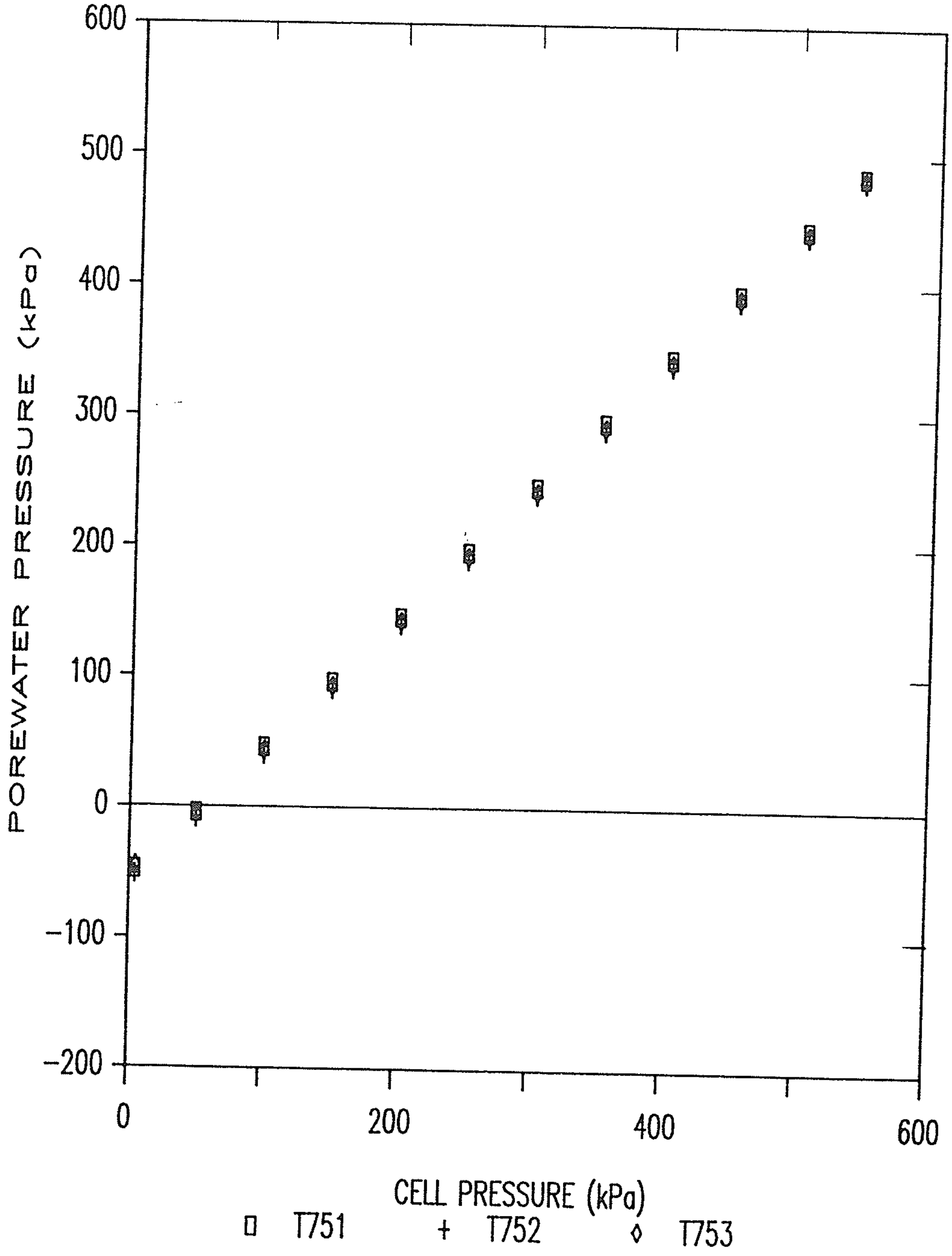


FIGURE 5.15 POREWATER PRESSURE BEHAVIOUR DURING ISOTROPIC UNLOADING OVERCONSOLIDATED SAMPLES T751, T752, T753

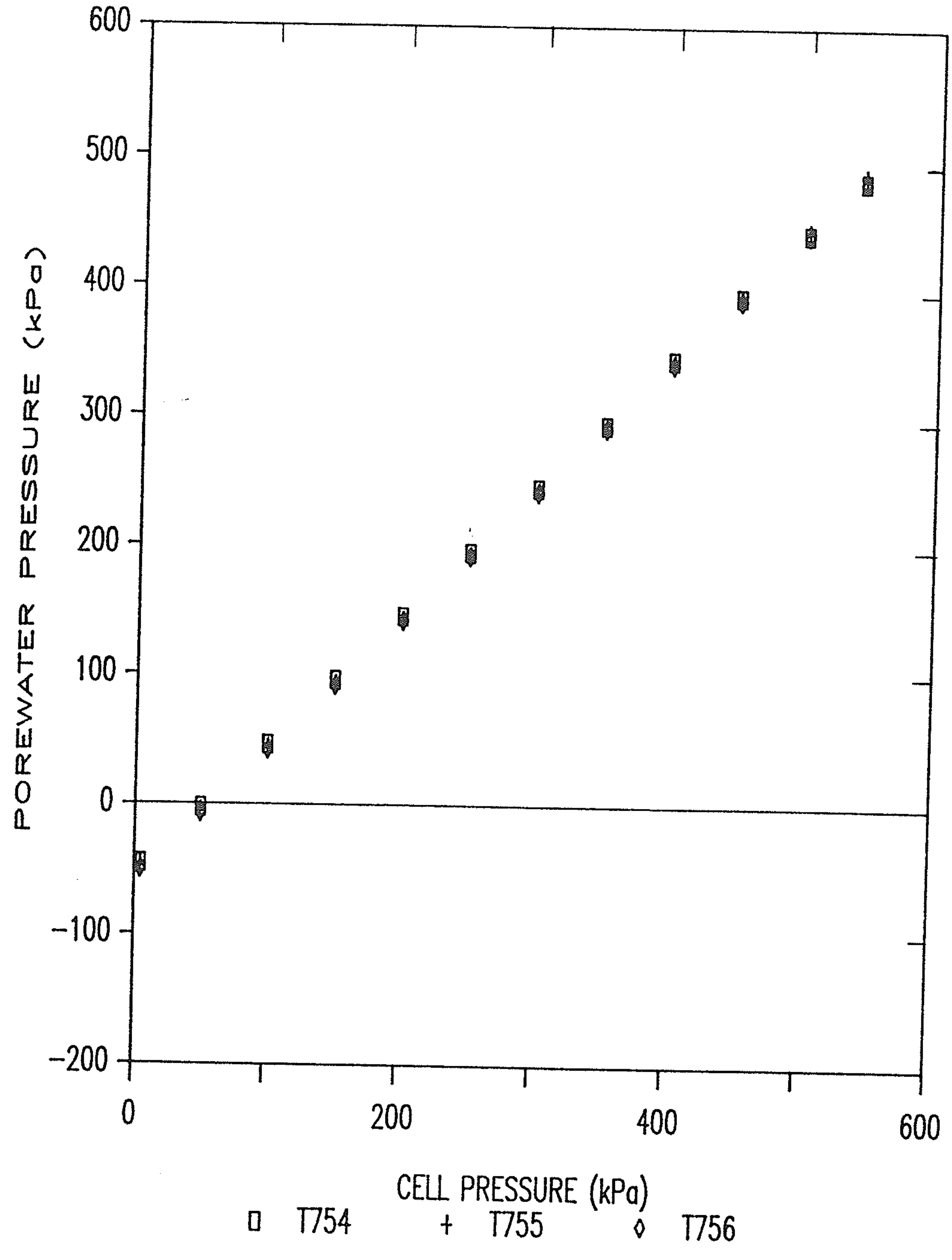


FIGURE 5.16 POREWATER PRESSURE BEHAVIOUR DURING ISOTROPIC UNLOADING OVERCONSOLIDATED SAMPLES T754, T755, T756

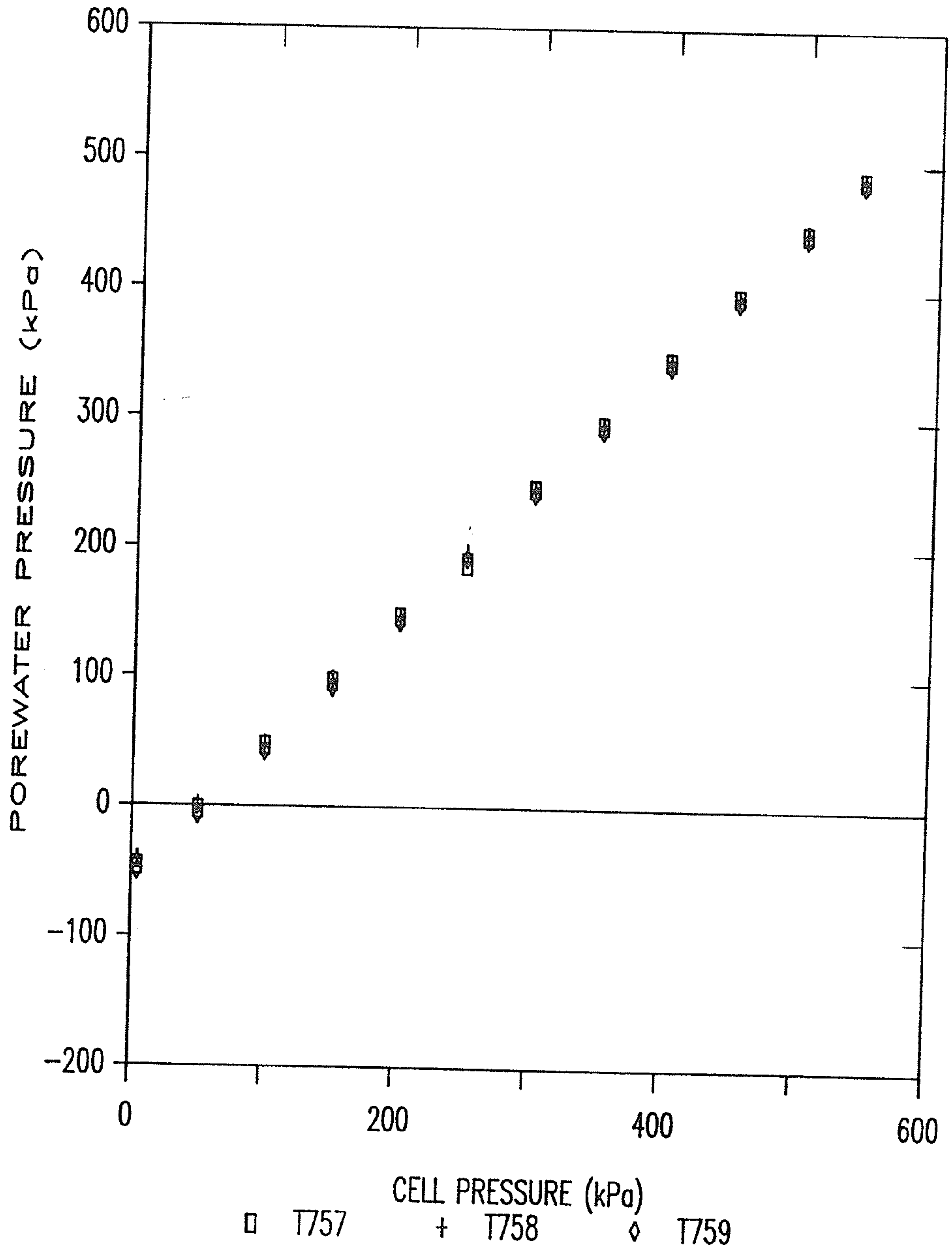


FIGURE 5.17 POREWATER PRESSURE BEHAVIOUR DURING ISOTROPIC UNLOADING OVERCONSOLIDATED SAMPLES T757, T758, T759

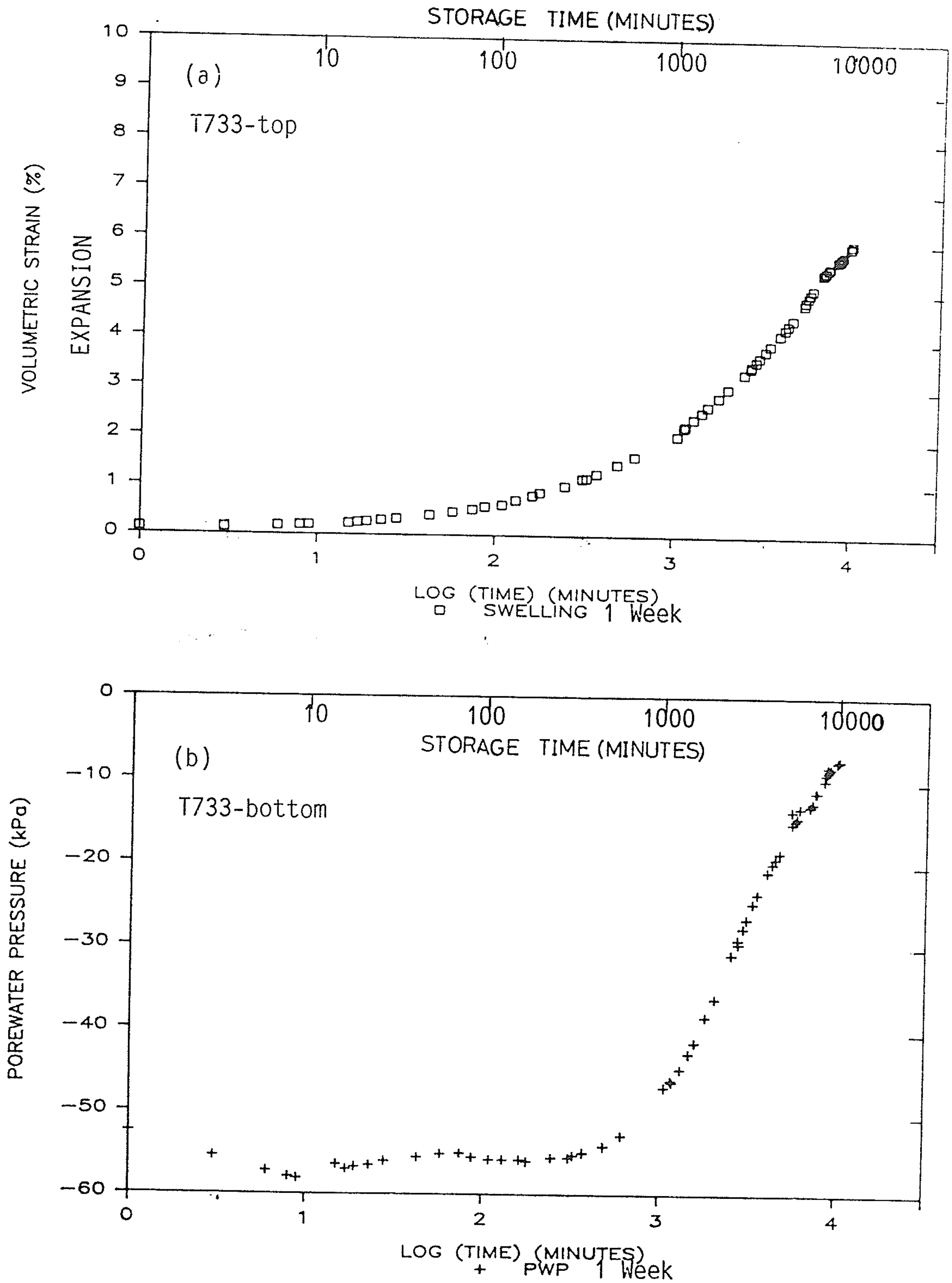


FIGURE 5.18 a,b SWELLING AND POREWATER PRESSURE BEHAVIOUR DURING STORAGE T733

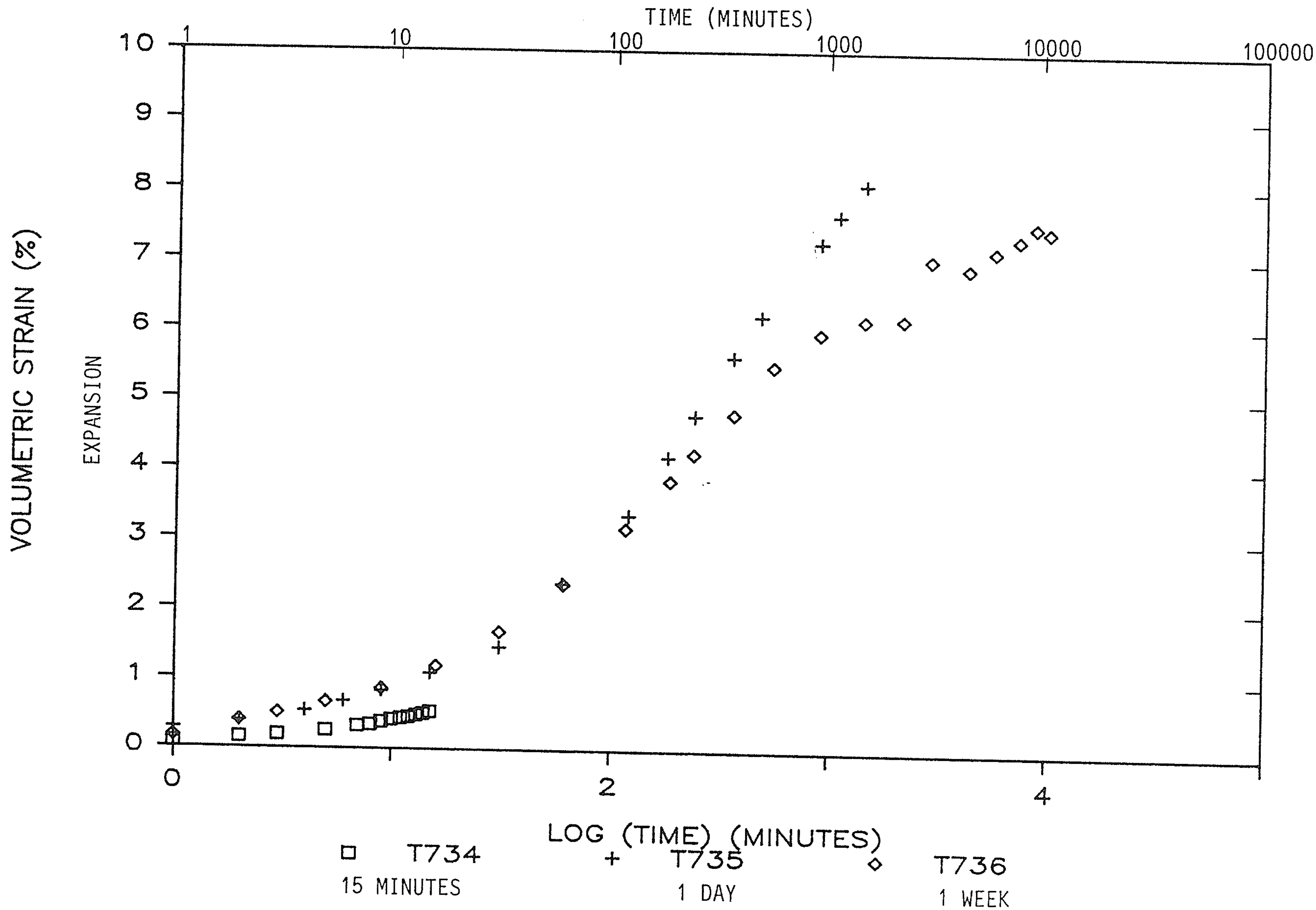


FIGURE 5.19 SWELLING BEHAVIOUR DURING STORAGE
NORMALLY CONSOLIDATED SAMPLES T734, T735, T736

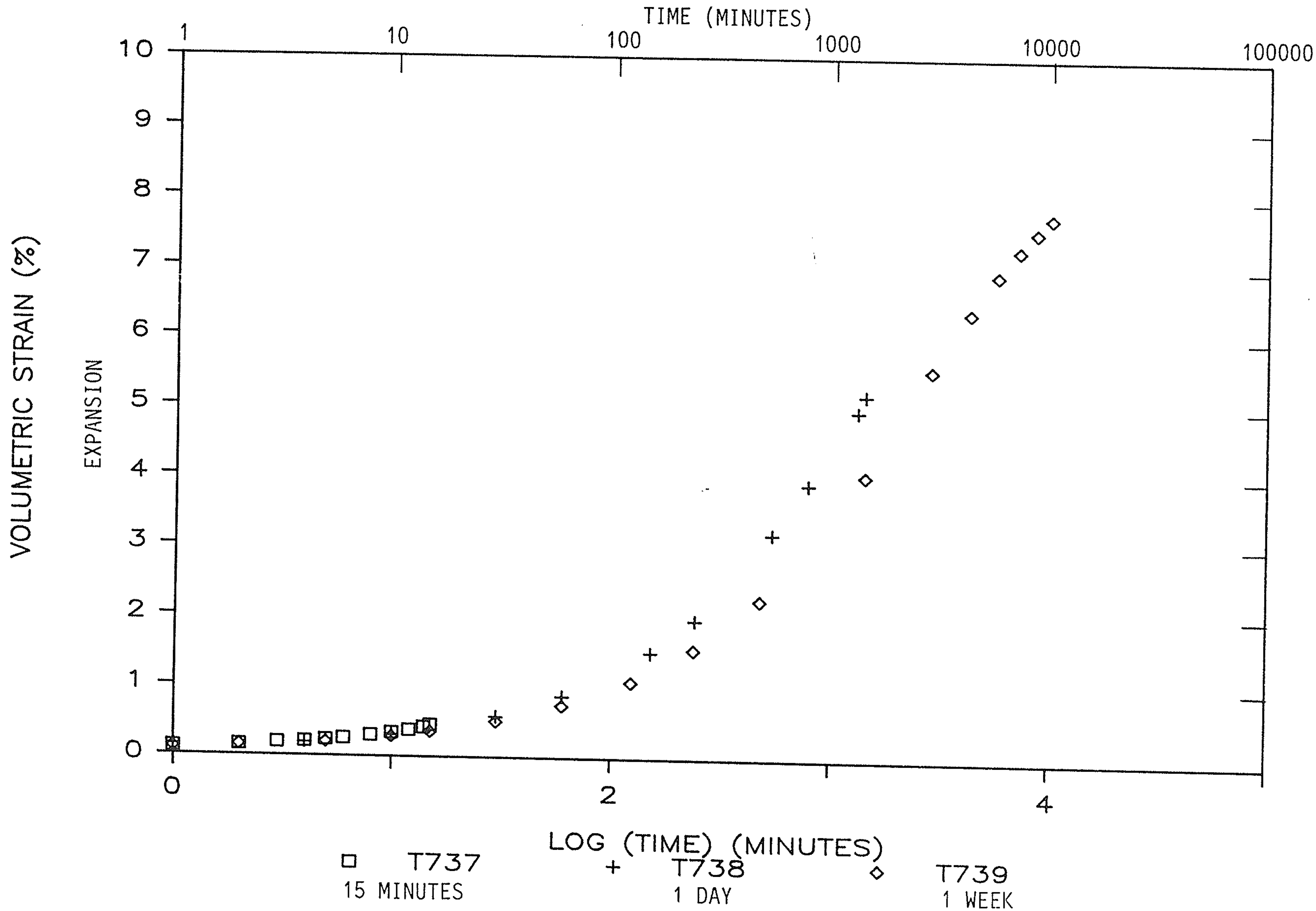


FIGURE 5.20 SWELLING BEHAVIOUR DURING STORAGE
NORMALLY CONSOLDATED SAMPLES T737, T738, T739

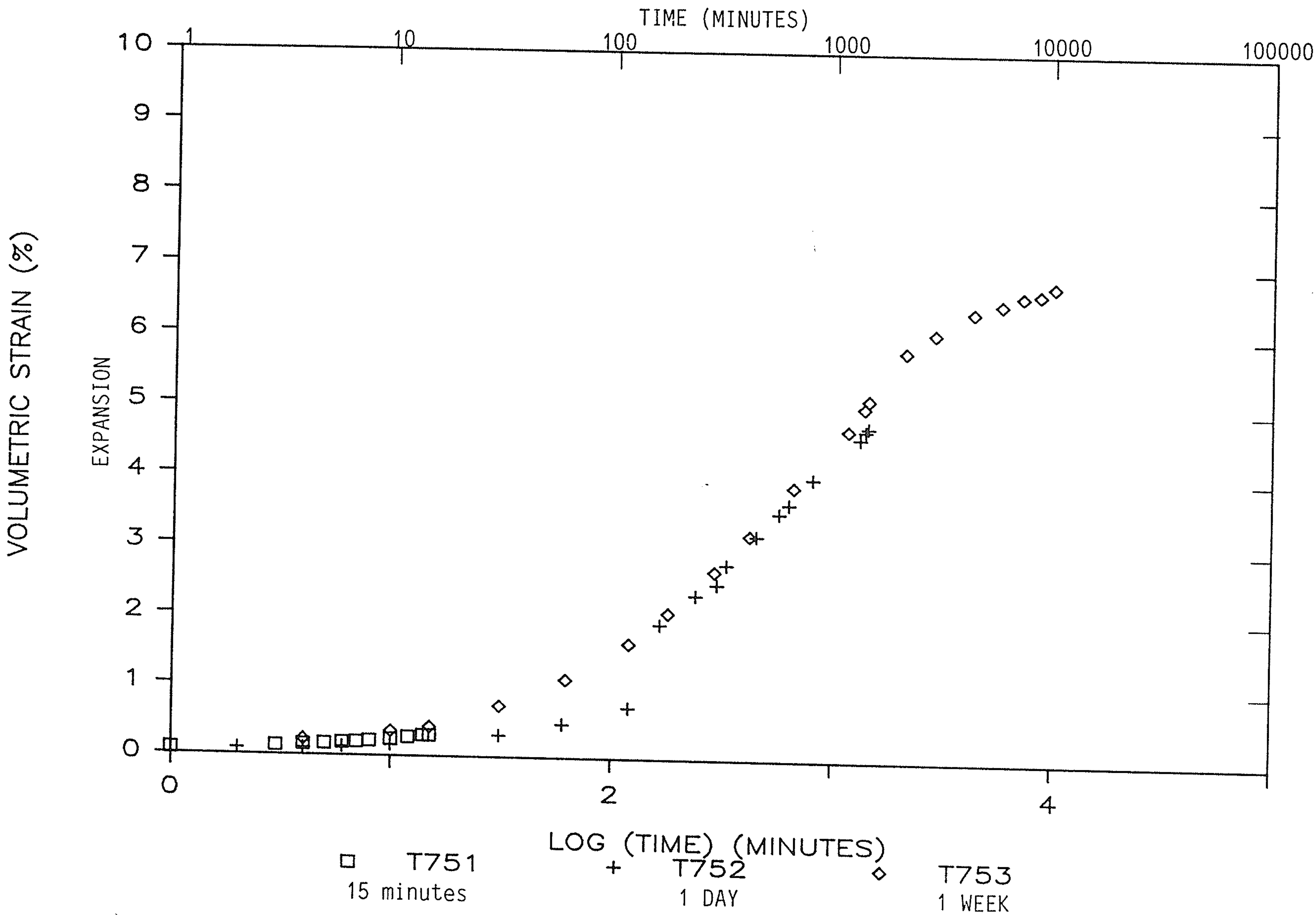


FIGURE 5.21 SWELLING BEHAVIOUR DURING STORAGE
OVERCONSOLIDATED SAMPLES T751, T752, T753

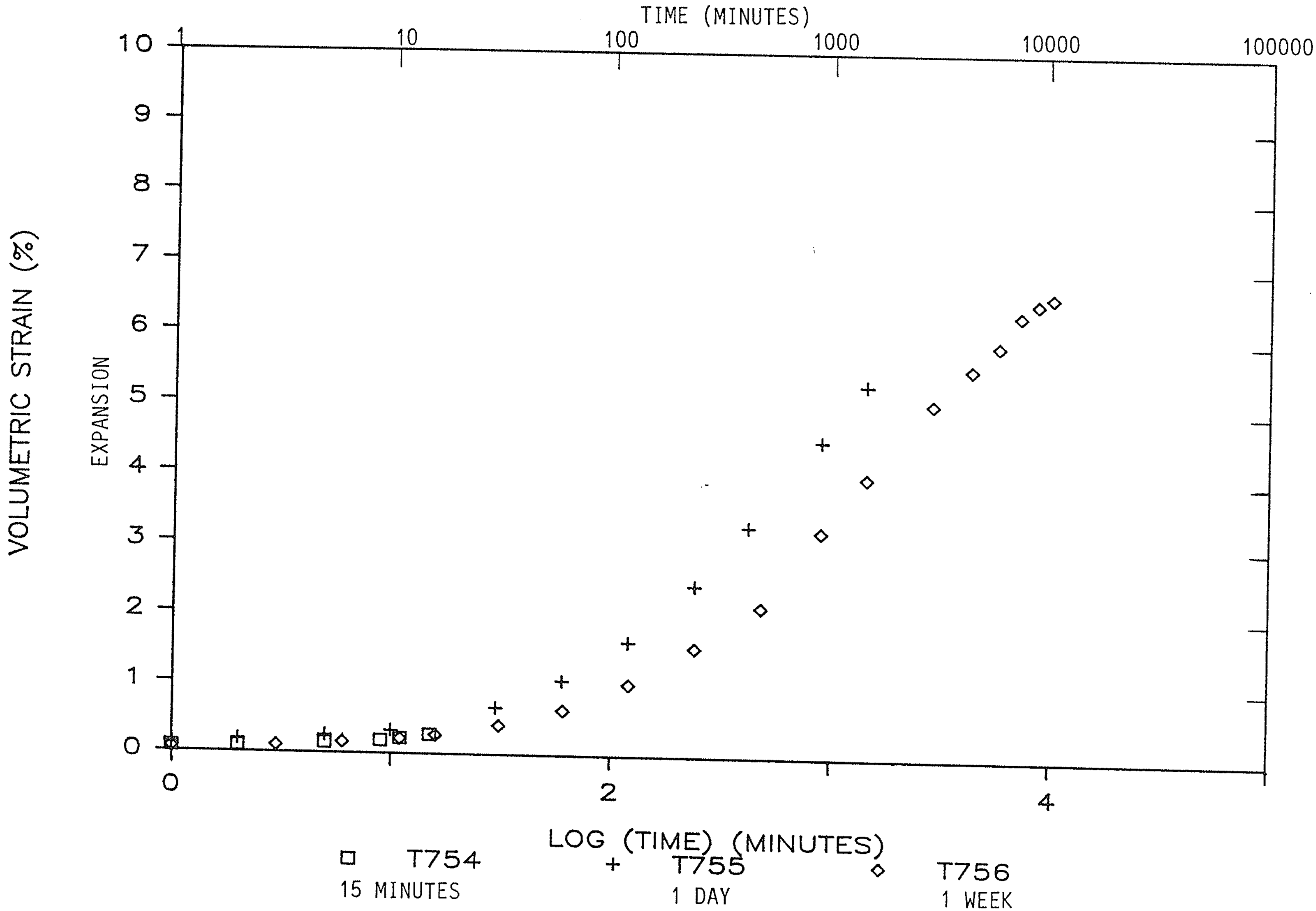


FIGURE 5.22 SWELLING BEHAVIOUR DURING STORAGE
OVERCONSOLIDATED SAMPLES T754, T755, T756

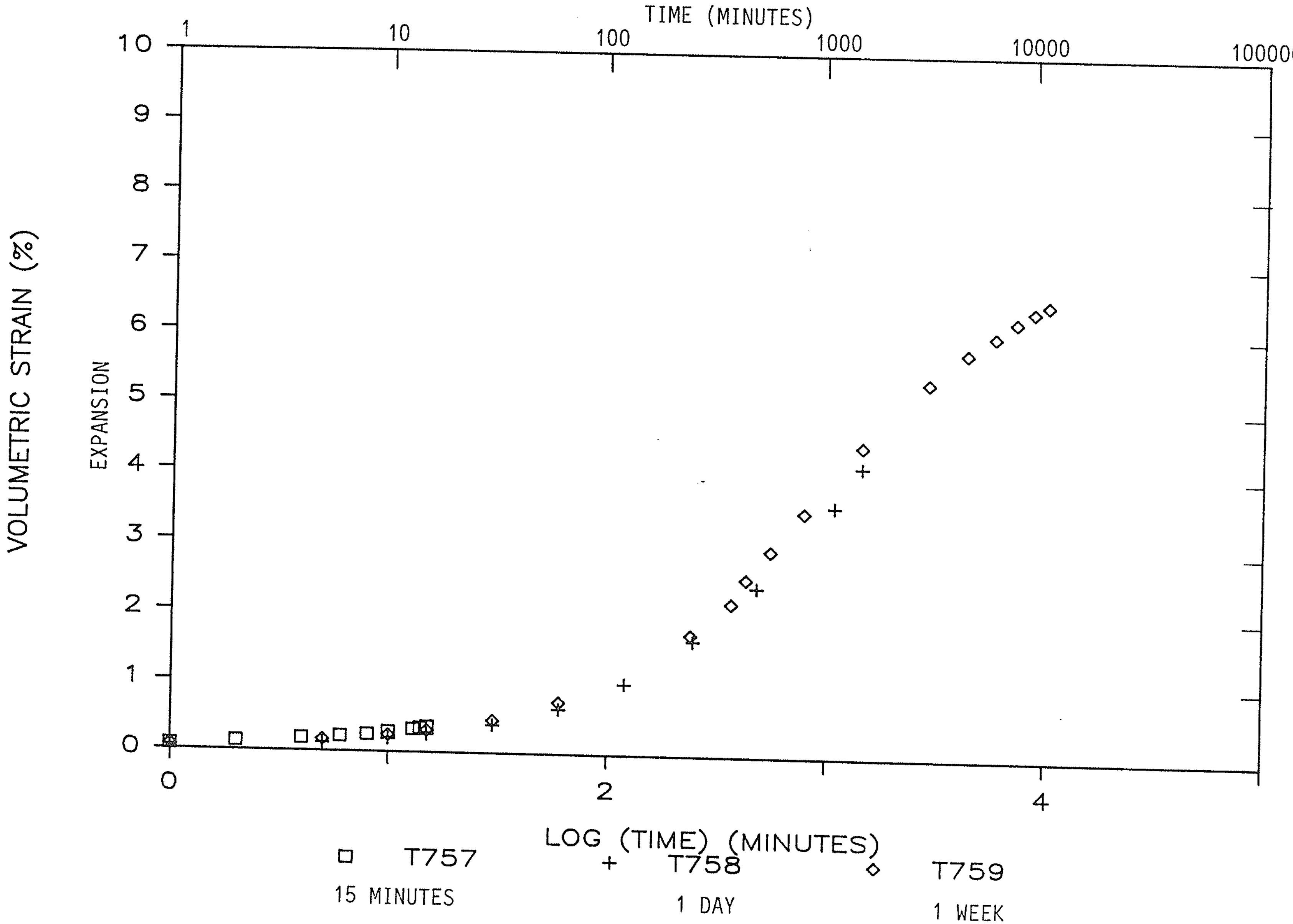


FIGURE 5.23 SWELLING BEHAVIOUR DURING STORAGE
OVERCONSOLIDATED SAMPLES T757,T758, T759

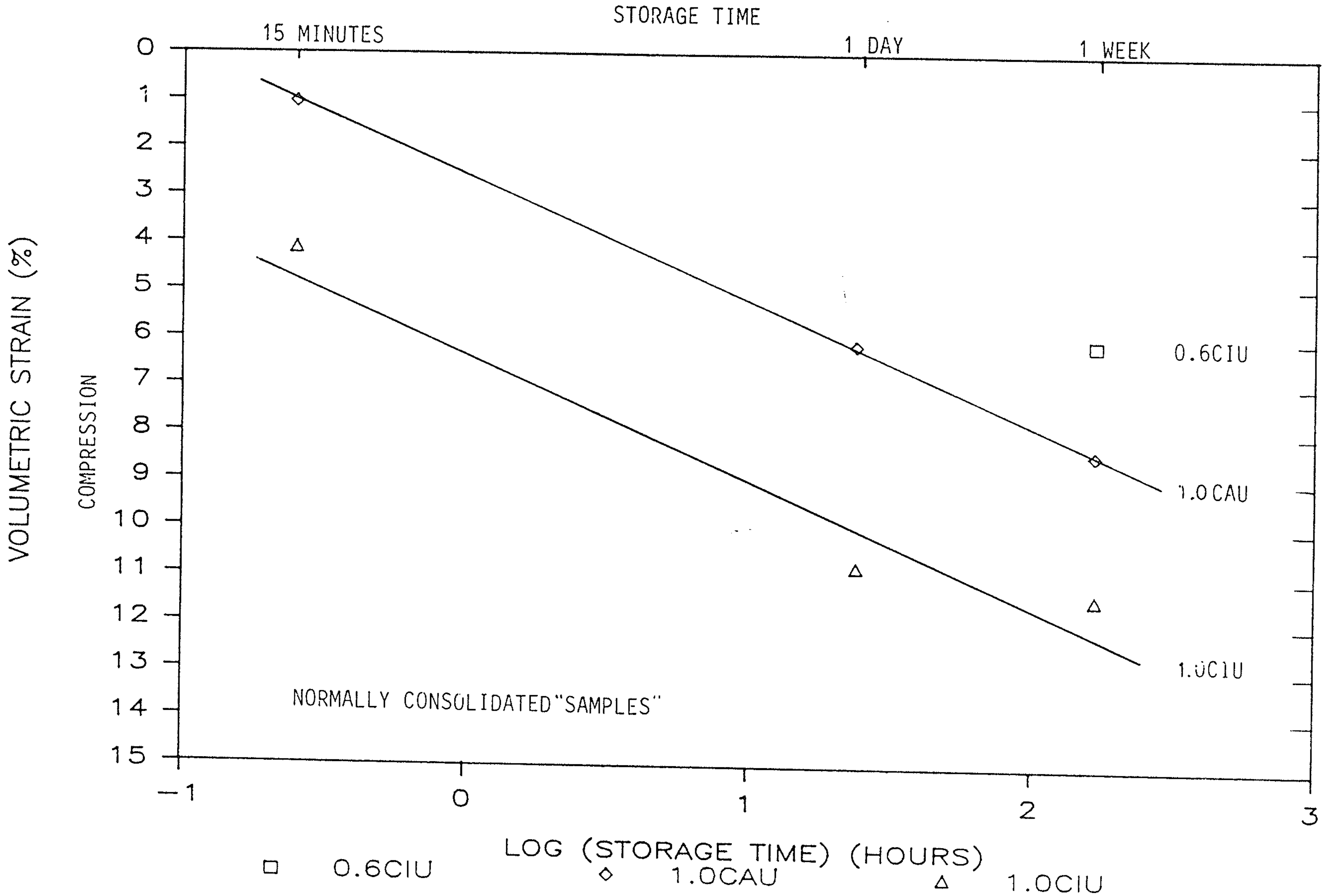


FIGURE 5.24 VOLUMETRIC RECONSOLIDATION STRAIN VS. STORAGE TIME
NORMALLY CONSOLIDATED"SAMPLES"

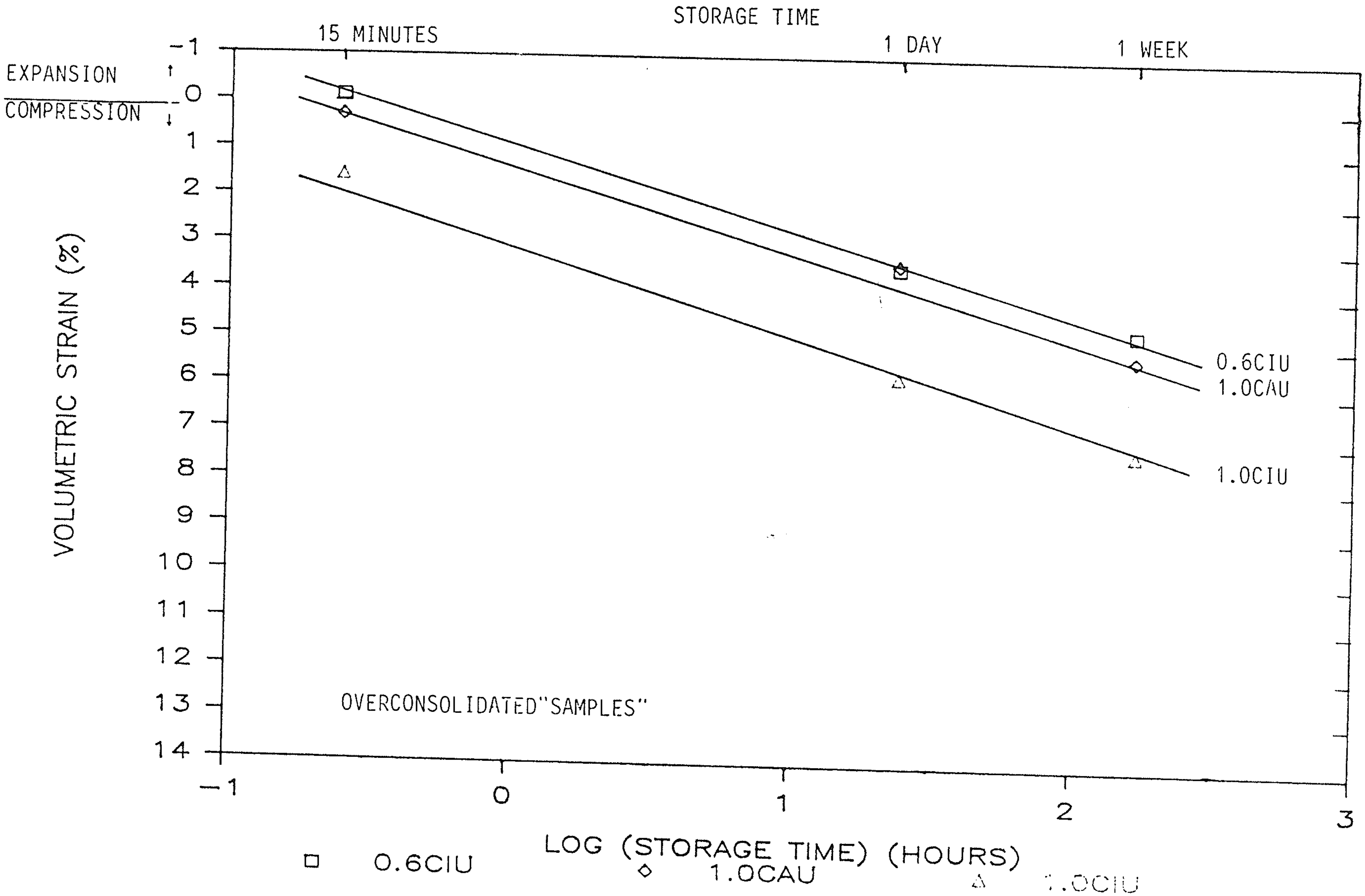


FIGURE 5.25 VOLUMETRIC RECONSOLIDATION STRAIN VS. STORAGE TIME
OVERCONSOLIDATED"SAMPLES"

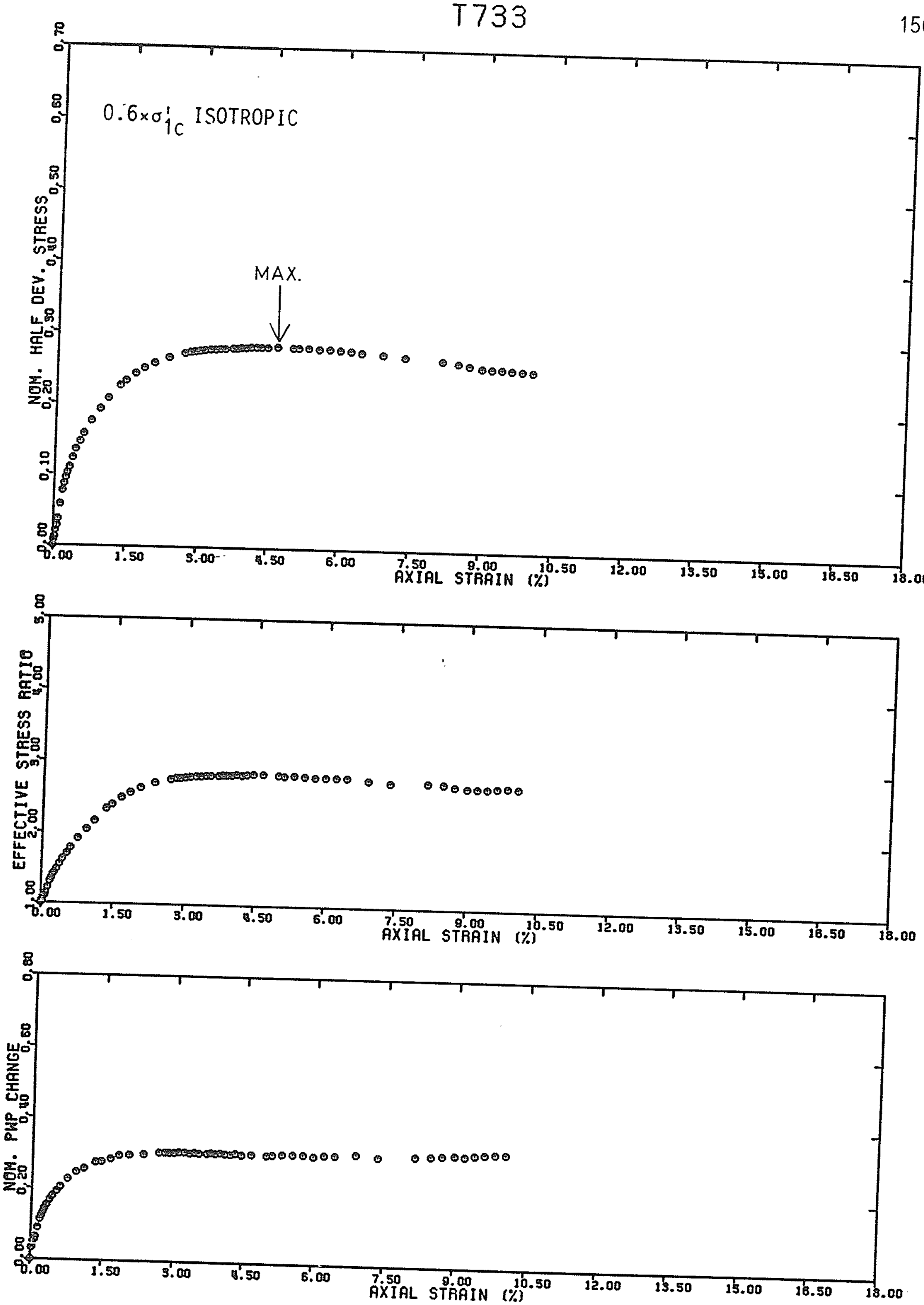


FIGURE 6.1 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T733

T736

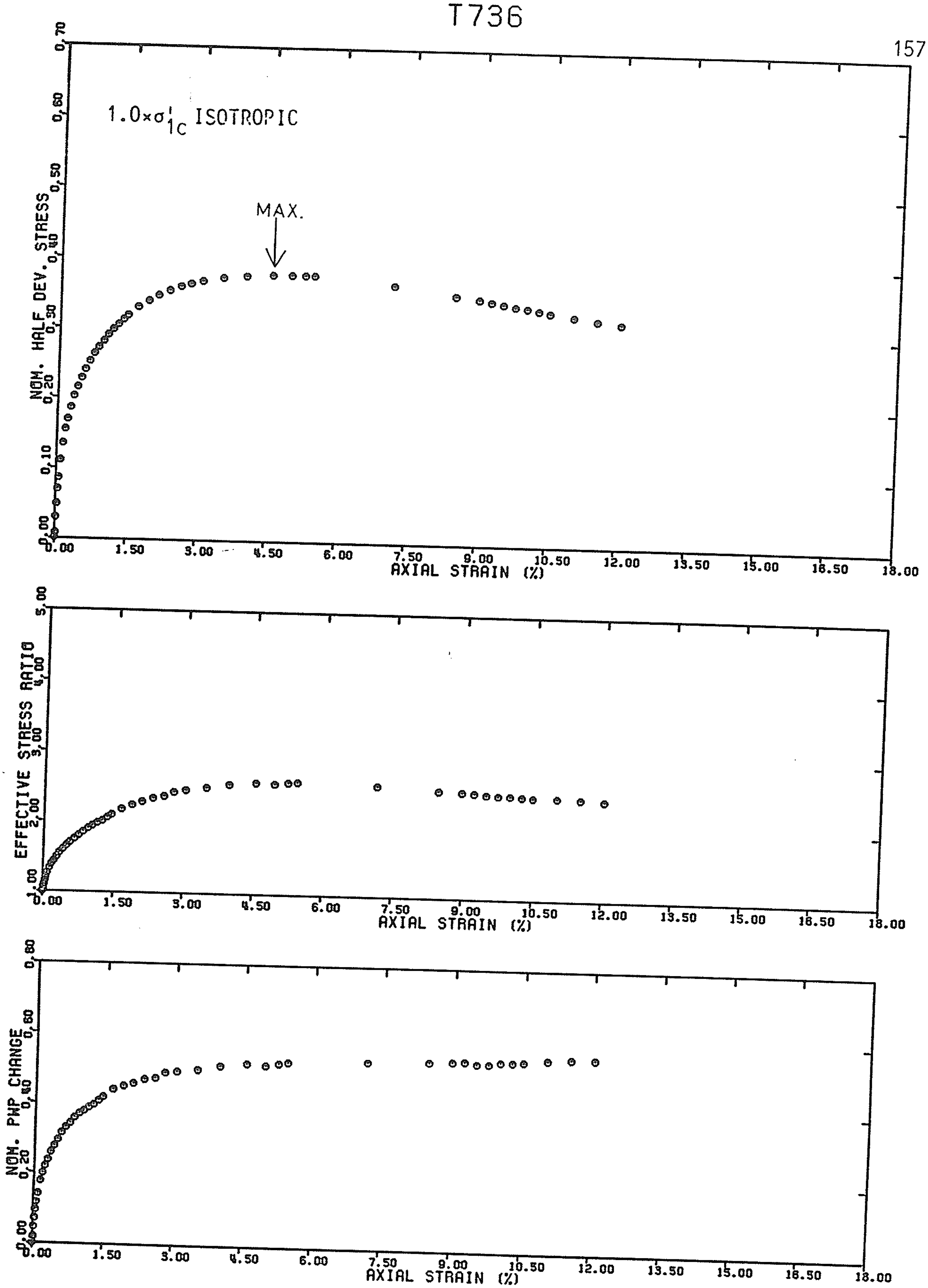
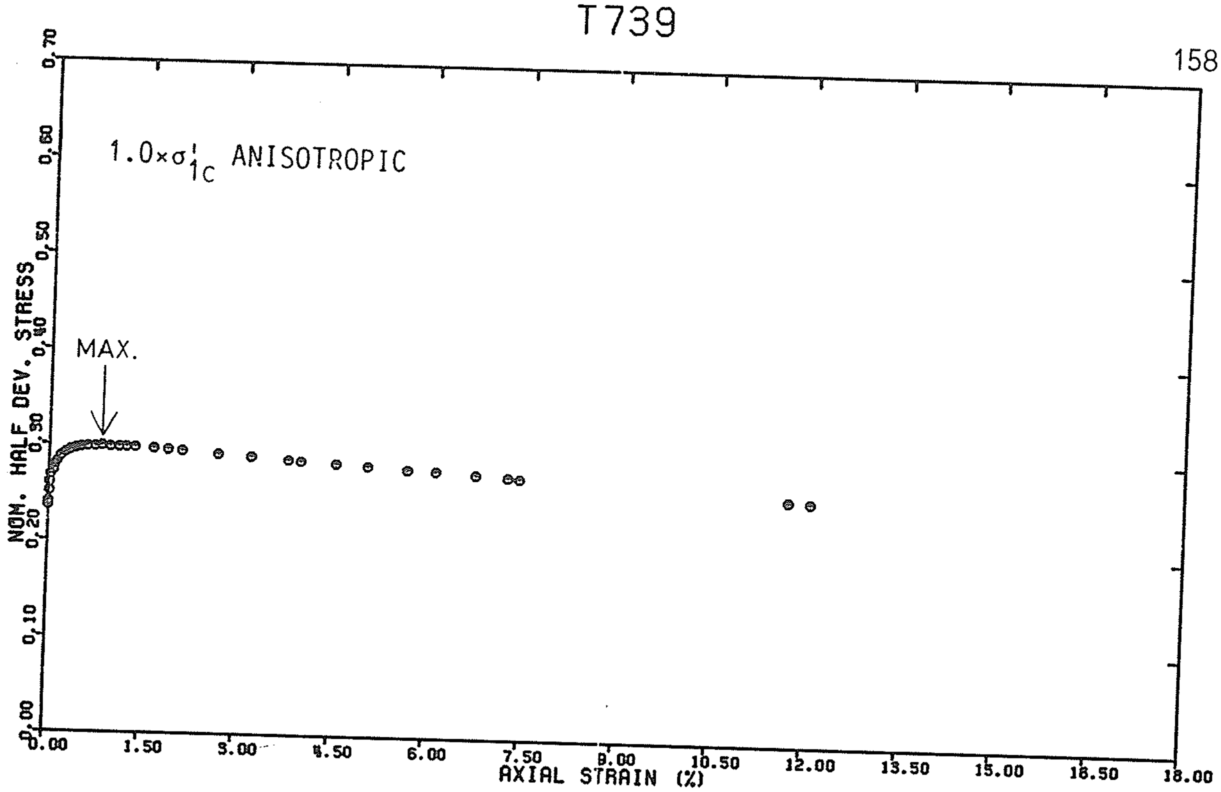
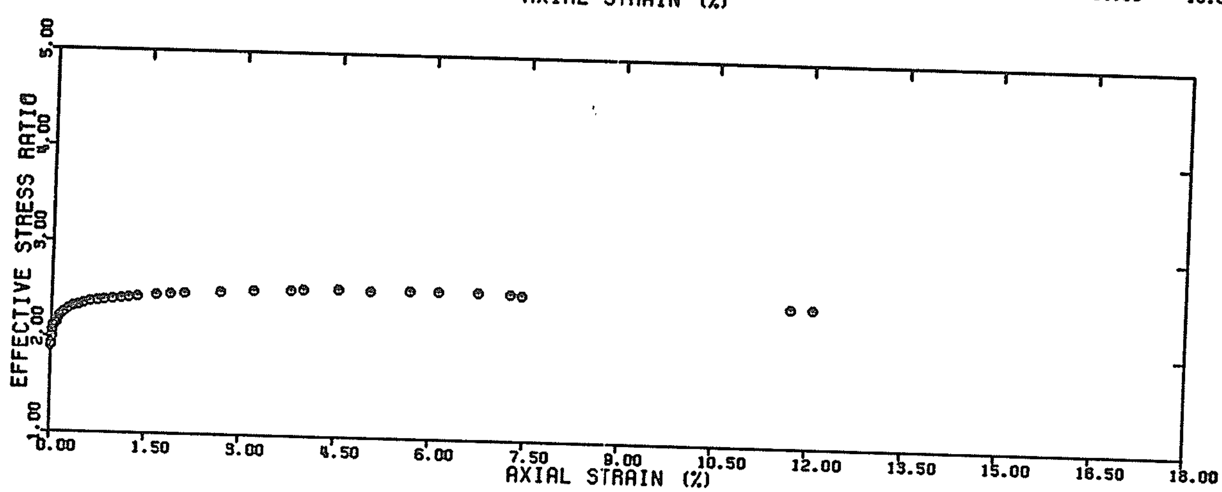


FIGURE 6.2 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T736





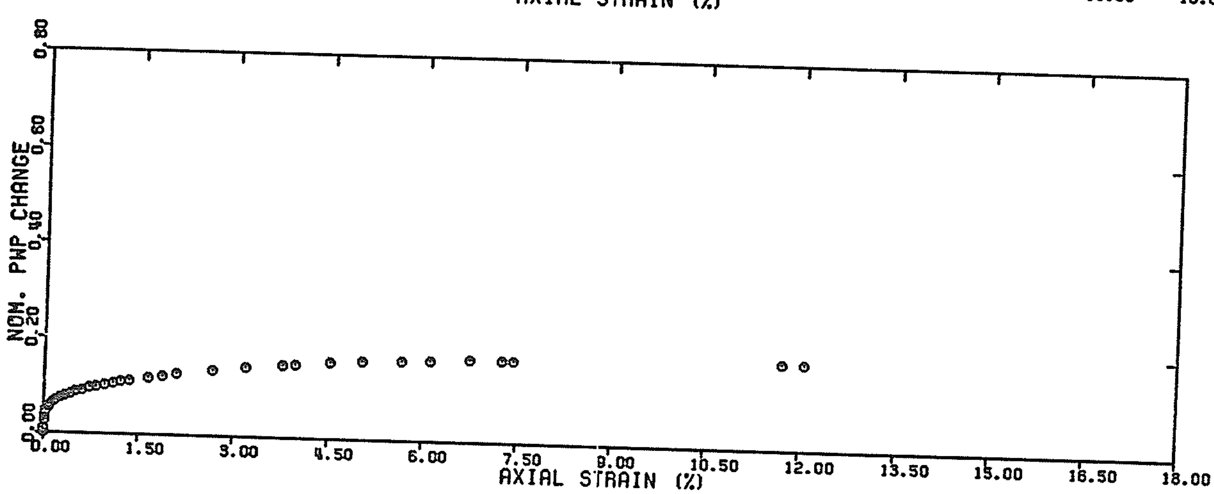


FIGURE 6.3 UNDRAINED STRESS-STRAIN POREWATER RESULTS
NORMALLY CONSOLIDATED SAMPLE T739

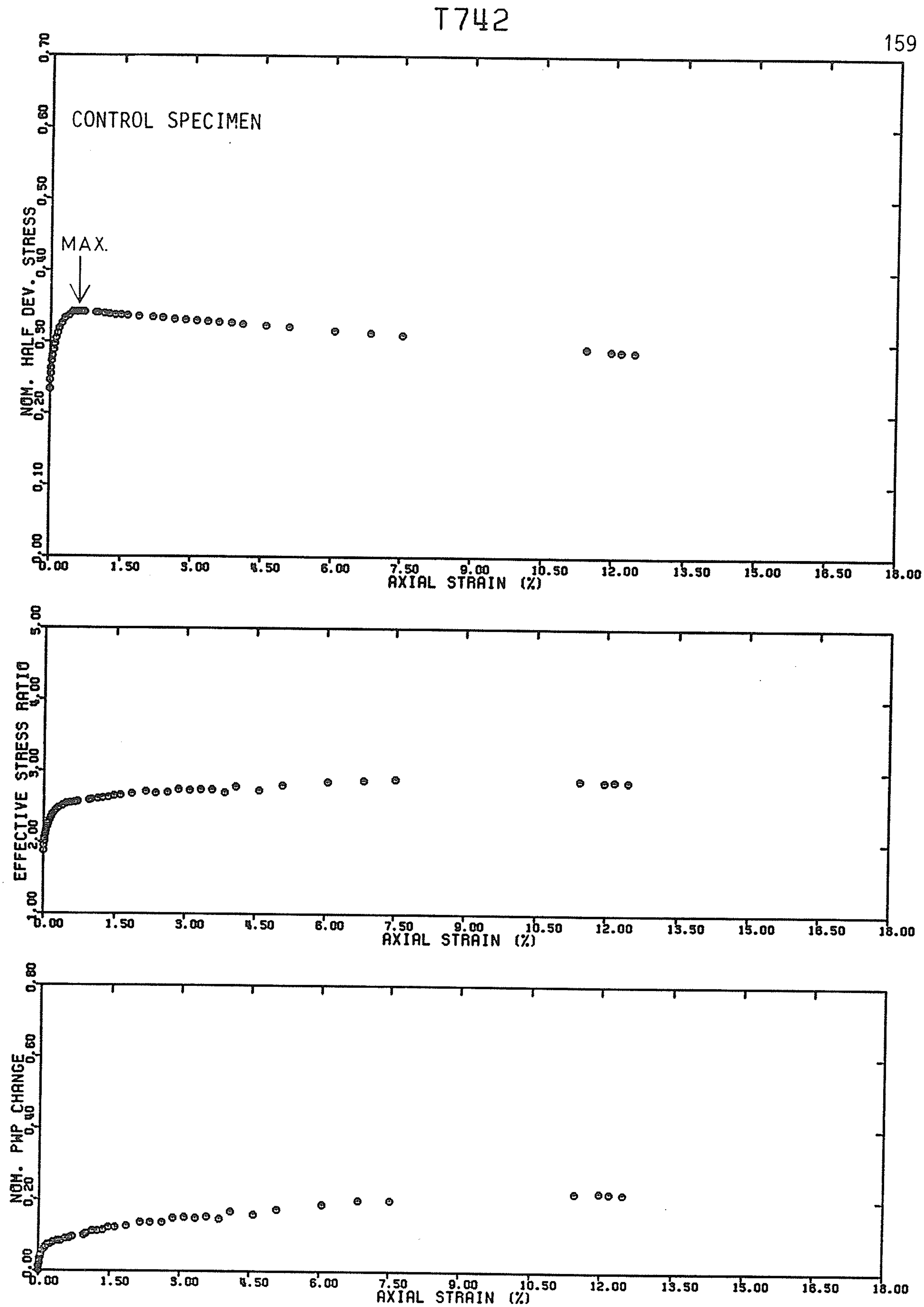


FIGURE 6.4 UNDRAINED STRESS-STRAIN POREWATER RESULTS
NORMALLY CONSOLIDATED SAMPLE T742

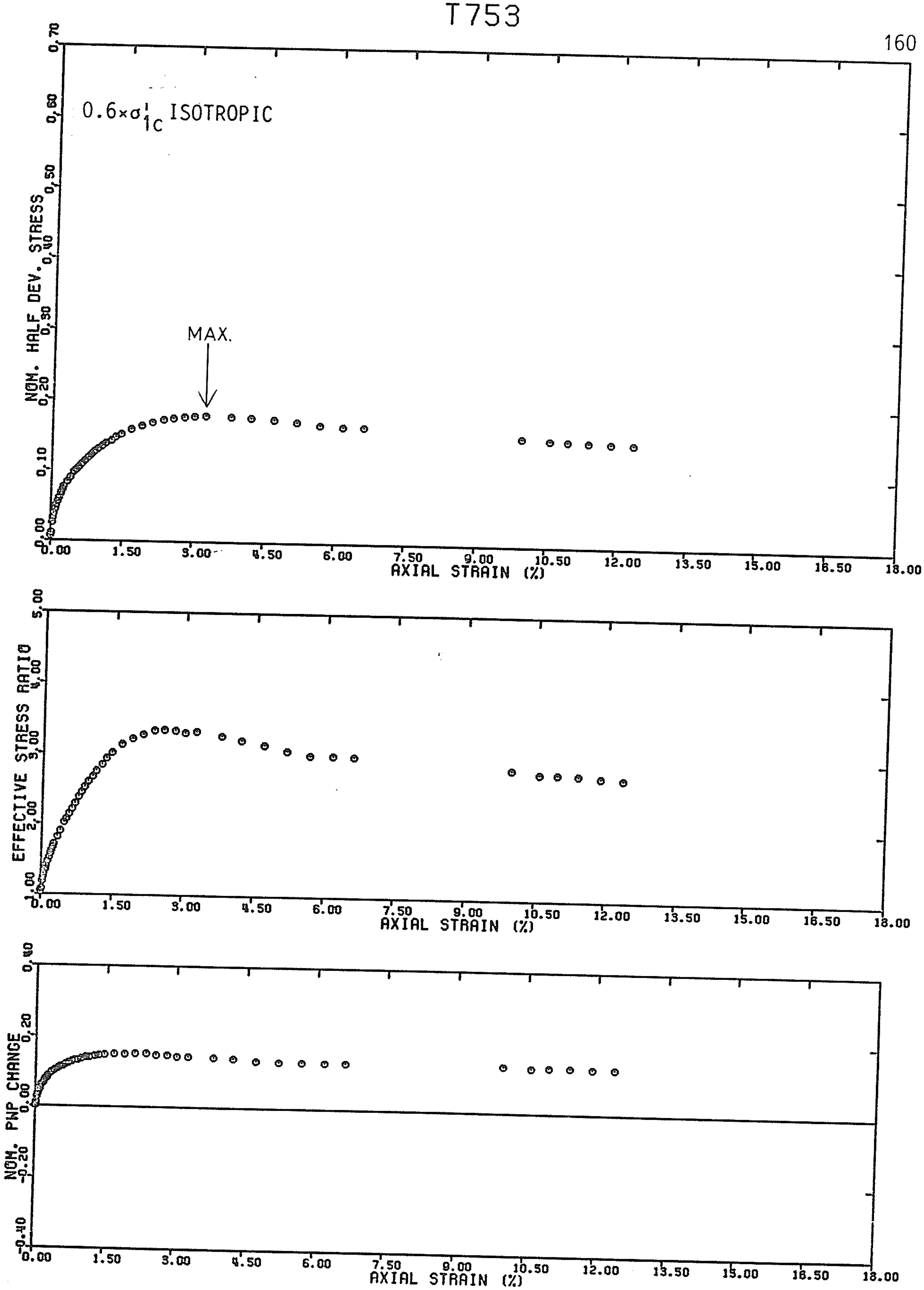


FIGURE 6.5 UNDRAINED STRESS-STRAIN POREWATER RESULTS
OVERCONSOLIDATED SAMPLE T753

T756

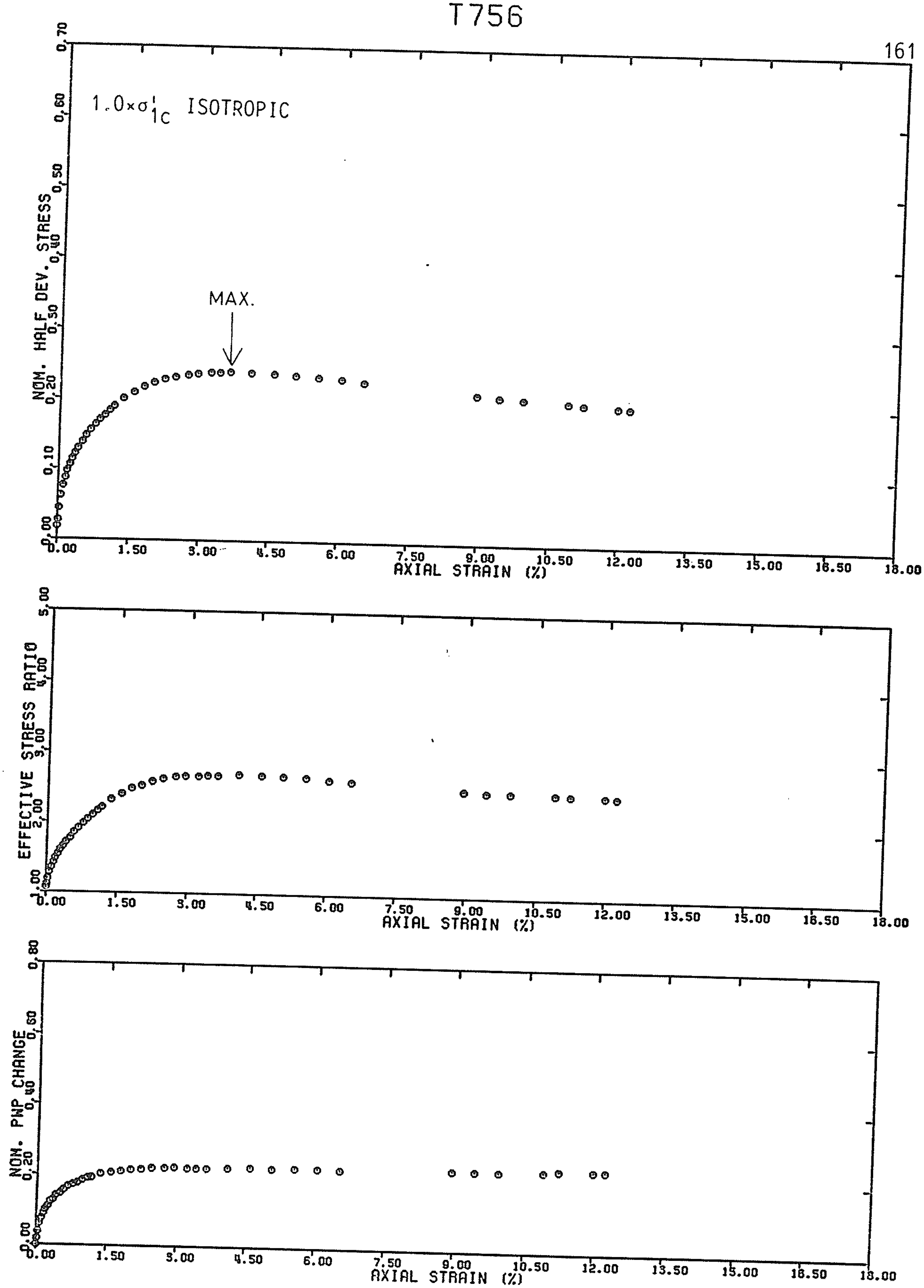


FIGURE 6.6 UNDRAINED STRESS-STRAIN POREWATER RESULTS
OVERCONSOLIDATED SAMPLE T756

T759

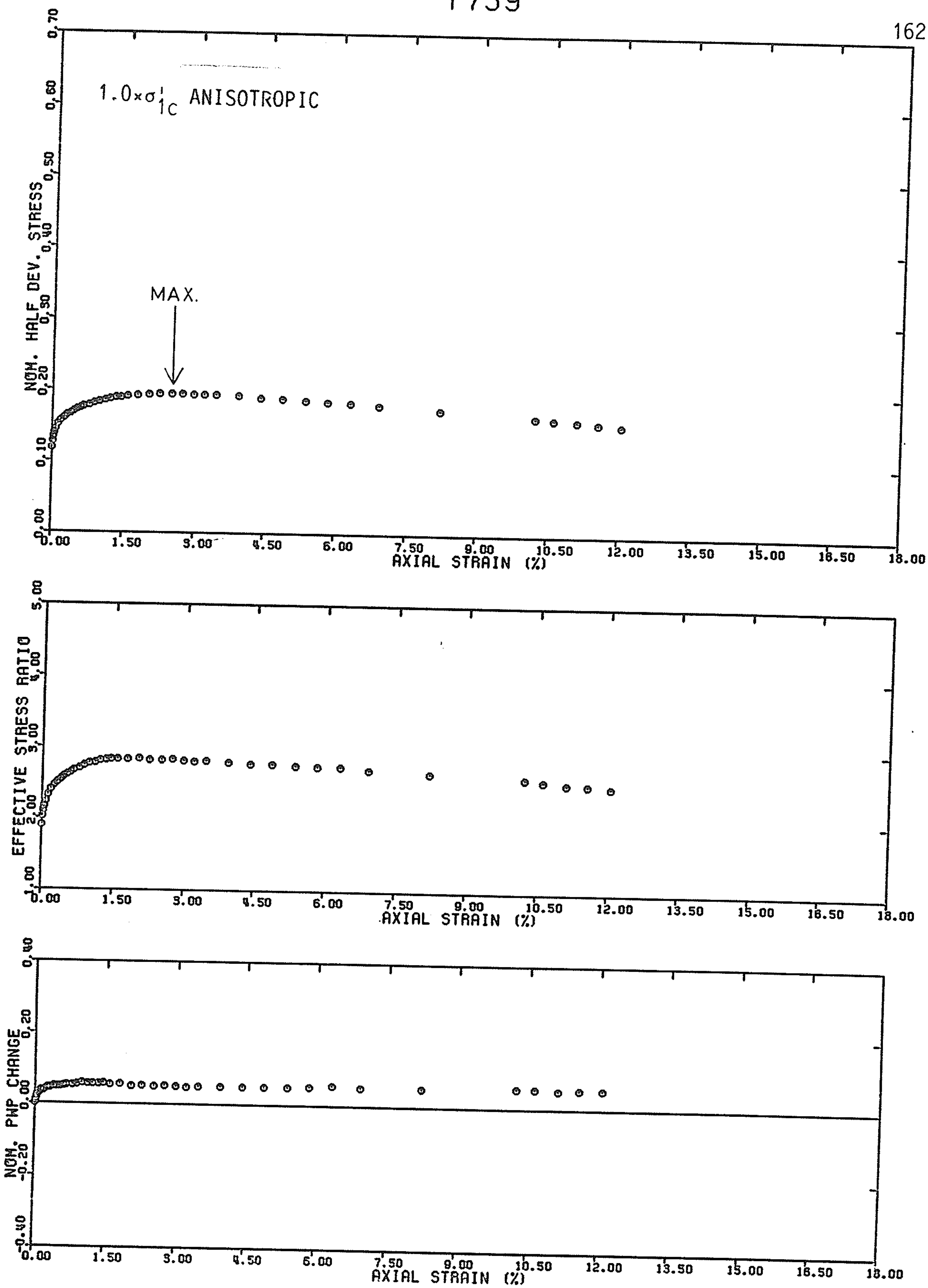


FIGURE 6.7 UNDRAINED STRESS-STRAIN POREWATER RESULTS
OVERCONSOLIDATED SAMPLE T759

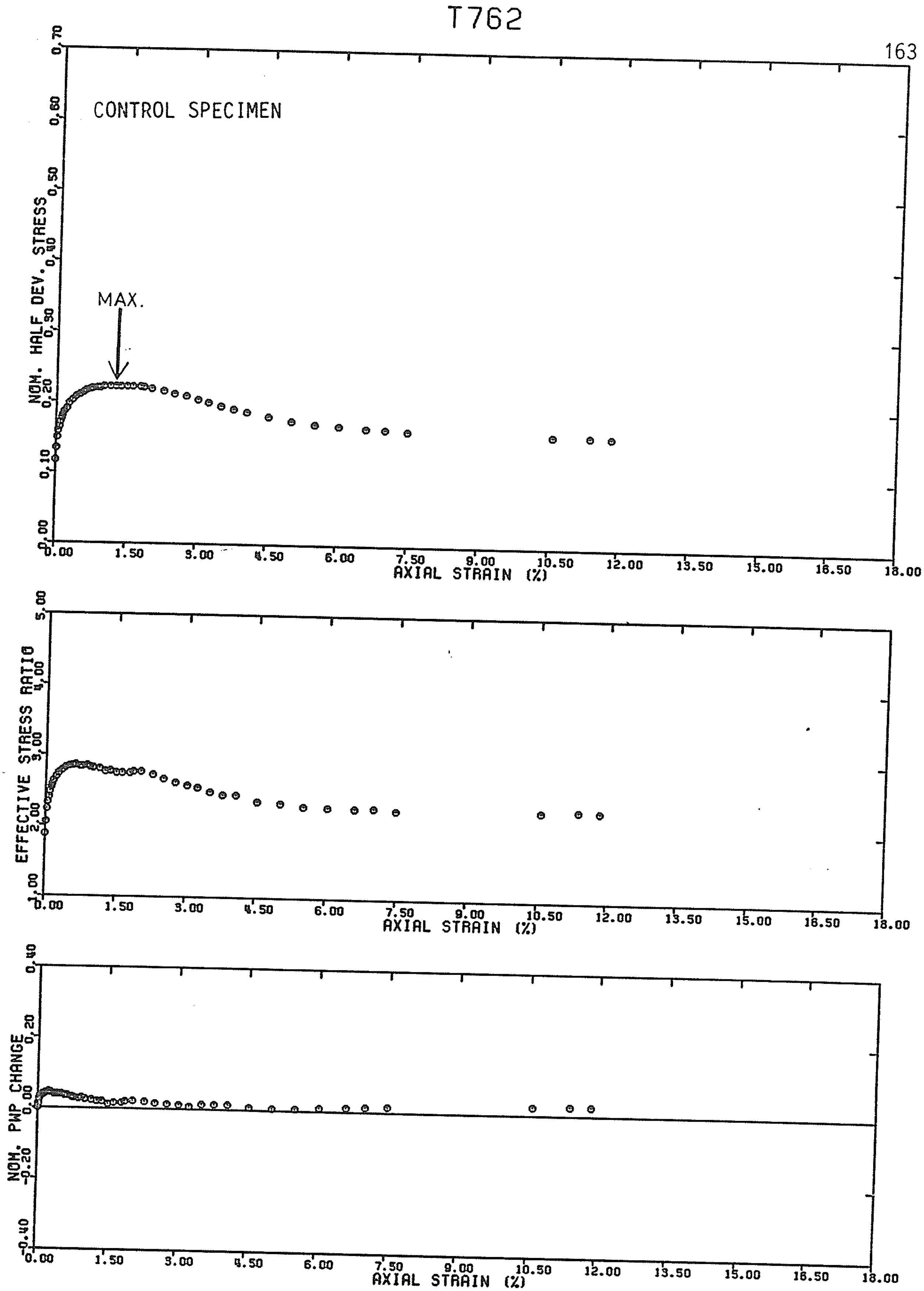


FIGURE 6.8 UNDRAINED STRESS-STRAIN POREWATER RESULTS
OVERCONSOLIDATED SAMPLE T762

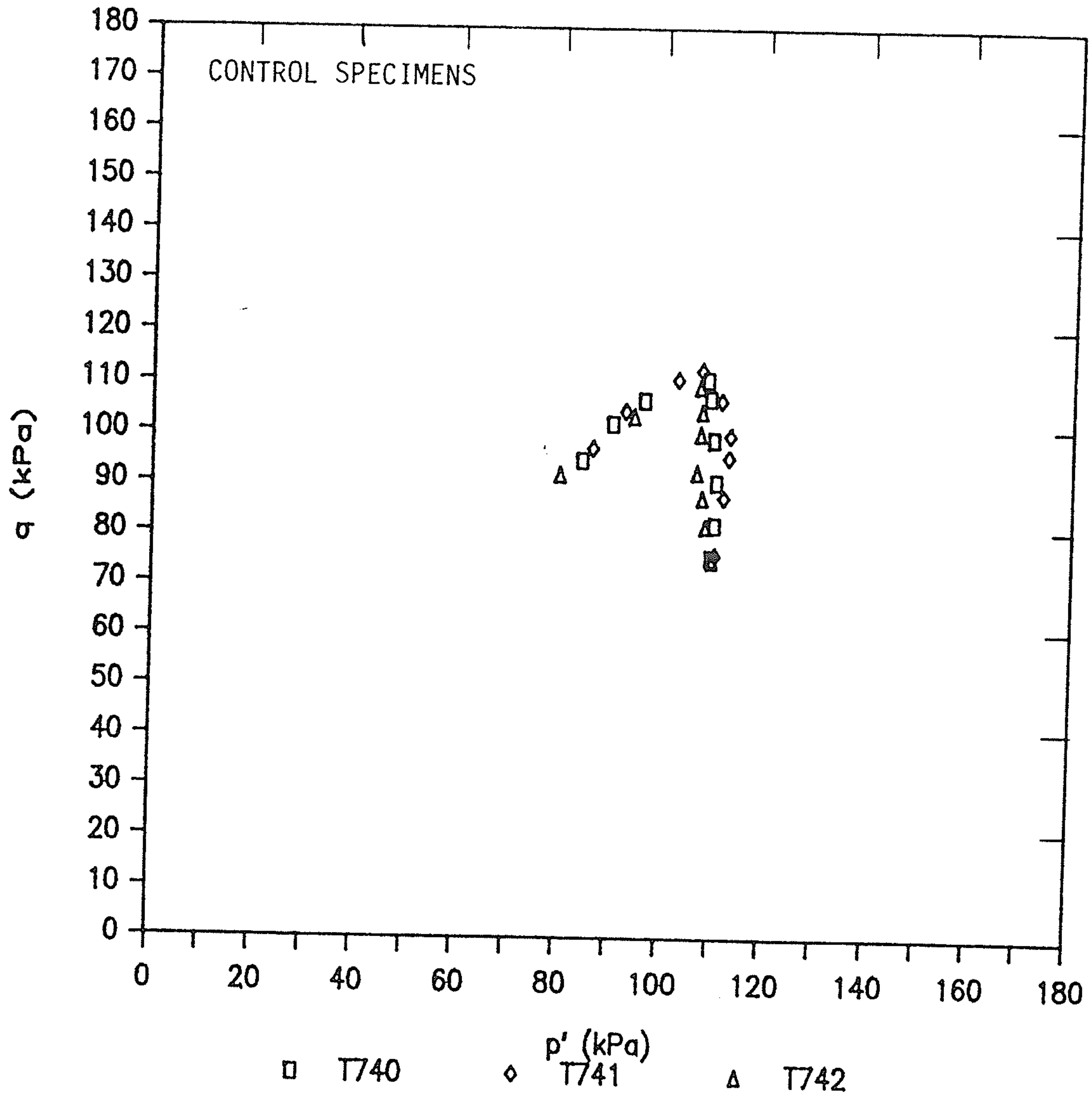


FIGURE 6.9 EFFECTIVE STRESS PATHS IN p',q-SPACE
NORMALLY CONSOLIDATED SAMPLES T740, T741, T742

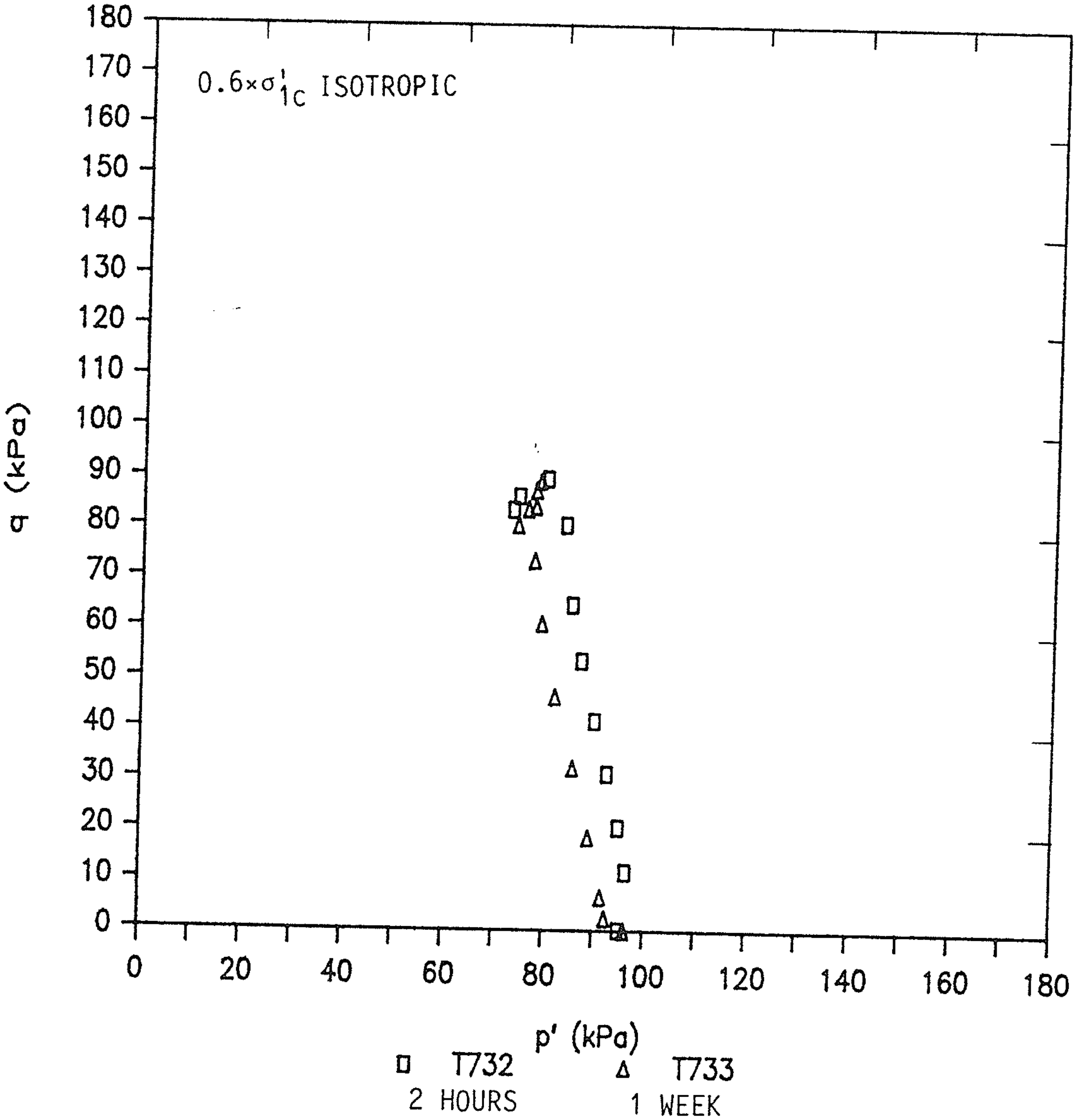


FIGURE 6.10 EFFECTIVE STRESS PATHS IN p',q-SPACE
NORMALLY CONSOLIDATED SAMPLES T732, T733

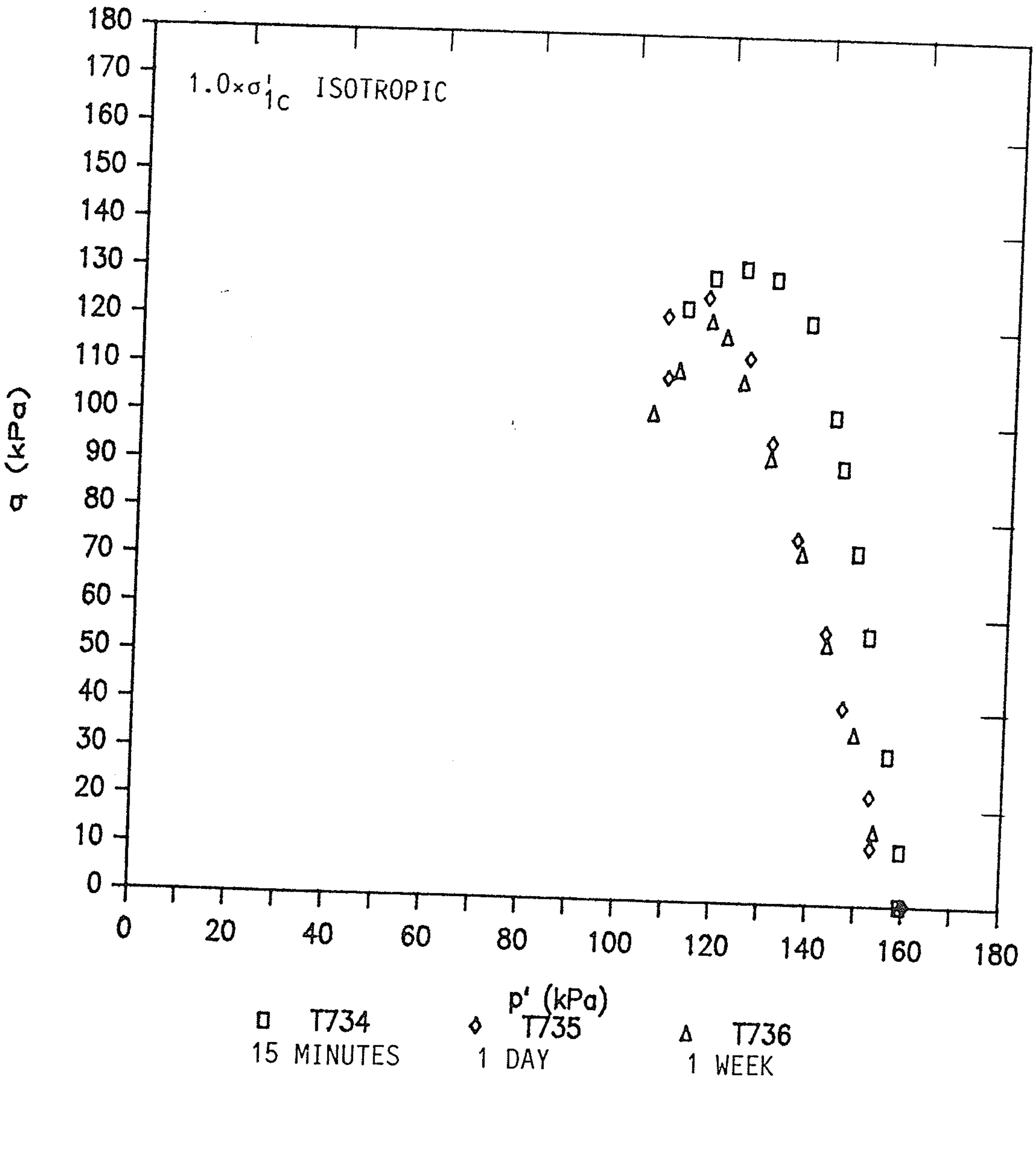


FIGURE 6.11 EFFECTIVE STRESS PATHS IN p',q-SPACE
NORMALLY CONSOLIDATED SAMPLES T734, T735, T736

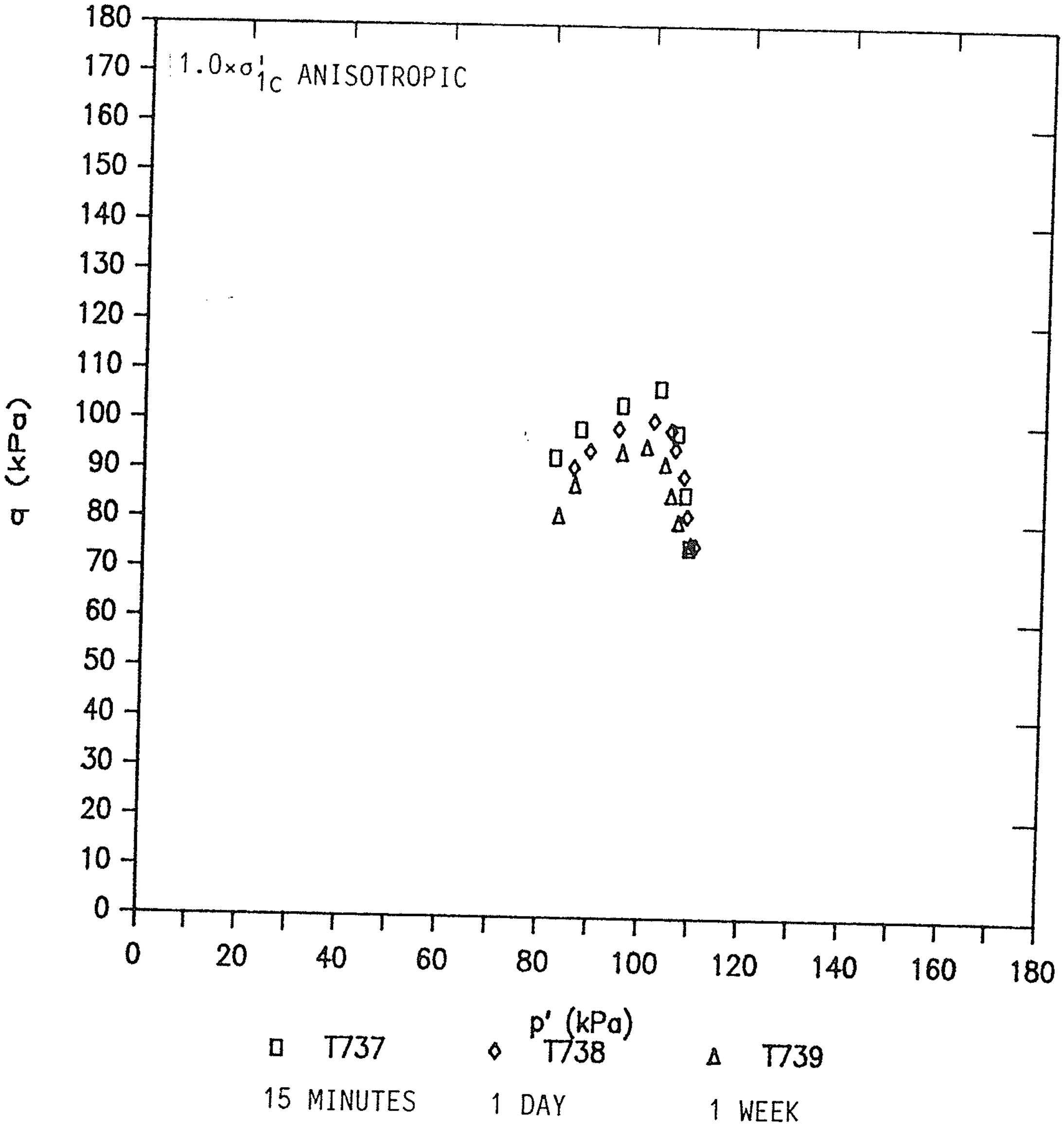


FIGURE 6.12 EFFECTIVE STRESS PATHS IN p',q-SPACE
NORMALLY CONSOLIDATED SAMPLES T737, T738, T739

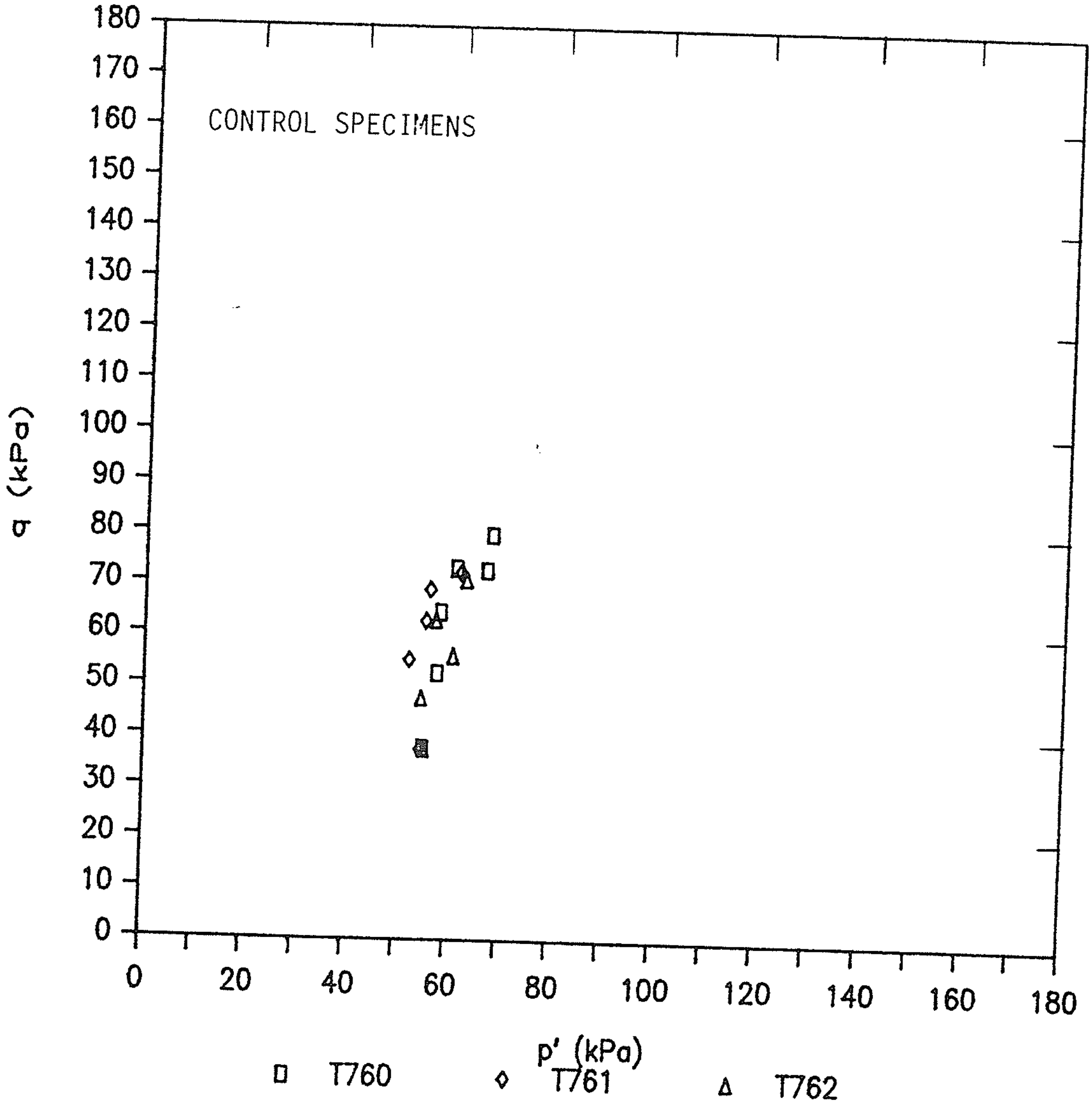


FIGURE 6.13 EFFECTIVE STRESS PATHS IN p',q-SPACE
OVERCONSOLIDATED SAMPLES T760, T761, T762

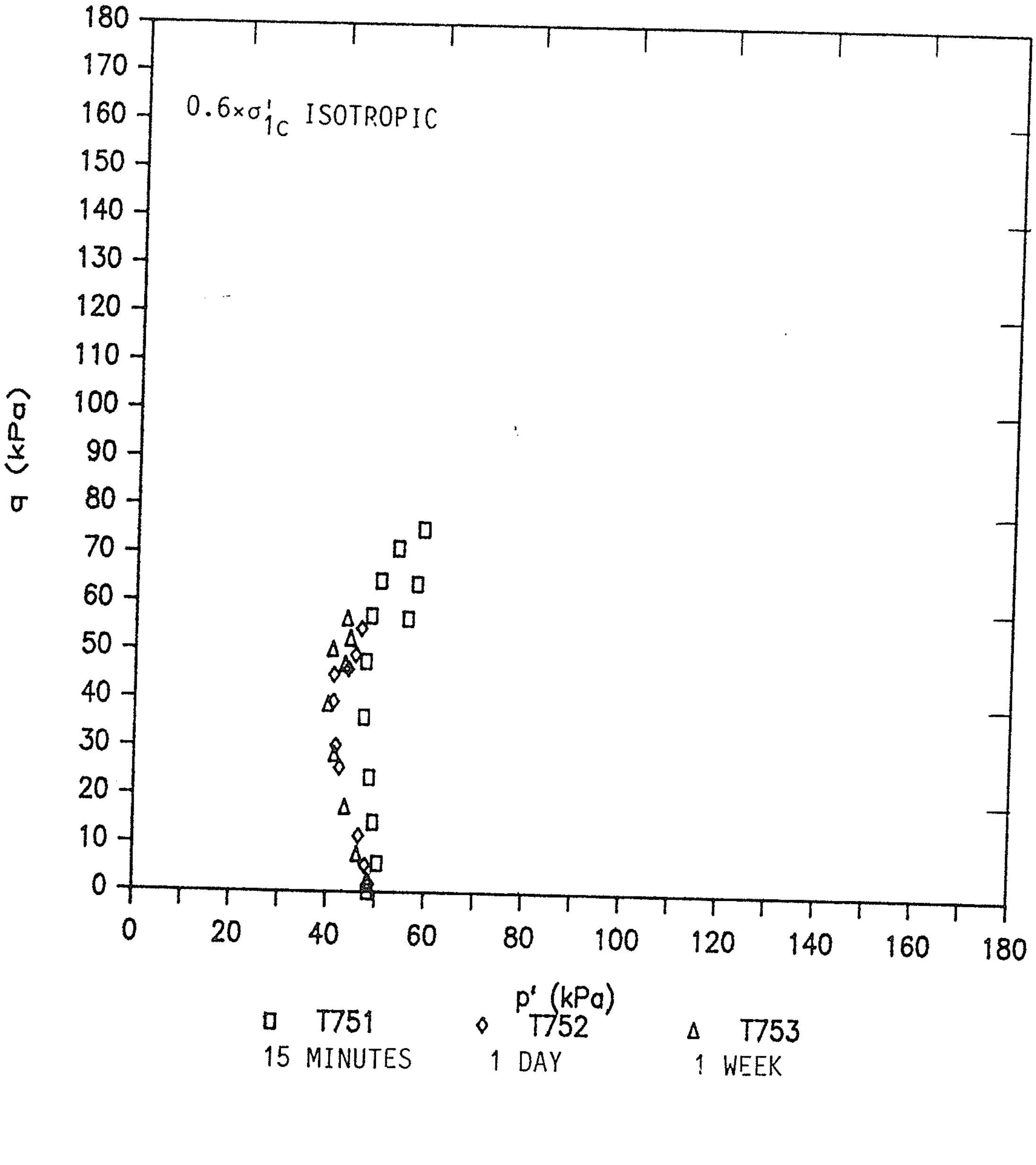


FIGURE 6.14 EFFECTIVE STRESS PATHS IN p',q-SPACE OVERCONSOLIDATED SAMPLES T751, T752, T753

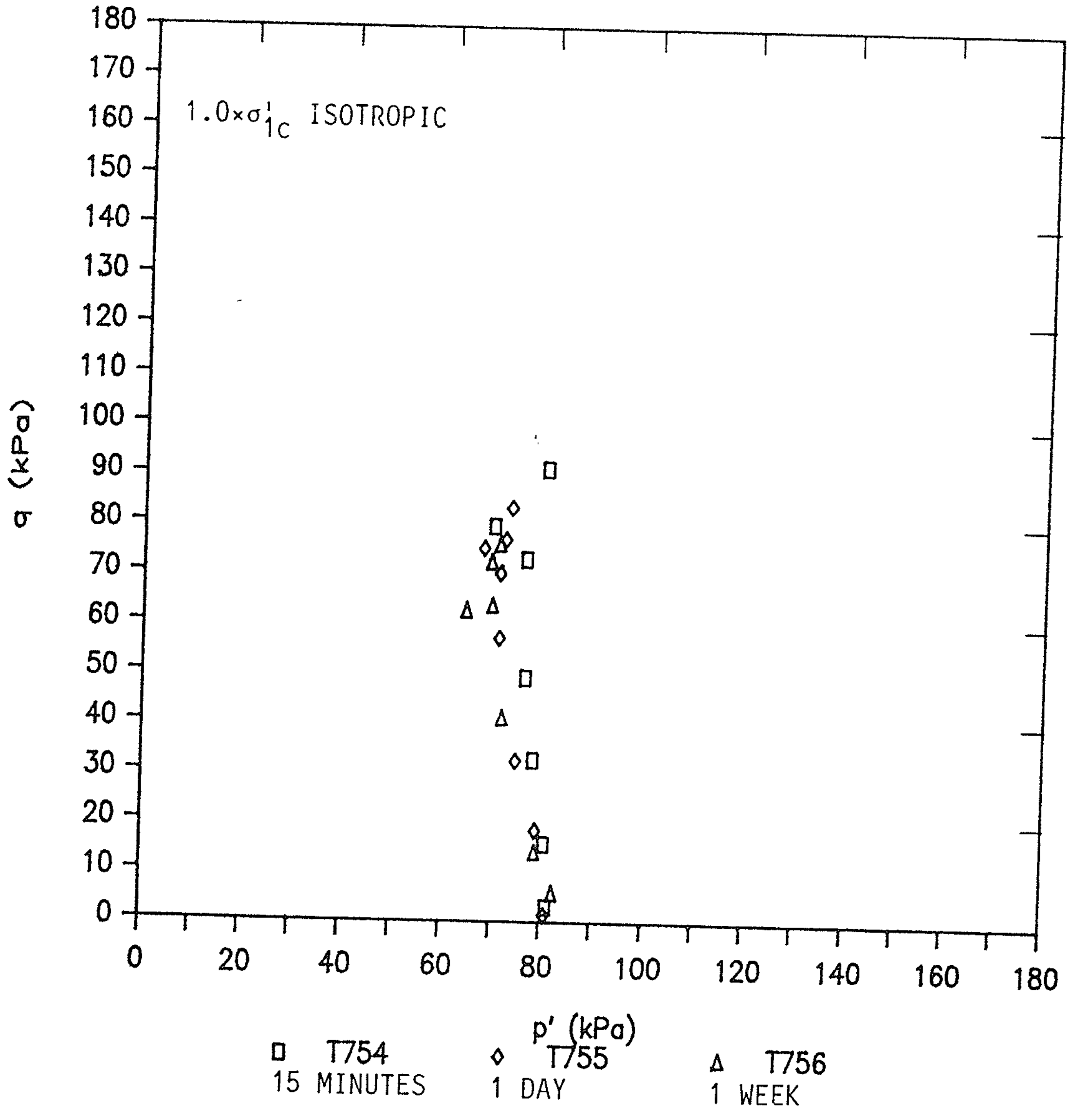


FIGURE 6.15 EFFECTIVE STRESS PATHS IN p',q-SPACE
OVERCONSOLIDATED SAMPLES T754, T755, T756

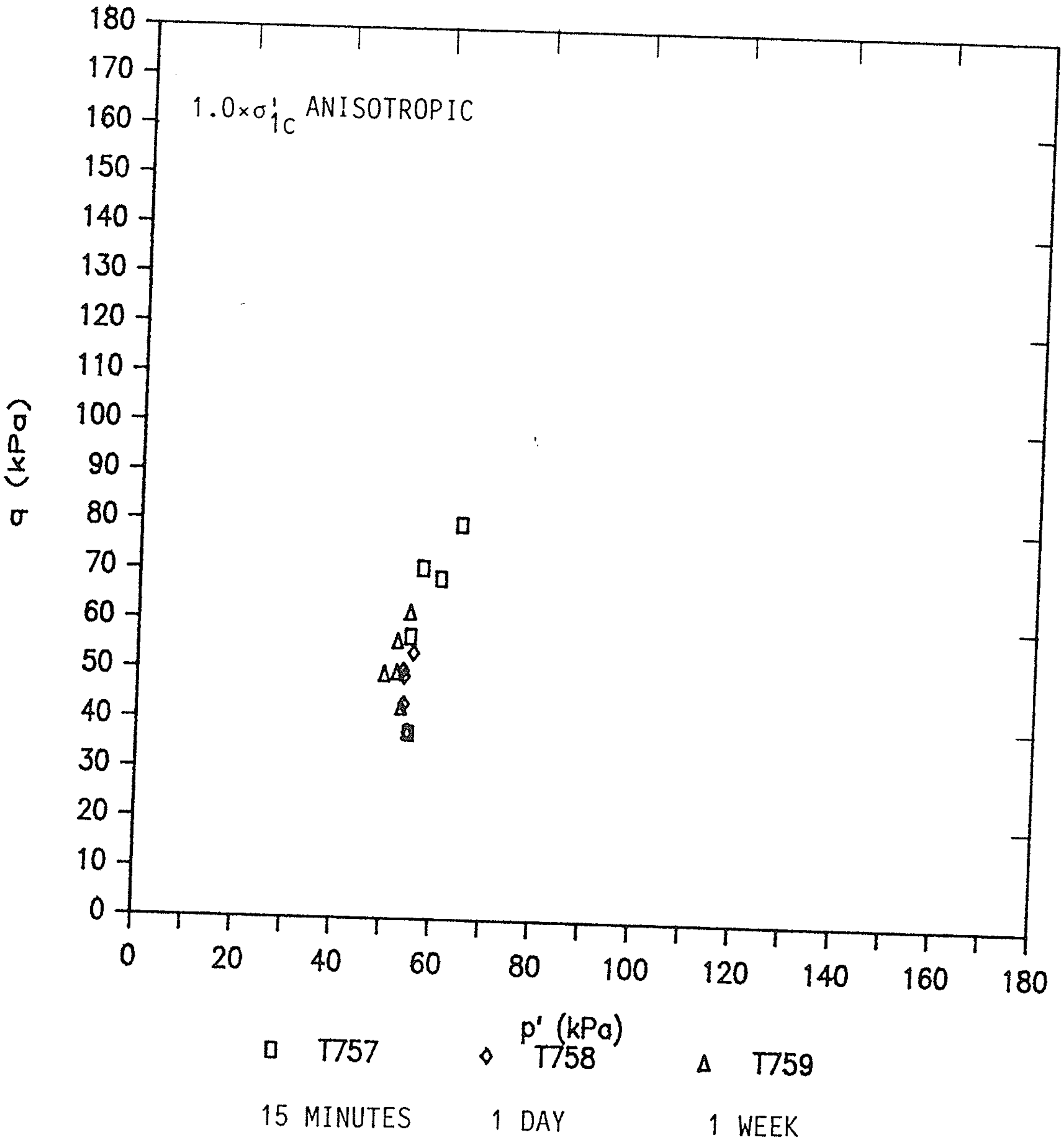


FIGURE 6.16 EFFECTIVE STRESS PATHS IN p',q-SPACE
OVERCONSOLIDATED SAMPLES T757, T758, T759

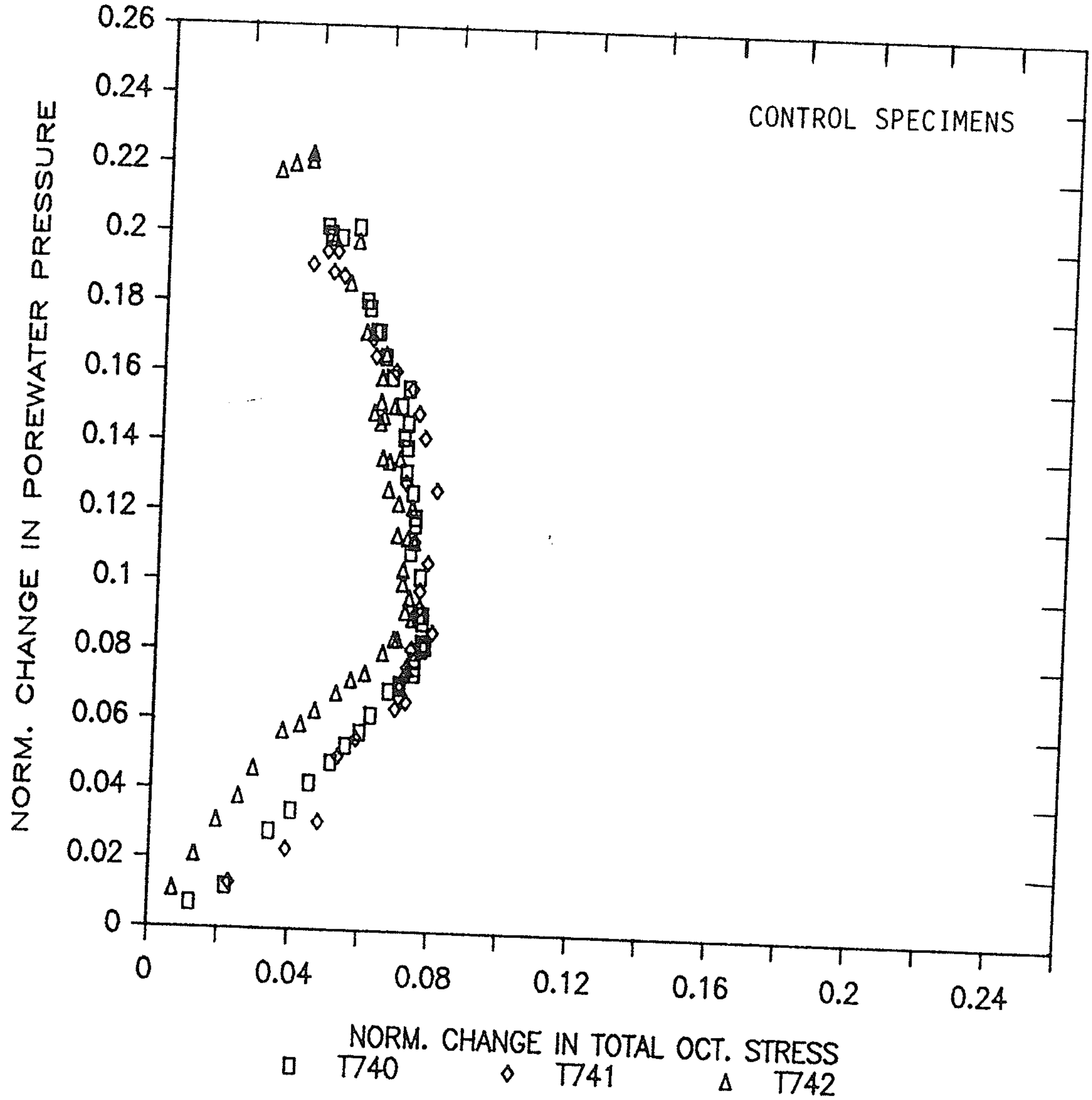


FIGURE 6.17 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ vs. $\Delta p/\sigma'_{vc}$
NORMALLY CONSOLIDATED SAMPLES T740, T741, T742

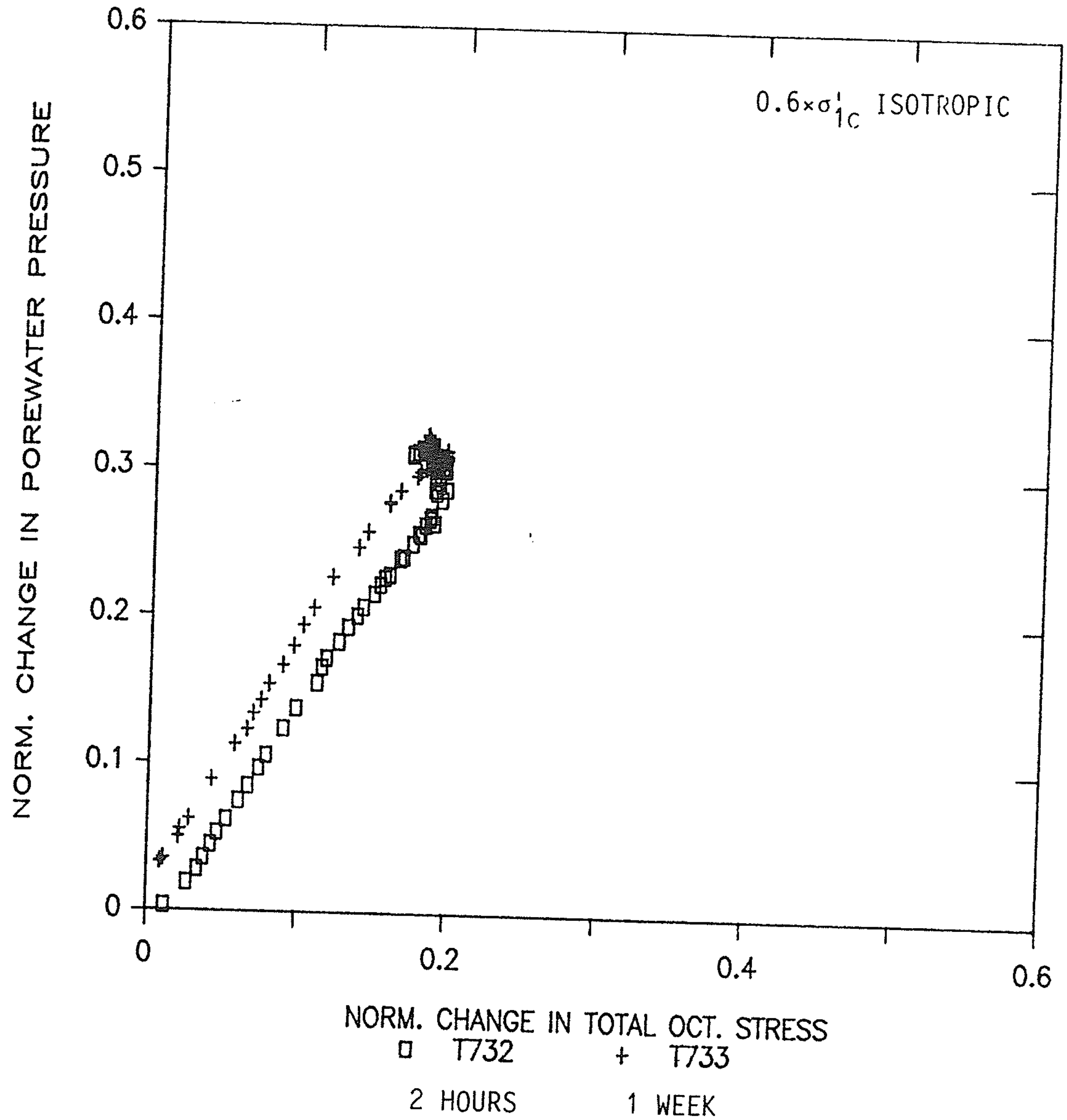


FIGURE 6.18 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ vs. $\Delta p/\sigma'_{vc}$
NORMALLY CONSOLIDATED SAMPLES T732, T733

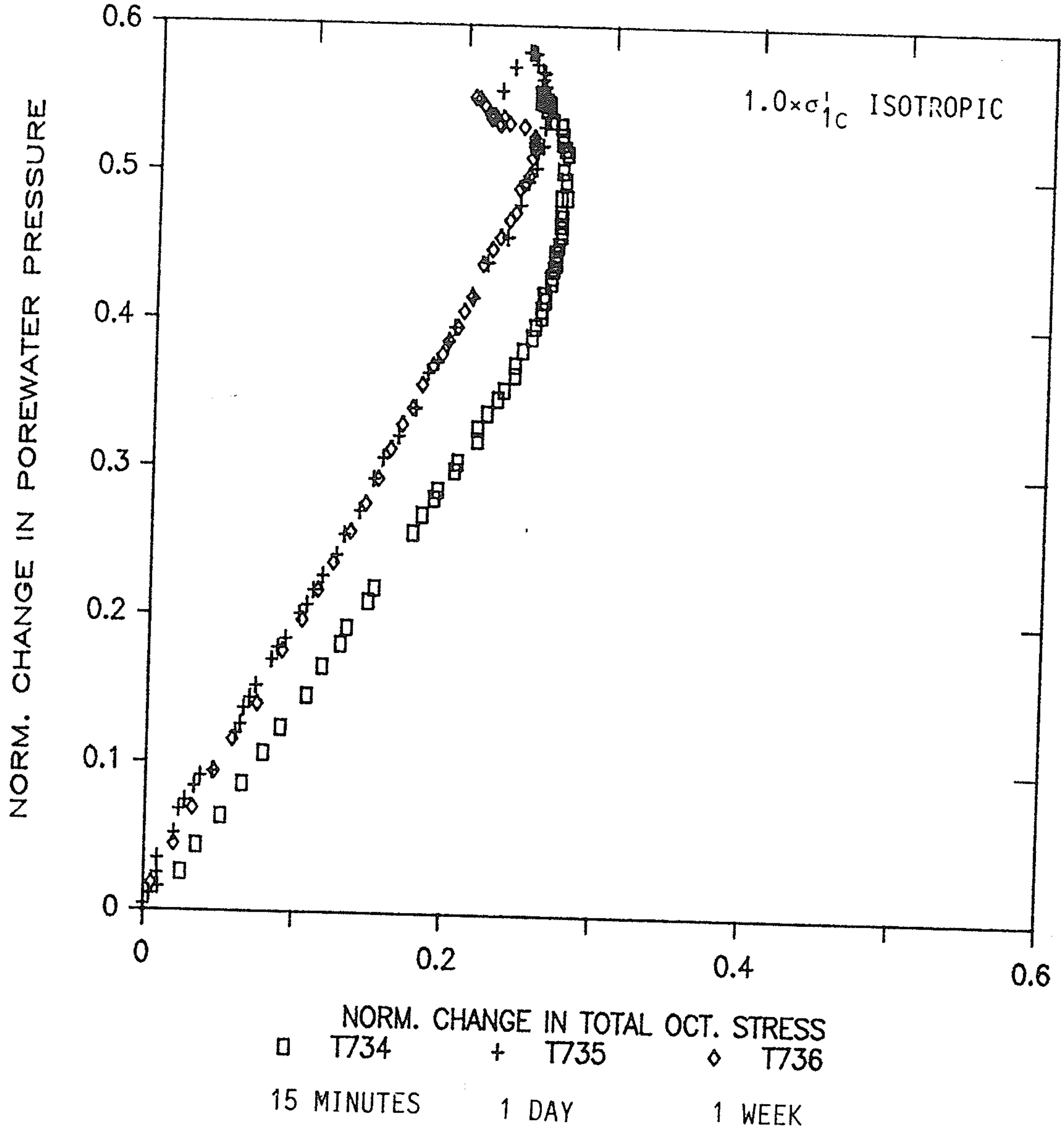


FIGURE 6.19 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ VS. $\Delta p/\sigma'_{vc}$
NORMALLY CONSOLIDATED SAMPLES T734, T735, T736

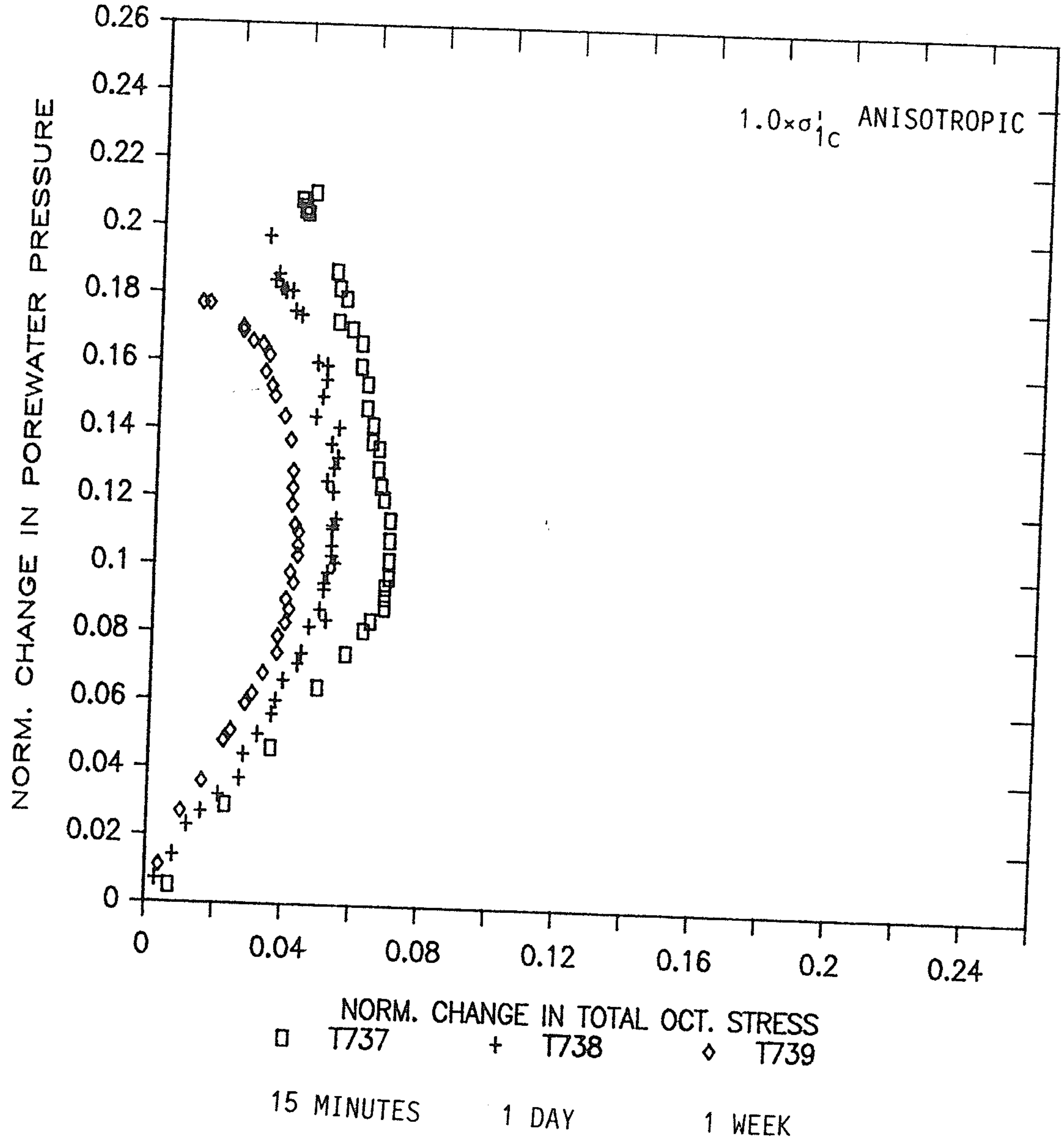


FIGURE 6.20 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ VS. $\Delta p/\sigma'_{vc}$
NORMALLY CONSOLIDATED SAMPLES T737, T738, T739

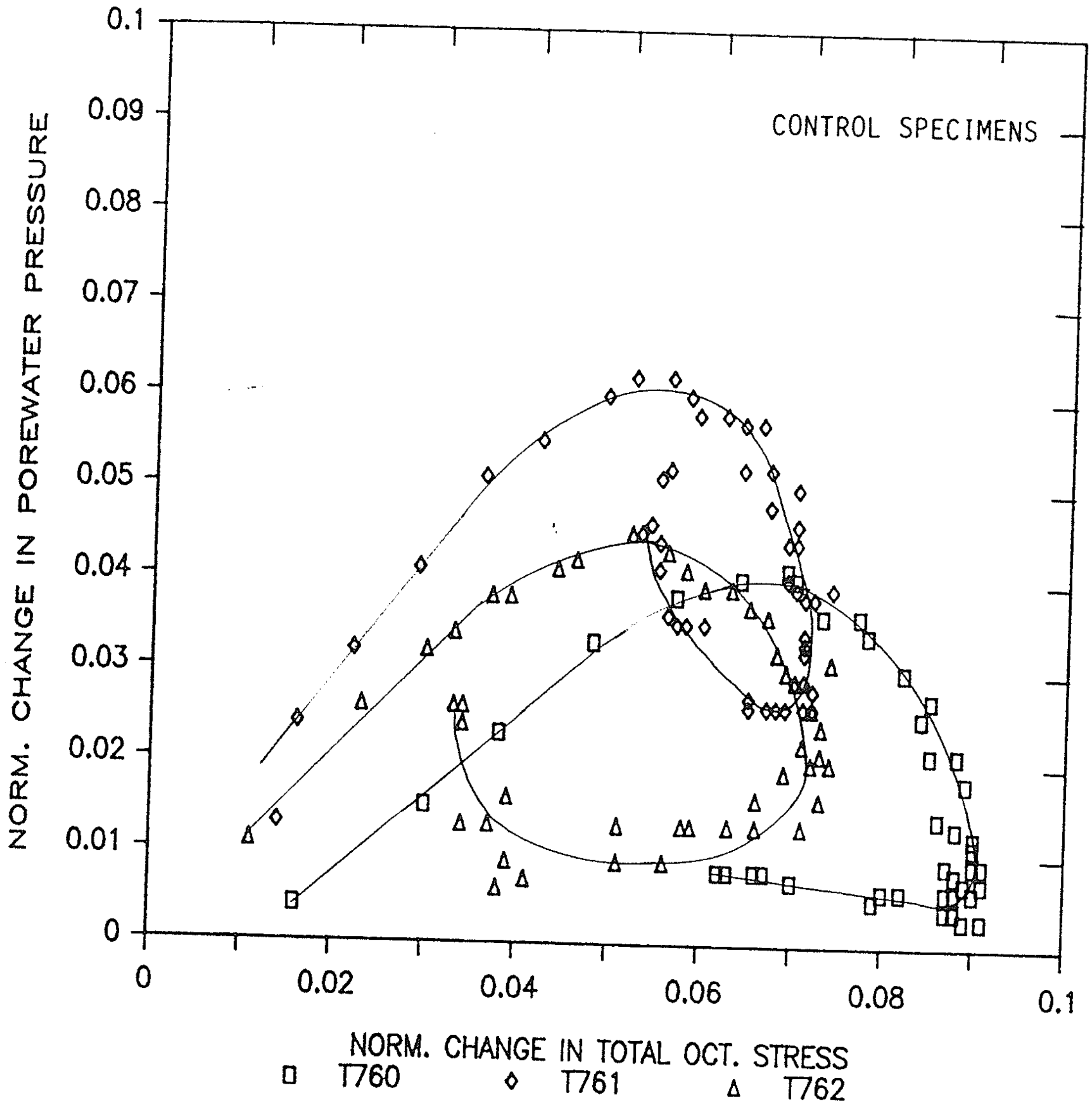


FIGURE 6.21 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ VS. $\Delta p/\sigma'_{vc}$ OVERCONSOLIDATED SAMPLES T760, T761, T762

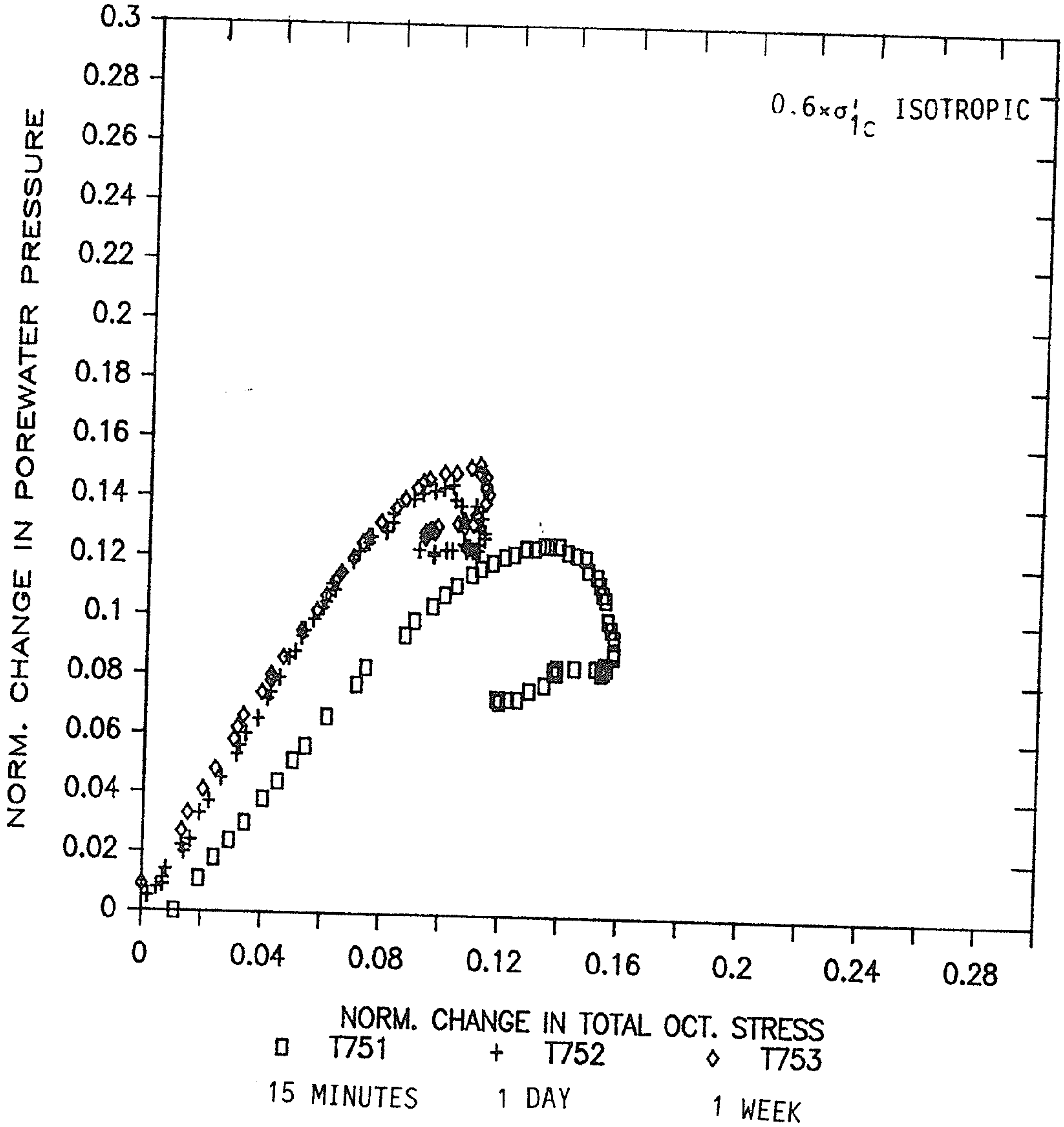


FIGURE 6.22 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ vs. $\Delta p/\sigma'_{vc}$ OVERCONSOLIDATED SAMPLES T751, T752, T753

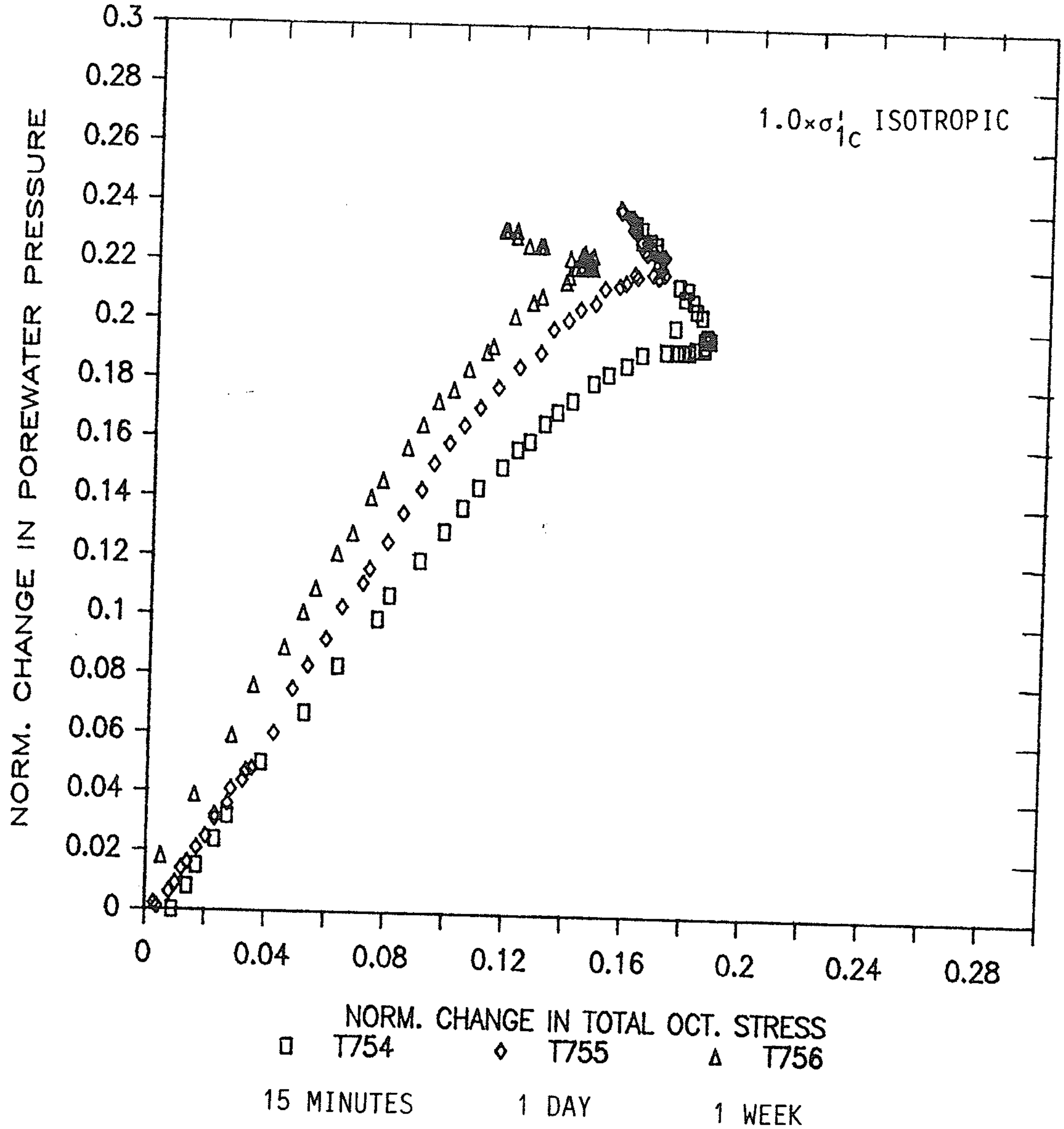


FIGURE 6.23 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ vs. $\Delta p/\sigma'_{vc}$
OVERCONSOLIDATED SAMPLES T754, T755, T756

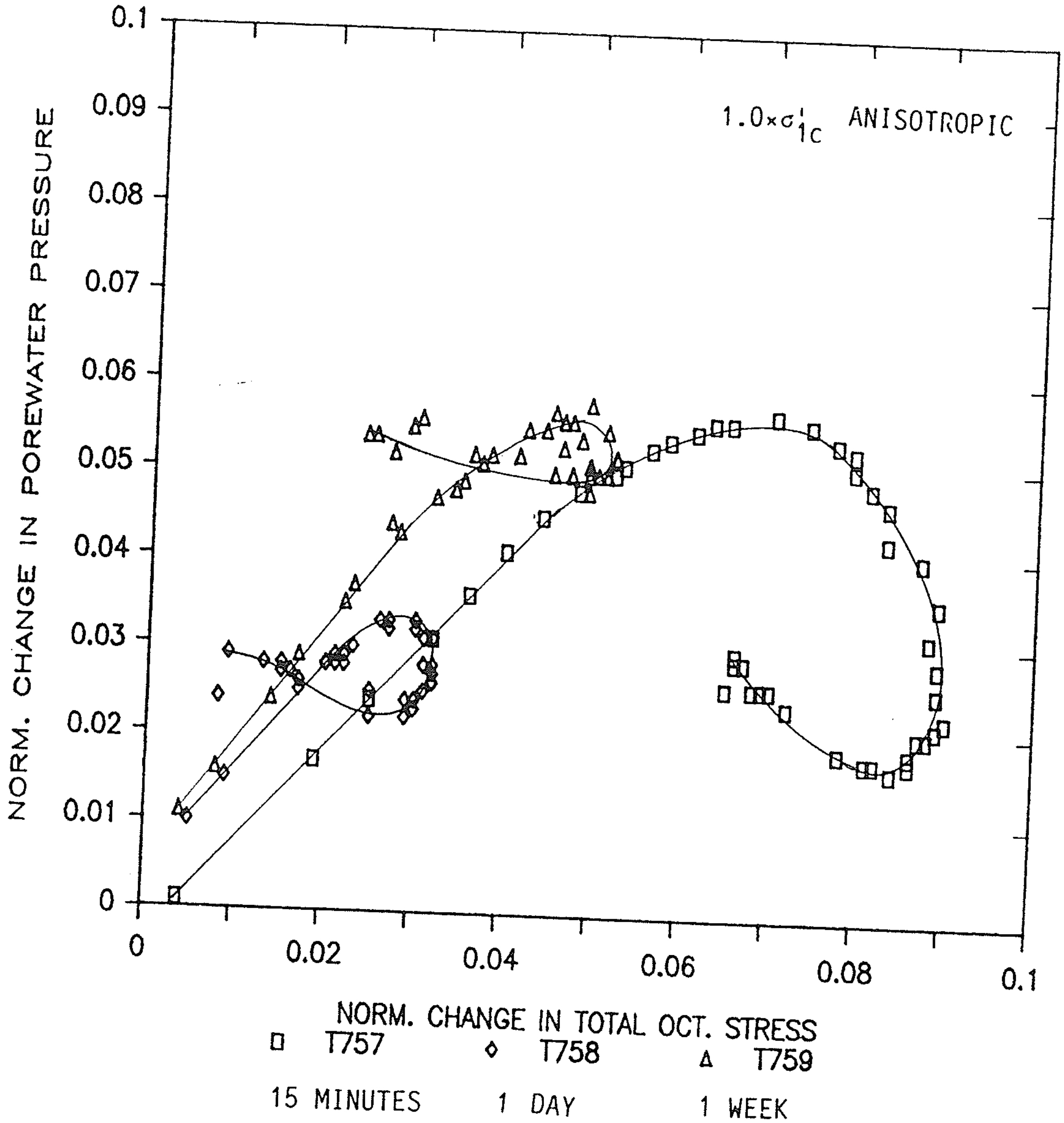


FIGURE 6.24 POREWATER PRESSURE BEHAVIOUR, $\Delta u/\sigma'_{vc}$ VS. $\Delta p/\sigma'_{vc}$
OVERCONSOLIDATED SAMPLES T757, T758, T759

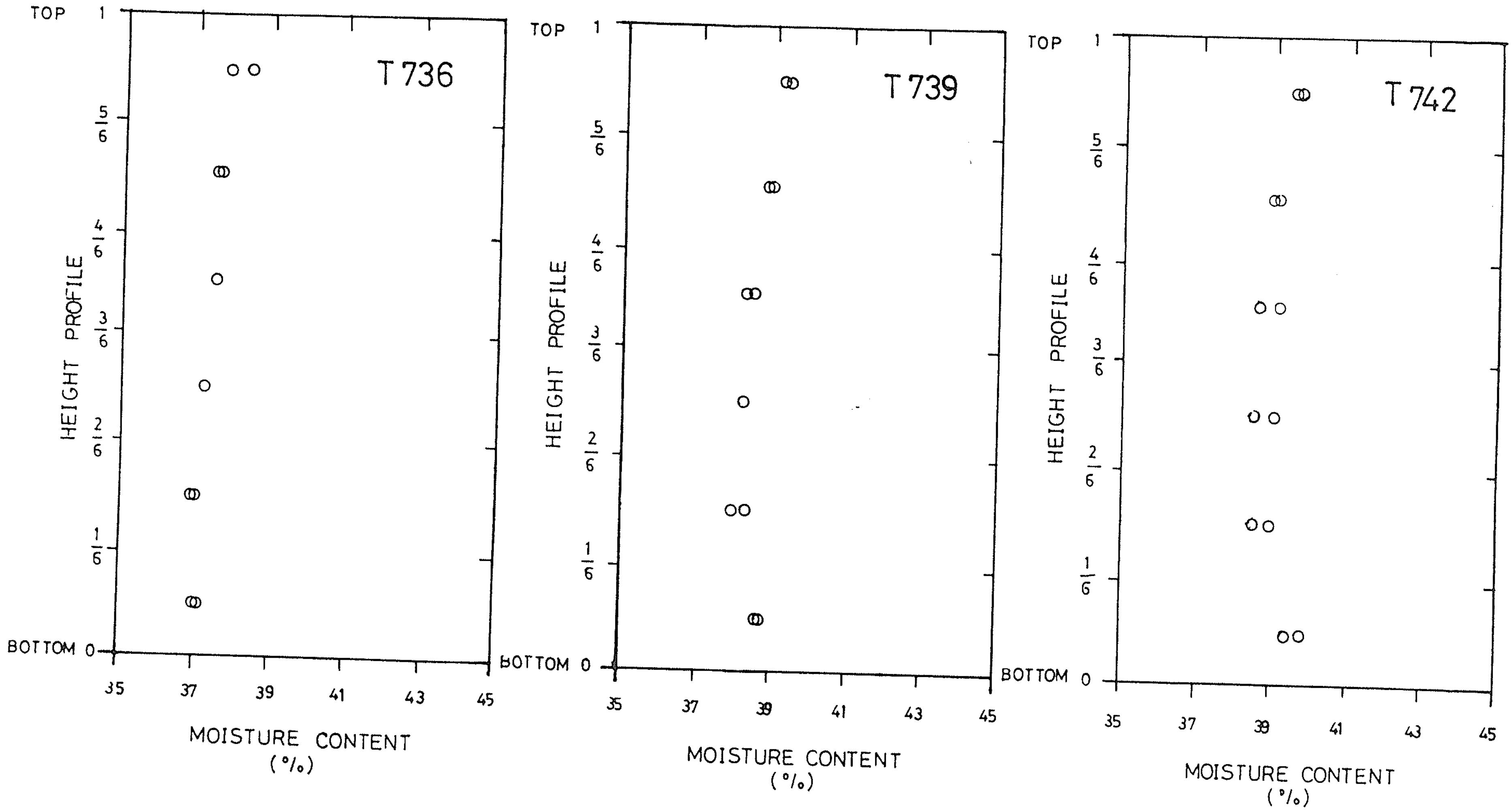


FIGURE 7.1 MOISTURE CONTENT PROFILES ACROSS NORMALLY CONSOLIDATED SAMPLES T736, T739, T740
AFTER UNDRAINED SHEAR

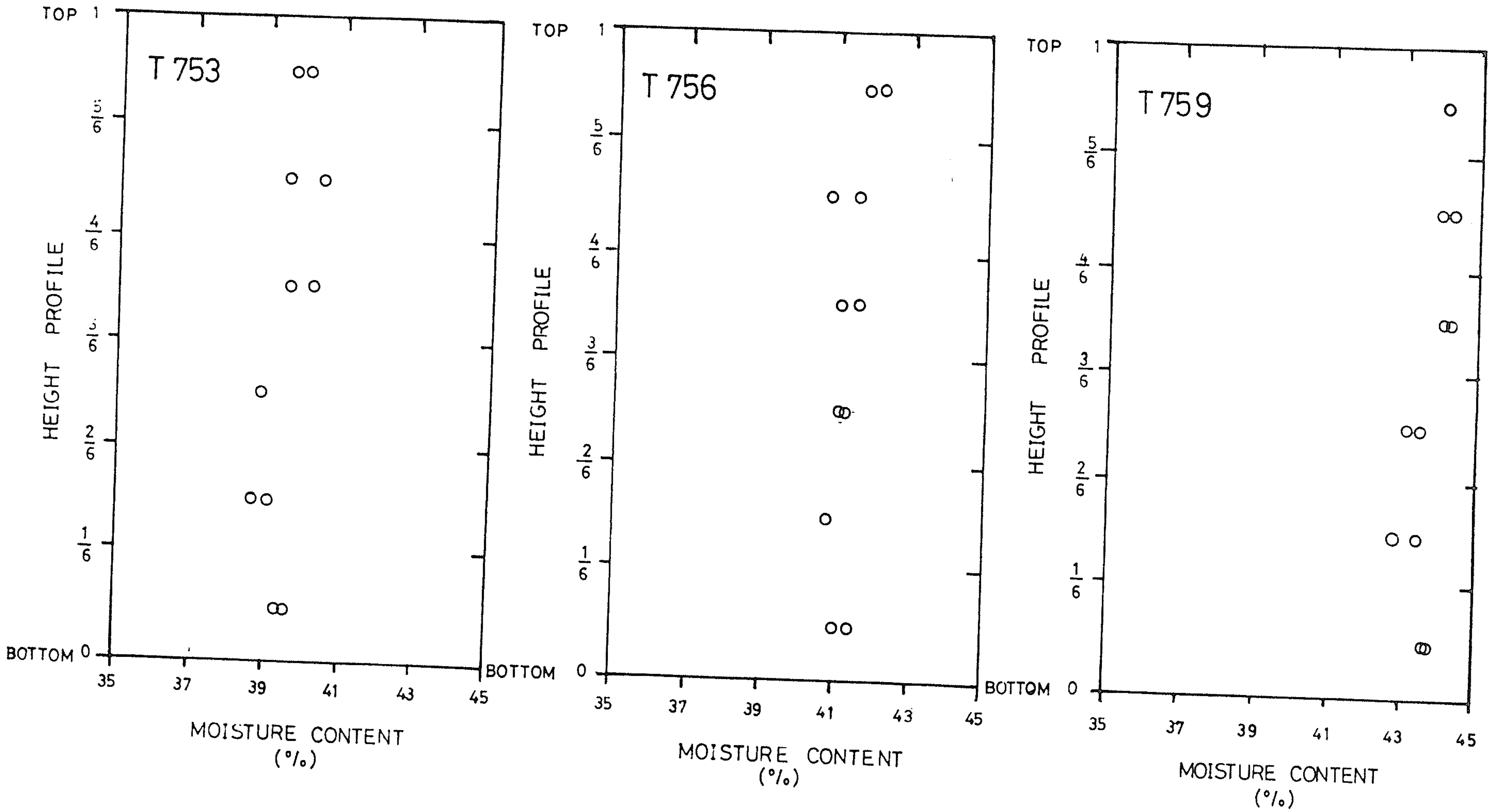


FIGURE 7.2 MOISTURE CONTENT PROFILES ACROSS OVERCONSOLIDATED SAMPLES T753, T756, T759 AFTER UNDRAINED SHEAR

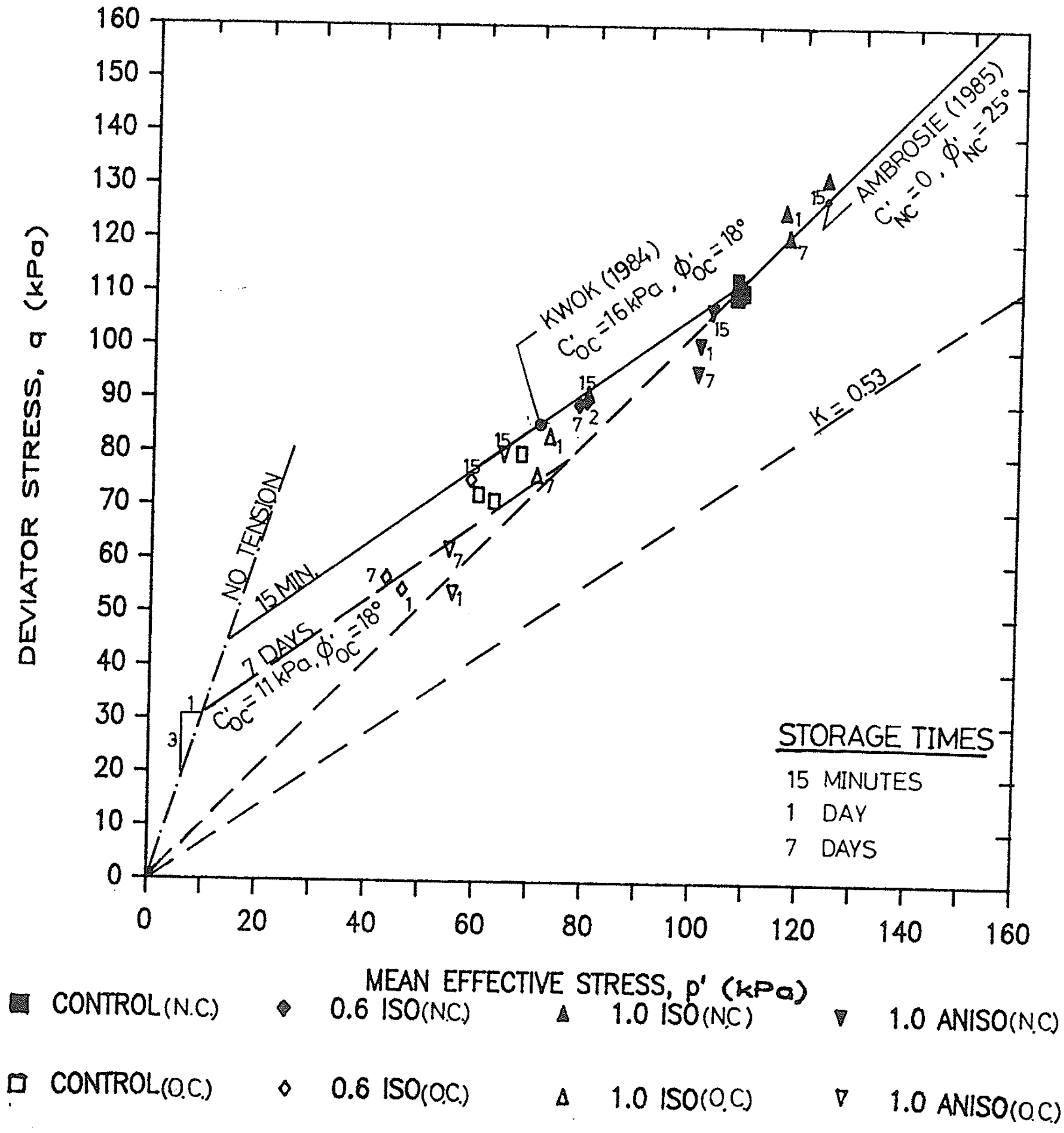


FIGURE 7.3 NORMALLY CONSOLIDATED AND OVERCONSOLIDATED RUPTURE ENVELOPES (σ'_{vc}=160 kPa) OF ILLITE

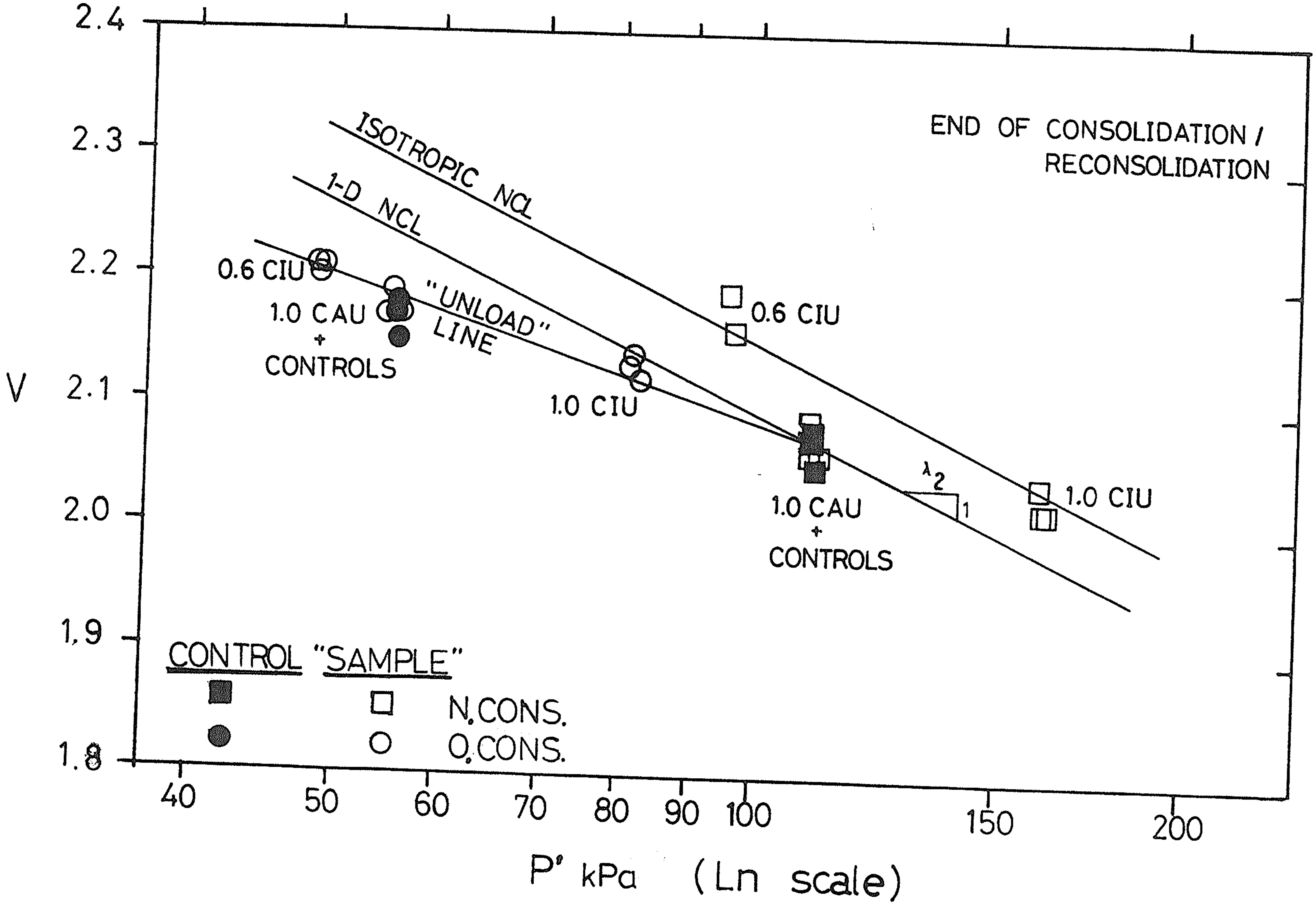


FIGURE 7.4 GRAPH OF END OF CONSOLIDATION/RECONSOLIDATION IN V,LN p'-SPACE

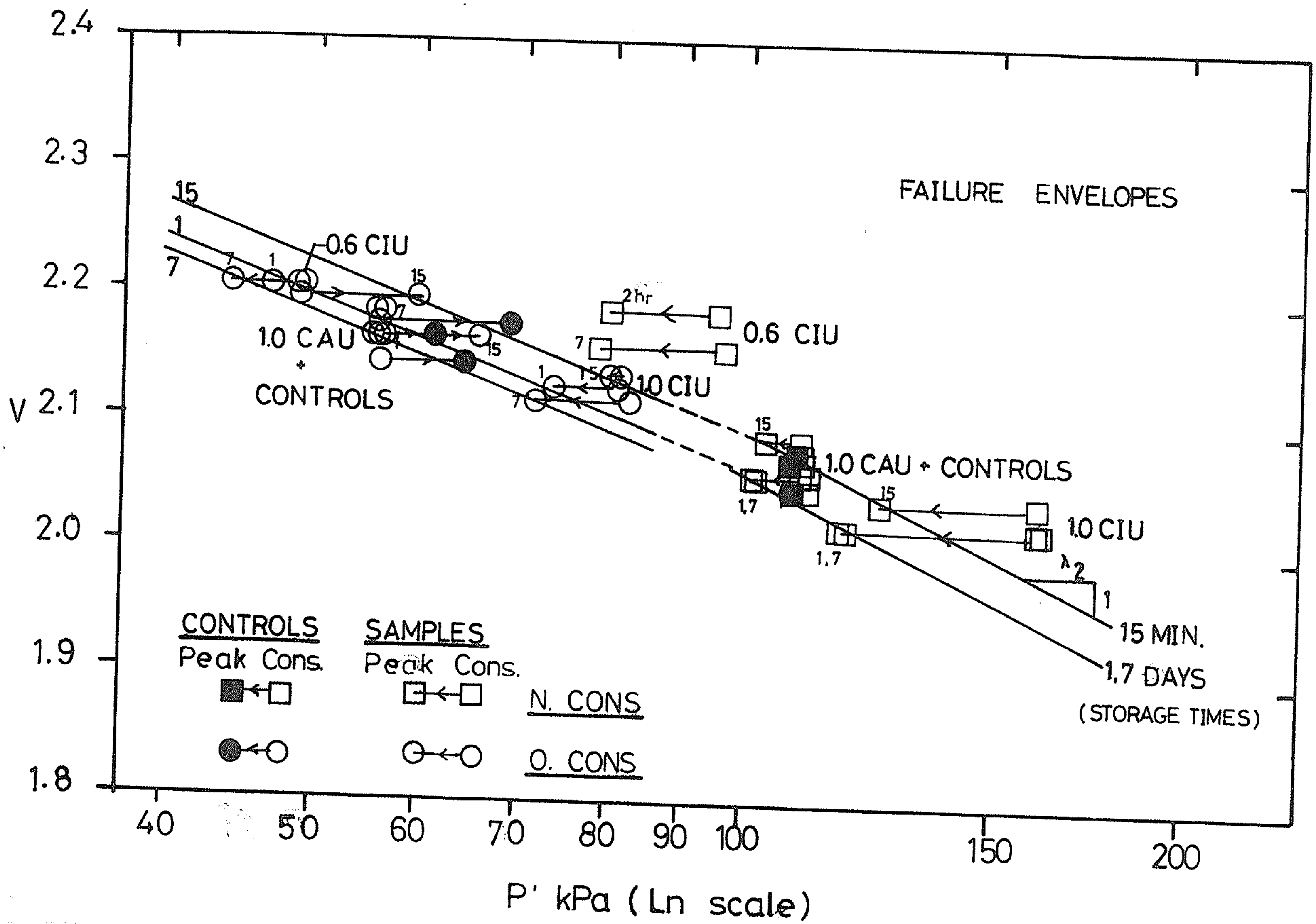


FIGURE 7.5 GRAPH OF NORMALLY CONSOLIDATED AND OVERCONSOLIDATED FAILURE ENVELOPES IN V,LN p'-SPACE

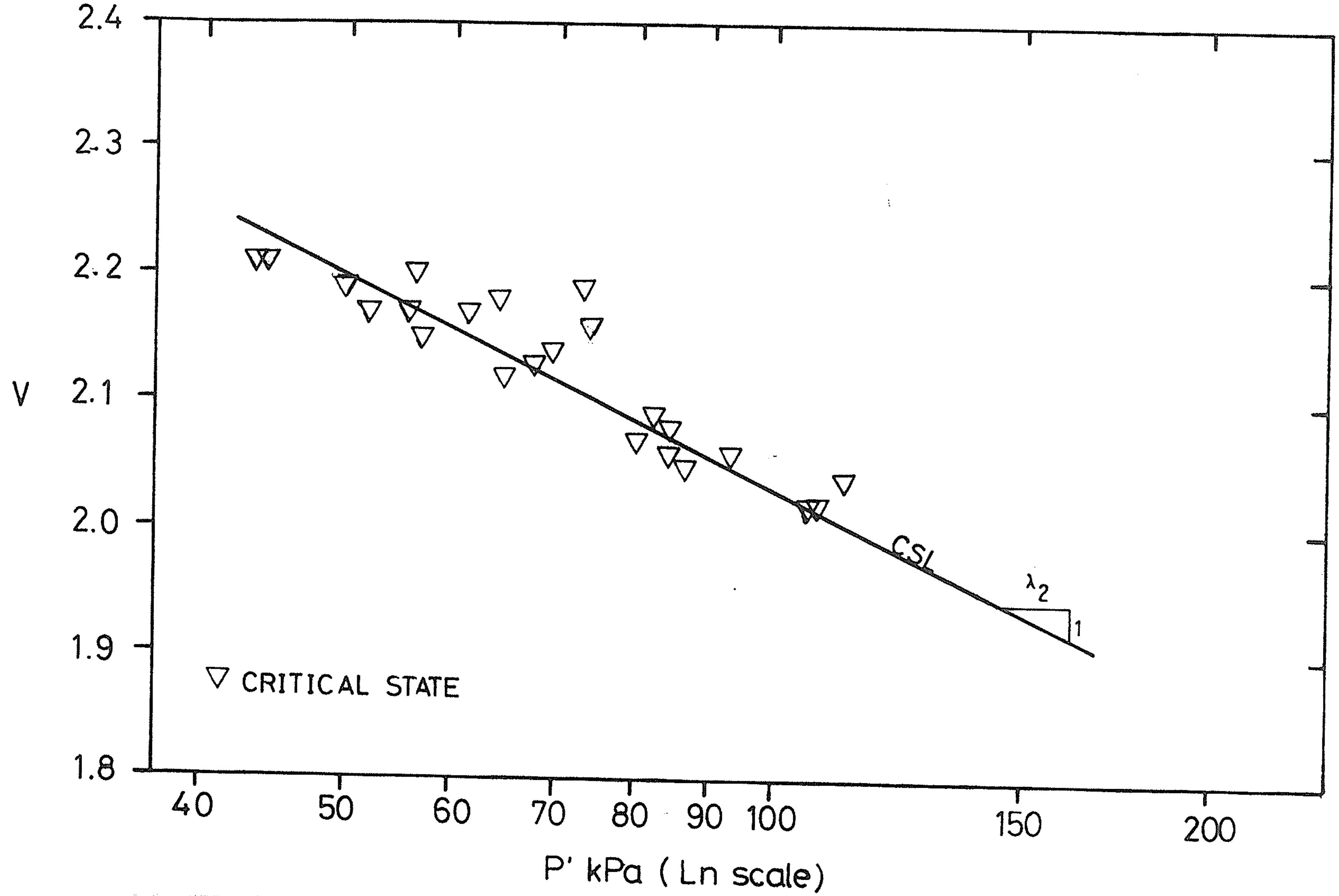


FIGURE 7.6 GRAPH OF CRITICAL STATE LINE IN V,LN p'-SPACE

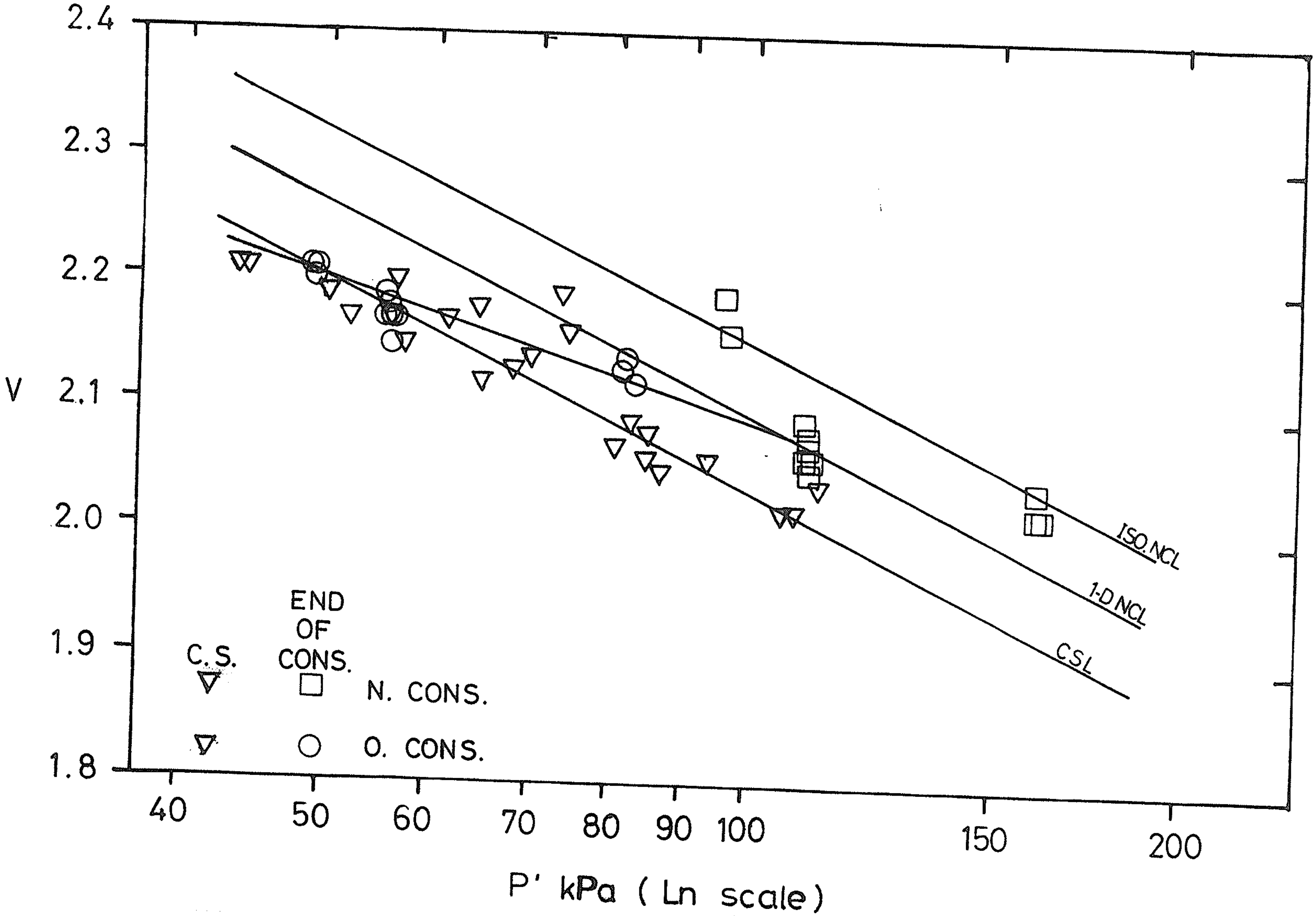


FIGURE 7.7 COMPOSITE PLOT FOR CRITICAL STATE MODEL IN V,LN p'-SPACE

APPENDIX A

PREPARATION OF RECONSTITUTED CLAY SAMPLES FOR GEOTECHNICAL TESTING

APPENDIX A

PREPARATION OF RECONSTITUTED CLAY SAMPLES FOR GEOTECHNICAL TESTING

A.1 INTRODUCTION

This note describes the process of preparing "slurry cakes", each of which can be subsequently cut and trimmed into three identical reconstituted clay samples for further triaxial testing. The process usually consisted of three stages: (1) remoulding, (2) consolidation and (3) extrusion. The procedures used for remoulding soil in a mechanical unit and pouring slurry into a consolidation cylinder are similar to those described by Li (1983), and they will not be repeated here. The equipment (Figures A1 and A2) used throughout the consolidation and extrusion stages was designed by the author and Mr. N.Piamsalee. Usefully advice given by Dr. J.Graham during the design stage is much appreciated.

This note takes the form of a set of abbreviated instruction for the operation of the equipment and preparation of specimens for testing.

A.2 ONE-DIMENSIONAL CONSOLIDATION

1. Place a load cell that is connected to a strain gauge box on the top of the hydraulic jack.
2. Place the steel stand plate on the top of the load cell and make sure the plate sits well and is in good contact with the load cell.
3. Transfer the 254-mm diameter consolidation cylinder with slurry inside to the loading frame (Figure A1). Place the guide plate in

place to prevent any lateral movement of the cylinder.

4. Record the initial load cell reading.
5. Place a filter paper on the top of the slurry.
6. Apply a thin layer of silicone grease to the side of the top cap, and lower the cap into the cylinder with care until it reaches the top of slurry.
7. Place the ball bearing on the top cap, and lower the cylinder piston until it is brought in contact with the steel ball.
8. Tighten the the clamping nut at the top of the cylinder piston. Care must be taken to line up the piston vertically without any lateral and vertical movement.
9. Connect top and bottom drainage leads and collect drainage in a 1-litre measuring cylinder.
10. Attach a dial gauge platform on the side of the loading frame, set the vertical dial gauge in place, and take the initial dial gauge reading. Its placement should facilite the reading of slurry compression as indicated by the movement of the jack piston and steel stand plate.
11. Determine the desired vertical stress level and calculate the load requirement.
12. Adjust the air pressure to the booster slowly and carefully until the load cell indicated that the required vertical load is achieved.
13. Record times, dial gauge readings and load cell readings according to the following elapsed time schedule:

    30 sec., 1, 2, 4, 8, 15, 30 min., 1, 4, 8 hr. and every 24-hr.
14. Repeated step 11 to step 13 for next load increment.

A.3 EXTRUSION

1. Once equilibrium is obtained at the desired stress level, the dial gauge is removed after the final reading is recorded.
2. Disconnect drainage and store the measuring cylinder safely.
3. Release the air pressure to the booster, and lower down the hydraulic jack and the consolidation cylinder.
4. Remove the cylinder piston from the loading frame and the ball bearing from the top cap.
5. Clamp the top cap with the specially made clamping ring.
6. Remove the guide plate from the cylinder and move the cylinder from the loading frame to the floor.
7. Remove the steel stand plate and the load cell from the top of the hydraulic jack.
8. Invert the consolidation cylinder and place it over the hydraulic jack
9. Unscrew the six screws on the bottom cap of the consolidation cylinder.
10. Remove the bottom cap from the cylinder.
11. Remove the bottom filter stone and the filter paper from the "cake" with care.
12. Align the cutting plate with three cutting wires exactly over the top of the consolidation cylinder.
13. Tighten the screws of the cutting plate on the loading frame.
14. Release the screw of the clamping ring on the top cap.
15. Applied air pressure to the booster to push the "cake" slowly out of the cylinder. The "cake" at this stage is cut into three "pie slices".

16. One slice is ready for the trimming and building-in procedures described by Lew (1981). The two other slices while waiting for trimming are wrapped with Saran Wrap, sealed with wax, and stored in a cool, humid, sample room to minimize changes in moisture content.
17. Six moisture contents are obtained from the trimmings of the working slice.
18. Finally, all the equipment should be cleaned and set aside for the next time.

A.4 A LEVER-LOADING SYSTEM

This is an alternative way to load the consolidation cylinder in a lever-loading system (Figure A2), rather than using the booster-hydraulic jack system described in Section A.2.

1. Place the consolidation cylinder on the steel plate.
2. Place a filter paper on the top of the slurry. Prior to loading, weigh the top cap with top filter stone and the load cell with its adaptor.
3. Apply a thin layer of silicon grease on the side of top cap and lower it carefully into the cylinder.
4. Place a load cell with its adaptor on the top of the top cap.
5. Set dial gauge platform on the cylinder piston shaft.
6. Lower down the piston into the cylinder until it comes into contact with the top of load cell.
7. Rotate the "screw" until the lever arm is horizontal. This can be moinitored by the level on the lever arm.
8. Set up a dial gauge on the loading frame and take the initial

reading.

9. Connect top and bottom drainage connections and collect drainage in a 1-litre measuring cylinder.
10. Determined the desired vertical stress level and determine the required load.
11. Place the roughly calculated dead weight on the pan, and adjust the load carefully until the load cell indicates the required load is achieved.
12. Record times, dial gauge readings and load cell readings using double time schedule.
13. Adjust the "screw" as necessary to keep the lever arm in the horizontal position.
14. Repeat step 10 to step 13 for next load increment until the final stress level is attained.
15. For extrusion of the "cake" , use steps 1, 2, 4-6, and 8-18 in Section A.3.

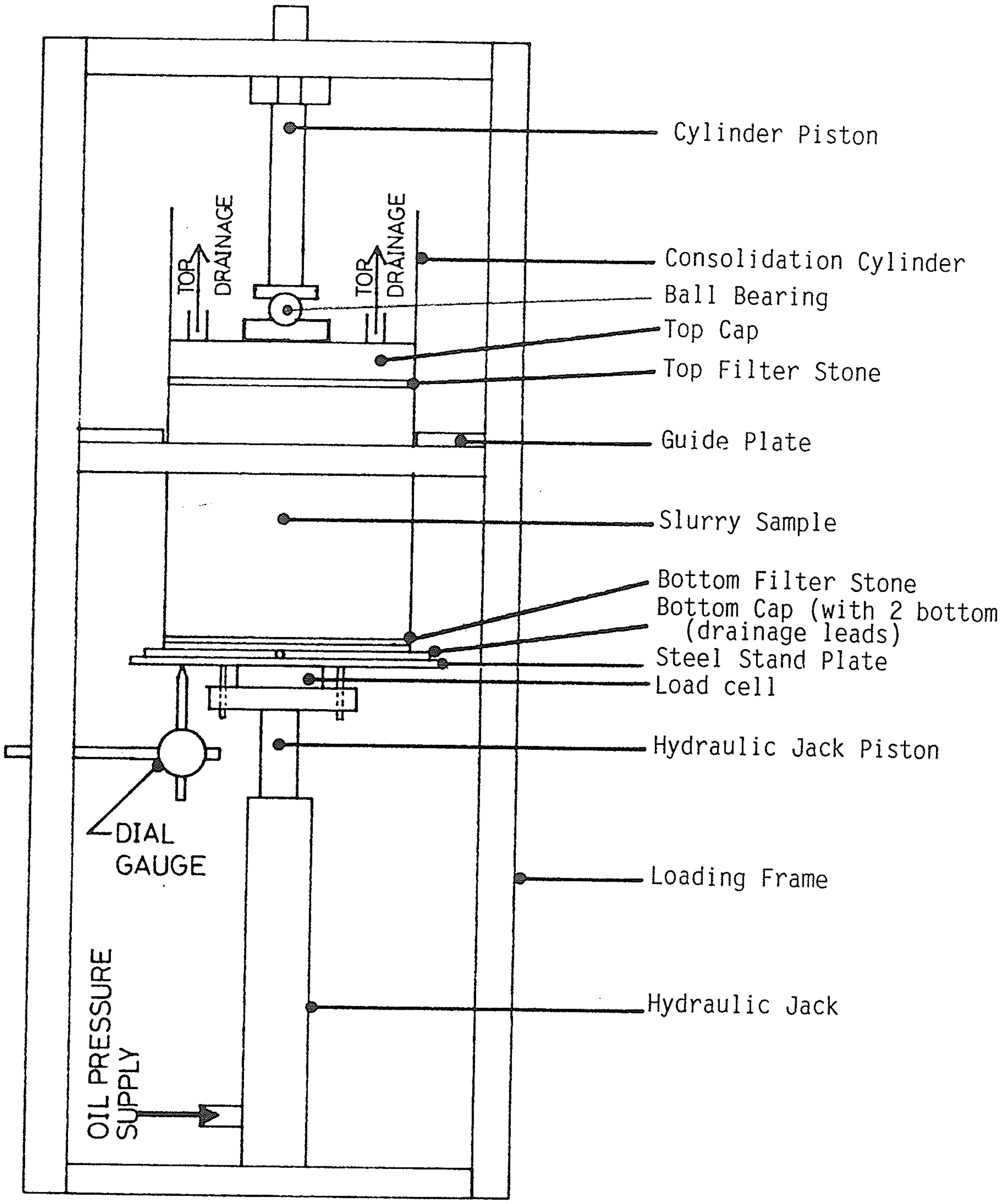


FIGURE A1 SCHMATIC DIAGRAM OF A LOADING FRAME FOR ONE-DIMENSIONAL SLURRY CONSOLIDATION

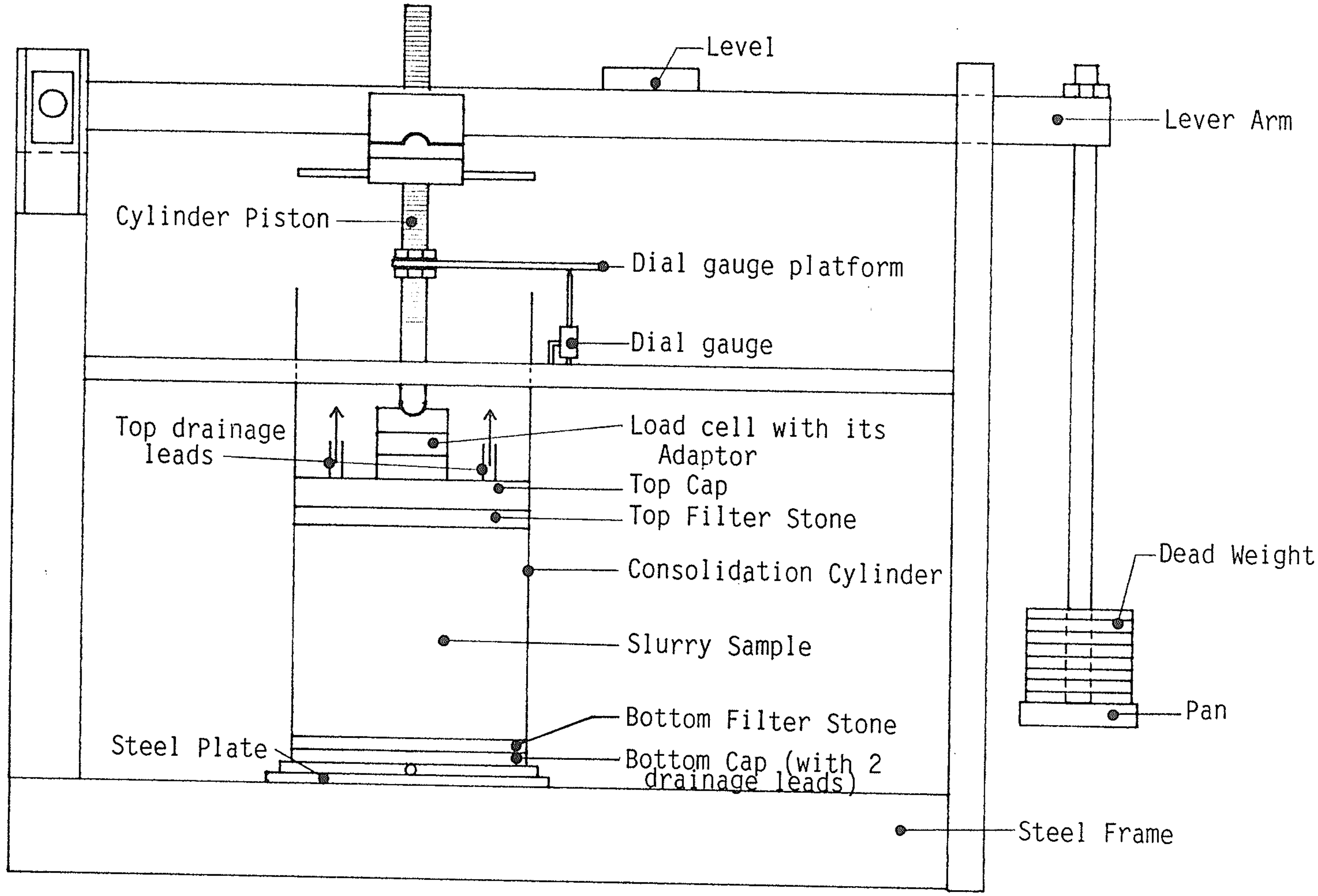


FIGURE A2 SCHMATIC DIAGRAM OF A LEVER-LOADING SYSTEM FOR ONE-DIMENSIONAL CONSOLIDATION

APPENDIX B

ADDITIONAL PLOTS FOR TRIAXIAL CONSOLIDATION TESTS

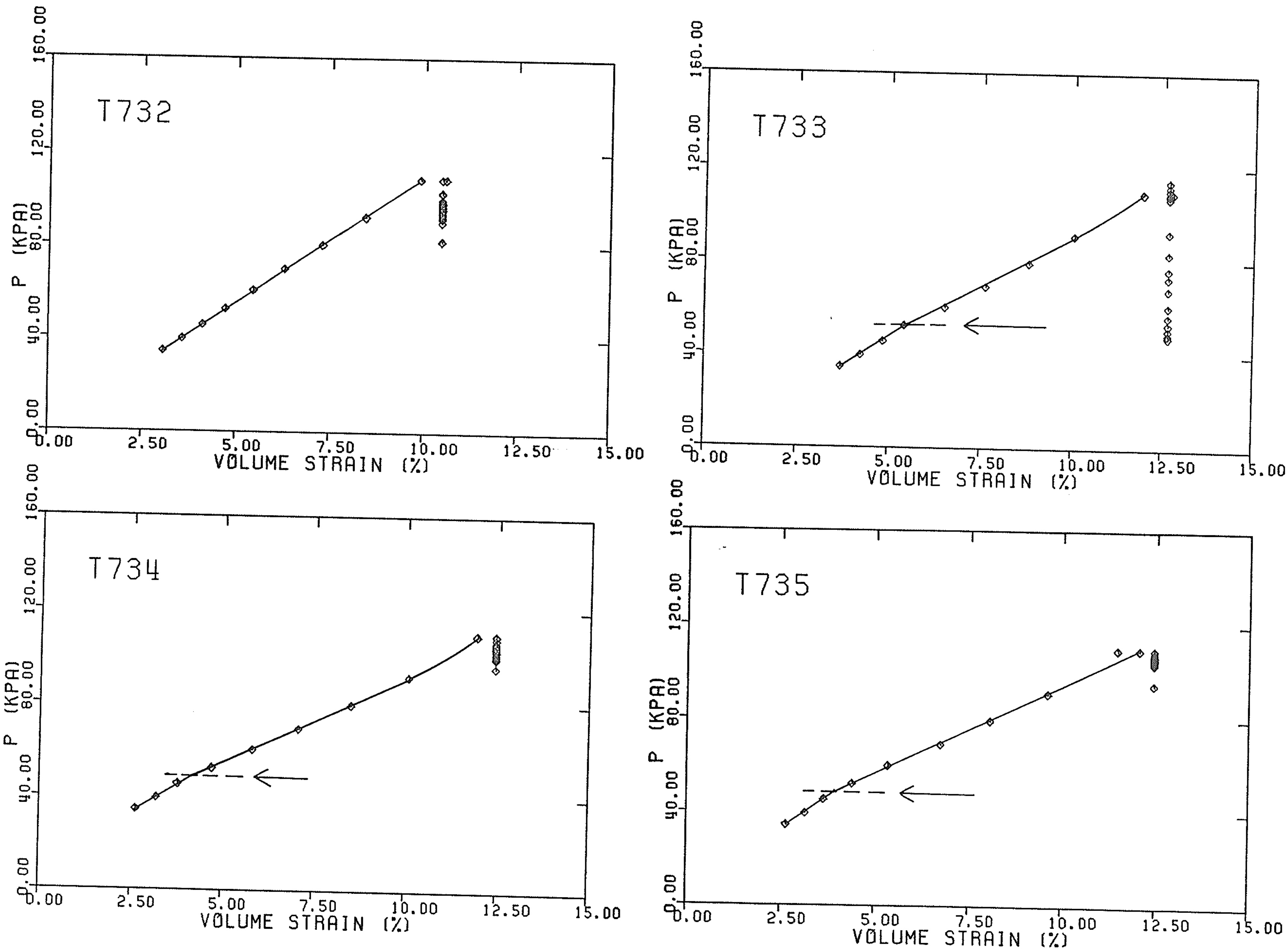


FIGURE B1 a,b,c,d YIELD DETERMINATION—p' vs. v
T732, T733, T734, T735

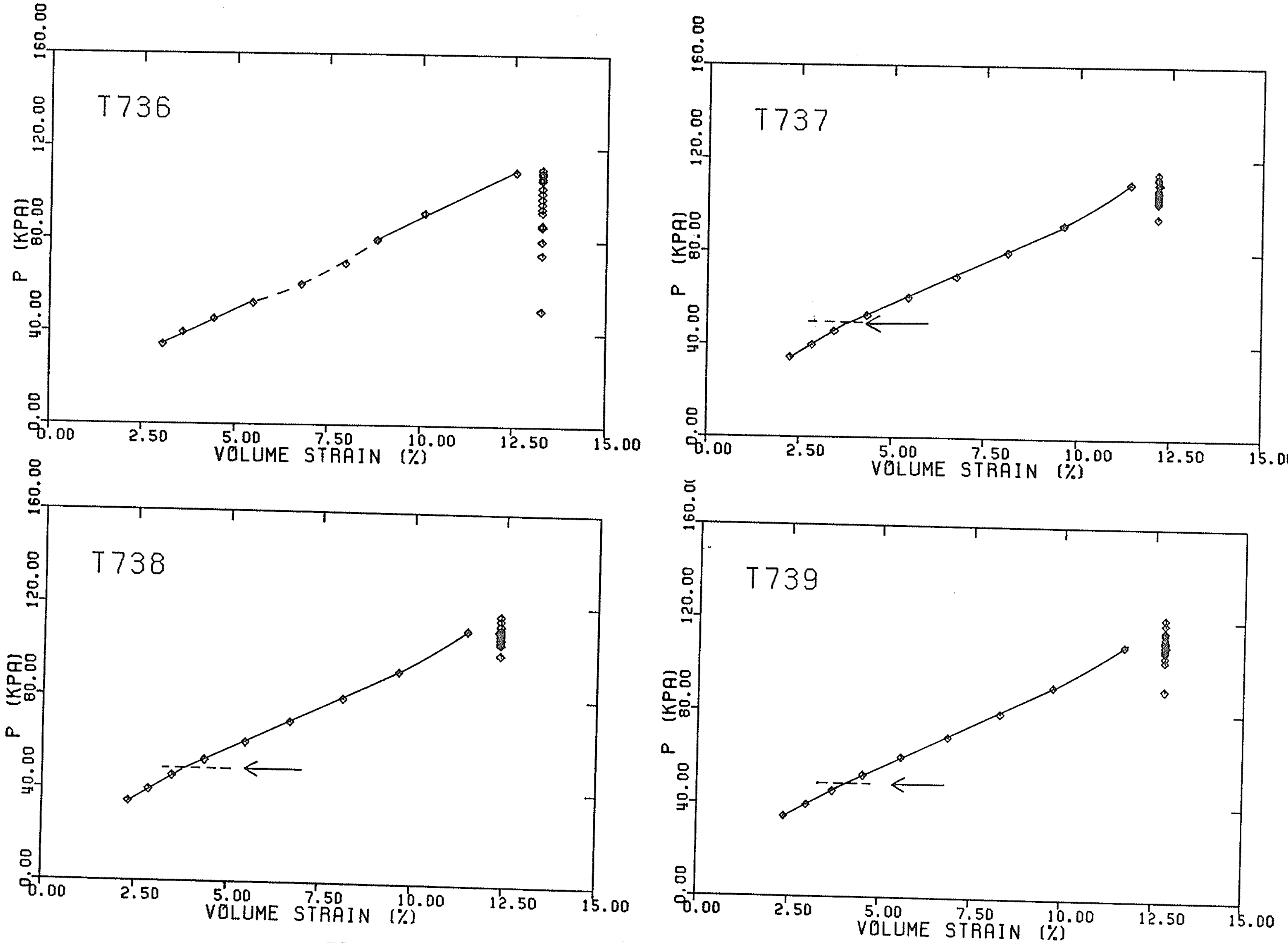


FIGURE B2 a,b,c,d YIELD DETERMINATION—p' vs. v
T736, T737, T738, T739

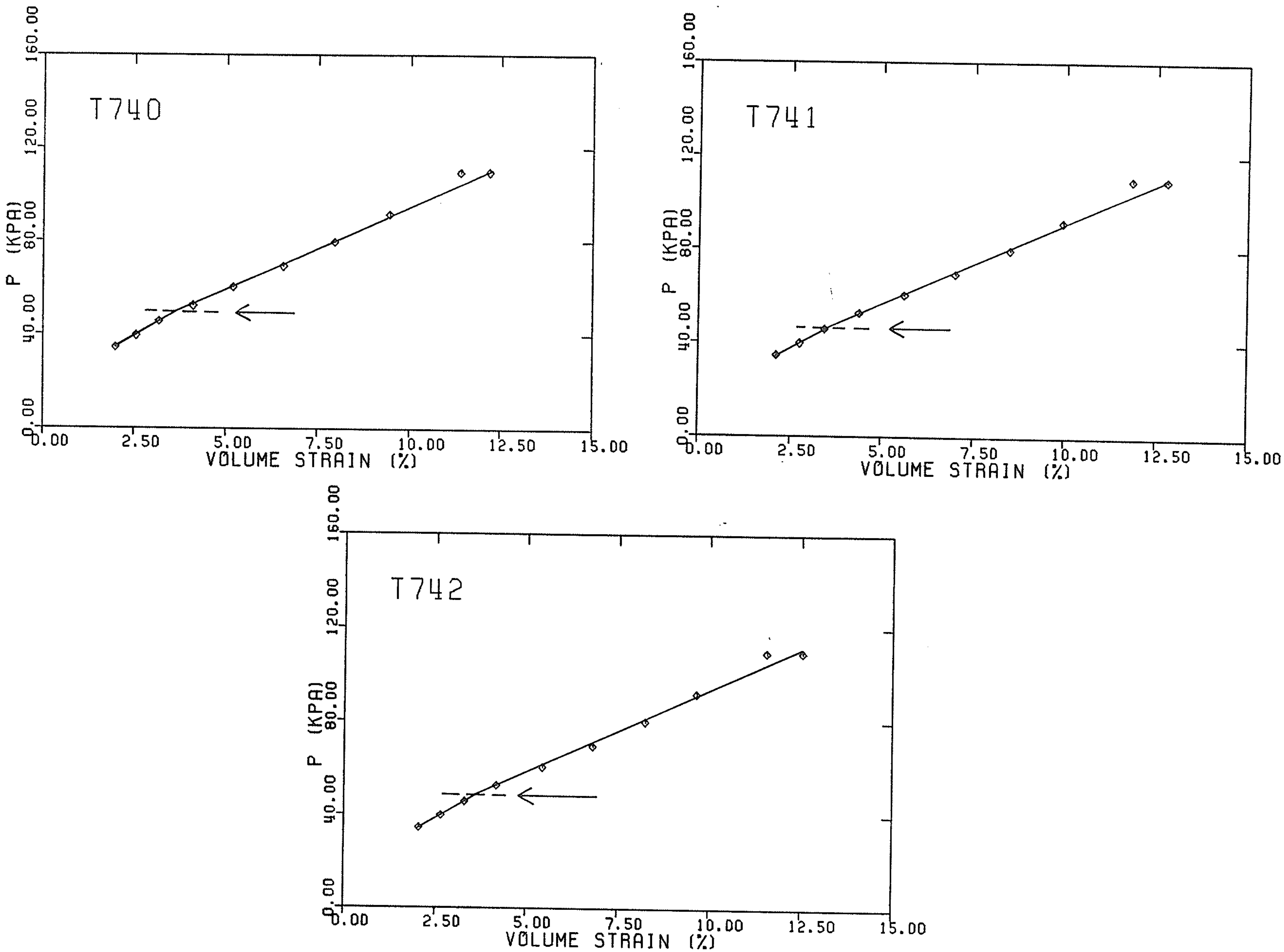


FIGURE B3 a,b,c YIELD DETERMINATION—p' vs. v
T740, T741, T742

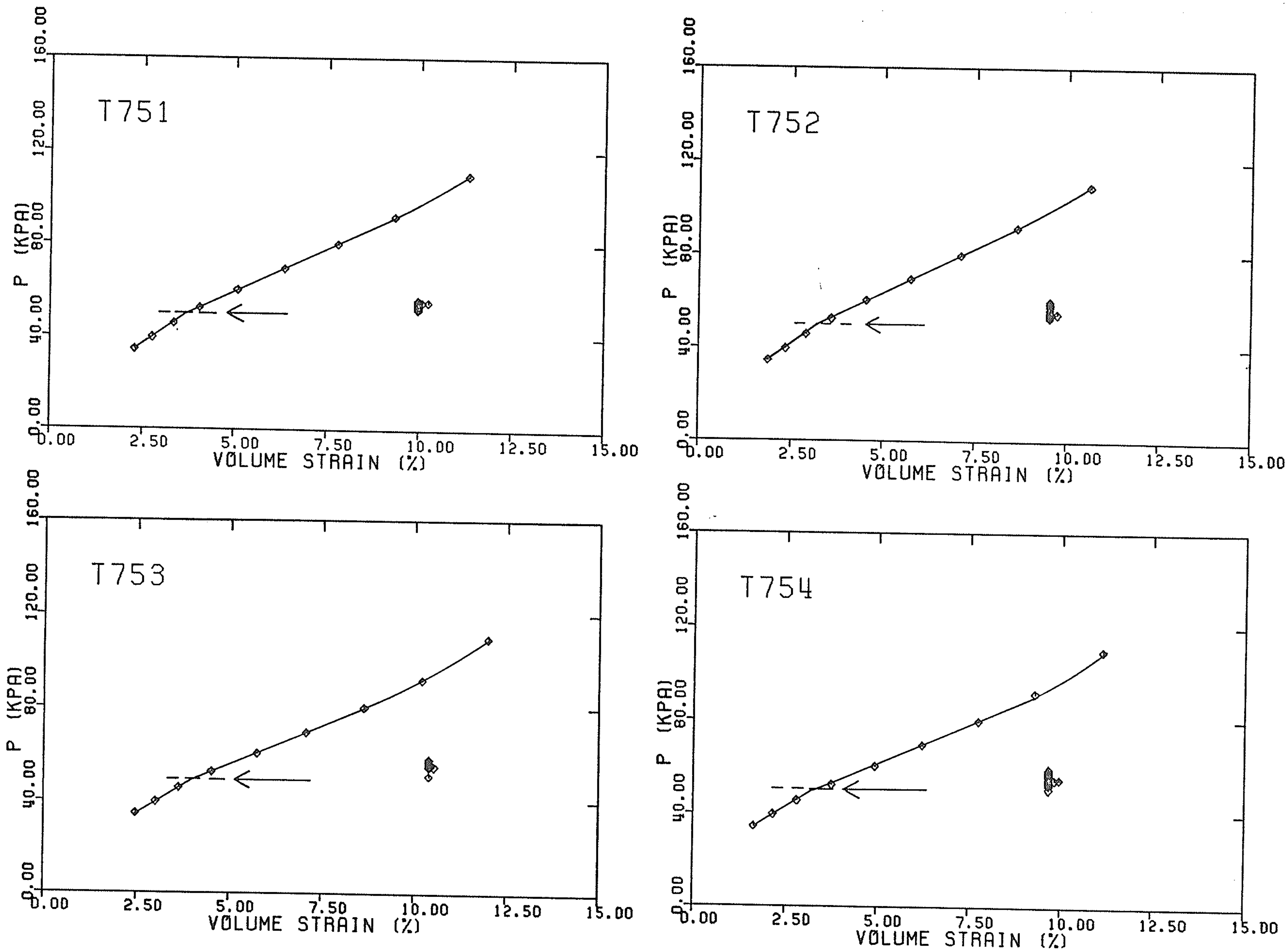


FIGURE B4 a,b,c,d YIELD DETERMINATION—p' vs. v
T751, T752, T753, T754

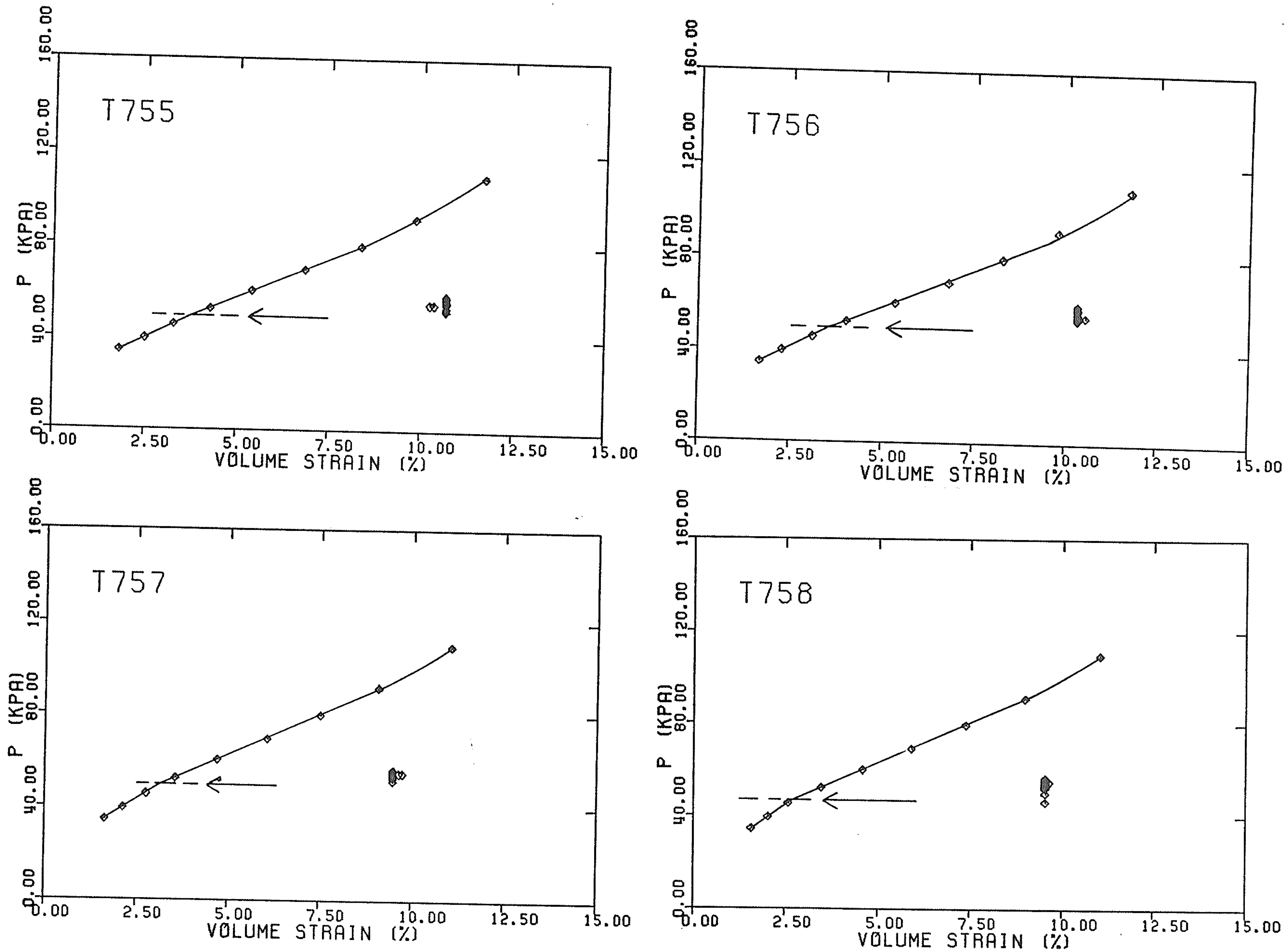


FIGURE B5 a,b,c,d YIELD DETERMINATION—p' vs. v
T755, T756, T757, T758

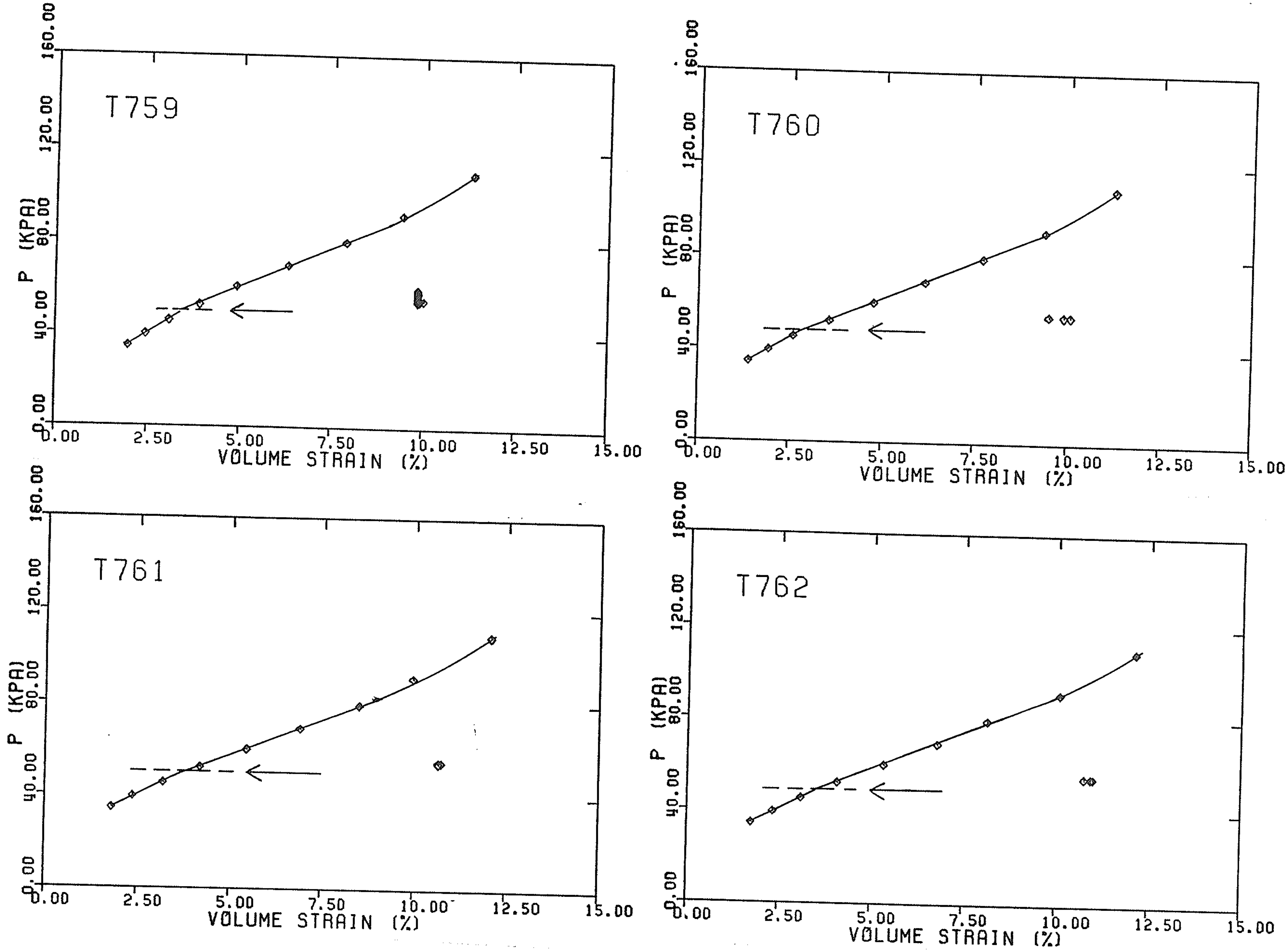


FIGURE B6 a,b,c,d YIELD DETERMINATION—p' vs. v
T759, T760, T761, T762

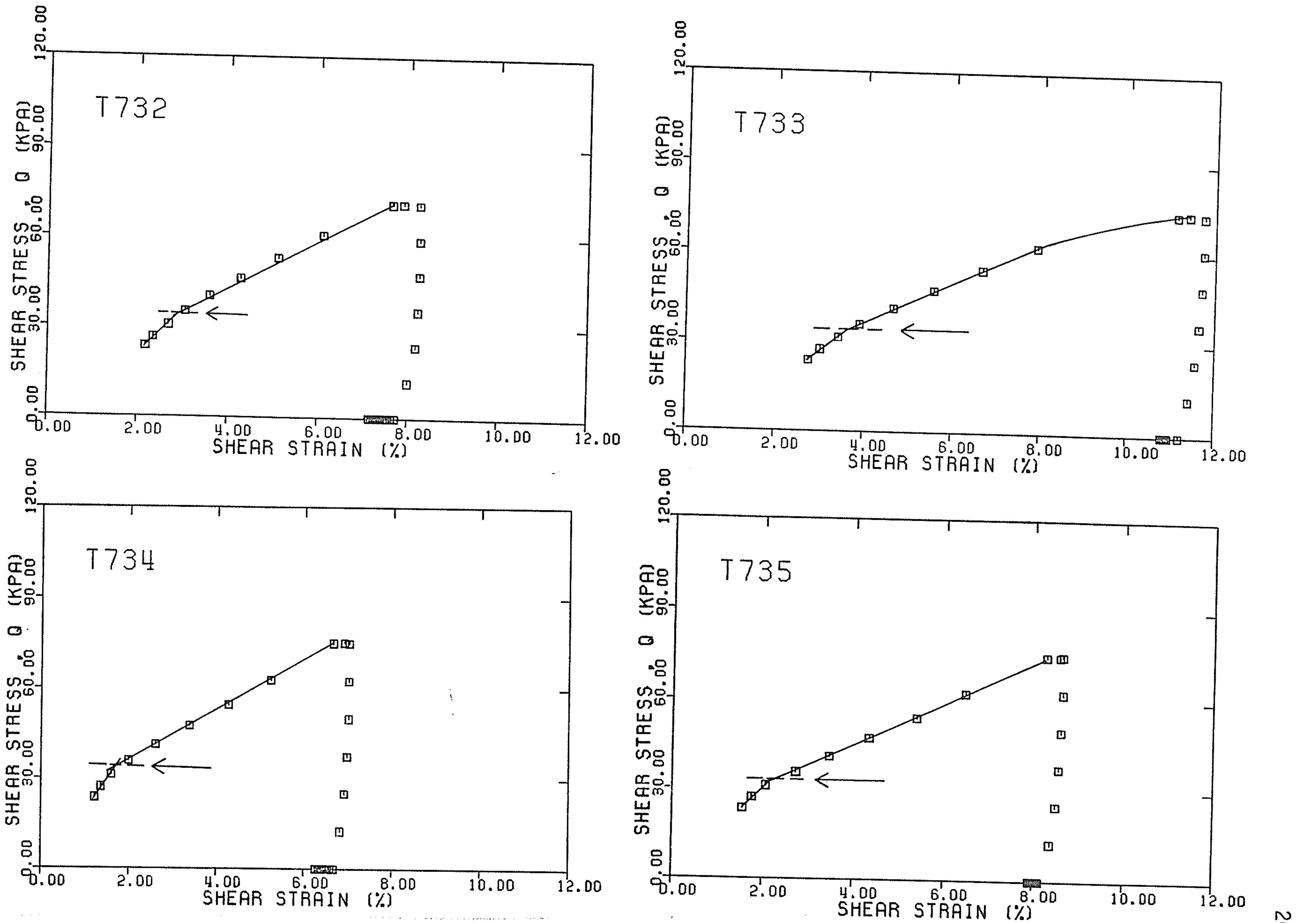


FIGURE B7 a,b,c,d YIELD DETERMINATION—q vs. ε
T732, T733, T734, T735

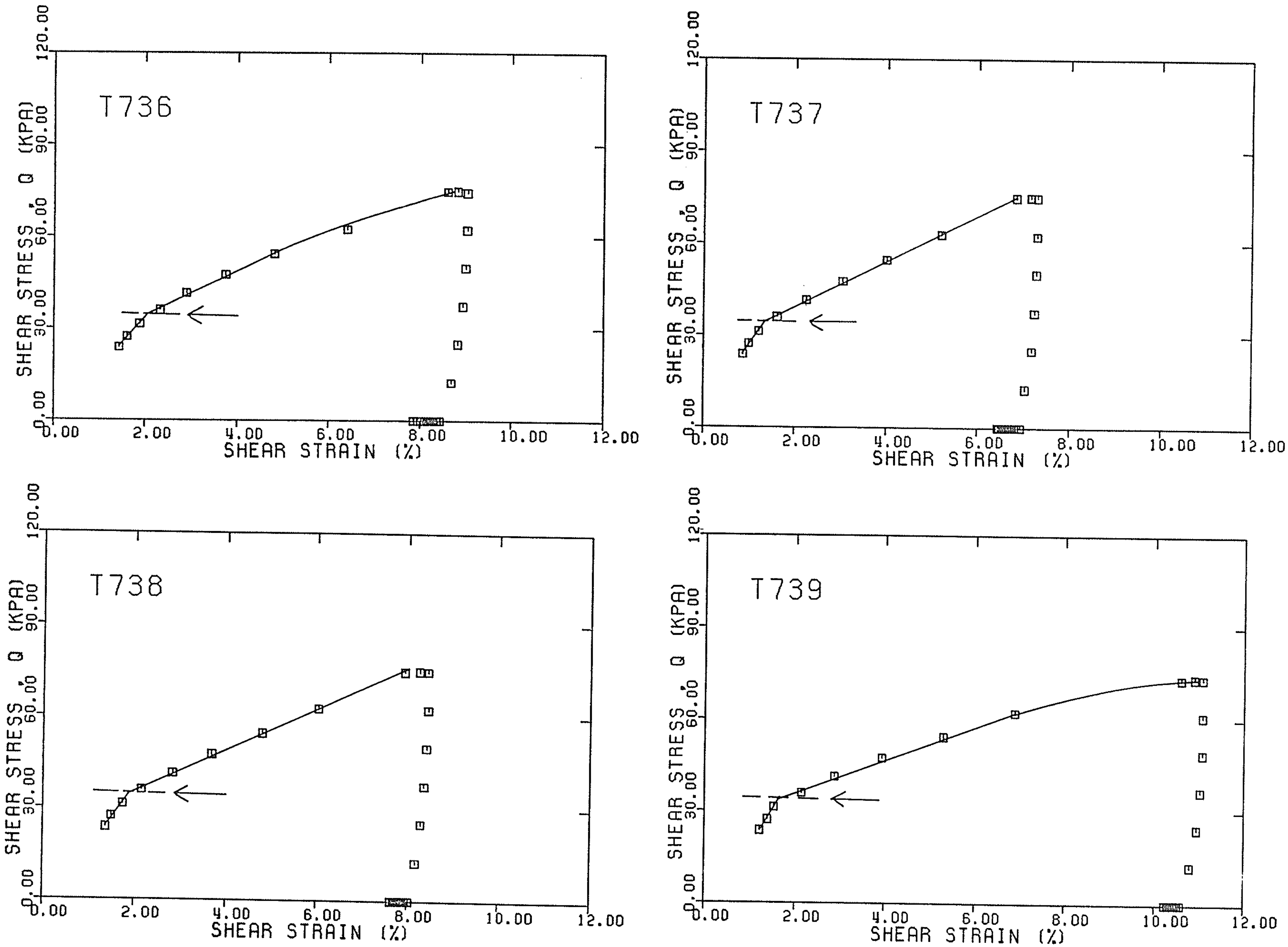


FIGURE B8 a,b,c,d YIELD DETERMINATION—q vs. ε
T736, T737, T738, T739

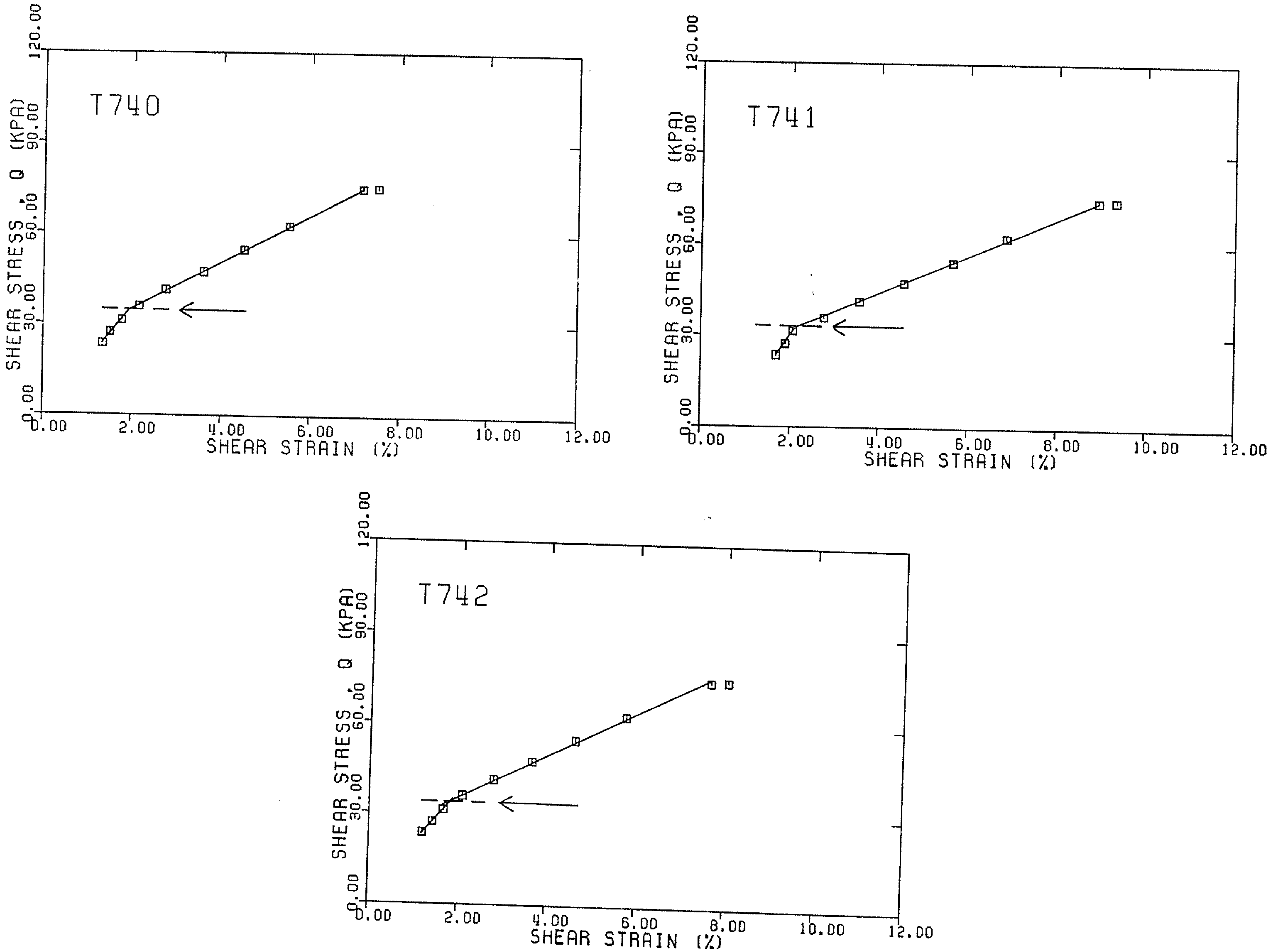


FIGURE B9 a,b,c YIELD DETERMINATION—q vs. ε
T740, T741, T742

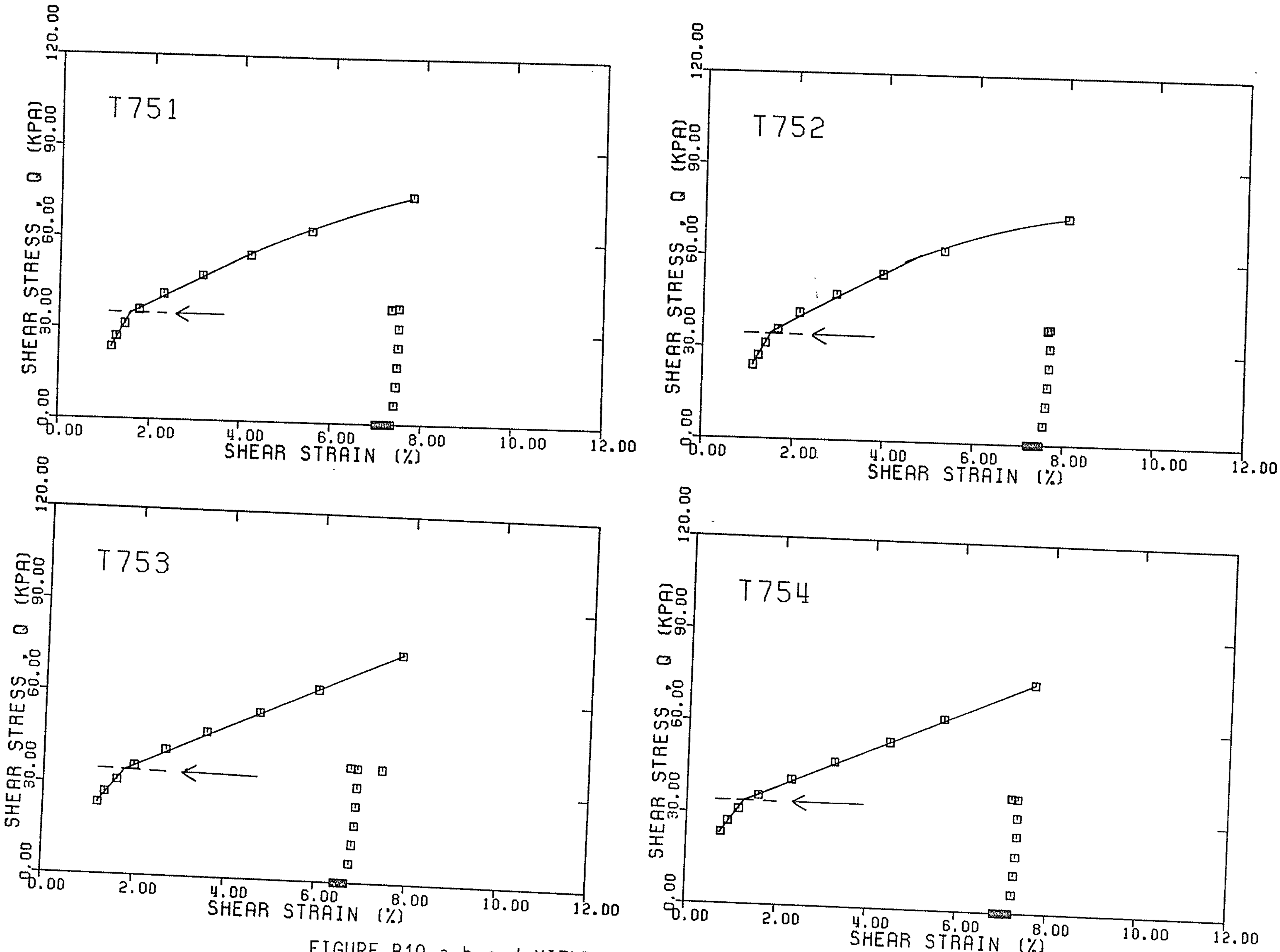


FIGURE B10 a,b,c,d YIELD DETERMINATION—q vs. ε
T751, T752, T753, T754

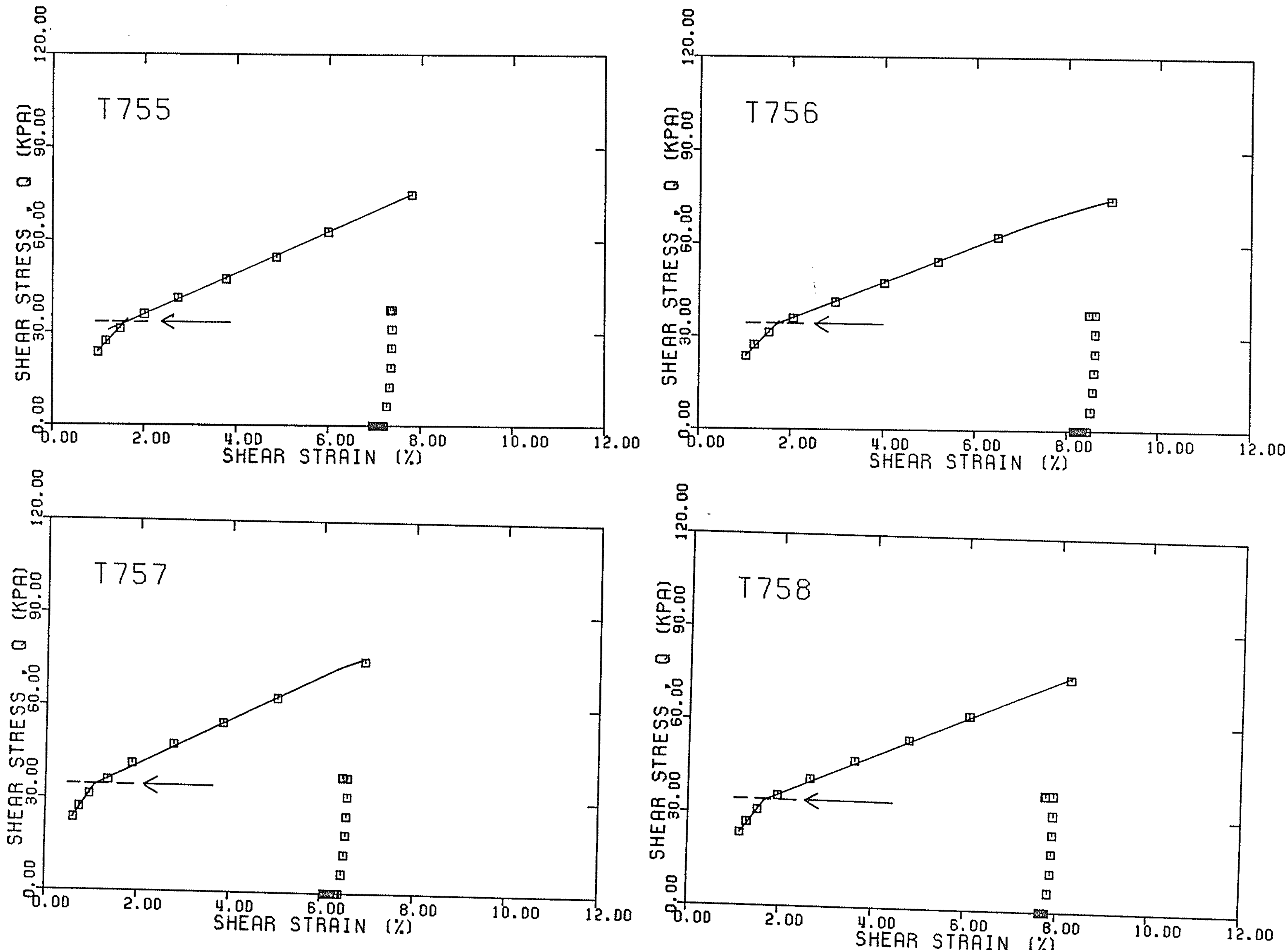


FIGURE B11 a,b,c,d YIELD DETERMINATION—q vs. ε
T755, T756, T757, T758

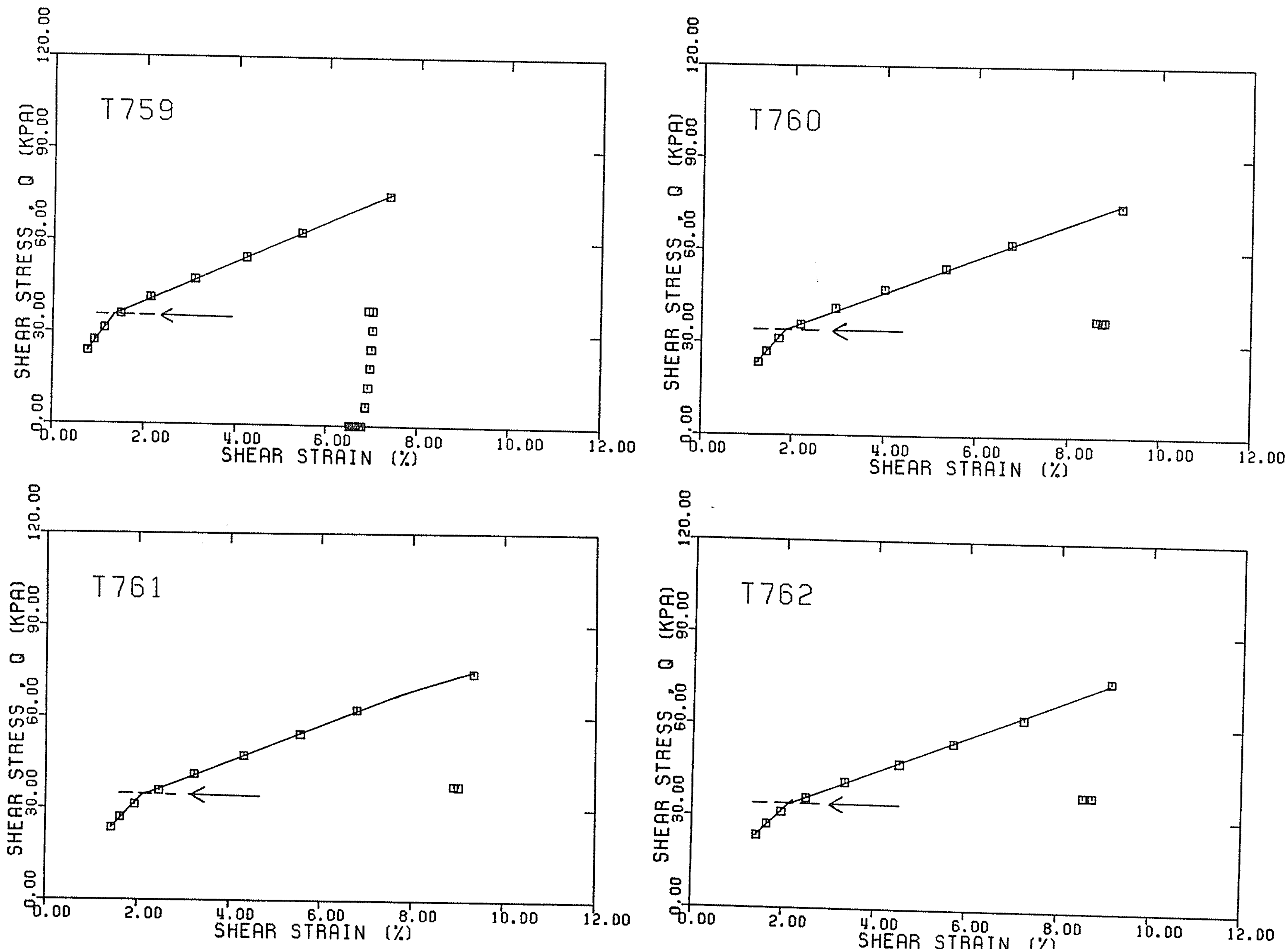


FIGURE B12 a,b,c,d YIELD DETERMINATION—q vs. ε
T759, T760, T761, T762

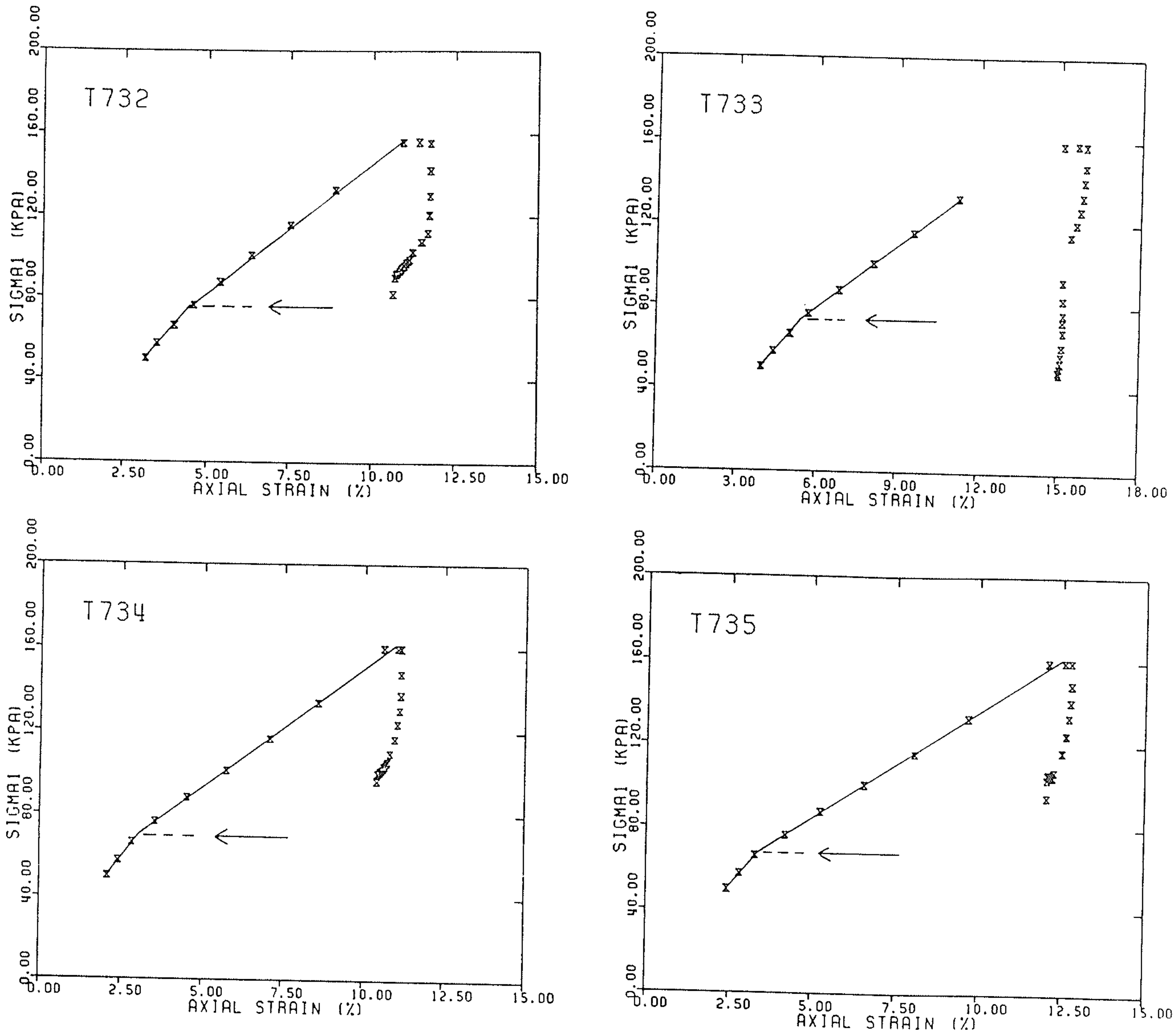


FIGURE B13 a,b,c,d YIELD DETERMINATION—σ_1 vs. ε_1
T732, T733, T734, T735

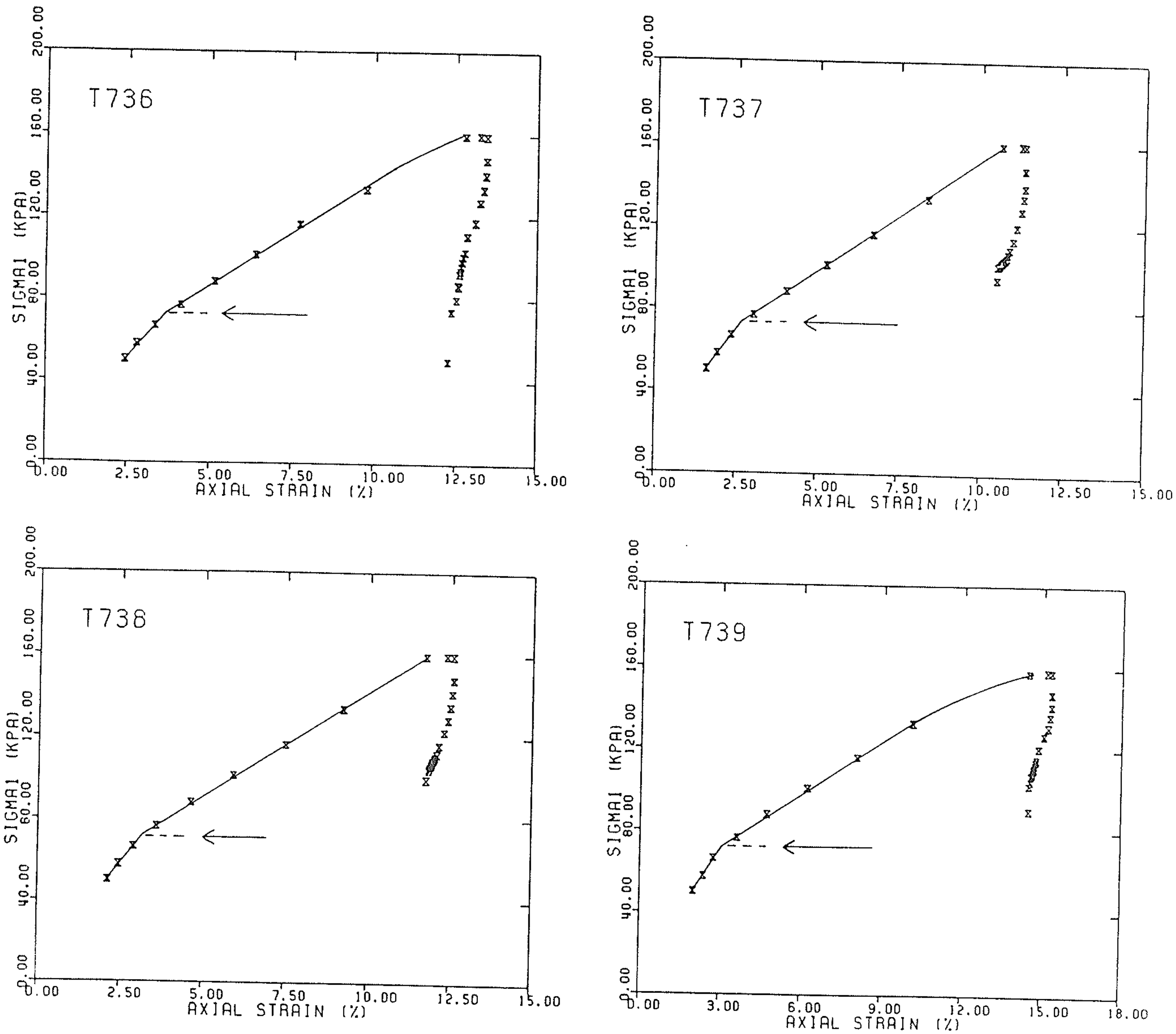


FIGURE B14 a,b,c,d YIELD DETERMINATION—σ_1 VS. ε_1

T736, T737, T738, T739

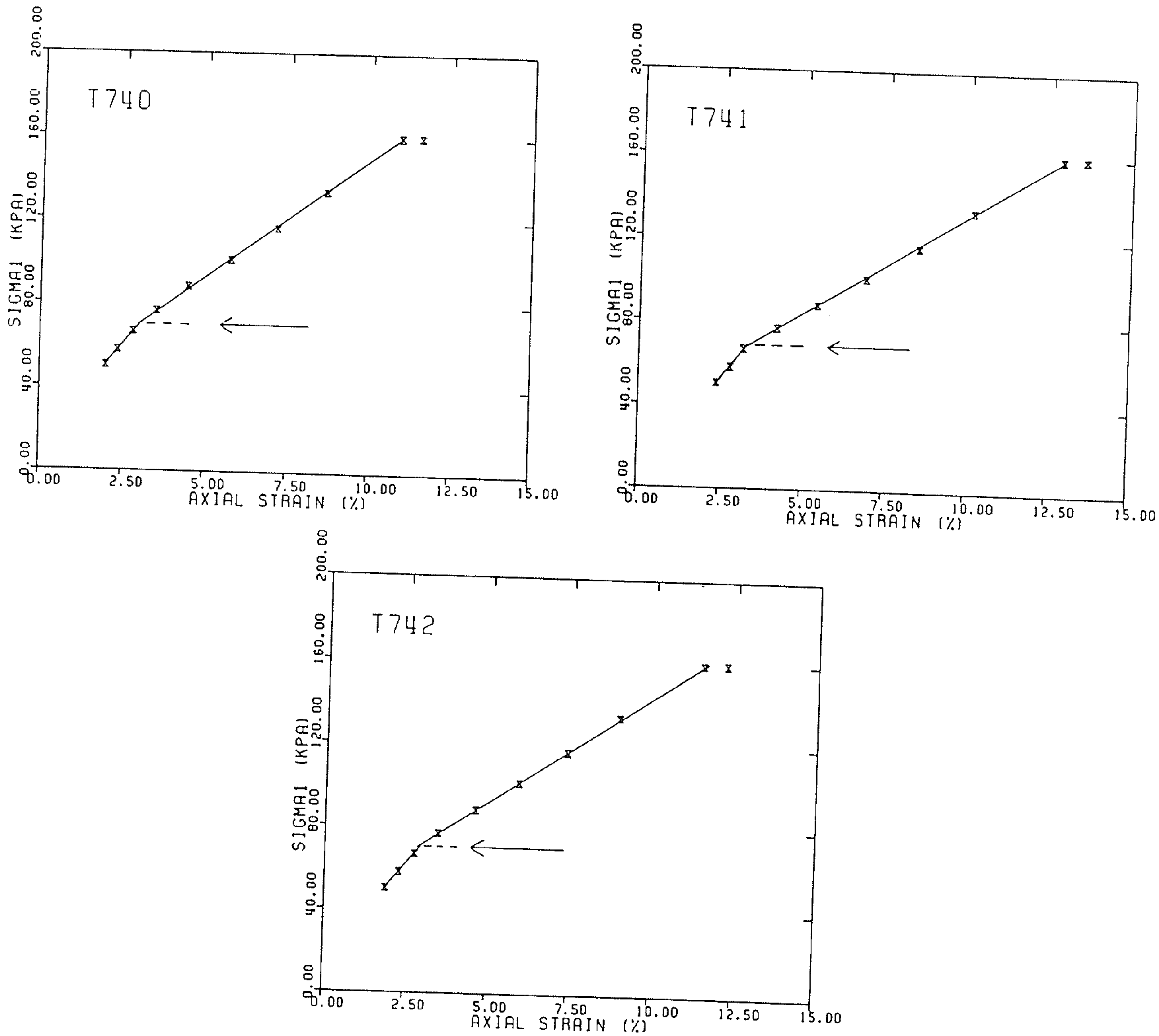


FIGURE B15 a,b,c YIELD DETERMINATION—σ_1 vs. ε_1
T740, T741, T742

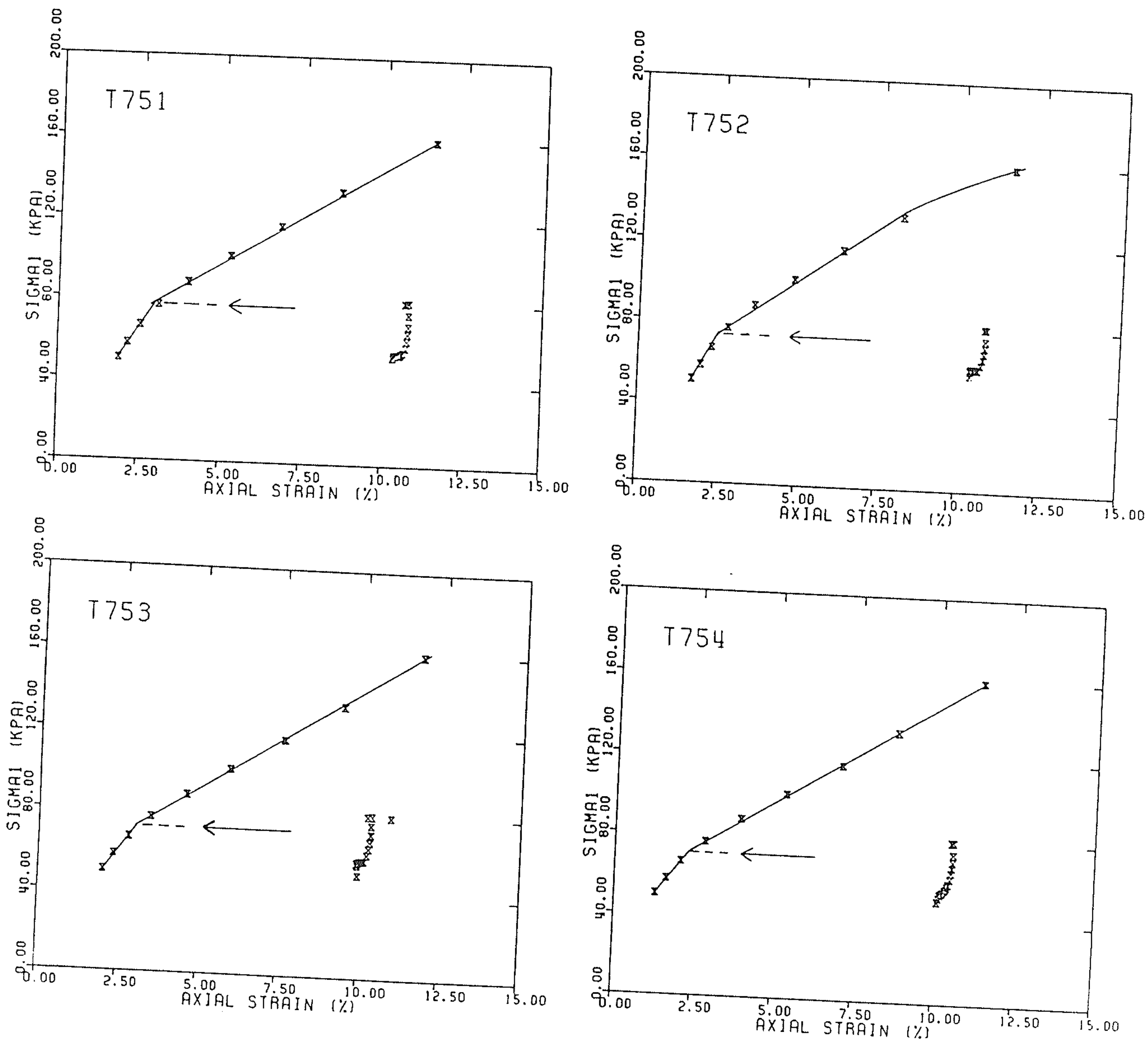


FIGURE B16 a,b,c,d YIELD DETERMINATION— σ_1 vs. ε_1
T751, T752, T753, T754

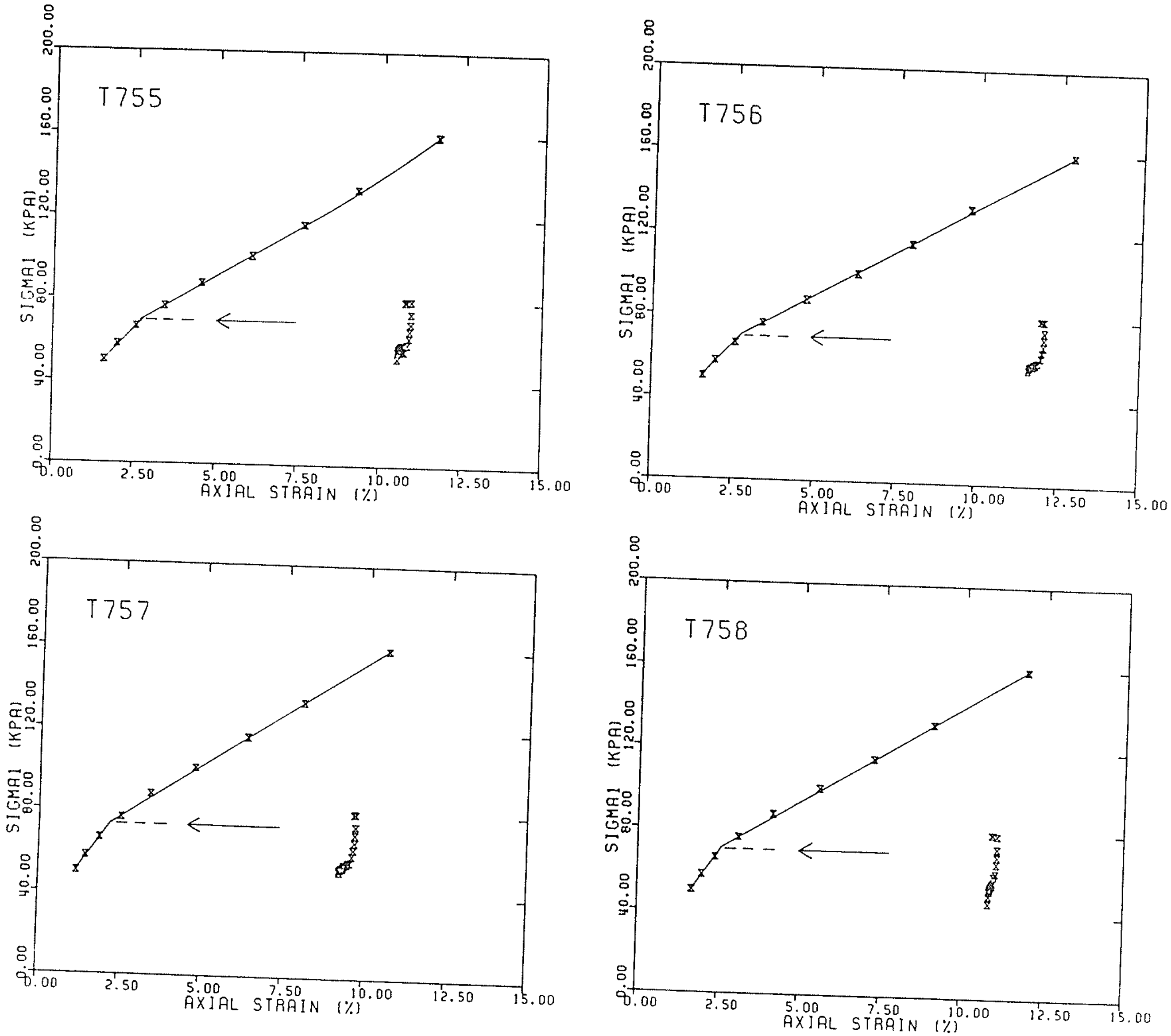


FIGURE B17 a,b,c,d YIELD DETERMINATION— σ_1 VS. ε_1
T755, T756, T757, T758

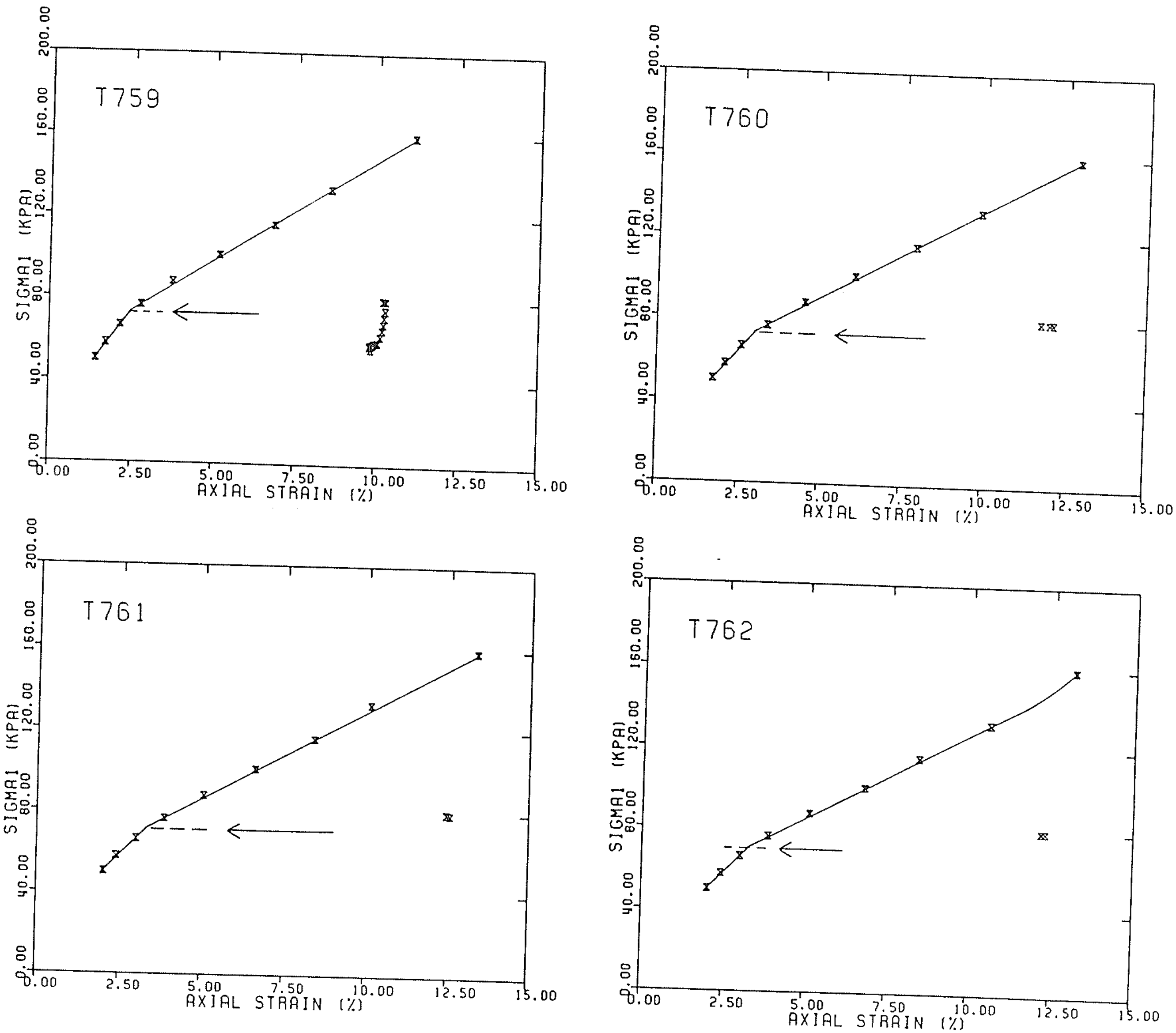


FIGURE B18 a,b,c,d YIELD DETERMINATION— σ_1 VS. ϵ_1
T759, T760, T761, T762

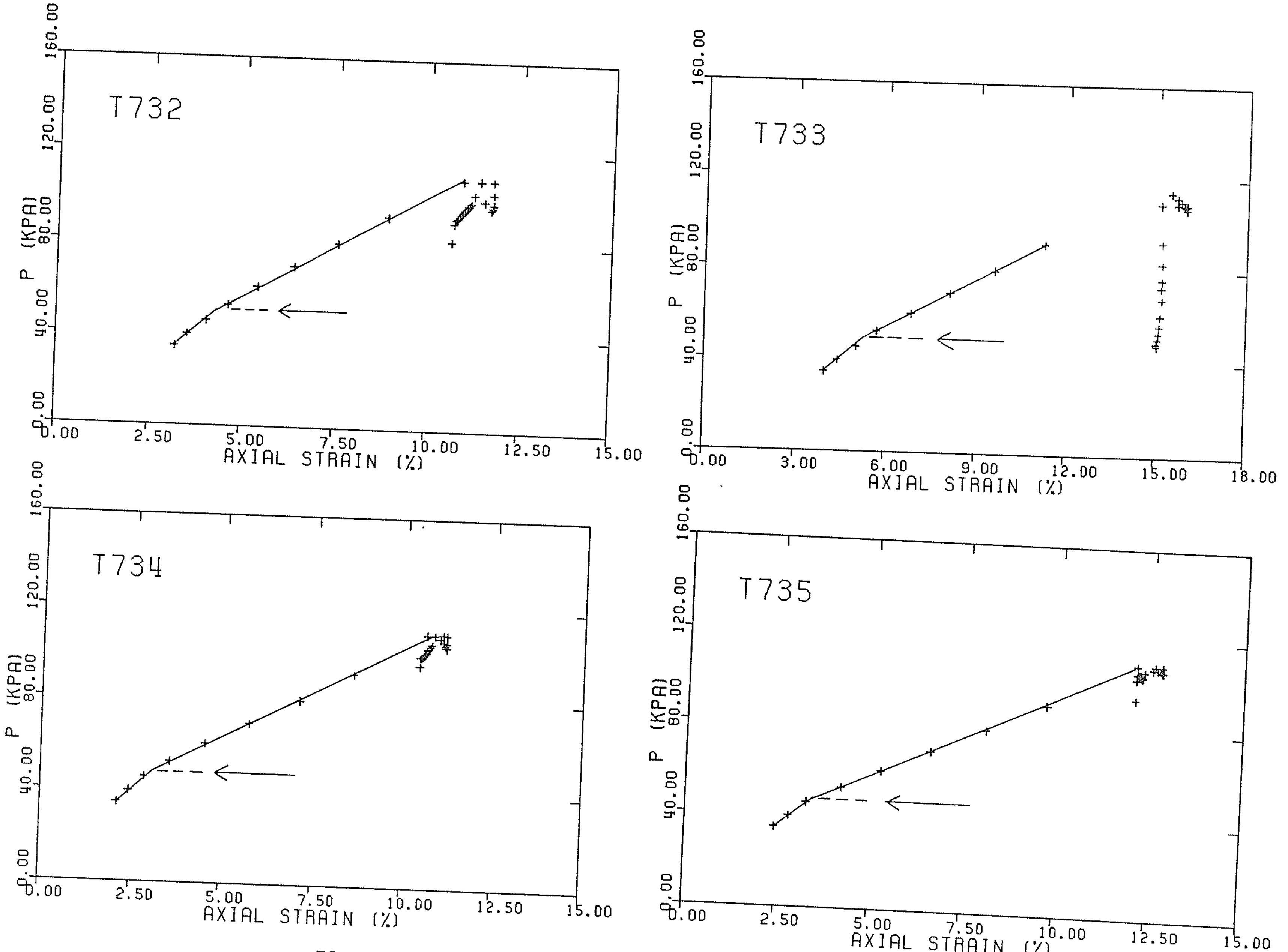


FIGURE B19 a,b,c,d YIELD DETERMINATION—p' vs. ε_1
T732, T733, T734, T735

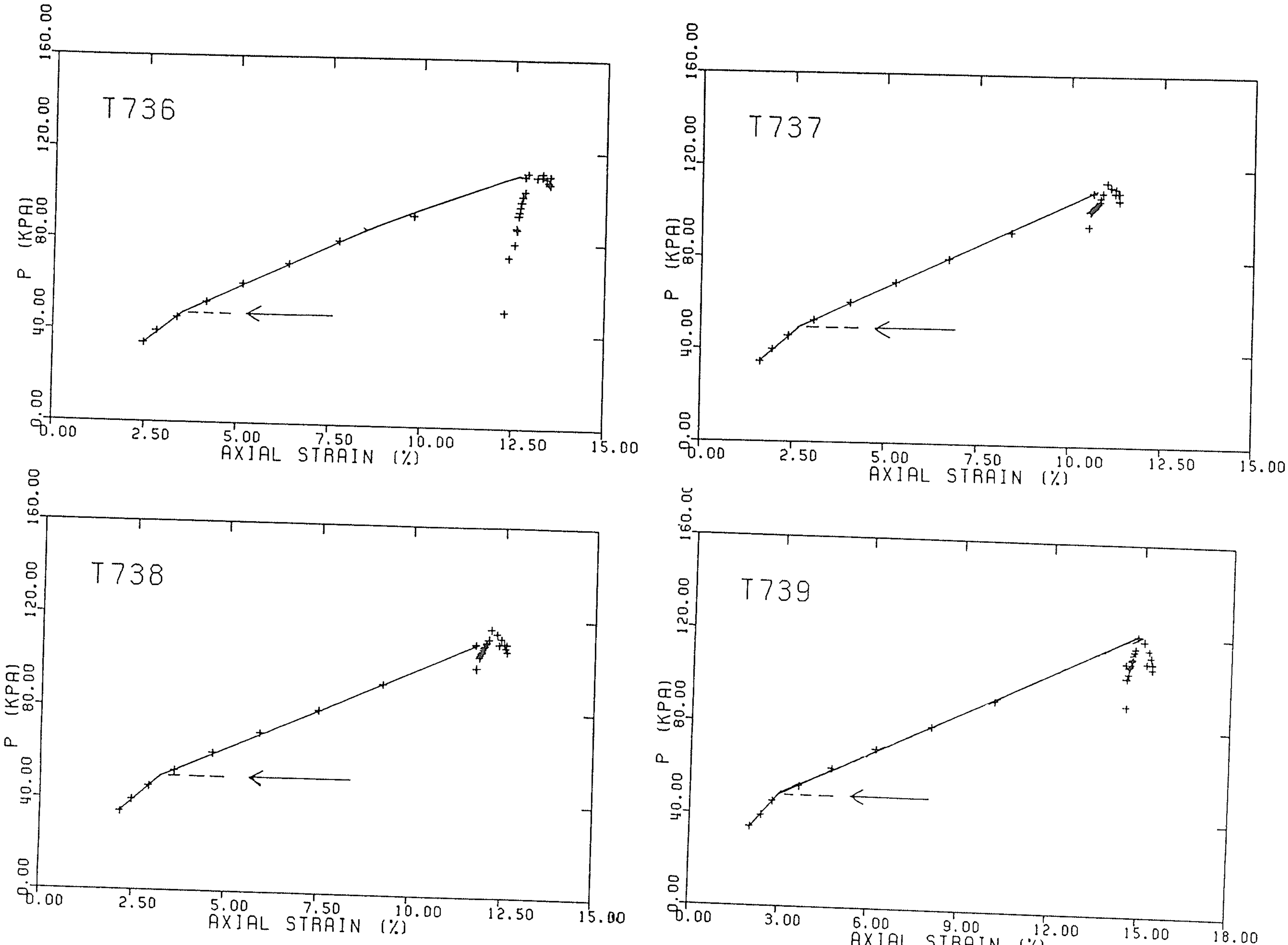


FIGURE B20 a,b,c,d YIELD DETERMINATION—p' vs. ε_1
T736, T737, T738, T739

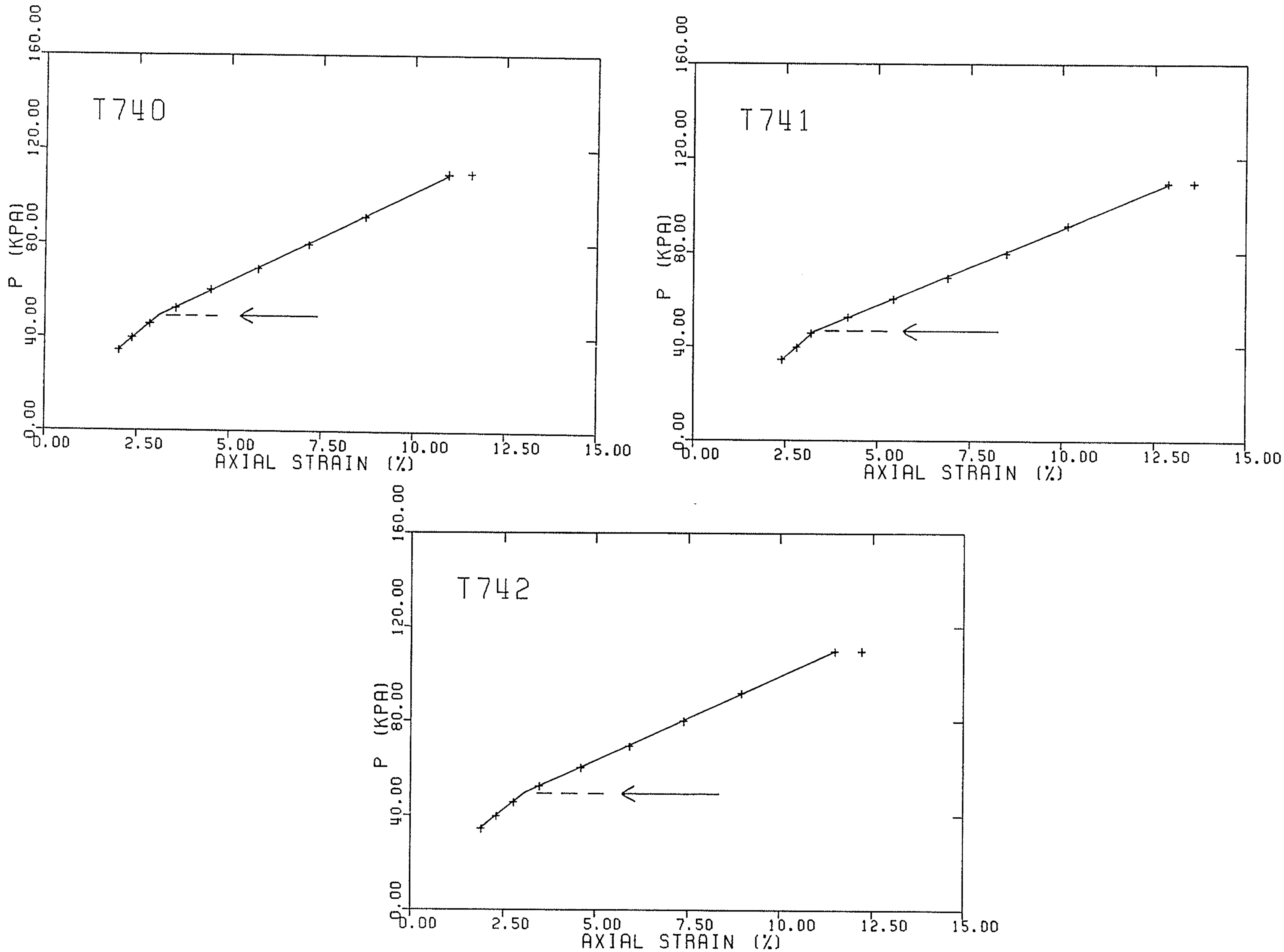


FIGURE B21 a,b,c YIELD DETERMINATION—p' vs. ε_1
T740, T741, T742

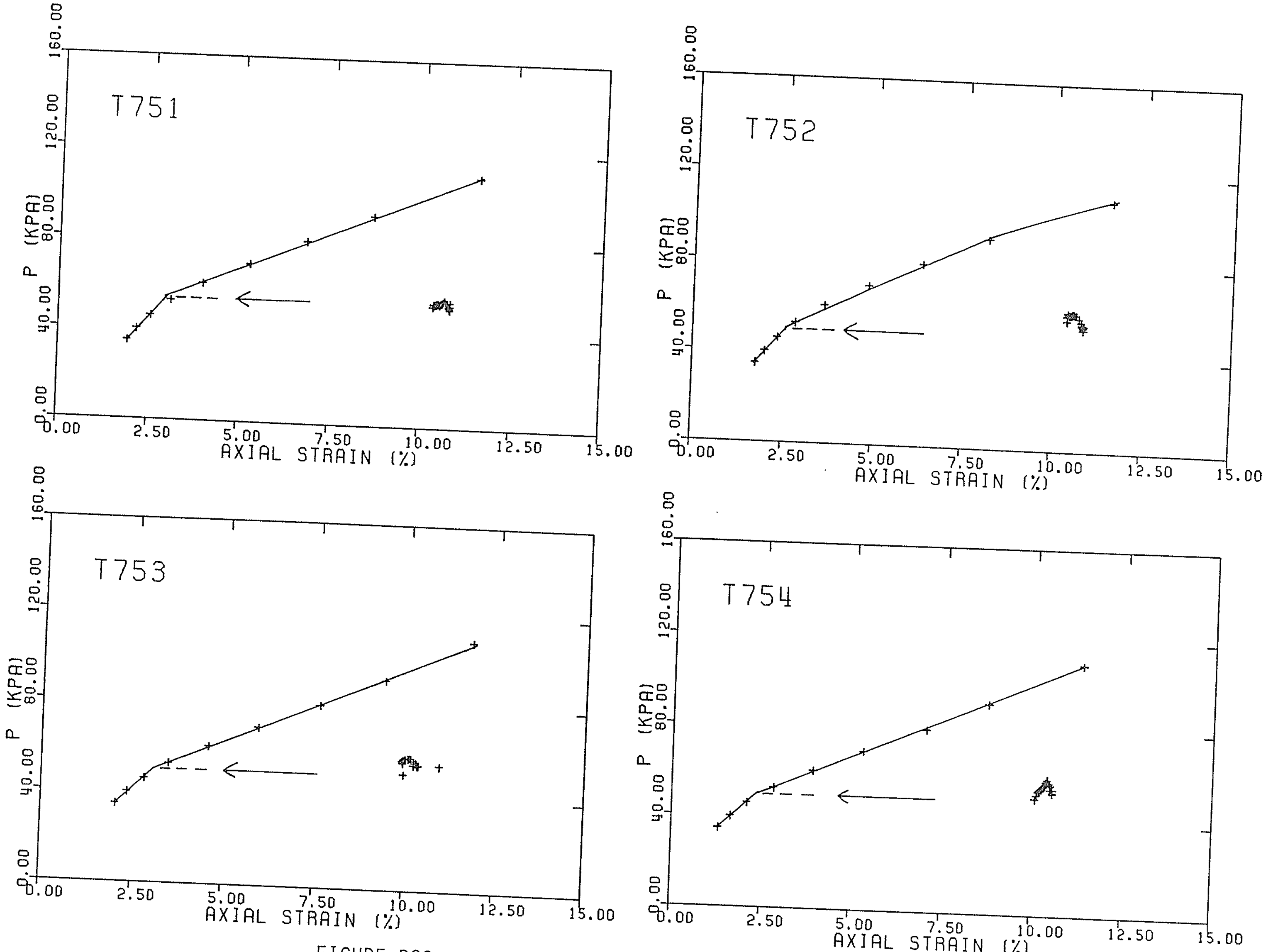


FIGURE B22 a,b,c,d YIELD DETERMINATION—p' vs. ε_1
T751, T752, T753, T754

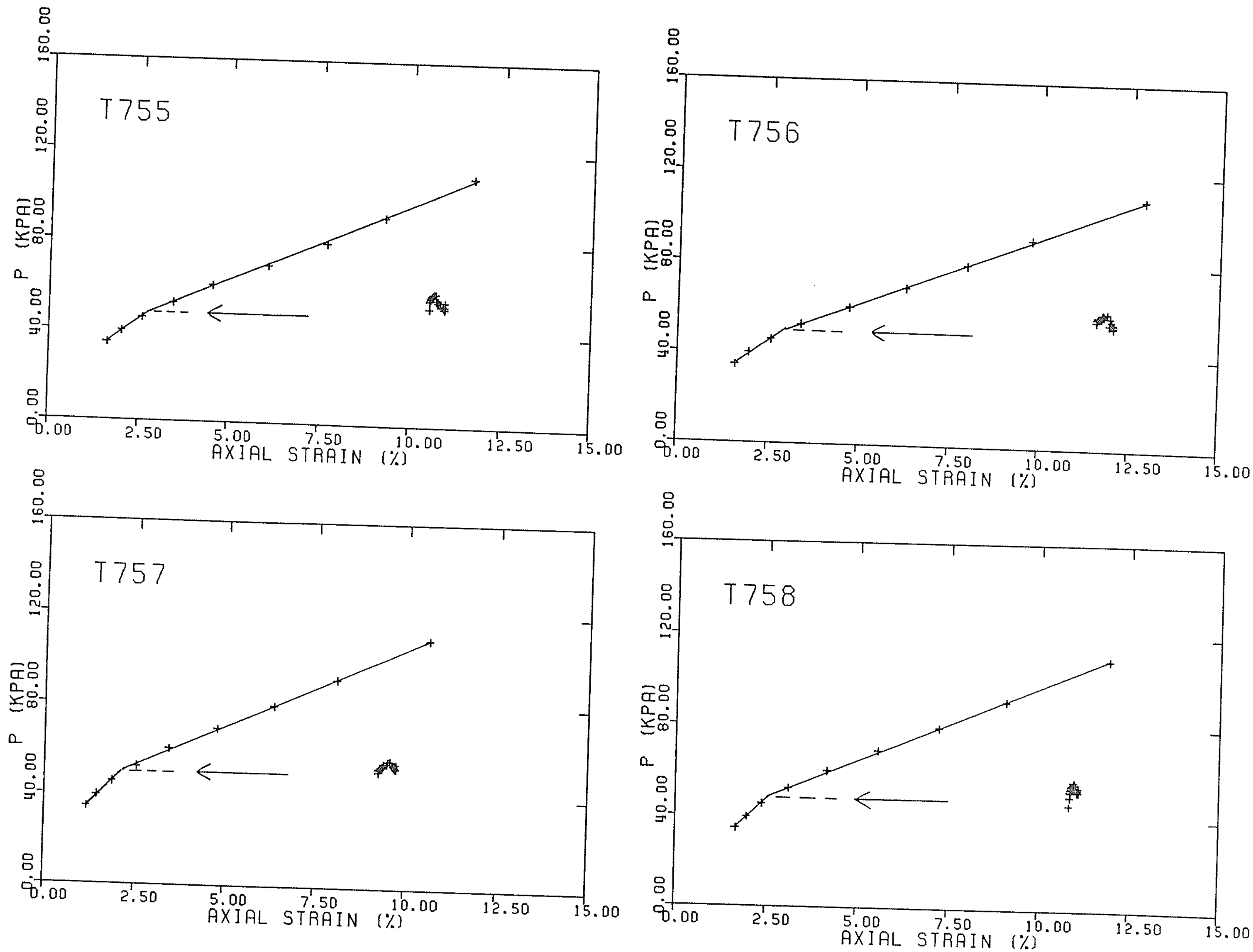


FIGURE B23 a,b,c,d YIELD DETERMINATION—p' vs. ε_1
T755, T756, T757, T758

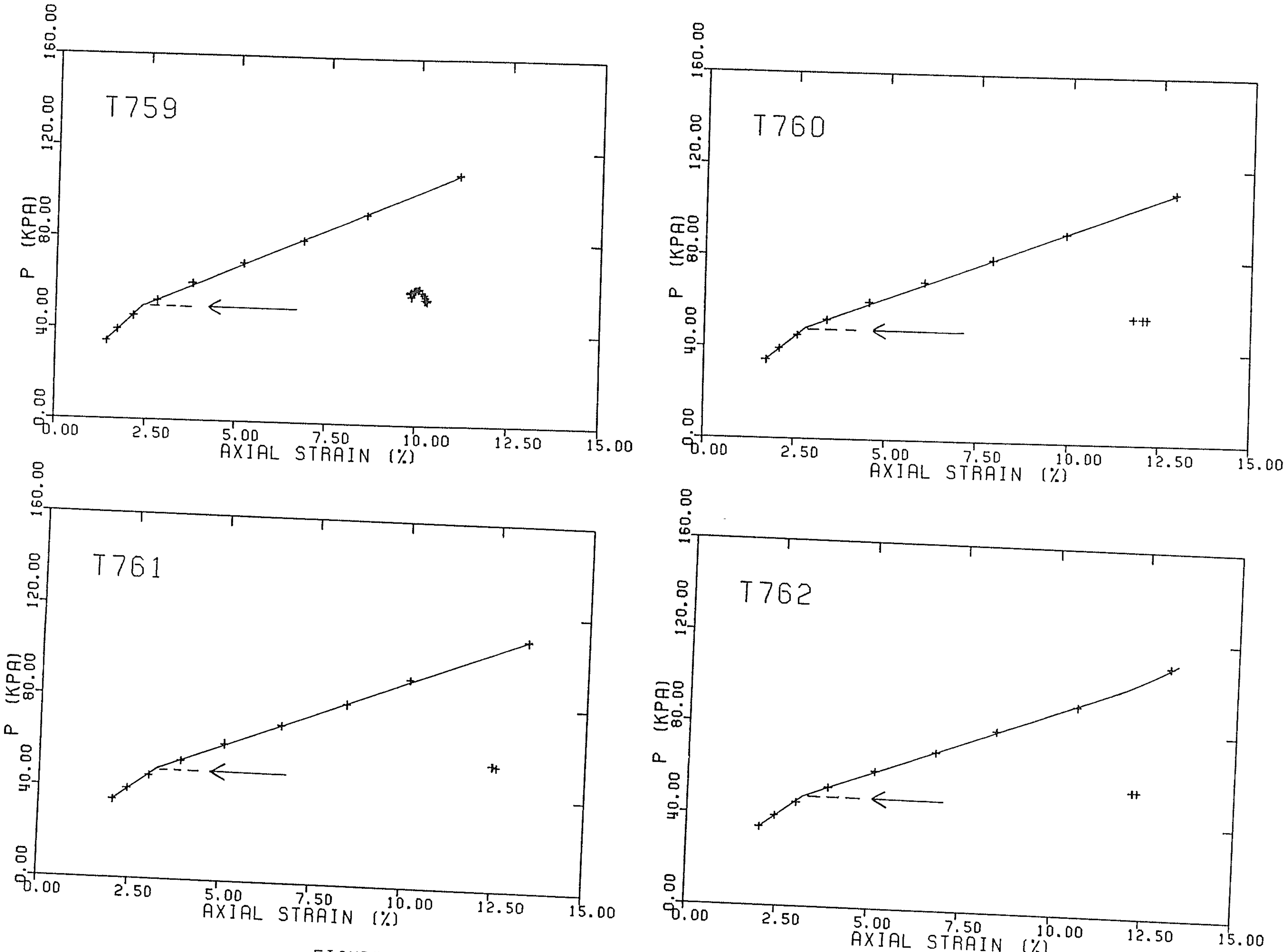


FIGURE B24 a,b,c,d YIELD DETERMINATION—p' vs. ε_1
T759, T760, T761, T762

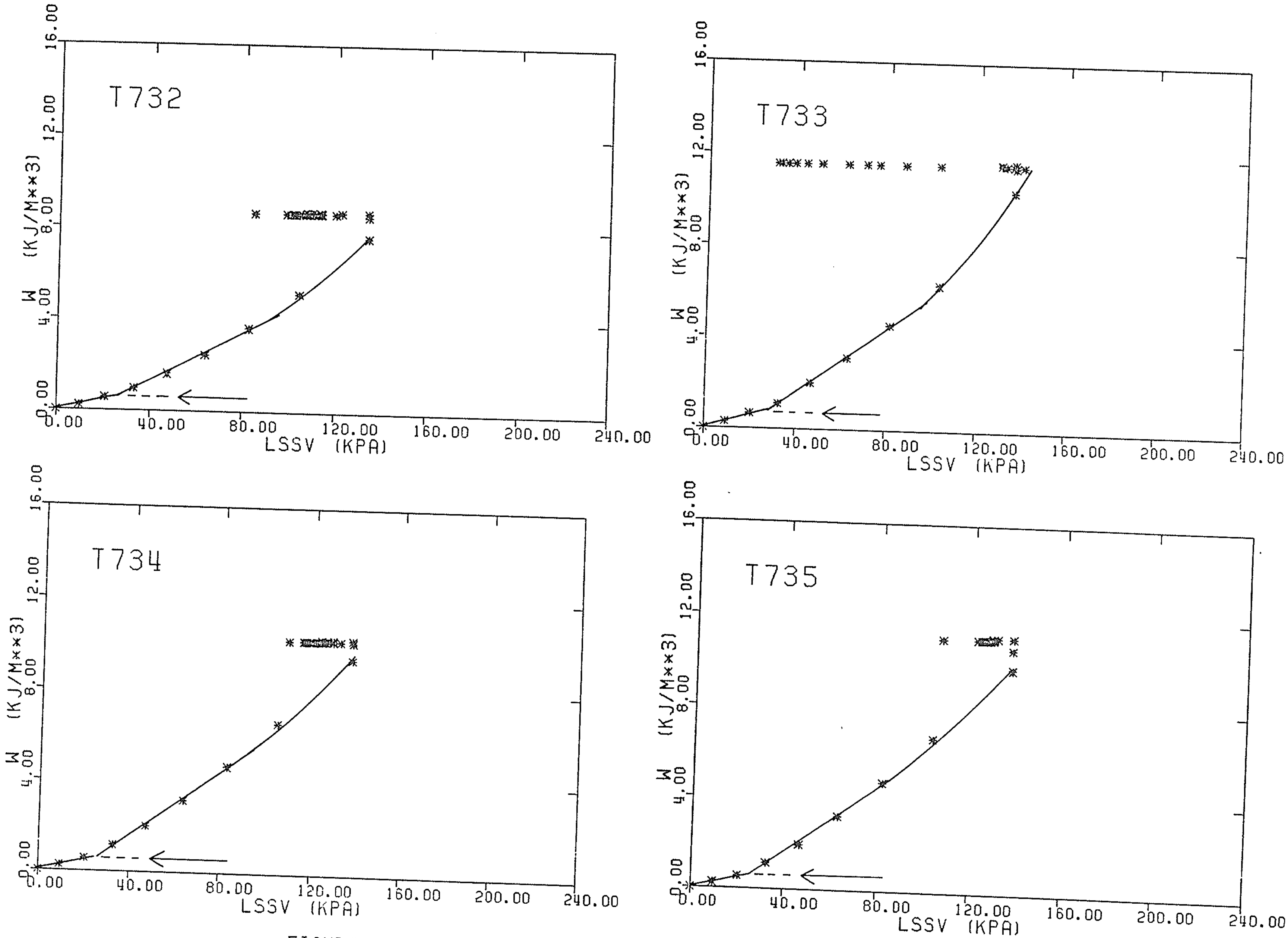


FIGURE B25 a,b,c,d YIELD DETERMINATION—W vs. LSSV
T732, T733, T734, T735

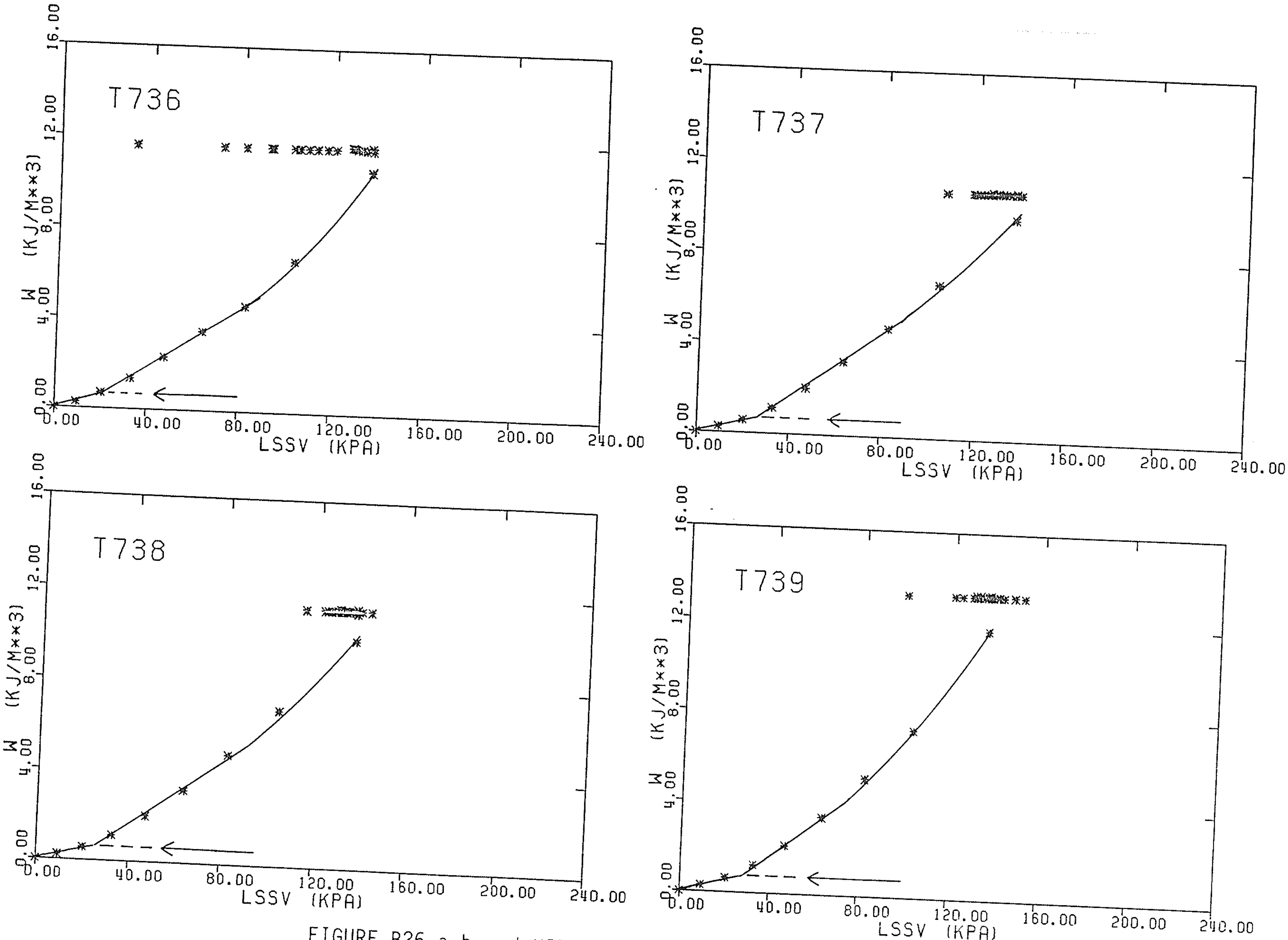


FIGURE B26 a,b,c,d YIELD DETERMINATION— W vs. LSSV
T736, T737, T738, T739

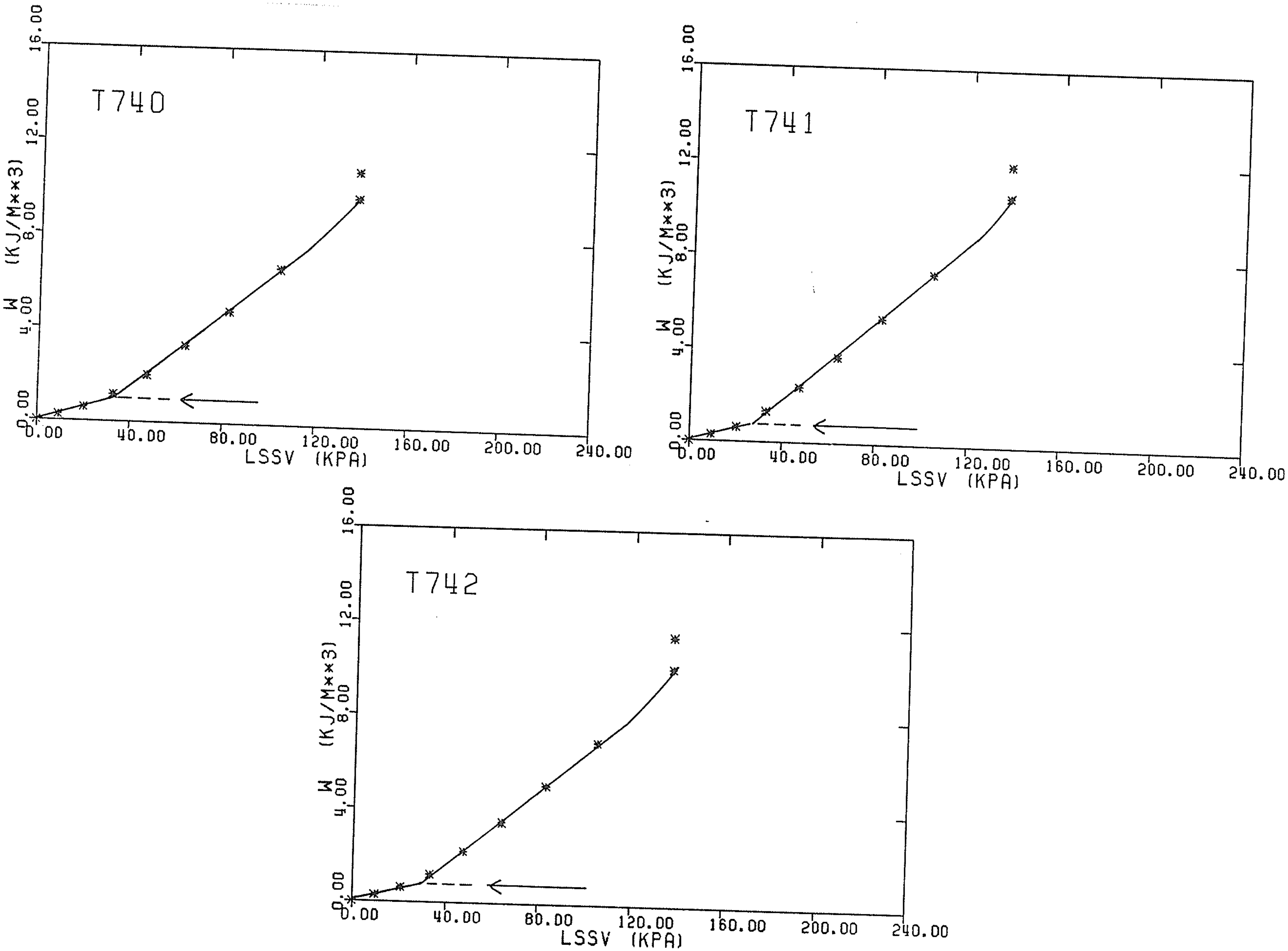


FIGURE B27 a,b,c YIELD DETERMINATION—W vs. LSSV
T740, T741, T742

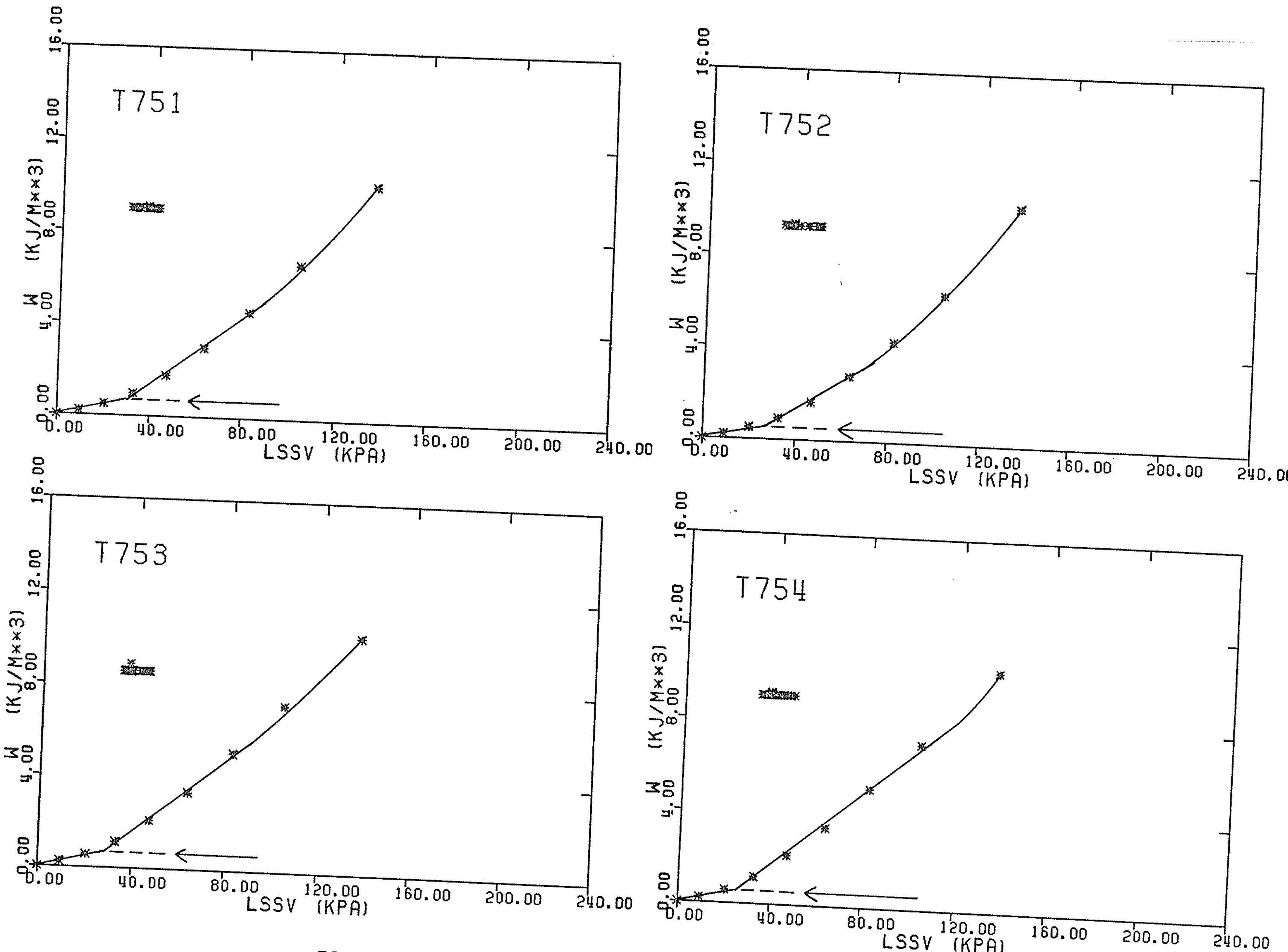


FIGURE B28 a,b,c,d YIELD DETERMINATION—W vs. LSSV
T751, T752, T753, T754

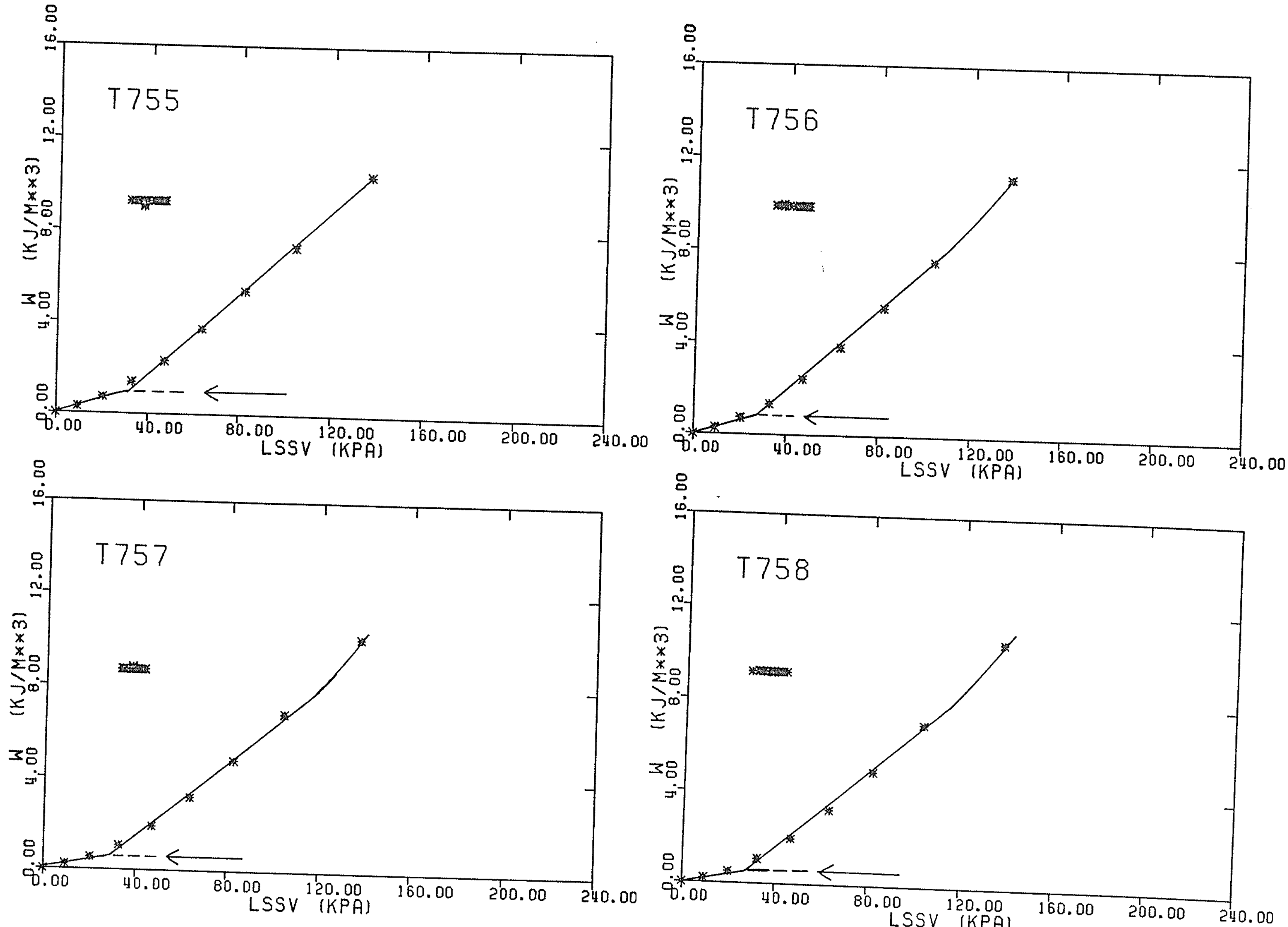


FIGURE B29 a,b,c,d YIELD DETERMINATION—W vs. LSSV
T755, T756, T757, T758

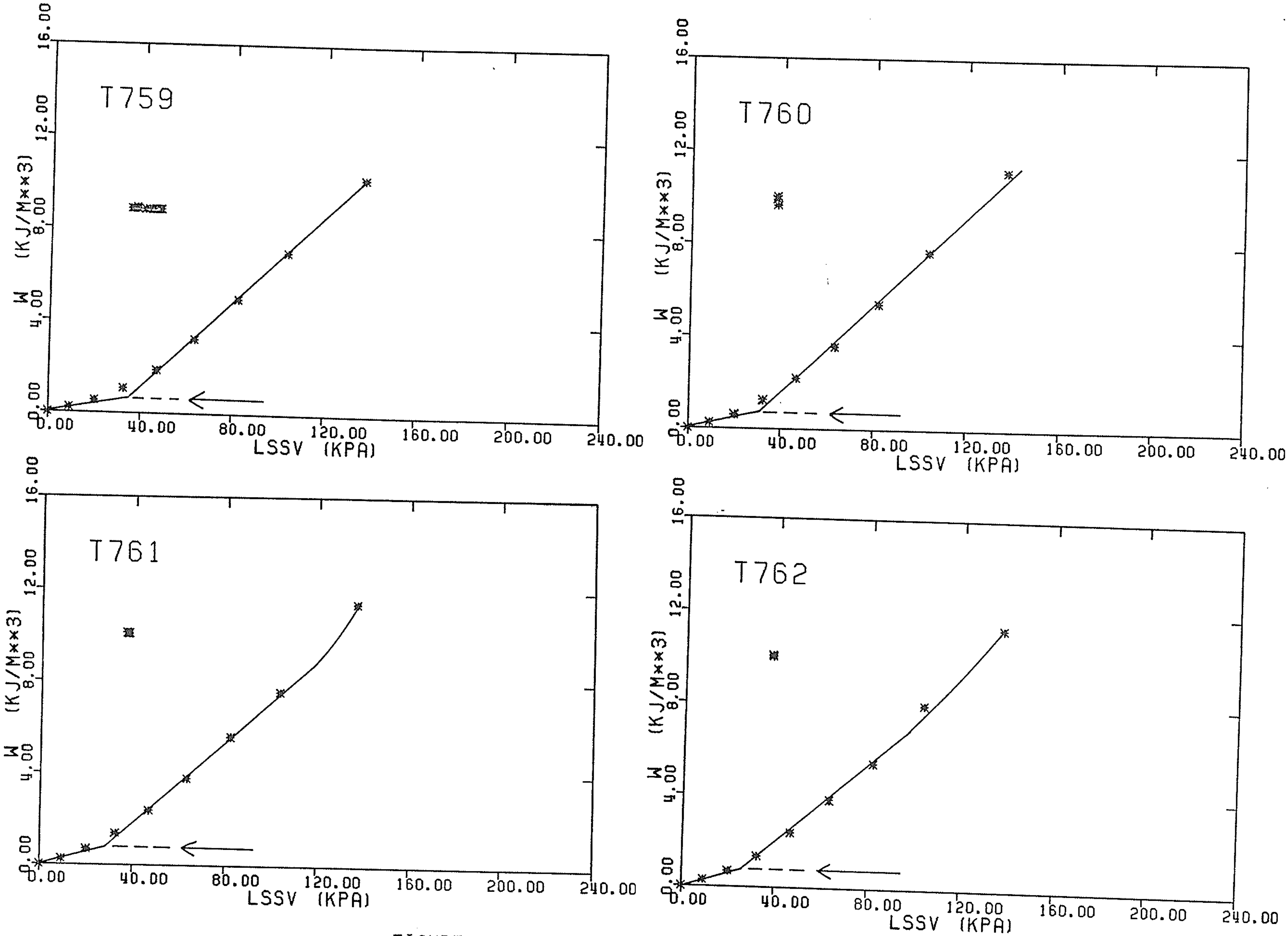


FIGURE B30 a,b,c,d YIELD DETERMINATION—W vs. LSSV
T759, T760, T761, T762

APPENDIX C

ADDITIONAL PLOTS FOR UNDRAINED SHEAR TESTS

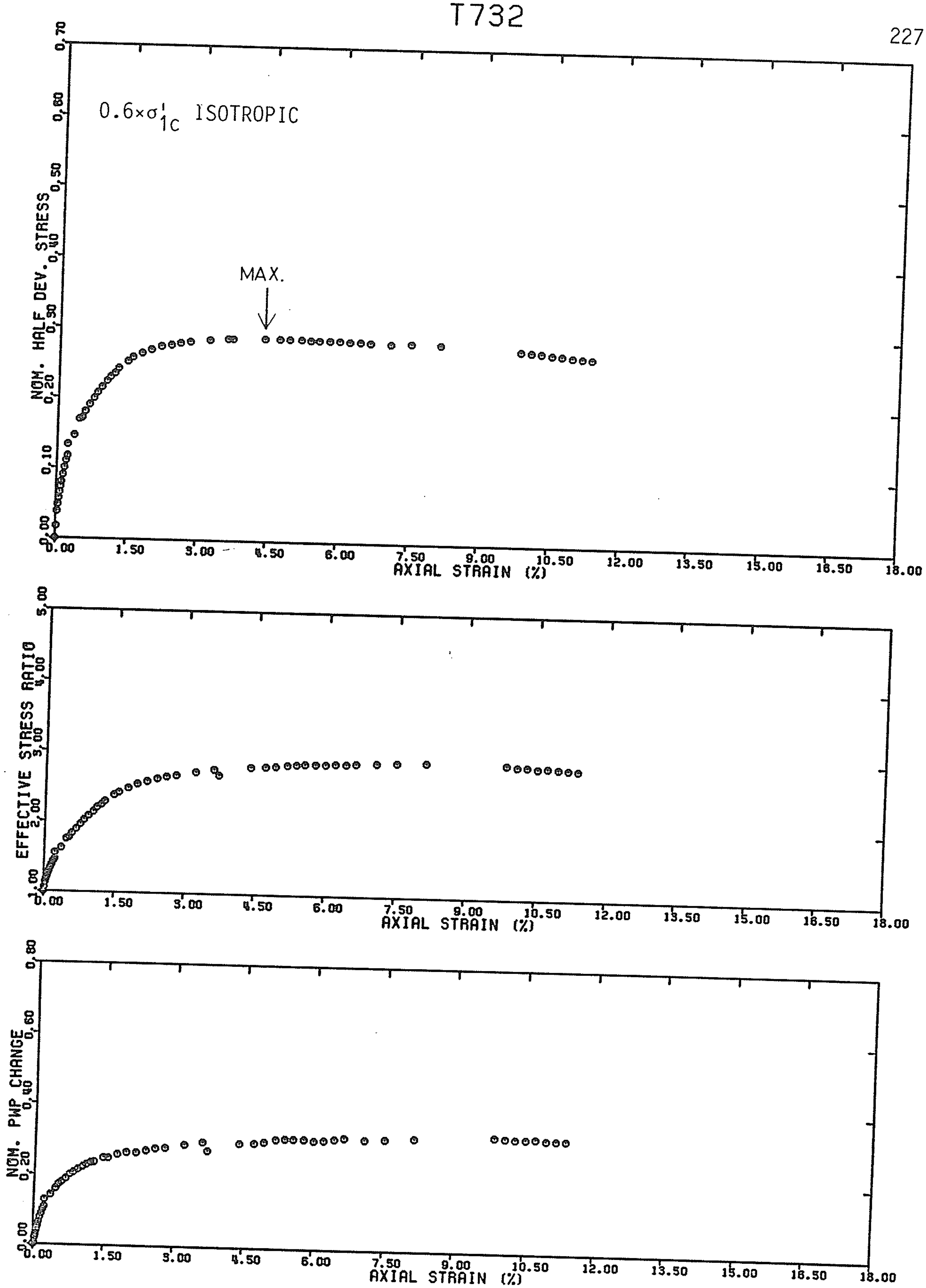


FIGURE C1 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T732

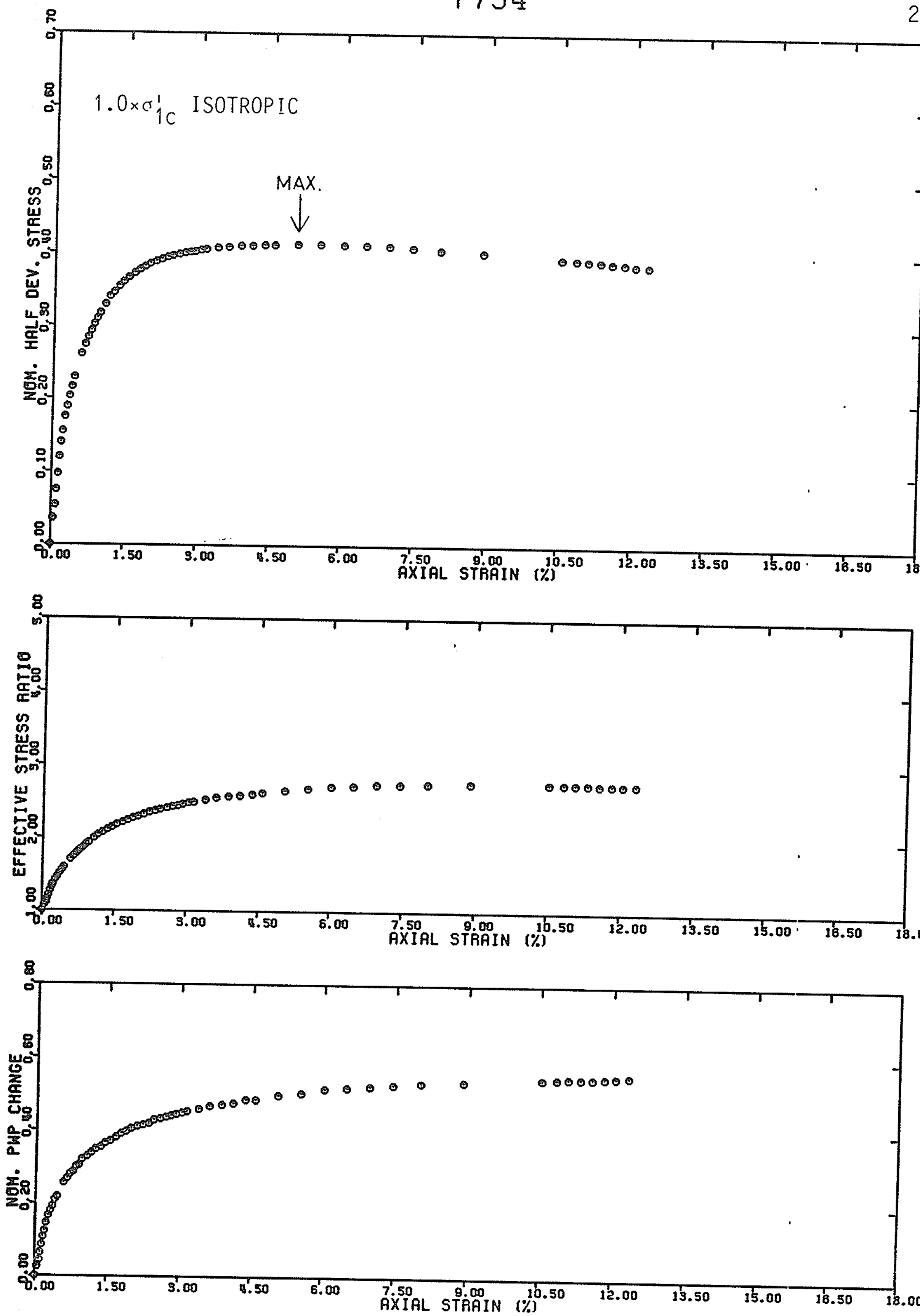


FIGURE C2 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T734

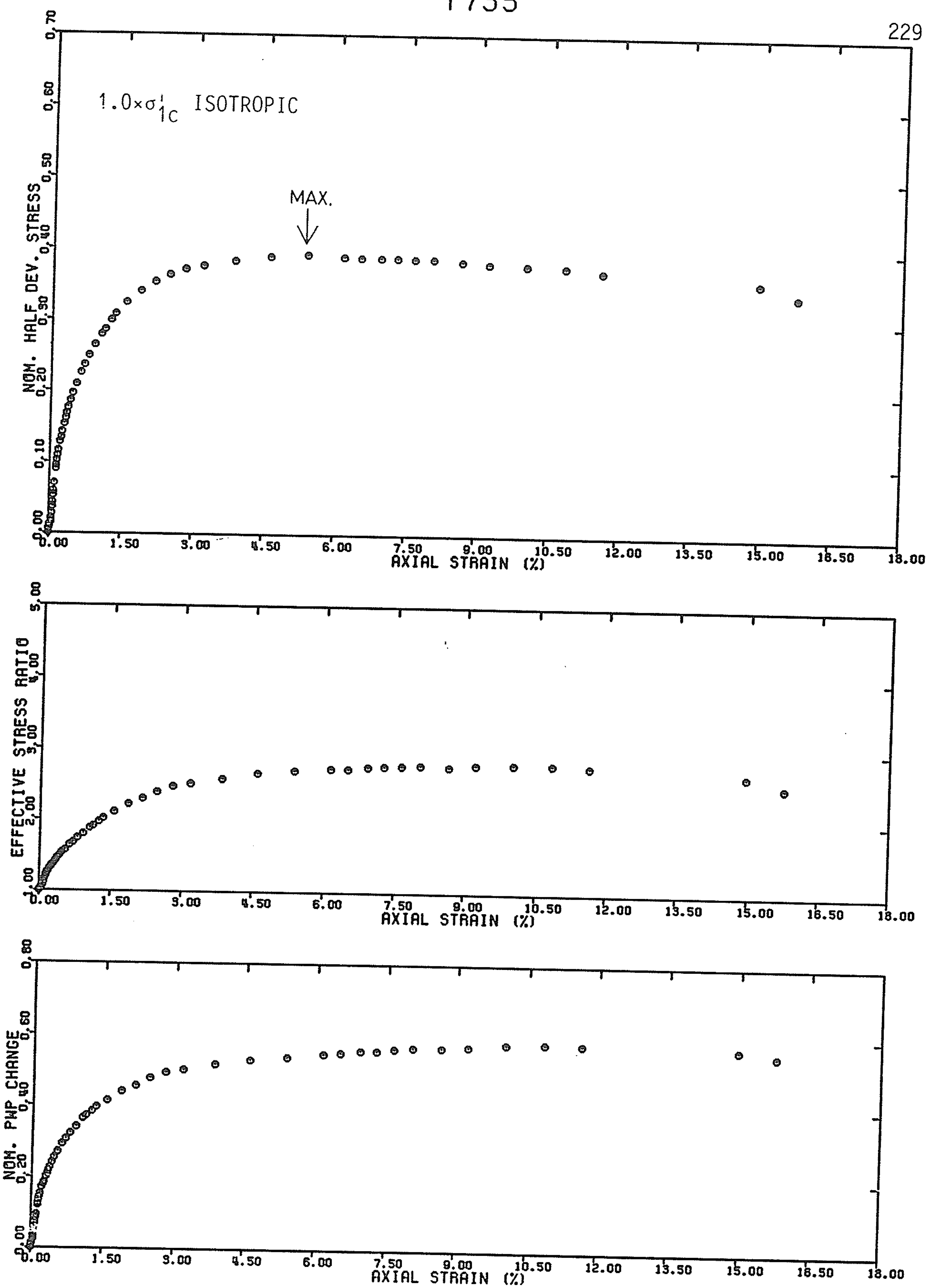


FIGURE C3 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T735

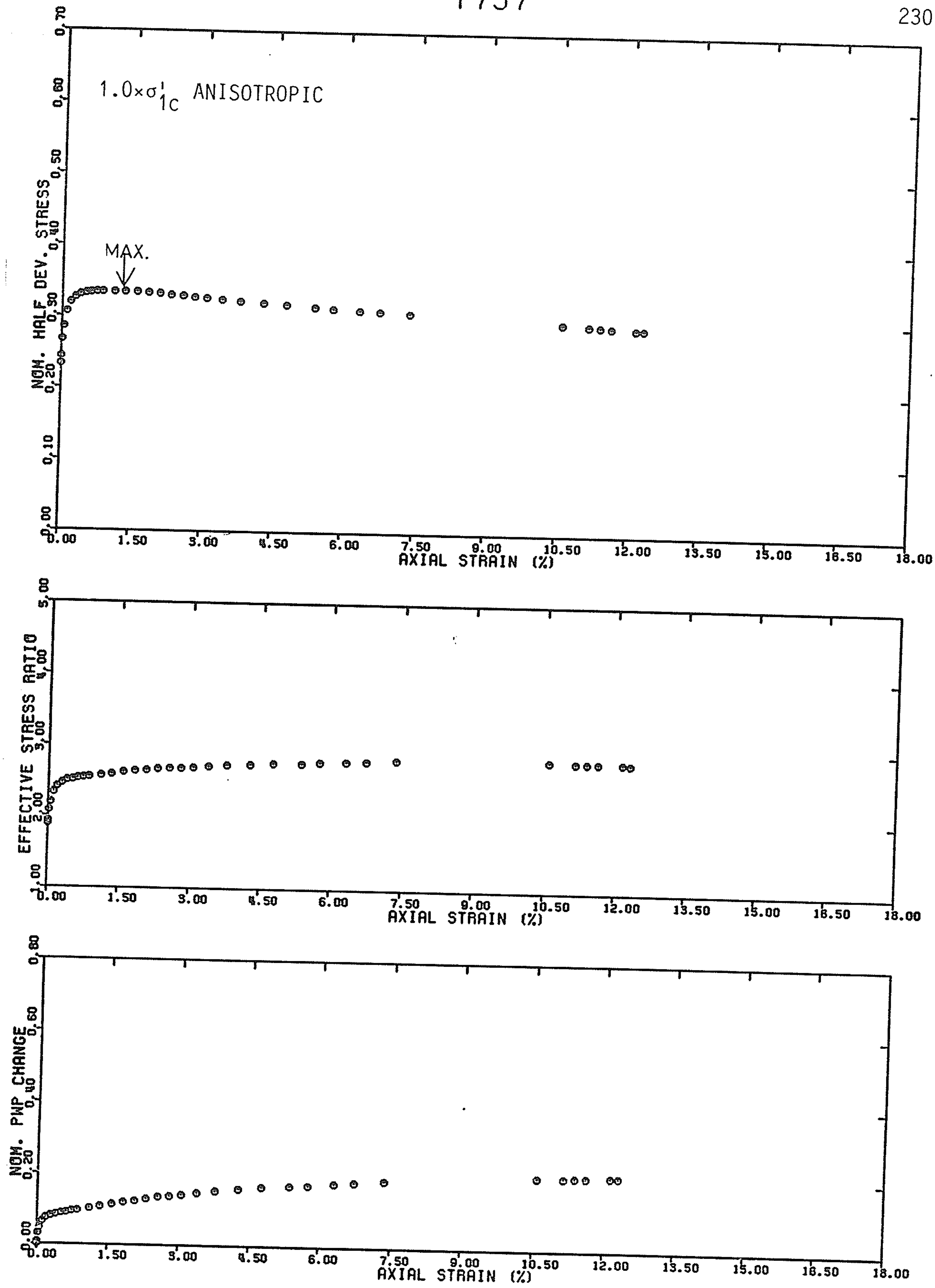


FIGURE C4 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T737

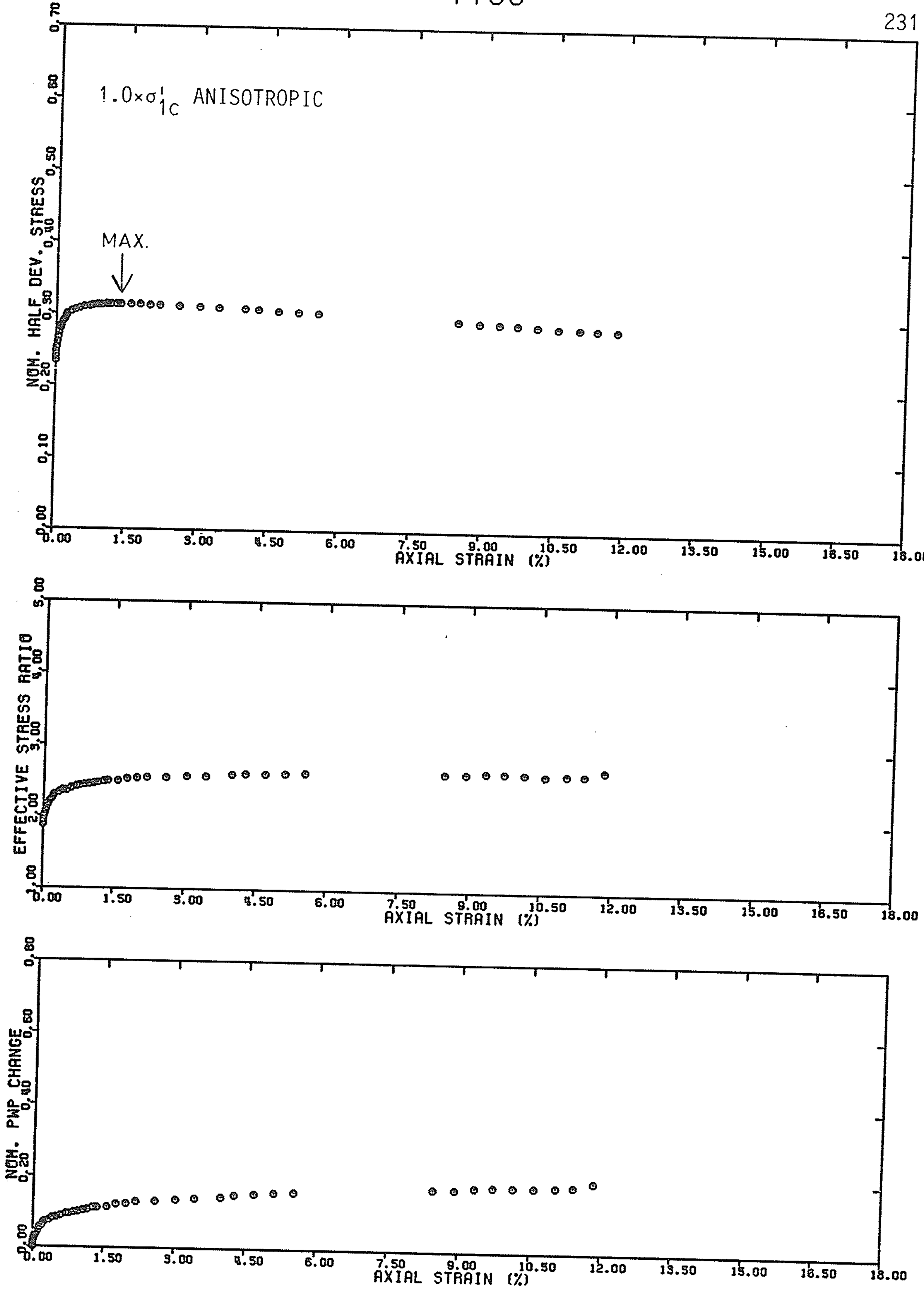


FIGURE C5 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T738

T740

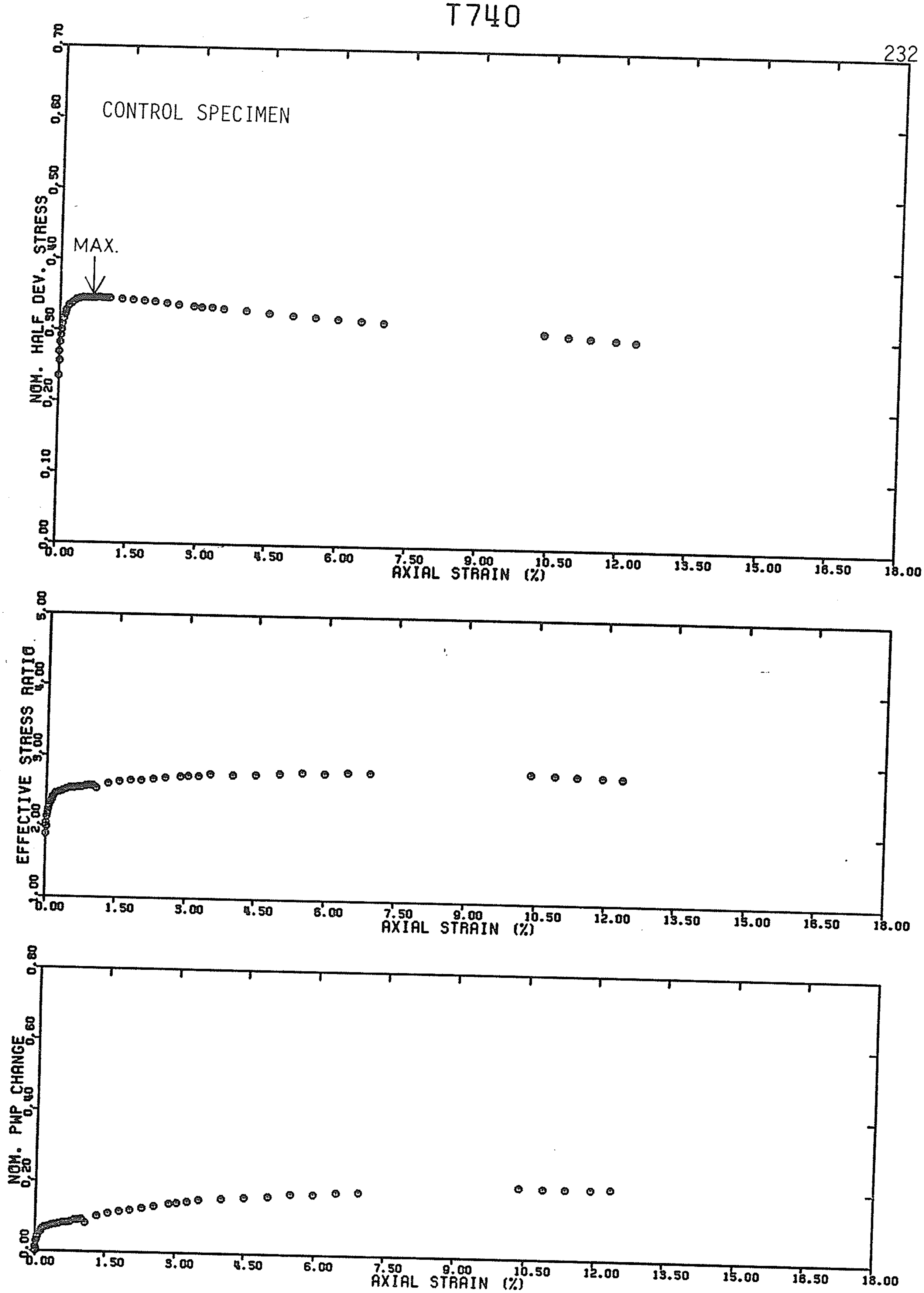


FIGURE C6 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T740

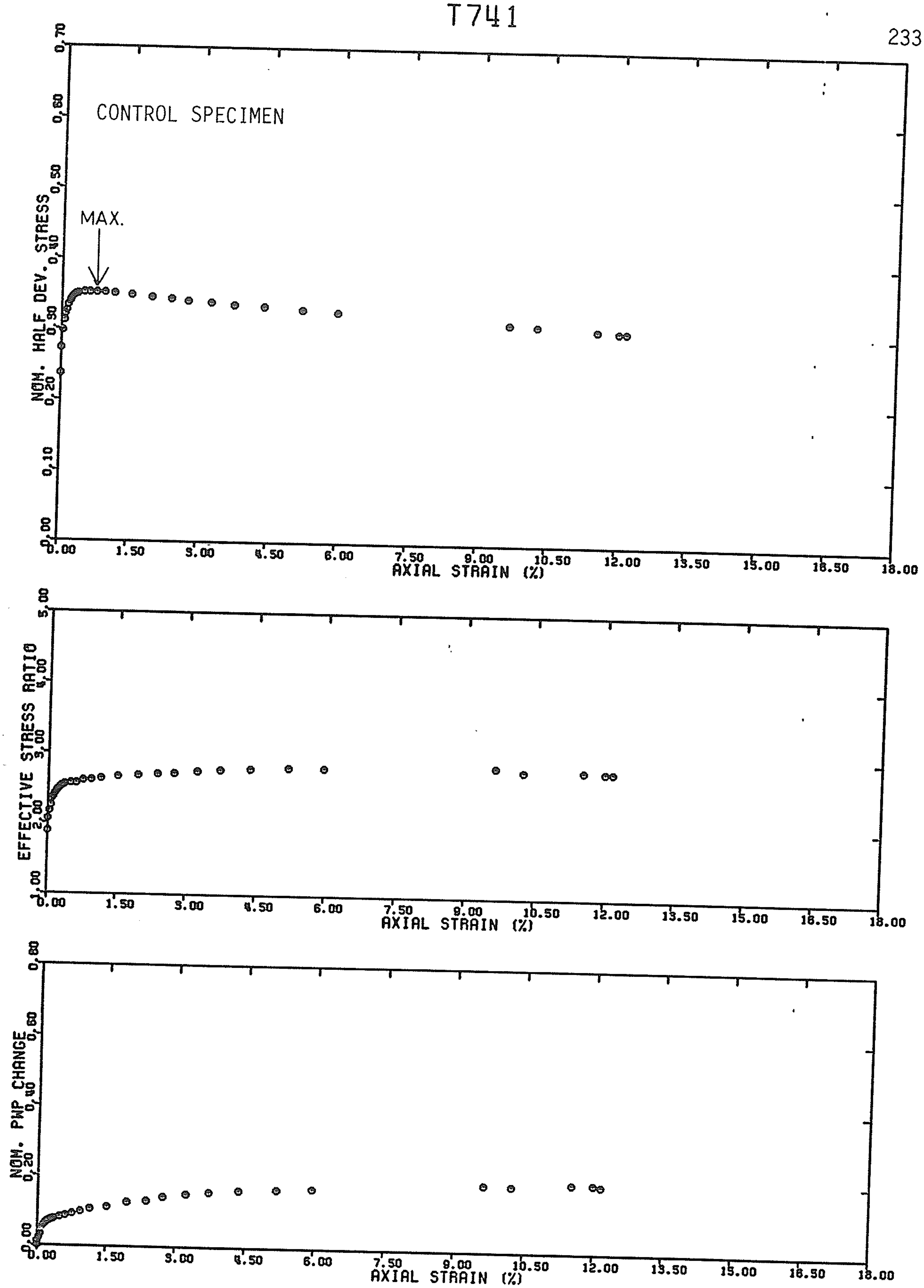


FIGURE C7 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
NORMALLY CONSOLIDATED SAMPLE T741

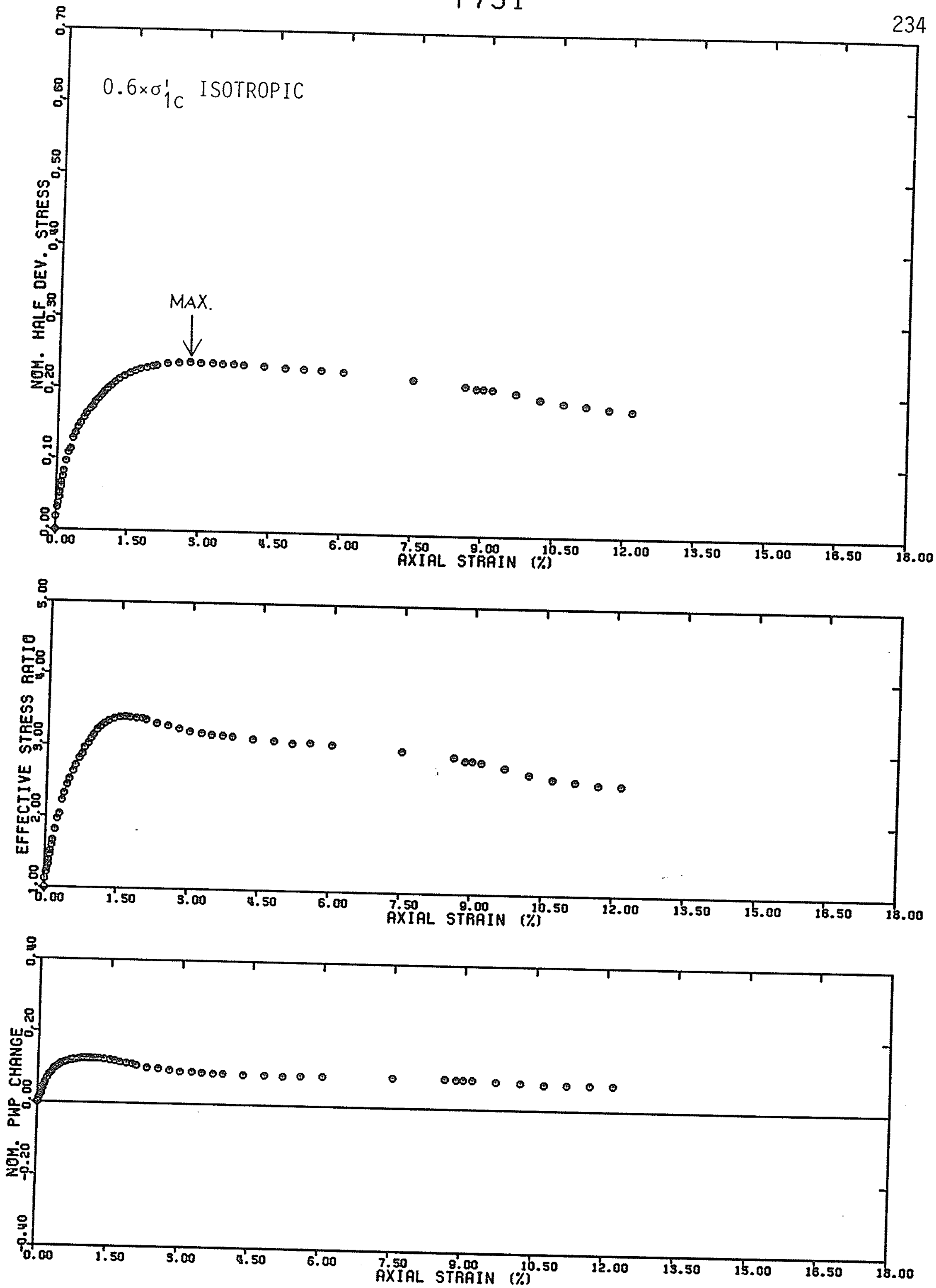


FIGURE C8 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T751

T752

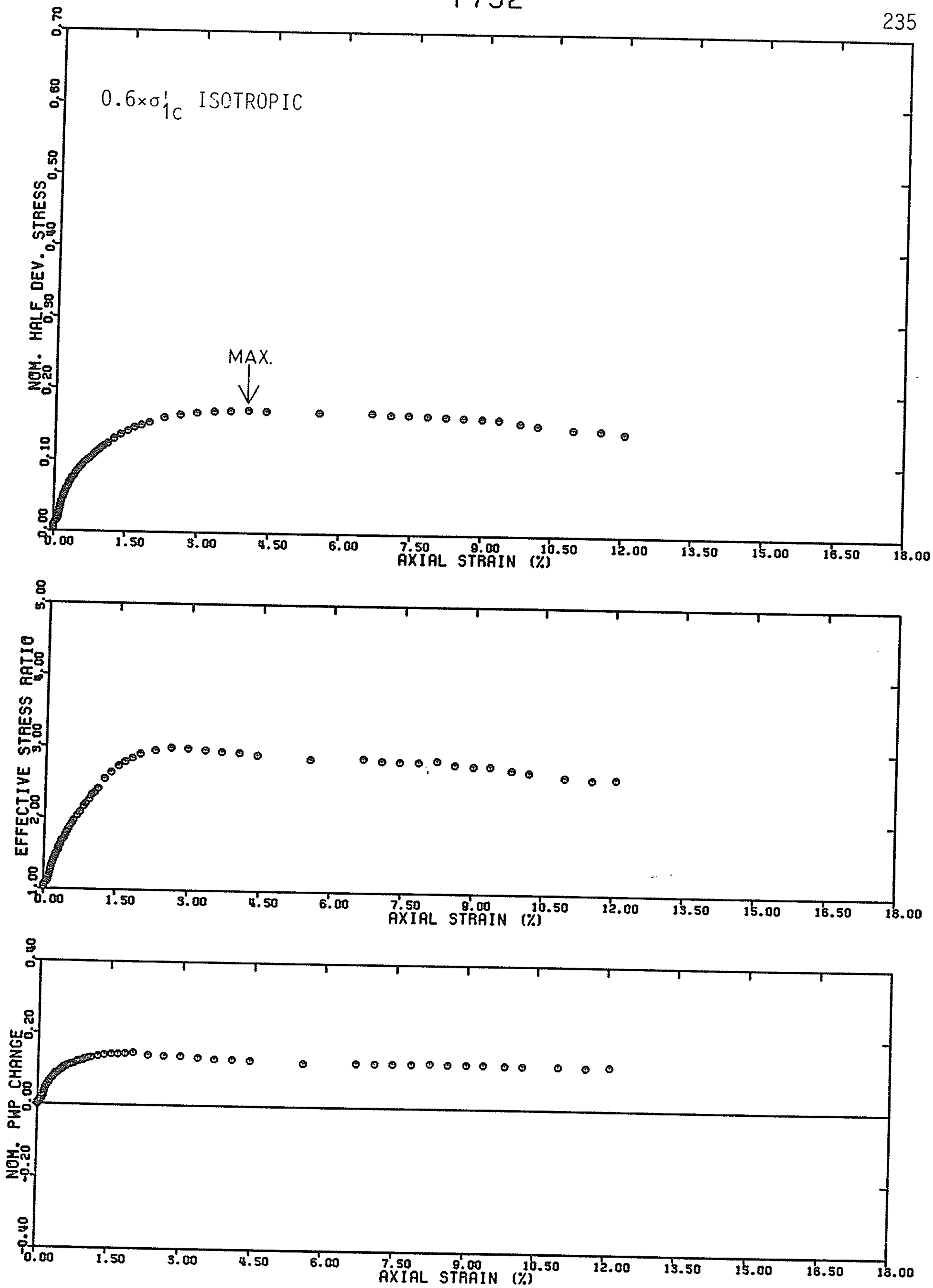


FIGURE C9 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T752

T754

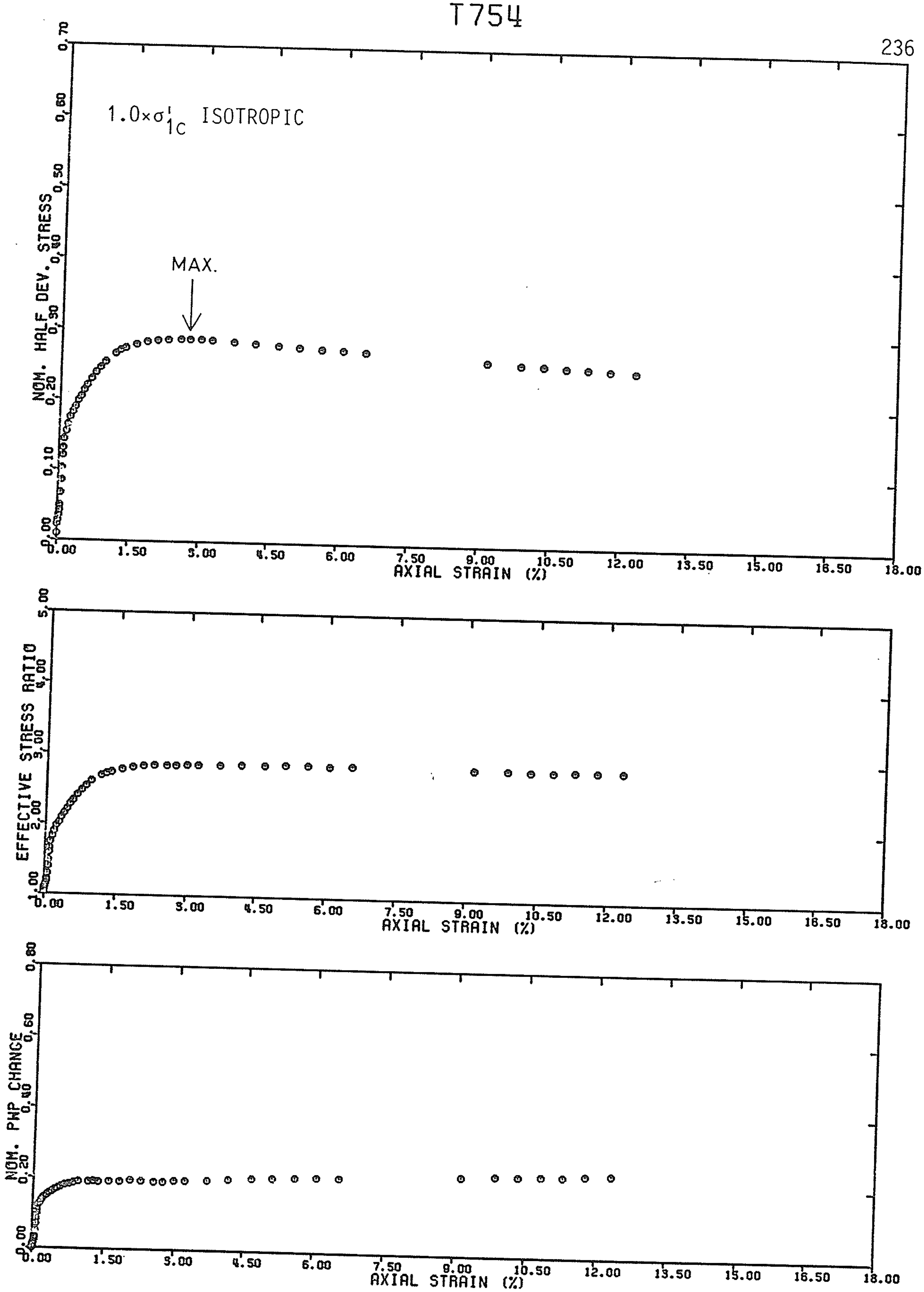


FIGURE C10 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLF T754

T755

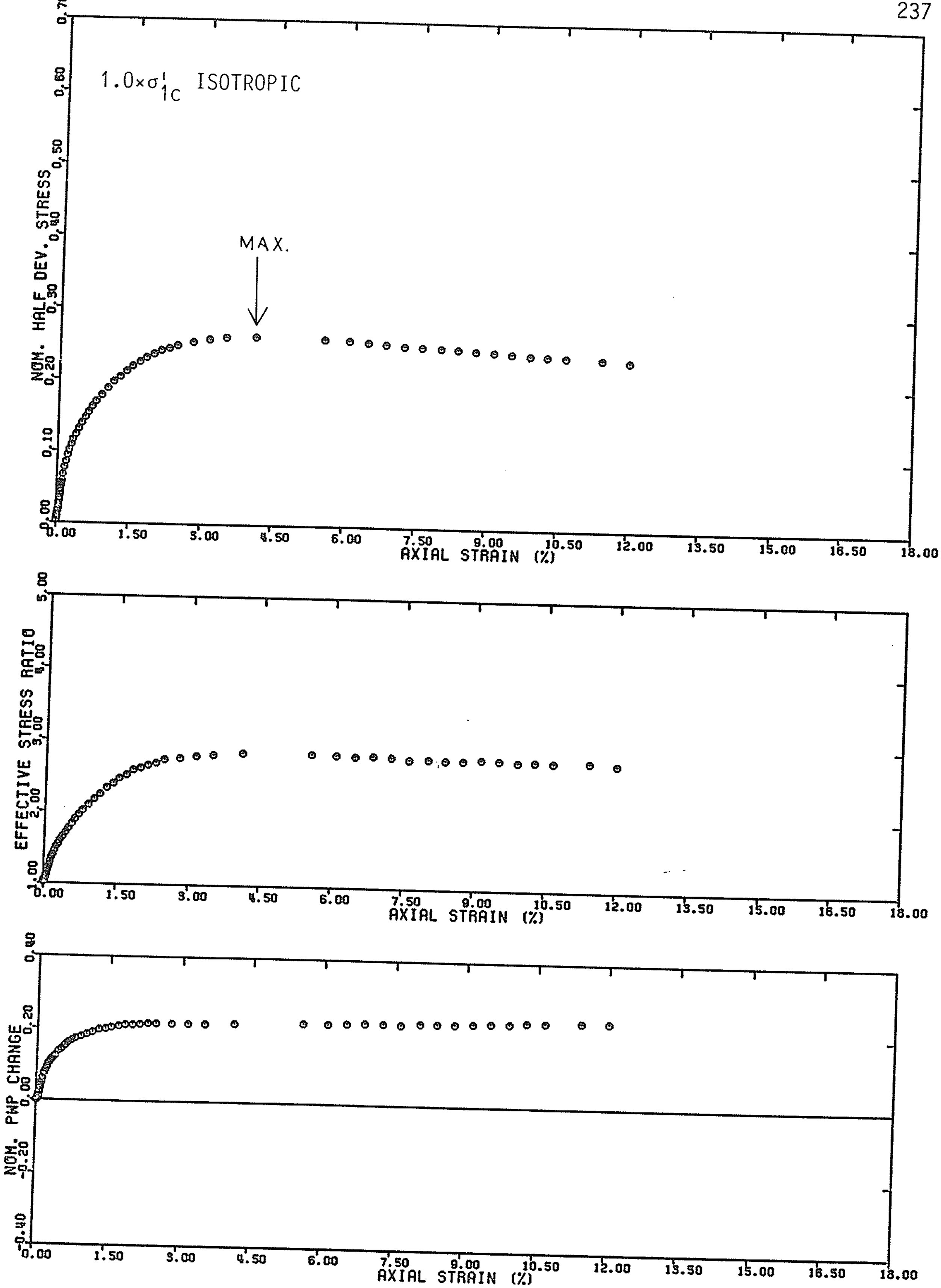


FIGURE C11 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T755

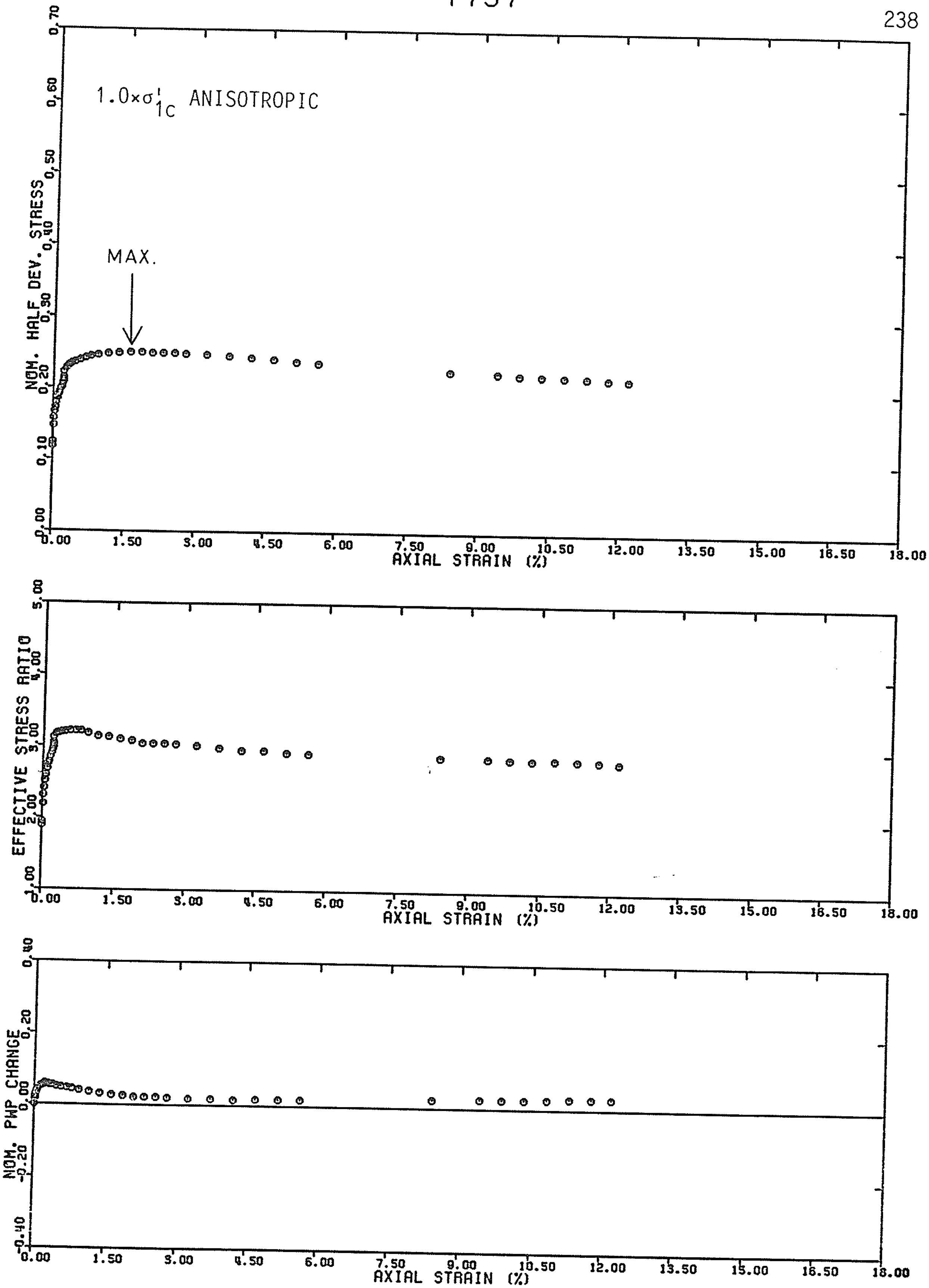


FIGURE C12 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T757

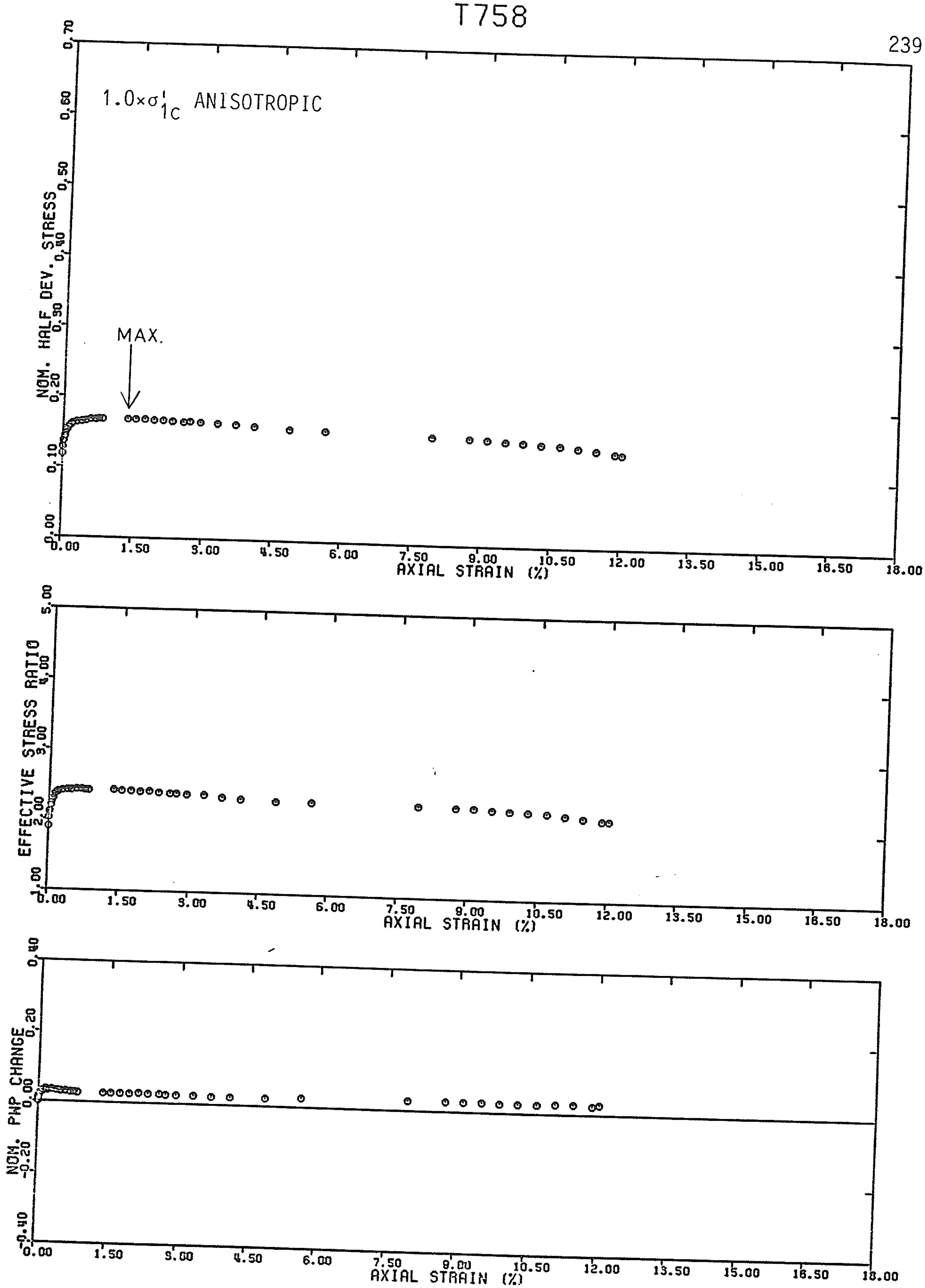


FIGURE C13 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T758

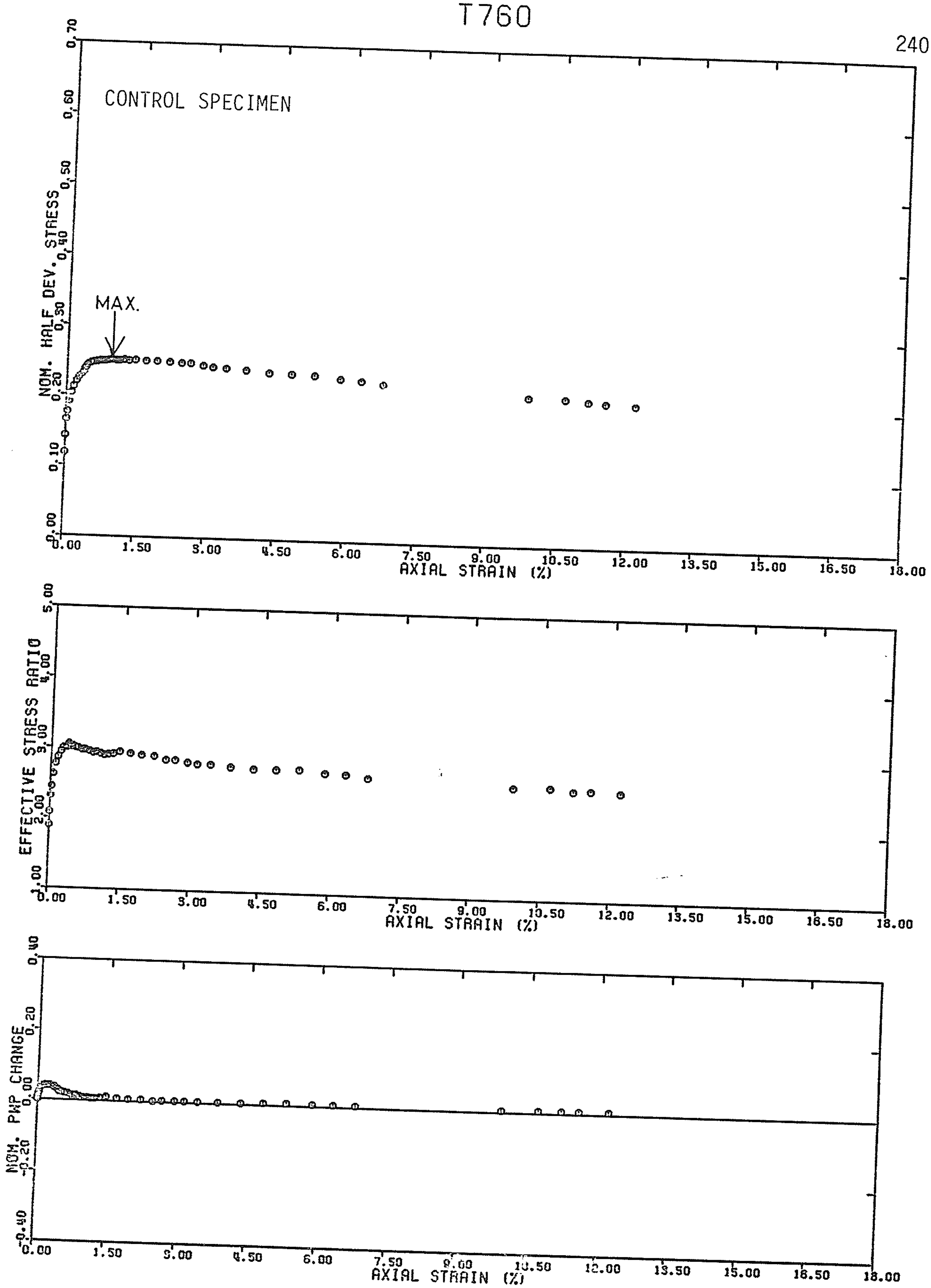


FIGURE C14 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T760

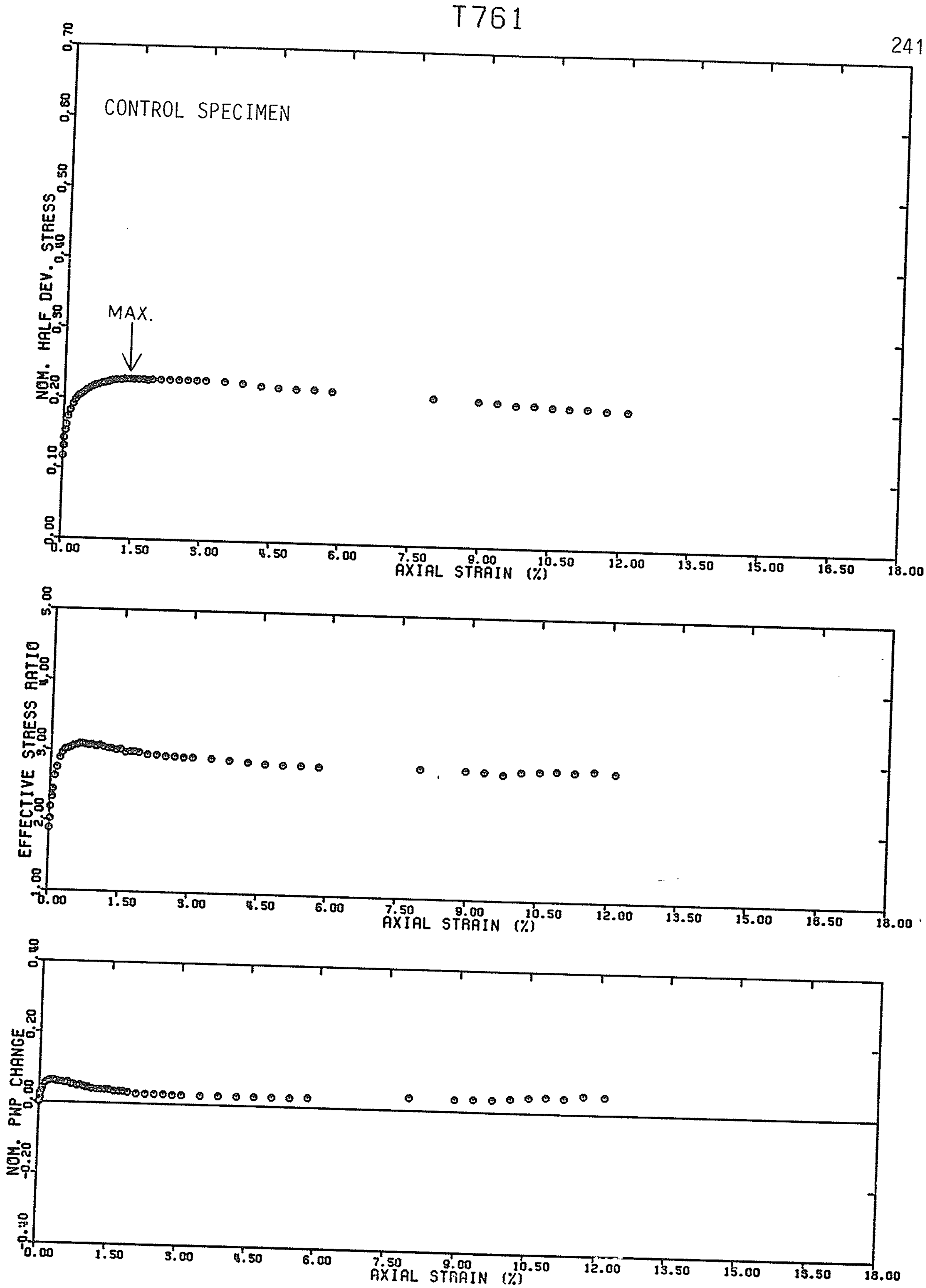


FIGURE C15 UNDRAINED STRESS-STRAIN POREWATER PRESSURE RESULTS
OVERCONSOLIDATED SAMPLE T761

APPENDIX D

DRAINED STRESS-CONTROLLED TRIAXIAL TESTING IN EXPLORING YIELD ENVELOPE OF ILLITE

APPENDIX D

DRAINED STRESS-CONTROLLED TRIAXIAL TESTING IN EXPLORING YIELD ENVELOPE OF ILLITE

An understanding that yielding is a fundamental feature of clay behaviour is essential to designing structures on the soft ground. The locus of effective stress conditions at which yielding occurs can be represented in stress space by a "yield envelope". It separates relatively stiff, linear, pseudo-elastic pre-yield hehaviour, from the larger strains, porewater pressures and dissipation times that accompany post-yield stressing. The existance of a yield envelope is now confirmed both in the laboratory and in the field.

A preliminary yield envelope for illite was given by Ambrosie (1985). In order to supplement data for the envelope, three lightly overconsolidated samples with OCR=2 were tested in the present program. The reconstituted specimens used for the drained stress-controlled triaxial testing were prepared individually in the same way as described by Li (1983) and Kwok (1984). It will only be briefly reviewed here.

A slurry with moisture content at $2xw_L$ was first consolidated in five load increments up to a maximum vertical stress of 70 kPa in a 100 mm diameter perspex consolidation cylinder. The axial load was applied through a hanger and dead load system. Upon reaching porepressure equilibrium, the sample was extruded and trimmed simultaneously with a extrusion unit designed by Kwok (1984). A sample of 76 mm in diameter and 130 mm in height was finally obtained and transferred to a triaxial consolidation cell. It was then subjected to further anisotropic consolidation described in Section 3.4.3 to give the sample an OCR equal to 2.

After lightly overconsolidated samples had reached the "in situ" stresses for four days, drained stress-controlled triaxial tests were subsequently followed along the selected stress paths shown in Figure D1. Deformations of the samples in the course of testing were measured with a dial gauge and a drainage burette. The yield stresses for T728 were determined from various TXCEP plots given in Figures D2-D8 with the bilinear plotting technique. The yielding of samples T729 and T730 was taken at the stress conditions at which ruptures occurred as they moved towards the overconsolidated failure envelopes shown in Figure 7.3. Since it is believed that a unique yield envelope would be obtained when normalized with respected to preconsolidation (Graham et al. 1983), the yield stresses obtained in the present study, in conjunction with the results from Ambrosie (1985), were normalized with σ'_{vc}=160 kPa. The shape of the yield envelope is shown in Figure D9 and has been recently published by Graham et al. (1986). Figure D9 also includes the results of lightly overconsolidated control specimens subjected to strain-controlled, undrained shear test.

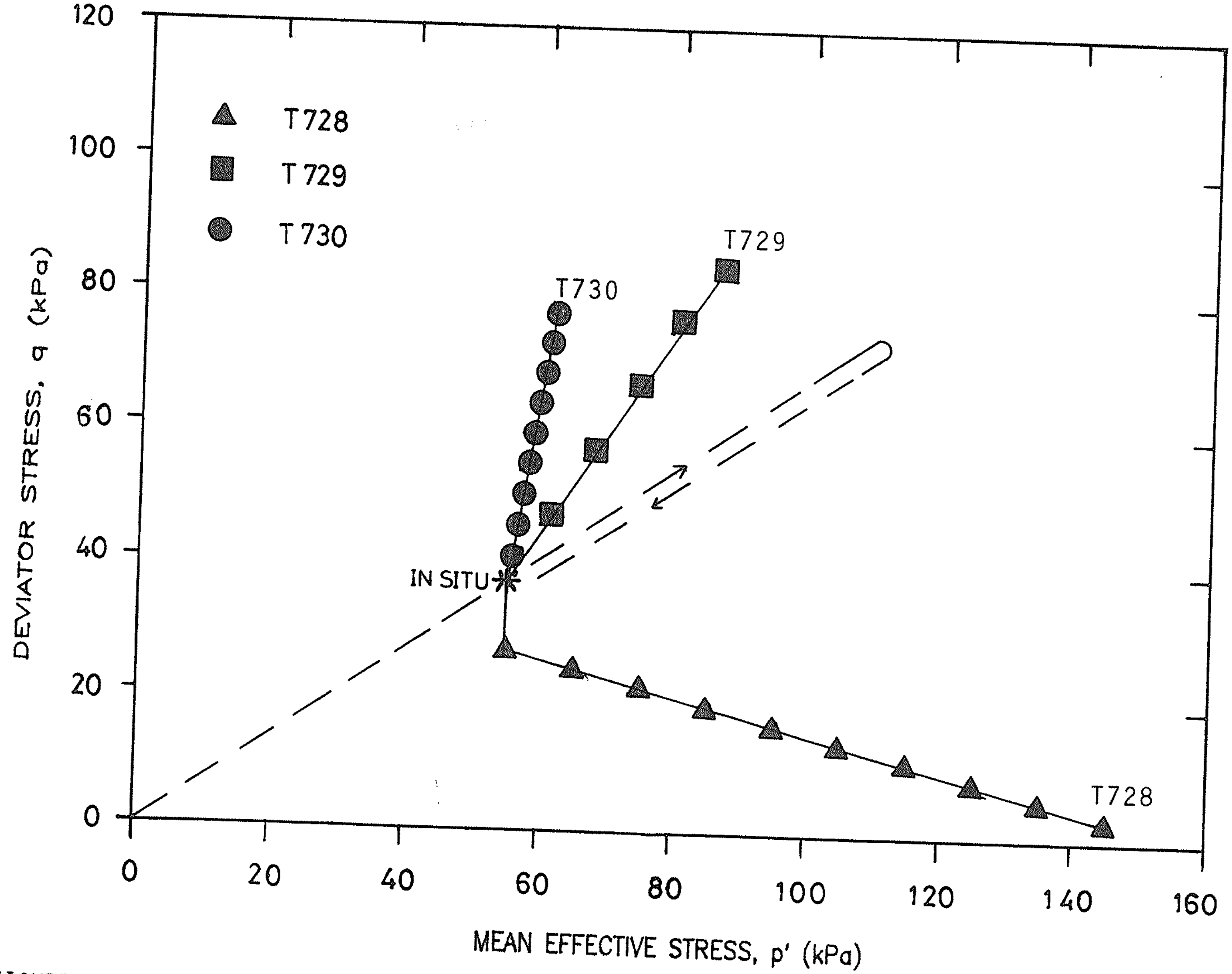


FIGURE D1 PROPOSED STRESS PATHS FOR DRAINED STRESS-CONTROLLED TESTS IN EXPLORING YIELD ENVELOPE OF ILLITE (σ'_{VC}=160 kPa)

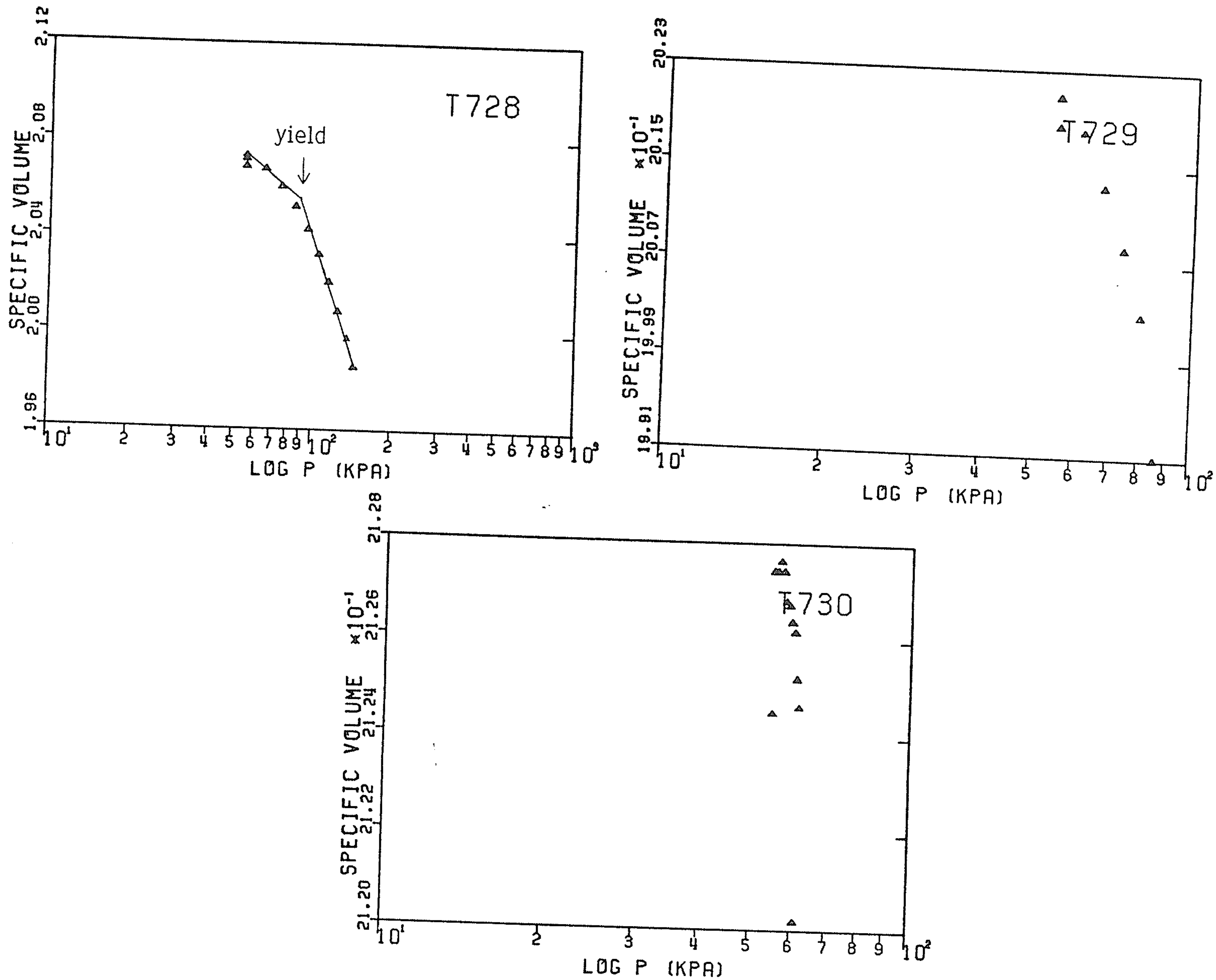


FIGURE D2 YIELD DETERMINATION FOR YIELD ENVELOPE—LOG (p') vs. V
T728, T729, T730

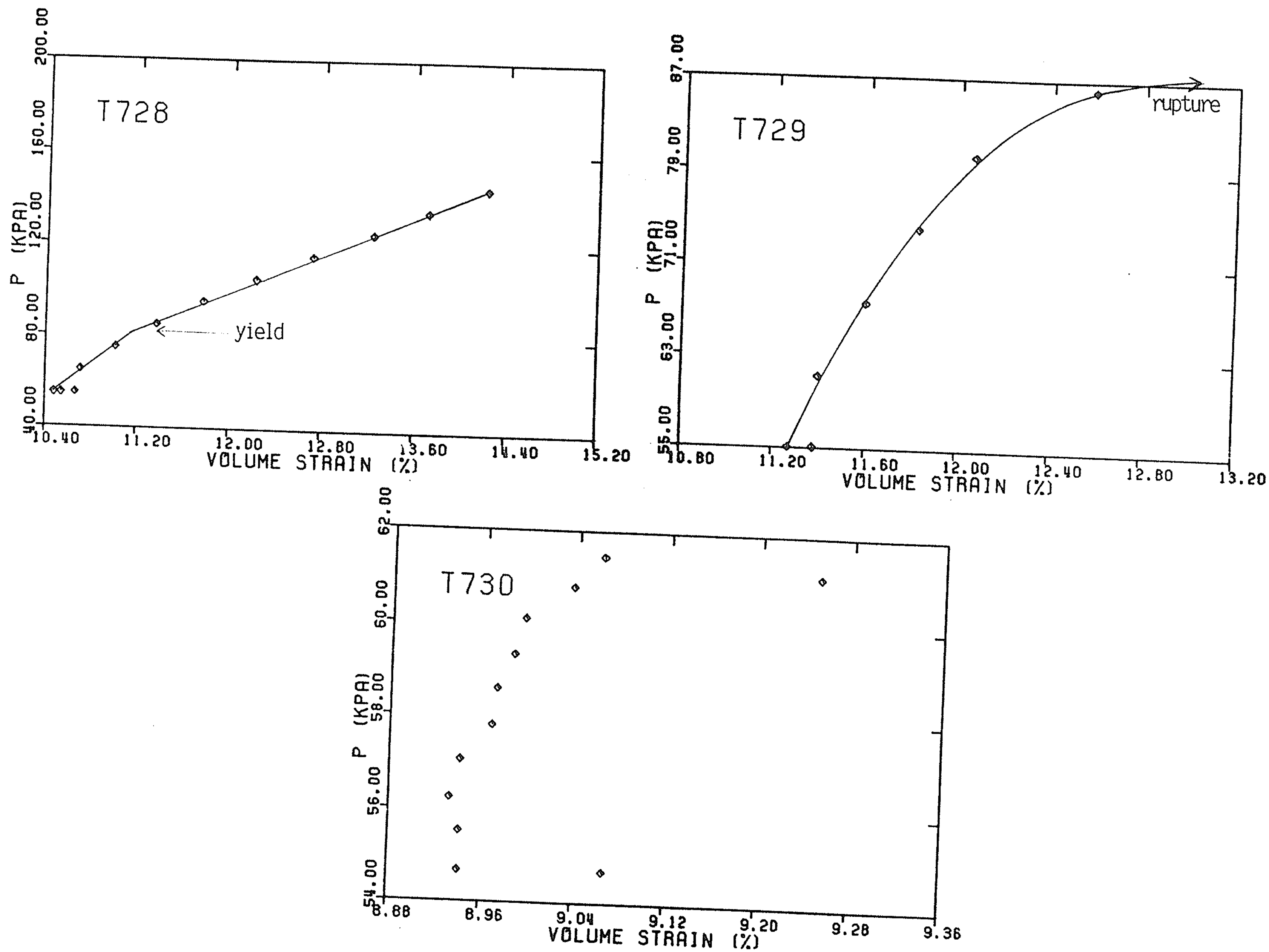


FIGURE D3 YIELD DETERMINATION FOR YIELD ENVELOPE—p' vs. v
T728, T729, T730

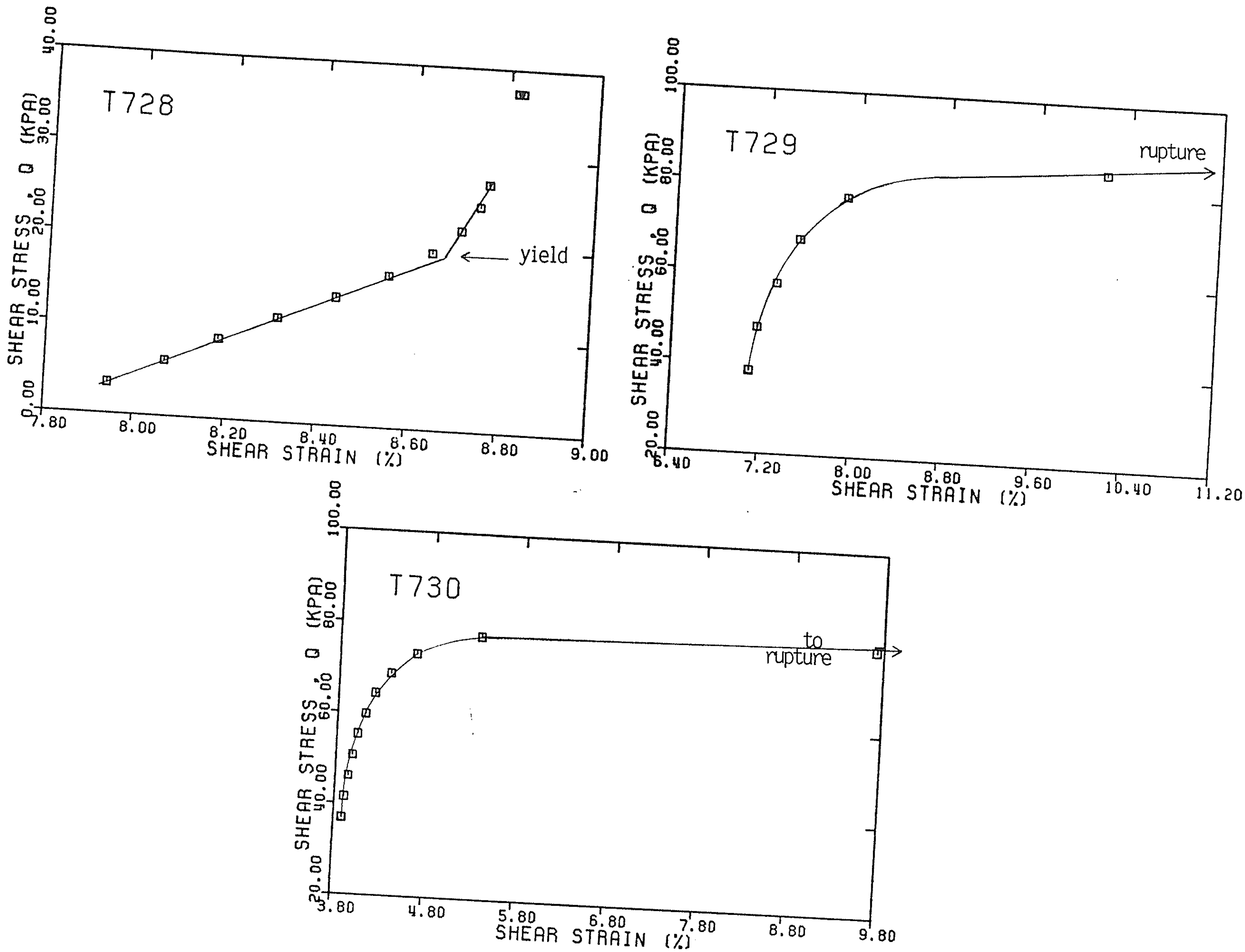


FIGURE D4 YIELD DETERMINATION FOR YIELD ENVELOPE—q vs. ε
T728, T729, T730

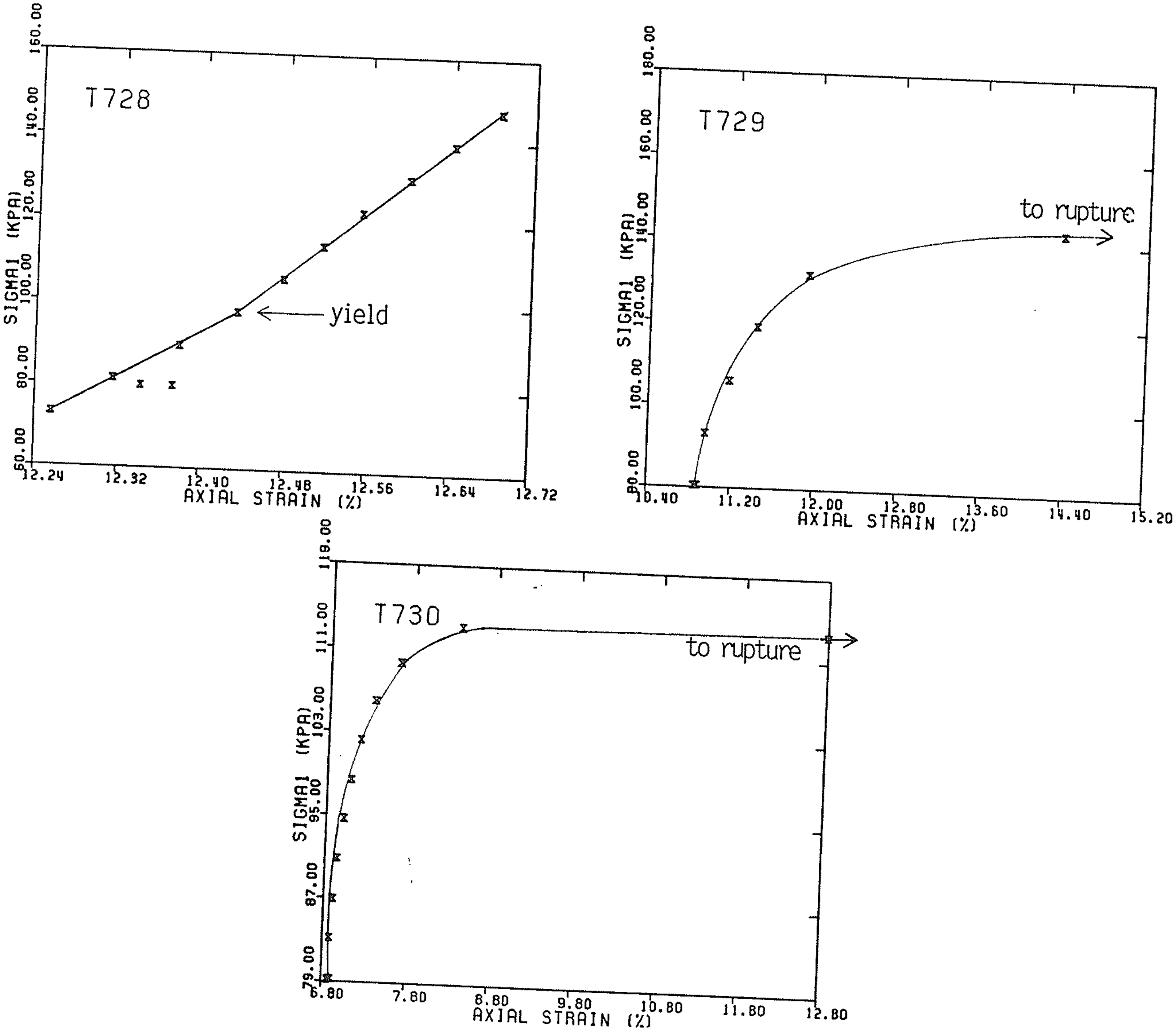


FIGURE D5 YIELD DETERMINATION FOR YIELD ENVELOPE—σ_1 vs. ε_1
T728, T729, T730

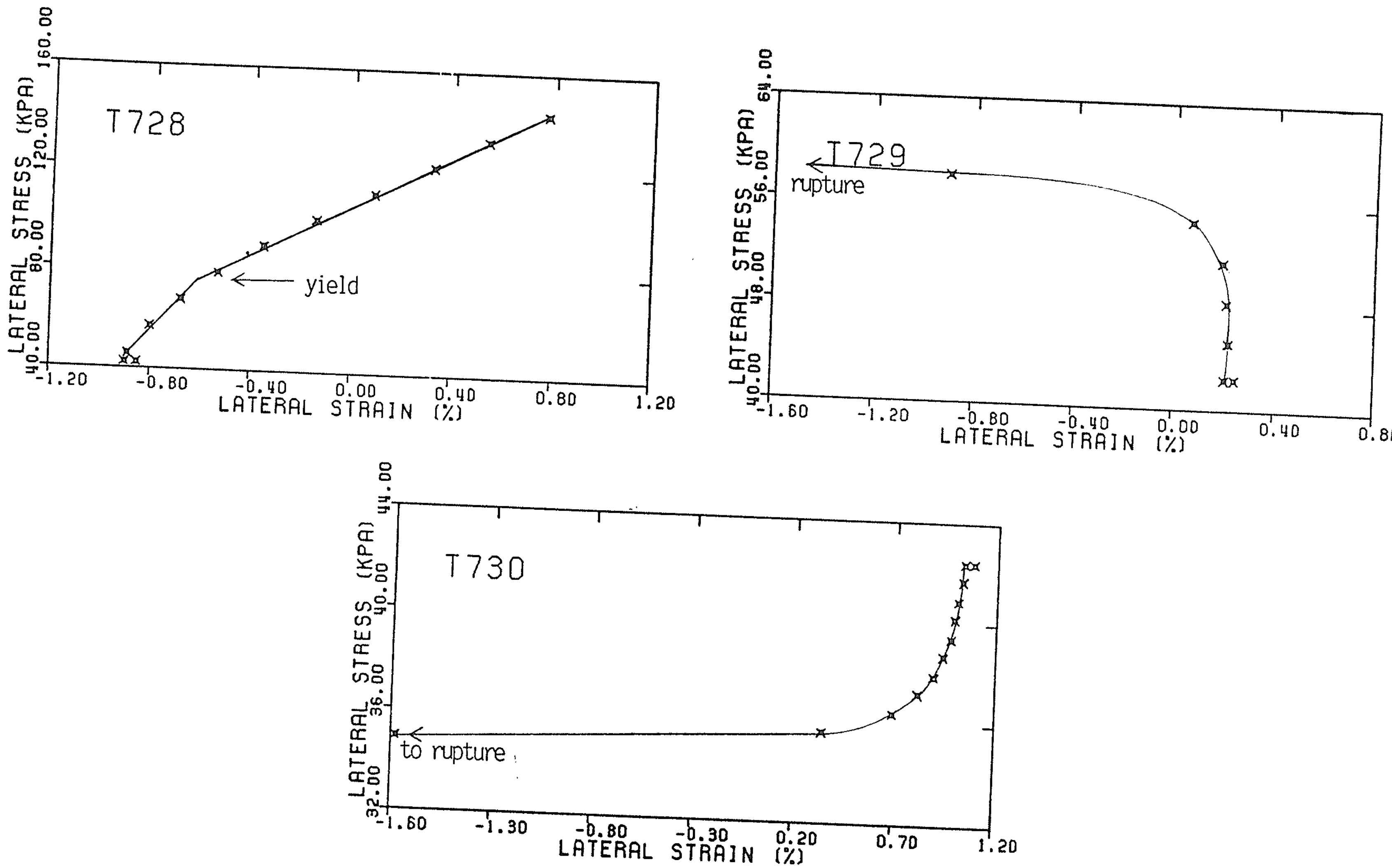


FIGURE D6 YIELD DETERMINATION FOR YIELD ENVELOPE—σ_3 vs. ε_3
T728, T729, T730

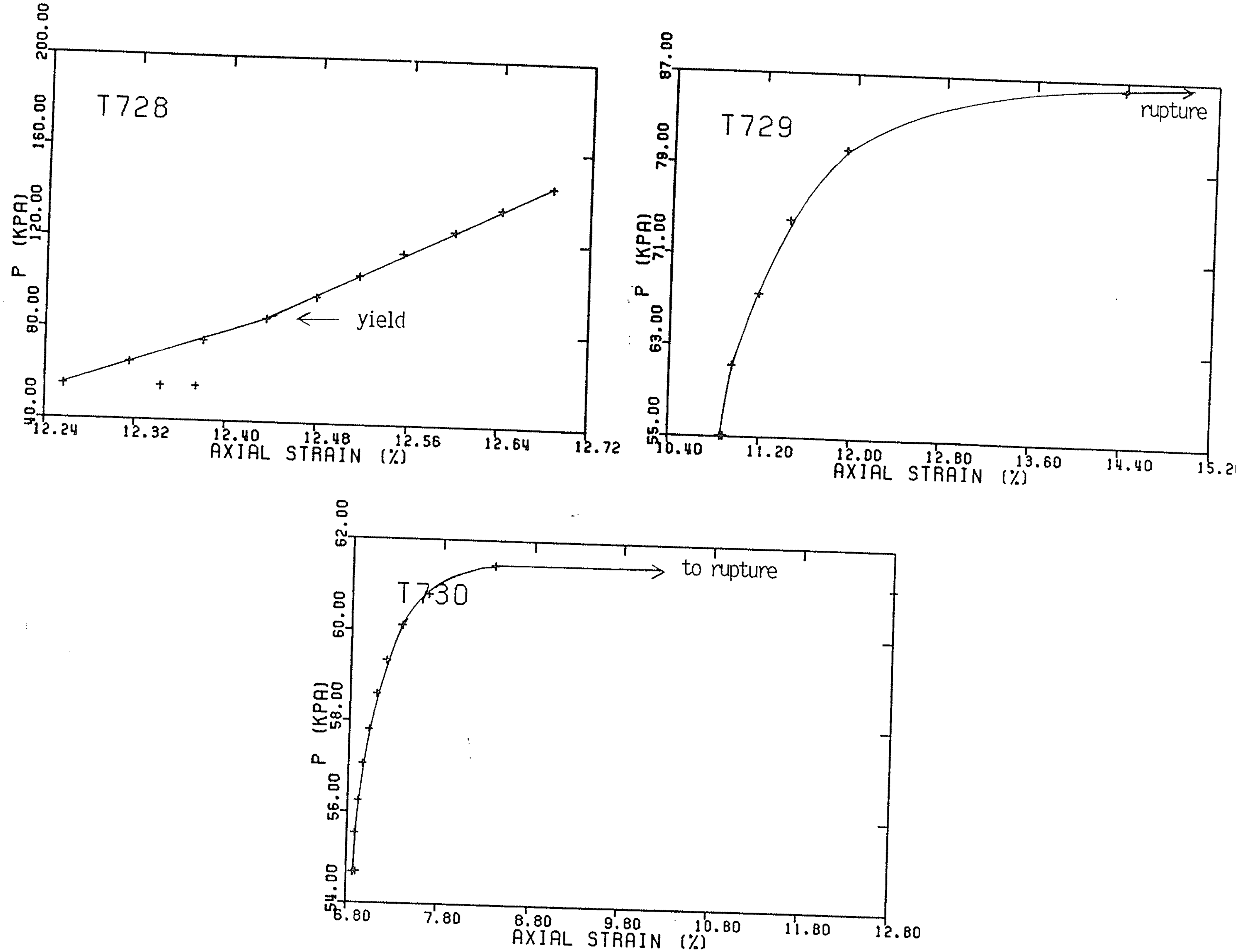


FIGURE D7 YIELD DETERMINATION FOR YIELD ENVELOPE—p' vs. ε_1
T728, T729, T730

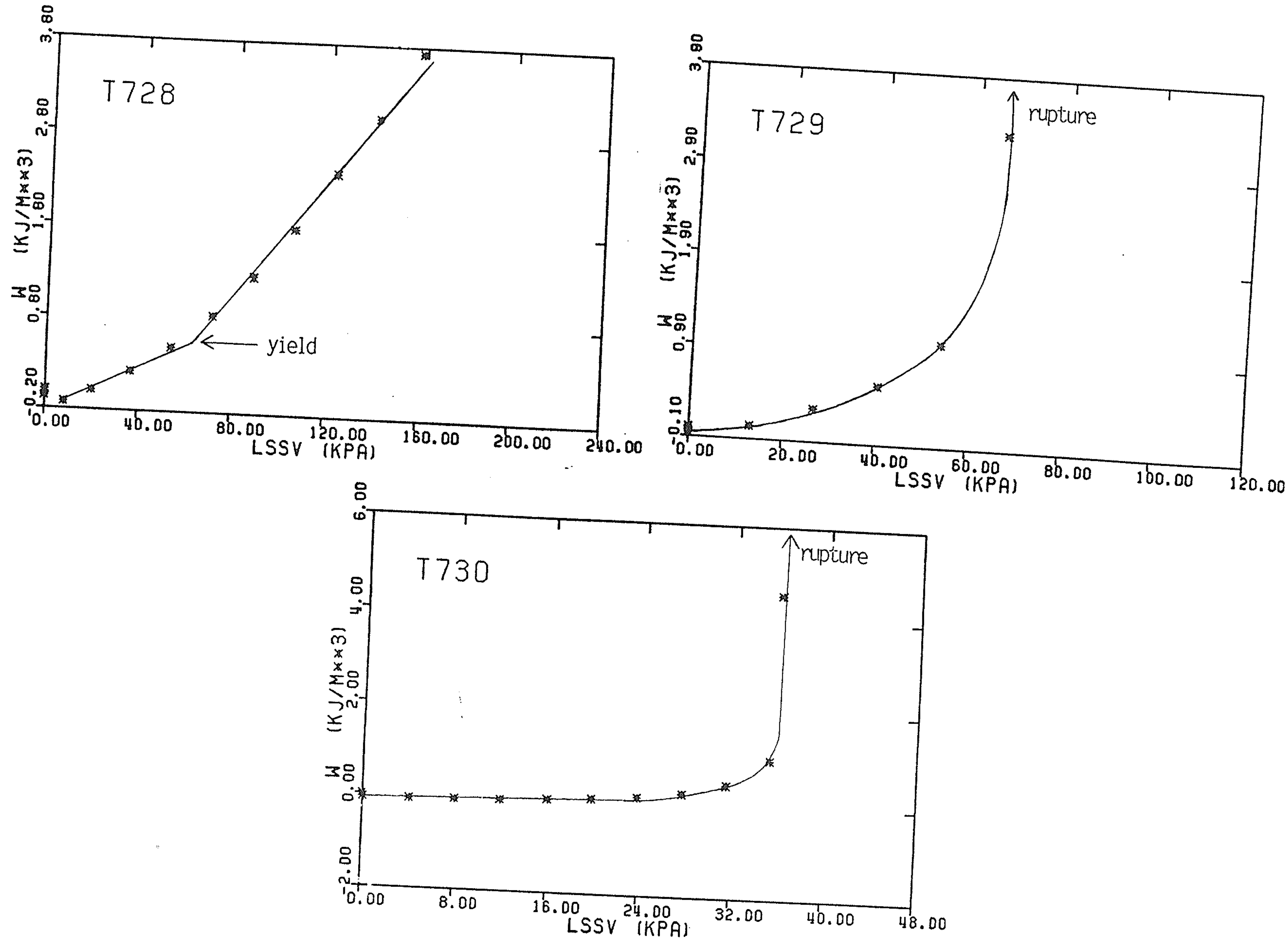


FIGURE D8 YIELD DETERMINATION FOR YIELD ENVELOPE—W vs. LSSV
T728, T729, T730

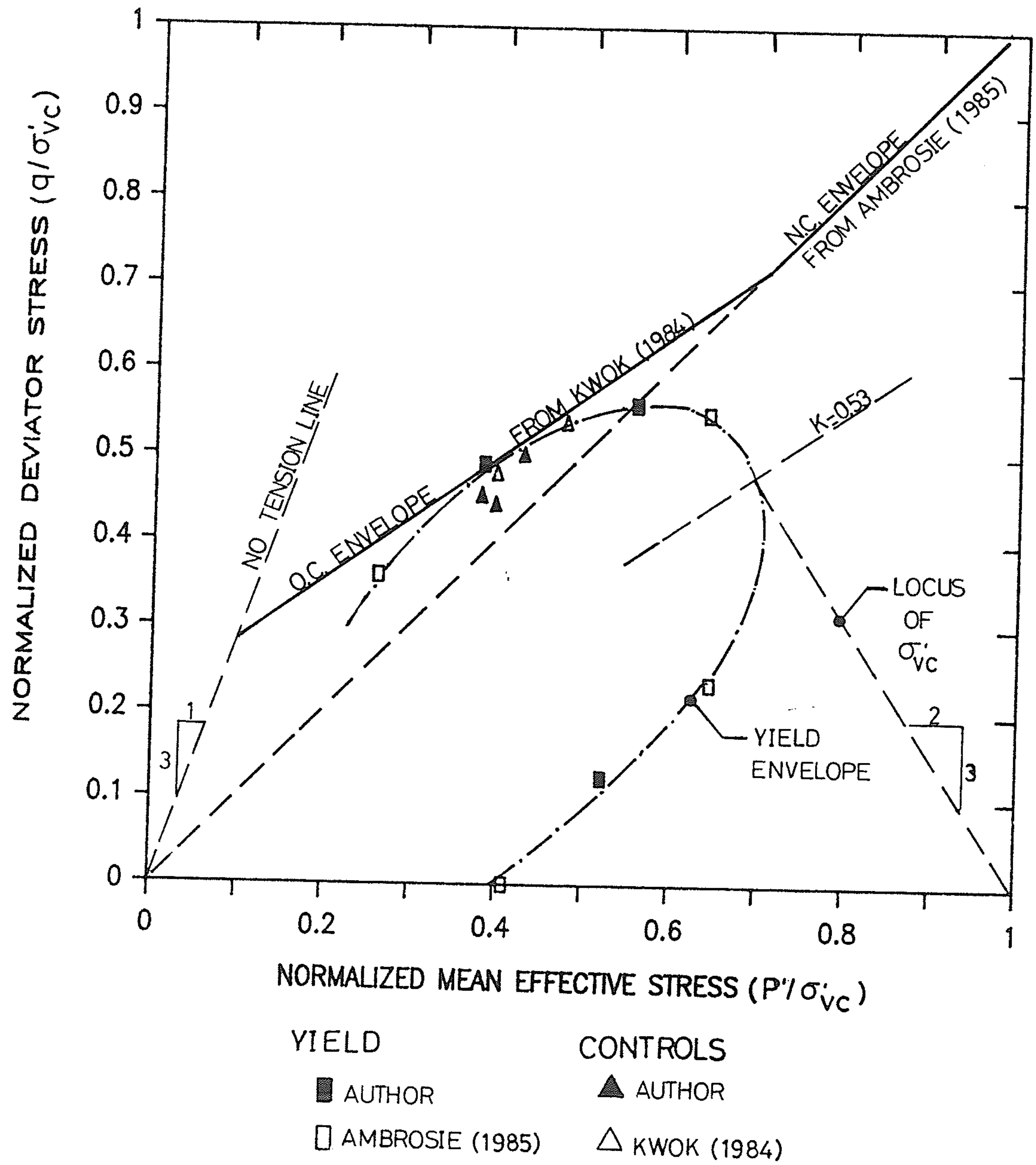


FIGURE D9 YIELD ENVELOPE OF ILLITE, σ'_{vc} = 160 kPa

APPENDIX E

RELATED PUBLICATION

DRAFT: 2nd June, 1986

YIELD ENVELOPES: IDENTIFICATION AND GEOMETRIC PROPERTIES

by

J. Graham[1], J.H.A. Crooks[2], and S. Lau[1]

Submitted to the Canadian Geotechnical Journal
for possible publication as a Technical Note

January, 1986

[1] Dept. of Civil Engineering, University of Manitoba, Winnipeg, Canada R3T 2N2
[2] Golder Associates, 7017 Farrell Road S.E., Calgary, Canada T2H 0T3

ABSTRACT

Yielding is an important feature of the stress-strain behaviour of lightly overconsolidated clays. Of necessity however, techniques used for evaluating yield states must be partly empirical. It is therefore important that the techniques are as general as possible, that they do not lead to spurious conclusions, and that their limitations are understood.

Attention is drawn to four features of yield envelopes. They are commonly identified from the intersection of two straight-line approximations to measured stress-strain curves in natural clays which have experienced diagenetic aging. However the procedure is inapplicable in reconstituted clays where linear pre-yield behaviour proceeds directly into exponential post-yield behaviour. Envelopes are often considered to be symmetric about the K_o-line in s',t-space. Such envelopes are shown to be nonsymmetric in p',q-space, and this raises questions regarding the relationship between K_o and yielding. Factors influencing the shape of yield envelopes in different clays are explored in the following section.

Finally, the geometry of the complete state boundary surface of a natural clay in p',q,V-space is related to the Critical State Model. Discrepancies between measured envelopes in p',q-space and the Modified Cam Clay model are shown to be largely the result of differences in plotting the data.

KEYWORDS

Clays, overconsolidated, yielding, yield envelopes, symmetry, state boundary surface, Critical state

INTRODUCTION

An understanding that yielding is a fundamental feature of clay behaviour is essential to the design of structures on soft ground (for example, Folkes and Crooks, 1985). The locus of effective stress conditions at which yielding occurs can be represented in stress space by a "yield envelope" (Crooks and Graham, 1972, 1976). Yield envelopes separate relatively stiff, linear, pseudo-elastic pre-yield behaviour, from the larger strains, porewater pressures and dissipation times that accompany post-yield stressing. In p', q, V-space* (Graham et al., 1983a; Wood, 1984) they are traces of a state boundary surface with non-constant V. The shapes and magnitudes of yield envelopes depend on the composition and stress history of the clay. For given testing rates in the laboratory, unique yield envelopes can be obtained by normalizing measured yield stresses by a characteristic stress which is representative of the stress history of the material. In natural clays this has commonly been taken as the oedometer preconsolidation pressure σ'_{vc} (Bell, 1977; Graham et al., 1983a). In reconstituted clays it is more common to use the "equivalent pressure" p'_e (Atkinson and Bransby, 1978).

The Paper examines interpretive procedures used in the laboratory for identifying yielding in clay soils. It considers implications of plotting techniques for defining yielding; features related to asymmetry of yield envelopes about the hydrostatic stress axis; and factors that influence the three-dimensional shape of yield envelopes in different clays.

GRAPHICAL TECHNIQUES FOR ESTIMATING YIELD STRESSES

The stresses at which yielding occurs must be estimated on the

* Notation is summarized at the end of the Paper.

basis of empirical procedures. These should ideally be as general as possible (Graham et al, 1982) and as free as possible from observer influence.

There is typically a region of transitional behaviour between pre-yield and post-yield straining, and consequently some degree of judgement must be exercised in selecting a "yield stress". An example of this is the widely used construction for oedometer preconsolidation pressures in which Casagrande recommended using a "likely range" of σ'_{vc} rather than a single value.

Triaxial samples may be loaded along a wide variety of stress paths. On completion of these tests, it is common to plot a series of graphs such as σ'_1 vs. ε_1; p' vs. v; q vs. ε ; σ_3 vs. ε_3; and W vs. length of stress vector LSSV (Graham et al., 1983a). The yield stress is then estimated from each of the plots in turn and converted to a common parameter such as p', (or W, or σ_1). Yield values obtained from the different graphs are usually remarkably similar (Graham et al., 1983a) and suggest that the tests do in fact measure a real component of soil behaviour. This has now been confirmed in many studies of field behaviour, for example by Clausen et al. (1984); Watson et al. (1984); Folkes and Crooks (1985).

It is important to be sure that the techniques used for interpreting the test data are thoroughly understood, and do not themselves suggest spurious behaviour which is then assigned to the clay.

ARITHMETIC-LOGARITHMIC MAPPING

Some implications of the commonly-used log σ'_v vs. ε_v plots were presented in an earlier Paper by Graham et al. (1982). They also discussed how yielding in natural clays could be interpreted from straight-line curve-fitting (bilinear plotting) of the pre-yield and post-yield behaviour in arithmetic stress-strain space. This deserves some further attention since it appears to conflict with the common understanding that post-yield stable straining (plastic strain-hardening) is exponential in nature. The differences lie in part in the aging or diagenetic processes experienced by natural clays following deposition. The discussion here will be restricted simply to stress-strain behaviour in fixed time periods with small stress increment ratios. Questions of the relationship between primary and secondary consolidation, rate effects, superposition of strains, etc. will be left for a future occasion.

Realization that clay behaviour inside the state boundary surface is more linear than previously thought, has encouraged the plotting of stress-strain curves in arithmetic (as opposed to logarithmic) stress space (Mitchell, 1970; Tavenas and Leroueil, 1977; Graham et al., 1983a). This also avoids the difficulty in logarithmic plotting that the inferred preconsolidation pressure can depend on the scale at which the data is plotted.

Fig. 1 examines the mapping of identical oedometer data for reconstituted plastic clay between arithmetic and logarithmic stress-strain space. For emphasis, the observed behaviour has been idealized in the insert drawing so that the transitional region has been removed, and the yielding is made "sharper" than would be normally observed. The Figure also shows the importance of using natural stains $[\Sigma(\delta_i/H_i)]$ rather than engineering strains $[(\Sigma\delta_i)/H_0]$ when the strains exceed about 10%. By the nature of logarithmic transforms a straight pre-yield line AB in Fig. 1a plots as a curve AB in the logarithmic stress space in Fig. 1b. Conversely a straight post-yield (normal consolidation line (NCL) BC in Fig. 1b maps into Fig. 1a as exponential strain hardening behaviour.

Understanding the yielding of lightly overconsolidated clays has been developed from studies on carefully handled "undisturbed" natural clays (Mitchell, 1970; Crooks and Graham, 1976; Tavenas and Leroueil, 1977; Graham et al., 1983a) rather than from reconstituted clays as in Fig. 1. In the natural clays, the observed behaviour can often be reasonably approximated by straight pre-yield and post-yield segments, particularly if the clay is sensitive or cemented. Fig. 2 shows data from anisotropic triaxial consolidation (close to K_0-consolidation) of natural plastic clay from Winnipeg. In contrast with Fig. 1, the micro-structure of the clay here is probably cemented (Graham et al., 1983a) and yields quite markedly before proceeding to exponential strain hardening.

The natural clay in Fig. 2 shows clearer evidence of yielding than the reconstituted samples in Fig. 1, and faster post-yield straining before exponential strain-hardening is observed. (Note the different strain-scales in the two Figures.) This suggests that for natural clays the schematic behaviour AB, BC in Fig. 1 should be conceptually modified as shown in Fig. 2 by the addition of an additional region B_1 B_2 between the pre-yield and post-yield behaviour. In this region, the micro-structure of the clay experiences major disturbance (Bjerrum, 1967) or de-structuring (Leroueil et al., 1979). The change in logarithmic function at B_1 in Fig. 2b may explain why the Casagrande construction "at the point of maximum curvature" can be successful.

Fitting observed stress-strain results with two straight lines (bilinear plotting) in arithmetic $\{\sigma'\}$, $\{\varepsilon\}$ space appears acceptable in a variety of natural clays (Mitchell, 1970; Bell, 1977; Graham et al., 1983a, among others) over a measurable range of post-yield strains. At larger strains (B_2C in Fig. 2) the behaviour converts into the usual exponential plastic strain hardening behaviour. Houlsby et al. (1982) showed that when soils undergo a large amount of plastic strain hardening, then the behaviour linearizes in log σ'_v, log V plotting rather than in the more common semi-logarithmic plots.

SYMMETRY OF YIELD ENVELOPES

The magnitude and locations of yield envelopes depends on the apparent stress history of the clay. Envelopes are commonly thought to be approximately symmetric about the K_o-consolidation line, with their size controlled by the (apparent) preconsolidation pressure. Thus there is a causal relationship between not only the magnitude, but also the detailed shape of the envelope and consolidation history. A suggestion that yield envelopes were symmetric about the K_o-line was implicit in the work by Mitchell (1970), and was proposed as an approximation by Graham (1972) based on work on Norwegian and Belfast clay. Tavenas and Leroueil (1977) presented the arguments more precisely, and the understanding is now widely held. Some care is needed, however, since it can be shown that the observed "symmetry" depends on the plotting techniques which are used. The causality between the K_o-line and the shape of the yield envelopes is less direct than is commonly assumed.

Fig. 3a shows an idealised yield envelope drawn as an ellipse in $s' = (\sigma'_1 + \sigma'_3)/2\sigma'_{vc}$, $t = (\sigma_1 - \sigma_3)/2\sigma'_{vc}$-space, and symmetric about the K-line $\sigma'_3/\sigma'_1 = 0.5$. The same σ'_1, σ'_3 data used to generate this ellipse and the line K = 0.5 are replotted in Fig. 3b in terms of the stress invariants $p' = (\sigma'_1 + 2\sigma'_3)/3\sigma'_{vc}$; $q = (\sigma_1 - \sigma_3)/\sigma'_{vc}$. It is evident from Fig. 3b that the yield envelope is no longer symmetric about the line K = 0.5.

It is sufficient to disprove the symmetry of the mapping in p', q-space if the perpendicular directions between the tangent AB and normal AC at point A in Fig. 3a (the intersection between the yield envelope and the K-line) do not map as perpendiculars in Fig. 3b. The product of the slopes of A'B' and A'C' in Fig. 7b is $9(1-K^2)/(2K^2-3K-2)$. When K = 0.5 as in Fig. 3, the product of the slopes is -2.25, and not -1 required for orthogonality. A'B' and A'C' are only orthogonal when K = .81 and -1.24. (The latter value requires tensile stresses and is unattainable in clay soils.)

The mapping between z = (s' + it)-space and w = f(z) = (p' + iq)-space can be examined more formally (D.W. Trim, pers. comm.) using the Cauchy-Reimann conditions for conformality

[3] $$\frac{\partial p'}{\partial s'} = \frac{\partial q}{\partial t} \quad ; \quad \frac{\partial q}{\partial s'} = -\frac{\partial p'}{\partial t}$$

By rewriting the variables in terms of σ_3' and σ_1' it is seen that

[4] $$p' = s' - t/3; \quad q = 2t,$$

and therefore the conditions in [3] are not met. This means that mapping between s', t-space and p', q-space does not preserve angular relationships. The symmetrical ellipse in Fig. 3a cannot map as a symmetrical locus into Fig. 3b. Note also that the t-axis (s' = 0) in Fig. 3a does not map as the q-axis in Fig. 3b.

Figs. 4a and 4b show two published examples of yield envelopes that have been selected because of their approximate symmetry in s', t-space. The lines of symmetry shown in these Figures have been reconstructed graphically and may not correspond to in situ K_o-values. The same data are shown plotted in p', q-space in Figs. 4c and 4d. As expected from the preceding discussion, symmetry is not shown in p',q-space.

Chan (1985) has shown a yield envelope for overconsolidated clay (OCR = 2.0, K_o = 1.0) that is approximately symmetrical about the p'-axis. Consideration of Eqns. 3, 4 and a development of Fig. 7 will show that even in this apparently simpler case, a yield envelope cannot be formally symmetric about a K_o = 1.0 axis in both s', t-space and p', q-space.

Fig. 5 shows a selection of yield envelopes taken from the literature. Basic classification information for these clays is given in Table 1. They are all recent (mostly post-glacial) clays from a variety of sources with varied mineralogies, geochemistries, sensitivities and activities. They all exhibit stress-strain behaviour that can be summarized by unique yield envelopes in normalized p'/σ'_{vc}, q/σ'_{vc}-space. There is considerable variation in the shapes of the envelopes and it is reasonable to examine the causes of the variability.

As a first approach, Fig. 6a represents an attempt to include the effect of mineralogy on the observed variability at the top (high q-values) of the yield envelope. In this Figure, the q/σ'_{vc} data has been normalized with respect to $M = 6\sin\Phi'/(3-\sin\Phi')$ following a suggestion from C.P. Wroth (pers. comm.). While this process reduces the variability of the data in the q-direction, quite significant variability still exists in the p'-direction, particularly for Winnipeg clay. Fig. 6b is an approximate examination of the influence of overconsolidation ratio (OCR) on the bulk compressibility of the clays. This has been done by dividing p'/σ'_{vc}-values by $(1 + 2K_0)/3$, where K_0 values have been taken from the data produced by Brooker and Ireland (1965). This also produces some concentration of the data but anomalies still remain, particularly in the way that high OCR's appear to be associated with low normalized p'-values. This is contrary to a perception (and the experimental results of Chan, 1985) that when the clay has an OCR of about 2-2.5 then the yield envelope will be approximately symmetrical about the p'-axis, with $K_0 \approx 1.0$.

YIELDING AS A STATE BOUNDARY SURFACE IN p',q,V-space

It is now common to present normalized yield envelopes as a relationship between stresses in the form shown in Figs. 4, 5. The usefulness of these envelopes in geotechnical practice has been well demonstrated (for example by Wood, 1980; Clausen et al., 1984; Folkes and Crooks, 1985). However the behaviour is one in which straining as well as stressing is important. It should be remembered that yielding is described by a three dimensional state boundary surface in p', q, V-space. The present practice of plotting only normalized yield envelopes in p'/σ'_{vc}, q/σ'_{vc}-space, while it is helpful in many instances has, in other ways, obscured some fundamental features of yielding in natural clays. For example, undrained strengths are of course located on the state boundary surface. However they do not in general plot on yield envelopes that are obtained by drained stress probing from the same initial stresses and specific volumes (Wroth and Houlsby, 1985).

Figs. 7a,b show one of the few published examples of a complete state boundary surface (Graham et al., 1983a). In these Figures the lighter lines represent previously published envelopes for four different depths and preconsolidation pressures in Winnipeg clay. Two features of these envelopes differ noticeably from the shapes which are commonly adopted in the Critical State modified Cam-clay model of soil behaviour (for example, Houlsby et al., 1982). Firstly, the envelopes in p', q-space are not elliptical, that is, the hydrostatic yield stress p'_{iso} is not the largest value of p'_y. Secondly, in p', V-space, the traces of the yield envelopes have an unusual "hooked" shape rather than the straight κ-lines of the model. However, apart from these differences, important similarities are apparent. The yield data normalize well in p', q-space; the separation of the envelopes in p', V-space corresponds well with the expected value $V = \lambda \ln(\sigma'_{vc2} / \sigma'_{vc1})$ (Graham et al., 1983a); and a straight envelope with $\kappa = 0.09$ is obtained in $(V + \lambda \ln \sigma'_{vc})$, $\ln(p'/\sigma'_{vc})$ - space (Wroth and Houlsby, 1985). Nevertheless, the in-turning shape of the yield envelopes suggests a limitation on the applicability of the Critical State model.

Graham and Li (1985) reported that yield data for natural and reconstituted Winnipeg clay lay on the same normalized yield envelope, so the geometric shape of the yield envelopes in this clay is not a function of geological aging or weathering. (The envelopes did however differ in p', V-space). The heavier lines in Figs. 7a,b have been constructed graphically as constant-V traces of the drained state boundary surface measured in the laboratory. They therefore permit a better appreciation of the true shape of the surface than can be obtained from yield envelopes that are skewed to the reference planes. It is now seen that the traces (no longer "yield envelopes") are much more elliptical, and closer in shape to the Critical State model. Their shape has not been established in detail at low stresses close to the q, V-plane, although some information on the strength envelope in this region has been reported by Graham and Au (1985). Stress path testing into this region is difficult due to accelerating displacements in load-controlled tests (Graham et al., 1983a), and strain controlled testing will be required. Fig. 7 and Fig. 8 show different three-dimensional views of the state boundary surface for Winnipeg clay. These have been constructed graphically in this case, but have also been viewed using axis rotation of digital data on a micro-computer. The similarity between the data and the Critical State model is now clearer than before.

Additional information has been shown schematically in Fig. 8. The normally consolidated Coulomb Mohr plane with slope M(Φ) intersects the state boundary surface at the Critical State line, CSL. Overconsolidated undrained samples of this clay strain-soften from the Hvorslev surface and approach this plane at large strains (Graham et al., 1983a). The Figure also gives an impression of how rate effects such as those discussed by Tavenas and

Lerouei1 (1977) and Graham et al. (1983b) might form a series of 'skins' or 'shells' round the state boundary surface. Undrained strengths, preconsolidation pressures and yield envelopes all decrease in magnitude with increased durations of testing. The changes in natural clays are rather larger than would normally be expected from reconstituted samples. Different straining rates produce different undrained strengths at the same specific volume. There must therefore be a strain rate component in the constitutive relationships (Leroueil et al., 1985) which is separate from the expansion of the elastic behaviour yield envelope that accompanies aging or delayed compression.

Consider a typical stress path such as ABCD in Fig. 8 in which a sample at its in situ state at A is first consolidated anistropically with constant stress ratio. Small volume strains are measured until the sample yields at B on the state boundary surface. With further stress increases (and the same stress ratio) large consolidation strains occur as plastic strain hardening expands the region of pseudo-elastic behaviour between B and C. Undrained shear leads to normally consolidated failure at D. Different speeds of testing will produce different values of undrained strength, but identical values of M(Φ). In p', q-space, the constant-volume trace of CD will not coincide with the drained yield envelope through C. Different rates of straining or porewater pressure dissipation occur between AB and BC. Changes similar to these have been clearly observed in field applications (for example Folkes and Crooks, 1985).

SUMMARY AND CONCLUSIONS

Yielding is an inherent feature of most lightly overconsolidated clays. It is observed in the field under embankments; and in the laboratory provided careful sampling, trimming and testing are undertaken. The criteria for identifying yielding are empirical and require judgement. It is therefore important to understand the limitations of the procedures which are used, and the impact they might have on the interpretation of test data.

Figs. 1 and 2 show that bilinear curve-fitting in σ', ε -space is formally incompatible with exponential post-yield straining. However, as an empirical procedure, it works reasonably well in natural clays that are very carefully handled to preserve their "aged" microstructure. Reconstituted samples are widely used because of their uniformity, but may lead to important misconceptions about the behaviour of real clays.

Figs. 3 and 6b raise questions about the influence of overconsolidation and K_o on the shape of the yield surface. The symmetry which is frequently observed in s',t-plots is not seen in q,p'-plots of the same data. Geometrically-similar yield envelopes which can be normalized into a unique envelope have been measured in several clays with OCR's up to about 2.0 (for example Graham et al., 1983a; Fig. 8). This means that K_o should be approaching 1.0, and yet the shape of the envelopes does not appear to become more symmetrical about the $q = 0$ axis. The microstructure, and hence the shape of the yield envelope, in these clays may be controlled mostly by normally consolidated conditions during and shortly after deposition, and to a lesser extent by the subsequent development of apparent overconsolidation. Consideration of the envelopes in Figs. 5, 6 shows no systematic relationship between the geometry of the envelopes and classification data of the clays given in Table 1. Further work is needed.

Finally, yielding is a particular "state" in the clay, and should be examined in terms of a state boundary surface, for example in p',q,V-space. It is only in this way that some of the apparent anomalies in yield envelope plotting in p',q-space can be understood. For example, Figs. 7, 8 suggest that the Critical State model of soil behaviour may be rather better than is commonly understood from considering only yield envelopes in q,p'-space.

ACKNOWLEDGEMENTS

This work was funded in part from Grant A3712 from the Natural Sciences and Engineering Research Council, Canada. This Paper has drawn on data and ideas provided to us at various times by K. Been, A.L. Bell, G.T. Houlsby, K.T. Law, K.V. Lew, E.C.C. Li and C.P. Wroth. N. Piamsalee assisted with the tests. I. Trestrail typed the manuscript.

REFERENCES

Atkinson, J.H. and Bransby, P.L. 1978. The mechanics of soils: an introduction to critical state soil mechanics. McGraw Hill (U.K.) Ltd., Maidenhead, England, 375 pp.

Bell, A.L. 1977. A geotechnical investigation of post-glacial estuarine deposits at Kinnegar, Belfastlough. Ph.D. Thesis, Queen's University, Belfast.

Bjerrum, L. 1967. The engineering geology of Norwegian normally consolidated marine clays as related to the settlement of buildings. Geotechnique 17, pp. 81-118.

Brooker, E.W. and Ireland, H.O. 1965. Earth pressures at rest related to stress history. Canadian Geotechnical Journal, 2, pp. 1-15.

Chan, A.C.Y. 1985. Geotechnical characteristics of genesee clay. Ph.D. Thesis, University of Alberta, 374 pp.

Clausen, C.-J.F., Graham, J. and Wood, D.M. 1984 in soft clay at Mastemyr, Norway. Geotechnique, 34, No. 4, pp. 581-600.

Crooks, J.H.A. and Graham, J. 1972. Stress-strain properties of Belfast estuarine clay. Engineering Geology, Elsevier, Amsterdam, 6, pp. 275-288.

Crooks, J.H.A. and Graham, J. 1976. Geotechnical properties of the Belfast estuarine deposits. Geotechnique, 26, No. 2, pp. 293-315.

Folkes, D.J. and Crooks, J.H.A. 1985. Effective stress paths and yielding in soft clays below embankments. Canadian Geotechnical Journal, 22, No. 3, pp. 357-374.

Graham, J. 1972. Discussion on Session 3 "The meaning and measurement of basic soil parameters (3)". Roscoe Memorial Symposium, Cambridge 1971. Ed. R.H.G. Parry, publ. Fonlis, Henley-on-Thames, 1972, pp. 388-389.

Graham, J. 1974. Laboratory testing of sensitive clay from Lyndhurst, Ontario. Civil Engineering Research Report CE74-2, Royal Military College of Canada, Kingston, Ontario, 50 p.

Graham, J., Pinkney, R.B., Lew, K.V. and Trainor, P.G.S. 1982. Curve-fitting and laboratory data. Canadian Geotechnical Journal, 19, No. 2, pp. 201-205.

Graham, J., Noonan, M.L. and Lew, K.V. 1983a. Yield states and stress-strain relationships in a natural plastic clay. Canadian Geotechnical Journal, 20, No. 3, pp. 502-516.

Graham, J., Crooks, J.H.A. and Bell, A.L. 1983b. Time effects on the stress-strain behaviour of natural soft clays. Geotechnique, 33, No. 3, pp. 327-340.

Graham, J. and Au, V.C.S. 1985. Effects of freeze-thaw and softening on a natural clay at low stresses. Canadian Geotechnical Journal, 22, No. 1, pp. 69-78.

Graham, J. and Li, E.C.C. 1985. Comparison of natural and remoulded plastic clay. Journal Geotechnical Engineering, Amer. Soc. Civil Engrs., Vol. III, pp. 865-881.

Houlsby, G.T., Wroth, C.P. and Wood, D.M. 1982. Predictions of the results of laboratory tests on a clay using a critical state model. Results of the Int. Workshop on constitutive relations for soils, Grenoble. Ed. G. Gudehus, F. Darve, I. Vardoulakis, publ. Balkema, Amsterdam.

Leroueil, S., Tavenas, F., Brucy, F., La Rochelle, P. and Roy, M. 1979. Behaviour of destructured natural clays. ASCE Journal of the Geotechnical Engineering Division, 105 (GT6), pp. 759-778.

Leroueil, S., Kabbaj, M., Tavenas, F. and Bouchard, R. 1985. Stress-strain-strain rate relation for the compressibility of sensitive natural clays. Geotechnique, 35, pp. 159-180.

Mitchell, R.J. 1970. On the yielding and mechanical strength of Leda clays. Canadian Geotechnical Journal, 7, pp. 297-312.

Tavenas, F. and Leroueil, S. 1977. The effect of stresses and time on yielding of clays. Proc. 9th Intl. Conf. on Soil Mechs. and Founds. Eng., Tokyo, Japan, 1, pp. 319-326.

Tavenas, F., Des Rosiers, J.-P., Leroueil, S., La Rochelle, P. and Roy, M. 1979. The use of strain energy as a yield and creep criterion for lightly over-consolidated clays. Geotechnique, 29, pp. 285-304.

Watson, G.H., Crooks, J.H.A., Williams, R.S. and Yam, C.C. 1984. Performance of preloaded and stage-loaded structures on soft soils in Trinidad. Géotechnique, 34, No. 2, pp. 239-257.

Wood, D.M. 1980. Yielding in soft clays at Bäckebol, Sweden. Geotechnique, 30, pp. 49-65.

Wood, D.M. 1984. On stress parameters. Geotechnique, 34, No. 2, pp. 282-287.

Wroth, C.P. and Houlsby, G.T. 1985. Soil mechanics - property characterization and analysis procedures. Proc. 11th Int. Conf. on Soil Mechs. and Founds. Eng., San Francisco, California, 3, pp. 1-54.

Classification data for clays yield envelopes in Fig. 7.

Site		L	I_p	C_F	Activity	OCR	Reference
Rang de Fleuve	80	70	50	-	-	1.0≈1.2	Tavenas et al., 1979
Belfast	a) 35-55	40-60	20-40	40-50	0.6	1.6-2.0	Bell, 1977
	b) 60-80	75-110	50-70	30-40	1.5	1.2-1.8	Crooks and Graham, 1976
Winnipeg	54-63	65-85	35-60	70-80	0.67	2.4	Graham et al., 1983a
St. Alban	90	50	23	61	0.38	2.2	Tavenas and Leroueil, 1977
Lyndhurst	45	36	13-16	60	0.25	1.5	Graham, 1974
Mastemyr	40	26	5.13	-	-	1.2	Clausen Graham Wood, 1984

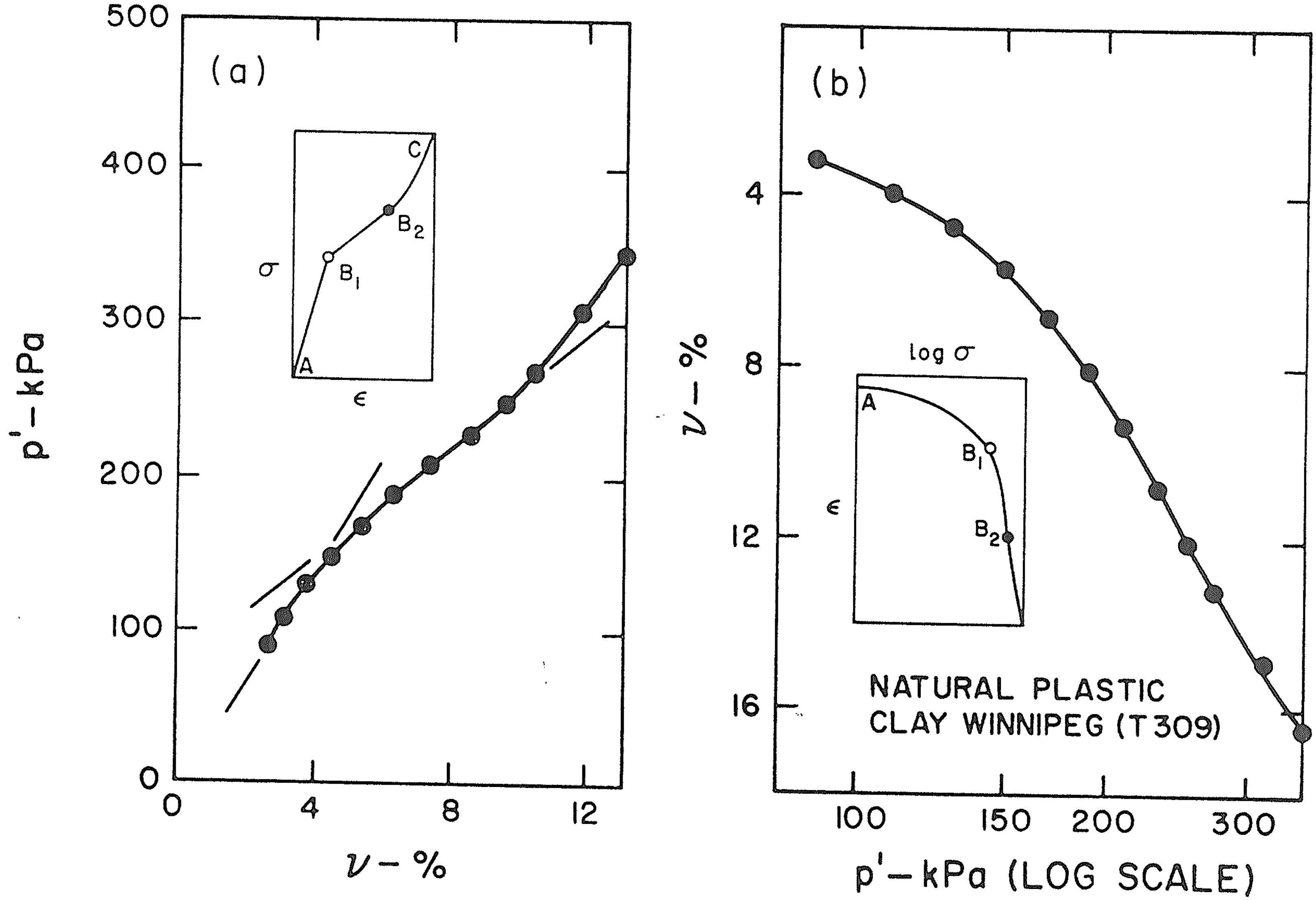


FIG.2 (a) STRESS-STRAIN AND (b) LOG(STRESS)-STRAIN PLOTS FOR NATURAL PLASTIC CLAY.

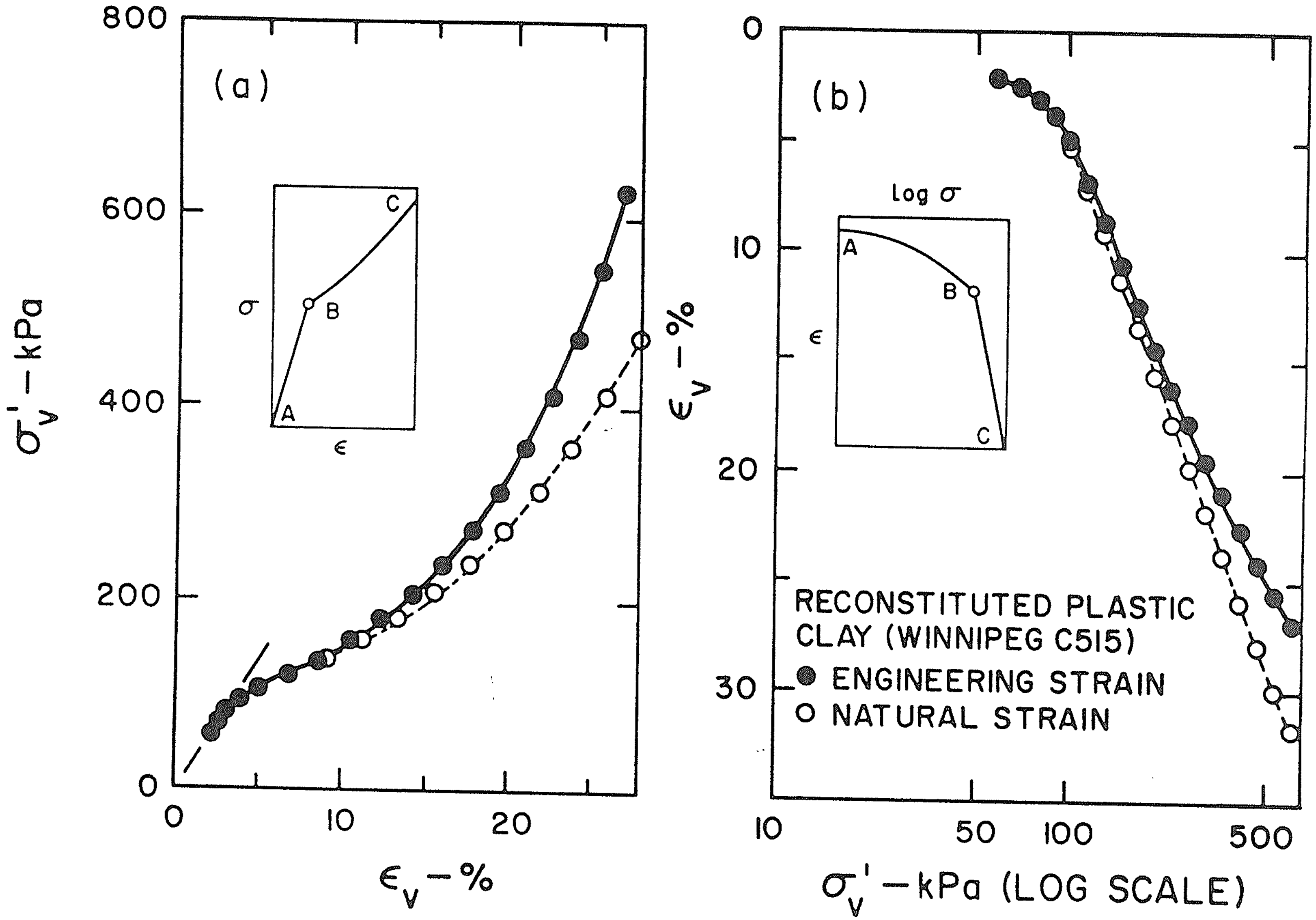


FIG.1 (a) STRESS-STRAIN AND (b) LOG(STRESS)-STRAIN PLOTS FOR RECONSTITUTED PLASTIC CLAY: ENGINEERING STRAINS AND NATURAL STRAINS.

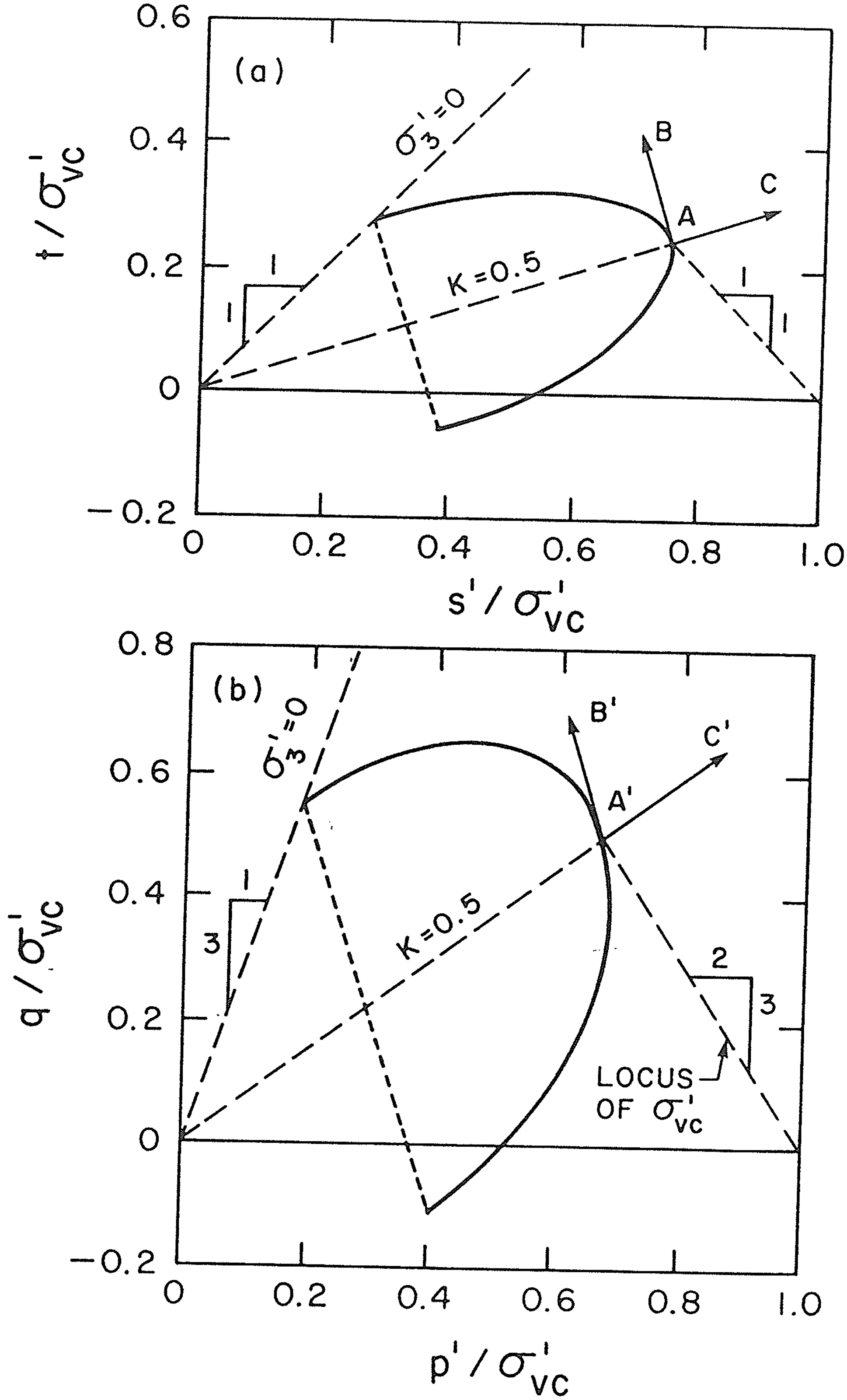


FIG.3 SCHEMATIC OF IDEALIZED YIELD ENVELOPES IN s',t- and p',q-SPACES.

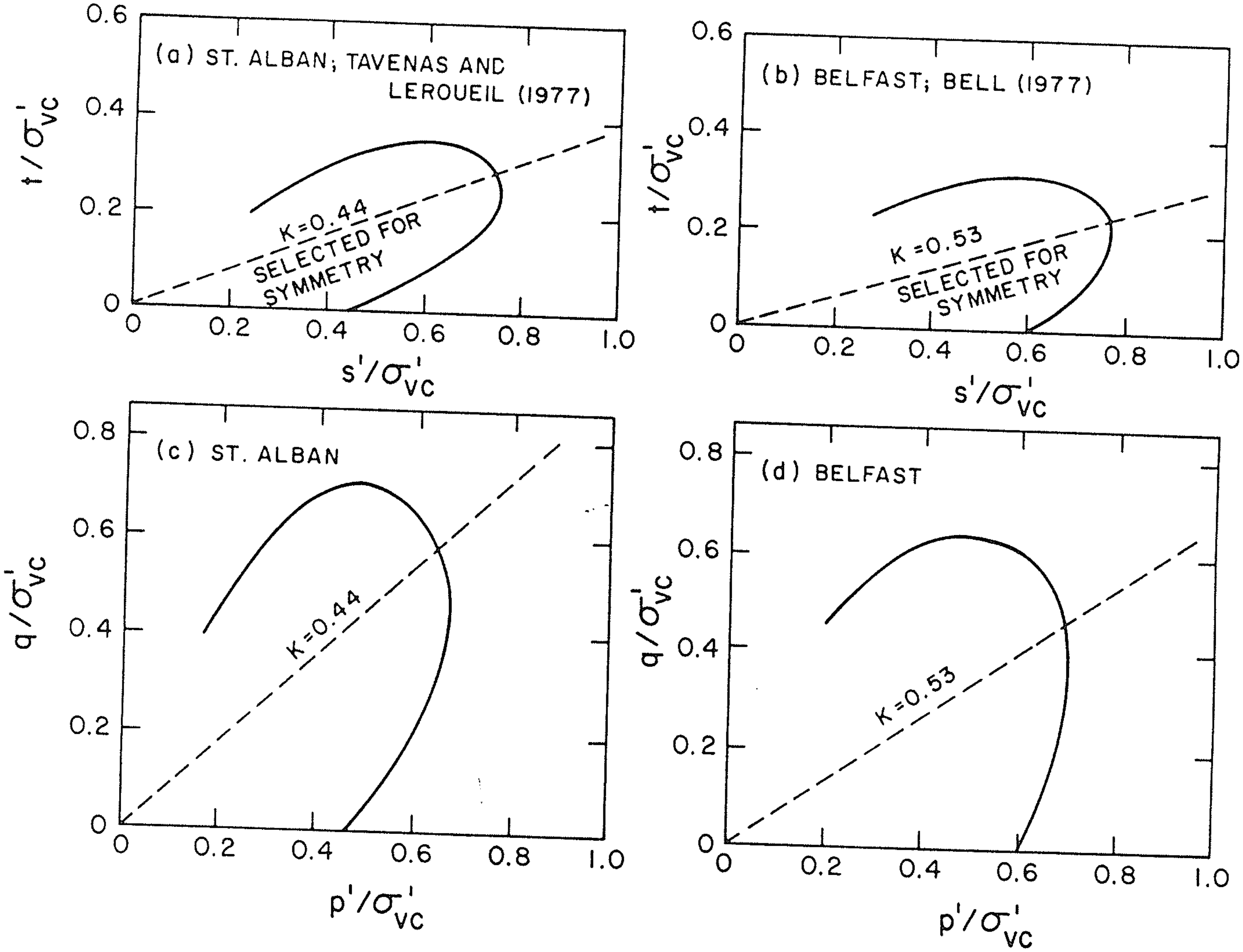


FIG.4 MEASURED YIELD ENVELOPES IN s',t- AND p',q'-SPACE.

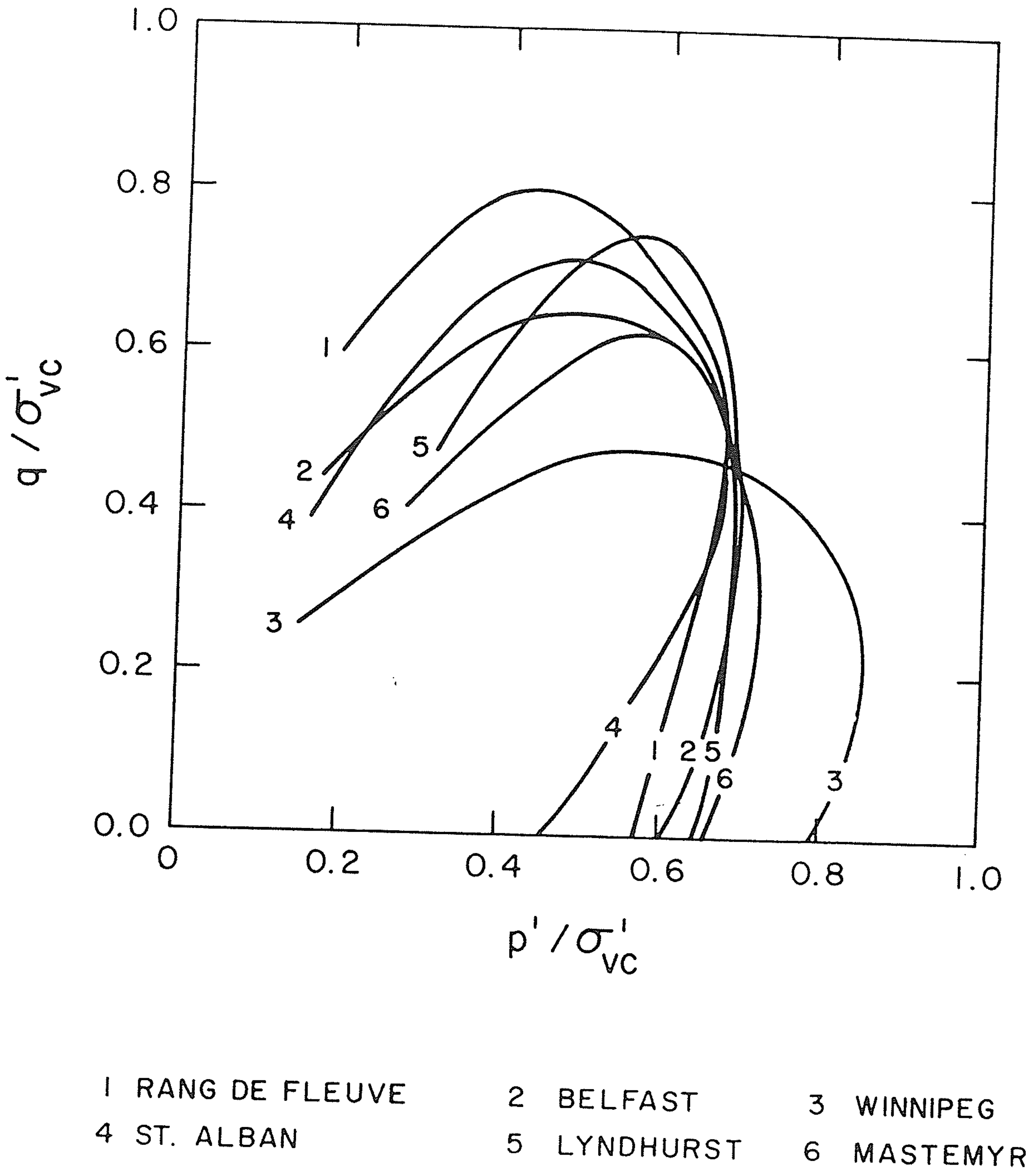


FIG.5 EXAMPLES OF NORMALIZED YIELD ENVELOPES FROM VARIOUS SITES.

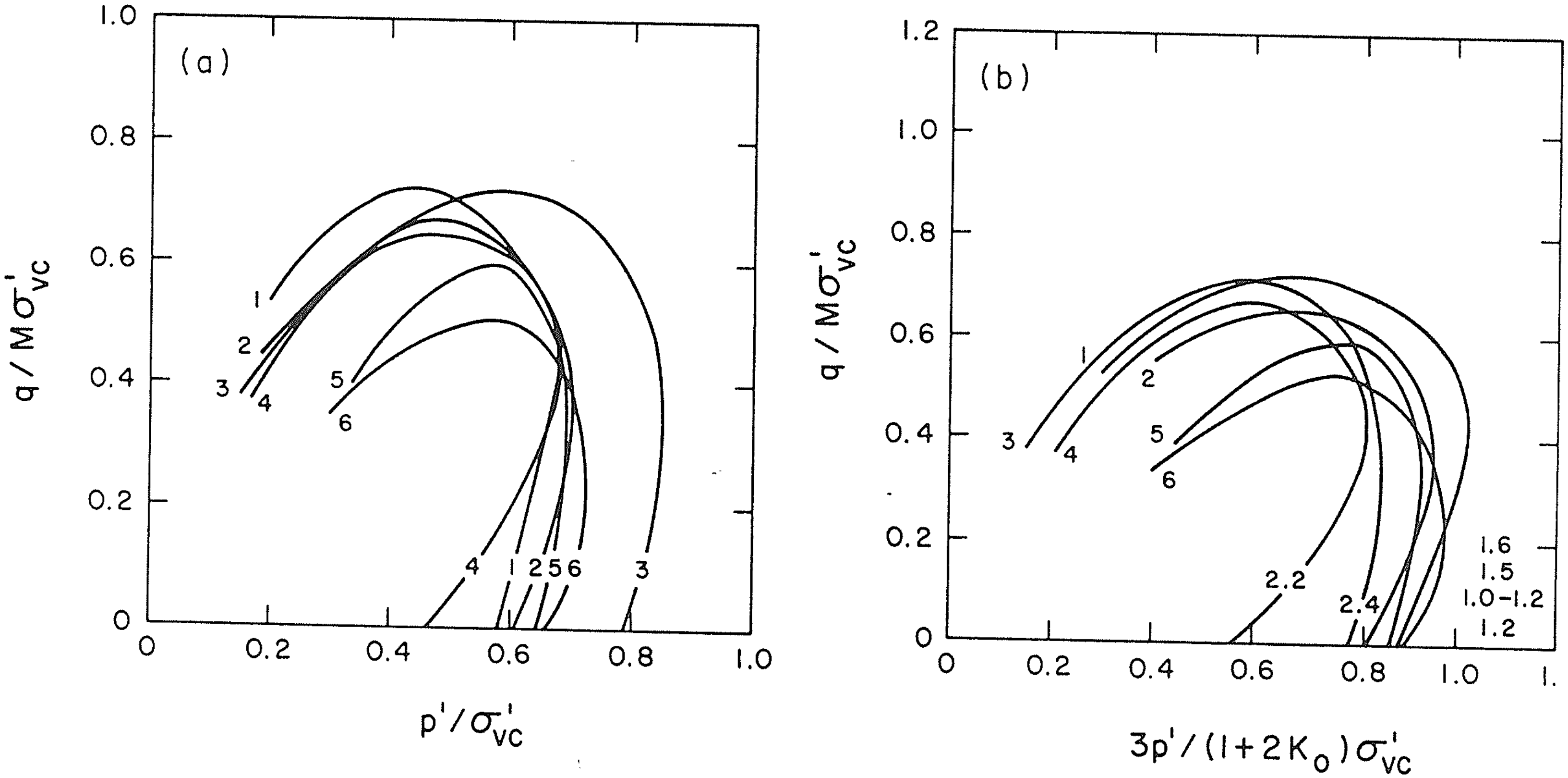


FIG.6 NORMALIZED YIELD ENVELOPES EXAMINED FOR (a) INFLUENCE OF MINERALOGY THROUGH THE M-PARAMETER, AND (b) OCR THROUGH $(1+2K_0)/3$

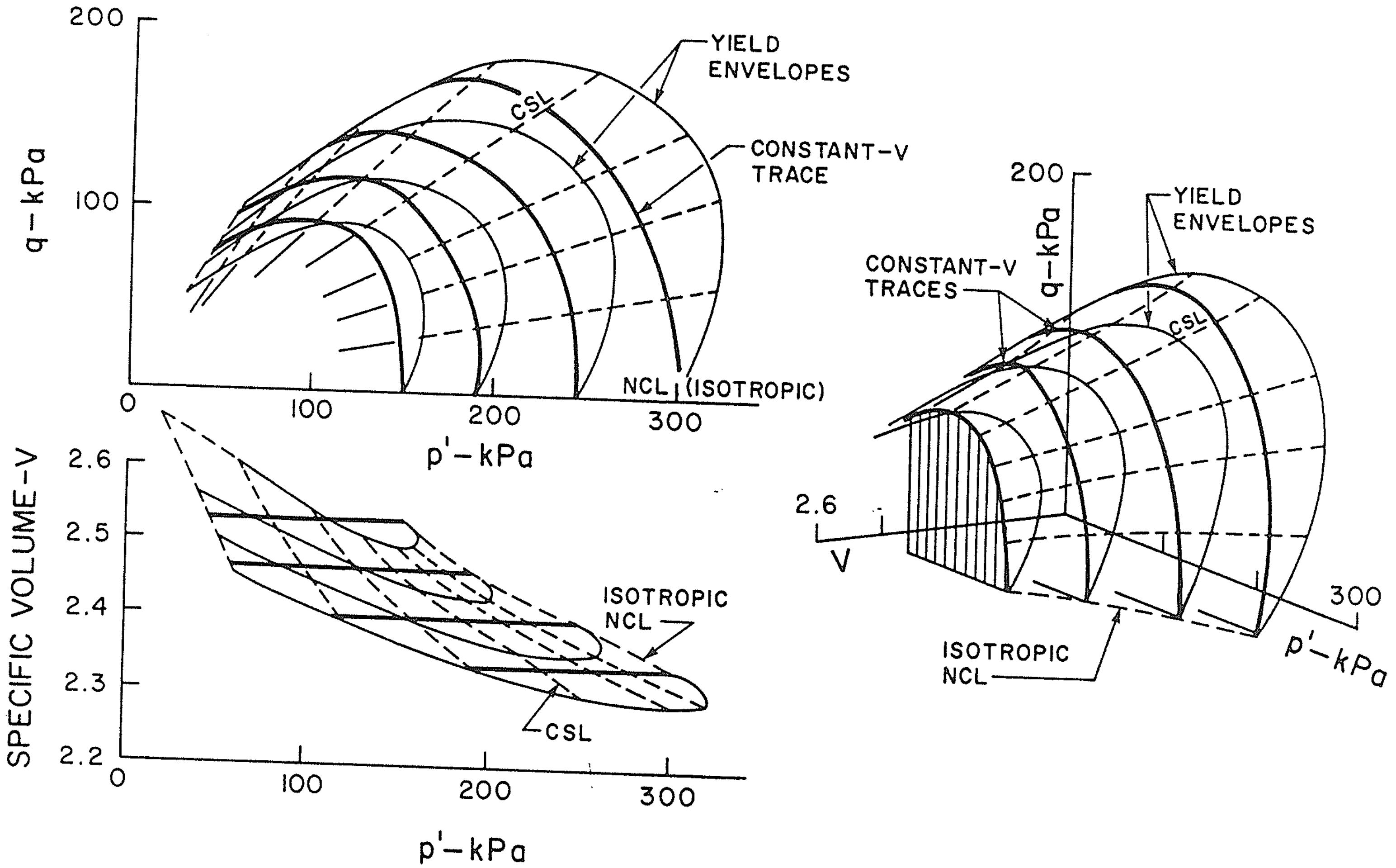


FIG.7 MEASURED YIELD ENVELOPE FOR NATURAL PLASTIC WINNIPEG CLAY SHOWING GRAPHICALLY CONSTRUCTED CONSTANT-V TRACES AND SHAPE OF STATE BOUNDARY SURFACE

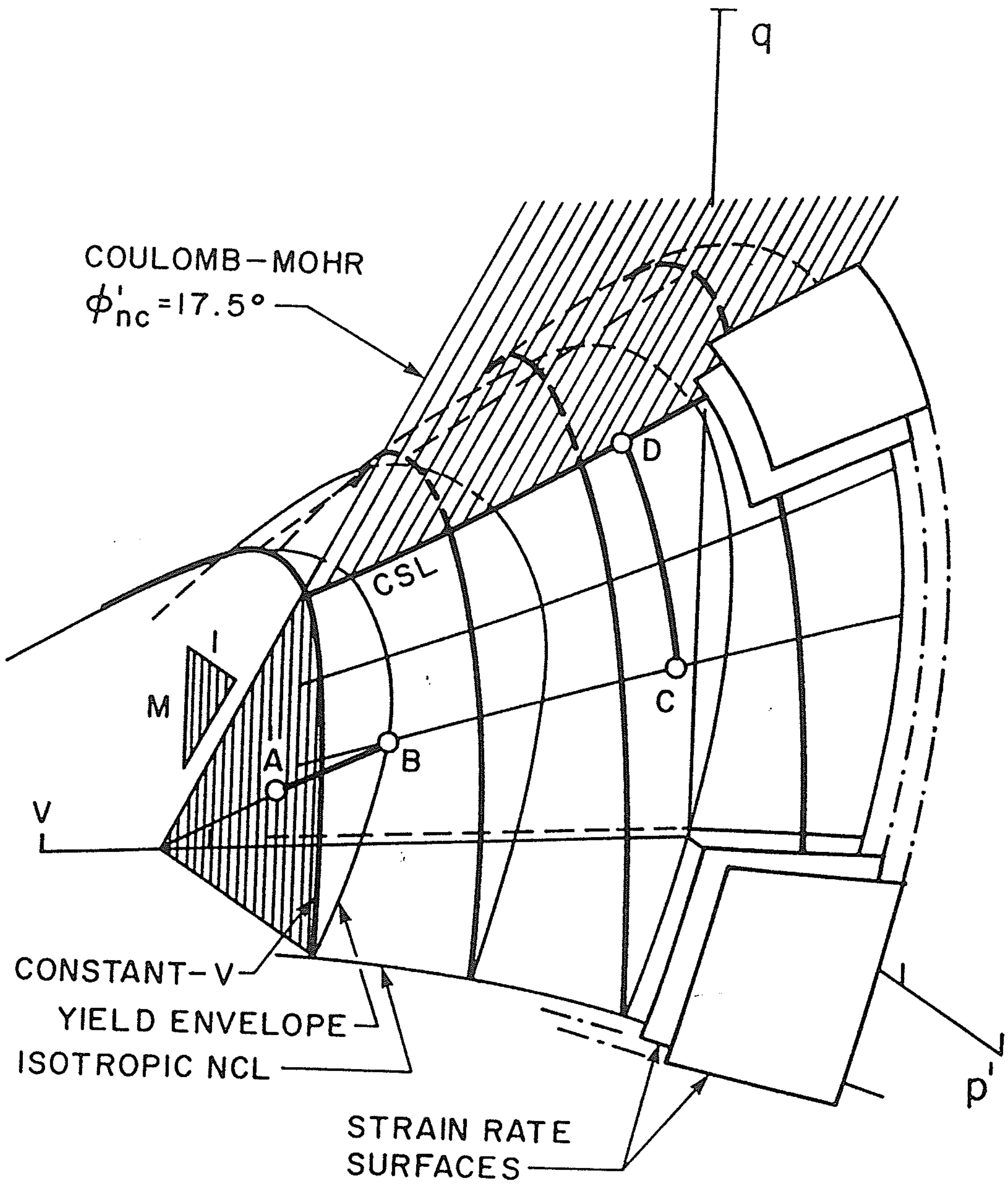


FIG. 8 IDEALIZED STATE BOUNDARY SURFACE FOR NATURAL PLASTIC CLAY INDICATING EFFECTS OF CHANGES IN STRAIN RATE.

APPENDIX F

TABULATED LABORATORY TEST RESULTS

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 728 (REMOULDED SAMPLE)

INITIAL MOISTURE CONTENT	=	48.2 PERCENT
SPECIFIC GRAVITY OF SOIL	=	2.73
INITIAL VOID RATIO	=	1.316
INITIAL HEIGHT OF SAMPLE	=	13.29 CM
INITIAL VOLUME OF SAMPLE	=	604.96 CC
EFFECTIVE PRINCIPAL STRESS RATIO	=	0.98
FINAL MOISTURE CONTENT	=	36.1 PERCENT

TX. CONSOLIDATION START 270584 END 190684
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	79.85	42.40	12.374	10.670	-0.852	54.88	37.45	1.069	2.069	8.817
2	79.82	42.40	12.342	10.543	-0.900	54.87	37.42	1.072	2.072	8.828
3	72.97	45.80	12.257	10.480	-0.888	54.86	27.17	1.073	2.073	8.765
4	81.37	56.70	12.315	10.711	-0.802	64.92	24.67	1.068	2.068	8.745
5	89.58	67.60	12.380	11.021	-0.680	74.93	21.98	1.061	2.061	8.706
6	97.85	78.50	12.436	11.373	-0.532	84.95	19.35	1.052	2.052	8.645
7	106.05	89.40	12.479	11.778	-0.351	94.95	16.65	1.043	2.043	8.553
8	114.23	100.20	12.517	12.232	-0.142	104.88	14.03	1.033	2.033	8.440
9	122.49	111.10	12.555	12.728	0.087	114.90	11.39	1.021	2.021	8.312
10	130.73	122.00	12.600	13.249	0.325	124.91	8.73	1.009	2.009	8.183
11	139.01	132.90	12.641	13.720	0.539	134.94	6.11	0.998	1.998	8.068
12	147.19	143.80	12.686	14.232	0.773	144.93	3.39	0.986	1.986	7.942

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	79.85	42.40	12.374	-0.852	2.069
2	79.82	42.40	12.342	-0.900	2.072
3	72.97	45.80	12.257	-0.888	2.073
4	81.37	56.70	12.315	-0.802	2.068
5	89.58	67.60	12.380	-0.680	2.061
6	97.85	78.50	12.436	-0.532	2.052
7	106.05	89.40	12.479	-0.351	2.043
8	114.23	100.20	12.517	-0.142	2.033
9	122.49	111.10	12.555	0.087	2.021
10	130.73	122.00	12.600	0.325	2.009
11	139.01	132.90	12.641	0.539	1.998
12	147.19	143.80	12.686	0.773	1.986

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 728 (REMOULDED SAMPLE)
TEST RESULTS START 270584 END 190684

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	79.9	42.4	37.5	54.9	12.374	-0.852	10.670	0.0	0.0		0.0
2	79.8	42.4	37.4	54.9	12.342	-0.900	10.543	0.0	0.1	-0.066	-0.066
3	73.0	45.8	27.2	54.9	12.257	-0.888	10.480	8.4	0.1	-0.055	-0.121
4	81.4	56.7	24.7	64.9	12.315	-0.802	10.711	20.3	0.1	0.134	0.013
5	89.6	67.6	22.0	74.9	12.380	-0.680	11.021	36.9	0.2	0.207	0.220
6	97.9	78.5	19.4	85.0	12.436	-0.532	11.373	54.1	0.5	0.269	0.489
7	106.1	89.4	16.7	95.0	12.479	-0.351	11.778	71.4	0.7	0.348	0.836
8	114.2	100.2	14.0	104.9	12.517	-0.142	12.232	88.7	1.0	0.437	1.273
9	122.5	111.1	11.4	114.9	12.555	0.087	12.728	106.1	1.3	0.529	1.802
10	130.7	122.0	8.7	124.9	12.600	0.325	13.249	123.5	1.7	0.611	2.413
11	139.0	132.9	6.1	134.9	12.641	0.539	13.720	141.0	2.0	0.603	3.017
12	147.2	143.8	3.4	144.9	12.686	0.773	14.232	158.4	2.3	0.711	3.728

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 728 (REMOULDED SAMPLE)
TEST RESULTS START 270584 END 190684

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	79.9	42.4	37.5	54.9	13.190	-0.959	11.271	0.0	0.0		0.0
2	79.8	42.4	37.4	54.9	13.154	-1.012	11.129	0.0	0.1	-0.074	-0.074
3	73.0	45.8	27.2	54.9	13.056	-0.999	11.059	8.4	0.1	-0.063	-0.136
4	81.4	56.7	24.7	64.9	13.123	-0.903	11.318	20.3	0.1	0.150	0.014
5	89.6	67.6	22.0	74.9	13.197	-0.766	11.665	36.9	0.3	0.233	0.246
6	97.9	78.5	19.4	85.0	13.260	-0.600	12.061	54.1	0.5	0.303	0.549
7	106.1	89.4	16.7	95.0	13.310	-0.396	12.519	71.4	0.8	0.393	0.943
8	114.2	100.2	14.0	104.9	13.353	-0.159	13.036	88.7	1.1	0.496	1.439
9	122.5	111.1	11.4	114.9	13.396	0.103	13.602	106.1	1.5	0.604	2.043
10	130.7	122.0	8.7	124.9	13.448	0.376	14.201	123.5	1.9	0.703	2.746
11	139.0	132.9	6.1	134.9	13.495	0.625	14.745	141.0	2.3	0.698	3.443
12	147.2	143.8	3.4	144.9	13.547	0.897	15.341	158.4	2.6	0.827	4.270

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 729 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 46.8 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.278
INITIAL HEIGHT OF SAMPLE : 13.19 CM
INITIAL VOLUME OF SAMPLE : 600.95 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.41
FINAL MOISTURE CONTENT : 36.3 PERCENT

TX. CONSOLIDATION START 10684 END 190684
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	80.49	42.40	10.890	11.382	0.246	55.10	38.09	1.018	2.018	7.097
2	80.45	42.40	10.859	11.274	0.207	55.08	38.05	1.021	2.021	7.101
3	92.97	45.30	10.958	11.399	0.220	61.19	47.67	1.018	2.018	7.158
4	105.74	48.40	11.178	11.598	0.210	67.51	57.34	1.013	2.013	7.312
5	118.80	51.60	11.438	11.823	0.192	74.00	67.20	1.008	2.008	7.497
6	131.56	54.70	11.923	12.064	0.070	80.32	76.86	1.003	2.003	7.902
7	142.76	57.90	14.383	12.580	-0.902	86.19	84.86	0.991	1.991	10.190

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	80.49	42.40	10.890	0.246	2.018
2	80.45	42.40	10.859	0.207	2.021
3	92.97	45.30	10.958	0.220	2.018
4	105.74	48.40	11.178	0.210	2.013
5	118.80	51.60	11.438	0.192	2.008
6	131.56	54.70	11.923	0.070	2.003
7	142.76	57.90	14.383	-0.902	1.991

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 729 (REMOULDED SAMPLE)
TEST RESULTS START 10684 END 190684

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	80.5	42.4	38.1	55.1	10.890	0.246	11.382	0.0	0.0		0.0
2	80.5	42.4	38.1	55.1	10.859	0.207	11.274	0.0	0.1	-0.058	-0.058
3	93.0	45.3	47.7	61.2	10.958	0.220	11.399	13.1	0.1	0.097	0.039
4	105.7	48.4	57.3	67.5	11.178	0.210	11.598	26.6	0.3	0.209	0.249
5	118.8	51.6	67.2	74.0	11.438	0.192	11.823	40.5	0.6	0.274	0.523
6	131.6	54.7	76.9	80.3	11.923	0.070	12.064	54.0	1.1	0.478	1.000
7	142.8	57.9	84.9	86.2	14.383	-0.902	12.580	66.0	3.9	2.280	3.280

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 729 (REMOULDED SAMPLE)
TEST RESULTS START 10684 END 190684

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	80.5	42.4	38.1	55.1	11.518	0.276	12.069	0.0	0.0		0.0
2	80.5	42.4	38.1	55.1	11.483	0.232	11.947	0.0	0.1	-0.065	-0.065
3	93.0	45.3	47.7	61.2	11.593	0.247	12.088	13.1	0.1	0.109	0.044
4	105.7	48.4	57.3	67.5	11.841	0.236	12.313	26.6	0.3	0.236	0.280
5	118.8	51.6	67.2	74.0	12.134	0.217	12.568	40.5	0.6	0.310	0.590
6	131.6	54.7	76.9	80.3	12.684	0.079	12.842	54.0	1.2	0.541	1.131
7	142.8	57.9	84.9	86.2	15.516	-1.043	13.430	66.0	4.4	2.622	3.753

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 730 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 48.8 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.336
INITIAL HEIGHT OF SAMPLE : 12.26 CM
INITIAL VOLUME OF SAMPLE : 558.07 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.31
FINAL MOISTURE CONTENT : 41.0 PERCENT

TX. CONSOLIDATION START 260684 END 190784
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	79.25	42.40	6.905	9.067	1.081	54.68	36.85	1.125	2.125	3.883
2	79.21	42.40	6.872	8.941	1.035	54.67	36.81	1.127	2.127	3.891
3	83.18	41.70	6.886	8.941	1.028	55.53	41.48	1.127	2.127	3.905
4	86.94	40.90	6.916	8.933	1.008	56.25	46.04	1.128	2.128	3.938
5	90.79	40.20	6.958	8.941	0.992	57.06	50.59	1.127	2.127	3.977
6	94.65	39.40	7.016	8.968	0.976	57.82	55.25	1.127	2.127	4.027
7	98.37	38.70	7.095	8.972	0.939	58.59	59.67	1.127	2.127	4.104
8	102.19	37.90	7.196	8.986	0.895	59.33	64.29	1.126	2.126	4.200
9	105.94	37.20	7.359	8.995	0.818	60.11	68.74	1.126	2.126	4.360
10	109.60	36.40	7.647	9.036	0.695	60.80	73.20	1.125	2.125	4.635
11	113.16	35.60	8.369	9.062	0.346	61.45	77.56	1.125	2.125	5.348
12	113.56	34.90	12.802	9.251	-1.775	61.12	78.66	1.120	2.120	9.718

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	79.25	42.40	6.905	1.081	2.125
2	79.21	42.40	6.872	1.035	2.127
3	83.18	41.70	6.886	1.028	2.127
4	86.94	40.90	6.916	1.008	2.128
5	90.79	40.20	6.958	0.992	2.127
6	94.65	39.40	7.016	0.976	2.127
7	98.37	38.70	7.095	0.939	2.127
8	102.19	37.90	7.196	0.895	2.126
9	105.94	37.20	7.359	0.818	2.126
10	109.60	36.40	7.647	0.695	2.125
11	113.16	35.60	8.369	0.346	2.125
12	113.56	34.90	12.802	-1.775	2.120

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 730 (REMOULDED SAMPLE)
TEST RESULTS START 260684 END 190784

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	79.3	42.4	36.9	54.7	6.905	1.081	9.067	0.0	0.0		0.0
2	79.2	42.4	36.8	54.7	6.872	1.035	8.941	0.0	0.1	-0.065	-0.065
3	83.2	41.7	41.5	55.5	6.886	1.028	8.941	4.1	0.1	0.005	-0.080
4	86.9	40.9	46.0	56.2	6.916	1.008	8.933	8.0	0.1	0.010	-0.051
5	90.8	40.2	50.6	57.1	6.958	0.992	8.941	12.0	0.1	0.024	-0.027
6	94.6	39.4	55.3	57.8	7.016	0.976	8.968	16.0	0.2	0.042	0.015
7	98.4	38.7	59.7	58.6	7.095	0.939	8.972	19.8	0.3	0.046	0.061
8	102.2	37.9	64.3	59.3	7.196	0.895	8.986	23.8	0.4	0.068	0.130
9	105.9	37.2	68.7	60.1	7.359	0.818	8.995	27.7	0.6	0.112	0.241
10	109.6	36.4	73.2	60.8	7.647	0.695	9.036	31.5	0.9	0.220	0.461
11	113.2	35.6	77.6	61.5	8.369	0.346	9.062	35.2	1.8	0.553	1.014
12	113.6	34.9	78.7	61.1	12.802	-1.775	9.251	35.9	7.1	3.530	4.544

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 730 (REMOULDED SAMPLE)
TEST RESULTS START 260684 END 190784

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	79.3	42.4	36.9	54.7	7.152	1.173	9.497	0.0	0.0		0.0
2	79.2	42.4	36.8	54.7	7.116	1.122	9.360	0.0	0.1	-0.072	-0.072
3	83.2	41.7	41.5	55.5	7.131	1.114	9.360	4.1	0.1	0.006	-0.066
4	86.9	40.9	46.0	56.2	7.164	1.093	9.350	8.0	0.1	0.010	-0.056
5	90.8	40.2	50.6	57.1	7.208	1.076	9.360	12.0	0.1	0.026	-0.030
6	94.6	39.4	55.3	57.8	7.272	1.059	9.389	16.0	0.2	0.045	0.015
7	98.4	38.7	59.7	58.6	7.356	1.019	9.393	19.8	0.3	0.050	0.065
8	102.2	37.9	64.3	59.3	7.465	0.972	9.409	23.8	0.4	0.074	0.139
9	105.9	37.2	68.7	60.1	7.641	0.889	9.419	27.7	0.6	0.121	0.259
10	109.6	36.4	73.2	60.8	7.952	0.756	9.464	31.5	1.0	0.238	0.497
11	113.2	35.6	77.6	61.5	8.737	0.377	9.492	35.2	1.9	0.601	1.098
12	113.6	34.9	78.7	61.1	13.695	-1.997	9.701	35.9	7.9	3.946	5.045

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 732 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT = 50.1 PERCENT
SPECIFIC GRAVITY OF SOIL = 2.73
INITIAL VOID RATIO = 1.368
INITIAL HEIGHT OF SAMPLE = 12.91 CM
INITIAL VOLUME OF SAMPLE = 587.97 CC
EFFECTIVE PRINCIPAL STRESS RATIO = 1.00
FINAL MOISTURE CONTENT = 41.0 PERCENT

TX. CONSOLIDATION START 171184 END 11284
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.93	26.50	3.199	3.061	-0.069	34.31	23.43	1.296	2.296	2.179
2	57.47	30.90	3.532	3.572	0.020	39.76	26.57	1.283	2.283	2.342
3	66.06	35.50	4.051	4.116	0.032	45.69	30.56	1.271	2.271	2.679
4	75.97	40.90	4.624	4.728	0.052	52.59	35.07	1.256	2.256	3.048
5	87.35	47.10	5.422	5.476	0.027	60.52	40.25	1.238	2.238	3.597
6	100.38	54.20	6.383	6.310	-0.036	69.59	46.18	1.219	2.219	4.279
7	115.36	62.40	7.552	7.313	-0.120	80.05	52.95	1.195	2.195	5.115
8	132.50	71.80	8.908	8.436	-0.236	92.03	60.70	1.168	2.168	6.096
9	155.95	84.80	10.922	9.898	-0.512	108.52	71.15	1.134	2.134	7.622
10	156.11	84.80	11.394	10.579	-0.408	108.57	71.31	1.117	2.117	7.868
11	155.73	84.80	11.735	10.494	-0.621	108.44	70.83	1.120	2.120	8.237
12	142.33	83.20	11.743	10.494	-0.625	102.91	59.13	1.120	2.120	8.245
13	130.10	82.80	11.743	10.494	-0.625	98.57	47.30	1.120	2.120	8.245
14	120.81	85.30	11.712	10.494	-0.609	97.14	35.51	1.120	2.120	8.214
15	111.98	88.30	11.673	10.494	-0.590	96.19	23.68	1.120	2.120	8.175
16	107.56	95.70	11.495	10.494	-0.501	99.65	11.86	1.120	2.120	7.997
17	102.60	102.60	11.224	10.494	-0.365	102.60	0.0	1.120	2.120	7.726
18	98.70	98.70	11.139	10.494	-0.322	98.70	0.0	1.120	2.120	7.641
19	97.70	97.70	11.084	10.494	-0.295	97.70	0.0	1.120	2.120	7.587
20	97.00	97.00	11.030	10.494	-0.268	97.00	0.0	1.120	2.120	7.532
21	95.80	95.80	10.976	10.494	-0.241	95.80	0.0	1.120	2.120	7.478
22	94.90	94.90	10.922	10.494	-0.214	94.90	0.0	1.120	2.120	7.424
23	94.00	94.00	10.883	10.494	-0.195	94.00	0.0	1.120	2.120	7.385
24	93.10	93.10	10.837	10.494	-0.171	93.10	0.0	1.120	2.120	7.339
25	92.10	92.10	10.782	10.494	-0.144	92.10	0.0	1.120	2.120	7.284
26	91.60	91.60	10.744	10.494	-0.125	91.60	0.0	1.120	2.120	7.246
27	90.00	90.00	10.697	10.494	-0.102	90.00	0.0	1.120	2.120	7.199
28	82.00	82.00	10.651	10.494	-0.078	82.00	0.0	1.120	2.120	7.153

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE .

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.93	26.50	3.199	-0.069	2.296
2	57.47	30.90	3.532	0.020	2.283
3	66.06	35.50	4.051	0.032	2.271
4	75.97	40.90	4.624	0.052	2.256
5	87.35	47.10	5.422	0.027	2.238
6	100.38	54.20	6.383	-0.036	2.219
7	115.36	62.40	7.552	-0.120	2.195
8	132.50	71.80	8.908	-0.236	2.168
9	155.95	84.80	10.922	-0.512	2.134
10	156.11	84.80	11.394	-0.408	2.117
11	155.73	84.80	11.735	-0.621	2.120
12	142.33	83.20	11.743	-0.625	2.120
13	130.10	82.80	11.743	-0.625	2.120
14	120.81	85.30	11.712	-0.609	2.120
15	111.98	88.30	11.673	-0.590	2.120
16	107.56	95.70	11.495	-0.501	2.120
17	102.60	102.60	11.224	-0.365	2.120
18	98.70	98.70	11.139	-0.322	2.120
19	97.70	97.70	11.084	-0.295	2.120
20	97.00	97.00	11.030	-0.268	2.120
21	95.80	95.80	10.976	-0.241	2.120
22	94.90	94.90	10.922	-0.214	2.120
23	94.00	94.00	10.883	-0.195	2.120
24	93.10	93.10	10.837	-0.171	2.120
25	92.10	92.10	10.782	-0.144	2.120
26	91.60	91.60	10.744	-0.125	2.120
27	90.00	90.00	10.697	-0.102	2.120
28	82.00	82.00	10.651	-0.078	2.120

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 732 (REMOULDED SAMPLE)
TEST RESULTS START 171184 END 11284

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNY %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	3.199	-0.069	3.061	0.0	0.0		0.0
2	57.5	30.9	26.6	39.8	3.532	0.020	3.572	9.8	0.4	0.230	0.230
3	66.1	35.5	30.6	45.7	4.051	0.032	4.116	20.5	0.9	0.329	0.559
4	76.0	40.9	35.1	52.6	4.624	0.052	4.728	33.1	1.4	0.422	0.981
5	87.4	47.1	40.3	60.5	5.422	0.027	5.476	47.4	2.2	0.630	1.610
6	100.4	54.2	46.2	69.6	6.383	-0.036	6.310	63.9	3.2	0.837	2.448
7	115.4	62.4	53.0	80.0	7.552	-0.120	7.313	82.8	4.4	1.165	3.612
8	132.5	71.8	60.7	92.0	8.908	-0.236	8.436	104.5	5.7	1.523	5.136
9	155.9	84.8	71.1	108.5	10.922	-0.512	9.898	134.3	7.7	2.473	7.609
10	156.1	84.8	71.3	108.6	11.394	-0.408	10.579	134.4	8.2	0.913	8.522
11	155.7	84.8	70.9	108.4	11.735	-0.621	10.494	134.1	8.6	0.170	8.692
12	142.3	83.2	59.1	102.9	11.743	-0.625	10.494	122.3	8.6	0.005	8.697
13	130.1	82.8	47.3	98.6	11.743	-0.625	10.494	113.0	8.6	0.0	8.697
14	120.8	85.3	35.5	97.1	11.712	-0.609	10.494	109.3	8.5	-0.013	8.685
15	112.0	88.3	23.7	96.2	11.673	-0.590	10.494	107.2	8.5	-0.011	8.673
16	107.6	95.7	11.9	99.7	11.495	-0.501	10.494	113.6	8.3	-0.032	8.642
17	102.6	102.6	0.0	102.6	11.224	-0.365	10.494	119.8	8.0	-0.016	8.625
18	98.7	98.7	0.0	98.7	11.139	-0.322	10.494	113.2	7.9	0.0	8.625
19	97.7	97.7	0.0	97.7	11.084	-0.295	10.494	111.4	7.9	0.0	8.625
20	97.0	97.0	0.0	97.0	11.030	-0.268	10.494	110.3	7.8	0.0	8.625
21	95.8	95.8	0.0	95.8	10.976	-0.241	10.494	108.2	7.8	0.0	8.625
22	94.9	94.9	0.0	94.9	10.922	-0.214	10.494	106.7	7.7	0.0	8.625
23	94.0	94.0	0.0	94.0	10.883	-0.195	10.494	105.1	7.7	0.0	8.625
24	93.1	93.1	0.0	93.1	10.837	-0.171	10.494	103.6	7.6	0.0	8.625
25	92.1	92.1	0.0	92.1	10.782	-0.144	10.494	101.9	7.6	0.0	8.625
26	91.6	91.6	0.0	91.6	10.744	-0.125	10.494	101.1	7.5	0.0	8.625
27	90.0	90.0	0.0	90.0	10.697	-0.102	10.494	98.3	7.5	0.0	8.625
28	82.0	82.0	0.0	82.0	10.651	-0.078	10.494	84.8	7.5	0.0	8.625

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 732 (REMOULDED SAMPLE)
TEST RESULTS START 171184 END 11284

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	3.251	-0.071	3.109	0.0	0.0		0.0
2	57.5	30.9	26.6	39.8	3.596	0.020	3.637	9.8	0.4	0.238	0.238
3	66.1	35.5	30.6	45.7	4.135	0.034	4.203	20.5	0.9	0.342	0.580
4	76.0	40.9	35.1	52.6	4.734	0.054	4.843	33.1	1.5	0.441	1.021
5	87.4	47.1	40.3	60.5	5.574	0.029	5.632	47.4	2.3	0.663	1.684
6	100.4	54.2	46.2	69.6	6.595	-0.039	6.517	63.9	3.3	0.890	2.574
7	115.4	62.4	53.0	80.0	7.852	-0.129	7.594	82.8	4.6	1.251	3.825
8	132.5	71.8	60.7	92.0	9.329	-0.258	8.813	104.5	6.1	1.657	5.482
9	155.9	84.8	71.1	108.5	11.565	-0.571	10.423	134.3	8.3	2.735	8.216
10	156.1	84.8	71.3	108.6	12.097	-0.458	11.181	134.4	8.9	1.022	9.238
11	155.7	84.8	70.9	108.4	12.482	-0.698	11.086	134.1	9.3	0.193	9.431
12	142.3	83.2	59.1	102.9	12.491	-0.703	11.086	122.3	9.3	0.006	9.437
13	130.1	82.8	47.3	98.6	12.491	-0.703	11.086	113.0	9.3	0.0	9.437
14	120.8	85.3	35.5	97.1	12.456	-0.685	11.086	109.3	9.2	-0.015	9.423
15	112.0	88.3	23.7	96.2	12.412	-0.663	11.086	107.2	9.2	-0.013	9.410
16	107.6	95.7	11.9	99.7	12.211	-0.562	11.086	113.6	9.0	-0.036	9.374
17	102.6	102.6	0.0	102.6	11.905	-0.410	11.086	119.8	8.7	-0.018	9.356
18	98.7	98.7	0.0	98.7	11.809	-0.362	11.086	113.2	8.6	-0.000	9.356
19	97.7	97.7	0.0	97.7	11.748	-0.331	11.086	111.4	8.5	-0.000	9.356
20	97.0	97.0	0.0	97.0	11.687	-0.301	11.086	110.3	8.4	-0.000	9.356
21	95.8	95.8	0.0	95.8	11.626	-0.270	11.086	108.2	8.4	-0.000	9.356
22	94.9	94.9	0.0	94.9	11.565	-0.240	11.086	106.7	8.3	-0.000	9.356
23	94.0	94.0	0.0	94.0	11.522	-0.218	11.086	105.1	8.3	-0.000	9.356
24	93.1	93.1	0.0	93.1	11.469	-0.192	11.086	103.6	8.2	-0.000	9.356
25	92.1	92.1	0.0	92.1	11.409	-0.161	11.086	101.9	8.2	-0.000	9.356
26	91.6	91.6	0.0	91.6	11.365	-0.140	11.086	101.1	8.1	-0.000	9.356
27	90.0	90.0	0.0	90.0	11.313	-0.114	11.086	98.3	8.1	-0.000	9.356
28	82.0	82.0	0.0	82.0	11.261	-0.088	11.086	84.8	8.0	-0.000	9.356

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 732 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.677 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 530.490 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 45.430 SQUARE CENTIMETRES

CONSTANT LOAD : 16.29 N .
PROVING RING FACTOR : 1.2365 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 1930.00 DIVISIONS

SHEAR TEST RESULTS START 121284 END 141284

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	630	1930.0	108.2	201.3	0.0	95.1	95.1	-0.0	-0.0	95.1	1.000	0.0
2	645	1928.5	128.0	201.8	0.01	100.1	94.8	2.7	5.3	96.6	1.056	0.09
3	710	1926.5	152.0	204.3	0.03	104.3	92.5	5.9	11.8	96.4	1.128	0.25
4	720	1925.2	164.0	205.8	0.04	106.3	91.2	7.5	15.1	96.2	1.165	0.30
5	730	1923.8	173.5	207.4	0.05	107.3	89.6	8.8	17.7	95.5	1.197	0.34
6	740	1922.0	183.5	208.5	0.07	108.4	88.0	10.2	20.4	94.8	1.232	0.35
7	750	1920.0	192.0	209.8	0.09	109.4	86.7	11.4	22.7	94.3	1.262	0.37
8	800	1918.0	200.5	211.3	0.10	110.5	85.5	12.5	25.0	93.8	1.293	0.40
9	815	1914.8	212.4	213.4	0.13	111.7	83.5	14.1	28.2	92.9	1.338	0.43
10	830	1911.6	223.0	215.0	0.16	113.1	82.0	15.5	31.1	92.4	1.379	0.44
11	845	1907.5	234.5	216.9	0.19	114.3	80.1	17.1	34.2	91.5	1.427	0.46
12	900	1904.5	243.0	218.3	0.22	115.2	78.7	18.3	36.5	90.9	1.464	0.47
13	930	1903.5	262.0	221.2	0.23	117.5	75.9	20.8	41.6	89.8	1.549	0.48
14	1000	1888.3	277.2	223.5	0.36	119.2	73.5	22.9	45.7	88.7	1.622	0.49
15	1040	1876.2	303.5	226.2	0.46	123.5	70.7	26.4	52.8	88.3	1.747	0.47
16	1105	1869.5	306.3	228.0	0.52	122.7	69.2	26.8	53.5	87.0	1.773	0.50
17	1130	1861.5	316.5	229.0	0.59	124.1	67.8	28.1	56.3	86.6	1.830	0.49
18	1200	1852.0	328.0	230.7	0.67	125.6	66.3	29.7	59.3	86.1	1.895	0.50
19	1230	1841.5	338.8	232.4	0.76	126.9	64.7	31.1	62.2	85.4	1.961	0.50
20	1300	1832.0	348.0	233.6	0.84	128.1	63.5	32.3	64.6	85.0	2.017	0.50
21	1330	1821.0	357.5	234.6	0.93	129.5	62.4	33.6	67.1	84.8	2.078	0.50
22	1405	1810.0	368.0	236.0	1.03	131.0	61.1	34.9	69.9	84.4	2.143	0.50
23	1435	1800.0	376.0	237.0	1.11	132.1	60.1	36.0	72.0	84.1	2.197	0.50
24	1500	1790.5	382.0	237.8	1.19	132.8	59.3	36.8	73.5	83.8	2.240	0.50
25	1530	1780.5	390.0	238.2	1.28	134.4	58.8	37.8	75.6	84.0	2.286	0.49
26	1630	1758.0	402.0	239.9	1.47	135.8	57.1	39.3	78.7	83.3	2.378	0.49
27	1705	1745.5	409.0	240.0	1.58	137.2	56.7	40.3	80.5	83.5	2.420	0.48
28	1800	1723.5	416.5	241.5	1.77	137.9	55.6	41.2	82.3	83.0	2.480	0.49
29	1900	1700.0	424.0	242.4	1.87	138.8	54.7	42.1	84.1	82.7	2.538	0.49
30	2000	1676.5	429.5	242.6	2.17	139.5	54.0	42.7	85.5	82.5	2.583	0.48
31	2100	1652.0	433.5	243.6	2.38	139.7	53.4	43.2	86.3	82.2	2.617	0.49
32	2200	1628.0	437.5	244.3	2.59	140.1	52.9	43.6	87.2	82.0	2.648	0.49
33	2300	1604.0	440.8	244.6	2.79	140.4	52.5	43.9	87.9	81.8	2.674	0.49
34	100	1555.2	445.8	246.3	3.21	140.3	51.6	44.4	88.7	81.2	2.720	0.51
35	250	1510.0	449.5	247.5	3.60	140.1	50.8	44.7	89.3	80.6	2.758	0.52
36	320	1497.8	449.5	243.7	3.70	142.6	53.2	44.7	89.4	83.0	2.680	0.47
37	632	1417.0	453.5	247.2	4.39	139.5	49.8	44.9	89.7	79.7	2.802	0.51
38	800	1380.0	454.0	247.5	4.71	139.0	49.4	44.8	89.6	79.3	2.814	0.52
39	900	1355.6	454.5	248.2	4.92	138.6	49.1	44.7	89.5	78.9	2.822	0.52
40	1009	1326.2	455.7	249.5	5.17	138.0	48.5	44.7	89.5	78.3	2.845	0.54
41	1104	1303.5	456.2	249.7	5.37	137.7	48.3	44.7	89.4	78.1	2.851	0.54
42	1200	1281.2	456.8	249.8	5.56	137.4	48.0	44.7	89.4	77.8	2.863	0.54
43	1300	1256.0	456.8	249.8	5.77	137.2	48.0	44.6	89.2	77.7	2.859	0.54
44	1400	1231.0	457.5	249.1	5.99	137.2	47.9	44.6	89.3	77.7	2.864	0.54
45	1500	1206.0	457.5	249.5	6.20	136.7	47.6	44.5	89.1	77.3	2.871	0.54
46	1600	1180.5	457.7	250.1	6.42	136.3	47.4	44.4	88.9	77.0	2.875	0.55
47	1700	1155.5	457.9	250.5	6.63	135.9	47.2	44.3	88.7	76.8	2.879	0.55
48	1900	1104.2	458.2	250.0	7.07	135.2	46.8	44.2	88.4	76.3	2.890	0.55
49	2100	1055.0	460.2	250.4	7.49	135.1	46.6	44.3	88.5	76.1	2.900	0.55
50	2400	980.0	461.9	250.9	8.14	134.6	46.3	44.2	88.3	75.7	2.907	0.56
51	800	779.0	460.1	252.2	9.86	131.6	45.4	43.1	86.2	74.1	2.898	0.59
52	901	753.0	459.2	252.0	10.08	131.3	45.5	42.9	85.8	74.1	2.885	0.59
53	1000	728.0	458.8	251.7	10.29	131.0	45.5	42.7	85.5	74.0	2.879	0.59
54	1101	702.0	458.0	251.7	10.52	130.8	45.8	42.5	85.0	74.1	2.857	0.59
55	1203	676.8	456.5	251.9	10.73	129.7	45.2	42.3	84.5	73.4	2.870	0.60
56	1300	652.2	455.2	251.4	10.94	129.3	45.3	42.0	84.0	73.3	2.855	0.60
57	1404	626.0	454.5	251.1	11.17	129.0	45.3	41.8	83.7	73.2	2.848	0.59
58	1500	602.5	454.0	251.3	11.37	128.6	45.2	41.7	83.4	73.0	2.845	0.60

SAMPLE NO. : T 732 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 95.10 KPA
PRECONSOLIDATION PRESSURE = 156.11 KPA
NORMALIZING STRESS = 156.11 KPA

NORMALIZED SHEAR TEST RESULTS START 121284 END 141284

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	-0.000	1.000	0.609	0.0
2	0.01	0.017	1.056	0.619	0.003
3	0.03	0.038	1.128	0.618	0.019
4	0.04	0.048	1.165	0.616	0.029
5	0.05	0.057	1.197	0.612	0.039
6	0.07	0.065	1.232	0.607	0.046
7	0.09	0.073	1.262	0.604	0.054
8	0.10	0.080	1.293	0.601	0.064
9	0.13	0.090	1.338	0.595	0.078
10	0.16	0.100	1.379	0.592	0.088
11	0.19	0.110	1.427	0.586	0.100
12	0.22	0.117	1.464	0.582	0.109
13	0.23	0.133	1.549	0.575	0.127
14	0.36	0.146	1.622	0.568	0.142
15	0.46	0.169	1.747	0.566	0.160
16	0.52	0.171	1.773	0.558	0.171
17	0.59	0.180	1.830	0.554	0.177
18	0.67	0.190	1.895	0.551	0.188
19	0.76	0.199	1.961	0.547	0.199
20	0.84	0.207	2.017	0.545	0.207
21	0.93	0.215	2.076	0.543	0.213
22	1.03	0.224	2.143	0.541	0.222
23	1.11	0.230	2.197	0.539	0.229
24	1.19	0.235	2.240	0.537	0.234
25	1.28	0.242	2.286	0.538	0.236
26	1.47	0.252	2.378	0.534	0.247
27	1.58	0.258	2.420	0.535	0.248
28	1.77	0.264	2.480	0.532	0.258
29	1.97	0.269	2.538	0.530	0.263
30	2.17	0.274	2.583	0.528	0.265
31	2.38	0.276	2.617	0.526	0.271
32	2.59	0.279	2.648	0.525	0.275
33	2.79	0.281	2.674	0.524	0.277
34	3.21	0.284	2.720	0.520	0.288
35	3.60	0.286	2.758	0.516	0.296
36	3.70	0.286	2.680	0.532	0.272
37	4.39	0.287	2.802	0.511	0.294
38	4.71	0.287	2.814	0.508	0.296
39	4.92	0.287	2.822	0.506	0.300
40	5.17	0.287	2.845	0.502	0.309
41	5.37	0.286	2.851	0.500	0.310
42	5.56	0.286	2.863	0.498	0.311
43	5.77	0.286	2.859	0.498	0.311
44	5.99	0.286	2.864	0.497	0.306
45	6.20	0.285	2.871	0.495	0.309
46	6.42	0.285	2.875	0.493	0.313
47	6.63	0.284	2.879	0.492	0.315
48	7.07	0.283	2.890	0.489	0.312
49	7.49	0.284	2.900	0.488	0.315
50	8.14	0.283	2.907	0.485	0.318
51	9.86	0.276	2.898	0.475	0.326
52	10.08	0.275	2.885	0.475	0.325
53	10.29	0.274	2.879	0.474	0.323
54	10.52	0.272	2.857	0.475	0.323
55	10.73	0.271	2.870	0.470	0.324
56	10.94	0.269	2.855	0.470	0.321
57	11.17	0.268	2.848	0.469	0.319
58	11.37	0.267	2.845	0.468	0.320

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 733 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.8 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.386
INITIAL HEIGHT OF SAMPLE : 13.01 CM
INITIAL VOLUME OF SAMPLE : 592.53 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 39.7 PERCENT

TX. CONSOLIDATION START 171184 END 11284
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.90	26.50	3.978	3.688	-0.145	34.30	23.40	1.298	2.298	2.749
2	57.46	30.40	4.424	4.245	-0.089	39.42	27.06	1.284	2.284	3.009
3	66.12	35.00	5.042	4.852	-0.095	45.37	31.12	1.270	2.270	3.425
4	75.98	40.30	5.719	5.434	-0.142	52.19	35.68	1.256	2.256	3.907
5	87.37	46.40	6.845	6.523	-0.161	60.06	40.97	1.230	2.230	4.670
6	100.36	53.30	8.121	7.611	-0.255	68.99	47.06	1.204	2.204	5.584
7	115.24	61.20	9.596	8.793	-0.402	79.21	54.04	1.176	2.176	6.666
8	132.25	70.30	11.249	10.033	-0.608	90.95	61.95	1.146	2.146	7.905
9	158.12	84.80	15.111	11.957	-1.577	109.24	73.32	1.100	2.100	11.126
10	158.33	84.80	15.653	12.767	-1.443	109.31	73.53	1.081	2.081	11.398
11	157.97	84.80	15.968	12.675	-1.647	109.19	73.17	1.083	2.083	11.744
12	147.88	87.00	15.957	12.675	-1.641	107.29	60.88	1.083	2.083	11.732
13	140.80	92.10	15.922	12.675	-1.624	108.33	48.70	1.083	2.083	11.698
14	133.31	96.80	15.872	12.675	-1.599	108.97	36.51	1.083	2.083	11.648
15	126.72	102.40	15.784	12.675	-1.555	110.51	24.32	1.083	2.083	11.559
16	120.32	108.20	15.646	12.675	-1.486	112.24	12.12	1.083	2.083	11.421
17	114.30	114.30	15.438	12.675	-1.382	114.30	0.0	1.083	2.083	11.213
18	92.40	92.40	15.170	12.675	-1.248	92.40	0.0	1.083	2.083	10.945
19	83.50	83.50	15.178	12.675	-1.252	83.50	0.0	1.083	2.083	10.953
20	76.50	76.50	15.185	12.675	-1.255	76.50	0.0	1.083	2.083	10.960
21	68.20	68.20	15.185	12.675	-1.255	68.20	0.0	1.083	2.083	10.960
22	73.20	73.20	15.174	12.675	-1.250	73.20	0.0	1.083	2.083	10.949
23	60.90	60.90	15.151	12.675	-1.238	60.90	0.0	1.083	2.083	10.927
24	56.60	56.60	15.124	12.675	-1.225	56.60	0.0	1.083	2.083	10.899
25	53.30	53.30	15.101	12.675	-1.213	53.30	0.0	1.083	2.083	10.876
26	51.00	51.00	15.070	12.675	-1.198	51.00	0.0	1.083	2.083	10.845
27	48.00	48.00	15.039	12.675	-1.182	48.00	0.0	1.083	2.083	10.814
28	49.10	49.10	15.032	12.675	-1.178	49.10	0.0	1.083	2.083	10.807

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.90	26.50	3.978	-0.145	2.298
2	57.46	30.40	4.424	-0.089	2.284
3	66.12	35.00	5.042	-0.095	2.270
4	75.98	40.30	5.719	-0.142	2.256
5	87.37	46.40	6.845	-0.161	2.230
6	100.36	53.30	8.121	-0.255	2.204
7	115.24	61.20	9.596	-0.402	2.176
8	132.25	70.30	11.249	-0.608	2.146
9	158.12	84.80	15.111	-1.577	2.100
10	158.33	84.80	15.653	-1.443	2.081
11	157.97	84.80	15.968	-1.647	2.083
12	147.88	87.00	15.957	-1.641	2.083
13	140.80	92.10	15.922	-1.624	2.083
14	133.31	96.80	15.872	-1.599	2.083
15	126.72	102.40	15.784	-1.555	2.083
16	120.32	108.20	15.646	-1.486	2.083
17	114.30	114.30	15.438	-1.382	2.083
18	92.40	92.40	15.170	-1.248	2.083
19	83.50	83.50	15.178	-1.252	2.083
20	76.50	76.50	15.185	-1.255	2.083
21	68.20	68.20	15.185	-1.255	2.083
22	73.20	73.20	15.174	-1.250	2.083
23	60.90	60.90	15.151	-1.238	2.083
24	56.60	56.60	15.124	-1.225	2.083
25	53.30	53.30	15.101	-1.213	2.083
26	51.00	51.00	15.070	-1.198	2.083
27	48.00	48.00	15.039	-1.182	2.083
28	49.10	49.10	15.032	-1.178	2.083

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 733 (REMOULDED SAMPLE)
TEST RESULTS START 171184 END 11284

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	3.978	-0.145	3.688	0.0	0.0		0.0
2	57.5	30.4	27.1	39.4	4.424	-0.089	4.245	9.4	0.5	0.271	0.271
3	66.1	35.0	31.1	45.4	5.042	-0.095	4.852	20.2	1.1	0.379	0.650
4	76.0	40.3	35.7	52.2	5.719	-0.142	5.434	32.6	1.7	0.445	1.095
5	87.4	46.4	41.0	60.1	6.845	-0.161	6.523	46.9	2.9	0.903	1.998
6	100.4	53.3	47.1	69.0	8.121	-0.255	7.611	63.1	4.1	1.104	3.102
7	115.2	61.2	54.0	79.2	9.596	-0.402	8.793	81.7	5.6	1.422	4.525
8	132.2	70.3	61.9	90.9	11.249	-0.608	10.033	103.0	7.3	1.774	6.299
9	158.1	84.8	73.3	109.2	15.111	-1.577	11.957	136.0	11.3	4.104	10.403
10	158.3	84.8	73.5	109.3	15.653	-1.443	12.767	136.2	11.8	1.085	11.488
11	158.0	84.8	73.2	109.2	15.968	-1.647	12.675	135.9	12.2	0.152	11.640
12	147.9	87.0	60.9	107.3	15.957	-1.641	12.675	130.1	12.2	-0.008	11.633
13	140.8	92.1	48.7	108.3	15.922	-1.624	12.675	129.9	12.1	-0.019	11.614
14	133.3	96.8	36.5	109.0	15.872	-1.599	12.675	129.8	12.1	-0.021	11.592
15	126.7	102.4	24.3	110.5	15.784	-1.555	12.675	132.0	12.0	-0.027	11.566
16	120.3	108.2	12.1	112.2	15.646	-1.486	12.675	135.3	11.8	-0.025	11.540
17	114.3	114.3	0.0	114.3	15.438	-1.382	12.675	139.9	11.6	-0.013	11.528
18	92.4	92.4	0.0	92.4	15.170	-1.248	12.675	102.4	11.3	-0.000	11.528
19	83.5	83.5	0.0	83.5	15.178	-1.252	12.675	87.3	11.3	0.0	11.528
20	76.5	76.5	0.0	76.5	15.185	-1.255	12.675	75.5	11.3	0.000	11.528
21	68.2	68.2	0.0	68.2	15.185	-1.255	12.675	61.7	11.3	0.0	11.528
22	73.2	73.2	0.0	73.2	15.174	-1.250	12.675	70.0	11.3	0.0	11.528
23	60.9	60.9	0.0	60.9	15.151	-1.238	12.675	49.9	11.3	-0.000	11.528
24	56.6	56.6	0.0	56.6	15.124	-1.225	12.675	43.1	11.3	0.0	11.528
25	53.3	53.3	0.0	53.3	15.101	-1.213	12.675	38.1	11.2	0.0	11.528
26	51.0	51.0	0.0	51.0	15.070	-1.198	12.675	34.7	11.2	0.000	11.528
27	48.0	48.0	0.0	48.0	15.039	-1.182	12.675	30.5	11.2	0.0	11.528
28	49.1	49.1	0.0	49.1	15.032	-1.178	12.675	32.0	11.1	0.0	11.528

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 733 (REMOULDED SAMPLE)
TEST RESULTS START 171184 END 11284

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	4.058	-0.151	3.757	0.0	0.0		0.0
2	57.5	30.4	27.1	39.4	4.524	-0.093	4.337	9.4	0.5	0.282	0.282
3	66.1	35.0	31.1	45.4	5.173	-0.100	4.973	20.2	1.1	0.397	0.679
4	76.0	40.3	35.7	52.2	5.888	-0.151	5.587	32.6	1.8	0.470	1.149
5	87.4	46.4	41.0	60.1	7.090	-0.172	6.745	46.9	3.0	0.962	2.112
6	100.4	53.3	47.1	69.0	8.469	-0.276	7.916	63.1	4.4	1.191	3.303
7	115.2	61.2	54.0	79.2	10.088	-0.442	9.203	81.7	6.0	1.555	4.858
8	132.2	70.3	61.9	90.9	11.933	-0.680	10.573	103.0	7.9	1.970	6.828
9	158.1	84.8	73.3	109.2	16.382	-1.824	12.734	136.0	12.5	4.685	11.513
10	158.3	84.8	73.5	109.3	17.022	-1.682	13.659	136.2	13.1	1.254	12.768
11	158.0	84.8	73.2	109.2	17.396	-1.922	13.552	135.9	13.6	0.184	12.952
12	147.9	87.0	60.9	107.3	17.383	-1.915	13.552	130.1	13.6	-0.009	12.943
13	140.8	92.1	48.7	108.3	17.341	-1.895	13.552	129.9	13.5	-0.023	12.920
14	133.3	96.8	36.5	109.0	17.282	-1.865	13.552	128.8	13.4	-0.025	12.895
15	126.7	102.4	24.3	110.5	17.177	-1.812	13.552	132.0	13.3	-0.032	12.863
16	120.3	108.2	12.1	112.2	17.013	-1.730	13.552	135.3	13.1	-0.030	12.833
17	114.3	114.3	0.0	114.3	16.767	-1.608	13.552	139.9	12.9	-0.015	12.818
18	92.4	92.4	0.0	92.4	16.450	-1.449	13.552	102.4	12.5	-0.000	12.818
19	83.5	83.5	0.0	83.5	16.459	-1.454	13.552	87.3	12.5	-0.000	12.818
20	76.5	76.5	0.0	76.5	16.469	-1.458	13.552	75.5	12.5	-0.000	12.818
21	68.2	68.2	0.0	68.2	16.469	-1.458	13.552	61.7	12.5	0.0	12.818
22	73.2	73.2	0.0	73.2	16.455	-1.451	13.552	70.0	12.5	-0.000	12.818
23	60.9	60.9	0.0	60.9	16.429	-1.438	13.552	49.9	12.5	0.000	12.818
24	56.6	56.6	0.0	56.6	16.396	-1.422	13.552	43.1	12.5	-0.000	12.818
25	53.3	53.3	0.0	53.3	16.369	-1.408	13.552	38.1	12.4	-0.000	12.818
26	51.0	51.0	0.0	51.0	16.333	-1.390	13.552	34.7	12.4	-0.000	12.818
27	48.0	48.0	0.0	48.0	16.296	-1.372	13.552	30.5	12.4	0.0	12.818
28	49.1	49.1	0.0	49.1	16.287	-1.368	13.552	32.0	12.3	0.000	12.818

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 733 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.208 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 516.727 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 46.103 SQUARE CENTIMETRES

CONSTANT LOAD : 16.47 N .
PROVING RING FACTOR : 1.0225 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 1183.50 DIVISIONS

SHEAR TEST RESULTS START 111284 END 131284

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	1408	1183.5	130.7	199.7	0.0	96.2	96.2	0.0	0.0	96.2	1.000	0.0
2	1413	1181.0	141.8	204.9	0.02	94.1	91.7	1.2	2.4	92.5	1.026	2.18
3	1421	1180.5	148.5	205.2	0.03	95.0	91.1	2.0	3.9	92.4	1.043	1.41
4	1435	1177.7	161.5	207.5	0.05	96.1	89.4	3.4	6.7	91.6	1.075	1.16
5	1447	1175.6	171.0	208.3	0.07	96.9	88.0	4.5	8.9	91.0	1.101	0.97
6	1500	1173.5	184.2	209.5	0.09	98.7	86.9	5.9	11.8	90.8	1.136	0.83
7	1530	1168.5	214.0	213.7	0.13	101.2	82.8	9.2	18.4	88.9	1.222	0.76
8	1600	1163.0	241.0	217.5	0.18	103.7	79.4	12.2	24.3	87.5	1.306	0.73
9	1615	1159.8	255.7	219.0	0.21	105.7	78.1	13.8	27.6	87.3	1.353	0.70
10	1630	1156.2	267.2	220.7	0.24	106.2	76.1	15.1	30.1	86.1	1.396	0.70
11	1645	1153.0	277.0	222.2	0.27	107.1	74.8	16.1	32.3	85.6	1.431	0.70
12	1702	1149.0	288.5	223.8	0.31	107.7	72.9	17.4	34.8	84.5	1.478	0.69
13	1730	1142.2	307.5	225.9	0.37	109.9	70.9	19.5	39.0	83.9	1.550	0.67
14	1800	1134.0	325.0	227.9	0.44	111.5	68.7	21.4	42.8	83.0	1.624	0.66
15	1830	1125.2	341.0	230.2	0.52	112.7	66.3	23.2	46.4	81.8	1.699	0.66
16	1902	1116.0	357.0	232.1	0.60	114.2	64.3	24.9	49.9	80.9	1.775	0.65
17	1959	1099.0	382.0	235.4	0.75	116.3	61.0	27.6	55.3	79.4	1.906	0.65
18	2101	1080.0	408.5	238.5	0.92	119.6	58.7	30.5	60.9	79.0	2.038	0.64
19	2200	1061.0	429.5	240.2	1.09	121.8	56.3	32.8	65.5	78.1	2.163	0.62
20	2324	1033.3	456.5	243.1	1.34	124.8	53.6	35.6	71.2	77.3	2.329	0.61
21	2400	1020.0	466.5	243.4	1.46	126.2	52.8	36.7	73.4	77.3	2.390	0.60
22	100	999.2	481.4	244.6	1.64	128.0	51.5	38.3	76.5	77.0	2.485	0.59
23	200	978.0	495.0	246.2	1.83	130.0	50.8	39.6	79.2	77.2	2.559	0.59
24	300	955.0	505.6	246.6	2.04	131.4	50.0	40.7	81.4	77.1	2.628	0.58
25	430	920.5	519.0	247.0	2.35	133.5	49.4	42.0	84.1	77.4	2.702	0.56
26	600	885.0	528.5	247.8	2.66	134.8	49.0	42.9	85.8	77.6	2.751	0.56
27	635	871.0	531.5	247.7	2.79	135.3	48.9	43.2	86.4	77.7	2.766	0.56
28	700	860.0	533.5	247.8	2.89	135.7	49.0	43.3	86.7	77.9	2.769	0.56
29	730	849.0	535.5	247.9	2.98	135.9	48.9	43.5	87.0	77.9	2.780	0.55
30	800	837.0	537.5	248.1	3.09	136.1	48.7	43.7	87.4	77.8	2.794	0.55
31	830	824.5	539.0	248.0	3.20	136.2	48.6	43.8	87.6	77.8	2.803	0.56
32	900	811.8	540.5	247.9	3.32	136.5	48.7	43.9	87.8	78.0	2.803	0.55

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
33	930	800.0	541.8	248.0	3.42	136.6	48.6	44.0	88.0	77.9	2.811	0.55
34	1000	787.6	543.0	247.9	3.53	136.8	48.6	44.1	88.2	78.0	2.814	0.55
35	1040	770.5	544.5	247.8	3.68	137.1	48.7	44.2	88.4	78.2	2.814	0.54
36	1105	760.3	545.5	248.3	3.78	137.0	48.5	44.2	88.5	78.0	2.824	0.55
37	1130	750.5	546.0	247.7	3.86	137.1	48.6	44.3	88.5	78.1	2.822	0.54
38	1200	738.0	547.2	248.0	3.97	137.3	48.6	44.3	88.7	78.2	2.824	0.54
39	1230	725.5	548.5	247.9	4.09	137.4	48.6	44.4	88.8	78.2	2.828	0.54
40	1300	713.0	549.0	247.6	4.20	137.6	48.7	44.4	88.9	78.3	2.825	0.54
41	1330	701.0	550.0	248.1	4.30	137.6	48.7	44.5	88.9	78.3	2.826	0.54
42	1405	686.0	551.0	247.6	4.44	137.6	48.5	44.5	89.1	78.2	2.837	0.54
43	1502	663.0	552.5	247.7	4.64	137.8	48.6	44.6	89.2	78.3	2.835	0.54
44	1630	625.5	553.5	247.6	4.98	137.7	48.6	44.5	89.1	78.3	2.833	0.54
45	1703	612.0	554.5	247.9	5.10	138.0	48.9	44.6	89.1	78.6	2.823	0.54
46	1800	588.2	554.5	248.0	5.31	137.6	48.7	44.5	88.9	78.3	2.826	0.54
47	1900	562.8	554.8	248.1	5.54	137.5	48.7	44.4	88.8	78.3	2.823	0.55
48	2000	537.5	554.8	248.2	5.76	137.3	48.8	44.3	88.5	78.3	2.814	0.55
49	2100	512.0	554.2	247.5	5.99	137.1	48.8	44.1	88.3	78.2	2.809	0.54
50	2200	487.5	553.5	248.2	6.21	136.4	48.5	43.9	87.9	77.8	2.812	0.55
51	2300	462.0	552.2	248.3	6.44	135.7	48.3	43.7	87.4	77.4	2.810	0.56
52	100	411.5	551.2	248.8	6.89	135.4	48.7	43.3	86.7	77.6	2.780	0.57
53	300	360.0	549.0	247.7	7.35	135.0	49.1	42.9	85.9	77.7	2.749	0.56
54	633	271.0	546.0	248.6	8.14	132.6	48.1	42.3	84.5	76.3	2.758	0.58
55	800	233.0	543.0	248.7	8.48	131.5	47.9	41.8	83.6	75.8	2.746	0.59
56	900	207.5	539.8	249.0	8.71	130.8	48.1	41.4	82.7	75.7	2.720	0.60
57	1010	176.8	536.3	249.4	8.98	129.9	48.2	40.9	81.7	75.4	2.696	0.61
58	1106	153.0	535.8	249.2	9.19	129.4	47.9	40.7	81.5	75.1	2.701	0.61
59	1200	130.0	535.8	249.8	9.40	129.0	47.7	40.6	81.3	74.8	2.704	0.62
60	1300	105.8	535.8	250.0	9.62	128.6	47.5	40.5	81.1	74.5	2.707	0.62
61	1400	80.6	535.5	250.4	9.84	127.9	47.1	40.4	80.8	74.0	2.716	0.63
62	1500	55.0	534.5	250.5	10.07	127.5	47.1	40.2	80.4	73.9	2.707	0.63

SAMPLE NO. = T 733 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 96.20 KPA
PRECONSOLIDATION PRESSURE = 158.33 KPA
NORMALIZING STRESS = 158.33 KPA

NORMALIZED SHEAR TEST RESULTS START 111284 END 131284

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.000	1.000	0.608	0.0
2	0.02	0.008	1.026	0.584	0.033
3	0.03	0.012	1.043	0.584	0.035
4	0.05	0.021	1.075	0.579	0.049
5	0.07	0.028	1.101	0.575	0.054
6	0.09	0.037	1.136	0.574	0.062
7	0.13	0.058	1.222	0.562	0.088
8	0.18	0.077	1.306	0.553	0.112
9	0.21	0.087	1.353	0.551	0.122
10	0.24	0.095	1.396	0.544	0.133
11	0.27	0.102	1.431	0.540	0.142
12	0.31	0.110	1.478	0.534	0.152
13	0.37	0.123	1.550	0.530	0.165
14	0.44	0.135	1.624	0.524	0.178
15	0.52	0.146	1.699	0.516	0.193
16	0.60	0.157	1.775	0.511	0.205
17	0.75	0.175	1.906	0.502	0.225
18	0.92	0.192	2.038	0.499	0.245
19	1.09	0.207	2.163	0.493	0.256
20	1.34	0.225	2.329	0.488	0.274
21	1.46	0.232	2.390	0.488	0.276
22	1.64	0.242	2.485	0.486	0.284
23	1.83	0.250	2.559	0.488	0.294
24	2.04	0.257	2.628	0.487	0.296
25	2.35	0.265	2.702	0.489	0.299
26	2.66	0.271	2.751	0.490	0.304
27	2.79	0.273	2.766	0.491	0.303
28	2.89	0.274	2.769	0.492	0.304
29	2.98	0.276	2.780	0.492	0.304
30	3.09	0.276	2.794	0.492	0.306
31	3.20	0.277	2.803	0.491	0.305
32	3.32	0.277	2.803	0.492	0.304
33	3.42	0.278	2.811	0.492	0.305
34	3.53	0.278	2.814	0.493	0.304
35	3.68	0.279	2.814	0.494	0.304
36	3.78	0.279	2.824	0.493	0.307
37	3.86	0.280	2.822	0.493	0.303
38	3.97	0.280	2.824	0.494	0.305
39	4.09	0.281	2.828	0.494	0.304
40	4.20	0.281	2.825	0.495	0.303
41	4.30	0.281	2.826	0.495	0.306
42	4.44	0.281	2.837	0.494	0.303
43	4.64	0.282	2.835	0.495	0.303
44	4.98	0.281	2.833	0.495	0.303
45	5.10	0.281	2.823	0.496	0.304
46	5.31	0.281	2.826	0.495	0.305
47	5.54	0.280	2.823	0.494	0.306
48	5.76	0.280	2.814	0.495	0.306
49	5.99	0.279	2.809	0.494	0.302
50	6.21	0.278	2.812	0.491	0.306
51	6.44	0.276	2.810	0.489	0.307
52	6.89	0.274	2.780	0.490	0.310
53	7.35	0.271	2.749	0.491	0.303
54	8.14	0.267	2.758	0.482	0.309
55	8.48	0.264	2.746	0.479	0.309
56	8.71	0.261	2.720	0.478	0.311
57	8.98	0.258	2.696	0.476	0.314
58	9.19	0.257	2.701	0.474	0.313
59	9.40	0.257	2.704	0.472	0.316
60	9.62	0.256	2.707	0.471	0.318
61	9.84	0.255	2.716	0.468	0.320
62	10.07	0.254	2.707	0.467	0.321

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 734 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 49.4 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.349
INITIAL HEIGHT OF SAMPLE : 13.02 CM
INITIAL VOLUME OF SAMPLE : 583.67 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 38.7 PERCENT

TX. CONSOLIDATION START 271284 END 90185
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.04	26.50	2.100	2.645	0.272	34.35	23.54	1.287	2.287	1.218
2	57.56	30.50	2.430	3.200	0.385	39.52	27.06	1.273	2.273	1.363
3	66.22	35.10	2.852	3.782	0.465	45.47	31.12	1.260	2.260	1.592
4	76.26	40.40	3.557	4.733	0.588	52.35	35.86	1.237	2.237	1.979
5	87.79	46.50	4.534	5.837	0.652	60.26	41.29	1.212	2.212	2.588
6	101.03	53.50	5.735	7.083	0.674	69.34	47.53	1.182	2.182	3.374
7	116.25	61.60	7.099	8.498	0.699	79.82	54.65	1.149	2.149	4.267
8	133.79	70.90	8.595	10.073	0.739	91.86	62.89	1.112	2.112	5.237
9	159.89	84.80	10.614	11.926	0.656	109.83	75.09	1.069	2.069	6.639
10	159.97	84.80	11.046	12.448	0.701	109.86	75.17	1.056	2.056	6.896
11	159.86	84.80	11.152	12.448	0.648	109.82	75.06	1.056	2.056	7.002
12	147.86	85.30	11.152	12.448	0.648	106.15	62.56	1.056	2.056	7.002
13	137.65	87.60	11.144	12.448	0.652	104.28	50.05	1.056	2.056	6.895
14	130.26	92.70	11.113	12.448	0.667	105.22	37.56	1.056	2.056	6.964
15	123.66	98.60	11.056	12.448	0.696	106.95	25.06	1.056	2.056	6.906
16	116.65	104.10	10.967	12.448	0.740	108.28	12.55	1.056	2.056	6.818
17	109.70	109.70	10.814	12.448	0.817	109.70	0.0	1.056	2.056	6.664
18	105.60	105.60	10.737	12.448	0.856	105.60	0.0	1.056	2.056	6.588
19	104.60	104.60	10.699	12.448	0.875	104.60	0.0	1.056	2.056	6.549
20	103.70	103.70	10.668	12.448	0.890	103.70	0.0	1.056	2.056	6.519
21	103.30	103.30	10.630	12.448	0.909	103.30	0.0	1.056	2.056	6.480
22	102.10	102.10	10.599	12.448	0.925	102.10	0.0	1.056	2.056	6.449
23	101.50	101.50	10.568	12.448	0.940	101.50	0.0	1.056	2.056	6.419
24	101.20	101.20	10.537	12.448	0.955	101.20	0.0	1.056	2.056	6.388
25	100.60	100.60	10.507	12.448	0.971	100.60	0.0	1.056	2.056	6.357
26	100.10	100.10	10.476	12.448	0.986	100.10	0.0	1.056	2.056	6.327
27	99.90	99.90	10.438	12.448	1.005	99.90	0.0	1.056	2.056	6.288
28	96.20	96.20	10.422	12.448	1.013	96.20	0.0	1.056	2.056	6.273

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.04	26.50	2.100	0.272	2.287
2	57.56	30.50	2.430	0.385	2.273
3	66.22	35.10	2.852	0.465	2.260
4	76.26	40.40	3.557	0.588	2.237
5	87.79	46.50	4.534	0.652	2.212
6	101.03	53.50	5.735	0.674	2.182
7	116.25	61.60	7.099	0.699	2.149
8	133.79	70.90	8.595	0.739	2.112
9	159.89	84.80	10.614	0.656	2.069
10	159.97	84.80	11.046	0.701	2.056
11	159.86	84.80	11.152	0.648	2.056
12	147.86	85.30	11.152	0.648	2.056
13	137.65	87.60	11.144	0.652	2.056
14	130.26	92.70	11.113	0.667	2.056
15	123.66	98.60	11.056	0.696	2.056
16	116.65	104.10	10.967	0.740	2.056
17	109.70	109.70	10.814	0.817	2.056
18	105.60	105.60	10.737	0.856	2.056
19	104.60	104.60	10.699	0.875	2.056
20	103.70	103.70	10.668	0.890	2.056
21	103.30	103.30	10.630	0.909	2.056
22	102.10	102.10	10.599	0.925	2.056
23	101.50	101.50	10.568	0.940	2.056
24	101.20	101.20	10.537	0.955	2.056
25	100.60	100.60	10.507	0.971	2.056
26	100.10	100.10	10.476	0.986	2.056
27	99.90	99.90	10.438	1.005	2.056
28	96.20	96.20	10.422	1.013	2.056

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. = T 734 (REMOULDED SAMPLE)
TEST RESULTS START 271284 END 90185

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	2.100	0.272	2.645	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.430	0.385	3.200	9.4	0.4	0.242	0.242
3	66.2	35.1	31.1	45.5	2.852	0.465	3.782	20.2	0.8	0.313	0.555
4	76.3	40.4	35.9	52.4	3.557	0.588	4.733	32.8	1.5	0.595	1.151
5	87.8	46.5	41.3	60.3	4.534	0.652	5.837	47.2	2.5	0.856	2.007
6	101.0	53.5	47.5	69.3	5.735	0.674	7.083	63.7	3.7	1.157	3.164
7	116.2	61.6	54.6	79.8	7.099	0.699	8.498	82.8	5.0	1.511	4.675
8	133.8	70.9	62.9	91.9	8.595	0.739	10.073	104.7	6.5	1.922	6.597
9	159.9	84.8	75.1	109.8	10.614	0.656	11.926	137.3	8.5	2.836	9.433
10	160.0	84.8	75.2	109.9	11.046	0.701	12.448	137.4	9.0	0.767	10.200
11	159.9	84.8	75.1	109.8	11.152	0.648	12.448	137.3	9.1	0.080	10.279
12	147.9	85.3	62.6	106.2	11.152	0.648	12.448	128.4	9.1	0.0	10.279
13	137.6	87.6	50.0	104.3	11.144	0.652	12.448	123.1	9.1	-0.004	10.275
14	130.3	92.7	37.6	105.2	11.113	0.667	12.448	123.3	9.0	-0.013	10.262
15	123.7	98.6	25.1	107.0	11.056	0.696	12.448	125.8	9.0	-0.018	10.244
16	116.6	104.1	12.5	108.3	10.967	0.740	12.448	128.4	8.9	-0.017	10.227
17	109.7	109.7	0.0	109.7	10.814	0.817	12.448	131.9	8.7	-0.010	10.217
18	105.6	105.6	0.0	105.6	10.737	0.856	12.448	124.9	8.7	0.0	10.217
19	104.6	104.6	0.0	104.6	10.699	0.875	12.448	123.2	8.6	0.0	10.217
20	103.7	103.7	0.0	103.7	10.668	0.890	12.448	121.7	8.6	0.0	10.217
21	103.3	103.3	0.0	103.3	10.630	0.909	12.448	121.0	8.6	0.0	10.217
22	102.1	102.1	0.0	102.1	10.599	0.925	12.448	118.9	8.5	0.0	10.217
23	101.5	101.5	0.0	101.5	10.568	0.940	12.448	117.9	8.5	0.0	10.217
24	101.2	101.2	0.0	101.2	10.537	0.955	12.448	117.4	8.5	0.0	10.217
25	100.6	100.6	0.0	100.6	10.507	0.971	12.448	116.4	8.5	0.0	10.217
26	100.1	100.1	0.0	100.1	10.476	0.986	12.448	115.5	8.4	0.0	10.217
27	99.9	99.9	0.0	99.9	10.438	1.005	12.448	115.2	8.4	-0.000	10.217
28	96.2	96.2	0.0	96.2	10.422	1.013	12.448	108.8	8.4	0.0	10.217

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 734 (REMOULDED SAMPLE)
TEST RESULTS START 271284 END 90185

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	2.122	0.279	2.680	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.460	0.396	3.253	9.4	0.4	0.249	0.249
3	66.2	35.1	31.1	45.5	2.894	0.481	3.855	20.2	0.8	0.324	0.572
4	76.3	40.4	35.9	52.4	3.622	0.614	4.849	32.8	1.6	0.619	1.191
5	87.8	46.5	41.3	60.3	4.639	0.687	6.014	47.2	2.6	0.899	2.090
6	101.0	53.5	47.5	69.3	5.906	0.720	7.346	63.7	3.8	1.229	3.319
7	116.2	61.6	54.6	79.8	7.364	0.758	8.881	82.8	5.3	1.628	4.947
8	133.8	70.9	62.9	91.9	8.987	0.815	10.617	104.7	6.9	2.104	7.051
9	159.9	84.8	75.1	109.8	11.221	0.739	12.699	137.3	9.1	3.162	10.213
10	160.0	84.8	75.2	109.9	11.704	0.795	13.293	137.4	9.6	0.868	11.080
11	159.9	84.8	75.1	109.8	11.824	0.735	13.293	137.3	9.7	0.090	11.170
12	147.9	85.3	62.6	106.2	11.824	0.735	13.293	128.4	9.7	0.0	11.170
13	137.6	87.6	50.0	104.3	11.815	0.739	13.293	123.1	9.7	-0.005	11.165
14	130.3	92.7	37.6	105.2	11.780	0.757	13.293	123.3	9.7	-0.015	11.150
15	123.7	98.6	25.1	107.0	11.716	0.789	13.293	125.8	9.6	-0.020	11.130
16	116.6	104.1	12.5	108.3	11.616	0.838	13.293	128.4	9.5	-0.019	11.111
17	109.7	109.7	0.0	109.7	11.444	0.925	13.293	131.9	9.4	-0.011	11.100
18	105.6	105.6	0.0	105.6	11.358	0.968	13.293	124.9	9.3	-0.000	11.100
19	104.6	104.6	0.0	104.6	11.315	0.989	13.293	123.2	9.2	-0.000	11.100
20	103.7	103.7	0.0	103.7	11.281	1.006	13.293	121.7	9.2	-0.000	11.100
21	103.3	103.3	0.0	103.3	11.238	1.028	13.293	121.0	9.2	-0.000	11.100
22	102.1	102.1	0.0	102.1	11.203	1.045	13.293	118.9	9.1	-0.000	11.100
23	101.5	101.5	0.0	101.5	11.169	1.062	13.293	117.9	9.1	-0.000	11.100
24	101.2	101.2	0.0	101.2	11.135	1.079	13.293	117.4	9.1	-0.000	11.100
25	100.6	100.6	0.0	100.6	11.100	1.097	13.293	116.4	9.1	-0.000	11.100
26	100.1	100.1	0.0	100.1	11.066	1.114	13.293	115.5	9.0	-0.000	11.100
27	99.9	99.9	0.0	99.9	11.023	1.135	13.293	115.2	9.0	-0.000	11.100
28	96.2	96.2	0.0	96.2	11.006	1.144	13.293	108.8	9.0	-0.000	11.100

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 734 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.700 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 501.166 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 42.835 SQUARE CENTIMETRES

CONSTANT LOAD : 16.48 N .
PROVING RING FACTOR : 1.2365 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2017.00 DIVISIONS

SHEAR TEST RESULTS START 110185 END 120185

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	839	2017.0	134.3	200.6	0.0	159.4	159.4	0.0	0.0	159.4	1.000	0.0
2	940	2011.0	174.0	204.7	0.05	166.8	155.4	5.7	11.4	159.2	1.074	0.36
3	950	2007.0	194.5	207.7	0.09	169.5	152.1	8.7	17.4	157.9	1.114	0.41
4	1000	2004.5	217.5	210.9	0.11	173.3	149.3	12.0	24.0	157.3	1.161	0.43
5	1010	2001.5	242.0	214.3	0.13	176.8	145.7	15.5	31.1	156.1	1.213	0.44
6	1020	1998.0	267.0	217.8	0.16	180.4	142.2	18.1	38.2	154.9	1.269	0.45
7	1030	1994.0	289.0	220.4	0.20	183.6	139.0	22.3	44.6	153.9	1.321	0.44
8	1040	1990.5	307.0	224.0	0.23	186.2	136.5	24.8	49.7	153.1	1.364	0.47
9	1052	1985.0	328.5	227.1	0.27	188.8	132.9	28.0	55.9	151.5	1.421	0.47
10	1100	1981.0	344.8	229.5	0.31	191.4	130.9	30.3	60.5	151.1	1.462	0.48
11	1110	1975.5	360.2	231.4	0.35	193.3	128.3	32.5	65.0	150.0	1.507	0.47
12	1120	1970.2	375.0	234.2	0.40	195.4	126.2	34.6	69.2	149.3	1.548	0.49
13	1130	1965.0	389.0	235.6	0.44	197.3	124.1	36.6	73.2	148.5	1.590	0.48
14	1158	1948.0	425.5	241.7	0.59	202.1	118.6	41.8	83.5	146.4	1.704	0.49
15	1210	1939.5	440.0	243.6	0.66	203.9	116.2	43.8	87.7	145.4	1.755	0.49
16	1220	1933.0	451.0	245.4	0.72	205.5	114.7	45.4	90.8	145.0	1.791	0.49
17	1230	1926.2	461.0	246.4	0.78	206.7	113.1	46.8	93.6	144.3	1.828	0.49
18	1240	1919.2	471.6	248.5	0.84	208.3	111.8	48.3	96.5	144.0	1.863	0.50
19	1250	1912.5	480.5	249.4	0.89	209.4	110.3	49.5	99.1	143.3	1.888	0.49
20	1300	1905.5	489.0	251.8	0.95	210.5	109.2	50.7	101.3	143.0	1.928	0.51
21	1315	1882.0	502.5	253.1	1.07	211.9	106.7	52.6	105.2	141.8	1.986	0.50
22	1331	1881.0	515.0	254.7	1.16	213.6	104.9	54.3	108.7	141.1	2.036	0.50
23	1345	1872.0	522.8	256.3	1.24	214.5	103.7	55.4	110.8	140.6	2.088	0.50
24	1401	1859.0	532.0	257.3	1.35	215.8	102.6	56.6	113.3	140.3	2.105	0.50
25	1415	1848.0	539.5	258.8	1.44	216.7	101.4	57.6	115.3	139.8	2.137	0.50
26	1430	1836.0	546.5	259.9	1.55	216.8	99.6	58.6	117.2	138.7	2.177	0.51
27	1445	1823.0	553.2	261.5	1.66	217.2	98.3	59.5	118.9	137.9	2.210	0.51
28	1500	1810.0	559.9	263.0	1.77	217.9	97.2	60.3	120.7	137.4	2.241	0.52
29	1515	1797.8	565.2	264.1	1.87	218.0	96.0	61.0	122.0	136.7	2.271	0.52
30	1530	1784.8	569.6	265.2	1.98	218.2	95.1	61.6	123.1	136.1	2.295	0.52
31	1545	1771.5	574.0	266.1	2.10	218.3	94.0	62.1	124.3	135.4	2.322	0.53
32	1600	1758.0	577.5	267.0	2.21	218.1	93.0	62.6	125.1	134.7	2.345	0.53
33	1617	1743.2	581.0	267.6	2.34	217.9	91.9	63.0	126.0	133.9	2.371	0.53
34	1630	1731.8	583.9	269.0	2.44	217.8	91.2	63.3	126.6	133.4	2.388	0.54
35	1647	1715.5	586.9	269.6	2.58	217.7	90.4	63.6	127.3	132.8	2.408	0.54
36	1703	1701.8	589.6	270.3	2.69	217.4	89.5	63.9	127.9	132.1	2.429	0.55
37	1717	1689.1	591.5	271.0	2.80	217.3	89.0	64.1	128.3	131.8	2.441	0.55
38	1732	1676.0	593.6	271.6	2.91	216.9	88.1	64.4	128.8	131.0	2.462	0.55
39	1747	1662.1	595.8	272.2	3.03	216.7	87.5	64.6	129.2	130.6	2.477	0.55
40	1800	1650.0	597.9	273.0	3.14	216.5	86.8	64.8	129.7	130.0	2.494	0.56
41	1830	1622.6	601.1	274.0	3.37	216.0	85.8	65.1	130.2	129.2	2.518	0.56
42	1900	1595.4	603.5	275.1	3.60	215.1	84.5	65.3	130.6	128.0	2.546	0.57
43	1931	1566.8	606.5	275.9	3.85	214.7	83.6	65.6	131.1	127.3	2.568	0.57
44	2000	1538.5	608.5	276.5	4.09	214.3	82.9	65.7	131.4	126.7	2.585	0.58
45	2035	1507.2	610.4	278.0	4.36	213.4	82.0	65.7	131.4	125.8	2.603	0.59
46	2100	1484.0	611.5	278.0	4.56	212.9	81.3	65.8	131.6	125.2	2.618	0.59
47	2200	1427.0	614.8	279.9	5.04	211.5	79.7	65.9	131.8	123.6	2.653	0.60
48	2300	1371.2	617.0	281.0	5.52	210.2	78.5	65.9	131.7	122.4	2.678	0.61
49	2402	1313.9	619.2	282.9	6.01	208.7	77.1	65.8	131.6	121.0	2.706	0.63
50	100	1259.6	620.9	283.4	6.47	207.8	76.4	65.7	131.4	120.2	2.720	0.63
51	201	1201.9	622.1	284.0	6.97	206.6	75.5	65.6	131.1	119.2	2.736	0.64
52	300	1146.0	622.5	284.7	7.44	205.4	74.9	65.2	130.5	118.4	2.742	0.64
53	410	1080.4	622.5	285.8	8.01	203.6	73.9	64.8	129.7	117.1	2.755	0.66
54	600	976.5	622.5	286.3	8.89	201.4	72.9	64.2	128.5	115.7	2.762	0.67
55	924	784.5	622.8	287.7	10.53	197.9	71.7	63.1	126.2	113.8	2.780	0.69
56	1000	749.2	622.8	288.1	10.84	197.4	71.6	62.9	125.8	113.5	2.757	0.70
57	1030	721.0	622.8	288.3	11.08	196.8	71.4	62.7	125.4	113.2	2.757	0.70
58	1100	692.6	622.8	288.4	11.32	196.3	71.2	62.5	125.1	112.9	2.757	0.70
59	1131	663.5	622.3	288.3	11.57	195.8	71.2	62.3	124.6	112.7	2.750	0.70
60	1202	634.2	621.5	288.5	11.82	195.1	71.0	62.0	124.1	112.4	2.747	0.71
61	1230	607.6	621.2	288.9	12.05	194.5	70.8	61.8	123.7	112.0	2.747	0.71
62	1304	575.6	620.9	289.2	12.32	193.7	70.5	61.6	123.2	111.6	2.747	0.72

SAMPLE NO. : T 734 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 159.40 KPA
PRECONSOLIDATION PRESSURE : 160.00 KPA
NORMALIZING STRESS : 160.00 KPA

NORMALIZED SHEAR TEST RESULTS START 110185 END 120185

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.000	1.000	0.996	0.0
2	0.05	0.036	1.074	0.995	0.026
3	0.09	0.054	1.114	0.987	0.044
4	0.11	0.075	1.161	0.983	0.064
5	0.13	0.097	1.213	0.975	0.086
6	0.16	0.120	1.269	0.968	0.107
7	0.20	0.140	1.321	0.962	0.124
8	0.23	0.155	1.364	0.957	0.146
9	0.27	0.175	1.421	0.947	0.166
10	0.31	0.189	1.462	0.944	0.181
11	0.35	0.203	1.507	0.937	0.192
12	0.40	0.216	1.548	0.933	0.210
13	0.44	0.229	1.590	0.928	0.219
14	0.59	0.261	1.704	0.915	0.257
15	0.66	0.274	1.755	0.909	0.269
16	0.72	0.284	1.791	0.906	0.280
17	0.78	0.293	1.828	0.902	0.286
18	0.84	0.302	1.863	0.900	0.299
19	0.89	0.310	1.898	0.896	0.305
20	0.95	0.317	1.928	0.894	0.320
21	1.07	0.329	1.986	0.886	0.328
22	1.16	0.340	2.036	0.882	0.338
23	1.24	0.346	2.068	0.879	0.348
24	1.35	0.354	2.105	0.877	0.354
25	1.44	0.360	2.137	0.874	0.364
26	1.55	0.366	2.177	0.867	0.371
27	1.66	0.372	2.210	0.862	0.381
28	1.77	0.377	2.241	0.859	0.390
29	1.87	0.381	2.271	0.854	0.397
30	1.98	0.385	2.295	0.851	0.404
31	2.10	0.388	2.322	0.846	0.409
32	2.21	0.391	2.345	0.842	0.415
33	2.34	0.394	2.371	0.837	0.419
34	2.44	0.396	2.388	0.834	0.427
35	2.58	0.398	2.408	0.830	0.431
36	2.69	0.400	2.429	0.826	0.436
37	2.80	0.401	2.441	0.824	0.440
38	2.91	0.402	2.462	0.819	0.444
39	3.03	0.404	2.477	0.816	0.447
40	3.14	0.405	2.494	0.813	0.452
41	3.37	0.407	2.518	0.808	0.459
42	3.60	0.408	2.546	0.800	0.466
43	3.85	0.410	2.568	0.796	0.471
44	4.09	0.410	2.585	0.792	0.474
45	4.36	0.411	2.603	0.786	0.484
46	4.56	0.411	2.618	0.782	0.484
47	5.04	0.412	2.653	0.773	0.496
48	5.52	0.412	2.678	0.765	0.502
49	6.01	0.411	2.706	0.756	0.514
50	6.47	0.411	2.720	0.751	0.517
51	6.97	0.410	2.736	0.745	0.521
52	7.44	0.408	2.742	0.740	0.526
53	8.01	0.405	2.755	0.732	0.533
54	8.89	0.402	2.762	0.723	0.536
55	10.53	0.394	2.760	0.711	0.544
56	10.84	0.393	2.757	0.710	0.547
57	11.08	0.392	2.757	0.708	0.548
58	11.32	0.391	2.757	0.706	0.549
59	11.57	0.389	2.750	0.705	0.548
60	11.82	0.388	2.747	0.702	0.549
61	12.05	0.386	2.747	0.700	0.552
62	12.32	0.385	2.747	0.697	0.554

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 735 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT = 49.7 PERCENT
SPECIFIC GRAVITY OF SOIL = 2.73
INITIAL VOID RATIO = 1.357
INITIAL HEIGHT OF SAMPLE = 12.96 CM
INITIAL VOLUME OF SAMPLE = 590.25 CC
EFFECTIVE PRINCIPAL STRESS RATIO = 1.00
FINAL MOISTURE CONTENT = 39.0 PERCENT

TX. CONSOLIDATION START 281284 END 110185
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.88	26.50	2.442	2.660	0.109	34.29	23.38	1.294	2.294	1.555
2	57.56	30.40	2.810	3.160	0.175	39.45	27.16	1.282	2.282	1.757
3	66.15	35.10	3.279	3.651	0.186	45.45	31.05	1.271	2.271	2.062
4	76.03	40.30	4.198	4.413	0.108	52.21	35.73	1.253	2.253	2.726
5	87.32	46.30	5.253	5.345	0.046	59.97	41.02	1.231	2.231	3.471
6	100.47	53.20	6.582	6.734	0.076	68.96	47.27	1.198	2.198	4.337
7	115.38	61.20	8.063	8.073	0.005	79.26	54.18	1.167	2.167	5.372
8	132.62	70.30	9.676	9.615	-0.031	91.07	62.32	1.130	2.130	6.471
9	159.50	84.80	12.087	11.461	-0.313	109.70	74.70	1.087	2.087	8.267
10	159.57	84.80	12.573	12.046	-0.264	109.72	74.77	1.073	2.073	8.558
11	159.73	84.80	12.778	12.444	-0.167	109.78	74.93	1.064	2.064	8.630
12	148.94	86.50	12.784	12.444	-0.170	107.31	62.44	1.064	2.064	8.636
13	140.76	90.80	12.761	12.444	-0.158	107.45	49.96	1.064	2.064	8.613
14	133.40	95.90	12.708	12.444	-0.132	108.40	37.50	1.064	2.064	8.560
15	125.02	100.00	12.639	12.444	-0.098	108.34	25.02	1.064	2.064	8.491
16	116.72	104.20	12.515	12.444	-0.036	108.37	12.52	1.064	2.064	8.367
17	107.10	107.10	12.276	12.444	0.084	107.10	0.0	1.064	2.064	8.128
18	105.00	105.00	12.242	12.444	0.101	105.00	0.0	1.064	2.064	8.094
19	104.70	104.70	12.221	12.444	0.112	104.70	0.0	1.064	2.064	8.073
20	105.00	105.00	12.199	12.444	0.122	105.00	0.0	1.064	2.064	8.051
21	105.50	105.50	12.180	12.444	0.132	105.50	0.0	1.064	2.064	8.032
22	106.10	106.10	12.160	12.444	0.142	106.10	0.0	1.064	2.064	8.013
23	106.10	106.10	12.145	12.444	0.149	106.10	0.0	1.064	2.064	7.997
24	105.90	105.90	12.130	12.444	0.157	105.90	0.0	1.064	2.064	7.982
25	106.10	106.10	12.114	12.444	0.165	106.10	0.0	1.064	2.064	7.966
26	105.90	105.90	12.099	12.444	0.173	105.90	0.0	1.064	2.064	7.951
27	103.80	103.80	12.076	12.444	0.184	103.80	0.0	1.064	2.064	7.928
28	94.90	94.90	12.068	12.444	0.188	94.90	0.0	1.064	2.064	7.920

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.88	26.50	2.442	0.109	2.294
2	57.56	30.40	2.810	0.175	2.282
3	66.15	35.10	3.279	0.186	2.271
4	76.03	40.30	4.198	0.108	2.253
5	87.32	46.30	5.253	0.046	2.231
6	100.47	53.20	6.582	0.076	2.198
7	115.38	61.20	8.063	0.005	2.167
8	132.62	70.30	9.676	-0.031	2.130
9	159.50	84.80	12.087	-0.313	2.087
10	159.57	84.80	12.573	-0.264	2.073
11	159.73	84.80	12.778	-0.167	2.064
12	148.94	86.50	12.784	-0.170	2.064
13	140.76	90.80	12.761	-0.158	2.064
14	133.40	95.90	12.708	-0.132	2.064
15	125.02	100.00	12.639	-0.098	2.064
16	116.72	104.20	12.515	-0.036	2.064
17	107.10	107.10	12.276	0.084	2.064
18	105.00	105.00	12.242	0.101	2.064
19	104.70	104.70	12.221	0.112	2.064
20	105.00	105.00	12.199	0.122	2.064
21	105.50	105.50	12.180	0.132	2.064
22	106.10	106.10	12.160	0.142	2.064
23	106.10	106.10	12.145	0.149	2.064
24	105.90	105.90	12.130	0.157	2.064
25	106.10	106.10	12.114	0.165	2.064
26	105.90	105.90	12.099	0.173	2.064
27	103.80	103.80	12.076	0.184	2.064
28	94.90	94.90	12.068	0.188	2.064

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 735 (REMOULDED SAMPLE)
TEST RESULTS START 281284 END 110185

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	2.442	0.109	2.660	0.0	0.0		0.0
2	57.6	30.4	27.2	39.5	2.810	0.175	3.160	9.5	0.4	0.235	0.235
3	66.1	35.1	31.0	45.4	3.279	0.186	3.651	20.3	0.8	0.297	0.533
4	76.0	40.3	35.7	52.2	4.198	0.108	4.413	32.6	1.8	0.594	1.127
5	87.3	46.3	41.0	60.0	5.253	0.046	5.345	46.8	2.8	0.809	1.835
6	100.5	53.2	47.3	69.0	6.582	0.076	6.734	63.1	4.1	1.278	3.213
7	115.4	61.2	54.2	79.3	8.063	0.005	8.073	81.8	5.6	1.517	4.730
8	132.6	70.3	62.3	91.1	9.676	-0.031	9.615	103.4	7.2	1.953	6.683
9	159.5	84.8	74.7	109.7	12.087	-0.313	11.461	137.2	9.7	3.084	9.767
10	159.6	84.8	74.8	109.7	12.573	-0.264	12.046	137.2	10.1	0.859	10.626
11	159.7	84.8	74.9	109.8	12.778	-0.167	12.444	137.3	10.3	0.491	11.117
12	148.9	86.5	62.4	107.3	12.784	-0.170	12.444	130.4	10.3	0.004	11.121
13	140.8	90.8	50.0	107.5	12.761	-0.158	12.444	128.6	10.3	-0.013	11.108
14	133.4	95.9	37.5	108.4	12.708	-0.132	12.444	128.9	10.3	-0.023	11.085
15	125.0	100.0	25.0	108.3	12.639	-0.098	12.444	128.3	10.2	-0.022	11.063
16	116.7	104.2	12.5	108.4	12.515	-0.036	12.444	128.6	10.1	-0.023	11.040
17	107.1	107.1	0.0	107.1	12.276	0.084	12.444	127.5	9.8	-0.015	11.025
18	105.0	105.0	0.0	105.0	12.242	0.101	12.444	123.9	9.8	0.0	11.025
19	104.7	104.7	0.0	104.7	12.221	0.112	12.444	123.4	9.8	0.0	11.025
20	105.0	105.0	0.0	105.0	12.199	0.122	12.444	123.9	9.8	0.0	11.025
21	105.5	105.5	0.0	105.5	12.180	0.132	12.444	124.8	9.7	0.0	11.025
22	106.1	106.1	0.0	106.1	12.160	0.142	12.444	125.8	9.7	0.0	11.025
23	106.1	106.1	0.0	106.1	12.145	0.149	12.444	125.8	9.7	0.0	11.025
24	105.9	105.9	0.0	105.9	12.130	0.157	12.444	125.5	9.7	0.0	11.025
25	106.1	106.1	0.0	106.1	12.114	0.165	12.444	125.8	9.7	0.0	11.025
26	105.9	105.9	0.0	105.9	12.099	0.173	12.444	125.5	9.7	0.0	11.025
27	103.8	103.8	0.0	103.8	12.076	0.184	12.444	121.9	9.6	0.0	11.025
28	94.9	94.9	0.0	94.9	12.068	0.188	12.444	106.7	9.6	0.0	11.025

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 735 (REMOULDED SAMPLE)
TEST RESULTS START 281284 END 110185

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	2.472	0.112	2.696	0.0	0.0		0.0
2	57.6	30.4	27.2	39.5	2.850	0.180	3.211	9.5	0.4	0.242	0.242
3	66.1	35.1	31.0	45.4	3.334	0.192	3.719	20.3	0.9	0.307	0.549
4	76.0	40.3	35.7	52.2	4.288	0.113	4.514	32.6	1.8	0.618	1.167
5	87.3	46.3	41.0	60.0	5.396	0.049	5.493	46.8	2.9	0.849	2.017
6	100.5	53.2	47.3	69.0	6.808	0.082	6.972	63.1	4.3	1.359	3.376
7	115.4	61.2	54.2	79.3	8.407	0.005	8.417	81.8	5.9	1.638	5.013
8	132.6	70.3	62.3	91.1	10.176	-0.034	10.108	103.4	7.7	2.143	7.156
9	159.5	84.8	74.7	109.7	12.882	-0.355	12.173	137.2	10.4	3.454	10.611
10	159.6	84.8	74.8	109.7	13.437	-0.301	12.835	137.2	11.0	0.976	11.587
11	159.7	84.8	74.9	109.8	13.671	-0.191	13.289	137.3	11.2	0.560	12.147
12	148.9	86.5	62.4	107.3	13.678	-0.195	13.289	130.4	11.2	0.005	12.152
13	140.8	90.8	50.0	107.5	13.651	-0.181	13.289	128.6	11.2	-0.015	12.137
14	133.4	95.9	37.5	108.4	13.591	-0.151	13.289	128.9	11.1	-0.026	12.110
15	125.0	100.0	25.0	108.3	13.512	-0.111	13.289	128.3	11.0	-0.025	12.085
16	116.7	104.2	12.5	108.4	13.370	-0.041	13.289	128.6	10.9	-0.027	12.059
17	107.1	107.1	0.0	107.1	13.097	0.096	13.289	127.5	10.6	-0.017	12.042
18	105.0	105.0	0.0	105.0	13.058	0.115	13.289	123.9	10.6	-0.000	12.042
19	104.7	104.7	0.0	104.7	13.034	0.127	13.289	123.4	10.6	-0.000	12.042
20	105.0	105.0	0.0	105.0	13.009	0.140	13.289	123.8	10.5	0.0	12.042
21	105.5	105.5	0.0	105.5	12.987	0.151	13.289	124.8	10.5	-0.000	12.042
22	106.1	106.1	0.0	106.1	12.965	0.162	13.289	125.8	10.5	-0.000	12.042
23	106.1	106.1	0.0	106.1	12.948	0.170	13.289	125.8	10.5	-0.000	12.042
24	105.9	105.9	0.0	105.9	12.930	0.179	13.289	125.5	10.5	-0.000	12.042
25	106.1	106.1	0.0	106.1	12.913	0.188	13.289	125.8	10.4	0.0	12.042
26	105.9	105.9	0.0	105.9	12.895	0.197	13.289	125.5	10.4	-0.000	12.042
27	103.8	103.8	0.0	103.8	12.869	0.210	13.289	121.9	10.4	-0.000	12.042
28	94.9	94.9	0.0	94.9	12.860	0.214	13.289	106.7	10.4	-0.000	12.042

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 735 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.427 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 503.100 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 44.027 SQUARE CENTIMETRES

CONSTANT LOAD : 15.33 N .
PROVING RING FACTOR : 0.4177 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2071.00 DIVISIONS

SHEAR TEST RESULTS START 150185 END 170185

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	914	2071.0	400.3	200.3	0.0	160.3	160.4	-0.0	-0.1	160.4	1.000	0.0
2	920	2070.5	419.0	200.9	0.00	160.9	159.1	0.9	1.8	159.7	1.011	0.32
3	930	2070.0	428.0	202.1	0.01	161.0	158.4	1.3	2.6	159.3	1.016	0.68
4	942	2068.5	442.5	202.8	0.02	161.9	158.0	2.0	3.9	159.3	1.025	0.63
5	957	2066.5	450.0	204.3	0.04	160.9	156.2	2.3	4.7	157.8	1.030	0.84
6	1011	2065.5	471.0	205.9	0.05	160.6	153.9	3.4	6.7	156.1	1.044	0.82
7	1021	2065.0	497.0	208.7	0.05	161.3	152.2	4.5	9.1	155.2	1.060	0.92
8	1033	2063.0	526.0	211.2	0.07	161.0	149.1	5.9	11.9	153.1	1.080	0.91
9	1040	2062.0	545.5	212.1	0.08	162.0	148.3	6.9	13.7	152.9	1.093	0.86
10	1052	2061.2	580.0	213.8	0.09	163.5	146.5	8.5	17.0	152.2	1.116	0.79
11	1100	2060.0	599.0	214.8	0.10	164.2	145.4	9.4	18.8	151.7	1.129	0.77
12	1116	2059.0	639.0	215.4	0.11	167.6	145.0	11.3	22.6	152.5	1.156	0.67
13	1143	2056.0	704.0	219.5	0.13	169.8	141.1	14.4	28.7	150.7	1.203	0.67
14	1150	2054.8	721.5	220.5	0.14	170.5	140.1	15.2	30.4	150.2	1.217	0.66
15	1200	2053.5	744.5	222.2	0.15	170.5	137.9	16.3	32.6	148.8	1.236	0.67
16	1211	2051.5	768.5	223.4	0.17	171.6	136.7	17.4	34.9	148.3	1.255	0.66
17	1221	2049.8	791.5	224.7	0.19	172.3	135.3	18.5	37.0	147.6	1.274	0.66
18	1240	2046.2	832.5	227.5	0.22	173.7	132.8	20.4	40.9	146.4	1.308	0.66
19	1250	2044.2	855.2	228.8	0.23	174.4	131.4	21.5	43.0	145.7	1.328	0.66
20	1301	2041.8	880.0	229.8	0.26	175.8	130.4	22.7	45.4	145.5	1.348	0.65
21	1320	2037.3	920.0	232.4	0.29	177.1	128.0	24.6	49.1	144.4	1.384	0.65
22	1335	2034.0	947.0	233.5	0.32	178.6	127.0	25.8	51.6	144.2	1.407	0.64
23	1345	2032.0	969.9	235.1	0.34	179.1	125.3	26.9	53.8	143.2	1.429	0.65
24	1400	2028.0	997.0	236.6	0.38	180.1	123.7	28.2	56.4	142.5	1.456	0.64
25	1420	2023.0	1033.5	238.9	0.42	181.5	121.8	29.9	59.7	141.7	1.491	0.65
26	1438	2017.4	1067.6	241.1	0.47	182.4	119.4	31.5	63.0	140.4	1.527	0.65
27	1502	2009.8	1110.5	243.6	0.54	184.0	117.0	33.5	67.0	139.3	1.572	0.65
28	1534	1999.2	1166.0	247.1	0.63	185.4	113.3	36.1	72.1	137.3	1.637	0.65
29	1600	1991.0	1204.0	249.4	0.70	186.5	110.8	37.8	75.7	136.0	1.683	0.65
30	1627	1980.8	1250.0	251.8	0.79	188.5	108.6	40.0	79.9	135.2	1.736	0.64
31	1702	1967.0	1302.0	254.8	0.91	190.4	105.7	42.4	84.7	133.9	1.801	0.64
32	1740	1951.0	1353.5	256.7	1.05	191.1	101.6	44.7	89.5	131.4	1.880	0.65
33	1800	1942.2	1378.0	259.9	1.13	192.3	100.6	45.8	91.7	131.2	1.911	0.65
34	1835	1929.5	1422.0	262.0	1.24	193.9	98.2	47.9	95.7	130.1	1.975	0.64
35	1900	1918.0	1454.0	263.7	1.34	194.9	96.3	49.3	98.6	129.2	2.024	0.64
36	1950	1892.1	1511.0	266.8	1.57	196.9	93.2	51.9	103.7	127.8	2.113	0.64
37	2058	1859.2	1569.5	270.7	1.85	198.1	89.2	54.4	108.9	125.5	2.221	0.65
38	2201	1824.5	1620.0	273.4	2.16	200.3	87.1	56.6	113.2	124.8	2.289	0.65
39	2300	1790.0	1659.6	276.9	2.46	200.2	83.7	58.2	116.5	122.5	2.392	0.66
40	2401	1752.0	1692.0	279.5	2.79	200.2	81.1	59.5	119.1	120.8	2.468	0.66
41	105	1710.0	1714.5	280.9	3.16	200.6	79.9	60.3	120.7	120.1	2.510	0.67
42	300	1632.0	1747.0	283.4	3.84	200.3	77.5	61.4	122.8	118.4	2.584	0.68
43	502	1547.2	1777.5	285.4	4.58	199.6	75.0	62.3	124.6	116.5	2.662	0.68
44	708	1457.2	1799.4	286.5	5.37	199.6	74.0	62.8	125.6	115.9	2.697	0.69
45	905	1370.5	1802.0	288.0	6.13	197.1	72.3	62.4	124.8	113.9	2.726	0.70
46	1000	1329.0	1804.8	288.7	6.49	196.6	72.1	62.3	124.5	113.6	2.727	0.71
47	1108	1281.0	1809.8	289.7	6.91	195.1	70.7	62.2	124.4	112.2	2.780	0.72
48	1200	1242.0	1813.0	289.7	7.25	194.6	70.3	62.2	124.3	111.7	2.768	0.72
49	1300	1198.0	1818.1	290.6	7.64	193.9	69.7	62.1	124.2	111.1	2.782	0.73
50	1400	1153.0	1822.0	291.2	8.03	193.3	69.3	62.0	124.0	110.6	2.789	0.73
51	1533	1082.5	1820.0	291.4	8.65	192.3	69.3	61.5	123.0	110.3	2.774	0.74
52	1700	1017.0	1819.0	292.1	9.22	190.2	68.0	61.1	122.2	108.7	2.797	0.75
53	1900	926.0	1822.9	293.2	10.02	188.4	67.0	60.7	121.4	107.5	2.812	0.75
54	2103	834.0	1828.2	293.5	10.83	187.6	66.8	60.4	120.8	107.1	2.808	0.77
55	2301	742.5	1820.0	293.4	11.63	186.0	67.0	59.5	119.0	106.7	2.776	0.78
56	726	362.0	1820.0	291.8	14.96	183.1	68.6	57.3	114.5	106.8	2.669	0.80
57	906	270.0	1762.0	289.2	15.76	180.4	71.7	54.4	108.7	107.9	2.517	0.82

SAMPLE NO. : T 735 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 159.70 KPA
PRECONSOLIDATION PRESSURE : 159.70 KPA
NORMALIZING STRESS : 160.30 KPA

NORMALIZED SHEAR TEST RESULTS START 150185 END 170185

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	-0.000	1.000	1.000	0.0
2	0.00	0.006	1.011	0.996	0.004
3	0.01	0.008	1.016	0.993	0.011
4	0.02	0.012	1.025	0.994	0.016
5	0.04	0.015	1.030	0.984	0.025
6	0.05	0.021	1.044	0.974	0.035
7	0.05	0.028	1.060	0.968	0.052
8	0.07	0.037	1.080	0.955	0.068
9	0.08	0.043	1.093	0.954	0.074
10	0.09	0.053	1.116	0.949	0.084
11	0.10	0.059	1.129	0.946	0.090
12	0.11	0.070	1.156	0.952	0.094
13	0.13	0.090	1.203	0.940	0.120
14	0.14	0.095	1.217	0.937	0.126
15	0.15	0.102	1.236	0.928	0.137
16	0.17	0.109	1.255	0.925	0.144
17	0.19	0.116	1.274	0.921	0.152
18	0.22	0.128	1.308	0.913	0.170
19	0.23	0.134	1.328	0.909	0.178
20	0.26	0.142	1.348	0.908	0.184
21	0.29	0.153	1.384	0.901	0.200
22	0.32	0.161	1.407	0.900	0.207
23	0.34	0.168	1.429	0.894	0.217
24	0.38	0.176	1.456	0.889	0.226
25	0.42	0.186	1.491	0.884	0.241
26	0.47	0.196	1.527	0.876	0.255
27	0.54	0.209	1.572	0.869	0.270
28	0.63	0.225	1.637	0.857	0.282
29	0.70	0.236	1.683	0.849	0.306
30	0.79	0.249	1.736	0.844	0.321
31	0.91	0.264	1.801	0.836	0.340
32	1.05	0.279	1.880	0.820	0.364
33	1.13	0.285	1.911	0.818	0.372
34	1.24	0.299	1.975	0.812	0.385
35	1.34	0.308	2.024	0.806	0.396
36	1.57	0.324	2.113	0.797	0.415
37	1.85	0.340	2.221	0.783	0.439
38	2.16	0.353	2.299	0.779	0.456
39	2.46	0.363	2.392	0.764	0.478
40	2.79	0.371	2.468	0.754	0.494
41	3.16	0.376	2.510	0.749	0.503
42	3.84	0.383	2.584	0.739	0.518
43	4.58	0.389	2.662	0.727	0.531
44	5.37	0.392	2.697	0.723	0.538
45	6.13	0.389	2.726	0.711	0.547
46	6.49	0.388	2.727	0.708	0.551
47	6.91	0.388	2.760	0.700	0.558
48	7.25	0.388	2.768	0.697	0.558
49	7.64	0.387	2.782	0.693	0.563
50	8.03	0.387	2.789	0.690	0.567
51	8.65	0.384	2.774	0.688	0.568
52	9.22	0.381	2.787	0.678	0.573
53	10.02	0.379	2.812	0.670	0.580
54	10.83	0.377	2.808	0.668	0.581
55	11.63	0.371	2.776	0.665	0.581
56	14.96	0.357	2.669	0.666	0.571
57	15.76	0.339	2.517	0.673	0.555

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 736 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT = 49.9 PERCENT
SPECIFIC GRAVITY OF SOIL = 2.73
INITIAL VOID RATIO = 1.362
INITIAL HEIGHT OF SAMPLE = 12.94 CM
INITIAL VOLUME OF SAMPLE = 589.57 CC
EFFECTIVE PRINCIPAL STRESS RATIO = 1.00
FINAL MOISTURE CONTENT = 38.4 PERCENT

TX. CONSOLIDATION START 281284 END 100185
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.14	26.50	2.453	3.062	0.304	34.38	23.64	1.290	2.290	1.432
2	57.73	30.60	2.804	3.596	0.396	39.64	27.13	1.277	2.277	1.606
3	66.53	35.20	3.359	4.427	0.534	45.64	31.33	1.258	2.258	1.883
4	76.58	40.60	4.164	5.496	0.666	52.59	35.98	1.232	2.232	2.332
5	88.17	46.70	5.153	6.793	0.820	60.52	41.47	1.202	2.202	2.888
6	101.32	53.70	6.404	7.989	0.792	69.57	47.62	1.174	2.174	3.741
7	116.22	61.80	7.760	8.829	0.534	79.94	54.42	1.154	2.154	4.817
8	133.09	70.80	9.776	10.109	0.167	91.56	62.29	1.123	2.123	6.406
9	159.49	84.80	12.785	12.577	-0.104	109.70	74.69	1.065	2.065	8.593
10	159.70	84.80	13.241	13.272	0.016	109.77	74.90	1.049	2.049	8.816
11	159.24	84.80	13.449	13.272	-0.088	109.61	74.44	1.049	2.049	9.025
12	147.75	85.50	13.449	13.272	-0.088	106.25	62.25	1.049	2.049	9.025
13	140.44	90.60	13.417	13.272	-0.072	107.21	49.84	1.049	2.049	8.993
14	133.59	96.20	13.357	13.272	-0.042	108.66	37.39	1.049	2.049	8.932
15	127.46	102.50	13.252	13.272	0.010	110.82	24.96	1.049	2.049	8.828
16	117.69	105.20	13.109	13.272	0.082	109.36	12.49	1.049	2.049	8.684
17	111.00	111.00	12.862	13.272	0.205	111.00	0.0	1.049	2.049	8.438
18	103.20	103.20	12.800	13.272	0.236	103.20	0.0	1.049	2.049	8.376
19	100.90	100.90	12.731	13.272	0.271	100.90	0.0	1.049	2.049	8.307
20	98.40	98.40	12.704	13.272	0.284	98.40	0.0	1.049	2.049	8.280
21	96.20	96.20	12.681	13.272	0.296	96.20	0.0	1.049	2.049	8.256
22	94.00	94.00	12.657	13.272	0.308	94.00	0.0	1.049	2.049	8.233
23	92.60	92.60	12.629	13.272	0.322	92.60	0.0	1.049	2.049	8.205
24	86.40	86.40	12.603	13.272	0.335	86.40	0.0	1.049	2.049	8.179
25	87.00	87.00	12.580	13.272	0.346	87.00	0.0	1.049	2.049	8.156
26	80.00	80.00	12.534	13.272	0.369	80.00	0.0	1.049	2.049	8.110
27	74.00	74.00	12.383	13.272	0.445	74.00	0.0	1.049	2.049	7.959
28	50.00	50.00	12.283	13.272	0.495	50.00	0.0	1.049	2.049	7.859

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.14	26.50	2.453	0.304	2.290
2	57.73	30.60	2.804	0.396	2.277
3	66.53	35.20	3.359	0.534	2.258
4	76.58	40.60	4.164	0.666	2.232
5	88.17	46.70	5.153	0.820	2.202
6	101.32	53.70	6.404	0.792	2.174
7	116.22	61.80	7.760	0.534	2.154
8	133.09	70.80	9.776	0.167	2.123
9	159.49	84.80	12.785	-0.104	2.065
10	159.70	84.80	13.241	0.016	2.049
11	159.24	84.80	13.449	-0.088	2.049
12	147.75	85.50	13.449	-0.088	2.049
13	140.44	90.60	13.417	-0.072	2.049
14	133.59	96.20	13.357	-0.042	2.049
15	127.46	102.50	13.252	0.010	2.049
16	117.69	105.20	13.109	0.082	2.049
17	111.00	111.00	12.862	0.205	2.049
18	103.20	103.20	12.800	0.236	2.049
19	100.90	100.90	12.731	0.271	2.049
20	98.40	98.40	12.704	0.284	2.049
21	96.20	96.20	12.681	0.296	2.049
22	94.00	94.00	12.657	0.308	2.049
23	92.60	92.60	12.629	0.322	2.049
24	86.40	86.40	12.603	0.335	2.049
25	87.00	87.00	12.580	0.346	2.049
26	80.00	80.00	12.534	0.369	2.049
27	74.00	74.00	12.383	0.445	2.049
28	50.00	50.00	12.283	0.495	2.049

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 736 (REMOULDED SAMPLE)
TEST RESULTS START 281284 END 100185

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.453	0.304	3.062	0.0	0.0		0.0
2	57.7	30.6	27.1	39.6	2.804	0.396	3.596	9.6	0.4	0.242	0.242
3	66.5	35.2	31.3	45.6	3.359	0.534	4.427	20.5	1.0	0.436	0.677
4	76.6	40.6	36.0	52.6	4.164	0.666	5.496	33.1	1.8	0.676	1.353
5	88.2	46.7	41.5	60.5	5.153	0.820	6.793	47.6	2.8	0.949	2.303
6	101.3	53.7	47.6	69.6	6.404	0.792	7.989	64.0	4.0	1.158	3.460
7	116.2	61.8	54.4	79.9	7.760	0.534	8.829	82.8	5.3	1.177	4.637
8	133.1	70.8	62.3	91.6	9.776	0.167	10.109	104.0	7.3	2.026	6.662
9	159.5	84.8	74.7	109.7	12.785	-0.104	12.577	136.9	10.3	3.981	10.643
10	159.7	84.8	74.9	109.8	13.241	0.016	13.272	137.1	10.8	0.931	11.574
11	159.2	84.8	74.4	109.6	13.449	-0.088	13.272	136.8	11.0	0.156	11.730
12	147.7	85.5	62.3	106.3	13.449	-0.088	13.272	128.4	11.0	0.0	11.730
13	140.4	90.6	49.8	107.2	13.417	-0.072	13.272	128.0	11.0	-0.018	11.711
14	133.6	96.2	37.4	108.7	13.357	-0.042	13.272	129.2	10.9	-0.026	11.685
15	127.5	102.5	25.0	110.8	13.252	0.010	13.272	132.4	10.8	-0.033	11.653
16	117.7	105.2	12.5	109.4	13.109	0.082	13.272	130.2	10.7	-0.027	11.626
17	111.0	111.0	0.0	111.0	12.862	0.205	13.272	134.1	10.4	-0.015	11.610
18	103.2	103.2	0.0	103.2	12.800	0.236	13.272	120.8	10.3	0.0	11.610
19	100.9	100.9	0.0	100.9	12.731	0.271	13.272	116.8	10.3	0.0	11.610
20	98.4	98.4	0.0	98.4	12.704	0.284	13.272	112.6	10.3	0.0	11.610
21	96.2	96.2	0.0	96.2	12.681	0.296	13.272	108.8	10.2	0.0	11.610
22	94.0	94.0	0.0	94.0	12.657	0.308	13.272	105.1	10.2	0.0	11.610
23	92.6	92.6	0.0	92.6	12.629	0.322	13.272	102.7	10.2	0.0	11.610
24	86.4	86.4	0.0	86.4	12.603	0.335	13.272	92.1	10.2	0.0	11.610
25	87.0	87.0	0.0	87.0	12.580	0.346	13.272	93.2	10.1	0.0	11.610
26	80.0	80.0	0.0	80.0	12.534	0.369	13.272	81.3	10.1	0.0	11.610
27	74.0	74.0	0.0	74.0	12.383	0.445	13.272	71.3	9.9	0.0	11.610
28	50.0	50.0	0.0	50.0	12.283	0.495	13.272	33.2	9.8	0.0	11.610

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 736 (REMOULDED SAMPLE)
TEST RESULTS START 281284 END 100185

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.483	0.313	3.109	0.0	0.0		0.0
2	57.7	30.6	27.1	39.6	2.844	0.409	3.662	9.6	0.4	0.249	0.249
3	66.5	35.2	31.3	45.6	3.416	0.556	4.528	20.5	1.0	0.452	0.702
4	76.6	40.6	36.0	52.6	4.253	0.700	5.652	33.1	1.9	0.708	1.409
5	88.2	46.7	41.5	60.5	5.290	0.872	7.035	47.6	2.9	1.005	2.414
6	101.3	53.7	47.6	69.6	6.618	0.854	8.326	64.0	4.2	1.240	3.654
7	116.2	61.8	54.4	79.9	8.077	0.583	9.242	82.8	5.6	1.274	4.928
8	133.1	70.8	62.3	91.6	10.287	0.185	10.657	104.0	7.8	2.227	7.155
9	159.5	84.8	74.7	109.7	13.679	-0.119	13.441	136.9	11.2	4.488	11.644
10	159.7	84.8	74.9	109.8	14.203	0.018	14.239	137.1	11.7	1.069	12.713
11	159.2	84.8	74.4	109.6	14.443	-0.102	14.239	136.8	12.0	0.180	12.893
12	147.7	85.5	62.3	106.3	14.443	-0.102	14.239	128.4	12.0	0.0	12.893
13	140.4	90.6	49.8	107.2	14.406	-0.083	14.239	128.0	11.9	-0.021	12.872
14	133.6	96.2	37.4	108.7	14.336	-0.048	14.239	129.2	11.9	-0.030	12.841
15	127.5	102.5	25.0	110.8	14.216	0.012	14.239	132.4	11.7	-0.038	12.804
16	117.7	105.2	12.5	109.4	14.050	0.094	14.239	130.2	11.6	-0.031	12.773
17	111.0	111.0	0.0	111.0	13.767	0.236	14.239	134.1	11.3	-0.018	12.755
18	103.2	103.2	0.0	103.2	13.696	0.272	14.239	120.8	11.2	-0.000	12.755
19	100.9	100.9	0.0	100.9	13.617	0.311	14.239	116.8	11.1	-0.000	12.755
20	98.4	98.4	0.0	98.4	13.586	0.327	14.239	112.6	11.1	-0.000	12.755
21	96.2	96.2	0.0	96.2	13.559	0.340	14.239	108.8	11.1	-0.000	12.755
22	94.0	94.0	0.0	94.0	13.533	0.353	14.239	105.1	11.0	-0.000	12.755
23	92.6	92.6	0.0	92.6	13.500	0.370	14.239	102.7	11.0	-0.000	12.755
24	86.4	86.4	0.0	86.4	13.471	0.384	14.239	92.1	11.0	-0.000	12.755
25	87.0	87.0	0.0	87.0	13.444	0.398	14.239	93.2	11.0	-0.000	12.755
26	80.0	80.0	0.0	80.0	13.391	0.424	14.239	81.3	10.9	0.0	12.755
27	74.0	74.0	0.0	74.0	13.219	0.510	14.239	71.3	10.7	-0.000	12.755
28	50.0	50.0	0.0	50.0	13.105	0.567	14.239	33.2	10.6	-0.000	12.755

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 736 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.358 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 491.217 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 43.247 SQUARE CENTIMETRES

CONSTANT LOAD : 16.55 N .
PROVING RING FACTOR : 1.0225 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2133.50 DIVISIONS

SHEAR TEST RESULTS START 200185 END 210185

CONSOLIDATED UNDRAINED TRIAXIAL TEST
:::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	1116	2133.5	163.0	200.5	0.0	159.7	159.5	0.1	0.2	159.6	1.001	0.0
2	1120	2132.5	173.0	203.4	0.01	159.1	156.6	1.3	2.5	157.4	1.016	1.23
3	1130	2131.5	202.5	207.7	0.02	161.8	152.3	4.8	9.5	155.5	1.062	0.77
4	1140	2130.0	228.0	211.6	0.03	163.9	148.4	7.8	15.5	153.6	1.105	0.72
5	1150	2128.5	256.5	215.6	0.04	166.7	144.4	11.1	22.3	151.8	1.154	0.68
6	1200	2126.5	279.0	219.0	0.06	168.6	141.0	13.8	27.6	150.2	1.196	0.67
7	1215	2122.8	313.0	222.9	0.09	172.7	137.1	17.8	35.6	149.0	1.260	0.63
8	1232	2118.0	345.0	228.6	0.14	174.5	131.4	21.6	43.1	145.8	1.328	0.65
9	1247	2112.5	371.5	232.0	0.18	177.4	128.0	24.7	49.4	144.5	1.386	0.64
10	1300	2108.0	391.5	235.2	0.22	178.9	124.8	27.0	54.1	142.8	1.433	0.64
11	1315	2101.8	414.0	238.3	0.28	181.0	121.7	29.7	59.3	141.5	1.488	0.64
12	1330	2094.2	436.0	241.7	0.35	182.8	118.3	32.2	64.5	139.8	1.545	0.64
13	1345	2086.2	454.5	244.6	0.42	184.2	115.4	34.4	68.8	138.3	1.596	0.64
14	1400	2077.5	472.0	247.3	0.49	185.6	112.7	36.4	72.9	137.0	1.647	0.64
15	1415	2068.0	489.0	250.6	0.58	186.2	109.4	38.4	76.8	135.0	1.702	0.65
16	1430	2058.0	504.5	253.3	0.66	187.1	106.7	40.2	80.4	133.5	1.753	0.66
17	1445	2047.8	520.0	255.1	0.75	188.8	104.9	42.0	83.9	132.9	1.800	0.65
18	1500	2037.5	532.5	257.7	0.85	189.1	102.3	43.4	86.8	131.2	1.848	0.66
19	1515	2026.5	546.0	259.7	0.94	190.2	100.3	44.9	89.9	130.3	1.896	0.66
20	1530	2016.0	558.0	261.0	1.03	191.6	99.0	46.3	92.6	129.9	1.935	0.65
21	1545	2004.5	569.0	262.5	1.14	192.6	97.5	47.5	95.1	129.2	1.975	0.85
22	1600	1992.2	580.0	263.9	1.24	193.6	96.1	48.8	97.5	128.6	2.015	0.65
23	1615	1980.5	589.5	265.7	1.35	193.9	94.3	49.8	99.6	127.5	2.057	0.66
24	1630	1969.5	598.5	267.2	1.44	194.4	92.8	50.8	101.6	126.7	2.095	0.66
25	1700	1945.5	615.0	270.7	1.66	194.6	89.3	52.6	105.3	124.4	2.179	0.67
26	1730	1920.8	629.0	272.4	1.87	195.9	87.6	54.1	108.3	123.7	2.236	0.67
27	1800	1896.5	641.5	273.7	2.09	197.2	86.3	55.5	110.9	123.3	2.285	0.66
28	1830	1870.0	652.0	275.5	2.32	197.6	84.5	56.5	113.1	122.2	2.338	0.66
29	1901	1843.0	661.5	276.3	2.56	198.7	83.7	57.5	115.0	122.0	2.374	0.66
30	1930	1818.0	668.0	278.9	2.78	197.3	81.1	58.1	116.2	119.8	2.433	0.68
31	2001	1790.0	675.0	279.3	3.02	198.3	80.7	58.8	117.6	119.9	2.457	0.67
32	2100	1737.8	684.5	280.4	3.48	198.8	79.6	59.6	119.2	119.3	2.497	0.67
33	2200	1682.4	691.2	282.3	3.97	197.8	77.7	60.0	120.1	117.7	2.546	0.68
34	2310	1618.0	697.5	283.6	4.54	197.2	76.4	60.4	120.8	116.7	2.581	0.69
35	2400	1571.0	700.0	283.0	4.95	197.8	77.0	60.4	120.8	117.3	2.569	0.68
36	2434	1539.6	701.0	283.9	5.23	196.8	76.1	60.4	120.7	116.3	2.586	0.69
37	100	1516.5	702.0	284.5	5.43	196.2	75.5	60.3	120.7	115.7	2.598	0.70
38	426	1320.8	695.0	285.6	7.15	191.3	74.4	58.5	116.9	113.4	2.572	0.73
39	700	1171.5	683.5	286.0	8.47	186.8	74.0	56.4	112.8	111.6	2.524	0.76
40	800	1115.0	679.5	286.4	8.97	184.9	73.6	55.7	111.3	110.7	2.513	0.77
41	830	1085.5	676.5	286.6	9.23	183.8	73.4	55.2	110.4	110.2	2.504	0.78
42	900	1057.0	674.5	285.8	9.48	183.8	74.2	54.8	109.6	110.7	2.477	0.78
43	930	1028.5	671.8	285.9	9.73	182.8	74.1	54.4	108.7	110.3	2.488	0.79
44	1000	999.0	669.0	286.8	9.99	181.0	73.2	53.9	107.8	109.1	2.473	0.80
45	1030	970.0	666.0	286.7	10.24	180.2	73.3	53.4	106.9	108.9	2.458	0.81
46	1058	942.5	663.5	286.9	10.49	179.2	73.1	53.0	106.1	108.5	2.451	0.82
47	1200	883.0	658.0	287.9	11.01	176.4	72.1	52.2	104.3	106.9	2.447	0.84
48	1300	824.5	654.0	288.5	11.52	174.4	71.5	51.4	102.9	105.8	2.439	0.86
49	1400	767.5	650.0	288.7	12.03	172.7	71.3	50.7	101.4	105.1	2.423	0.87

SAMPLE NO. : T 736 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 159.70 KPA
PRECONSOLIDATION PRESSURE : 159.70 KPA
NORMALIZING STRESS : 159.70 KPA

NORMALIZED SHEAR TEST RESULTS START 200185 END 210185

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.001	1.001	0.999	0.0
2	0.01	0.008	1.016	0.986	0.018
3	0.02	0.030	1.062	0.973	0.045
4	0.03	0.049	1.105	0.962	0.070
5	0.04	0.070	1.154	0.951	0.095
6	0.06	0.086	1.196	0.940	0.116
7	0.09	0.111	1.260	0.933	0.140
8	0.14	0.135	1.328	0.913	0.176
9	0.18	0.155	1.386	0.905	0.197
10	0.22	0.169	1.433	0.894	0.217
11	0.28	0.186	1.488	0.886	0.237
12	0.35	0.202	1.545	0.875	0.258
13	0.42	0.215	1.596	0.866	0.276
14	0.49	0.228	1.647	0.858	0.293
15	0.58	0.240	1.702	0.845	0.314
16	0.66	0.252	1.753	0.836	0.331
17	0.75	0.263	1.800	0.832	0.342
18	0.85	0.272	1.848	0.822	0.358
19	0.94	0.281	1.898	0.816	0.371
20	1.03	0.290	1.935	0.813	0.379
21	1.14	0.298	1.975	0.809	0.388
22	1.24	0.305	2.015	0.805	0.397
23	1.35	0.312	2.057	0.798	0.408
24	1.44	0.318	2.095	0.793	0.418
25	1.66	0.330	2.179	0.779	0.440
26	1.87	0.339	2.236	0.775	0.450
27	2.09	0.347	2.285	0.772	0.458
28	2.32	0.354	2.338	0.765	0.470
29	2.56	0.360	2.374	0.764	0.475
30	2.78	0.364	2.433	0.750	0.491
31	3.02	0.368	2.457	0.751	0.493
32	3.48	0.373	2.497	0.747	0.500
33	3.97	0.376	2.546	0.737	0.512
34	4.54	0.378	2.581	0.731	0.520
35	4.95	0.378	2.569	0.734	0.517
36	5.23	0.378	2.586	0.728	0.522
37	5.43	0.378	2.598	0.725	0.526
38	7.15	0.366	2.572	0.710	0.533
39	8.47	0.353	2.524	0.699	0.535
40	8.97	0.349	2.513	0.693	0.538
41	9.23	0.346	2.504	0.690	0.539
42	9.48	0.343	2.477	0.693	0.534
43	9.73	0.340	2.468	0.691	0.535
44	9.99	0.338	2.473	0.683	0.540
45	10.24	0.335	2.458	0.682	0.540
46	10.49	0.332	2.451	0.679	0.541
47	11.01	0.327	2.447	0.669	0.547
48	11.52	0.322	2.439	0.662	0.551
49	12.03	0.318	2.423	0.658	0.552

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 737 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT = 48.0 PERCENT
SPECIFIC GRAVITY OF SOIL = 2.73
INITIAL VOID RATIO = 1.338
INITIAL HEIGHT OF SAMPLE = 13.13 CM
INITIAL VOLUME OF SAMPLE = 597.76 CC
EFFECTIVE PRINCIPAL STRESS RATIO = 1.00
FINAL MOISTURE CONTENT = 38.6 PERCENT

TX. CONSOLIDATION START 240185 END 60285
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.16	26.50	1.624	2.258	0.317	34.39	23.66	1.285	2.285	0.872
2	57.78	30.60	1.947	2.844	0.449	39.66	27.18	1.271	2.271	0.999
3	66.45	35.20	2.373	3.446	0.536	45.62	31.25	1.257	2.257	1.225
4	76.49	40.50	3.059	4.324	0.633	52.50	35.99	1.237	2.237	1.618
5	88.01	46.60	4.065	5.445	0.690	60.40	41.41	1.210	2.210	2.250
6	101.18	53.60	5.288	6.750	0.731	68.46	47.58	1.180	2.180	3.038
7	116.35	61.70	6.712	8.122	0.705	79.92	54.65	1.148	2.148	4.005
8	133.73	70.90	8.404	9.619	0.608	91.84	62.83	1.113	2.113	5.197
9	159.67	84.80	10.629	11.418	0.394	108.76	74.87	1.071	2.071	6.823
10	159.85	84.80	11.204	12.204	0.500	109.82	75.05	1.052	2.052	7.136
11	159.70	84.80	11.333	12.170	0.418	109.77	74.90	1.053	2.053	7.277
12	148.17	85.80	11.333	12.170	0.418	106.59	62.37	1.053	2.053	7.277
13	139.74	89.70	11.322	12.170	0.424	106.38	50.04	1.053	2.053	7.265
14	134.65	97.20	11.284	12.170	0.443	109.68	37.45	1.053	2.053	7.227
15	128.43	103.30	11.227	12.170	0.472	111.68	25.13	1.053	2.053	7.170
16	120.52	108.00	11.093	12.170	0.539	112.17	12.52	1.053	2.053	7.037
17	114.00	114.00	10.987	12.170	0.592	114.00	0.0	1.053	2.053	6.930
18	109.70	109.70	10.872	12.170	0.649	109.70	0.0	1.053	2.053	6.816
19	107.40	107.40	10.827	12.170	0.672	107.40	0.0	1.053	2.053	6.770
20	106.00	106.00	10.796	12.170	0.687	106.00	0.0	1.053	2.053	6.739
21	105.10	105.10	10.758	12.170	0.706	105.10	0.0	1.053	2.053	6.701
22	104.30	104.30	10.728	12.170	0.721	104.30	0.0	1.053	2.053	6.671
23	104.10	104.10	10.680	12.170	0.740	104.10	0.0	1.053	2.053	6.633
24	103.40	103.40	10.651	12.170	0.759	103.40	0.0	1.053	2.053	6.595
25	103.20	103.20	10.621	12.170	0.775	103.20	0.0	1.053	2.053	6.564
26	102.30	102.30	10.583	12.170	0.794	102.30	0.0	1.053	2.053	6.526
27	101.60	101.60	10.537	12.170	0.817	101.60	0.0	1.053	2.053	6.480
28	95.00	95.00	10.507	12.170	0.832	85.00	0.0	1.053	2.053	6.450

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.16	26.50	1.624	0.317	2.285
2	57.78	30.60	1.947	0.449	2.271
3	66.45	35.20	2.373	0.536	2.257
4	76.49	40.50	3.059	0.633	2.237
5	88.01	46.60	4.065	0.690	2.210
6	101.18	53.60	5.288	0.731	2.180
7	116.35	61.70	6.712	0.705	2.148
8	133.73	70.90	8.404	0.608	2.113
9	159.67	84.80	10.629	0.394	2.071
10	159.85	84.80	11.204	0.500	2.052
11	159.70	84.80	11.333	0.418	2.053
12	148.17	85.80	11.333	0.418	2.053
13	139.74	89.70	11.322	0.424	2.053
14	134.65	97.20	11.284	0.443	2.053
15	128.43	103.30	11.227	0.472	2.053
16	120.52	108.00	11.093	0.539	2.053
17	114.00	114.00	10.987	0.592	2.053
18	109.70	109.70	10.872	0.649	2.053
19	107.40	107.40	10.827	0.672	2.053
20	106.00	106.00	10.796	0.687	2.053
21	105.10	105.10	10.758	0.706	2.053
22	104.30	104.30	10.728	0.721	2.053
23	104.10	104.10	10.680	0.740	2.053
24	103.40	103.40	10.651	0.759	2.053
25	103.20	103.20	10.621	0.775	2.053
26	102.30	102.30	10.583	0.794	2.053
27	101.60	101.60	10.537	0.817	2.053
28	95.00	95.00	10.507	0.832	2.053

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 737 (REMOULDED SAMPLE)
TEST RESULTS START 240185 END 60285

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.2	26.5	23.7	34.4	1.624	0.317	2.258	0.0	0.0		0.0
2	57.8	30.6	27.2	39.7	1.947	0.449	2.844	9.6	0.4	0.249	0.249
3	66.4	35.2	31.3	45.6	2.373	0.536	3.446	20.4	0.8	0.323	0.572
4	76.5	40.5	36.0	52.5	3.059	0.633	4.324	32.9	1.5	0.563	1.135
5	88.0	46.6	41.4	60.4	4.065	0.690	5.445	47.3	2.5	0.877	2.012
6	101.2	53.6	47.6	69.5	5.288	0.731	6.750	63.8	3.7	1.198	3.210
7	116.4	61.7	54.7	79.9	6.712	0.705	8.122	82.8	5.1	1.519	4.729
8	133.7	70.9	62.8	91.8	8.404	0.608	9.619	104.5	6.8	1.986	6.715
9	159.7	84.8	74.9	109.8	10.629	0.394	11.418	137.1	9.0	2.932	9.647
10	159.9	84.8	75.1	109.8	11.204	0.500	12.204	137.2	9.6	1.098	10.745
11	159.7	84.8	74.9	109.8	11.333	0.418	12.170	137.1	9.7	0.069	10.814
12	148.2	85.8	62.4	106.6	11.333	0.418	12.170	129.0	9.7	0.0	10.814
13	139.7	89.7	50.0	106.4	11.322	0.424	12.170	126.5	9.7	-0.006	10.807
14	134.6	97.2	37.4	109.7	11.284	0.443	12.170	130.9	9.7	-0.017	10.791
15	128.4	103.3	25.1	111.7	11.227	0.472	12.170	133.9	9.6	-0.018	10.773
16	120.5	108.0	12.5	112.2	11.093	0.539	12.170	135.0	9.5	-0.025	10.748
17	114.0	114.0	0.0	114.0	10.987	0.592	12.170	139.2	9.4	-0.007	10.741
18	109.7	109.7	0.0	109.7	10.872	0.649	12.170	131.9	9.3	0.0	10.741
19	107.4	107.4	0.0	107.4	10.827	0.672	12.170	127.9	9.2	0.0	10.741
20	106.0	106.0	0.0	106.0	10.796	0.687	12.170	125.5	9.2	0.0	10.741
21	105.1	105.1	0.0	105.1	10.758	0.706	12.170	124.0	9.2	0.0	10.741
22	104.3	104.3	0.0	104.3	10.728	0.721	12.170	122.6	9.1	0.0	10.741
23	104.1	104.1	0.0	104.1	10.690	0.740	12.170	122.3	9.1	0.0	10.741
24	103.4	103.4	0.0	103.4	10.651	0.759	12.170	121.1	9.0	0.0	10.741
25	103.2	103.2	0.0	103.2	10.621	0.775	12.170	120.7	9.0	0.0	10.741
26	102.3	102.3	0.0	102.3	10.583	0.794	12.170	119.2	9.0	0.0	10.741
27	101.6	101.6	0.0	101.6	10.537	0.817	12.170	118.0	8.9	0.0	10.741
28	95.0	95.0	0.0	95.0	10.507	0.832	12.170	106.7	8.9	0.0	10.741

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 737 (REMOULDED SAMPLE)
TEST RESULTS START 240185 END 60285

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.2	26.5	23.7	34.4	1.638	0.323	2.284	0.0	0.0		0.0
2	57.8	30.6	27.2	39.7	1.966	0.460	2.885	9.6	0.4	0.255	0.255
3	66.4	35.2	31.3	45.6	2.402	0.552	3.507	20.4	0.8	0.332	0.587
4	76.5	40.5	36.0	52.5	3.107	0.657	4.421	32.9	1.5	0.583	1.170
5	88.0	46.6	41.4	60.4	4.150	0.725	5.599	47.3	2.6	0.917	2.087
6	101.2	53.6	47.6	69.5	5.432	0.778	6.989	63.8	3.8	1.267	3.354
7	116.4	61.7	54.7	79.9	6.948	0.761	8.471	82.8	5.3	1.629	4.983
8	133.7	70.9	62.8	91.8	8.778	0.668	10.114	104.5	7.2	2.164	7.147
9	159.7	84.8	74.9	109.8	11.237	0.443	12.123	137.1	9.6	3.257	10.404
10	159.9	84.8	75.1	109.8	11.882	0.566	13.015	137.2	10.3	1.240	11.644
11	159.7	84.8	74.9	109.8	12.028	0.474	12.977	137.1	10.4	0.077	11.721
12	148.2	85.8	62.4	106.6	12.028	0.474	12.977	129.0	10.4	0.0	11.721
13	139.7	89.7	50.0	106.4	12.015	0.481	12.977	126.5	10.4	-0.007	11.714
14	134.6	97.2	37.4	109.7	11.972	0.502	12.977	130.9	10.3	-0.019	11.695
15	128.4	103.3	25.1	111.7	11.908	0.534	12.977	133.9	10.3	-0.020	11.675
16	120.5	108.0	12.5	112.2	11.758	0.609	12.977	135.0	10.1	-0.028	11.647
17	114.0	114.0	0.0	114.0	11.638	0.669	12.977	139.2	10.0	-0.008	11.639
18	109.7	109.7	0.0	109.7	11.510	0.733	12.977	131.9	9.9	-0.000	11.639
19	107.4	107.4	0.0	107.4	11.459	0.759	12.977	127.9	9.8	-0.000	11.639
20	106.0	106.0	0.0	106.0	11.424	0.776	12.977	125.5	9.8	-0.000	11.639
21	105.1	105.1	0.0	105.1	11.382	0.798	12.977	124.0	9.8	-0.000	11.639
22	104.3	104.3	0.0	104.3	11.348	0.815	12.977	122.6	9.7	-0.000	11.639

23	104.1	104.1	0.0	104.1	11.305	0.836	12.977	122.3	9.7	-0.000	11.639
24	103.4	103.4	0.0	103.4	11.262	0.857	12.977	121.1	9.7	0.0	11.639
25	103.2	103.2	0.0	103.2	11.228	0.874	12.977	120.7	9.6	-0.000	11.639
26	102.3	102.3	0.0	102.3	11.185	0.896	12.977	119.2	9.6	-0.000	11.639
27	101.6	101.6	0.0	101.6	11.134	0.921	12.977	118.0	9.5	-0.000	11.639
28	95.0	95.0	0.0	95.0	11.100	0.938	12.977	106.7	9.5	-0.000	11.639

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 737 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.606 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 521.965 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 44.974 SQUARE CENTIMETRES

CONSTANT LOAD : 16.50 N .
PROVING RING FACTOR : 1.2365 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2114.00 DIVISIONS

SHEAR TEST RESULTS START 100285 END 110285

CONSOLIDATED UNDRAINED TRIAXIAL TEST
:::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	936	2114.0	374.0	200.8	0.0	158.4	84.0	37.2	74.4	108.8	1.886	0.0
2	940	2113.9	386.0	201.6	0.00	161.0	83.3	38.8	77.7	109.2	1.932	0.24
3	951	2112.0	414.0	205.5	0.02	164.8	79.4	42.7	85.4	107.9	2.075	0.43
4	1000	2109.0	435.5	208.1	0.04	168.0	76.8	45.6	91.2	107.2	2.188	0.43
5	1015	2102.5	459.8	211.1	0.10	171.6	73.7	48.9	97.9	106.3	2.328	0.44
6	1030	2093.0	474.5	212.6	0.18	174.0	72.2	50.9	101.8	106.1	2.410	0.43
7	1045	2081.4	483.0	213.7	0.28	175.2	71.1	52.0	104.1	105.8	2.464	0.43
8	1100	2068.8	488.5	214.3	0.39	176.0	70.5	52.7	105.5	105.7	2.496	0.43
9	1115	2055.5	491.5	214.9	0.50	176.3	70.2	53.1	106.1	105.6	2.512	0.44
10	1130	2042.0	493.0	215.3	0.62	176.1	69.7	53.2	106.4	105.2	2.527	0.45
11	1145	2028.0	494.2	215.8	0.74	175.7	69.1	53.3	106.6	104.6	2.543	0.47
12	1200	2014.0	495.0	216.3	0.86	175.5	68.8	53.3	106.7	104.4	2.551	0.48
13	1230	1986.0	496.2	217.2	1.10	174.7	67.9	53.4	106.8	103.5	2.572	0.51
14	1300	1959.0	497.5	218.1	1.34	173.9	67.0	53.4	106.9	102.6	2.595	0.53
15	1330	1930.0	497.8	219.1	1.59	172.7	66.0	53.3	106.7	101.6	2.616	0.57
16	1400	1902.0	497.8	220.0	1.83	171.3	64.9	53.2	106.4	100.4	2.640	0.60
17	1430	1873.5	497.8	220.6	2.07	170.4	64.2	53.1	106.2	99.6	2.654	0.62
18	1500	1845.5	496.8	221.5	2.31	168.9	63.3	52.8	105.6	98.5	2.669	0.66
19	1530	1816.5	495.9	222.4	2.56	167.6	62.5	52.6	105.1	97.5	2.682	0.70
20	1600	1789.0	495.0	222.8	2.80	166.7	62.1	52.3	104.6	97.0	2.685	0.73
21	1630	1758.0	494.0	223.6	3.07	165.5	61.4	52.0	104.1	96.1	2.695	0.77
22	1710	1721.0	493.0	224.4	3.39	164.1	60.6	51.7	103.5	95.1	2.707	0.81
23	1800	1674.5	492.2	225.4	3.79	162.4	59.6	51.4	102.8	93.9	2.725	0.87
24	1900	1617.5	492.0	226.3	4.28	161.0	58.8	51.1	102.2	92.9	2.739	0.92
25	2000	1560.5	492.0	227.3	4.77	159.5	57.8	50.9	101.7	91.7	2.760	0.97
26	2113	1491.5	490.0	228.0	5.36	157.6	57.0	50.3	100.6	90.5	2.764	1.04
27	2200	1446.0	489.5	228.4	5.76	156.3	56.3	50.0	100.0	89.6	2.777	1.08
28	2310	1381.0	489.5	229.4	6.32	155.0	55.6	49.7	99.4	88.7	2.788	1.14
29	2400	1333.0	489.8	229.9	6.73	154.1	55.0	49.5	99.1	88.0	2.801	1.18
30	118	1260.0	490.2	230.7	7.36	152.7	54.2	49.3	98.5	87.0	2.817	1.24
31	755	885.5	489.0	233.4	10.59	146.5	51.7	47.4	94.8	83.3	2.833	1.60
32	900	820.0	488.0	233.5	11.15	145.4	51.5	47.0	93.9	82.8	2.824	1.67

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
33	932	793.0	488.0	233.6	11.38	145.1	51.4	46.8	93.7	82.6	2.823	1.70
34	1000	765.5	488.0	233.7	11.62	144.7	51.3	46.7	93.4	82.4	2.821	1.73
35	1107	703.5	488.0	234.1	12.15	143.9	51.0	46.4	92.9	82.0	2.821	1.80
36	1127	685.0	488.0	234.1	12.31	143.8	51.1	46.3	92.7	82.0	2.814	1.82

SAMPLE NO. : T 737 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 158.40 KPA
PRECONSOLIDATION PRESSURE : 159.85 KPA
NORMALIZING STRESS : 159.85 KPA

NORMALIZED SHEAR TEST RESULTS START 100285 END 110285

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.233	1.886	0.681	0.0
2	0.00	0.243	1.932	0.683	0.005
3	0.02	0.267	2.075	0.675	0.029
4	0.04	0.285	2.188	0.671	0.046
5	0.10	0.306	2.328	0.665	0.064
6	0.18	0.319	2.410	0.664	0.074
7	0.28	0.326	2.464	0.662	0.081
8	0.39	0.330	2.496	0.661	0.084
9	0.50	0.332	2.512	0.660	0.088
10	0.62	0.333	2.527	0.658	0.091
11	0.74	0.334	2.543	0.655	0.094
12	0.86	0.334	2.551	0.653	0.097
13	1.10	0.334	2.572	0.647	0.103
14	1.34	0.334	2.595	0.642	0.108
15	1.59	0.334	2.616	0.635	0.114
16	1.83	0.333	2.640	0.628	0.120
17	2.07	0.332	2.654	0.623	0.124
18	2.31	0.330	2.669	0.616	0.129
19	2.56	0.329	2.682	0.610	0.135
20	2.80	0.327	2.685	0.607	0.138
21	3.07	0.326	2.695	0.601	0.143
22	3.39	0.324	2.707	0.595	0.148
23	3.79	0.322	2.725	0.587	0.154
24	4.28	0.320	2.739	0.581	0.160
25	4.77	0.318	2.760	0.574	0.166
26	5.36	0.315	2.764	0.566	0.170
27	5.76	0.313	2.777	0.561	0.173
28	6.32	0.311	2.788	0.555	0.179
29	6.73	0.310	2.801	0.551	0.182
30	7.36	0.308	2.817	0.544	0.187
31	10.59	0.296	2.833	0.521	0.204
32	11.15	0.294	2.824	0.518	0.205
33	11.38	0.293	2.823	0.517	0.205
34	11.62	0.292	2.821	0.516	0.206
35	12.15	0.290	2.821	0.513	0.208
36	12.31	0.290	2.814	0.513	0.208

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 738 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 49.1 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.340
INITIAL HEIGHT OF SAMPLE : 12.97 CM
INITIAL VOLUME OF SAMPLE : 590.71 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 38.5 PERCENT

TX. CONSOLIDATION START 250185 END 70285
TRIAXIAL CONSOLIDATION TEST
:::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.06	25.50	2.151	2.336	0.083	34.35	23.56	1.286	2.286	1.372
2	57.66	30.50	2.463	2.878	0.207	39.55	27.16	1.273	2.273	1.504
3	66.30	35.10	2.922	3.504	0.291	45.50	31.20	1.258	2.258	1.754
4	76.30	40.40	3.616	4.368	0.376	52.37	35.90	1.238	2.238	2.160
5	87.81	46.50	4.649	5.485	0.418	60.27	41.31	1.212	2.212	2.821
6	100.94	53.50	5.914	6.704	0.395	69.31	47.44	1.184	2.184	3.679
7	116.00	61.50	7.502	8.126	0.312	79.67	54.50	1.150	2.150	4.793
8	133.28	70.70	9.241	9.633	0.196	91.56	62.58	1.115	2.115	6.030
9	159.46	84.80	11.742	11.478	-0.132	109.69	74.66	1.072	2.072	7.917
10	159.66	84.80	12.359	12.324	-0.018	109.75	74.86	1.052	2.052	8.251
11	159.54	84.80	12.567	12.375	-0.096	109.71	74.74	1.051	2.051	8.442
12	148.19	85.90	12.571	12.375	-0.098	106.66	62.29	1.051	2.051	8.446
13	141.46	91.60	12.540	12.375	-0.083	108.22	49.86	1.051	2.051	8.415
14	135.03	97.60	12.490	12.375	-0.058	110.08	37.43	1.051	2.051	8.365
15	128.80	103.80	12.421	12.375	-0.023	112.13	25.00	1.051	2.051	8.296
16	122.76	110.30	12.305	12.375	0.035	114.45	12.46	1.051	2.051	8.180
17	116.30	116.30	12.151	12.375	0.112	116.30	0.0	1.051	2.051	8.026
18	112.00	112.00	12.082	12.375	0.147	112.00	0.0	1.051	2.051	7.957
19	110.60	110.60	12.035	12.375	0.170	110.60	0.0	1.051	2.051	7.910
20	109.90	109.90	12.005	12.375	0.185	109.90	0.0	1.051	2.051	7.880
21	109.00	109.00	11.981	12.375	0.197	109.00	0.0	1.051	2.051	7.856
22	108.40	108.40	11.955	12.375	0.210	108.40	0.0	1.051	2.051	7.829
23	107.60	107.60	11.931	12.375	0.222	107.60	0.0	1.051	2.051	7.806
24	106.70	106.70	11.908	12.375	0.233	106.70	0.0	1.051	2.051	7.783
25	106.00	106.00	11.885	12.375	0.245	106.00	0.0	1.051	2.051	7.760
26	105.00	105.00	11.858	12.375	0.258	105.00	0.0	1.051	2.051	7.733
27	104.20	104.20	11.835	12.375	0.270	104.20	0.0	1.051	2.051	7.710
28	99.50	99.50	11.766	12.375	0.305	99.50	0.0	1.051	2.051	7.641

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.06	25.50	2.151	0.093	2.286
2	57.66	30.50	2.463	0.207	2.273
3	66.30	35.10	2.922	0.291	2.258
4	76.30	40.40	3.616	0.376	2.238
5	87.81	46.50	4.649	0.418	2.212
6	100.94	53.50	5.914	0.395	2.184
7	116.00	61.50	7.502	0.312	2.150
8	133.28	70.70	9.241	0.196	2.115
9	159.46	84.80	11.742	-0.132	2.072
10	159.66	84.80	12.359	-0.018	2.052
11	159.54	84.80	12.567	-0.096	2.051
12	148.19	85.90	12.571	-0.098	2.051
13	141.46	91.60	12.540	-0.083	2.051
14	135.03	97.60	12.490	-0.058	2.051
15	128.80	103.80	12.421	-0.023	2.051
16	122.76	110.30	12.305	0.035	2.051
17	116.30	116.30	12.151	0.112	2.051
18	112.00	112.00	12.082	0.147	2.051
19	110.60	110.60	12.035	0.170	2.051
20	109.90	109.90	12.005	0.185	2.051
21	109.00	109.00	11.981	0.197	2.051
22	108.40	108.40	11.955	0.210	2.051
23	107.60	107.60	11.931	0.222	2.051
24	106.70	106.70	11.908	0.233	2.051
25	106.00	106.00	11.885	0.245	2.051
26	105.00	105.00	11.858	0.258	2.051
27	104.20	104.20	11.835	0.270	2.051
28	99.50	99.50	11.766	0.305	2.051

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 738 (REMOULDED SAMPLE)
TEST RESULTS START 250186 END 70286

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.151	0.093	2.336	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.463	0.207	2.878	9.5	0.4	0.234	0.234
3	66.3	35.1	31.2	45.5	2.922	0.291	3.504	20.3	0.8	0.339	0.573
4	76.3	40.4	35.9	52.4	3.616	0.376	4.368	32.8	1.5	0.559	1.132
5	87.8	46.5	41.3	60.3	4.649	0.418	5.485	47.2	2.5	0.884	2.016
6	100.9	53.5	47.4	69.3	5.914	0.395	6.704	63.6	3.8	1.171	3.186
7	116.0	61.5	54.5	79.7	7.502	0.312	8.126	82.5	5.4	1.627	4.814
8	133.3	70.7	62.6	91.6	9.241	0.196	9.633	104.1	7.1	2.014	6.827
9	159.5	84.8	74.7	109.7	11.742	-0.132	11.478	137.0	9.6	3.152	9.979
10	159.7	84.8	74.9	109.8	12.359	-0.018	12.324	137.1	10.2	1.179	11.158
11	159.5	84.8	74.7	109.7	12.567	-0.096	12.375	137.1	10.4	0.199	11.357
12	148.2	85.9	62.3	106.7	12.571	-0.098	12.375	129.2	10.4	0.003	11.359
13	141.5	91.6	49.9	108.2	12.540	-0.083	12.375	129.7	10.4	-0.017	11.342
14	135.0	97.6	37.4	110.1	12.490	-0.058	12.375	131.6	10.3	-0.022	11.320
15	128.8	103.8	25.0	112.1	12.421	-0.023	12.375	134.7	10.3	-0.022	11.298
16	122.8	110.3	12.5	114.5	12.305	0.035	12.375	139.0	10.2	-0.022	11.277
17	116.3	116.3	0.0	116.3	12.151	0.112	12.375	143.2	10.0	-0.010	11.267
18	112.0	112.0	0.0	112.0	12.082	0.147	12.375	135.9	9.9	0.0	11.267
19	110.6	110.6	0.0	110.6	12.035	0.170	12.375	133.5	9.9	0.0	11.267
20	109.9	109.9	0.0	109.9	12.005	0.185	12.375	132.3	9.9	0.0	11.267
21	109.0	109.0	0.0	109.0	11.981	0.197	12.375	130.7	9.8	0.0	11.267
22	108.4	108.4	0.0	108.4	11.955	0.210	12.375	129.7	9.8	0.0	11.267
23	107.6	107.6	0.0	107.6	11.931	0.222	12.375	128.3	9.8	0.0	11.267
24	106.7	106.7	0.0	106.7	11.908	0.233	12.375	126.8	9.8	0.0	11.267
25	106.0	106.0	0.0	106.0	11.885	0.245	12.375	125.6	9.7	0.0	11.267
26	105.0	105.0	0.0	105.0	11.858	0.258	12.375	123.9	9.7	0.0	11.267
27	104.2	104.2	0.0	104.2	11.835	0.270	12.375	122.5	9.7	0.0	11.267
28	99.5	99.5	0.0	99.5	11.766	0.305	12.375	114.5	9.6	0.0	11.267

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 738 (REMOULDED SAMPLE)
TEST RESULTS START 250185 END 70285

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.175	0.095	2.364	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.494	0.213	2.920	9.5	0.4	0.240	0.240
3	66.3	35.1	31.2	45.5	2.966	0.301	3.567	20.3	0.8	0.350	0.589
4	76.3	40.4	35.9	52.4	3.683	0.391	4.466	32.8	1.6	0.580	1.169
5	87.8	46.5	41.3	60.3	4.761	0.440	5.641	47.2	2.6	0.927	2.096
6	100.9	53.5	47.4	69.3	6.096	0.422	6.939	63.6	3.9	1.241	3.337
7	116.0	61.5	54.5	79.7	7.798	0.338	8.475	82.5	5.6	1.751	5.088
8	133.3	70.7	62.6	91.6	9.696	0.216	10.128	104.1	7.5	2.204	7.292
9	159.5	84.8	74.7	109.7	12.491	-0.150	12.191	137.0	10.3	3.522	10.814
10	159.7	84.8	74.9	109.8	13.192	-0.020	13.152	137.1	11.0	1.339	12.153
11	159.5	84.8	74.7	109.7	13.430	-0.110	13.210	137.1	11.3	0.227	12.380
12	148.2	85.9	62.3	106.7	13.434	-0.112	13.210	129.2	11.3	0.003	12.383
13	141.5	91.6	49.9	108.2	13.399	-0.094	13.210	129.7	11.2	-0.020	12.363
14	135.0	97.6	37.4	110.1	13.342	-0.066	13.210	131.6	11.2	-0.025	12.338
15	128.8	103.8	25.0	112.1	13.262	-0.026	13.210	134.7	11.1	-0.025	12.314
16	122.8	110.3	12.5	114.5	13.130	0.040	13.210	139.0	11.0	-0.025	12.289
17	116.3	116.3	0.0	116.3	12.955	0.128	13.210	143.2	10.8	-0.011	12.278
18	112.0	112.0	0.0	112.0	12.876	0.167	13.210	135.9	10.7	-0.000	12.278
19	110.6	110.6	0.0	110.6	12.823	0.183	13.210	133.5	10.6	-0.000	12.278
20	109.9	109.9	0.0	109.9	12.788	0.211	13.210	132.3	10.6	-0.000	12.278
21	109.0	109.0	0.0	109.0	12.762	0.224	13.210	130.7	10.6	-0.000	12.278
22	108.4	108.4	0.0	108.4	12.731	0.239	13.210	129.7	10.6	-0.000	12.278
23	107.6	107.6	0.0	107.6	12.705	0.253	13.210	128.3	10.5	-0.000	12.278
24	106.7	106.7	0.0	106.7	12.679	0.266	13.210	126.8	10.5	-0.000	12.278
25	106.0	106.0	0.0	106.0	12.652	0.279	13.210	125.6	10.5	-0.000	12.278
26	105.0	105.0	0.0	105.0	12.622	0.294	13.210	123.9	10.5	-0.000	12.278
27	104.2	104.2	0.0	104.2	12.586	0.307	13.210	122.5	10.4	-0.000	12.278
28	99.5	99.5	0.0	99.5	12.517	0.347	13.210	114.5	10.3	-0.000	12.278

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 738 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 10.792 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 512.956 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 47.531 SQUARE CENTIMETRES

CONSTANT LOAD : 15.27 N .
PROVING RING FACTOR : 0.4177 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2013.50 DIVISIONS

SHEAR TEST RESULTS START 120285 END 130285

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	903	2013.5	1162.6	199.7	0.0	160.1	85.1	37.5	75.0	110.1	1.881	0.0
2	910	2013.0	1182.0	200.9	0.00	160.6	83.9	38.4	76.7	109.5	1.914	0.71
3	920	2012.9	1208.5	202.0	0.01	161.8	82.8	39.5	79.0	109.1	1.954	0.57
4	930	2012.0	1232.0	203.4	0.01	162.5	81.4	40.5	81.1	108.4	1.996	0.61
5	940	2010.8	1256.0	204.1	0.03	163.9	80.7	41.6	83.2	108.4	2.031	0.54
6	950	2009.0	1281.0	204.9	0.04	165.3	79.9	42.7	85.4	108.4	2.068	0.50
7	1000	2007.0	1303.0	205.6	0.06	166.7	79.4	43.6	87.3	108.5	2.099	0.48
8	1010	2004.5	1325.0	206.8	0.08	167.1	77.9	44.6	89.2	107.6	2.145	0.50
9	1020	2002.0	1342.5	207.7	0.11	167.8	77.1	45.4	90.7	107.3	2.177	0.51
10	1030	1998.5	1359.0	208.6	0.14	168.3	76.2	46.1	92.1	106.9	2.209	0.52
11	1040	1994.6	1374.0	209.3	0.18	168.8	75.4	46.7	93.4	106.5	2.239	0.52
12	1050	1990.5	1388.0	210.2	0.21	168.9	74.2	47.3	94.7	105.8	2.276	0.53
13	1102	1988.5	1401.0	211.0	0.23	169.5	73.8	47.9	95.7	105.7	2.297	0.55
14	1116	1978.0	1415.0	211.6	0.33	169.9	73.0	48.4	96.9	105.3	2.327	0.54
15	1130	1969.8	1425.4	212.9	0.40	169.5	71.8	48.9	97.7	104.4	2.361	0.58
16	1145	1960.5	1434.5	213.1	0.49	170.5	72.1	49.2	98.4	104.9	2.364	0.57
17	1200	1951.0	1442.0	213.7	0.58	170.1	71.1	49.5	99.0	104.1	2.392	0.58
18	1220	1937.0	1448.0	214.6	0.71	169.6	70.2	49.7	99.4	103.3	2.416	0.61
19	1230	1930.5	1450.5	214.9	0.77	169.3	69.8	49.8	99.5	103.0	2.426	0.62
20	1245	1920.4	1454.4	215.4	0.86	169.2	69.4	49.9	99.8	102.7	2.438	0.63
21	1300	1909.8	1458.0	215.8	0.96	169.1	69.1	50.0	100.0	102.4	2.447	0.64
22	1315	1899.0	1461.5	216.2	1.06	168.8	68.6	50.1	100.2	102.0	2.461	0.65
23	1330	1888.5	1463.5	216.8	1.16	168.3	68.0	50.1	100.3	101.4	2.475	0.67
24	1345	1876.0	1465.2	217.5	1.27	167.6	67.3	50.1	100.3	100.7	2.490	0.70
25	1400	1866.0	1466.6	217.6	1.37	167.4	67.1	50.2	100.3	100.5	2.495	0.71
26	1430	1844.0	1468.2	218.0	1.57	167.1	66.9	50.1	100.2	100.3	2.498	0.72
27	1500	1823.0	1468.8	219.2	1.77	165.6	65.5	50.1	100.1	98.9	2.529	0.76
28	1530	1800.0	1470.2	219.7	1.98	164.8	64.8	50.0	100.0	98.1	2.544	0.80
29	1600	1777.8	1470.8	220.4	2.18	164.4	64.6	49.9	99.8	97.9	2.545	0.83
30	1700	1733.5	1473.0	220.9	2.59	163.9	64.3	49.8	99.6	97.5	2.549	0.86
31	1801	1687.0	1475.4	221.5	3.03	162.8	63.4	49.7	99.4	96.5	2.568	0.89
32	1900	1642.0	1476.8	222.2	3.44	162.0	63.0	49.5	99.0	96.0	2.572	0.94
33	2020	1582.5	1478.0	222.8	3.99	160.2	61.5	49.3	98.7	94.4	2.604	0.98
34	2100	1552.0	1478.0	223.7	4.28	159.4	61.1	49.2	98.3	93.9	2.609	1.03
35	2200	1507.0	1476.5	224.6	4.69	158.3	60.6	48.9	97.7	93.2	2.613	1.09
36	2300	1461.0	1478.0	225.1	5.12	157.4	60.1	48.6	97.3	92.5	2.618	1.14
37	2400	1416.5	1476.5	225.3	5.53	156.5	59.6	48.5	96.9	91.9	2.626	1.17
38	700	1099.0	1479.0	227.5	8.47	151.6	57.5	47.0	94.1	88.9	2.636	1.46
39	801	1051.0	1478.8	227.7	8.92	150.8	57.2	46.8	93.6	88.4	2.637	1.50
40	905	1005.0	1480.0	228.6	9.34	149.5	56.2	46.6	93.3	87.3	2.660	1.58
41	1000	962.5	1480.0	228.7	9.74	148.9	56.0	46.4	92.9	87.0	2.659	1.62
42	1100	917.0	1478.5	228.9	10.16	148.1	55.8	46.2	92.3	86.6	2.655	1.68
43	1201	870.0	1477.0	228.7	10.60	148.0	56.3	45.9	91.7	86.9	2.629	1.73
44	1305	821.5	1475.5	229.2	11.05	146.7	55.5	45.6	91.2	85.9	2.643	1.82
45	1400	781.0	1475.8	229.5	11.42	146.3	55.5	45.4	90.8	85.8	2.636	1.89
46	1500	734.5	1478.6	231.3	11.85	144.0	53.4	45.3	90.6	83.6	2.697	2.03

SAMPLE NO. : T 738 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 160.10 KPA
PRECONSOLIDATION PRESSURE : 159.66 KPA
NORMALIZING STRESS : 160.10 KPA

NORMALIZED SHEAR TEST RESULTS START 120285 END 130285

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.234	1.881	0.688	0.0
2	0.00	0.240	1.914	0.684	0.007
3	0.01	0.247	1.954	0.682	0.014
4	0.01	0.253	1.996	0.677	0.023
5	0.03	0.260	2.031	0.677	0.027
6	0.04	0.267	2.068	0.677	0.032
7	0.06	0.273	2.099	0.678	0.037
8	0.08	0.279	2.145	0.672	0.044
9	0.11	0.283	2.177	0.670	0.050
10	0.14	0.288	2.209	0.668	0.056
11	0.18	0.292	2.239	0.665	0.060
12	0.21	0.296	2.276	0.661	0.066
13	0.23	0.299	2.297	0.660	0.071
14	0.33	0.303	2.327	0.658	0.074
15	0.40	0.305	2.361	0.652	0.082
16	0.49	0.307	2.364	0.655	0.084
17	0.58	0.309	2.392	0.650	0.087
18	0.71	0.310	2.416	0.645	0.093
19	0.77	0.311	2.426	0.643	0.095
20	0.86	0.312	2.438	0.641	0.098
21	0.96	0.312	2.447	0.640	0.101
22	1.06	0.313	2.461	0.637	0.103
23	1.16	0.313	2.475	0.634	0.106
24	1.27	0.313	2.490	0.629	0.111
25	1.37	0.313	2.495	0.628	0.112
26	1.57	0.313	2.498	0.627	0.114
27	1.77	0.313	2.529	0.618	0.122
28	1.98	0.312	2.544	0.613	0.125
29	2.18	0.312	2.545	0.611	0.129
30	2.59	0.311	2.549	0.609	0.132
31	3.03	0.310	2.568	0.603	0.136
32	3.44	0.309	2.572	0.600	0.141
33	3.99	0.308	2.604	0.590	0.144
34	4.28	0.307	2.609	0.586	0.150
35	4.69	0.305	2.613	0.582	0.155
36	5.12	0.304	2.618	0.578	0.159
37	5.53	0.303	2.626	0.574	0.160
38	8.47	0.294	2.636	0.555	0.174
39	8.92	0.292	2.637	0.552	0.175
40	9.34	0.291	2.660	0.546	0.181
41	9.74	0.290	2.659	0.543	0.181
42	10.16	0.288	2.655	0.541	0.182
43	10.60	0.286	2.629	0.543	0.181
44	11.05	0.285	2.643	0.537	0.184
45	11.42	0.284	2.636	0.536	0.186
46	11.85	0.283	2.697	0.522	0.197

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 739 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 49.3 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.346
INITIAL HEIGHT OF SAMPLE : 13.23 CM
INITIAL VOLUME OF SAMPLE : 802.55 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 38.3 PERCENT

TX. CONSOLIDATION START 250185 END 70285
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.07	28.50	2.014	2.382	0.184	34.36	23.57	1.290	2.290	1.221
2	57.59	30.50	2.395	2.996	0.301	39.53	27.09	1.276	2.276	1.396
3	66.26	35.10	2.772	3.718	0.473	45.49	31.16	1.259	2.259	1.533
4	76.24	40.40	3.651	4.547	0.448	52.35	35.84	1.239	2.239	2.135
5	87.68	46.50	4.747	5.601	0.427	60.23	41.18	1.214	2.214	2.880
6	100.67	53.40	6.224	6.871	0.323	69.16	47.27	1.185	2.185	3.934
7	115.65	61.40	8.065	8.290	0.112	79.48	54.25	1.151	2.151	5.302
8	132.63	70.50	10.121	9.750	-0.185	91.21	62.13	1.117	2.117	6.871
9	157.90	84.80	14.467	11.684	-1.392	109.17	73.10	1.072	2.072	10.573
10	158.27	84.80	15.151	12.829	-1.161	109.29	73.47	1.045	2.045	10.875
11	158.10	84.80	15.329	12.787	-1.271	109.23	73.30	1.046	2.046	11.066
12	147.68	86.60	15.329	12.787	-1.271	106.96	61.08	1.046	2.046	11.066
13	141.68	92.80	15.325	12.787	-1.269	109.09	48.88	1.046	2.046	11.063
14	136.49	99.80	15.276	12.787	-1.244	112.03	36.69	1.046	2.046	11.013
15	131.40	106.90	15.200	12.787	-1.206	115.07	24.50	1.046	2.046	10.938
16	127.10	114.80	15.049	12.787	-1.131	118.90	12.30	1.046	2.046	10.787
17	121.00	121.00	14.845	12.787	-1.029	121.00	0.0	1.046	2.046	10.583
18	115.50	115.50	14.769	12.787	-0.991	115.50	0.0	1.046	2.046	10.507
19	114.30	114.30	14.732	12.787	-0.972	114.30	0.0	1.046	2.046	10.469
20	112.80	112.80	14.694	12.787	-0.953	112.80	0.0	1.046	2.046	10.431
21	111.40	111.40	14.667	12.787	-0.940	111.40	0.0	1.046	2.046	10.405
22	110.50	110.50	14.641	12.787	-0.927	110.50	0.0	1.046	2.046	10.379
23	109.20	109.20	14.618	12.787	-0.915	109.20	0.0	1.046	2.046	10.356
24	108.20	108.20	14.596	12.787	-0.904	108.20	0.0	1.046	2.046	10.333
25	107.60	107.60	14.558	12.787	-0.885	107.60	0.0	1.046	2.046	10.295
26	104.70	104.70	14.558	12.787	-0.885	104.70	0.0	1.046	2.046	10.295
27	102.80	102.80	14.497	12.787	-0.855	102.80	0.0	1.046	2.046	10.235
28	90.50	90.50	14.497	12.787	-0.855	90.50	0.0	1.046	2.046	10.235

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.07	28.50	2.014	0.184	2.290
2	57.59	30.50	2.395	0.301	2.276
3	66.26	35.10	2.772	0.473	2.259
4	76.24	40.40	3.651	0.448	2.239
5	87.68	46.50	4.747	0.427	2.214
6	100.67	53.40	6.224	0.323	2.185
7	115.65	61.40	8.065	0.112	2.151
8	132.63	70.50	10.121	-0.185	2.117
9	157.90	84.80	14.467	-1.392	2.072
10	158.27	84.80	15.151	-1.161	2.045
11	158.10	84.80	15.329	-1.271	2.046
12	147.68	86.60	15.329	-1.271	2.046
13	141.68	92.80	15.325	-1.269	2.046
14	136.49	99.80	15.276	-1.244	2.046
15	131.40	106.90	15.200	-1.206	2.046
16	127.10	114.80	15.049	-1.131	2.046
17	121.00	121.00	14.845	-1.029	2.046
18	115.50	115.50	14.769	-0.991	2.046
19	114.30	114.30	14.732	-0.972	2.046
20	112.80	112.80	14.694	-0.953	2.046
21	111.40	111.40	14.667	-0.940	2.046
22	110.50	110.50	14.641	-0.927	2.046
23	109.20	109.20	14.618	-0.915	2.046
24	108.20	108.20	14.596	-0.904	2.046
25	107.60	107.60	14.558	-0.885	2.046
26	104.70	104.70	14.558	-0.885	2.046
27	102.80	102.80	14.497	-0.855	2.046
28	90.50	90.50	14.497	-0.855	2.046

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 739 (REMOULDED SAMPLE)
TEST RESULTS START 250185 END 70285

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	ÊFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.014	0.184	2.382	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.395	0.301	2.996	9.4	0.4	0.271	0.271
3	66.3	35.1	31.2	45.5	2.772	0.473	3.718	20.2	0.9	0.347	0.618
4	76.2	40.4	35.8	52.3	3.651	0.448	4.547	32.7	1.7	0.607	1.226
5	87.7	46.5	41.2	60.2	4.747	0.427	5.601	47.1	2.8	0.880	2.106
6	100.7	53.4	47.3	69.2	6.224	0.323	6.871	63.3	4.2	1.288	3.393
7	115.6	61.4	54.3	79.5	8.065	0.112	8.290	82.1	6.1	1.749	5.142
8	132.6	70.5	62.1	91.2	10.121	-0.185	9.750	103.4	8.1	2.160	7.302
9	157.9	84.8	73.1	109.2	14.467	-1.392	11.684	135.7	12.7	4.440	11.742
10	158.3	84.8	73.5	109.3	15.151	-1.161	12.829	136.0	13.3	1.472	13.214
11	158.1	84.8	73.3	109.2	15.329	-1.271	12.787	135.9	13.5	0.095	13.309
12	147.7	86.6	61.1	107.0	15.329	-1.271	12.787	129.4	13.5	0.0	13.309
13	141.7	92.8	48.9	109.1	15.325	-1.269	12.787	131.1	13.5	-0.002	13.307
14	136.5	99.8	36.7	112.0	15.276	-1.244	12.787	135.0	13.4	-0.021	13.286
15	131.4	106.9	24.5	115.1	15.200	-1.206	12.787	139.8	13.3	-0.023	13.263
16	127.1	114.8	12.3	118.9	15.049	-1.131	12.787	146.7	13.2	-0.028	13.235
17	121.0	121.0	0.0	121.0	14.845	-1.029	12.787	151.3	12.9	-0.013	13.223
18	115.5	115.5	0.0	115.5	14.769	-0.991	12.787	141.9	12.9	-0.000	13.223
19	114.3	114.3	0.0	114.3	14.732	-0.972	12.787	139.8	12.8	0.0	13.223
20	112.8	112.8	0.0	112.8	14.694	-0.953	12.787	137.2	12.8	0.0	13.223
21	111.4	111.4	0.0	111.4	14.667	-0.940	12.787	134.8	12.8	0.0	13.223
22	110.5	110.5	0.0	110.5	14.641	-0.927	12.787	133.3	12.7	0.0	13.223
23	109.2	109.2	0.0	109.2	14.618	-0.915	12.787	131.1	12.7	0.0	13.223
24	108.2	108.2	0.0	108.2	14.596	-0.904	12.787	129.3	12.7	0.0	13.223
25	107.6	107.6	0.0	107.6	14.558	-0.885	12.787	128.3	12.6	0.0	13.223
26	104.7	104.7	0.0	104.7	14.558	-0.885	12.787	123.3	12.6	0.0	13.223
27	102.8	102.8	0.0	102.8	14.497	-0.855	12.787	120.1	12.6	0.0	13.223
28	90.5	90.5	0.0	90.5	14.497	-0.855	12.787	99.1	12.6	0.0	13.223

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 739 (REMOULDED SAMPLE)
TEST RESULTS START 250185 END 70285

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.035	0.188	2.410	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.424	0.309	3.041	9.4	0.4	0.278	0.278
3	66.3	35.1	31.2	45.5	2.812	0.488	3.788	20.2	0.9	0.358	0.636
4	76.2	40.4	35.8	52.3	3.719	0.467	4.654	32.7	1.7	0.631	1.267
5	87.7	46.5	41.2	60.2	4.863	0.451	5.764	47.1	2.9	0.923	2.190
6	100.7	53.4	47.3	69.2	6.427	0.346	7.118	63.3	4.4	1.368	3.558
7	115.6	61.4	54.3	79.5	8.409	0.122	8.653	82.1	6.4	1.887	5.445
8	132.6	70.5	62.1	91.2	10.670	-0.206	10.259	103.4	8.7	2.375	7.820
9	157.9	84.8	73.1	109.2	15.626	-1.601	12.424	135.7	13.8	5.032	12.852
10	158.3	84.8	73.5	109.3	16.429	-1.350	13.729	136.0	14.6	1.695	14.547
11	158.1	84.8	73.3	109.2	16.638	-1.478	13.682	135.9	14.8	0.113	14.661
12	147.7	86.6	61.1	107.0	16.638	-1.478	13.682	129.4	14.8	0.0	14.661
13	141.7	92.8	48.9	109.1	16.634	-1.476	13.682	131.1	14.8	-0.002	14.658
14	136.5	99.8	36.7	112.0	16.576	-1.447	13.682	135.0	14.7	-0.025	14.633
15	131.4	106.9	24.5	115.1	16.486	-1.402	13.682	139.8	14.6	-0.027	14.606
16	127.1	114.8	12.3	118.9	16.308	-1.313	13.682	146.7	14.4	-0.033	14.573
17	121.0	121.0	0.0	121.0	16.068	-1.193	13.882	151.3	14.2	-0.015	14.558
18	115.5	115.5	0.0	115.5	15.980	-1.149	13.682	141.9	14.1	0.000	14.558
19	114.3	114.3	0.0	114.3	15.935	-1.127	13.682	139.8	14.0	0.000	14.558
20	112.8	112.8	0.0	112.8	15.891	-1.105	13.682	137.2	14.0	0.000	14.558
21	111.4	111.4	0.0	111.4	15.860	-1.089	13.682	134.8	13.9	0.0	14.558
22	110.5	110.5	0.0	110.5	15.829	-1.074	13.682	133.3	13.9	0.000	14.558
23	109.2	109.2	0.0	109.2	15.802	-1.060	13.682	131.1	13.9	0.000	14.558
24	108.2	108.2	0.0	108.2	15.776	-1.047	13.682	129.3	13.9	0.000	14.558
25	107.6	107.6	0.0	107.6	15.732	-1.025	13.682	128.3	13.8	0.000	14.558
26	104.7	104.7	0.0	104.7	15.732	-1.025	13.682	123.3	13.8	0.0	14.558
27	102.8	102.8	0.0	102.8	15.661	-0.990	13.682	120.1	13.7	-0.000	14.558
28	90.5	90.5	0.0	90.5	15.661	-0.990	13.682	99.1	13.7	0.0	14.558

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 739 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 10.780 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 522.247 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 48.440 SQUARE CENTIMETRES

CONSTANT LOAD : 16.56 N .
PROVING RING FACTOR : 1.0225 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2011.50 DIVISIONS

SHEAR TEST RESULTS START 190285 END 200285

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	858	2011.5	482.2	200.7	0.0	159.5	84.1	37.7	75.4	109.2	1.897	0.0
2	900	2011.0	488.5	202.4	0.00	159.2	82.5	38.4	76.7	108.1	1.930	1.29
3	905	2010.0	504.0	205.0	0.01	159.9	79.9	40.0	80.0	106.6	2.001	0.94
4	910	2009.2	518.0	206.4	0.02	161.3	78.4	41.5	82.9	106.0	2.058	0.76
5	915	2009.0	530.0	208.3	0.02	162.1	76.6	42.7	85.5	105.1	2.116	0.76
6	920	2004.0	537.0	208.9	0.07	162.9	76.0	43.4	86.9	105.0	2.143	0.71
7	926	2001.0	545.0	210.1	0.10	163.4	74.8	44.3	88.6	104.3	2.184	0.71
8	930	1999.0	550.5	210.6	0.12	164.0	74.3	44.9	89.7	104.2	2.207	0.69
9	940	1992.0	560.0	211.6	0.18	164.9	73.2	45.8	91.7	103.8	2.252	0.67
10	850	1984.2	566.5	212.5	0.25	165.3	72.3	46.5	93.0	103.3	2.286	0.67
11	1000	1976.0	571.0	213.3	0.33	165.2	71.3	46.9	93.9	102.6	2.316	0.68
12	1010	1967.0	574.0	213.9	0.41	165.2	70.8	47.2	94.4	102.3	2.333	0.69
13	1020	1957.5	576.0	214.6	0.50	164.9	70.2	47.4	94.7	101.8	2.349	0.72
14	1031	1947.5	577.5	215.1	0.59	164.5	69.5	47.5	95.0	101.2	2.366	0.74
15	1047	1933.5	579.0	215.9	0.72	164.0	68.9	47.6	95.1	100.6	2.381	0.77
16	1100	1922.8	580.0	216.4	0.82	163.6	68.3	47.6	95.3	100.1	2.395	0.79
17	1115	1908.0	580.0	217.1	0.96	162.9	67.8	47.6	95.1	99.5	2.403	0.83
18	1130	1894.0	580.5	217.6	1.09	162.4	67.3	47.5	95.1	99.0	2.413	0.86
19	1145	1880.0	580.8	218.2	1.22	161.8	66.8	47.5	95.0	98.5	2.422	0.89
20	1200	1865.5	581.0	218.6 -	1.35	161.2	66.3	47.5	94.9	97.9	2.432	0.92
21	1234	1834.0	580.8	219.6	1.85	159.9	65.3	47.3	94.6	96.8	2.449	0.98
22	1300	1810.0	580.8	220.3	1.87	159.0	64.6	47.2	94.4	96.1	2.461	1.03
23	1326	1784.5	580.2	221.1	2.11	157.9	63.9	47.0	94.0	95.2	2.472	1.09
24	1430	1724.0	579.0	222.5	2.67	155.8	62.6	46.6	93.2	93.7	2.490	1.22
25	1530	1667.5	577.6	223.6	3.19	153.9	61.4	46.2	92.5	92.2	2.506	1.34
26	1637	1604.0	576.2	224.6	3.78	151.8	60.2	45.8	91.6	90.7	2.522	1.47
27	1700	1583.0	575.8	225.1	3.97	151.0	59.6	45.7	91.4	90.1	2.533	1.53
28	1801	1523.5	575.0	225.8	4.53	149.7	59.0	45.3	90.7	89.2	2.537	1.64
29	1900	1468.0	573.5	226.5	5.04	148.5	58.6	44.9	89.9	88.6	2.534	1.78
30	2010	1401.0	572.5	227.0	5.66	147.1	58.0	44.5	89.1	87.7	2.536	1.92
31	2100	1352.0	572.0	227.2	6.12	146.2	57.6	44.3	88.6	87.1	2.538	2.01
32	2215	1283.5	570.5	227.7	6.75	144.6	56.9	43.9	87.7	86.1	2.541	2.19
33	2311	1229.0	570.0	227.8	7.26	144.1	57.0	43.6	87.1	86.0	2.528	2.31
34	2332	1209.0	569.5	227.8	7.44	143.8	57.0	43.4	86.8	85.9	2.524	2.37
35	741	747.0	562.5	229.0	11.73	137.6	58.1	40.7	81.5	83.3	2.453	4.65
36	820	710.0	562.2	229.0	12.07	137.0	55.9	40.6	81.1	82.9	2.451	4.93

SAMPLE NO. : T 739 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 159.50 KPA
PRECONSOLIDATION PRESSURE : 158.30 KPA
NORMALIZING STRESS : 159.50 KPA

NORMALIZED SHEAR TEST RESULTS START 190285 END 200285

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.236	1.897	0.685	0.0
2	0.00	0.240	1.930	0.678	0.011
3	0.01	0.251	2.001	0.668	0.027
4	0.02	0.260	2.058	0.665	0.036
5	0.02	0.268	2.116	0.659	0.048
6	0.07	0.272	2.143	0.658	0.051
7	0.10	0.278	2.184	0.654	0.059
8	0.12	0.281	2.207	0.653	0.062
9	0.18	0.287	2.252	0.650	0.068
10	0.25	0.291	2.286	0.648	0.074
11	0.33	0.294	2.316	0.643	0.079
12	0.41	0.296	2.333	0.641	0.083
13	0.50	0.297	2.349	0.638	0.087
14	0.59	0.298	2.366	0.634	0.090
15	0.72	0.298	2.381	0.631	0.095
16	0.82	0.299	2.395	0.627	0.098
17	0.96	0.298	2.403	0.624	0.103
18	1.09	0.298	2.413	0.621	0.106
19	1.22	0.298	2.422	0.617	0.110
20	1.35	0.298	2.432	0.614	0.112
21	1.65	0.297	2.449	0.607	0.118
22	1.87	0.296	2.461	0.602	0.123
23	2.11	0.295	2.472	0.597	0.128
24	2.67	0.292	2.490	0.587	0.137
25	3.19	0.290	2.506	0.578	0.144
26	3.78	0.287	2.522	0.569	0.150
27	3.97	0.286	2.533	0.565	0.153
28	4.53	0.284	2.537	0.559	0.157
29	5.04	0.282	2.534	0.555	0.162
30	5.66	0.279	2.536	0.550	0.165
31	6.12	0.278	2.538	0.546	0.166
32	6.75	0.275	2.541	0.540	0.169
33	7.26	0.273	2.528	0.539	0.170
34	7.44	0.272	2.524	0.539	0.170
35	11.73	0.255	2.453	0.522	0.177
36	12.07	0.254	2.451	0.520	0.177

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 740 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 49.5 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.351
INITIAL HEIGHT OF SAMPLE : 13.20 CM
INITIAL VOLUME OF SAMPLE : 601.18 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.53
FINAL MOISTURE CONTENT : 39.0 PERCENT

TX. CONSOLIDATION START 150885 END 280885
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.01	26.50	2.015	1.996	-0.010	34.34	23.51	1.304	2.304	1.350
2	57.80	30.50	2.371	2.553	0.091	39.53	27.10	1.291	2.291	1.520
3	66.33	35.10	2.841	3.185	0.172	45.51	31.23	1.276	2.276	1.779
4	76.33	40.40	3.538	4.092	0.277	52.38	35.93	1.255	2.255	2.174
5	87.76	46.50	4.489	5.190	0.351	60.25	41.26	1.229	2.229	2.759
6	100.73	53.50	5.780	6.570	0.395	68.24	47.23	1.197	2.197	3.590
7	115.93	61.40	7.155	7.968	0.406	79.58	54.53	1.164	2.164	4.499
8	133.33	70.70	8.667	9.448	0.391	91.58	62.63	1.129	2.129	5.517
9	159.87	84.80	10.947	11.386	0.219	109.82	75.07	1.083	2.083	7.152
10	160.03	84.80	11.557	12.184	0.314	109.88	75.23	1.065	2.065	7.495

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.01	26.50	2.015	-0.010	2.304
2	57.80	30.50	2.371	0.091	2.291
3	66.33	35.10	2.841	0.172	2.276
4	76.33	40.40	3.538	0.277	2.255
5	87.76	46.50	4.489	0.351	2.229
6	100.73	53.50	5.780	0.395	2.197
7	115.93	61.40	7.155	0.406	2.164
8	133.33	70.70	8.667	0.391	2.129
9	159.87	84.80	10.947	0.219	2.083
10	160.03	84.80	11.557	0.314	2.065

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 740 (REMOULDED SAMPLE)
TEST RESULTS START 150885 END 280885

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	2.015	-0.010	1.996	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.371	0.091	2.553	9.5	0.4	0.249	0.249
3	66.3	35.1	31.2	45.5	2.841	0.172	3.185	20.4	0.9	0.344	0.593
4	76.3	40.4	35.9	52.4	3.538	0.277	4.092	32.9	1.6	0.576	1.169
5	87.8	46.5	41.3	60.3	4.489	0.351	5.190	47.2	2.5	0.844	2.013
6	100.7	53.5	47.2	69.2	5.780	0.395	6.570	63.5	3.8	1.262	3.275
7	115.9	61.4	54.5	79.6	7.155	0.406	7.968	82.3	5.2	1.502	4.778
8	133.3	70.7	62.6	91.6	8.667	0.391	9.448	104.2	6.7	1.863	6.641
9	159.9	84.8	75.1	109.8	10.947	0.219	11.386	137.4	8.9	3.077	9.717
10	160.0	84.8	75.2	109.9	11.557	0.314	12.184	137.5	9.6	1.135	10.853

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 740 (REMOULDED SAMPLE)
TEST RESULTS START 150885 END 280885

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	2.036	-0.010	2.016	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.400	0.093	2.586	9.5	0.4	0.255	0.255
3	66.3	35.1	31.2	45.5	2.882	0.178	3.237	20.4	0.9	0.354	0.609
4	76.3	40.4	35.9	52.4	3.602	0.288	4.178	32.9	1.6	0.597	1.206
5	87.8	46.5	41.3	60.3	4.592	0.368	5.329	47.2	2.6	0.883	2.088
6	100.7	53.5	47.2	69.2	5.954	0.421	6.796	63.5	4.0	1.336	3.424
7	115.9	61.4	54.5	79.6	7.424	0.439	8.303	82.3	5.4	1.614	5.038
8	133.3	70.7	62.6	91.6	9.085	0.430	9.924	104.2	7.1	2.032	7.070
9	159.9	84.8	75.1	109.8	11.594	0.247	12.088	137.4	9.6	3.423	10.493
10	160.0	84.8	75.2	109.9	12.281	0.358	12.993	137.5	10.3	1.284	11.777

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 740 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.527 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 528.330 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 45.300 SQUARE CENTIMETRES

CONSTANT LOAD : 16.53 N .
PROVING RING FACTOR : 1.2365 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2107.00 DIVISIONS

SHEAR TEST RESULTS START 280885 END 290885

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	913	2107.0	502.0	500.7	0.0	159.5	84.3	37.6	75.2	109.4	1.892	0.0
2	920	2106.0	526.0	501.8	0.01	164.6	82.8	40.9	81.8	110.1	1.988	0.17
3	925	2106.8	541.5	502.7	0.00	168.3	82.3	43.0	86.0	111.0	2.045	0.19
4	930	2105.2	557.5	505.2	0.02	170.5	80.2	45.1	90.3	110.3	2.126	0.30
5	935	2103.8	569.5	506.2	0.03	172.6	79.0	46.8	93.6	110.2	2.185	0.30
6	940	2102.0	579.0	507.4	0.04	174.0	77.8	48.1	96.2	109.9	2.236	0.32
7	945	2099.8	588.5	508.4	0.06	175.5	76.8	49.4	98.7	109.7	2.285	0.33
8	950	2097.0	597.5	509.2	0.09	177.1	75.9	50.6	101.2	109.6	2.333	0.33
9	955	2094.0	604.5	509.8	0.11	178.3	75.2	51.5	103.1	109.6	2.370	0.33
10	1000	2091.5	611.0	510.7	0.13	179.2	74.4	52.4	104.8	109.3	2.409	0.34
11	1010	2084.0	619.0	511.7	0.20	180.2	73.3	53.5	106.9	108.9	2.459	0.35
12	1020	2076.0	624.0	512.0	0.27	181.2	73.0	54.1	108.2	109.1	2.482	0.34
13	1030	2068.0	629.0	512.5	0.34	182.3	72.8	54.7	109.5	109.3	2.504	0.34
14	1040	2059.0	632.0	512.9	0.42	182.5	72.3	55.1	110.2	109.0	2.524	0.35
15	1050	2050.0	633.0	513.2	0.49	182.2	71.8	55.2	110.4	108.6	2.538	0.36
16	1100	2040.0	634.0	513.7	0.58	182.2	71.7	55.3	110.5	108.5	2.542	0.37
17	1112	2029.0	634.5	513.8	0.68	182.1	71.5	55.3	110.6	108.4	2.547	0.37
18	1120	2021.0	634.8	514.0	0.75	182.0	71.4	55.3	110.6	108.3	2.549	0.38
19	1130	2011.0	635.4	515.0	0.83	180.9	70.3	55.3	110.6	107.2	2.574	0.40
20	1140	2002.0	635.2	515.2	0.91	180.6	70.1	55.3	110.5	106.9	2.576	0.41
21	1150	1993.5	635.2	515.3	0.98	180.4	70.0	55.2	110.4	106.8	2.578	0.41
22	1200	1983.5	635.2	513.8	1.07	182.1	71.8	55.1	110.3	108.6	2.536	0.37
23	1230	1955.0	635.2	517.1	1.32	178.3	68.3	55.0	110.0	105.0	2.611	0.47
24	1300	1927.0	635.0	518.2	1.56	176.6	66.8	54.9	109.8	103.4	2.643	0.51
25	1330	1899.0	634.8	519.4	1.80	175.2	65.8	54.7	109.4	102.3	2.663	0.55
26	1400	1873.0	634.2	519.8	2.03	174.6	65.6	54.6	109.0	101.9	2.661	0.57
27	1430	1844.0	633.5	520.9	2.28	173.0	64.5	54.3	108.5	100.7	2.682	0.61
28	1500	1815.0	632.5	521.9	2.53	171.4	63.4	54.0	108.0	99.4	2.703	0.65
29	1540	1777.0	631.5	523.0	2.88	169.7	62.4	53.7	107.3	98.2	2.720	0.69
30	1600	1757.0	631.0	523.5	3.04	169.0	62.0	53.5	107.0	97.7	2.726	0.72
31	1630	1731.0	631.0	524.0	3.26	168.3	61.6	53.4	106.7	97.2	2.733	0.74
32	1700	1703.0	630.5	524.9	3.50	167.0	60.6	53.2	106.4	96.1	2.755	0.78
33	1800	1646.0	629.4	525.6	4.00	165.8	60.3	52.7	105.5	95.5	2.749	0.82
34	1900	1589.0	628.5	526.2	4.49	164.1	59.4	52.4	104.7	94.3	2.763	0.86
35	2000	1530.0	627.0	527.1	5.01	162.1	58.3	51.9	103.8	92.9	2.781	0.92
36	2102	1473.5	626.5	528.3	5.50	160.3	57.2	51.6	103.1	91.6	2.803	0.99
37	2200	1418.5	626.0	528.3	5.97	159.8	57.3	51.2	102.5	91.5	2.788	1.01
38	2300	1361.0	625.0	529.3	6.47	157.8	56.1	50.8	101.7	90.0	2.813	1.08
39	2400	1307.0	625.0	529.6	6.94	157.0	55.8	50.6	101.2	89.5	2.813	1.11
40	700	910.5	624.5	533.1	10.38	150.4	53.2	48.6	97.2	85.6	2.828	1.47
41	803	852.0	623.5	532.6	10.89	149.6	53.1	48.2	96.5	85.3	2.817	1.50
42	900	796.0	622.5	532.6	11.37	148.6	52.9	47.9	95.7	84.8	2.810	1.55
43	1010	732.0	622.5	532.7	11.83	148.0	52.9	47.6	95.1	84.6	2.798	1.60
44	1100	683.0	622.0	533.1	12.35	147.2	52.7	47.3	94.5	84.2	2.794	1.68

SAMPLE NO. = T 740 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 160.03 KPA
PRECONSOLIDATION PRESSURE = 160.03 KPA
NORMALIZING STRESS = 160.03 KPA

NORMALIZED SHEAR TEST RESULTS START 280885 END 290885

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.235	1.892	0.683	0.0
2	0.01	0.256	1.988	0.688	0.007
3	0.00	0.269	2.045	0.693	0.012
4	0.02	0.282	2.126	0.689	0.028
5	0.03	0.292	2.185	0.689	0.034
6	0.04	0.300	2.236	0.686	0.042
7	0.06	0.308	2.285	0.686	0.048
8	0.09	0.316	2.333	0.685	0.053
9	0.11	0.322	2.370	0.685	0.057
10	0.13	0.327	2.409	0.683	0.062
11	0.20	0.334	2.459	0.681	0.069
12	0.27	0.338	2.482	0.682	0.071
13	0.34	0.342	2.504	0.683	0.074
14	0.42	0.344	2.524	0.681	0.076
15	0.49	0.345	2.538	0.679	0.078
16	0.58	0.345	2.542	0.678	0.081
17	0.68	0.345	2.547	0.677	0.082
18	0.75	0.345	2.549	0.676	0.083
19	0.83	0.346	2.574	0.670	0.089
20	0.91	0.345	2.576	0.668	0.091
21	0.98	0.345	2.578	0.667	0.091
22	1.07	0.345	2.536	0.678	0.082
23	1.32	0.344	2.611	0.656	0.102
24	1.56	0.343	2.643	0.648	0.109
25	1.80	0.342	2.663	0.639	0.117
26	2.03	0.341	2.661	0.637	0.119
27	2.28	0.339	2.682	0.629	0.126
28	2.53	0.337	2.703	0.621	0.132
29	2.86	0.335	2.720	0.614	0.139
30	3.04	0.334	2.726	0.610	0.142
31	3.26	0.334	2.733	0.607	0.146
32	3.50	0.332	2.755	0.800	0.151
33	4.00	0.330	2.749	0.597	0.156
34	4.49	0.327	2.763	0.589	0.159
35	5.01	0.324	2.781	0.581	0.165
36	5.50	0.322	2.803	0.572	0.172
37	5.97	0.320	2.788	0.571	0.172
38	6.47	0.318	2.813	0.562	0.179
39	6.94	0.316	2.813	0.559	0.181
40	10.38	0.304	2.828	0.535	0.202
41	10.89	0.301	2.817	0.533	0.199
42	11.37	0.299	2.810	0.530	0.199
43	11.93	0.297	2.798	0.529	0.200
44	12.35	0.295	2.794	0.526	0.202

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 741 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 49.5 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.352
INITIAL HEIGHT OF SAMPLE : 13.22 CM
INITIAL VOLUME OF SAMPLE : 601.86 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.53
FINAL MOISTURE CONTENT : 38.5 PERCENT

TX. CONSOLIDATION START 160885 END 300885
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.05	26.50	2.398	2.135	-0.132	34.35	23.55	1.302	2.302	1.687
2	57.63	30.50	2.807	2.750	-0.029	39.54	27.13	1.288	2.288	1.891
3	66.42	35.10	3.197	3.431	0.117	45.54	31.32	1.272	2.272	2.053
4	76.38	40.50	4.207	4.386	0.090	52.46	35.88	1.249	2.249	2.745
5	87.92	46.60	5.433	5.632	0.100	60.37	41.32	1.220	2.220	3.556
6	100.99	53.60	6.894	7.003	0.055	69.40	47.39	1.188	2.188	4.559
7	116.05	61.60	8.490	8.480	-0.000	79.75	54.45	1.153	2.153	5.660
8	133.35	70.70	10.163	9.936	-0.113	91.58	62.65	1.119	2.119	6.851
9	159.41	84.80	12.872	11.830	-0.521	109.67	74.61	1.074	2.074	8.928
10	159.62	84.80	13.583	12.785	-0.399	109.74	74.82	1.052	2.052	9.321

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.05	26.50	2.399	-0.132	2.302
2	57.63	30.50	2.807	-0.029	2.288
3	66.42	35.10	3.197	0.117	2.272
4	76.38	40.50	4.207	0.090	2.249
5	87.82	46.60	5.433	0.100	2.220
6	100.99	53.80	6.894	0.055	2.188
7	116.05	61.80	8.490	-0.000	2.153
8	133.35	70.70	10.163	-0.113	2.119
9	159.41	84.80	12.872	-0.521	2.074
10	159.62	84.80	13.583	-0.399	2.052

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 741 (REMOULDED SAMPLE)
TEST RESULTS START 160885 END 300885

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.3	2.399	-0.132	2.135	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.807	-0.029	2.760	9.5	0.4	0.279	0.279
3	66.4	35.1	31.3	45.5	3.197	0.117	3.431	20.4	0.9	0.337	0.616
4	76.4	40.5	35.9	52.5	4.207	0.090	4.386	32.9	1.8	0.701	1.317
5	87.9	46.6	41.3	60.4	5.433	0.100	5.632	47.4	3.1	1.016	2.333
6	101.0	53.6	47.4	69.4	6.894	0.055	7.003	63.7	4.5	1.335	3.667
7	116.1	61.6	54.4	79.8	8.490	-0.000	8.490	82.6	6.1	1.670	5.337
8	133.4	70.7	62.7	91.6	10.163	-0.113	9.936	104.1	7.8	1.935	7.272
9	159.4	84.8	74.6	109.7	12.872	-0.521	11.830	137.0	10.5	3.332	10.604
10	159.6	84.8	74.8	109.7	13.583	-0.399	12.785	137.1	11.2	1.342	11.945

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 741 (REMOULDED SAMPLE)
TEST RESULTS START 160885 END 300885

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.3	2.428	-0.135	2.158	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.847	-0.030	2.788	9.5	0.4	0.286	0.286
3	66.4	35.1	31.3	45.5	3.249	0.121	3.491	20.4	0.9	0.348	0.634
4	76.4	40.5	35.9	52.5	4.298	0.094	4.485	32.9	1.9	0.728	1.362
5	87.9	46.6	41.3	60.4	5.586	0.105	5.797	47.4	3.2	1.068	2.431
6	101.0	53.6	47.4	69.4	7.143	0.059	7.260	63.7	4.7	1.423	3.854
7	116.1	61.6	54.4	79.8	8.872	-0.000	8.872	82.6	6.4	1.809	5.663
8	133.4	70.7	62.7	91.6	10.717	-0.126	10.465	104.1	8.3	2.133	7.796
9	159.4	84.8	74.6	109.7	13.778	-0.594	12.590	137.0	11.4	3.754	11.550
10	159.6	84.8	74.8	109.7	14.598	-0.459	13.679	137.1	12.2	1.536	13.086

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 741 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.338 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 523.364 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 46.160 SQUARE CENTIMETRES

CONSTANT LOAD : 15.04 N .
PROVING RING FACTOR : 1.3970 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 1752.00 DIVISIONS

SHEAR TEST RESULTS START 300885 END 310885

CONSOLIDATED UNDRAINED TRIAXIAL TEST
:::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	800	1752.0	452.0	500.2	0.0	160.7	84.9	37.9	75.8	110.2	1.893	0.0
2	805	1751.5	490.0	502.2	0.00	170.0	82.7	43.7	87.3	111.8	2.056	0.17
3	810	1749.0	516.0	503.8	0.03	176.2	81.0	47.6	95.2	112.7	2.175	0.19
4	815	1746.0	530.5	505.2	0.05	179.2	79.7	49.8	99.5	112.9	2.249	0.21
5	820	1743.0	540.0	508.2	0.08	178.9	76.5	51.2	102.4	110.6	2.338	0.30
6	825	1740.1	546.0	508.9	0.10	180.1	75.9	52.1	104.2	110.6	2.372	0.31
7	830	1736.0	554.0	509.7	0.14	182.1	75.6	53.2	106.5	111.1	2.409	0.31
8	835	1732.0	560.0	510.4	0.18	183.1	74.8	54.1	108.3	110.9	2.447	0.31
9	840	1728.5	563.0	510.9	0.20	183.4	74.2	54.6	109.2	110.6	2.471	0.32
10	845	1725.5	567.0	511.4	0.23	183.8	73.4	55.2	110.4	110.2	2.504	0.32
11	850	1721.5	569.5	511.6	0.27	184.1	73.0	55.6	111.1	110.0	2.522	0.32
12	855	1717.5	571.0	512.0	0.30	184.2	72.7	55.8	111.5	109.9	2.534	0.33
13	900	1713.0	572.0	512.4	0.34	184.0	72.2	55.9	111.8	109.5	2.548	0.34
14	922	1697.0	574.0	513.2	0.49	183.6	71.4	56.1	112.2	108.8	2.572	0.36
15	940	1684.0	575.0	514.0	0.60	183.9	71.6	56.1	112.3	109.0	2.588	0.38
16	1004	1666.5	576.0	515.0	0.75	182.2	69.7	56.3	112.5	107.2	2.614	0.40
17	1030	1647.0	576.0	515.9	0.93	181.4	69.1	56.1	112.3	106.5	2.625	0.43
18	1100	1622.0	576.0	517.1	1.15	180.2	68.2	56.0	112.0	105.5	2.642	0.47
19	1155	1581.0	575.5	518.0	1.51	178.2	66.7	55.8	111.5	103.9	2.672	0.50
20	1300	1531.0	574.5	520.4	1.95	176.2	65.6	55.3	110.6	102.5	2.685	0.58
21	1403	1483.0	573.0	520.8	2.37	174.0	64.2	54.9	109.8	100.8	2.710	0.61
22	1500	1442.0	572.0	522.8	2.73	172.1	63.2	54.5	108.9	99.5	2.724	0.68
23	1611	1385.5	571.0	524.0	3.23	170.0	61.9	54.1	108.1	97.9	2.746	0.74
24	1725	1330.0	570.5	525.1	3.72	168.2	60.8	53.7	107.4	95.6	2.767	0.79
25	1900	1257.0	570.0	525.9	4.37	166.1	59.5	53.3	106.6	95.0	2.792	0.83
26	2103	1163.0	569.0	526.6	5.19	163.7	58.3	52.7	105.4	93.4	2.809	0.89
27	2256	1077.0	568.0	527.4	5.95	161.9	57.6	52.2	104.3	92.4	2.811	0.95
28	806	859.0	567.0	530.4	9.64	154.1	54.1	50.0	100.0	87.4	2.848	1.25
29	938	590.0	567.0	530.2	10.25	154.2	55.0	49.6	99.2	88.1	2.804	1.28
30	1250	445.0	566.5	531.4	11.53	151.8	54.1	48.8	97.7	86.7	2.805	1.43
31	1400	391.0	566.0	531.4	12.00	150.8	53.8	48.5	97.0	86.1	2.804	1.47
32	1425	372.0	566.0	530.7	12.17	150.8	53.9	48.5	96.9	86.2	2.798	1.44

SAMPLE NO. : T 741 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 159.62 KPA
PRECONSOLIDATION PRESSURE : 159.62 KPA
NORMALIZING STRESS : 159.62 KPA

NORMALIZED SHEAR TEST RESULTS START 300885 END 310885

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.237	1.893	0.690	0.0
2	0.00	0.273	2.056	0.700	0.013
3	0.03	0.298	2.175	0.706	0.023
4	0.05	0.312	2.249	0.707	0.031
5	0.08	0.321	2.338	0.693	0.050
6	0.10	0.326	2.372	0.693	0.055
7	0.14	0.334	2.409	0.696	0.060
8	0.18	0.339	2.447	0.695	0.064
9	0.20	0.342	2.471	0.693	0.067
10	0.23	0.346	2.504	0.690	0.070
11	0.27	0.348	2.522	0.689	0.071
12	0.30	0.349	2.534	0.688	0.074
13	0.34	0.350	2.548	0.686	0.076
14	0.49	0.352	2.572	0.682	0.081
15	0.60	0.352	2.588	0.683	0.086
16	0.75	0.352	2.614	0.672	0.093
17	0.93	0.352	2.625	0.667	0.098
18	1.15	0.351	2.642	0.661	0.106
19	1.51	0.349	2.672	0.651	0.112
20	1.95	0.346	2.685	0.642	0.127
21	2.37	0.344	2.710	0.631	0.129
22	2.73	0.341	2.724	0.623	0.142
23	3.23	0.339	2.746	0.614	0.149
24	3.72	0.336	2.767	0.605	0.156
25	4.37	0.334	2.792	0.595	0.161
26	5.19	0.330	2.809	0.585	0.165
27	5.95	0.327	2.811	0.579	0.170
28	9.64	0.313	2.848	0.548	0.189
29	10.25	0.311	2.804	0.552	0.188
30	11.53	0.306	2.805	0.543	0.195
31	12.00	0.304	2.804	0.540	0.195
32	12.17	0.304	2.798	0.540	0.191

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 742 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT = 49.9 PERCENT
SPECIFIC GRAVITY OF SOIL = 2.73
INITIAL VOID RATIO = 1.363
INITIAL HEIGHT OF SAMPLE = 13.23 CM
INITIAL VOLUME OF SAMPLE = 602.55 CC
EFFECTIVE PRINCIPAL STRESS RATIO = 0.53
FINAL MOISTURE CONTENT = 39.1 PERCENT

TX. CONSOLIDATION START 160885 END 290885
TRIAXIAL CONSOLIDATION TEST
:::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.03	26.50	1.890	2.050	0.080	34.34	23.53	1.315	2.315	1.206
2	57.71	30.50	2.305	2.647	0.171	39.57	27.21	1.301	2.301	1.423
3	66.45	35.20	2.768	3.303	0.268	45.62	31.25	1.285	2.285	1.686
4	76.45	40.50	3.477	4.174	0.349	52.48	35.95	1.265	2.265	2.086
5	87.98	46.60	4.603	5.452	0.424	60.39	41.38	1.235	2.235	2.786
6	101.26	53.60	5.918	6.813	0.447	69.49	47.66	1.202	2.202	3.847
7	116.40	61.70	7.377	8.240	0.431	79.93	54.70	1.169	2.169	4.630
8	133.70	70.90	8.972	9.651	0.339	91.83	62.80	1.135	2.135	5.755
9	159.63	84.80	11.489	11.559	0.035	109.74	74.83	1.090	2.090	7.636
10	159.85	84.80	12.207	12.538	0.166	109.82	75.05	1.067	2.067	8.028

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.03	26.50	1.890	0.080	2.315
2	57.71	30.50	2.305	0.171	2.301
3	66.45	35.20	2.768	0.268	2.285
4	76.45	40.50	3.477	0.349	2.265
5	87.98	46.60	4.603	0.424	2.235
6	101.26	53.60	5.918	0.447	2.202
7	116.40	61.70	7.377	0.431	2.169
8	133.70	70.90	8.972	0.339	2.135
9	159.63	84.80	11.489	0.035	2.090
10	159.85	84.80	12.207	0.166	2.067

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 742 (REMOULDED SAMPLE)
TEST RESULTS START 160885 END 290885

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.890	0.080	2.050	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.305	0.171	2.647	9.5	0.4	0.276	0.276
3	66.4	35.2	31.3	45.6	2.766	0.268	3.303	20.5	0.9	0.350	0.626
4	76.4	40.5	35.9	52.5	3.477	0.349	4.174	33.0	1.6	0.569	1.194
5	88.0	46.6	41.4	60.4	4.603	0.424	5.452	47.4	2.8	0.992	2.186
6	101.3	53.6	47.7	69.5	5.918	0.447	6.813	64.0	4.1	1.267	3.454
7	116.4	61.7	54.7	79.9	7.377	0.431	8.240	83.0	5.5	1.569	5.023
8	133.7	70.9	62.8	91.8	8.972	0.339	9.651	104.6	7.1	1.872	6.895
9	159.6	84.8	74.8	109.7	11.489	0.035	11.559	137.1	9.6	3.218	10.113
10	159.9	84.8	75.1	109.8	12.207	0.166	12.538	137.3	10.3	1.368	11.482

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 742 (REMOULDED SAMPLE)
TEST RESULTS START 160885 END 290885

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.908	0.082	2.071	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.332	0.175	2.683	9.5	0.4	0.282	0.282
3	66.4	35.2	31.3	45.6	2.805	0.276	3.358	20.5	0.9	0.360	0.642
4	76.4	40.5	35.9	52.5	3.539	0.362	4.263	33.0	1.7	0.589	1.231
5	88.0	46.6	41.4	60.4	4.712	0.447	5.606	47.4	2.9	1.038	2.270
6	101.3	53.6	47.7	69.5	6.101	0.478	7.058	64.0	4.2	1.344	3.614
7	116.4	61.7	54.7	79.9	7.663	0.488	8.599	83.0	5.8	1.690	5.304
8	133.7	70.9	62.8	91.8	9.400	0.374	10.148	104.6	7.5	2.048	7.351
9	159.6	84.8	74.8	109.7	12.204	0.040	12.283	137.1	10.3	3.592	10.943
10	159.9	84.8	75.1	109.8	13.019	0.189	13.397	137.3	11.1	1.555	12.497

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 742 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION = 11.572 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION = 526.797 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION = 45.523 SQUARE CENTIMETRES

CONSTANT LOAD = 16.55 N .
PROVING RING FACTOR = 1.0225 N ./DIV
PISTON AREA = 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING = 2100.00 DIVISIONS

SHEAR TEST RESULTS START 290885 END 300885

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIPMA3	A
1	809	2100.0	607.0	500.2	0.0	159.5	84.7	37.4	74.8	109.6	1.884	0.0
2	815	2099.5	624.0	502.0	0.00	161.5	82.8	39.3	78.7	109.0	1.950	0.47
3	820	2098.8	637.0	503.5	0.01	162.7	81.1	40.8	81.6	108.3	2.006	0.49
4	825	2097.8	648.5	505.2	0.02	163.8	79.7	42.1	84.1	107.7	2.056	0.54
5	830	2096.0	662.5	506.3	0.03	165.8	78.5	43.6	87.3	107.6	2.112	0.49
6	835	2094.0	673.0	507.6	0.05	166.7	77.0	44.8	89.7	106.9	2.164	0.50
7	841	2091.5	685.0	509.3	0.07	168.0	75.7	46.1	92.3	106.5	2.219	0.52
8	846	2089.5	697.5	509.6	0.09	170.3	75.2	47.5	95.1	106.9	2.265	0.46
9	851	2086.5	708.5	510.2	0.12	172.0	74.5	48.8	97.5	107.0	2.309	0.44
10	855	2083.0	719.0	511.0	0.15	173.7	73.8	49.9	99.9	107.1	2.353	0.43
11	900	2079.2	728.5	511.7	0.18	175.1	73.1	51.0	102.0	107.1	2.395	0.42
12	910	2072.5	739.5	512.1	0.24	177.0	72.6	52.2	104.4	107.4	2.438	0.40
13	920	2064.5	748.5	513.0	0.31	178.1	71.8	53.2	106.3	107.2	2.481	0.41
14	930	2055.0	755.8	513.6	0.39	179.1	71.2	53.9	107.9	107.2	2.515	0.41
15	940	2046.0	762.0	513.6	0.47	180.1	70.9	54.6	109.2	107.3	2.540	0.39
16	950	2035.5	763.4	514.6	0.56	179.8	70.5	54.7	109.3	106.9	2.551	0.42
17	1003	2025.0	763.5	514.9	0.65	179.2	69.9	54.6	109.3	106.3	2.564	0.43
18	1010	2019.0	763.5	515.6	0.70	178.7	69.5	54.6	109.2	105.9	2.571	0.45
19	1030	1990.0	763.8	516.2	0.95	177.8	68.6	54.5	109.0	104.9	2.589	0.47
20	1045	1985.0	763.5	516.8	0.99	176.8	67.9	54.5	108.9	104.2	2.604	0.49
21	1100	1970.5	763.0	518.1	1.12	175.9	67.3	54.3	108.6	103.5	2.614	0.53
22	1115	1957.5	762.8	518.2	1.23	175.3	66.8	54.2	108.5	103.0	2.624	0.54
23	1130	1943.0	762.0	518.4	1.36	174.4	66.2	54.1	108.2	102.3	2.634	0.55
24	1845	1929.5	762.0	519.7	1.47	173.6	65.6	54.0	108.0	101.6	2.646	0.59
25	1200	1915.0	761.0	519.8	1.60	172.7	65.0	53.8	107.7	100.9	2.657	0.60
26	1230	1886.0	761.0	520.5	1.85	171.5	64.0	53.7	107.5	99.8	2.679	0.62
27	1307	1851.0	761.0	521.8	2.15	169.8	62.7	53.6	107.1	98.4	2.708	0.67
28	1331	1827.0	760.5	522.0	2.36	169.9	63.2	53.4	106.7	98.8	2.688	0.68
29	1400	1798.5	759.5	522.0	2.61	168.9	62.6	53.1	106.3	98.0	2.698	0.69
30	1430	1771.0	759.0	523.8	2.84	166.7	60.8	53.0	105.9	96.1	2.742	0.76
31	1500	1742.0	758.5	524.3	3.09	166.4	60.9	52.7	105.5	96.1	2.732	0.79
32	1530	1714.0	758.5	524.0	3.34	165.7	60.4	52.6	105.3	95.5	2.743	0.78
33	1600	1686.5	758.0	524.5	3.57	165.2	60.3	52.4	104.9	95.3	2.739	0.81
34	1630	1656.5	757.5	523.6	3.83	165.9	61.4	52.2	104.5	96.2	2.701	0.79
35	1700	1628.5	756.0	526.7	4.07	162.4	58.5	51.9	103.9	93.1	2.775	0.91
36	1802	1570.0	756.0	525.6	4.58	163.0	59.7	51.7	103.3	94.1	2.730	0.89
37	1900	1513.5	755.0	527.7	5.07	159.7	57.1	51.3	102.6	91.3	2.797	0.99
38	2100	1401.0	752.5	530.0	6.04	155.7	54.6	50.5	101.1	88.3	2.851	1.14
39	2234	1311.0	751.5	531.8	6.82	153.3	53.4	50.0	99.9	86.7	2.872	1.26
40	2400	1229.5	750.0	532.0	7.52	151.4	52.4	49.5	99.0	85.4	2.889	1.32
41	800	776.0	742.5	535.5	11.44	142.9	49.7	46.6	93.2	80.8	2.875	1.92
42	905	715.0	741.5	535.8	11.97	142.0	49.6	46.2	92.4	80.4	2.863	2.02
43	930	690.0	741.0	535.3	12.18	141.5	49.3	46.1	92.2	80.0	2.870	2.02
44	1005	658.0	740.0	535.0	12.46	140.9	49.2	45.9	91.7	79.8	2.884	2.06

SAMPLE NO. : T 742 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 159.85 KPA
PRECONSOLIDATION PRESSURE : 159.85 KPA
NORMALIZING STRESS : 159.85 KPA

NORMALIZED SHEAR TEST RESULTS START 290885 END 300885

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.234	1.884	0.686	0.0
2	0.00	0.246	1.950	0.682	0.011
3	0.01	0.255	2.006	0.678	0.021
4	0.02	0.263	2.056	0.674	0.031
5	0.03	0.273	2.112	0.673	0.038
6	0.05	0.280	2.164	0.669	0.046
7	0.07	0.289	2.219	0.666	0.057
8	0.09	0.297	2.265	0.669	0.059
9	0.12	0.305	2.309	0.669	0.063
10	0.15	0.312	2.353	0.670	0.068
11	0.18	0.319	2.395	0.670	0.072
12	0.24	0.326	2.438	0.672	0.074
13	0.31	0.333	2.481	0.671	0.080
14	0.39	0.337	2.515	0.670	0.084
15	0.47	0.342	2.540	0.671	0.084
16	0.56	0.342	2.551	0.669	0.090
17	0.65	0.342	2.564	0.665	0.092
18	0.70	0.342	2.571	0.662	0.096
19	0.95	0.341	2.589	0.656	0.100
20	0.99	0.341	2.604	0.652	0.104
21	1.12	0.340	2.614	0.647	0.112
22	1.23	0.339	2.624	0.644	0.113
23	1.36	0.338	2.634	0.640	0.114
24	1.47	0.338	2.646	0.636	0.122
25	1.60	0.337	2.657	0.631	0.123
26	1.85	0.336	2.679	0.624	0.127
27	2.15	0.335	2.708	0.616	0.135
28	2.36	0.334	2.688	0.618	0.136
29	2.61	0.332	2.698	0.613	0.136
30	2.84	0.331	2.742	0.601	0.148
31	3.09	0.330	2.732	0.601	0.151
32	3.34	0.329	2.743	0.597	0.149
33	3.57	0.328	2.739	0.596	0.152
34	3.83	0.327	2.701	0.602	0.146
35	4.07	0.325	2.775	0.583	0.166
36	4.58	0.323	2.730	0.589	0.159
37	5.07	0.321	2.797	0.571	0.172
38	6.04	0.316	2.851	0.552	0.186
39	6.82	0.313	2.872	0.542	0.198
40	7.52	0.310	2.889	0.534	0.199
41	11.44	0.292	2.875	0.505	0.221
42	11.97	0.289	2.863	0.503	0.223
43	12.18	0.288	2.870	0.501	0.220
44	12.46	0.287	2.864	0.499	0.218

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 751 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.0 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.365
INITIAL HEIGHT OF SAMPLE : 13.02 CM
INITIAL VOLUME OF SAMPLE : 592.58 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 41.3 PERCENT

TX. CONSOLIDATION START 130385 END 270385
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.10	26.50	1.920	2.287	0.183	34.37	23.60	1.311	2.311	1.158
2	57.61	30.50	2.177	2.759	0.291	39.54	27.11	1.300	2.300	1.258
3	66.37	35.10	2.550	3.333	0.391	45.52	31.27	1.286	2.286	1.439
4	76.47	40.50	3.107	4.067	0.480	52.49	35.97	1.269	2.269	1.751
5	87.99	46.60	3.978	5.088	0.555	60.40	41.39	1.245	2.245	2.283
6	101.19	53.60	5.280	6.370	0.545	69.46	47.59	1.214	2.214	3.157
7	116.28	61.70	6.816	7.788	0.486	79.89	54.58	1.181	2.181	4.220
8	133.63	70.90	8.656	9.332	0.338	91.81	62.73	1.144	2.144	5.545
9	159.31	84.80	11.536	11.323	-0.106	109.64	74.51	1.097	2.097	7.762
10	79.99	42.40	10.745	10.252	-0.247	54.93	37.59	1.123	2.123	7.328
11	79.94	42.40	10.702	10.091	-0.305	54.91	37.54	1.126	2.126	7.338
12	80.34	42.40	10.826	9.990	-0.418	55.05	37.94	1.129	2.129	7.496
13	74.28	42.90	10.826	9.990	-0.418	53.36	31.38	1.129	2.129	7.496
14	68.68	43.60	10.822	9.990	-0.416	51.96	25.08	1.129	2.129	7.492
15	64.92	46.10	10.803	9.990	-0.406	52.37	18.82	1.129	2.129	7.473
16	61.56	49.00	10.776	9.990	-0.393	53.19	12.56	1.129	2.129	7.446
17	58.29	52.00	10.737	9.990	-0.374	54.10	6.29	1.129	2.129	7.407
18	56.00	56.00	10.668	9.990	-0.339	56.00	0.0	1.129	2.129	7.338
19	55.40	55.40	10.630	9.990	-0.320	55.40	0.0	1.129	2.129	7.300
20	54.90	54.90	10.607	9.990	-0.308	54.90	0.0	1.129	2.129	7.277
21	54.70	54.70	10.580	9.990	-0.295	54.70	0.0	1.129	2.129	7.250
22	54.40	54.40	10.545	9.990	-0.278	54.40	0.0	1.129	2.129	7.215
23	54.00	54.00	10.522	9.990	-0.266	54.00	0.0	1.129	2.129	7.192
24	54.60	54.60	10.492	9.990	-0.251	54.60	0.0	1.129	2.129	7.161
25	54.50	54.50	10.453	9.990	-0.231	54.50	0.0	1.129	2.129	7.123
26	54.30	54.30	10.426	9.990	-0.218	54.30	0.0	1.129	2.128	7.096
27	54.10	54.10	10.399	9.990	-0.205	54.10	0.0	1.129	2.129	7.089
28	54.30	54.30	10.369	9.990	-0.189	54.30	0.0	1.129	2.129	7.039
29	53.10	53.10	10.353	9.990	-0.182	53.10	0.0	1.129	2.129	7.023

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.10	26.50	1.920	0.183	2.311
2	57.61	30.50	2.177	0.291	2.300
3	66.37	35.10	2.550	0.391	2.286
4	76.47	40.50	3.107	0.480	2.269
5	87.99	46.60	3.978	0.555	2.245
6	101.19	53.60	5.280	0.545	2.214
7	116.28	61.70	6.816	0.486	2.181
8	133.63	70.90	8.656	0.338	2.144
9	158.31	84.80	11.536	-0.106	2.097
10	79.99	42.40	10.745	-0.247	2.123
11	79.94	42.40	10.702	-0.305	2.126
12	80.34	42.40	10.828	-0.418	2.129
13	74.28	42.90	10.826	-0.418	2.129
14	68.68	43.60	10.822	-0.416	2.129
15	64.92	46.10	10.803	-0.406	2.129
16	61.56	49.00	10.776	-0.393	2.129
17	58.29	52.00	10.737	-0.374	2.129
18	56.00	56.00	10.668	-0.339	2.129
19	55.40	55.40	10.630	-0.320	2.129
20	54.90	54.90	10.607	-0.308	2.129
21	54.70	54.70	10.580	-0.295	2.129
22	54.40	54.40	10.545	-0.278	2.129
23	54.00	54.00	10.522	-0.266	2.129
24	54.60	54.60	10.492	-0.251	2.129
25	54.50	54.50	10.453	-0.231	2.129
26	54.30	54.30	10.426	-0.218	2.129
27	54.10	54.10	10.399	-0.205	2.129
28	54.30	54.30	10.369	-0.189	2.129
29	53.10	53.10	10.353	-0.182	2.129

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 751 (REMOULDED SAMPLE)
TEST RESULTS START 130385 END 270385

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	1.920	0.183	2.287	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.177	0.291	2.759	9.4	0.3	0.200	0.200
3	66.4	35.1	31.3	45.5	2.550	0.391	3.333	20.3	0.7	0.297	0.497
4	76.5	40.5	36.0	52.5	3.107	0.480	4.067	33.0	1.3	0.465	0.962
5	88.0	46.6	41.4	60.4	3.978	0.555	5.088	47.4	2.1	0.782	1.743
6	101.2	53.6	47.6	69.5	5.280	0.545	6.370	63.9	3.4	1.222	2.965
7	116.3	61.7	54.6	79.9	6.816	0.486	7.788	82.8	4.9	1.602	4.567
8	133.6	70.9	62.7	91.8	8.656	0.338	9.332	104.5	6.7	2.103	6.670
9	159.3	84.8	74.5	109.6	11.536	-0.106	11.323	136.8	9.6	3.527	10.196
10	80.0	42.4	37.6	54.9	10.745	-0.247	10.252	37.4	8.8	-1.125	9.071
11	79.9	42.4	37.5	54.9	10.702	-0.305	10.091	37.4	8.8	-0.084	8.987
12	80.3	42.4	37.9	55.0	10.826	-0.418	9.990	37.7	8.9	0.004	8.991
13	74.3	42.9	31.4	53.4	10.826	-0.418	9.990	33.5	8.9	0.0	8.991
14	68.7	43.6	25.1	52.0	10.822	-0.416	9.990	30.5	8.9	-0.001	8.990
15	64.9	46.1	18.8	52.4	10.803	-0.406	9.990	31.4	8.9	-0.004	8.986
16	61.6	49.0	12.6	53.2	10.776	-0.393	9.990	33.8	8.9	-0.004	8.981
17	58.3	52.0	6.3	54.1	10.737	-0.374	9.990	37.0	8.9	-0.004	8.978
18	56.0	56.0	0.0	56.0	10.668	-0.339	9.990	42.1	8.8	-0.002	8.976
19	55.4	55.4	0.0	55.4	10.630	-0.320	9.990	41.2	8.7	0.0	8.976
20	54.9	54.9	0.0	54.9	10.607	-0.308	9.990	40.4	8.7	0.0	8.976
21	54.7	54.7	0.0	54.7	10.580	-0.295	9.990	40.1	8.7	0.0	8.976
22	54.4	54.4	0.0	54.4	10.545	-0.278	9.990	39.7	8.6	0.0	8.976
23	54.0	54.0	0.0	54.0	10.522	-0.266	9.990	39.1	8.6	0.0	8.976
24	54.6	54.6	0.0	54.6	10.492	-0.251	9.990	40.0	8.6	0.0	8.976
25	54.5	54.5	0.0	54.5	10.453	-0.231	9.990	39.8	8.6	0.0	8.976
26	54.3	54.3	0.0	54.3	10.426	-0.218	9.990	39.5	8.5	0.0	8.976
27	54.1	54.1	0.0	54.1	10.399	-0.205	9.990	39.2	8.5	0.0	8.976
28	54.3	54.3	0.0	54.3	10.369	-0.189	9.990	39.5	8.5	0.0	8.976
29	53.1	53.1	0.0	53.1	10.353	-0.182	9.990	37.7	8.4	0.0	8.976

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 751 (REMOULDED SAMPLE)
TEST RESULTS START 130385 END 270385

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	1.939	0.187	2.313	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.201	0.298	2.798	9.4	0.3	0.205	0.205
3	66.4	35.1	31.3	45.5	2.583	0.403	3.390	20.3	0.7	0.305	0.510
4	76.5	40.5	36.0	52.5	3.156	0.498	4.152	33.0	1.3	0.481	0.991
5	88.0	46.6	41.4	60.4	4.060	0.581	5.222	47.4	2.2	0.816	1.807
6	101.2	53.6	47.6	69.5	5.425	0.579	6.582	63.9	3.5	1.289	3.095
7	116.3	61.7	54.6	79.9	7.060	0.524	8.108	82.8	5.1	1.715	4.810
8	133.6	70.9	62.7	91.8	9.053	0.371	9.796	104.5	7.1	2.289	7.099
9	159.3	84.8	74.5	109.6	12.257	-0.120	12.017	136.8	10.3	3.927	11.026
10	80.0	42.4	37.6	54.9	11.367	-0.275	10.816	37.4	9.5	-1.263	9.763
11	79.9	42.4	37.5	54.9	11.319	-0.341	10.637	37.4	9.4	-0.094	9.669
12	80.3	42.4	37.9	55.0	11.457	-0.466	10.525	37.7	9.6	0.005	9.674
13	74.3	42.9	31.4	53.4	11.457	-0.466	10.525	33.5	9.6	0.0	9.674
14	68.7	43.6	25.1	52.0	11.453	-0.464	10.525	30.5	9.6	-0.001	9.673
15	64.9	46.1	18.8	52.4	11.431	-0.453	10.525	31.4	9.5	-0.005	9.668
16	61.6	49.0	12.6	53.2	11.401	-0.438	10.525	33.8	9.5	-0.005	9.663
17	58.3	52.0	6.3	54.1	11.358	-0.417	10.525	37.0	9.5	-0.004	9.659
18	56.0	56.0	0.0	56.0	11.281	-0.378	10.525	42.1	9.4	-0.002	9.657
19	55.4	55.4	0.0	55.4	11.238	-0.356	10.525	41.2	9.3	-0.000	9.657
20	54.9	54.9	0.0	54.9	11.212	-0.344	10.525	40.4	9.3	-0.000	9.657
21	54.7	54.7	0.0	54.7	11.182	-0.329	10.525	40.1	9.3	-0.000	9.657
22	54.4	54.4	0.0	54.4	11.143	-0.309	10.525	39.7	9.2	-0.000	9.657
23	54.0	54.0	0.0	54.0	11.118	-0.296	10.525	39.1	9.2	-0.000	9.657
24	54.6	54.6	0.0	54.6	11.083	-0.279	10.525	40.0	9.2	0.0	9.657
25	54.5	54.5	0.0	54.5	11.040	-0.258	10.525	39.8	9.1	-0.000	9.657
26	54.3	54.3	0.0	54.3	11.010	-0.243	10.525	39.5	9.1	-0.000	9.657
27	54.1	54.1	0.0	54.1	10.980	-0.228	10.525	39.2	9.1	-0.000	9.657
28	54.3	54.3	0.0	54.3	10.946	-0.211	10.525	39.5	9.0	-0.000	9.657
29	53.1	53.1	0.0	53.1	10.929	-0.202	10.525	37.7	9.0	-0.000	9.657

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 751 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.738 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 536.030 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 45.666 SQUARE CENTIMETRES

CONSTANT LOAD : 16.52 N .
PROVING RING FACTOR : 1.2365 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2038.00 DIVISIONS

SHEAR TEST RESULTS START 300385 END 310385

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	907	2038.0	88.5	199.7	0.0	48.4	48.4	0.0	0.0	48.4	1.001	0.0
2	915	2037.2	110.0	199.7	0.01	54.2	48.3	2.9	5.9	50.3	1.121	0.0
3	925	2033.8	124.5	201.5	0.04	56.2	46.4	4.9	9.8	49.7	1.211	0.18
4	930	2032.0	132.0	202.6	0.05	57.2	45.4	5.9	11.8	49.3	1.260	0.25
5	935	2030.0	141.5	203.6	0.07	58.8	44.4	7.2	14.4	49.2	1.324	0.27
6	940	2028.5	149.0	204.4	0.08	60.0	43.6	8.2	16.4	49.1	1.376	0.29
7	945	2026.5	159.5	205.7	0.10	61.6	42.3	9.6	19.3	48.7	1.455	0.31
8	950	2025.0	166.5	206.7	0.11	62.6	41.5	10.6	21.1	48.5	1.509	0.33
9	955	2022.8	176.0	207.8	0.13	64.1	40.4	11.8	23.7	48.3	1.586	0.34
10	1000	2020.2	184.8	208.7	0.15	65.5	39.4	13.0	26.1	48.1	1.662	0.35
11	1011	2015.2	201.0	210.6	0.19	67.9	37.5	15.2	30.4	47.6	1.812	0.36
12	1021	2009.5	216.0	212.0	0.24	70.5	36.0	17.2	34.5	47.5	1.958	0.36
13	1030	2005.0	222.0	213.0	0.28	71.1	35.0	18.0	36.1	47.0	2.031	0.37
14	1041	2000.0	240.0	214.6	0.32	74.5	33.6	20.5	40.9	47.2	2.218	0.36
15	1050	1994.5	248.0	215.4	0.37	75.8	32.7	21.5	43.1	47.1	2.317	0.36
16	1102	1986.5	258.5	216.3	0.44	77.8	31.9	22.9	45.9	47.2	2.437	0.36
17	1110	1981.0	265.0	216.9	0.48	78.9	31.3	23.8	47.6	47.2	2.520	0.36
18	1121	1973.4	274.0	217.4	0.55	80.6	30.6	25.0	50.0	47.3	2.634	0.35
19	1130	1967.0	280.8	218.0	0.60	82.0	30.2	25.9	51.8	47.5	2.714	0.35
20	1141	1959.0	288.5	218.4	0.67	83.5	29.7	26.9	53.8	47.6	2.812	0.35
21	1150	1952.4	294.0	218.7	0.73	84.8	29.5	27.6	55.3	47.9	2.873	0.34
22	1200	1946.0	301.0	218.9	0.78	86.3	29.2	28.6	57.1	48.2	2.956	0.34
23	1210	1937.6	307.1	219.2	0.86	87.7	29.0	29.4	58.7	48.6	3.024	0.33
24	1220	1930.4	312.9	219.4	0.92	89.0	28.8	30.1	60.2	48.9	3.091	0.33
25	1230	1924.6	318.2	219.4	0.97	90.4	28.8	30.8	61.6	49.3	3.140	0.32
26	1240	1916.0	324.0	219.6	1.04	91.7	28.6	31.6	63.1	49.6	3.207	0.32
27	1250	1908.0	329.0	219.6	1.11	92.9	28.5	32.2	64.4	50.0	3.261	0.31
28	1302	1899.0	334.5	219.6	1.18	94.4	28.6	32.9	65.8	50.5	3.302	0.30
29	1316	1887.5	340.8	219.3	1.28	96.3	28.8	33.7	67.5	51.3	3.343	0.29
30	1330	1875.9	346.0	219.2	1.38	97.8	29.0	34.4	68.8	51.9	3.372	0.28
31	1345	1862.8	351.0	218.9	1.49	99.3	29.3	35.0	70.0	52.6	3.390	0.27
32	140c	1849.0	355.5	218.4	1.61	100.9	29.7	35.8	71.2	53.4	3.396	0.26
33	1415	1836.6	358.9	218.0	1.72	102.1	30.1	36.0	72.0	54.1	3.392	0.25
34	1432	1821.4	362.0	217.5	1.85	103.3	30.6	36.4	72.7	54.8	3.377	0.24
35	1446	1808.0	364.8	217.1	1.96	104.3	30.9	36.7	73.4	55.4	3.375	0.24
36	1500	1796.0	366.4	216.7	2.06	105.0	31.3	36.9	73.7	55.9	3.356	0.23
37	1530	1769.5	370.0	215.7	2.29	106.8	32.3	37.3	74.5	57.1	3.307	0.21
38	1600	1742.0	372.1	215.2	2.52	107.7	32.8	37.4	74.9	57.8	3.283	0.21
39	1630	1714.0	373.5	214.7	2.76	108.6	33.5	37.5	75.1	58.5	3.241	0.20
40	1700	1687.0	373.9	214.1	2.99	109.1	34.1	37.5	75.0	59.1	3.199	0.19
41	1733	1657.0	374.3	213.9	3.25	109.2	34.3	37.4	74.9	59.3	3.184	0.19
42	1800	1633.0	373.8	213.7	3.45	109.2	34.6	37.3	74.6	59.5	3.156	0.19
43	1830	1605.2	374.0	213.3	3.69	109.2	34.7	37.2	74.5	59.5	3.147	0.18
44	1900	1581.0	373.9	213.3	3.89	109.0	34.7	37.2	74.3	59.5	3.142	0.18
45	2000	1529.5	374.0	213.1	4.33	109.0	35.0	37.0	74.0	59.7	3.114	0.18
46	2105	1476.0	373.2	213.0	4.79	108.6	35.2	36.7	73.4	59.7	3.086	0.18
47	2200	1430.5	372.0	212.7	5.18	108.2	35.4	36.4	72.8	59.7	3.057	0.18
48	2300	1387.2	372.9	213.1	5.54	107.9	35.1	36.4	72.8	59.4	3.073	0.18
49	2400	1332.0	371.5	213.1	6.01	107.1	35.1	36.0	72.0	59.1	3.052	0.19
50	334	1158.0	364.5	213.1	7.50	104.1	34.9	34.6	69.2	58.0	2.982	0.19
51	800	1028.0	357.0	213.1	8.60	101.4	34.9	33.2	66.5	57.1	2.905	0.20
52	900	999.0	354.0	212.9	8.85	100.8	35.2	32.8	65.6	57.1	2.862	0.20
53	937	982.0	354.2	212.8	9.00	100.8	35.3	32.8	65.5	57.1	2.856	0.20
54	1000	958.0	354.2	212.8	9.20	100.8	35.5	32.7	65.3	57.3	2.840	0.20
55	1100	900.5	349.5	212.2	9.69	99.8	36.0	31.9	63.8	57.3	2.773	0.20
56	1200	841.0	340.5	211.8	10.20	97.8	36.5	30.6	61.3	56.9	2.679	0.20
57	1300	783.0	335.0	211.3	10.69	96.4	36.8	29.8	59.6	56.7	2.621	0.19
58	1400	725.5	331.5	211.3	11.18	95.2	36.7	29.2	58.5	56.2	2.593	0.20
59	1500	668.5	327.5	211.2	11.67	94.1	36.9	28.6	57.2	56.0	2.550	0.20
60	1600	610.0	326.0	211.3	12.17	93.3	36.8	28.3	56.5	55.6	2.536	0.21

SAMPLE NO. = T 751 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 48.40 KPA
PRECONSOLIDATION PRESSURE = 159.31 KPA
NORMALIZING STRESS = 159.31 KPA

NORMALIZED SHEAR TEST RESULTS START 300385 END 310385

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.000	1.001	0.304	0.0
2	0.01	0.018	1.121	0.315	0.0
3	0.04	0.031	1.211	0.312	0.011
4	0.05	0.037	1.260	0.310	0.018
5	0.07	0.045	1.324	0.309	0.024
6	0.08	0.052	1.376	0.308	0.030
7	0.10	0.060	1.455	0.306	0.038
8	0.11	0.066	1.509	0.305	0.044
9	0.13	0.074	1.586	0.303	0.051
10	0.15	0.082	1.662	0.302	0.056
11	0.19	0.096	1.812	0.299	0.068
12	0.24	0.108	1.958	0.298	0.077
13	0.28	0.113	2.031	0.295	0.083
14	0.32	0.128	2.218	0.297	0.094
15	0.37	0.135	2.317	0.295	0.099
16	0.44	0.144	2.437	0.296	0.104
17	0.49	0.149	2.520	0.296	0.108
18	0.55	0.157	2.634	0.297	0.111
19	0.60	0.163	2.714	0.298	0.115
20	0.67	0.169	2.812	0.299	0.117
21	0.73	0.173	2.873	0.301	0.119
22	0.78	0.179	2.956	0.303	0.121
23	0.86	0.184	3.024	0.305	0.122
24	0.92	0.189	3.091	0.307	0.124
25	0.97	0.193	3.140	0.310	0.124
26	1.04	0.198	3.207	0.312	0.125
27	1.11	0.202	3.261	0.314	0.125
28	1.18	0.207	3.302	0.317	0.125
29	1.28	0.212	3.343	0.322	0.123
30	1.38	0.216	3.372	0.326	0.122
31	1.49	0.220	3.390	0.330	0.121
32	1.61	0.223	3.396	0.335	0.117
33	1.72	0.226	3.392	0.340	0.115
34	1.85	0.228	3.377	0.344	0.112
35	1.96	0.230	3.376	0.348	0.109
36	2.06	0.231	3.356	0.351	0.107
37	2.29	0.234	3.307	0.359	0.100
38	2.52	0.235	3.283	0.363	0.097
39	2.76	0.236	3.241	0.367	0.094
40	2.99	0.235	3.199	0.371	0.090
41	3.25	0.235	3.184	0.372	0.089
42	3.45	0.234	3.166	0.373	0.088
43	3.69	0.234	3.147	0.374	0.085
44	3.89	0.233	3.142	0.373	0.085
45	4.33	0.232	3.114	0.375	0.084
46	4.79	0.230	3.086	0.376	0.083
47	5.18	0.229	3.057	0.375	0.082
48	5.54	0.228	3.073	0.373	0.084
49	6.01	0.226	3.052	0.371	0.084
50	7.50	0.217	2.982	0.364	0.084
51	8.60	0.209	2.906	0.358	0.084
52	8.85	0.206	2.862	0.358	0.083
53	9.00	0.206	2.856	0.359	0.082
54	9.20	0.205	2.840	0.360	0.082
55	9.69	0.200	2.773	0.360	0.078
56	10.20	0.192	2.679	0.357	0.076
57	10.69	0.187	2.621	0.356	0.073
58	11.18	0.184	2.593	0.353	0.073
59	11.67	0.180	2.560	0.351	0.072
60	12.17	0.177	2.536	0.349	0.073

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 752 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.5 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.379
INITIAL HEIGHT OF SAMPLE : 13.02 CM
INITIAL VOLUME OF SAMPLE : 592.98 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 42.2 PERCENT

TX. CONSOLIDATION START 140385 END 280385
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.50	26.50	1.736	1.872	0.068	34.50	24.00	1.334	2.334	1.112
2	57.64	30.50	2.001	2.344	0.172	39.55	27.14	1.323	2.323	1.219
3	66.33	35.10	2.350	2.909	0.279	45.51	31.23	1.309	2.309	1.381
4	76.31	40.40	2.834	3.592	0.379	52.37	35.91	1.293	2.293	1.637
5	87.85	46.50	3.633	4.553	0.460	60.28	41.35	1.270	2.270	2.115
6	101.01	53.50	4.846	5.767	0.461	69.34	47.51	1.241	2.241	2.924
7	116.09	61.60	6.329	7.117	0.394	79.76	54.49	1.209	2.209	3.957
8	133.32	70.80	8.172	8.634	0.231	91.64	62.52	1.173	2.173	5.294
9	158.80	84.80	11.582	10.633	-0.475	109.47	74.00	1.126	2.126	8.038
10	79.84	42.40	10.883	9.739	-0.572	54.88	37.44	1.147	2.147	7.637
11	79.80	42.40	10.829	9.587	-0.621	54.87	37.40	1.151	2.151	7.634
12	79.90	42.20	10.868	9.553	-0.657	54.77	37.70	1.151	2.151	7.883
13	74.11	42.70	10.868	9.553	-0.657	53.17	31.41	1.151	2.151	7.683
14	70.73	45.60	10.856	9.553	-0.651	53.98	25.13	1.151	2.151	7.672
15	67.74	48.90	10.831	9.553	-0.639	55.18	18.84	1.151	2.151	7.647
16	64.95	52.40	10.799	9.553	-0.623	56.58	12.55	1.151	2.151	7.614
17	62.16	55.90	10.745	9.553	-0.596	57.99	6.26	1.151	2.151	7.561
18	59.80	59.80	10.668	9.553	-0.557	59.80	0.0	1.151	2.151	7.484
19	59.80	59.80	10.622	9.553	-0.534	59.80	0.0	1.151	2.151	7.438
20	60.20	60.20	10.584	9.553	-0.515	60.20	0.0	1.151	2.151	7.399
21	60.10	60.10	10.561	9.553	-0.504	60.10	0.0	1.151	2.151	7.376
22	60.20	60.20	10.541	9.553	-0.494	60.20	0.0	1.151	2.151	7.357
23	59.80	59.80	10.522	9.553	-0.484	59.80	0.0	1.151	2.151	7.338
24	59.80	59.80	10.499	9.553	-0.473	59.80	0.0	1.151	2.151	7.315
25	59.80	59.80	10.484	9.553	-0.465	59.80	0.0	1.151	2.151	7.299
26	59.60	59.60	10.465	9.553	-0.456	59.60	0.0	1.151	2.151	7.280
27	60.20	60.20	10.430	9.553	-0.438	60.20	0.0	1.151	2.151	7.246
28	59.20	59.20	10.407	9.553	-0.427	59.20	0.0	1.151	2.151	7.223
29	56.80	56.80	10.406	9.553	-0.426	56.80	0.0	1.151	2.151	7.222

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.50	26.50	1.736	0.068	2.334
2	57.64	30.50	2.001	0.172	2.323
3	66.33	35.10	2.350	0.279	2.309
4	76.31	40.40	2.834	0.379	2.293
5	87.85	46.50	3.633	0.460	2.270
6	101.01	53.50	4.846	0.461	2.241
7	116.09	61.60	6.329	0.394	2.209
8	133.32	70.80	8.172	0.231	2.173
9	158.80	84.80	11.582	-0.475	2.126
10	79.84	42.40	10.883	-0.572	2.147
11	79.80	42.40	10.829	-0.621	2.151
12	79.90	42.20	10.868	-0.657	2.151
13	74.11	42.70	10.868	-0.657	2.151
14	70.73	45.60	10.856	-0.651	2.151
15	67.74	48.90	10.831	-0.639	2.151
16	64.95	52.40	10.799	-0.623	2.151
17	62.16	55.90	10.745	-0.596	2.151
18	59.80	59.80	10.668	-0.557	2.151
19	59.80	59.80	10.622	-0.534	2.151
20	60.20	60.20	10.584	-0.515	2.151
21	60.10	60.10	10.561	-0.504	2.151
22	60.20	60.20	10.541	-0.494	2.151
23	59.80	59.80	10.522	-0.484	2.151
24	59.80	59.80	10.499	-0.473	2.151
25	59.80	59.80	10.484	-0.465	2.151
26	59.60	59.60	10.465	-0.456	2.151
27	60.20	60.20	10.430	-0.438	2.151
28	59.20	59.20	10.407	-0.427	2.151
29	56.80	56.80	10.406	-0.426	2.151

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 752 (REMOULDED SAMPLE)
TEST RESULTS START 140385 END 280385

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.5	26.5	24.0	34.5	1.736	0.068	1.872	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.001	0.172	2.344	9.1	0.3	0.202	0.202
3	66.3	35.1	31.2	45.5	2.350	0.279	2.909	20.0	0.7	0.287	0.490
4	76.3	40.4	35.9	52.4	2.834	0.379	3.592	32.4	1.2	0.420	0.910
5	87.9	46.5	41.4	60.3	3.633	0.460	4.553	46.9	2.0	0.726	1.636
6	101.0	53.5	47.5	69.3	4.846	0.461	5.767	63.3	3.2	1.146	2.782
7	116.1	61.6	54.5	79.8	6.329	0.394	7.117	82.3	4.6	1.532	4.315
8	133.3	70.8	62.5	91.6	8.172	0.231	8.634	103.8	6.4	2.083	6.398
9	158.8	84.8	74.0	109.5	11.582	-0.475	10.633	136.1	9.9	3.882	10.280
10	79.8	42.4	37.4	54.9	10.883	-0.572	9.739	37.0	9.2	-0.958	9.323
11	79.8	42.4	37.4	54.9	10.829	-0.621	9.587	36.9	9.1	-0.084	9.238
12	79.9	42.2	37.7	54.8	10.868	-0.657	9.553	36.8	9.2	0.000	9.238
13	74.1	42.7	31.4	53.2	10.868	-0.657	9.553	32.9	9.2	0.0	9.238
14	70.7	45.6	25.1	54.0	10.856	-0.651	9.553	33.7	9.2	-0.003	9.235
15	67.7	48.9	18.8	55.2	10.831	-0.639	9.553	36.1	9.2	-0.006	9.229
16	64.9	52.4	12.6	56.6	10.799	-0.623	9.553	39.4	9.1	-0.005	9.224
17	62.2	55.9	6.3	58.0	10.745	-0.596	9.553	43.2	9.1	-0.005	9.219
18	59.8	59.8	0.0	59.8	10.668	-0.557	9.553	48.0	9.0	-0.002	9.217
19	59.8	59.8	0.0	59.8	10.622	-0.534	9.553	48.0	8.9	0.0	9.217
20	60.2	60.2	0.0	60.2	10.584	-0.515	9.553	48.6	8.9	0.0	9.217
21	60.1	60.1	0.0	60.1	10.561	-0.504	9.553	48.5	8.9	0.0	9.217
22	60.2	60.2	0.0	60.2	10.541	-0.494	9.553	48.6	8.8	0.0	9.217
23	59.8	59.8	0.0	59.8	10.522	-0.484	9.553	48.0	8.8	0.0	9.217
24	59.8	59.8	0.0	59.8	10.499	-0.473	9.553	48.0	8.8	0.0	9.217
25	59.8	59.8	0.0	59.8	10.484	-0.465	9.553	48.0	8.8	0.0	9.217
26	59.6	59.6	0.0	59.6	10.465	-0.456	9.553	47.7	8.8	0.0	9.217
27	60.2	60.2	0.0	60.2	10.430	-0.438	9.553	48.6	8.7	0.0	9.217
28	59.2	59.2	0.0	59.2	10.407	-0.427	9.553	47.1	8.7	0.0	9.217
29	56.8	56.8	0.0	56.8	10.406	-0.426	9.553	43.3	8.7	0.0	9.217

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 752 (REMOULDED SAMPLE)
TEST RESULTS START 140385 END 280385

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.5	26.5	24.0	34.5	1.751	0.069	1.890	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	2.021	0.175	2.372	9.1	0.3	0.207	0.207
3	66.3	35.1	31.2	45.5	2.378	0.287	2.952	20.0	0.7	0.295	0.501
4	76.3	40.4	35.9	52.4	2.875	0.392	3.658	32.4	1.2	0.433	0.934
5	87.9	46.5	41.4	60.3	3.700	0.480	4.660	46.9	2.0	0.754	1.689
6	101.0	53.5	47.5	69.3	4.968	0.486	5.940	63.3	3.3	1.203	2.892
7	116.1	61.6	54.5	79.8	6.538	0.422	7.382	82.3	4.8	1.631	4.522
8	133.3	70.8	62.5	91.6	8.525	0.252	9.030	103.8	6.8	2.253	6.776
9	158.8	84.8	74.0	109.5	12.309	-0.534	11.241	136.1	10.6	4.303	11.079
10	79.8	42.4	37.4	54.9	11.522	-0.638	10.246	37.0	9.8	-1.072	10.007
11	79.8	42.4	37.4	54.9	11.461	-0.692	10.078	36.9	9.8	-0.094	9.914
12	79.9	42.2	37.7	54.8	11.504	-0.732	10.041	36.8	9.8	0.000	9.914
13	74.1	42.7	31.4	53.2	11.504	-0.732	10.041	32.9	9.8	0.0	9.914
14	70.7	45.6	25.1	54.0	11.492	-0.725	10.041	33.7	9.8	-0.004	9.910
15	67.7	48.9	18.8	55.2	11.463	-0.711	10.041	36.1	9.8	-0.006	9.904
16	64.9	52.4	12.6	56.6	11.427	-0.693	10.041	39.4	9.7	-0.006	9.898
17	62.2	55.9	6.3	58.0	11.367	-0.663	10.041	43.2	9.7	-0.006	9.893
18	59.8	59.8	0.0	59.8	11.281	-0.620	10.041	48.0	9.6	-0.003	9.890
19	59.8	59.8	0.0	59.8	11.229	-0.594	10.041	48.0	9.5	-0.000	9.890
20	60.2	60.2	0.0	60.2	11.186	-0.573	10.041	48.6	9.5	-0.000	9.890
21	60.1	60.1	0.0	60.1	11.160	-0.560	10.041	48.5	9.5	-0.000	9.890
22	60.2	60.2	0.0	60.2	11.139	-0.549	10.041	48.6	9.4	-0.000	9.890
23	59.8	59.8	0.0	59.8	11.117	-0.538	10.041	48.0	9.4	-0.000	9.890
24	59.8	59.8	0.0	59.8	11.092	-0.525	10.041	48.0	9.4	0.0	9.890
25	59.8	59.8	0.0	59.8	11.075	-0.517	10.041	48.0	9.4	-0.000	9.890
26	59.6	59.6	0.0	59.6	11.053	-0.506	10.041	47.7	9.3	-0.000	9.890
27	60.2	60.2	0.0	60.2	11.014	-0.487	10.041	48.6	9.3	-0.000	9.890
28	59.2	59.2	0.0	59.2	10.989	-0.474	10.041	47.1	9.3	-0.000	9.890
29	56.8	56.8	0.0	56.8	10.988	-0.474	10.041	43.3	9.3	0.0	9.890

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 752 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.947 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 543.132 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 54.462 SQUARE CENTIMETRES

CONSTANT LOAD : 15.02 N .
PROVING RING FACTOR : 0.4177 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 1842.50 DIVISIONS

SHEAR TEST RESULTS START 20485 END 30485

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	912	1842.5	285.0	199.7	0.0	49.7	48.2	0.8	1.5	48.7	1.032	0.0
2	921	1842.0	301.5	200.5	0.00	50.1	47.3	1.4	2.8	48.2	1.059	0.63
3	930	1839.2	317.0	201.0	0.03	50.9	46.9	2.0	4.0	48.2	1.085	0.53
4	935	1837.0	322.8	201.1	0.05	51.4	47.0	2.2	4.4	48.5	1.094	0.49
5	940	1834.5	327.5	201.5	0.07	51.3	46.5	2.4	4.8	48.1	1.103	0.55
6	945	1833.2	337.0	201.9	0.08	51.5	46.0	2.8	5.5	47.8	1.120	0.55
7	950	1832.0	350.0	202.8	0.09	52.1	45.6	3.2	6.5	47.8	1.142	0.63
8	955	1831.0	361.0	203.2	0.10	52.2	44.9	3.7	7.3	47.3	1.164	0.60
9	1000	1830.5	371.4	203.5	0.10	52.8	44.7	4.1	8.1	47.4	1.182	0.58
10	1010	1829.0	393.4	204.9	0.11	53.1	43.3	4.9	9.8	46.6	1.227	0.63
11	1020	1826.0	415.0	205.6	0.14	54.1	42.6	5.7	11.5	46.4	1.269	0.59
12	1030	1824.0	436.0	206.9	0.15	54.4	41.3	6.5	13.1	45.7	1.317	0.62
13	1043	1821.2	462.0	208.1	0.18	55.3	40.2	7.5	15.1	45.2	1.374	0.62
14	1050	1820.0	476.0	208.6	0.19	55.7	39.6	8.1	16.1	45.0	1.407	0.61
15	1100	1816.0	491.5	209.3	0.22	56.1	38.8	8.7	17.3	44.6	1.446	0.61
16	1110	1813.0	509.5	210.1	0.25	56.9	38.2	9.3	18.7	44.4	1.489	0.61
17	1121	1809.0	528.5	211.2	0.28	57.2	37.1	10.1	20.1	43.8	1.542	0.62
18	1130	1806.0	542.5	211.5	0.31	57.8	36.6	10.6	21.2	43.7	1.579	0.60
19	1140	1802.8	557.5	212.3	0.33	58.2	35.9	11.2	22.3	43.3	1.622	0.61
20	1150	1799.0	574.5	213.4	0.36	58.4	34.8	11.8	23.6	42.7	1.679	0.62
21	1200	1795.0	586.0	213.6	0.40	59.0	34.5	12.3	24.5	42.7	1.710	0.61
22	1210	1790.5	601.0	214.4	0.44	59.3	33.7	12.8	25.6	42.2	1.761	0.61
23	1220	1787.8	613.0	214.8	0.46	59.8	33.2	13.3	26.6	42.1	1.800	0.60
24	1230	1783.5	624.5	215.4	0.49	60.2	32.8	13.7	27.4	41.9	1.836	0.61
25	1240	1779.0	636.5	216.1	0.53	60.6	32.3	14.1	28.3	41.7	1.876	0.61
26	1250	1774.5	648.8	216.4	0.57	61.0	31.8	14.6	29.2	41.5	1.920	0.60
27	1300	1770.0	660.5	217.0	0.61	61.5	31.4	15.1	30.1	41.4	1.959	0.61
28	1315	1762.4	676.5	217.4	0.67	61.9	30.6	15.7	31.4	41.0	2.028	0.59
29	1330	1755.0	681.2	217.9	0.73	62.5	30.0	16.2	32.5	40.8	2.082	0.59
30	1350	1745.0	713.5	218.6	0.82	63.5	29.4	17.1	34.1	40.8	2.160	0.58
31	1400	1740.0	724.0	219.1	0.86	64.0	29.1	17.4	34.9	40.7	2.199	0.58
32	1415	1732.0	739.9	219.5	0.92	64.7	28.6	18.0	36.1	40.6	2.261	0.57
33	1430	1725.5	753.5	219.9	0.98	65.3	28.2	18.5	37.1	40.6	2.315	0.57
34	1445	1718.2	767.8	220.2	1.04	66.3	28.2	19.1	38.1	40.9	2.352	0.56
35	1500	1710.0	781.8	220.7	1.11	66.9	27.7	19.6	39.2	40.8	2.414	0.56
36	1530	1694.5	808.5	221.2	1.24	67.8	26.6	20.6	41.2	40.3	2.548	0.54
37	1600	1678.0	834.5	222.0	1.38	69.3	26.3	21.5	43.0	40.6	2.637	0.54
38	1632	1660.0	858.0	222.3	1.53	70.7	25.9	22.4	44.8	40.8	2.728	0.52
39	1700	1644.0	879.0	222.4	1.66	72.2	25.9	23.1	46.3	41.3	2.787	0.51
40	1736	1625.0	896.0	222.6	1.82	73.3	25.8	23.7	47.5	41.6	2.840	0.50
41	1801	1606.5	914.0	222.8	1.98	74.4	25.7	24.4	48.7	41.9	2.897	0.49
42	1900	1569.0	943.0	222.0	2.29	76.8	26.0	25.4	50.8	42.9	2.954	0.45
43	2000	1529.0	961.8	221.6	2.62	78.2	26.1	26.0	52.1	43.5	2.995	0.43
44	2100	1487.8	977.4	221.6	2.97	79.7	26.7	26.5	53.0	44.4	2.984	0.43
45	2201	1445.0	988.0	220.9	3.33	81.0	27.4	26.8	53.6	45.3	2.955	0.41
46	2300	1403.5	996.3	220.4	3.67	81.8	27.8	27.0	54.0	45.8	2.943	0.39
47	2400	1358.5	1004.0	220.2	4.05	82.5	28.1	27.2	54.4	46.2	2.934	0.39
48	100	1314.0	1003.0	219.9	4.42	82.6	28.5	27.0	54.1	46.5	2.897	0.38
49	400	1180.0	1006.0	219.2	5.55	82.7	29.0	26.8	53.7	46.9	2.850	0.37
50	700	1045.0	1016.0	219.3	6.68	82.5	28.8	26.9	53.7	46.7	2.866	0.38
51	800	998.5	1009.5	219.5	7.06	81.8	28.8	26.5	53.0	46.5	2.842	0.38
52	900	953.0	1010.8	219.3	7.45	81.8	28.9	26.5	52.9	46.5	2.831	0.38
53	1000	907.0	1009.5	219.4	7.83	81.3	28.7	26.3	52.6	46.2	2.833	0.39
54	1102	860.5	1008.0	219.6	8.22	80.6	28.3	26.2	52.3	45.7	2.848	0.39
55	1202	815.0	1007.5	219.4	8.60	80.9	28.9	26.0	52.0	46.2	2.800	0.39
56	1305	767.0	1005.5	219.3	9.00	80.7	29.0	25.8	51.7	46.2	2.781	0.39
57	1400	725.0	1004.0	219.4	9.35	80.2	28.9	25.7	51.3	46.0	2.777	0.40
58	1509	668.0	986.0	219.2	9.83	78.7	28.8	24.9	49.9	45.4	2.731	0.40
59	1604	624.0	975.5	219.2	10.20	77.7	28.8	24.5	48.9	45.1	2.699	0.41
60	1800	532.0	959.0	219.0	10.97	76.3	28.9	23.7	47.4	44.7	2.640	0.42
61	1930	463.0	956.0	218.9	11.55	75.0	29.1	23.4	46.9	44.7	2.611	0.42
62	2050	401.0	945.0	219.2	12.07	74.3	28.4	22.9	45.9	43.7	2.616	0.44

SAMPLE NO. : T 752 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 50.00 KPA
PRECONSOLIDATION PRESSURE : 158.80 KPA
NORMALIZING STRESS : 158.80 KPA

NORMALIZED SHEAR TEST RESULTS START 20485 END 30485

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.005	1.032	0.307	0.0
2	0.00	0.009	1.059	0.304	0.005
3	0.03	0.013	1.085	0.304	0.008
4	0.05	0.014	1.094	0.305	0.009
5	0.07	0.015	1.103	0.303	0.011
6	0.08	0.017	1.120	0.301	0.014
7	0.09	0.020	1.142	0.301	0.020
8	0.10	0.023	1.164	0.298	0.022
9	0.10	0.026	1.182	0.299	0.024
10	0.11	0.031	1.227	0.293	0.033
11	0.14	0.036	1.269	0.292	0.037
12	0.15	0.041	1.317	0.288	0.045
13	0.18	0.047	1.374	0.285	0.053
14	0.19	0.051	1.407	0.283	0.056
15	0.22	0.055	1.446	0.281	0.060
16	0.25	0.059	1.489	0.280	0.065
17	0.28	0.063	1.542	0.276	0.072
18	0.31	0.067	1.579	0.275	0.074
19	0.33	0.070	1.622	0.273	0.079
20	0.36	0.074	1.679	0.269	0.086
21	0.40	0.077	1.710	0.269	0.088
22	0.44	0.081	1.761	0.266	0.093
23	0.46	0.084	1.800	0.265	0.095
24	0.49	0.086	1.836	0.264	0.099
25	0.53	0.089	1.876	0.263	0.103
26	0.57	0.092	1.920	0.262	0.105
27	0.61	0.095	1.959	0.261	0.109
28	0.67	0.099	2.028	0.258	0.111
29	0.73	0.102	2.082	0.257	0.115
30	0.82	0.107	2.160	0.257	0.119
31	0.86	0.110	2.199	0.256	0.122
32	0.92	0.114	2.261	0.256	0.125
33	0.98	0.117	2.315	0.255	0.127
34	1.04	0.120	2.352	0.258	0.129
35	1.11	0.123	2.414	0.257	0.132
36	1.24	0.130	2.548	0.254	0.135
37	1.38	0.136	2.637	0.256	0.140
38	1.53	0.141	2.728	0.257	0.142
39	1.66	0.146	2.787	0.260	0.143
40	1.82	0.149	2.840	0.262	0.144
41	1.98	0.153	2.897	0.264	0.145
42	2.29	0.160	2.954	0.270	0.140
43	2.62	0.164	2.995	0.274	0.138
44	2.97	0.167	2.984	0.279	0.138
45	3.33	0.169	2.955	0.285	0.134
46	3.67	0.170	2.943	0.288	0.130
47	4.05	0.171	2.934	0.291	0.129
48	4.42	0.170	2.897	0.293	0.127
49	5.55	0.169	2.850	0.295	0.123
50	6.68	0.169	2.866	0.294	0.123
51	7.06	0.167	2.842	0.293	0.125
52	7.46	0.167	2.831	0.293	0.123
53	7.83	0.166	2.833	0.291	0.124
54	8.22	0.165	2.848	0.288	0.125
55	8.60	0.164	2.800	0.291	0.124
56	9.00	0.163	2.781	0.291	0.123
57	9.35	0.162	2.777	0.290	0.124
58	9.83	0.157	2.731	0.286	0.123
59	10.20	0.154	2.699	0.284	0.123
60	10.97	0.149	2.640	0.281	0.122
61	11.55	0.148	2.611	0.282	0.121
62	12.07	0.144	2.616	0.275	0.123

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 753 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 51.0 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73 .
INITIAL VOID RATIO : 1.392
INITIAL HEIGHT OF SAMPLE : 12.96 CM
INITIAL VOLUME OF SAMPLE : 590.25 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 41.9 PERCENT

TX. CONSOLIDATION START 140385 END 280385
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.09	26.50	2.025	2.474	0.224	34.36	23.59	1.333	2.333	1.201
2	57.70	30.50	2.346	3.016	0.335	39.57	27.20	1.320	2.320	1.340
3	66.44	35.20	2.812	3.626	0.407	45.61	31.24	1.306	2.306	1.604
4	76.47	40.50	3.484	4.524	0.520	52.49	35.97	1.284	2.284	1.976
5	88.00	46.60	4.572	5.769	0.598	60.40	41.40	1.254	2.254	2.649
6	101.20	53.60	5.910	7.090	0.590	69.47	47.60	1.223	2.223	3.547
7	116.31	61.70	7.589	8.640	0.526	79.90	54.61	1.186	2.186	4.709
8	133.60	70.90	9.390	10.216	0.413	91.80	62.70	1.148	2.148	5.985
9	159.53	84.80	11.798	11.995	0.099	109.71	74.73	1.105	2.105	7.800
10	79.80	42.40	10.957	10.555	-0.201	54.87	37.40	1.140	2.140	7.439
11	80.07	42.40	10.228	10.453	0.113	54.96	37.67	1.142	2.142	6.743
12	80.16	42.60	10.367	10.411	0.022	55.12	37.56	1.143	2.143	6.896
13	75.67	44.40	10.359	10.411	0.026	54.82	31.27	1.143	2.143	6.889
14	71.29	46.30	10.347	10.411	0.032	54.63	24.99	1.143	2.143	6.877
15	67.50	48.80	10.324	10.411	0.043	55.03	18.70	1.143	2.143	6.854
16	64.43	51.90	10.285	10.411	0.063	56.08	12.53	1.143	2.143	6.815
17	61.18	54.90	10.239	10.411	0.086	56.99	6.28	1.143	2.143	6.769
18	58.20	58.20	10.147	10.411	0.132	58.20	0.0	1.143	2.143	6.676
19	58.20	58.20	10.131	10.411	0.140	58.20	0.0	1.143	2.143	6.661
20	58.10	58.10	10.089	1C.411	0.161	58.10	0.0	1.143	2.143	6.618
21	58.00	58.00	10.069	10.411	0.171	58.00	0.0	1.143	2.143	6.599
22	57.90	57.90	10.069	10.411	0.171	57.90	0.0	1.143	2.143	6.598
23	57.90	57.90	10.069	10.411	0.171	57.90	0.0	1.143	2.143	6.598
24	57.80	57.80	10.000	10.411	0.205	57.80	0.0	1.143	2.143	6.530
25	57.40	57.40	9.977	10.411	0.217	57.40	0.0	1.143	2.143	6.507
26	57.40	57.40	9.965	10.411	0.223	57.40	0.0	1.143	2.143	6.495
27	57.00	57.00	9.931	10.411	0.240	57.00	0.0	1.143	2.143	6.460
28	56.00	56.00	9.946	10.411	0.232	56.00	0.0	1.143	2.143	6.476
29	50.90	50.90	9.961	10.411	0.225	50.90	0.0	1.143	2.143	6.491

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.09	26.50	2.025	0.224	2.333
2	57.70	30.50	2.348	0.335	2.320
3	66.44	35.20	2.812	0.407	2.306
4	76.47	40.50	3.484	0.520	2.284
5	88.00	46.60	4.572	0.598	2.254
6	101.20	53.60	5.910	0.590	2.223
7	116.31	61.70	7.589	0.526	2.186
8	133.60	70.90	9.390	0.413	2.148
9	159.53	84.80	11.798	0.099	2.105
1C	79.80	42.40	10.957	-0.201	2.140
11	80.07	42.40	10.228	0.113	2.142
12	80.16	42.60	10.367	0.022	2.143
13	75.67	44.40	10.359	0.026	2.143
14	71.29	46.30	10.347	0.032	2.143
15	67.50	48.80	10.324	0.043	2.143
16	64.43	51.90	10.285	0.063	2.143
17	61.18	54.90	10.239	0.086	2.143
18	58.20	58.20	10.147	0.132	2.143
19	58.20	58.20	10.131	0.140	2.143
20	58.10	58.10	10.089	0.161	2.143
21	58.00	58.00	10.069	0.171	2.143
22	57.90	57.90	10.069	0.171	2.143
23	57.90	57.90	10.069	0.171	2.143
24	57.80	57.80	10.000	0.205	2.143
25	57.40	57.40	9.977	0.217	2.143
26	57.40	57.40	9.965	0.223	2.143
27	57.00	57.00	9.931	0.240	2.143
28	56.00	56.00	9.946	0.232	2.143
29	50.90	50.90	9.961	0.225	2.143

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 753 (REMOULDED SAMPLE)
TEST RESULTS START 140385 END 280385

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.025	0.224	2.474	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.346	0.335	3.016	9.5	0.4	0.236	0.236
3	66.4	35.2	31.2	45.6	2.812	0.407	3.626	20.5	0.8	0.337	0.573
4	76.5	40.5	36.0	52.5	3.484	0.520	4.524	33.0	1.5	0.565	1.138
5	88.0	46.6	41.4	60.4	4.572	0.598	5.769	47.4	2.6	0.963	2.101
6	101.2	53.6	47.6	69.5	5.910	0.590	7.090	63.9	3.9	1.258	3.359
7	116.3	61.7	54.6	79.9	7.589	0.526	8.640	82.8	5.6	1.751	5.110
8	133.6	70.9	62.7	91.8	9.390	0.413	10.216	104.5	7.4	2.101	7.212
9	159.5	84.8	74.7	109.7	11.798	0.099	11.995	137.0	9.8	3.039	10.251
10	79.8	42.4	37.4	54.9	10.957	-0.201	10.555	37.3	9.0	-1.387	8.863
11	80.1	42.4	37.7	55.0	10.228	0.113	10.453	37.5	8.2	-0.317	8.547
12	80.2	42.6	37.6	55.1	10.367	0.022	10.411	37.7	8.3	0.034	8.581
13	75.7	44.4	31.3	54.8	10.359	0.026	10.411	36.0	8.3	-0.003	8.578
14	71.3	46.3	25.0	54.6	10.347	0.032	10.411	35.1	8.3	-0.003	8.575
15	67.5	48.8	18.7	55.0	10.324	0.043	10.411	36.0	8.3	-0.005	8.570
16	64.4	51.9	12.5	56.1	10.285	0.063	10.411	38.7	8.3	-0.006	8.564
17	61.2	54.9	6.3	57.0	10.239	0.086	10.411	41.7	8.2	-0.004	8.560
18	58.2	58.2	0.0	58.2	10.147	0.132	10.411	45.6	8.1	-0.003	8.557
19	58.2	58.2	0.0	58.2	10.131	0.140	10.411	45.6	8.1	0.0	8.557
20	58.1	58.1	0.0	58.1	10.089	0.161	10.411	45.4	8.1	0.0	8.557
21	58.0	58.0	0.0	58.0	10.069	0.171	10.411	45.2	8.0	0.0	8.557
22	57.9	57.9	0.0	57.9	10.069	0.171	10.411	45.1	8.0	0.0	8.557
23	57.9	57.9	0.0	57.9	10.069	0.171	10.411	45.1	8.0	0.0	8.557
24	57.8	57.8	0.0	57.8	10.000	0.205	10.411	44.9	8.0	0.0	8.557
25	57.4	57.4	0.0	57.4	9.977	0.217	10.411	44.3	8.0	0.0	8.557
26	57.4	57.4	0.0	57.4	9.965	0.223	10.411	44.3	7.9	0.0	8.557
27	57.0	57.0	0.0	57.0	9.931	0.240	10.411	43.7	7.9	0.0	8.557
28	56.0	56.0	0.0	56.0	9.946	0.232	10.411	42.1	7.9	0.0	8.557
29	50.9	50.9	0.0	50.9	9.961	0.225	10.411	34.5	7.9	0.0	8.557

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 753 (REMOULDED SAMPLE)
TEST RESULTS START 140385 END 280385

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	2.046	0.229	2.505	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.374	0.344	3.062	9.5	0.4	0.242	0.242
3	66.4	35.2	31.2	45.6	2.853	0.420	3.693	20.5	0.9	0.347	0.589
4	76.5	40.5	36.0	52.5	3.546	0.542	4.629	33.0	1.6	0.587	1.176
5	88.0	46.6	41.4	60.4	4.679	0.631	5.942	47.4	2.7	1.010	2.187
6	101.2	53.6	47.6	69.5	6.092	0.631	7.354	63.9	4.1	1.336	3.523
7	116.3	61.7	54.6	79.9	7.892	0.572	9.036	82.8	5.9	1.890	5.413
8	133.6	70.9	62.7	91.8	9.861	0.458	10.776	104.5	7.8	2.308	7.721
9	159.5	84.8	74.7	109.7	12.553	0.112	12.777	137.0	10.5	3.408	11.129
10	79.8	42.4	37.4	54.9	11.604	-0.225	11.154	37.3	9.6	-1.564	9.565
11	80.1	42.4	37.7	55.0	10.789	0.126	11.041	37.5	8.7	-0.354	9.210
12	80.2	42.6	37.6	55.1	10.944	0.025	10.993	37.7	8.9	0.038	9.249
13	75.7	44.4	31.3	54.8	10.935	0.029	10.993	36.0	8.9	-0.003	9.246
14	71.3	46.3	25.0	54.6	10.922	0.036	10.993	35.1	8.9	-0.004	9.242
15	67.5	48.8	18.7	55.0	10.896	0.048	10.993	36.0	8.9	-0.006	9.236
16	64.4	51.9	12.5	56.1	10.853	0.070	10.993	38.7	8.8	-0.007	9.230
17	61.2	54.9	6.3	57.0	10.802	0.096	10.993	41.7	8.8	-0.005	9.225
18	58.2	58.2	0.0	58.2	10.699	0.147	10.993	45.6	8.7	-0.003	9.222
19	58.2	58.2	0.0	58.2	10.682	0.156	10.993	45.6	8.6	-0.000	9.222
20	58.1	58.1	0.0	58.1	10.634	0.179	10.993	45.4	8.6	-0.000	9.222
21	58.0	58.0	0.0	58.0	10.613	0.190	10.993	45.2	8.6	-0.000	9.222
22	57.9	57.9	0.0	57.9	10.612	0.191	10.993	45.1	8.6	-0.000	9.222
23	57.9	57.9	0.0	57.9	10.612	0.191	10.993	45.1	8.6	0.0	9.222
24	57.8	57.8	0.0	57.8	10.536	0.229	10.993	44.9	8.5	-0.000	9.222
25	57.4	57.4	0.0	57.4	10.510	0.242	10.993	44.3	8.5	-0.000	9.222
26	57.4	57.4	0.0	57.4	10.497	0.248	10.993	44.3	8.5	-0.000	9.222
27	57.0	57.0	0.0	57.0	10.459	0.267	10.993	43.7	8.4	-0.000	9.222
28	56.0	56.0	0.0	56.0	10.476	0.259	10.993	42.1	8.4	-0.000	9.222
29	50.9	50.9	0.0	50.9	10.493	0.250	10.993	34.5	8.4	-0.000	9.222

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 753 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.881 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 538.800 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 45.350 SQUARE CENTIMETRES

CONSTANT LOAD : 15.51 N .
PROVING RING FACTOR : 1.0225 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 1950.00 DIVISIONS

SHEAR TEST RESULTS START 80485 END 90485

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	855	1950.0	116.5	200.6	0.0	49.8	47.6	1.1	2.2	48.3	1.045	0.0
2	901	1949.0	122.5	202.1	0.01	49.3	45.7	1.8	3.6	46.9	1.078	1.07
3	910	1946.3	142.0	204.9	0.03	51.4	43.5	3.9	7.9	46.1	1.181	0.75
4	915	1944.3	152.0	205.9	0.05	52.3	42.1	5.1	10.2	45.5	1.242	0.66
5	920	1942.0	160.5	207.1	0.07	53.0	40.9	6.0	12.1	44.9	1.296	0.65
6	925	1939.5	168.5	208.2	0.09	53.7	39.8	6.9	13.9	44.4	1.349	0.65
7	930	1937.0	177.8	209.9	0.11	54.5	38.6	8.0	15.9	43.9	1.413	0.68
8	935	1934.0	185.0	210.5	0.13	55.2	37.6	8.8	17.6	43.5	1.468	0.64
9	940	1931.0	192.0	211.2	0.16	55.9	36.7	9.6	19.2	43.1	1.523	0.62
10	945	1927.5	199.0	212.4	0.19	56.6	35.9	10.4	20.7	42.8	1.577	0.64
11	950	1925.0	204.0	213.0	0.21	57.1	35.3	10.9	21.8	42.6	1.618	0.63
12	955	1922.0	209.5	213.4	0.24	57.7	34.6	11.5	23.1	42.3	1.688	0.61
13	1000	1919.0	214.4	214.3	0.26	58.1	33.9	12.1	24.2	42.0	1.713	0.62
14	1010	1911.0	225.0	215.8	0.33	59.2	32.7	13.3	26.5	41.5	1.811	0.62
15	1020	1904.5	234.0	216.8	0.38	60.1	31.6	14.3	28.5	41.1	1.903	0.61
16	1035	1894.0	245.0	217.7	0.47	61.5	30.5	15.5	31.0	40.8	2.016	0.59
17	1040	1889.5	249.5	218.5	0.51	61.9	29.9	16.0	32.0	40.6	2.069	0.60
18	1050	1882.5	255.3	218.9	0.57	62.6	29.3	16.6	33.3	40.4	2.135	0.59
19	1100	1875.0	262.0	219.8	0.63	63.3	28.6	17.4	34.7	40.2	2.214	0.59
20	1110	1867.5	268.2	220.5	0.69	64.0	27.9	18.0	36.1	39.9	2.294	0.59
21	1120	1858.8	275.0	220.9	0.77	64.9	27.3	18.8	37.6	39.8	2.378	0.57
22	1130	1852.0	280.5	221.7	0.82	65.6	26.8	19.4	38.8	39.7	2.447	0.58
23	1140	1844.0	286.2	221.6	0.89	66.5	26.4	20.0	40.1	39.8	2.518	0.55
24	1150	1835.5	292.0	222.4	0.96	67.2	25.9	20.7	41.3	39.7	2.595	0.56
25	1203	1825.0	298.5	223.0	1.05	68.2	25.5	21.4	42.7	39.7	2.675	0.55
26	1215	1816.0	304.0	223.0	1.13	69.0	25.1	22.0	43.9	39.7	2.751	0.54
27	1230	1802.5	310.5	223.5	1.24	69.8	24.6	22.7	45.3	39.7	2.843	0.53
28	1245	1790.5	317.0	223.9	1.34	70.9	24.2	23.4	46.7	39.8	2.932	0.52
29	1300	1778.0	323.0	224.1	1.45	71.9	23.9	24.0	48.0	39.9	3.010	0.51
30	1330	1752.0	333.5	224.4	1.67	73.9	23.6	25.1	50.3	40.4	3.130	0.49
31	1400	1726.0	342.5	224.4	1.89	75.7	23.6	26.1	52.1	41.0	3.209	0.48
32	1430	1699.4	350.0	224.7	2.11	77.2	23.6	26.8	53.6	41.5	3.273	0.47
33	1502	1671.0	355.5	224.8	2.35	78.2	23.5	27.4	54.7	41.7	3.329	0.46
34	1530	1646.0	360.0	224.3	2.56	79.4	23.8	27.8	55.6	42.3	3.337	0.44
35	1600	1617.5	363.0	224.2	2.80	80.2	24.1	28.1	56.1	42.8	3.328	0.44
36	1630	1591.0	365.0	223.6	3.02	80.9	24.5	28.2	56.4	43.3	3.304	0.42
37	1700	1563.0	366.5	223.7	3.26	81.0	24.4	28.3	56.6	43.3	3.321	0.42
38	1808	1499.0	367.4	223.2	3.80	81.5	25.0	28.3	56.5	43.8	3.260	0.42
39	1900	1450.0	366.5	222.8	4.21	81.6	25.5	28.0	56.1	44.2	3.198	0.41
40	2000	1393.0	364.8	222.1	4.69	81.3	25.9	27.7	55.4	44.4	3.141	0.40
41	2100	1335.0	362.5	221.7	5.18	81.1	26.5	27.3	54.6	44.7	3.062	0.40
42	2200	1277.0	357.5	221.5	5.66	78.9	26.6	26.7	53.3	44.4	3.004	0.41
43	2304	1217.0	356.5	221.8	6.17	79.2	26.4	26.4	52.8	44.0	3.000	0.42
44	2400	1164.4	356.2	221.6	6.61	78.9	26.4	26.3	52.5	43.9	2.989	0.42
45	700	765.0	347.5	221.5	9.97	75.4	26.6	24.4	48.8	42.9	2.836	0.45
46	815	693.5	346.0	221.1	10.58	75.2	27.0	24.1	48.2	43.1	2.786	0.45
47	903	647.0	345.6	221.3	10.97	74.7	26.8	24.0	47.9	42.8	2.788	0.45
48	1000	594.0	345.0	221.2	11.41	74.4	26.8	23.8	47.6	42.7	2.775	0.45
49	1100	537.0	345.0	221.1	11.89	74.3	27.0	23.7	47.3	42.8	2.752	0.45
50	1200	480.0	345.0	220.9	12.37	74.3	27.2	23.5	47.1	42.9	2.730	0.45

SAMPLE NO. : T 753 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 49.76 KPA
PRECONSOLIDATION PRESSURE : 159.53 KPA
NORMALIZING STRESS : 159.53 KPA

NORMALIZED SHEAR TEST RESULTS START 80485 END 90485

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.007	1.045	0.303	0.0
2	0.01	0.011	1.078	0.294	0.009
3	0.03	0.025	1.181	0.289	0.027
4	0.05	0.032	1.242	0.285	0.033
5	0.07	0.038	1.295	0.282	0.041
6	0.09	0.044	1.349	0.279	0.048
7	0.11	0.050	1.413	0.275	0.058
8	0.13	0.055	1.468	0.272	0.062
9	0.16	0.060	1.523	0.270	0.066
10	0.19	0.065	1.577	0.268	0.074
11	0.21	0.068	1.618	0.267	0.078
12	0.24	0.072	1.668	0.265	0.080
13	0.26	0.076	1.713	0.263	0.086
14	0.33	0.083	1.811	0.260	0.095
15	0.38	0.089	1.903	0.258	0.102
16	0.47	0.097	2.016	0.256	0.107
17	0.51	0.100	2.069	0.254	0.112
18	0.57	0.104	2.135	0.253	0.115
19	0.63	0.109	2.214	0.252	0.120
20	0.69	0.113	2.294	0.250	0.125
21	0.77	0.118	2.378	0.250	0.127
22	0.82	0.122	2.447	0.249	0.132
23	0.89	0.126	2.518	0.249	0.132
24	0.96	0.130	2.595	0.249	0.137
25	1.05	0.134	2.675	0.249	0.140
26	1.13	0.138	2.751	0.249	0.140
27	1.24	0.142	2.843	0.249	0.144
28	1.34	0.147	2.932	0.248	0.146
29	1.45	0.151	3.010	0.250	0.147
30	1.67	0.158	3.130	0.253	0.149
31	1.89	0.163	3.209	0.257	0.149
32	2.11	0.168	3.273	0.260	0.151
33	2.35	0.172	3.329	0.262	0.152
34	2.56	0.174	3.337	0.265	0.149
35	2.80	0.176	3.328	0.268	0.148
36	3.02	0.177	3.304	0.272	0.144
37	3.26	0.178	3.321	0.271	0.145
38	3.80	0.177	3.260	0.275	0.142
39	4.21	0.176	3.198	0.277	0.139
40	4.69	0.174	3.141	0.278	0.135
41	5.18	0.171	3.062	0.280	0.132
42	5.66	0.167	3.004	0.278	0.131
43	6.17	0.165	3.000	0.276	0.133
44	6.61	0.165	2.989	0.275	0.132
45	9.97	0.163	2.836	0.269	0.131

46	10.58	0.151	2.786	0.270	0.129
47	10.97	0.150	2.788	0.268	0.130
48	11.41	0.149	2.775	0.267	0.129
49	11.89	0.148	2.752	0.268	0.129
50	12.37	0.147	2.730	0.269	0.127

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 754 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.6 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.381
INITIAL HEIGHT OF SAMPLE : 13.24 CM
INITIAL VOLUME OF SAMPLE : 603.00 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 42.2 PERCENT

TX. CONSOLIDATION START 240485 END 80585
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.00	26.50	1.314	1.658	0.172	34.33	23.50	1.342	2.342	0.761
2	57.60	30.50	1.639	2.172	0.267	39.53	27.10	1.330	2.330	0.915
3	66.26	35.10	2.088	2.819	0.365	45.49	31.16	1.314	2.314	1.149
4	76.27	40.40	2.825	3.748	0.462	52.36	35.87	1.292	2.292	1.575
5	87.76	46.50	3.935	4.942	0.503	60.25	41.26	1.264	2.264	2.288
6	100.92	53.50	5.306	6.227	0.461	69.31	47.42	1.233	2.233	3.230
7	115.97	61.50	7.032	7.753	0.361	79.66	54.47	1.197	2.197	4.447
8	133.27	70.70	8.739	9.287	0.274	91.56	62.57	1.160	2.160	5.643
9	159.30	84.80	11.337	11.128	-0.105	109.63	74.50	1.116	2.116	7.628
10	79.87	42.40	10.514	9.959	-0.278	54.89	37.47	1.144	2.144	7.194
11	79.83	42.40	10.483	9.826	-0.329	54.88	37.43	1.147	2.147	7.208
12	79.93	42.60	10.555	9.677	-0.439	55.04	37.33	1.151	2.151	7.330
13	74.18	43.00	10.555	9.677	-0.439	53.39	31.18	1.151	2.151	7.330
14	70.40	45.40	10.551	9.677	-0.437	53.73	25.00	1.151	2.151	7.326
15	67.45	48.90	10.529	9.677	-0.426	55.08	18.55	1.151	2.151	7.303
16	64.97	52.60	10.498	9.677	-0.411	56.72	12.37	1.151	2.151	7.273
17	61.98	55.80	10.468	9.677	-0.396	57.86	6.18	1.151	2.151	7.243
18	59.50	59.50	10.408	9.677	-0.366	59.50	0.0	1.151	2.151	7.182
19	58.30	58.30	10.378	9.677	-0.351	58.30	0.0	1.151	2.151	7.152
20	57.30	57.30	10.347	9.677	-0.335	57.30	0.0	1.151	2.151	7.122
21	56.40	56.40	10.317	9.677	-0.320	56.40	0.0	1.151	2.151	7.092
22	56.30	56.30	10.287	9.677	-0.305	56.30	0.0	1.151	2.151	7.061
23	55.40	55.40	10.261	9.677	-0.292	55.40	0.0	1.151	2.151	7.035
24	55.20	55.20	10.230	9.677	-0.277	55.20	0.0	1.151	2.151	7.005
25	54.80	54.80	10.204	9.677	-0.264	54.80	0.0	1.151	2.151	6.978
26	54.40	54.40	10.174	9.677	-0.249	54.40	0.0	1.151	2.151	6.948
27	54.00	54.00	10.151	9.677	-0.237	54.00	0.0	1.151	2.151	6.926
28	52.60	52.60	10.113	9.677	-0.218	52.60	0.0	1.151	2.151	6.888
29	50.80	50.80	10.083	9.677	-0.203	50.80	0.0	1.151	2.151	6.858

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.00	26.50	1.314	0.172	2.342
2	57.60	30.50	1.639	0.267	2.330
3	66.26	35.10	2.088	0.365	2.314
4	76.27	40.40	2.825	0.462	2.292
5	87.76	46.50	3.935	0.503	2.264
6	100.92	53.50	5.306	0.461	2.233
7	115.97	61.50	7.032	0.361	2.197
8	133.27	70.70	8.739	0.274	2.160
9	159.30	84.80	11.337	-0.105	2.116
10	79.87	42.40	10.514	-0.278	2.144
11	79.83	42.40	10.483	-0.329	2.147
12	79.93	42.60	10.555	-0.439	2.151
13	74.18	43.00	10.555	-0.439	2.151
14	70.40	45.40	10.551	-0.437	2.151
15	67.45	48.90	10.529	-0.426	2.151
16	64.97	52.60	10.498	-0.411	2.151
17	61.98	55.80	10.468	-0.396	2.151
18	59.50	59.50	10.408	-0.366	2.151
19	58.30	58.30	10.378	-0.351	2.151
20	57.30	57.30	10.347	-0.335	2.151
21	56.40	56.40	10.317	-0.320	2.151
22	56.30	56.30	10.287	-0.305	2.151
23	55.40	55.40	10.261	-0.292	2.151
24	55.20	55.20	10.230	-0.277	2.151
25	54.80	54.80	10.204	-0.264	2.151
26	54.40	54.40	10.174	-0.249	2.151
27	54.00	54.00	10.151	-0.237	2.151
28	52.60	52.60	10.113	-0.218	2.151
29	50.80	50.80	10.083	-0.203	2.151

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 754 (REMOULDED SAMPLE)
TEST RESULTS START 240485 END 80585

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.314	0.172	1.658	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.639	0.267	2.172	9.5	0.4	0.229	0.229
3	66.3	35.1	31.2	45.5	2.088	0.365	2.819	20.3	0.8	0.343	0.572
4	76.3	40.4	35.9	52.4	2.825	0.462	3.748	32.8	1.6	0.597	1.169
5	87.8	46.5	41.3	60.3	3.935	0.503	4.942	47.2	2.7	0.947	2.116
6	100.9	53.5	47.4	69.3	5.306	0.461	6.227	63.6	4.0	1.250	3.367
7	116.0	61.5	54.5	79.7	7.032	0.361	7.753	82.5	5.7	1.757	5.123
8	133.3	70.7	62.6	91.6	8.739	0.274	9.287	104.1	7.4	2.013	7.136
9	159.3	84.8	74.5	109.6	11.337	-0.105	11.128	136.9	10.0	3.212	10.348
10	79.9	42.4	37.5	54.9	10.514	-0.278	9.959	37.4	9.2	-1.204	9.143
11	79.8	42.4	37.4	54.9	10.483	-0.329	9.826	37.4	9.2	-0.068	9.076
12	79.9	42.6	37.3	55.0	10.555	-0.439	9.677	37.6	9.3	-0.037	9.039
13	74.2	43.0	31.2	53.4	10.555	-0.439	9.677	33.6	9.3	0.0	9.039
14	70.4	45.4	25.0	53.7	10.551	-0.437	9.677	33.6	9.3	-0.001	9.038
15	67.4	48.9	18.6	55.1	10.529	-0.426	9.677	36.2	9.3	-0.005	9.033
16	65.0	52.6	12.4	56.7	10.498	-0.411	9.677	39.8	9.2	-0.005	9.028
17	62.0	55.8	6.2	57.9	10.468	-0.396	9.677	43.1	9.2	-0.003	9.026
18	59.5	59.5	0.0	59.5	10.408	-0.366	9.677	47.6	9.1	-0.002	9.024
19	58.3	58.3	0.0	58.3	10.378	-0.351	9.677	45.7	9.1	0.0	9.024
20	57.3	57.3	0.0	57.3	10.347	-0.335	9.677	44.2	9.1	0.0	9.024
21	56.4	56.4	0.0	56.4	10.317	-0.320	9.677	42.8	9.0	0.0	9.024
22	56.3	56.3	0.0	56.3	10.287	-0.305	9.677	42.6	9.0	0.0	9.024
23	55.4	55.4	0.0	55.4	10.261	-0.292	9.677	41.2	9.0	0.0	9.024
24	55.2	55.2	0.0	55.2	10.230	-0.277	9.677	40.9	8.9	0.0	9.024
25	54.8	54.8	0.0	54.8	10.204	-0.264	9.677	40.3	8.9	0.0	9.024
26	54.4	54.4	0.0	54.4	10.174	-0.249	9.677	39.7	8.9	0.0	9.024
27	54.0	54.0	0.0	54.0	10.151	-0.237	9.677	39.1	8.9	0.0	9.024
28	52.6	52.6	0.0	52.6	10.113	-0.218	9.677	37.0	8.8	0.0	9.024
29	50.8	50.8	0.0	50.8	10.083	-0.203	9.677	34.4	8.8	0.0	9.024

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 754 (REMOULDED SAMPLE)
TEST RESULTS START 240485 END 80585

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.323	0.175	1.672	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.653	0.272	2.196	9.5	0.4	0.233	0.233
3	66.3	35.1	31.2	45.5	2.110	0.375	2.860	20.3	0.8	0.351	0.584
4	76.3	40.4	35.9	52.4	2.865	0.477	3.820	32.8	1.6	0.616	1.199
5	87.8	46.5	41.3	60.3	4.015	0.527	5.068	47.2	2.7	0.986	2.185
6	100.9	53.5	47.4	69.3	5.452	0.489	6.429	63.6	4.2	1.318	3.503
7	116.0	61.5	54.5	79.7	7.291	0.389	8.070	82.5	6.0	1.880	5.383
8	133.3	70.7	62.6	91.6	9.144	0.301	9.747	104.1	7.8	2.193	7.576
9	159.3	84.8	74.5	109.6	12.032	-0.118	11.797	136.9	10.7	3.573	11.149
10	79.9	42.4	37.5	54.9	11.108	-0.309	10.490	37.4	9.8	-1.349	9.800
11	79.8	42.4	37.4	54.9	11.074	-0.366	10.343	37.4	9.8	-0.075	9.725
12	79.9	42.6	37.3	55.0	11.154	-0.489	10.177	37.6	9.9	-0.040	9.685
13	74.2	43.0	31.2	53.4	11.154	-0.489	10.177	33.6	9.9	0.0	9.685
14	70.4	45.4	25.0	53.7	11.150	-0.487	10.177	33.6	9.9	-0.001	9.684
15	67.4	48.9	18.6	55.1	11.125	-0.474	10.177	36.2	9.8	-0.006	9.678
16	65.0	52.6	12.4	56.7	11.091	-0.457	10.177	39.8	9.8	-0.005	9.673
17	62.0	55.8	6.2	57.9	11.057	-0.440	10.177	43.1	9.8	-0.003	9.670
18	59.5	59.5	0.0	59.5	10.990	-0.406	10.177	47.6	9.7	-0.002	9.668
19	58.3	58.3	0.0	58.3	10.956	-0.390	10.177	45.7	9.7	-0.000	9.668
20	57.3	57.3	0.0	57.3	10.922	-0.373	10.177	44.2	9.6	-0.000	9.668
21	56.4	56.4	0.0	56.4	10.889	-0.356	10.177	42.8	9.6	-0.000	9.668
22	56.3	56.3	0.0	56.3	10.855	-0.339	10.177	42.6	9.6	0.0	9.668
23	55.4	55.4	0.0	55.4	10.826	-0.324	10.177	41.2	9.5	-0.000	9.668
24	55.2	55.2	0.0	55.2	10.792	-0.307	10.177	40.9	9.5	-0.000	9.668
25	54.8	54.8	0.0	54.8	10.763	-0.293	10.177	40.3	9.5	-0.000	9.668
26	54.4	54.4	0.0	54.4	10.729	-0.276	10.177	39.7	9.4	-0.000	9.668
27	54.0	54.0	0.0	54.0	10.704	-0.263	10.177	39.1	9.4	0.0	9.668
28	52.6	52.6	0.0	52.6	10.662	-0.242	10.177	37.0	9.4	-0.000	9.668
29	50.8	50.8	0.0	50.8	10.628	-0.225	10.177	34.4	9.3	-0.000	9.668

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 754 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.927 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 537.500 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 45.066 SQUARE CENTIMETRES

CONSTANT LOAD : 16.53 N .
PROVING RING FACTOR : 1.2366 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2128.00 DIVISIONS

SHEAR TEST RESULTS START 120585 END 130585

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	904	2128.0	112.0	199.8	0.0	83.1	80.2	1.4	2.9	81.2	1.036	0.0
2	910	2127.8	126.8	199.8	0.00	87.3	80.4	3.5	6.9	82.7	1.086	0.0
3	915	2126.0	133.5	201.0	0.02	88.0	79.2	4.4	8.8	82.1	1.111	0.20
4	920	2124.5	142.0	202.2	0.03	89.0	77.9	5.6	11.1	81.6	1.143	0.29
5	925	2123.5	150.5	203.6	0.04	90.0	76.6	6.7	13.4	81.1	1.175	0.36
6	930	2123.2	158.5	204.9	0.04	90.9	75.3	7.8	15.6	80.5	1.208	0.40
7	940	2121.0	179.2	207.8	0.06	93.6	72.3	10.7	21.3	79.4	1.295	0.43
8	950	2119.6	200.5	210.5	0.07	96.9	69.8	13.6	27.1	78.8	1.389	0.44
9	1000	2119.0	220.0	213.0	0.08	99.7	67.2	16.2	32.5	78.0	1.483	0.45
10	1012	2117.0	240.5	215.5	0.09	103.0	64.9	19.0	38.1	77.6	1.587	0.45
11	1020	2116.8	252.2	216.8	0.09	104.5	63.2	20.7	41.3	77.0	1.654	0.44
12	1030	2114.6	267.3	218.8	0.11	106.8	61.4	22.7	45.4	76.5	1.740	0.45
13	1040	2111.0	280.5	220.3	0.14	108.9	59.9	24.5	49.0	76.2	1.819	0.44
14	1050	2106.5	292.5	221.6	0.18	110.9	58.6	26.2	52.3	76.0	1.893	0.44
15	1100	2100.4	303.5	222.8	0.23	112.6	57.3	27.7	55.3	75.7	1.965	0.44
16	1110	2094.0	313.0	223.8	0.29	114.3	56.5	28.9	57.8	75.8	2.024	0.44
17	1120	2087.8	322.0	224.8	0.34	115.8	55.5	30.1	60.3	75.6	2.086	0.44
18	1130	2080.8	332.0	225.3	0.40	117.9	54.9	31.5	63.0	75.9	2.147	0.42
19	1140	2075.0	340.0	226.2	0.44	119.1	53.9	32.6	65.2	75.6	2.209	0.42
20	1150	2068.0	350.0	226.9	0.50	121.0	53.1	33.9	67.9	75.7	2.278	0.42
21	1200	2080.5	358.0	227.5	0.57	122.5	52.5	35.0	70.0	75.8	2.333	0.41
22	1215	2050.0	369.0	228.4	0.65	124.6	51.7	36.5	72.9	76.0	2.410	0.41
23	1230	2038.0	380.0	228.9	0.75	127.0	51.1	37.9	75.9	76.4	2.484	0.40
24	1245	2027.0	389.0	229.5	0.85	128.9	50.7	39.1	78.2	76.8	2.543	0.39
25	1300	2015.0	398.5	230.0	0.95	130.8	50.1	40.4	80.7	77.0	2.611	0.39
26	1330	1991.0	412.5	230.2	1.15	134.3	50.0	42.2	84.3	78.1	2.687	0.37
27	1345	1978.5	418.5	230.3	1.25	135.9	50.0	42.9	85.9	78.6	2.717	0.37
28	1400	1965.5	423.0	230.2	1.36	137.0	50.0	43.5	87.0	79.0	2.740	0.36
29	1430	1939.0	429.8	230.3	1.58	138.5	49.8	44.3	88.7	79.4	2.780	0.36
30	1500	1911.0	434.5	230.4	1.82	139.3	49.6	44.9	89.7	79.5	2.809	0.35
31	1530	1885.0	438.0	230.9	2.04	139.7	49.3	45.2	90.4	79.4	2.834	0.36
32	1600	1857.0	440.4	230.8	2.27	140.4	49.5	45.4	90.9	79.8	2.835	0.35
33	1634	1825.5	442.0	230.4	2.54	140.7	49.6	45.5	91.1	80.0	2.836	0.35
34	1700	1802.0	442.8	230.5	2.73	140.6	49.5	45.6	91.1	79.9	2.840	0.35
35	1730	1774.5	443.4	231.0	2.96	140.1	49.1	45.5	91.0	79.4	2.854	0.35
36	1800	1745.0	443.5	231.1	3.21	140.0	49.2	45.4	90.8	79.5	2.846	0.36
37	1900	1688.5	443.0	231.5	3.88	138.9	48.7	45.1	90.2	78.8	2.853	0.36
38	2000	1632.0	441.8	232.1	4.16	137.7	48.2	44.7	89.5	78.0	2.856	0.37
39	2104	1571.0	441.5	232.5	4.67	136.7	47.8	44.5	88.9	77.4	2.860	0.38
40	2200	1518.5	441.0	233.0	5.11	135.7	47.3	44.2	88.4	76.8	2.868	0.39
41	2300	1461.0	440.0	233.1	5.59	134.6	46.9	43.8	87.7	76.1	2.870	0.39
42	2400	1405.0	439.8	233.5	6.06	134.0	46.8	43.6	87.2	75.9	2.863	0.40
43	100	1348.5	439.0	233.7	6.54	133.0	46.4	43.3	86.6	75.3	2.865	0.41
44	630	1036.0	435.0	235.2	9.16	128.1	45.0	41.6	83.1	72.7	2.847	0.44
45	800	951.0	434.5	235.7	9.87	126.9	44.6	41.2	82.3	72.0	2.846	0.45
46	900	893.0	434.0	235.9	10.35	126.3	44.5	40.9	81.8	71.8	2.837	0.46
47	1000	836.5	434.0	236.2	10.83	125.4	44.1	40.7	81.3	71.2	2.844	0.46
48	1100	780.5	433.5	236.2	11.30	124.6	43.8	40.4	80.8	70.7	2.845	0.47
49	1200	724.0	433.0	236.7	11.77	123.7	43.4	40.1	80.3	70.2	2.849	0.48
50	1310	658.0	432.0	237.0	12.32	122.5	43.0	39.8	79.5	69.5	2.849	0.49

SAMPLE NO. : T 754 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 83.10 KPA
PRECONSOLIDATION PRESSURE : 159.30 KPA
NORMALIZING STRESS : 159.30 KPA

NORMALIZED SHEAR TEST RESULTS START 120585 END 130585

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.009	1.036	0.510	0.0
2	0.00	0.022	1.086	0.519	0.0
3	0.02	0.028	1.111	0.516	0.008
4	0.03	0.035	1.143	0.512	0.015
5	0.04	0.042	1.175	0.509	0.024
6	0.04	0.049	1.208	0.505	0.032
7	0.06	0.067	1.295	0.498	0.050
8	0.07	0.085	1.389	0.495	0.067
9	0.08	0.102	1.483	0.490	0.083
10	0.09	0.120	1.587	0.487	0.099
11	0.09	0.130	1.654	0.483	0.107
12	0.11	0.143	1.740	0.481	0.119
13	0.14	0.154	1.819	0.479	0.129
14	0.18	0.164	1.893	0.477	0.137
15	0.23	0.174	1.965	0.475	0.144
16	0.29	0.182	2.024	0.476	0.151
17	0.34	0.189	2.086	0.475	0.157
18	0.40	0.198	2.147	0.476	0.160
19	0.44	0.204	2.209	0.475	0.166
20	0.50	0.213	2.278	0.475	0.170
21	0.57	0.220	2.333	0.476	0.174
22	0.65	0.229	2.410	0.477	0.180
23	0.75	0.238	2.484	0.479	0.183
24	0.85	0.245	2.543	0.482	0.186
25	0.95	0.253	2.611	0.483	0.190
26	1.15	0.265	2.687	0.490	0.191
27	1.25	0.270	2.717	0.494	0.191
28	1.36	0.273	2.740	0.496	0.191
29	1.58	0.278	2.780	0.498	0.191
30	1.82	0.282	2.809	0.499	0.192
31	2.04	0.284	2.834	0.499	0.195
32	2.27	0.285	2.835	0.501	0.195
33	2.54	0.286	2.836	0.502	0.192
34	2.73	0.286	2.840	0.501	0.193
35	2.96	0.286	2.854	0.499	0.196
36	3.21	0.285	2.846	0.498	0.196
37	3.68	0.283	2.853	0.495	0.198
38	4.16	0.281	2.856	0.490	0.203
39	4.67	0.279	2.860	0.486	0.205
40	5.11	0.277	2.868	0.482	0.208
41	5.59	0.275	2.870	0.478	0.209
42	6.06	0.274	2.863	0.476	0.212
43	6.54	0.272	2.865	0.472	0.213
44	8.16	0.261	2.847	0.456	0.222
45	9.87	0.258	2.846	0.452	0.225
46	10.35	0.257	2.837	0.450	0.227
47	10.83	0.255	2.844	0.447	0.228
48	11.30	0.254	2.845	0.444	0.228
49	11.77	0.252	2.849	0.440	0.232
50	12.32	0.250	2.848	0.436	0.234

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 755 (REMOULDED SAMPLE)

INITIAL MOISTURE CONTENT	:	50.6 PERCENT
SPECIFIC GRAVITY OF SOIL	:	2.73
INITIAL VOID RATIO	:	1.381
INITIAL HEIGHT OF SAMPLE	:	13.24 CM
INITIAL VOLUME OF SAMPLE	:	603.00 CC
EFFECTIVE PRINCIPAL STRESS RATIO	:	1.00
FINAL MOISTURE CONTENT	:	41.3 PERCENT

TX. CONSOLIDATION START 250485 END 90585
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.08	26.50	1.613	1.841	0.114	34.36	23.58	1.338	2.338	0.999
2	57.70	30.50	2.017	2.521	0.252	39.57	27.20	1.321	2.321	1.176
3	66.45	35.20	2.583	3.300	0.359	45.62	31.25	1.303	2.303	1.483
4	76.45	40.50	3.444	4.303	0.430	52.48	35.95	1.279	2.279	2.010
5	87.93	46.60	4.547	5.423	0.438	60.38	41.33	1.252	2.252	2.739
6	101.06	53.60	6.073	6.882	0.405	69.42	47.46	1.217	2.217	3.778
7	116.16	61.60	7.666	8.383	0.358	79.79	54.56	1.182	2.182	4.872
8	133.50	70.80	9.282	9.842	0.280	91.70	62.70	1.147	2.147	6.002
9	159.52	84.80	11.699	11.716	0.009	109.71	74.72	1.102	2.102	7.794
10	79.83	42.40	10.801	10.373	-0.214	54.88	37.43	1.134	2.134	7.343
11	79.80	42.40	10.770	10.257	-0.257	54.87	37.40	1.137	2.137	7.351
12	79.90	42.40	10.952	10.705	-0.123	54.90	37.50	1.126	2.126	7.383
13	73.95	42.70	10.952	10.705	-0.123	53.12	31.25	1.126	2.126	7.383
14	69.03	44.00	10.948	10.705	-0.122	52.34	25.03	1.126	2.126	7.380
15	65.53	46.80	10.925	10.705	-0.110	53.04	18.73	1.126	2.126	7.357
16	62.21	49.70	10.891	10.705	-0.093	53.87	12.51	1.126	2.126	7.323
17	59.19	52.90	10.838	10.705	-0.067	55.00	6.29	1.126	2.126	7.270
18	55.80	55.80	10.763	10.705	-0.029	55.80	0.0	1.126	2.126	7.195
19	55.80	55.80	10.718	10.705	-0.006	55.80	0.0	1.126	2.126	7.149
20	58.80	58.80	10.695	10.705	0.005	58.80	0.0	1.126	2.126	7.127
21	58.80	58.80	10.680	10.705	0.013	58.80	0.0	1.120	2.126	7.111
22	58.70	58.70	10.665	10.705	0.020	58.70	0.0	1.126	2.126	7.096
23	58.50	58.50	10.642	10.705	0.031	58.50	0.0	1.126	2.126	7.074
24	58.00	58.00	10.627	10.705	0.039	58.00	0.0	1.126	2.126	7.059
25	57.90	57.90	10.604	10.705	0.050	57.90	0.0	1.126	2.126	7.036
26	57.20	57.20	10.585	10.705	0.060	57.20	0.0	1.126	2.126	7.017
27	56.70	56.70	10.566	10.705	0.069	56.70	0.0	1.126	2.126	6.998
28	55.50	55.50	10.544	10.705	0.081	55.50	0.0	1.126	2.126	6.976
29	52.30	52.30	10.544	10.705	0.081	52.30	0.0	1.126	2.126	6.976

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.08	26.50	1.613	0.114	2.338
2	57.70	30.50	2.017	0.252	2.321
3	66.45	35.20	2.583	0.359	2.303
4	76.45	40.50	3.444	0.430	2.279
5	87.93	46.60	4.547	0.438	2.252
6	101.06	53.60	6.073	0.405	2.217
7	116.16	61.60	7.666	0.358	2.182
8	133.50	70.80	9.282	0.280	2.147
9	159.52	84.80	11.699	0.009	2.102
10	79.83	42.40	10.801	-0.214	2.134
11	79.80	42.40	10.770	-0.257	2.137
12	79.90	42.40	10.952	-0.123	2.126
13	73.95	42.70	10.952	-0.123	2.126
14	69.03	44.00	10.948	-0.122	2.126
15	65.53	46.80	10.925	-0.110	2.126
16	62.21	49.70	10.891	-0.093	2.126
17	59.19	52.90	10.838	-0.067	2.126
18	55.80	55.80	10.763	-0.029	2.126
19	55.80	55.80	10.718	-0.006	2.126
20	58.80	58.80	10.695	0.005	2.126
21	58.80	58.80	10.680	0.013	2.126
22	58.70	58.70	10.665	0.020	2.126
23	58.50	58.50	10.642	0.031	2.126
24	58.00	58.00	10.627	0.039	2.126
25	57.90	57.90	10.604	0.050	2.126
26	57.20	57.20	10.585	0.060	2.126
27	56.70	56.70	10.566	0.069	2.126
28	55.50	55.50	10.544	0.081	2.126
29	52.30	52.30	10.544	0.081	2.126

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 755 (REMOULDED SAMPLE)
TEST RESULTS START 250485 END 90585

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	1.613	0.114	1.841	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.017	0.252	2.521	9.5	0.4	0.296	0.296
3	66.4	35.2	31.3	45.6	2.583	0.359	3.300	20.5	1.0	0.422	0.718
4	76.4	40.5	35.9	52.5	3.444	0.430	4.303	33.0	1.9	0.669	1.387
5	87.9	46.6	41.3	60.4	4.547	0.438	5.423	47.3	3.0	0.914	2.301
6	101.1	53.6	47.5	69.4	6.073	0.405	6.882	63.8	4.5	1.408	3.709
7	116.2	61.6	54.6	79.8	7.666	0.358	8.383	82.6	6.1	1.677	5.386
8	133.5	70.8	62.7	91.7	9.282	0.280	9.842	104.3	7.7	1.914	7.300
9	159.5	84.8	74.7	109.7	11.699	0.009	11.716	137.0	10.1	3.119	10.419
10	79.8	42.4	37.4	54.9	10.801	-0.214	10.373	37.3	9.2	-1.358	9.061
11	79.8	42.4	37.4	54.9	10.770	-0.257	10.257	37.3	9.2	-0.061	9.000
12	79.9	42.4	37.5	54.9	10.952	-0.123	10.705	37.3	9.3	0.258	9.258
13	73.9	42.7	31.3	53.1	10.952	-0.123	10.705	33.1	9.3	0.0	9.258
14	69.0	44.0	25.0	52.3	10.948	-0.122	10.705	31.2	9.3	-0.001	9.257
15	65.5	46.8	18.7	53.0	10.925	-0.110	10.705	32.6	9.3	-0.005	9.252
16	62.2	49.7	12.5	53.9	10.891	-0.093	10.705	35.0	9.3	-0.005	9.246
17	59.2	52.9	6.3	55.0	10.838	-0.067	10.705	38.4	9.2	-0.005	9.241
18	55.8	55.8	0.0	55.8	10.763	-0.029	10.705	41.8	9.2	-0.002	9.239
19	55.8	55.8	0.0	55.8	10.718	-0.006	10.705	41.8	9.1	0.0	9.239
20	58.8	58.8	0.0	58.8	10.695	0.005	10.705	46.5	9.1	0.0	9.239
21	58.8	58.8	0.0	58.8	10.680	0.013	10.705	46.5	9.1	0.0	9.239
22	58.7	58.7	0.0	58.7	10.665	0.020	10.705	46.3	9.1	0.0	9.239
23	58.5	58.5	0.0	58.5	10.642	0.031	10.705	46.0	9.0	0.0	9.239
24	58.0	58.0	0.0	58.0	10.627	0.039	10.705	45.2	9.0	0.0	9.239
25	57.9	57.9	0.0	57.9	10.604	0.050	10.705	45.1	9.0	0.0	9.239
26	57.2	57.2	0.0	57.2	10.585	0.060	10.705	44.0	9.0	0.0	9.239
27	56.7	56.7	0.0	56.7	10.566	0.069	10.705	43.2	9.0	0.0	9.239
28	55.5	55.5	0.0	55.5	10.544	0.081	10.705	41.4	8.9	0.0	9.239
29	52.3	52.3	0.0	52.3	10.544	0.081	10.705	36.6	8.9	0.0	9.239

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 755 (REMOULDED SAMPLE)
TEST RESULTS START 250485 END 90585

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	1.626	0.116	1.858	0.0	0.0		0.0
2	57.7	30.5	27.2	39.6	2.037	0.258	2.563	9.5	0.5	0.303	0.303
3	66.4	35.2	31.3	45.6	2.617	0.369	3.356	20.5	1.1	0.433	0.736
4	76.4	40.5	35.9	52.5	3.505	0.447	4.399	33.0	1.9	0.693	1.429
5	87.9	46.6	41.3	60.4	4.653	0.461	5.575	47.3	3.1	0.956	2.385
6	101.1	53.6	47.5	69.4	6.265	0.433	7.130	63.8	4.7	1.494	3.879
7	116.2	61.6	54.6	79.8	7.976	0.390	8.755	82.6	6.4	1.809	5.688
8	133.5	70.8	62.7	91.7	9.742	0.310	10.361	104.3	8.1	2.098	7.787
9	159.5	84.8	74.7	109.7	12.442	0.010	12.461	137.0	10.8	3.489	11.276
10	79.8	42.4	37.4	54.9	11.429	-0.239	10.951	37.3	9.8	-1.528	9.748
11	79.8	42.4	37.4	54.9	11.395	-0.287	10.822	37.3	9.8	-0.068	9.680
12	79.9	42.4	37.5	54.9	11.599	-0.138	11.322	37.3	10.0	0.288	9.968
13	73.3	42.7	31.3	53.1	11.599	-0.138	11.322	33.1	10.0	0.0	9.968
14	69.0	44.0	25.0	52.3	11.594	-0.136	11.322	31.2	10.0	-0.001	9.967
15	65.5	46.8	18.7	53.0	11.569	-0.124	11.322	32.6	9.9	-0.006	9.962
16	62.2	49.7	12.5	53.9	11.531	-0.104	11.322	35.0	9.9	-0.006	9.956
17	59.2	52.9	6.3	55.0	11.472	-0.075	11.322	38.4	9.8	-0.006	9.950
18	55.8	55.8	0.0	55.8	11.387	-0.032	11.322	41.8	9.8	-0.003	9.947
19	55.8	55.8	0.0	55.8	11.336	-0.007	11.322	41.8	9.7	-0.000	9.947
20	58.8	58.8	0.0	58.8	11.311	0.006	11.322	46.5	9.7	-0.000	9.947
21	58.8	58.8	0.0	58.8	11.294	0.014	11.322	46.5	9.7	-0.000	9.947
22	58.7	58.7	0.0	58.7	11.277	0.023	11.322	46.3	9.7	-0.000	9.947
23	58.5	58.5	0.0	58.5	11.252	0.035	11.322	46.0	9.6	-0.000	9.947
24	58.0	58.0	0.0	58.0	11.235	0.044	11.322	45.2	9.6	-0.000	9.947
25	57.9	57.9	0.0	57.9	11.209	0.056	11.322	45.1	9.6	-0.000	9.947
26	57.2	57.2	0.0	57.2	11.188	0.067	11.322	44.0	9.6	-0.000	9.947
27	56.7	56.7	0.0	56.7	11.167	0.077	11.322	43.2	9.5	-0.000	9.947
28	55.5	55.5	0.0	55.5	11.142	0.090	11.322	41.4	9.5	-0.000	9.947
29	52.3	52.3	0.0	52.3	11.142	0.090	11.322	36.6	9.5	0.0	9.947

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 755 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.870 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 535.900 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 44.770 SQUARE CENTIMETRES

CONSTANT LOAD : 15.06 N .
PROVING RING FACTOR : 0.4177 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 1830.00 DIVISIONS

SHEAR TEST RESULTS START 140585 END 150585

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	935	1830.0	318.0	199.9	0.0	81.8	80.5	0.6	1.3	80.9	1.016	0.0
2	945	1829.0	334.0	200.0	0.01	83.3	80.5	1.4	2.8	81.4	1.034	0.07
3	950	1828.9	344.5	200.2	0.01	83.6	79.8	1.9	3.8	81.1	1.048	0.12
4	1000	1826.5	362.5	200.9	0.03	84.8	79.3	2.7	5.5	81.1	1.069	0.24
5	1005	1825.5	373.0	201.3	0.04	85.3	78.9	3.2	6.4	81.0	1.082	0.27
6	1010	1825.0	384.0	202.1	0.04	85.6	78.1	3.7	7.5	80.6	1.095	0.36
7	1015	1824.0	397.0	202.5	0.05	86.4	77.7	4.3	8.7	80.6	1.112	0.35
8	1020	1823.5	409.8	203.3	0.05	86.8	76.9	4.9	9.9	80.2	1.128	0.40
9	1025	1823.0	421.0	203.9	0.06	87.4	76.5	5.4	10.9	80.1	1.142	0.42
10	1030	1822.0	437.0	204.8	0.07	87.9	75.5	6.2	12.4	79.6	1.164	0.44
11	1035	1821.5	446.5	205.0	0.07	88.3	75.1	6.6	13.2	79.5	1.176	0.43
12	1040	1821.0	458.0	205.6	0.08	89.0	74.7	7.2	14.3	79.5	1.192	0.44
13	1046	1820.4	470.6	206.5	0.08	89.1	73.6	7.8	15.5	78.8	1.211	0.46
14	1050	1819.5	479.5	206.9	0.09	89.8	73.5	8.2	16.3	78.9	1.222	0.47
15	1055	1819.0	490.0	207.4	0.09	90.1	72.8	8.7	17.3	78.6	1.238	0.47
16	1100	1818.0	501.0	207.6	0.10	91.0	72.7	9.2	18.3	78.8	1.252	0.45
17	1115	1815.0	535.0	209.5	0.13	92.3	70.8	10.8	21.5	78.0	1.304	0.47
18	1130	1812.0	567.3	211.8	0.15	92.9	68.4	12.3	24.5	76.6	1.359	0.51
19	1145	1809.0	595.2	213.1	0.18	94.1	67.0	13.6	27.1	76.0	1.405	0.51
20	1200	1805.0	625.0	214.5	0.21	95.5	65.6	14.9	29.9	75.6	1.456	0.51
21	1215	1800.5	651.6	216.3	0.25	96.1	63.8	16.2	32.3	74.6	1.507	0.53
22	1230	1796.5	677.0	217.6	0.28	97.7	63.0	17.3	34.7	74.6	1.550	0.53
23	1245	1791.5	702.0	218.4	0.32	98.6	61.6	18.5	37.0	73.9	1.601	0.52
24	1300	1786.0	726.0	219.8	0.37	99.6	60.4	19.6	39.2	73.5	1.649	0.52
25	1320	1778.0	755.0	221.5	0.43	100.7	58.8	20.9	41.9	72.8	1.712	0.53
26	1340	1770.0	782.0	222.7	0.50	102.0	57.6	22.2	44.4	72.4	1.770	0.53
27	1400	1762.0	810.0	224.2	0.57	102.9	56.0	23.5	46.9	71.6	1.838	0.53
28	1420	1754.0	834.5	225.3	0.63	104.1	54.9	24.6	49.2	71.3	1.896	0.53
29	1440	1745.0	862.0	226.3	0.71	105.7	54.0	25.8	51.7	71.2	1.957	0.52
30	1500	1735.0	886.0	227.2	0.79	106.9	53.0	26.9	53.9	71.0	2.016	0.52
31	1530	1722.5	919.0	228.3	0.90	108.8	51.9	28.4	56.9	70.9	2.096	0.51
32	1600	1708.0	954.0	229.4	1.02	110.9	50.9	30.0	60.0	70.9	2.179	0.50
33	1630	1693.5	984.5	230.2	1.14	113.0	50.3	31.4	62.7	71.2	2.247	0.49
34	1700	1678.0	1012.0	231.5	1.27	113.9	48.7	32.6	65.2	70.4	2.339	0.49
35	1730	1662.0	1040.5	231.9	1.40	116.0	48.3	33.9	67.7	70.9	2.403	0.48
36	1800	1646.0	1065.5	232.6	1.54	117.5	47.5	35.0	70.0	70.8	2.473	0.48
37	1830	1629.5	1088.0	233.0	1.68	119.2	47.3	36.0	71.9	71.3	2.520	0.47
38	1900	1612.5	1110.0	233.7	1.82	120.2	46.4	36.9	73.8	71.0	2.591	0.47
39	1930	1595.0	1127.0	233.8	1.96	121.8	46.5	37.6	75.3	71.6	2.619	0.46
40	2000	1576.0	1146.0	234.0	2.12	123.0	46.2	38.4	76.8	71.8	2.662	0.45
41	2030	1557.0	1159.0	234.3	2.28	124.0	46.1	39.0	77.9	72.1	2.690	0.45
42	2100	1538.0	1172.5	234.5	2.44	124.6	45.5	39.5	79.1	71.9	2.738	0.44
43	2200	1498.0	1194.0	234.5	2.77	126.6	45.9	40.4	80.7	72.8	2.758	0.44
44	2300	1456.5	1212.0	234.3	3.12	128.0	45.9	41.0	82.1	73.3	2.788	0.43
45	2401	1414.0	1225.0	234.5	3.48	128.6	45.7	41.5	82.9	73.3	2.815	0.42
46	145	1337.5	1233.5	234.8	4.11	128.4	45.2	41.6	83.2	72.9	2.840	0.43
47	538	1164.0	1242.4	235.3	5.56	127.6	44.9	41.3	82.7	72.5	2.841	0.43
48	700	1103.0	1243.0	235.4	6.07	127.3	45.0	41.1	82.3	72.4	2.828	0.44
49	800	1057.0	1241.5	235.5	6.46	126.8	45.0	40.9	81.8	72.3	2.817	0.44
50	900	1011.5	1238.0	235.8	6.84	125.6	44.4	40.6	81.2	71.5	2.828	0.45
51	1000	964.0	1234.0	235.8	7.23	124.7	44.2	40.3	80.5	71.0	2.821	0.45
52	1100	919.0	1232.0	235.6	7.61	124.6	44.6	40.0	80.0	71.3	2.793	0.45
53	1203	872.0	1232.0	236.2	8.00	123.8	44.2	39.8	79.6	70.7	2.802	0.46
54	1300	828.0	1232.0	236.2	8.37	123.5	44.2	39.7	79.3	70.6	2.794	0.47
55	1400	782.5	1230.0	236.3	8.75	122.8	44.0	39.4	78.8	70.3	2.791	0.47
56	1500	737.2	1228.2	236.7	9.13	121.8	43.4	39.2	78.4	69.5	2.806	0.48
57	1600	691.5	1225.0	236.9	9.51	121.1	43.3	38.9	77.8	69.2	2.796	0.48
58	1700	645.0	1223.0	237.0	9.90	120.7	43.5	38.6	77.2	69.2	2.775	0.49
59	1800	601.0	1221.8	237.5	10.27	119.8	43.0	38.4	76.8	68.6	2.786	0.50
60	1900	555.0	1222.0	237.6	10.65	119.4	42.9	38.2	76.5	68.4	2.783	0.50
61	2100	464.0	1221.8	237.9	11.41	118.2	42.4	37.9	75.8	67.7	2.789	0.51
62	2235	393.0	1218.0	238.0	12.01	117.5	42.5	37.5	75.0	67.5	2.765	0.52

SAMPLE NO. : T 755 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 81.78 KPA
PRECONSOLIDATION PRESSURE : 159.52 KPA
NORMALIZING STRESS : 159.52 KPA

NORMALIZED SHEAR TEST RESULTS START 140585 END 150585

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.004	1.016	0.507	0.0
2	0.01	0.009	1.034	0.510	0.001
3	0.01	0.012	1.048	0.508	0.002
4	0.03	0.017	1.069	0.509	0.006
5	0.04	0.020	1.082	0.508	0.009
6	0.04	0.023	1.095	0.505	0.014
7	0.05	0.027	1.112	0.505	0.016
8	0.05	0.031	1.128	0.503	0.021
9	0.06	0.034	1.142	0.502	0.025
10	0.07	0.039	1.164	0.499	0.031
11	0.07	0.041	1.176	0.498	0.032
12	0.08	0.045	1.192	0.498	0.036
13	0.08	0.049	1.211	0.494	0.041
14	0.09	0.051	1.222	0.495	0.044
15	0.09	0.054	1.238	0.493	0.047
16	0.10	0.058	1.252	0.494	0.048
17	0.13	0.067	1.304	0.489	0.060
18	0.15	0.077	1.359	0.480	0.075
19	0.18	0.085	1.405	0.477	0.083
20	0.21	0.094	1.456	0.474	0.092
21	0.25	0.101	1.507	0.468	0.103
22	0.28	0.109	1.550	0.467	0.111
23	0.32	0.116	1.601	0.464	0.116
24	0.37	0.123	1.649	0.461	0.125
25	0.43	0.131	1.712	0.456	0.135
26	0.50	0.139	1.770	0.454	0.143
27	0.57	0.147	1.838	0.449	0.152
28	0.63	0.154	1.896	0.447	0.159
29	0.71	0.162	1.957	0.446	0.165
30	0.79	0.169	2.016	0.445	0.171
31	0.90	0.178	2.096	0.444	0.178
32	1.02	0.188	2.179	0.444	0.185
33	1.14	0.197	2.247	0.446	0.190
34	1.27	0.204	2.339	0.442	0.198
35	1.40	0.212	2.403	0.444	0.201
36	1.54	0.219	2.473	0.444	0.205
37	1.68	0.225	2.520	0.447	0.207
38	1.82	0.231	2.591	0.445	0.212
39	1.96	0.236	2.619	0.449	0.213
40	2.12	0.241	2.662	0.450	0.214
41	2.28	0.244	2.690	0.452	0.216
42	2.44	0.248	2.738	0.450	0.217
43	2.77	0.253	2.758	0.456	0.217
44	3.12	0.257	2.788	0.459	0.216
45	3.48	0.260	2.816	0.460	0.217
46	4.11	0.261	2.840	0.457	0.219
47	5.66	0.259	2.841	0.454	0.222
48	6.07	0.258	2.828	0.454	0.223
49	6.46	0.256	2.817	0.453	0.223
50	6.84	0.254	2.828	0.448	0.225
51	7.23	0.252	2.821	0.445	0.225
52	7.61	0.251	2.793	0.447	0.224
53	8.00	0.250	2.802	0.443	0.228
54	8.37	0.249	2.794	0.443	0.228
55	8.75	0.247	2.791	0.441	0.228
56	9.13	0.246	2.806	0.436	0.231
57	9.51	0.244	2.796	0.434	0.232
58	9.90	0.242	2.775	0.434	0.233
59	10.27	0.241	2.786	0.430	0.236
60	10.65	0.240	2.783	0.429	0.236
61	11.41	0.238	2.789	0.424	0.238
62	12.01	0.235	2.765	0.423	0.239

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 758 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.8 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.387
INITIAL HEIGHT OF SAMPLE : 13.24 CM
INITIAL VOLUME OF SAMPLE : 603.00 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 41.8 PERCENT

TX. CONSOLIDATION START 260485 END 100585
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.00	26.50	1.601	1.708	0.053	34.33	23.50	1.346	2.346	1.032
2	57.60	30.50	1.979	2.305	0.163	39.53	27.10	1.332	2.332	1.210
3	66.26	35.10	2.576	3.118	0.271	45.49	31.16	1.312	2.312	1.536
4	76.23	40.40	3.399	4.030	0.316	52.34	35.83	1.291	2.291	2.056
5	87.66	46.50	4.736	5.357	0.310	60.22	41.16	1.259	2.259	2.950
6	100.79	53.40	6.284	6.808	0.262	69.20	47.39	1.224	2.224	4.015
7	115.81	61.40	7.953	8.284	0.165	79.54	54.41	1.189	2.189	5.192
8	132.99	70.60	9.743	9.776	0.016	91.40	62.39	1.153	2.153	6.484
9	159.09	84.80	12.878	11.750	-0.564	109.56	74.29	1.106	2.106	8.961
10	79.94	42.40	11.994	10.539	-0.727	54.91	37.54	1.135	2.135	8.481
11	79.89	42.40	11.949	10.381	-0.784	54.90	37.49	1.139	2.139	8.488
12	79.88	42.40	12.089	10.332	-0.869	54.89	37.48	1.140	2.140	8.626
13	74.51	43.20	12.089	10.332	-0.889	53.64	31.31	1.140	2.140	8.626
14	70.83	45.90	12.089	10.332	-0.869	54.21	24.93	1.140	2.140	8.626
15	67.67	48.90	12.047	10.332	-0.858	55.16	18.77	1.140	2.140	8.603
16	65.11	52.50	12.017	10.332	-0.842	56.70	12.61	1.140	2.140	8.573
17	62.32	56.10	11.968	10.332	-0.818	58.17	6.22	1.140	2.140	8.524
18	60.00	60.00	11.892	10.332	-0.780	60.00	0.0	1.140	2.140	8.448
19	58.90	58.90	11.805	10.332	-0.737	58.90	0.0	1.140	2.140	8.361
20	59.80	59.80	11.788	10.332	-0.727	59.80	0.0	1.140	2.140	8.342
21	59.30	59.30	11.767	10.332	-0.718	59.30	0.0	1.140	2.140	8.323
22	58.50	58.50	11.745	10.332	-0.707	58.50	0.0	1.140	2.140	8.301
23	58.20	58.20	11.730	10.332	-0.699	58.20	0.0	1.140	2.140	8.286
24	58.30	58.30	11.707	10.332	-0.688	58.30	0.0	1.140	2.140	8.283
25	58.20	58.20	11.684	10.332	-0.676	58.20	0.0	1.140	2.140	8.240
26	58.40	58.40	11.669	10.332	-0.669	58.40	0.0	1.140	2.140	8.225
27	58.10	58.10	11.647	10.332	-0.657	58.10	0.0	1.140	2.140	8.203
28	57.40	57.40	11.624	10.332	-0.646	57.40	0.0	1.140	2.140	8.180
29	56.30	56.30	11.601	10.332	-0.635	56.30	0.0	1.140	2.140	8.157

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.00	26.50	1.601	0.053	2.346
2	57.60	30.50	1.979	0.163	2.332
3	66.26	35.10	2.576	0.271	2.312
4	76.23	40.40	3.399	0.316	2.291
5	87.66	46.50	4.736	0.310	2.259
6	100.79	53.40	6.284	0.262	2.224
7	115.81	61.40	7.953	0.165	2.189
8	132.99	70.60	9.743	0.016	2.153
9	159.09	84.80	12.878	-0.564	2.106
10	79.94	42.40	11.994	-0.727	2.135
11	79.89	42.40	11.949	-0.784	2.139
12	79.88	42.40	12.089	-0.869	2.140
13	74.51	43.20	12.089	-0.889	2.140
14	70.83	45.90	12.089	-0.869	2.140
15	67.67	48.90	12.047	-0.858	2.140
16	65.11	52.50	12.017	-0.842	2.140
17	62.32	56.10	11.968	-0.818	2.140
18	60.00	60.00	11.892	-0.780	2.140
19	58.90	58.90	11.805	-0.737	2.140
20	59.80	59.80	11.786	-0.727	2.140
21	59.30	59.30	11.767	-0.718	2.140
22	58.50	58.50	11.745	-0.707	2.140
23	58.20	58.20	11.730	-0.699	2.140
24	58.30	58.30	11.707	-0.688	2.140
25	58.20	58.20	11.684	-0.676	2.140
26	58.40	58.40	11.669	-0.669	2.140
27	58.10	58.10	11.647	-0.657	2.140
28	57.40	57.40	11.624	-0.646	2.140
29	56.30	56.30	11.601	-0.635	2.140

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 756 (REMOULDED SAMPLE)
TEST RESULTS START 260485 END 100585

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.601	0.053	1.708	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.979	0.163	2.305	9.5	0.4	0.266	0.266
3	66.3	35.1	31.2	45.5	2.576	0.271	3.118	20.3	1.0	0.440	0.706
4	76.2	40.4	35.8	52.3	3.399	0.316	4.030	32.8	1.8	0.620	1.326
5	87.7	46.5	41.2	60.2	4.736	0.310	5.357	47.1	3.2	1.091	2.417
6	100.8	53.4	47.4	69.2	6.284	0.262	6.808	63.5	4.7	1.410	3.828
7	115.8	61.4	54.4	79.5	7.953	0.165	8.284	82.3	6.4	1.697	5.524
8	133.0	70.6	62.4	91.4	9.743	0.016	9.776	103.8	8.1	2.030	7.555
9	159.1	84.8	74.3	109.6	12.878	-0.564	11.750	136.7	11.3	3.675	11.230
10	79.9	42.4	37.5	54.9	11.994	-0.727	10.539	37.4	10.5	-1.264	9.966
11	79.9	42.4	37.5	54.9	11.949	-0.784	10.381	37.4	10.4	-0.084	9.882
12	79.9	42.4	37.5	54.9	12.069	-0.869	10.332	37.4	10.5	0.024	9.907
13	74.5	43.2	31.3	53.6	12.069	-0.869	10.332	34.0	10.5	0.0	9.907
14	70.8	45.9	24.9	54.2	12.069	-0.869	10.332	34.4	10.5	0.0	9.907
15	67.7	48.9	18.8	55.2	12.047	-0.858	10.332	36.3	10.5	-0.005	9.902
16	65.1	52.5	12.6	56.7	12.017	-0.842	10.332	39.8	10.5	-0.005	9.897
17	62.3	56.1	6.2	58.2	11.968	-0.818	10.332	43.6	10.4	-0.005	9.892
18	60.0	60.0	0.0	60.0	11.892	-0.780	10.332	48.4	10.4	-0.002	9.890
19	58.9	58.9	0.0	58.9	11.805	-0.737	10.332	46.7	10.3	0.0	9.890
20	59.8	59.8	0.0	59.8	11.786	-0.727	10.332	48.1	10.2	0.0	9.890
21	59.3	59.3	0.0	59.3	11.767	-0.718	10.332	47.3	10.2	0.0	9.890
22	58.5	58.5	0.0	58.5	11.745	-0.707	10.332	46.0	10.2	0.0	9.890
23	58.2	58.2	0.0	58.2	11.730	-0.699	10.332	45.6	10.2	0.0	9.890
24	58.3	58.3	0.0	58.3	11.707	-0.688	10.332	45.7	10.2	0.0	9.890
25	58.2	58.2	0.0	58.2	11.684	-0.676	10.332	45.6	10.1	0.0	9.890
26	58.4	58.4	0.0	58.4	11.669	-0.669	10.332	45.9	10.1	0.0	9.890
27	58.1	58.1	0.0	58.1	11.647	-0.657	10.332	45.4	10.1	0.0	9.890
28	57.4	57.4	0.0	57.4	11.624	-0.646	10.332	44.3	10.1	0.0	9.890
29	56.3	56.3	0.0	56.3	11.601	-0.635	10.332	42.6	10.0	0.0	9.890

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 756 (REMOULDED SAMPLE)
TEST RESULTS START 260485 END 100585

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.614	0.054	1.723	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.999	0.167	2.332	9.5	0.4	0.271	0.271
3	66.3	35.1	31.2	45.5	2.609	0.279	3.167	20.3	1.0	0.452	0.723
4	76.2	40.4	35.8	52.3	3.458	0.328	4.113	32.8	1.9	0.641	1.364
5	87.7	46.5	41.2	60.2	4.851	0.327	5.505	47.1	3.3	1.141	2.505
6	100.8	53.4	47.4	69.2	6.490	0.280	7.050	63.5	4.9	1.497	4.003
7	115.8	61.4	54.4	79.5	8.287	0.180	8.647	82.3	6.7	1.831	5.834
8	133.0	70.6	62.4	91.4	10.251	0.018	10.287	103.8	8.6	2.230	8.063
9	159.1	84.8	74.3	109.6	13.785	-0.643	12.499	136.7	12.2	4.134	12.197
10	79.9	42.4	37.5	54.9	12.776	-0.820	11.136	37.4	11.2	-1.431	10.766
11	79.9	42.4	37.5	54.9	12.724	-0.882	10.961	37.4	11.2	-0.094	10.672
12	79.9	42.4	37.5	54.9	12.862	-0.978	10.905	37.4	11.3	0.028	10.700
13	74.5	43.2	31.3	53.6	12.862	-0.978	10.905	34.0	11.3	0.0	10.700
14	70.8	45.9	24.9	54.2	12.862	-0.978	10.905	34.4	11.3	0.0	10.700
15	67.7	48.9	18.8	55.2	12.836	-0.965	10.905	36.3	11.3	-0.006	10.695
16	65.1	52.5	12.6	56.7	12.802	-0.948	10.905	39.8	11.3	-0.005	10.689
17	62.3	56.1	6.2	58.2	12.746	-0.920	10.905	43.6	11.2	-0.005	10.684
18	60.0	60.0	0.0	60.0	12.660	-0.878	10.905	48.4	11.1	-0.003	10.681
19	58.9	58.9	0.0	58.9	12.562	-0.828	10.905	46.7	11.0	-0.000	10.681
20	59.8	59.8	0.0	59.8	12.540	-0.818	10.905	48.1	11.0	-0.000	10.681
21	59.3	59.3	0.0	59.3	12.519	-0.807	10.905	47.3	11.0	-0.000	10.681
22	58.5	58.5	0.0	58.5	12.493	-0.794	10.905	46.0	10.9	0.000	10.681
23	58.2	58.2	0.0	58.2	12.476	-0.785	10.905	45.6	10.9	-0.000	10.681
24	58.3	58.3	0.0	58.3	12.450	-0.773	10.905	45.7	10.9	-0.000	10.681
25	58.2	58.2	0.0	58.2	12.425	-0.760	10.905	45.6	10.9	-0.000	10.681
26	58.4	58.4	0.0	58.4	12.408	-0.751	10.905	45.9	10.9	-0.000	10.681
27	58.1	58.1	0.0	58.1	12.382	-0.738	10.905	45.4	10.8	-0.000	10.681
28	57.4	57.4	0.0	57.4	12.356	-0.726	10.905	44.3	10.8	-0.000	10.681
29	56.3	56.3	0.0	56.3	12.331	-0.713	10.905	42.6	10.8	-0.000	10.681

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 756 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.788 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 536.600 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 45.521 SQUARE CENTIMETRES

CONSTANT LOAD : 16.52 N .
PROVING RING FACTOR : 1.0225 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2083.00 DIVISIONS

SHEAR TEST RESULTS START 210585 END 220585

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	855	2083.0	149.0	200.0	0.0	86.3	80.4	2.9	5.9	82.4	1.073	0.0
2	900	2082.0	160.5	202.8	0.01	86.1	77.6	4.2	8.5	80.4	1.109	1.08
3	910	2078.5	185.5	206.2	0.03	88.2	74.1	7.0	14.1	78.8	1.190	0.76
4	920	2075.4	210.0	209.4	0.06	90.5	70.9	9.8	19.6	77.4	1.276	0.69
5	930	2071.0	230.0	212.1	0.10	92.0	67.9	12.0	24.1	75.9	1.355	0.66
6	940	2066.0	246.0	214.2	0.14	93.8	66.2	13.8	27.6	75.4	1.417	0.65
7	950	2061.0	260.0	216.0	0.19	95.0	64.2	15.4	30.8	74.5	1.479	0.64
8	1000	2055.0	272.5	217.4	0.24	96.2	62.6	16.8	33.6	73.8	1.536	0.63
9	1010	2049.5	285.0	219.3	0.28	97.2	60.9	18.2	36.3	73.0	1.597	0.63
10	1020	2042.0	296.2	220.3	0.35	98.5	59.7	19.4	38.8	72.6	1.651	0.62
11	1030	2035.5	306.5	222.2	0.40	99.1	58.0	20.6	41.1	71.7	1.709	0.63
12	1045	2024.0	319.5	223.2	0.50	100.8	56.8	22.0	44.0	71.5	1.775	0.61
13	1100	2015.4	332.5	224.9	0.57	102.1	55.3	23.4	46.8	70.9	1.847	0.61
14	1115	2004.5	344.0	226.3	0.67	103.4	54.1	24.7	49.3	70.5	1.912	0.60
15	1130	1992.8	355.0	227.5	0.77	104.6	52.8	25.9	51.8	70.1	1.980	0.60
16	1145	1981.5	365.5	228.1	0.86	106.2	52.2	27.0	54.0	70.2	2.035	0.58
17	1200	1970.0	375.2	229.3	0.96	107.3	51.2	28.1	56.1	69.9	2.096	0.58
18	1215	1958.0	385.0	230.2	1.06	108.6	50.4	29.1	58.2	69.8	2.155	0.58
19	1230	1946.0	394.0	230.5	1.16	110.0	49.8	30.1	60.2	69.9	2.209	0.56
20	1300	1923.0	410.0	232.2	1.36	111.8	48.2	31.8	63.6	69.4	2.320	0.56
21	1330	1897.6	424.0	232.9	1.57	114.0	47.4	33.3	66.6	69.6	2.405	0.54
22	1400	1872.0	436.0	233.3	1.79	115.8	46.7	34.6	69.1	69.7	2.480	0.53
23	1430	1847.0	445.0	234.0	2.00	117.4	46.5	35.5	70.9	70.1	2.525	0.52
24	1500	1820.5	452.5	234.4	2.23	118.2	45.8	36.2	72.4	69.9	2.581	0.52
25	1530	1794.0	458.5	234.9	2.45	118.9	45.3	36.8	73.6	69.8	2.624	0.52
26	1604	1763.0	463.8	235.0	2.71	119.6	45.1	37.3	74.5	69.9	2.653	0.51
27	1630	1739.0	466.9	235.3	2.92	120.2	45.2	37.5	75.0	70.2	2.660	0.51
28	1707	1705.0	470.5	234.9	3.21	121.2	45.6	37.8	75.6	70.8	2.657	0.50
29	1730	1682.0	471.5	234.9	3.40	121.0	45.3	37.8	75.7	70.5	2.670	0.50
30	1800	1655.0	473.5	234.9	3.63	121.3	45.4	38.0	75.9	70.7	2.672	0.50
31	1900	1599.5	474.8	235.2	4.10	120.8	45.0	37.9	75.8	70.3	2.685	0.50
32	2000	1542.0	475.0	235.5	4.59	120.5	45.0	37.7	75.5	70.2	2.677	0.51
33	2100	1487.0	474.0	235.3	5.06	119.8	44.9	37.5	74.9	69.9	2.668	0.51
34	2200	1428.0	472.5	235.5	5.56	119.0	44.8	37.1	74.2	69.5	2.656	0.52
35	2300	1371.0	470.5	235.6	6.04	118.4	45.0	36.7	73.4	69.5	2.630	0.53
36	2400	1313.0	467.5	235.3	6.53	117.3	44.9	36.2	72.4	69.0	2.612	0.53
37	500	1027.5	452.0	235.9	8.95	111.8	44.5	33.7	67.3	66.9	2.513	0.58
38	600	970.0	449.5	235.9	9.44	111.0	44.6	33.2	66.4	66.7	2.490	0.59
39	700	911.0	448.0	235.9	9.94	110.1	44.3	32.9	65.8	66.2	2.485	0.60
40	900	798.2	444.7	236.4	10.90	108.1	43.6	32.2	64.5	65.1	2.478	0.62
41	955	759.2	443.3	236.8	11.23	107.3	43.4	32.0	63.9	64.7	2.473	0.63
42	1115	670.0	441.5	236.8	11.99	106.3	43.3	31.6	63.0	64.3	2.456	0.64
43	1147	640.0	440.5	236.8	12.24	105.9	43.3	31.3	62.6	64.2	2.447	0.65

SAMPLE NO. = T 756 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 86.27 KPA
PRECONSOLIDATION PRESSURE = 159.09 KPA
NORMALIZING STRESS = 159.09 KPA

NORMALIZED SHEAR TEST RESULTS START 210585 END 220585

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.018	1.073	0.518	0.0
2	0.01	0.027	1.109	0.505	0.018
3	0.03	0.044	1.190	0.495	0.039
4	0.06	0.062	1.276	0.487	0.059
5	0.10	0.076	1.355	0.477	0.076
6	0.14	0.087	1.417	0.474	0.089
7	0.19	0.097	1.479	0.468	0.101
8	0.24	0.106	1.536	0.464	0.109
9	0.28	0.114	1.597	0.459	0.121
10	0.35	0.122	1.651	0.457	0.128
11	0.40	0.129	1.709	0.451	0.140
12	0.50	0.138	1.775	0.449	0.146
13	0.57	0.147	1.847	0.446	0.157
14	0.67	0.155	1.912	0.443	0.165
15	0.77	0.163	1.980	0.440	0.173
16	0.86	0.170	2.035	0.441	0.177
17	0.96	0.176	2.096	0.439	0.184
18	1.06	0.183	2.155	0.439	0.190
19	1.16	0.189	2.209	0.439	0.192
20	1.36	0.200	2.320	0.436	0.202
21	1.57	0.209	2.405	0.437	0.207
22	1.79	0.217	2.480	0.438	0.209
23	2.00	0.223	2.525	0.441	0.214
24	2.23	0.228	2.581	0.440	0.216
25	2.45	0.231	2.624	0.439	0.219
26	2.71	0.234	2.653	0.440	0.220
27	2.92	0.236	2.660	0.441	0.222
28	3.21	0.238	2.657	0.445	0.219
29	3.40	0.238	2.670	0.443	0.219
30	3.63	0.239	2.672	0.444	0.219
31	4.10	0.238	2.685	0.442	0.221
32	4.59	0.237	2.677	0.441	0.223
33	5.06	0.235	2.668	0.439	0.222
34	5.56	0.233	2.656	0.437	0.223
35	6.04	0.231	2.630	0.437	0.224
36	6.53	0.227	2.612	0.434	0.222
37	8.96	0.212	2.513	0.421	0.226
38	9.44	0.209	2.490	0.420	0.226
39	9.94	0.207	2.485	0.416	0.226
40	10.90	0.203	2.478	0.409	0.229
41	11.23	0.201	2.473	0.407	0.231
42	11.89	0.198	2.456	0.404	0.231
43	12.24	0.197	2.447	0.403	0.231

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 757 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.4 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.376
INITIAL HEIGHT OF SAMPLE : 13.20 CM
INITIAL VOLUME OF SAMPLE : 601.18 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 42.1 PERCENT

TX. CONSOLIDATION START 290585 END 120685
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.04	26.50	1.167	1.663	0.248	34.35	23.54	1.336	2.336	0.612
2	57.55	30.50	1.447	2.146	0.349	39.52	27.05	1.325	2.325	0.732
3	66.22	35.10	1.871	2.770	0.449	45.47	31.12	1.310	2.310	0.948
4	76.22	40.40	2.538	3.560	0.511	52.34	35.82	1.291	2.291	1.351
5	87.78	46.50	3.439	4.707	0.634	60.26	41.28	1.264	2.264	1.870
6	101.01	53.50	4.788	6.080	0.646	69.34	47.51	1.231	2.231	2.761
7	116.13	61.60	6.348	7.527	0.589	79.78	54.53	1.197	2.197	3.840
8	133.49	70.80	8.061	9.090	0.515	91.70	62.69	1.160	2.160	5.030
9	159.59	84.80	10.602	11.053	0.225	109.73	74.79	1.113	2.113	6.918
10	79.82	42.40	9.723	9.747	0.012	54.87	37.42	1.144	2.144	6.474
11	79.79	42.40	9.693	9.639	-0.027	54.86	37.39	1.147	2.147	6.480
12	79.80	42.50	9.739	9.490	-0.124	54.93	37.30	1.150	2.150	6.575
13	73.83	42.70	9.739	9.490	-0.124	53.08	31.13	1.150	2.150	6.575
14	69.71	44.80	9.727	9.490	-0.119	53.10	24.91	1.150	2.150	6.564
15	66.08	47.40	9.706	9.490	-0.108	53.63	18.68	1.150	2.150	6.543
16	62.56	50.10	9.676	9.490	-0.093	54.25	12.46	1.150	2.150	6.513
17	59.53	53.30	9.629	9.490	-0.070	55.38	6.23	1.150	2.150	6.466
18	56.40	56.40	9.568	9.490	-0.039	56.40	0.0	1.150	2.150	6.405
19	56.30	56.30	9.519	9.490	-0.015	56.30	0.0	1.150	2.150	6.356
20	55.20	55.20	9.496	9.490	-0.003	55.20	0.0	1.150	2.150	6.333
21	55.20	55.20	9.394	9.490	0.048	55.20	0.0	1.150	2.150	6.231
22	54.70	54.70	9.394	9.490	0.048	54.70	0.0	1.150	2.150	6.231
23	54.30	54.30	9.383	9.490	0.054	54.30	0.0	1.150	2.150	6.219
24	53.60	53.60	9.360	9.490	0.065	53.60	0.0	1.150	2.150	6.197
25	53.60	53.60	9.341	9.490	0.074	53.60	0.0	1.150	2.150	6.178
26	53.60	53.60	9.318	9.490	0.086	53.60	0.0	1.150	2.150	6.155
27	53.20	53.20	9.288	9.490	0.101	53.20	0.0	1.150	2.150	6.125
28	52.70	52.70	9.265	9.490	0.112	52.70	0.0	1.150	2.150	6.102
29	51.70	51.70	9.258	9.490	0.116	51.70	0.0	1.150	2.150	6.094

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.04	26.50	1.167	0.248	2.336
2	57.55	30.50	1.447	0.349	2.325
3	66.22	35.10	1.871	0.449	2.310
4	76.22	40.40	2.538	0.511	2.291
5	87.78	46.50	3.439	0.634	2.264
6	101.01	53.50	4.788	0.646	2.231
7	116.13	61.60	6.348	0.589	2.197
8	133.49	70.80	8.061	0.515	2.160
9	159.59	84.80	10.602	0.225	2.113
10	79.82	42.40	9.723	0.012	2.144
11	79.79	42.40	9.693	-0.027	2.147
12	79.80	42.50	9.739	-0.124	2.150
13	73.83	42.70	9.739	-0.124	2.150
14	69.71	44.80	9.727	-0.119	2.150
15	66.08	47.40	9.706	-0.108	2.150
16	62.56	50.10	9.676	-0.093	2.150
17	59.53	53.30	9.629	-0.070	2.150
18	56.40	56.40	9.568	-0.039	2.150
19	56.30	56.30	9.519	-0.015	2.150
20	55.20	55.20	9.496	-0.003	2.150
21	55.20	55.20	9.394	0.048	2.150
22	54.70	54.70	9.394	0.048	2.150
23	54.30	54.30	9.383	0.054	2.150
24	53.60	53.60	9.360	0.065	2.150
25	53.60	53.60	9.341	0.074	2.150
26	53.60	53.60	9.318	0.086	2.150
27	53.20	53.20	9.288	0.101	2.150
28	52.70	52.70	9.265	0.112	2.150
29	51.70	51.70	9.258	0.116	2.150

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 757 (REMOULDED SAMPLE)
TEST RESULTS START 290585 END 120685

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.167	0.248	1.663	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.447	0.349	2.146	9.4	0.3	0.208	0.208
3	66.2	35.1	31.1	45.5	1.871	0.449	2.770	20.2	0.8	0.328	0.536
4	76.2	40.4	35.8	52.3	2.538	0.511	3.560	32.7	1.4	0.521	1.058
5	87.8	46.5	41.3	60.3	3.439	0.634	4.707	47.2	2.3	0.846	1.904
6	101.0	53.5	47.5	69.3	4.788	0.646	6.080	63.7	3.7	1.285	3.189
7	116.1	61.6	54.5	79.8	6.348	0.589	7.527	82.7	5.2	1.629	4.818
8	133.5	70.8	62.7	91.7	8.061	0.515	9.090	104.3	6.9	2.039	6.856
9	159.6	84.8	74.8	109.7	10.602	0.225	11.053	137.1	9.4	3.274	10.131
10	79.8	42.4	37.4	54.9	9.723	0.012	9.747	37.3	8.6	-1.324	8.807
11	79.8	42.4	37.4	54.9	9.693	-0.027	9.639	37.3	8.5	-0.057	8.750
12	79.8	42.5	37.3	54.9	9.739	-0.124	9.490	37.4	8.6	-0.047	8.703
13	73.8	42.7	31.1	53.1	9.739	-0.124	9.490	33.0	8.6	0.0	8.703
14	69.7	44.8	24.9	53.1	9.727	-0.119	9.490	32.5	8.6	-0.003	8.700
15	66.1	47.4	18.7	53.6	9.706	-0.108	9.490	33.6	8.6	-0.005	8.696
16	62.6	50.1	12.5	54.3	9.676	-0.093	9.490	35.6	8.5	-0.005	8.691
17	59.5	53.3	6.2	55.4	9.629	-0.070	9.490	39.1	8.5	-0.004	8.686
18	56.4	56.4	0.0	56.4	9.568	-0.039	9.490	42.8	8.4	-0.002	8.685
19	56.3	56.3	0.0	56.3	9.519	-0.015	9.490	42.6	8.4	0.0	8.685
20	55.2	55.2	0.0	55.2	9.496	-0.003	9.490	40.9	8.3	0.0	8.685
21	55.2	55.2	0.0	55.2	9.394	0.048	9.490	40.9	8.2	0.0	8.685
22	54.7	54.7	0.0	54.7	9.394	0.048	9.490	40.2	3.2	0.0	8.685
23	54.3	54.3	0.0	54.3	9.383	0.054	9.490	39.5	8.2	0.0	8.685
24	53.6	53.6	0.0	53.6	9.360	0.065	9.490	38.5	8.2	0.0	8.685
25	53.6	53.6	0.0	53.6	9.341	0.074	9.490	38.5	8.2	0.0	8.685
26	53.6	53.6	0.0	53.6	9.318	0.086	9.490	38.5	8.2	0.0	8.685
27	53.2	53.2	0.0	53.2	9.288	0.101	9.490	37.9	8.1	0.0	8.685
28	52.7	52.7	0.0	52.7	9.265	0.112	9.490	37.1	8.1	0.0	8.685
29	51.7	51.7	0.0	51.7	9.258	0.116	9.490	35.7	8.1	0.0	8.685

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 757 (REMOULDED SAMPLE)
TEST RESULTS START 290585 END 120685

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	1.174	0.252	1.677	0.0	0.0	0.212	0.0
2	57.6	30.5	27.1	39.5	1.458	0.356	2.169	9.4	0.3	0.335	0.212
3	66.2	35.1	31.1	45.5	1.889	0.460	2.809	20.2	0.8	0.536	0.547
4	76.2	40.4	35.8	52.3	2.571	0.527	3.625	32.7	1.5	0.878	1.083
5	87.8	46.5	41.3	60.3	3.500	0.661	4.822	47.2	2.4	1 350	1.962
6	101.0	53.5	47.5	69.3	4.906	0.683	6.272	63.7	3.8	1.737	3.311
7	116.1	61.6	54.5	79.8	6.559	0.633	7.825	82.7	5.4	2.210	5.048
8	133.5	70.8	62.7	91.7	8.404	0.563	9.530	104.3	7.2	3.625	7.259
9	159.6	84.8	74.8	109.7	11.207	0.253	11.713	137.1	10.0	-1.476	10.884
10	79.8	42.4	37.4	54.9	10.229	0.013	10.256	37.3	9.1	-0.063	9.408
11	79.8	42.4	37.4	54.9	10.195	-0.030	10.136	37.3	9.0	-0.051	9.345
12	79.8	42.5	37.3	54.9	10.246	-0.138	9.970	37.4	9.1	0.0	9.293
13	73.8	42.7	31.1	53.1	10.246	-0.138	9.970	33.0	9.1	-0.004	9.293
14	69.7	44.8	24.9	53.1	10.233	-0.131	9.970	32.5	9.1	-0.005	9.290
15	66.1	47.4	18.7	53.6	10.210	-0.120	9.970	33.6	9.1	-0.005	9.284
16	62.6	50.1	12.5	54.3	10.176	-0.103	9.970	35.6	9.0	-0.005	9.279
17	59.5	53.3	6.2	55.4	10.124	-0.077	9.970	39.1	9.0	-0.002	9.274
18	56.4	56.4	0.0	56.4	10.057	-0.043	9.970	42.8	8.9	-0.000	9.272
19	56.3	56.3	0.0	56.3	10.003	-0.016	9.970	42.6	8.8	-0.000	9.272
20	55.2	55.2	0.0	55.2	9.978	-0.004	9.970	40.9	8.8	-0.000	9.272
21	55.2	55.2	0.0	55.2	9.865	0.053	9.970	40.3	8.7	0.0	9.272
22	54.7	54.7	0.0	54.7	9.865	0.053	9.970	40.2	8.7		9.272
										-0.000	
23	54.3	54.3	0.0	54.3	9.852	0.059	9.970	38.5	8.7	-0.000	9.272
24	53.6	53.6	0.0	53.6	9.827	0.072	9.970	38.5	8.7	-0.000	9.272
25	53.6	53.6	0.0	53.6	9.806	0.082	9.970	38.5	8.6	-0.000	9.272
26	53.6	53.6	0.0	53.6	9.781	0.095	9.970	38.5	8.6	-0.000	9.272
27	53.2	53.2	0.0	53.2	9.748	0.111	9.970	37.9	8.6	-0.000	9.272
28	52.7	52.7	0.0	52.7	9.723	0.124	9.970	37.1	8.6	-0.000	9.272
29	51.7	51.7	0.0	51.7	9.714	0.128	9.970	35.7	8.5		9.272

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 757 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION = 11.939 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION = 544.430 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION = 45.599 SQUARE CENTIMETRES

CONSTANT LOAD = 16.55 N .
PROVING RING FACTOR = 1.2365 N ./DIV
PISTON AREA = 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING = 2149.50 DIVISIONS

SHEAR TEST RESULTS START 160885 END 170685

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	1043	2149.5	224.5	200.1	0.0	79.9	42.4	18.8	37.6	54.9	1.885	0.0
2	1045	2149.2	232.5	200.2	0.00	81.9	42.2	19.9	39.7	55.4	1.941	0.05
3	1055	2148.0	259.2	202.8	0.01	86.6	39.6	23.5	47.0	55.3	2.186	0.29
4	1100	2147.0	271.0	204.0	0.02	88.5	38.3	25.1	50.2	55.0	2.310	0.31
5	1105	2145.2	281.0	205.0	0.04	90.3	37.4	26.4	52.9	55.0	2.413	0.32
6	1100	2143.8	289.0	205.9	0.05	91.5	36.5	27.5	55.0	54.8	2.507	0.33
7	1115	2141.9	296.5	206.6	0.06	92.8	35.8	28.5	57.0	54.8	2.593	0.33
8	1120	2139.4	304.0	207.3	0.08	94.2	35.1	29.6	59.1	54.8	2.683	0.33
9	1128	2136.8	310.0	207.7	0.11	95.4	34.7	30.3	60.7	54.9	2.749	0.33
10	1130	2134.8	314.0	208.0	0.12	96.3	34.6	30.9	61.7	55.2	2.784	0.33
11	1135	2132.0	319.2	208.3	0.15	97.3	34.2	31.6	63.1	55.2	2.846	0.32
12	1140	2128.9	323.5	208.6	0.17	98.2	33.9	32.1	64.3	55.3	2.898	0.32
13	1145	2126.0	328.5	208.7	0.20	99.3	33.7	32.8	65.6	55.6	2.947	0.31
14	1150	2125.2	332.0	208.9	0.20	100.2	33.8	33.3	66.6	55.8	2.981	0.30
15	1155	2124.8	335.5	209.0	0.21	101.0	33.5	33.8	67.5	56.0	3.015	0.30
16	1200	2124.6	339.0	209.0	0.21	101.9	33.6	34.2	68.4	56.3	3.043	0.29
17	1215	2123.8	348.0	209.2	0.22	104.3	33.4	35.4	70.9	57.0	3.122	0.27
18	1230	2118.5	355.0	209.0	0.28	106.2	33.5	36.4	72.7	57.7	3.171	0.25
19	1240	2112.0	359.0	208.7	0.31	107.7	33.9	36.9	73.8	58.5	3.178	0.24
20	1250	2104.0	362.5	208.6	0.38	108.8	34.1	37.3	74.7	59.0	3.189	0.23
21	1300	2096.0	365.5	208.2	0.45	109.7	34.3	37.7	75.4	59.4	3.199	0.21
22	1315	2083.0	369.5	207.9	0.58	111.0	34.6	38.2	76.4	60.1	3.209	0.20
23	1330	2068.5	373.0	207.6	0.68	112.2	34.9	38.6	77.3	60.7	3.214	0.19
24	1345	2055.5	376.0	207.0	0.79	113.3	35.3	39.0	78.0	61.3	3.210	0.17
25	1404	2039.0	378.5	206.6	0.93	114.6	36.0	39.3	78.6	62.2	3.182	0.16
26	1430	2014.2	381.0	205.8	1.13	116.0	37.0	39.5	79.0	63.3	3.138	0.14
27	1500	1986.5	383.5	205.2	1.37	116.9	37.4	39.8	79.5	63.9	3.127	0.12
28	1532	1957.5	385.0	204.7	1.61	117.7	37.9	39.9	79.8	64.5	3.104	0.11
29	1600	1930.0	385.5	204.3	1.84	118.1	38.4	39.8	79.7	65.0	3.075	0.10
30	1630	1902.5	386.0	203.7	2.07	118.6	39.0	39.8	79.6	65.5	3.042	0.09
31	1700	1875.0	386.5	203.6	2.30	118.6	39.0	39.8	79.6	65.5	3.041	0.08
32	1730	1846.0	386.5	203.5	2.54	118.3	38.9	39.7	79.4	65.4	3.041	0.08
33	1800	1818.8	386.8	203.4	2.77	118.4	39.1	39.6	79.3	65.5	3.028	0.08
34	1900	1764.0	386.5	203.1	3.23	118.2	39.3	39.4	78.9	65.6	3.006	0.07
35	2000	1707.0	385.9	202.9	3.71	117.9	39.6	39.1	78.3	65.7	2.977	0.07
36	2100	1650.0	384.5	202.8	4.18	117.3	39.8	38.8	77.5	65.6	2.948	0.07
37	2200	1593.0	383.5	203.0	4.66	116.4	39.5	38.4	76.9	65.1	2.947	0.07
38	2300	1536.0	381.5	202.9	5.14	115.6	39.6	38.0	76.0	64.9	2.919	0.07
39	2400	1479.5	380.0	203.1	5.61	114.5	39.3	37.6	75.2	64.4	2.915	0.08
40	553	1147.0	377.0	204.0	8.40	110.8	38.5	36.1	72.3	62.8	2.877	0.11
41	800	1027.0	376.5	204.2	9.40	109.5	38.1	35.7	71.4	61.9	2.873	0.12
42	900	971.0	376.5	204.3	9.87	109.1	38.1	35.5	71.0	61.8	2.863	0.13
43	1000	915.0	376.5	204.3	10.34	108.7	38.1	35.3	70.6	61.6	2.854	0.13
44	1100	858.0	376.2	204.6	10.82	108.0	37.8	35.1	70.2	61.2	2.857	0.14
45	1200	801.5	376.0	204.8	11.29	107.4	37.7	34.9	69.7	60.9	2.850	0.15
46	1300	745.0	375.5	204.8	11.76	107.0	37.7	34.6	69.3	60.8	2.837	0.15
47	1355	694.0	375.0	204.9	12.19	106.5	37.7	34.4	68.8	60.6	2.825	0.15

SAMPLE NO. = T 757 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 79.94 KPA
PRECONSOLIDATION PRESSURE = 159.59 KPA
NORMALIZING STRESS = 159.59 KPA

NORMALIZED SHEAR TEST RESULTS START 160685 END 170685

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.118	1.885	0.344	0.0
2	0.00	0.124	1.941	0.347	0.001
3	0.01	0.147	2.188	0.346	0.017
4	0.02	0.157	2.310	0.345	0.024
5	0.04	0.166	2.413	0.345	0.031
6	0.05	0.172	2.507	0.344	0.036
7	0.06	0.179	2.593	0.343	0.041
8	0.08	0.185	2.683	0.343	0.045
9	0.11	0.190	2.749	0.344	0.048
10	0.12	0.193	2.784	0.346	0.050
11	0.15	0.198	2.846	0.346	0.051
12	0.17	0.201	2.898	0.347	0.053
13	0.20	0.206	2.947	0.348	0.054
14	0.20	0.209	2.981	0.350	0.055
15	0.21	0.211	3.015	0.351	0.056
16	0.21	0.214	3.043	0.353	0.056
17	0.22	0.222	3.122	0.357	0.057
18	0.28	0.228	3.171	0.362	0.056
19	0.31	0.231	3.178	0.367	0.054
20	0.38	0.234	3.189	0.370	0.053
21	0.45	0.236	3.199	0.372	0.051
22	0.56	0.239	3.209	0.378	0.049
23	0.68	0.242	3.214	0.380	0.047
24	0.79	0.244	3.210	0.384	0.043
25	0.93	0.246	3.182	0.390	0.041
26	1.13	0.248	3.136	0.397	0.036
27	1.37	0.249	3.127	0.400	0.032
28	1.61	0.250	3.104	0.404	0.029
29	1.84	0.250	3.075	0.407	0.026
30	2.07	0.249	3.042	0.411	0.023
31	2.30	0.249	3.041	0.411	0.022
32	2.54	0.249	3.041	0.410	0.021
33	2.77	0.248	3.028	0.411	0.021
34	3.23	0.247	3.006	0.411	0.019
35	3.71	0.245	2.977	0.412	0.018
36	4.18	0.243	2.948	0.411	0.017
37	4.66	0.241	2.947	0.408	0.018
38	5.14	0.238	2.919	0.407	0.018
39	5.61	0.236	2.915	0.403	0.019
40	8.40	0.226	2.877	0.392	0.024
41	9.40	0.224	2.873	0.388	0.026
42	9.87	0.222	2.883	0.387	0.026
43	10.34	0.221	2.854	0.386	0.026
44	10.82	0.220	2.857	0.383	0.028
45	11.29	0.219	2.850	0.382	0.029
46	11.76	0.217	2.837	0.381	0.029
47	12.19	0.216	2.825	0.380	0.030

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 758 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.5 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.379
INITIAL HEIGHT OF SAMPLE : 13.23 CM
INITIAL VOLUME OF SAMPLE : 602.56 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 42.2 PERCENT

TX. CONSOLIDATION START 300585 END 130685
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.81	26.50	1.670	1.593	-0.039	34.30	23.41	1.341	2.341	1.139
2	57.39	30.40	1.969	2.041	0.036	39.40	26.99	1.330	2.330	1.289
3	66.01	35.00	2.381	2.589	0.104	45.34	31.01	1.317	2.317	1.518
4	75.90	40.20	3.107	3.477	0.185	52.10	35.70	1.296	2.296	1.948
5	87.37	46.30	4.165	4.589	0.212	59.99	41.07	1.269	2.269	2.635
6	100.46	53.30	5.563	5.917	0.177	69.02	47.16	1.238	2.238	3.591
7	115.38	61.20	7.230	7.394	0.082	79.26	54.18	1.203	2.203	4.786
8	132.59	70.30	9.063	8.979	-0.042	91.06	62.29	1.165	2.165	6.070
9	159.48	84.80	11.920	11.028	-0.446	109.70	74.68	1.116	2.116	8.244
10	79.76	42.40	10.960	9.651	-0.655	54.85	37.36	1.149	2.149	7.743
11	79.73	42.40	10.930	9.543	-0.693	54.84	37.33	1.152	2.152	7.749
12	78.96	41.60	11.096	9.543	-0.777	54.05	37.36	1.152	2.152	7.915
13	72.83	41.80	11.096	9.543	-0.777	52.14	31.03	1.152	2.152	7.915
14	68.82	43.90	11.089	9.543	-0.773	52.21	24.92	1.152	2.152	7.908
15	65.48	46.80	11.073	9.543	-0.765	53.03	18.68	1.152	2.152	7.892
16	60.97	48.50	11.054	9.543	-0.756	52.66	12.47	1.152	2.152	7.873
17	59.73	53.50	11.005	9.543	-0.731	55.58	6.23	1.152	2.152	7.824
18	56.50	56.50	10.967	9.543	-0.712	56.50	0.0	1.152	2.152	7.787
19	55.50	55.50	10.952	9.543	-0.705	55.50	0.0	1.152	2.152	7.771
20	55.40	55.40	10.941	9.543	-0.699	55.40	0.0	1.152	2.152	7.760
21	55.00	55.00	10.930	9.543	-0.693	55.00	0.0	1.152	2.152	7.749
22	55.00	55.00	10.915	9.543	-0.686	55.00	0.0	1.152	2.152	7.734
23	54.70	54.70	10.903	9.543	-0.680	54.70	0.0	1.152	2.152	7.722
24	53.90	53.90	10.892	9.543	-0.675	53.90	0.0	1.152	2.152	7.711
25	53.40	53.40	10.884	9.543	-0.671	53.40	0.0	1.152	2.152	7.703
26	52.10	52.10	10.869	9.543	-0.663	52.10	0.0	1.152	2.152	7.688
27	52.40	52.40	10.862	9.543	-0.659	52.40	0.0	1.152	2.152	7.681
28	50.00	50.00	10.854	9.543	-0.656	50.00	0.0	1.152	2.152	7.673
29	46.20	46.20	10.847	9.543	-0.652	46.20	0.0	1.152	2.152	7.666

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.81	26.50	1.670	-0.039	2.341
2	57.39	30.40	1.969	0.036	2.330
3	66.01	35.00	2.381	0.104	2.317
4	75.90	40.20	3.107	0.185	2.296
5	87.37	46.30	4.165	0.212	2.269
6	100.46	53.30	5.563	0.177	2.238
7	115.38	61.20	7.230	0.082	2.203
8	132.59	70.30	9.063	-0.042	2.165
9	159.48	84.80	11.920	-0.446	2.116
10	79.76	42.40	10.960	-0.655	2.149
11	79.73	42.40	10.930	-0.693	2.152
12	78.96	41.60	11.096	-0.777	2.152
13	72.83	41.80	11.096	-0.777	2.152
14	68.82	43.90	11.089	-0.773	2.152
15	65.48	46.80	11.073	-0.765	2.152
16	60.97	48.50	11.054	-0.756	2.152
17	59.73	53.50	11.005	-0.731	2.152
18	56.50	56.50	10.967	-0.712	2.152
19	55.50	55.50	10.952	-0.705	2.152
20	55.40	55.40	10.941	-0.699	2.152
21	55.00	55.00	10.930	-0.693	2.152
22	55.00	55.00	10.915	-0.686	2.152
23	54.70	54.70	10.903	-0.680	2.152
24	53.90	53.90	10.892	-0.675	2.152
25	53.40	53.40	10.884	-0.671	2.152
26	52.10	52.10	10.869	-0.663	2.152
27	52.40	52.40	10.862	-0.659	2.152
28	50.00	50.00	10.854	-0.656	2.152
29	46.20	46.20	10.847	-0.652	2.152

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 758 (REMOULDED SAMPLE)
TEST RESULTS START 300585 END 130685

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	1.670	-0.039	1.593	0.0	0.0		0.0
2	57.4	30.4	27.0	39.4	1.969	0.036	2.041	9.3	0.3	0.203	0.203
3	66.0	35.0	31.0	45.3	2.381	0.104	2.589	20.1	0.7	0.299	0.501
4	75.9	40.2	35.7	52.1	3.107	0.185	3.477	32.4	1.5	0.576	1.077
5	87.4	46.3	41.1	60.0	4.165	0.212	4.589	46.8	2.5	0.887	1.964
6	100.5	53.3	47.2	69.0	5.563	0.177	5.917	63.2	3.9	1.278	3.242
7	115.4	61.2	54.2	79.3	7.230	0.082	7.394	81.8	5.6	1.690	4.932
8	132.6	70.3	62.3	91.1	9.063	-0.042	8.979	103.3	7.4	2.110	7.042
9	159.5	84.8	74.7	109.7	11.920	-0.446	11.028	137.1	10.3	3.546	10.588
10	79.8	42.4	37.4	54.9	10.960	-0.655	9.651	37.4	9.3	-1.414	9.174
11	79.7	42.4	37.3	54.8	10.930	-0.693	9.543	37.3	9.3	-0.057	9.117
12	79.0	41.6	37.4	54.1	11.096	-0.777	9.543	36.1	9.5	0.062	9.179
13	72.8	41.8	31.0	52.1	11.096	-0.777	9.543	31.5	9.5	0.0	9.179
14	68.8	43.9	24.9	52.2	11.089	-0.773	9.543	31.0	9.5	-0.002	9.178
15	65.5	46.8	18.7	53.0	11.073	-0.765	9.543	32.7	9.5	-0.003	9.174
16	61.0	48.5	12.5	52.7	11.054	-0.756	9.543	33.0	9.4	-0.003	9.171
17	59.7	53.5	6.2	55.6	11.005	-0.731	9.543	39.4	9.4	-0.005	9.167
18	56.5	56.5	0.0	56.5	10.967	-0.712	9.543	42.9	9.3	-0.001	9.165
19	55.5	55.5	0.0	55.5	10.952	-0.705	9.543	41.4	9.3	0.0	9.165
20	55.4	55.4	0.0	55.4	10.941	-0.699	9.543	41.2	9.3	0.0	9.165
21	55.0	55.0	0.0	55.0	10.930	-0.693	9.543	40.6	9.3	0.0	9.165
22	55.0	55.0	0.0	55.0	10.915	-0.686	9.543	40.6	9.3	0.0	9.165
23	54.7	54.7	0.0	54.7	10.903	-0.680	9.543	40.2	9.3	0.0	9.165
24	53.9	53.9	0.0	53.9	10.892	-0.675	9.543	39.0	9.3	0.0	9.165
25	53.4	53.4	0.0	53.4	10.884	-0.671	9.543	38.2	9.3	0.0	9.165
26	52.1	52.1	0.0	52.1	10.869	-0.663	9.543	36.3	9.2	0.0	9.165
27	52.4	52.4	0.0	52.4	10.862	-0.659	9.543	36.7	9.2	0.0	9.165
28	50.0	50.0	0.0	50.0	10.854	-0.656	9.543	33.2	9.2	0.0	9.165
29	46.2	46.2	0.0	46.2	10.847	-0.652	9.543	28.1	9.2	0.0	9.165

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 758 (REMOULDED SAMPLE)
TEST RESULTS START 300585 END 130685

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	1.685	-0.039	1.606	0.0	0.0		0.0
2	57.4	30.4	27.0	39.4	1.989	0.037	2.062	9.3	0.3	0.206	0.206
3	66.0	35.0	31.0	45.3	2.410	0.107	2.623	20.1	0.8	0.305	0.512
4	75.9	40.2	35.7	52.1	3.156	0.191	3.539	32.4	1.5	0.593	1.105
5	87.4	46.3	41.1	60.0	4.254	0.222	4.697	46.8	2.6	0.923	2.028
6	100.5	53.3	47.2	69.0	5.724	0.187	6.099	63.2	4.1	1.346	3.374
7	115.4	61.2	54.2	79.3	7.504	0.088	7.681	81.8	5.8	1.808	5.182
8	132.6	70.3	62.3	91.1	9.500	-0.046	9.407	103.3	7.8	2.297	7.479
9	159.5	84.8	74.7	109.7	12.692	-0.504	11.685	137.1	11.0	3.952	11.432
10	79.8	42.4	37.4	54.9	11.608	-0.730	10.148	37.4	10.0	-1.584	9.847
11	79.7	42.4	37.3	54.8	11.574	-0.772	10.029	37.3	9.9	-0.063	9.784
12	79.0	41.6	37.4	54.1	11.761	-0.866	10.029	36.1	10.1	0.070	9.854
13	72.8	41.8	31.0	52.1	11.761	-0.866	10.029	31.5	10.1	0.0	9.854
14	68.8	43.9	24.9	52.2	11.753	-0.862	10.029	31.0	10.1	-0.002	9.852
15	65.5	46.8	18.7	53.0	11.735	-0.853	10.029	32.7	10.1	-0.004	9.848
16	61.0	48.5	12.5	52.7	11.714	-0.842	10.029	33.0	10.1	-0.003	9.844
17	59.7	53.5	6.2	55.6	11.659	-0.815	10.029	39.4	10.0	-0.005	9.839
18	56.5	56.5	0.0	56.5	11.616	-0.794	10.029	42.9	10.0	-0.001	9.838
19	55.5	55.5	0.0	55.5	11.599	-0.785	10.029	41.4	10.0	0.0	9.838
20	55.4	55.4	0.0	55.4	11.587	-0.779	10.029	41.2	10.0	0.000	9.838
21	55.0	55.0	0.0	55.0	11.574	-0.772	10.029	40.6	9.9	-0.000	9.838
22	55.0	55.0	0.0	55.0	11.557	-0.764	10.029	40.6	9.9	-0.000	9.838
23	54.7	54.7	0.0	54.7	11.544	-0.758	10.029	40.2	9.9	-0.000	9.838
24	53.9	53.9	0.0	53.9	11.532	-0.751	10.029	39.0	9.9	-0.000	9.838
25	53.4	53.4	0.0	53.4	11.523	-0.747	10.029	38.2	9.9	-0.000	9.838
26	52.1	52.1	0.0	52.1	11.506	-0.739	10.029	36.3	9.9	-0.000	9.838
27	52.4	52.4	0.0	52.4	11.498	-0.734	10.029	36.7	9.9	0.000	9.838
28	50.0	50.0	0.0	50.0	11.489	-0.730	10.029	33.2	9.9	0.000	9.838
29	46.2	46.2	0.0	46.2	11.481	-0.726	10.029	28.1	9.8	-0.000	9.838

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 758 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.686 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 549.050 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 46.984 SQUARE CENTIMETRES

CONSTANT LOAD : 15.07 N .
PROVING RING FACTOR : 1.3970 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2034.00 DIVISIONS

SHEAR TEST RESULTS START 180685 END 190685

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	915	2034.0	204.0	200.5	0.0	79.8	42.1	18.8	37.7	54.7	1.895	0.0
2	920	2033.2	216.0	202.1	0.01	81.3	40.3	20.5	41.0	54.0	2.017	0.49
3	925	2031.8	223.2	202.9	0.02	82.7	39.3	21.7	43.4	53.8	2.105	0.42
4	930	2029.2	230.9	204.5	0.04	83.9	38.2	22.8	45.7	53.4	2.195	0.50
5	935	2027.0	236.9	205.0	0.06	85.0	37.6	23.7	47.4	53.4	2.262	0.46
6	940	2024.0	240.4	205.1	0.09	85.9	37.4	24.2	48.5	53.6	2.296	0.43
7	945	2021.0	244.1	205.3	0.11	86.7	37.1	24.8	49.6	53.6	2.336	0.40
8	950	2017.8	246.3	205.8	0.14	87.1	36.9	25.1	50.2	53.6	2.360	0.42
9	955	2014.0	247.8	205.8	0.17	87.4	36.8	25.3	50.6	53.7	2.376	0.41
10	1000	2011.0	250.0	205.6	0.20	88.1	36.8	25.6	51.3	53.9	2.394	0.38
11	1015	2000.0	252.5	205.8	0.29	88.8	36.9	26.0	51.9	54.2	2.408	0.37
12	1030	1988.5	254.3	205.6	0.39	89.3	36.9	26.2	52.4	54.4	2.421	0.35
13	1045	1978.0	255.6	205.4	0.48	89.9	37.1	26.4	52.8	54.7	2.423	0.32
14	1100	1966.0	257.0	205.4	0.58	90.3	37.2	26.6	53.1	54.9	2.428	0.32
15	1115	1953.0	258.0	205.0	0.69	90.8	37.4	26.7	53.4	55.2	2.428	0.29
16	1130	1944.0	258.4	204.9	0.77	91.1	37.6	26.7	53.5	55.4	2.422	0.28
17	1141	1936.0	258.9	204.8	0.84	91.2	37.6	26.8	53.6	55.5	2.425	0.27
18	1305	1872.5	260.4	204.8	1.38	91.3	37.6	26.9	53.7	55.5	2.429	0.27
19	1330	1853.0	260.5	204.7	1.55	91.4	37.7	26.8	53.7	55.6	2.423	0.26
20	1400	1830.6	260.4	204.6	1.74	91.3	37.8	26.8	53.5	55.6	2.416	0.26
21	1430	1808.5	260.4	204.5	1.93	91.3	37.9	26.7	53.4	55.7	2.410	0.25
22	1500	1785.0	260.0	204.9	2.13	90.7	37.5	26.6	53.2	55.2	2.419	0.28
23	1530	1763.0	260.0	204.6	2.32	91.1	38.0	26.5	53.1	55.7	2.397	0.27
24	1606	1735.0	259.5	204.6	2.56	90.9	38.1	26.4	52.8	55.7	2.386	0.27
25	1630	1718.0	259.9	204.4	2.70	90.9	38.0	26.4	52.9	55.6	2.391	0.26
26	1703	1693.0	259.9	204.3	2.92	90.8	38.1	26.4	52.7	55.7	2.384	0.25
27	1800	1649.0	259.5	204.4	3.29	90.4	38.0	26.2	52.4	55.5	2.380	0.26
28	1900	1603.0	259.0	204.1	3.89	90.5	38.5	26.0	52.0	55.8	2.352	0.25
29	2002	1556.0	257.2	204.0	4.09	90.0	38.7	25.7	51.3	55.8	2.326	0.26
30	2200	1486.5	255.0	204.0	4.86	88.7	38.4	25.2	50.3	55.2	2.310	0.28
31	2401	1375.0	255.2	204.5	5.64	87.9	38.0	25.0	49.9	54.6	2.314	0.33
32	557	1107.0	255.9	204.9	7.93	86.4	37.5	24.6	48.9	53.8	2.305	0.39
33	802	1012.0	255.5	204.9	8.75	85.9	37.5	24.2	48.4	53.6	2.290	0.41
34	900	967.0	255.2	205.1	9.13	85.5	37.4	24.0	48.1	53.4	2.286	0.44
35	1000	921.5	254.4	205.0	9.52	85.2	37.5	23.8	47.7	53.4	2.271	0.45
36	1100	877.0	253.0	204.6	9.90	84.6	37.5	23.6	47.1	53.2	2.257	0.43
37	1200	831.5	252.0	204.8	10.29	84.1	37.4	23.3	46.7	53.0	2.247	0.48
38	1303	783.5	251.5	204.8	10.70	83.7	37.4	23.2	46.3	52.8	2.238	0.50
39	1400	738.5	248.5	204.9	11.09	82.8	37.5	22.6	45.3	52.6	2.208	0.58
40	1500	693.0	245.2	204.9	11.48	81.8	37.6	22.1	44.2	52.3	2.176	0.67
41	1600	645.0	242.0	204.4	11.89	80.9	37.7	21.6	43.2	52.1	2.146	0.71
42	1623	629.0	241.0	205.1	12.02	80.2	37.3	21.4	42.9	51.6	2.149	0.89

SAMPLE NO. = T 758 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 79.79 KPA
PRECONSOLIDATION PRESSURE = 159.49 KPA
NORMALIZING STRESS = 159.49 KPA

NORMALIZED SHEAR TEST RESULTS START 180685 END 190685

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.118	1.895	0.343	0.0
2	0.01	0.128	2.017	0.338	0.010
3	0.02	0.136	2.105	0.337	0.015
4	0.04	0.143	2.195	0.335	0.025
5	0.06	0.149	2.262	0.335	0.028
6	0.09	0.152	2.296	0.336	0.029
7	0.11	0.155	2.336	0.336	0.030
8	0.14	0.157	2.360	0.336	0.033
9	0.17	0.159	2.376	0.337	0.033
10	0.20	0.161	2.394	0.338	0.032
11	0.29	0.163	2.408	0.340	0.033
12	0.39	0.164	2.421	0.341	0.032
13	0.48	0.165	2.423	0.343	0.031
14	0.58	0.167	2.428	0.344	0.031
15	0.69	0.167	2.428	0.346	0.028
16	0.77	0.168	2.422	0.347	0.028
17	0.84	0.168	2.425	0.348	0.027
18	1.38	0.168	2.429	0.348	0.027
19	1.55	0.168	2.423	0.349	0.026
20	1.74	0.168	2.416	0.349	0.026
21	1.93	0.167	2.410	0.349	0.025
22	2.13	0.167	2.419	0.346	0.028
23	2.32	0.166	2.397	0.349	0.026
24	2.56	0.165	2.386	0.349	0.026
25	2.70	0.166	2.391	0.349	0.024
26	2.92	0.165	2.384	0.349	0.024
27	3.29	0.164	2.380	0.348	0.024
28	3.69	0.163	2.352	0.350	0.023
29	4.09	0.161	2.326	0.350	0.022
30	4.86	0.158	2.310	0.346	0.022
31	5.64	0.157	2.314	0.343	0.025
32	7.93	0.153	2.305	0.337	0.028
33	8.75	0.152	2.290	0.336	0.028
34	9.13	0.151	2.286	0.335	0.029
35	9.52	0.149	2.271	0.335	0.028
36	9.90	0.148	2.257	0.334	0.026
37	10.29	0.146	2.247	0.332	0.027
38	10.70	0.145	2.238	0.331	0.027
39	11.09	0.142	2.208	0.330	0.028
40	11.48	0.139	2.176	0.328	0.028
41	11.89	0.135	2.146	0.327	0.024
42	12.02	0.134	2.149	0.323	0.029

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 759 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 50.9 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.390
INITIAL HEIGHT OF SAMPLE : 13.24 CM
INITIAL VOLUME OF SAMPLE : 803.00 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 1.00
FINAL MOISTURE CONTENT : 42.3 PERCENT

TX. CONSOLIDATION START 310585 END 140685
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	50.11	26.50	1.427	1.998	0.285	34.37	23.61	1.342	2.342	0.761
2	57.62	30.50	1.726	2.463	0.368	39.54	27.12	1.331	2.331	0.905
3	66.29	35.10	2.156	3.093	0.468	45.50	31.19	1.316	2.316	1.125
4	76.31	40.40	2.787	3.905	0.559	52.37	35.91	1.296	2.296	1.485
5	87.70	46.50	3.761	4.925	0.582	60.23	41.20	1.272	2.272	2.120
6	100.87	53.50	5.196	6.335	0.569	69.29	47.37	1.238	2.238	3.085
7	116.02	61.50	6.858	7.902	0.522	79.67	54.52	1.201	2.201	4.224
8	133.35	70.70	8.580	9.436	0.428	91.58	62.65	1.164	2.164	5.435
9	159.54	84.80	11.137	11.343	0.103	109.71	74.74	1.119	2.119	7.356
10	79.87	42.40	10.272	10.025	-0.124	54.89	37.47	1.150	2.150	6.930
11	79.83	42.40	10.234	9.909	-0.163	54.88	37.43	1.153	2.153	6.931
12	79.76	42.40	10.302	9.858	-0.222	54.85	37.36	1.154	2.154	7.016
13	75.13	44.00	10.299	9.859	-0.220	54.38	31.13	1.154	2.154	7.013
14	71.72	46.80	10.279	9.859	-0.210	55.11	24.92	1.154	2.154	6.993
15	68.39	49.70	10.253	9.859	-0.197	55.93	18.69	1.154	2.154	6.967
16	65.56	53.10	10.215	9.859	-0.178	57.25	12.46	1.154	2.154	6.929
17	62.43	56.20	10.159	9.859	-0.150	58.28	6.23	1.154	2.154	6.872
18	59.60	59.60	10.079	9.859	-0.110	59.60	0.0	1.154	2.154	6.793
19	59.40	59.40	10.034	9.859	-0.087	59.40	0.0	1.154	2.154	6.748
20	59.30	59.30	9.977	9.859	-0.059	59.30	0.0	1.154	2.154	6.691
21	58.90	58.90	9.947	9.859	-0.044	58.90	0.0	1.154	2.154	6.661
22	58.80	58.80	9.924	9.859	-0.033	58.80	0.0	1.154	2.154	6.638
23	58.10	58.10	9.906	9.859	-0.023	58.10	0.0	1.154	2.154	6.619
24	58.20	58.20	9.887	9.859	-0.014	58.20	0.0	1.154	2.154	6.600
25	58.10	58.10	9.864	9.858	-0.003	58.10	0.0	1.154	2.154	6.578
26	58.40	58.40	9.845	9.859	0.007	58.40	0.0	1.154	2.154	6.559
27	58.00	58.00	9.830	9.859	0.014	58.00	0.0	1.154	2.154	6.544
28	57.80	57.80	9.823	9.859	0.018	57.80	0.0	1.154	2.154	6.536
29	56.20	56.20	9.856	9.858	0.001	56.20	0.0	1.154	2.154	6.570

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	50.11	26.50	1.427	0.285	2.342
2	57.62	30.50	1.726	0.368	2.331
3	66.29	35.10	2.156	0.468	2.316
4	76.31	40.40	2.787	0.559	2.296
5	87.70	46.50	3.761	0.582	2.272
6	100.87	53.50	5.196	0.569	2.238
7	116.02	61.50	6.858	0.522	2.201
8	133.35	70.70	8.580	0.428	2.164
9	159.54	84.80	11.137	0.103	2.119
10	79.87	42.40	10.272	-0.124	2.150
11	79.83	42.40	10.234	-0.163	2.153
12	79.76	42.40	10.302	-0.222	2.154
13	75.13	44.00	10.299	-0.220	2.154
14	71.72	46.80	10.279	-0.210	2.154
15	68.39	49.70	10.253	-0.197	2.154
16	65.56	53.10	10.215	-0.178	2.154
17	62.43	56.20	10.159	-0.150	2.154
18	59.60	59.60	10.079	-0.110	2.154
19	59.40	59.40	10.034	-0.087	2.154
20	59.30	59.30	9.977	-0.059	2.154
21	58.90	58.90	9.947	-0.044	2.154
22	58.80	58.80	9.924	-0.033	2.154
23	58.10	58.10	9.906	-0.023	2.154
24	58.20	58.20	9.887	-0.014	2.154
25	58.10	58.10	9.864	-0.003	2.154
26	58.40	58.40	9.845	0.007	2.154
27	58.00	58.00	9.830	0.014	2.154
28	57.80	57.80	9.823	0.018	2.154
29	56.20	56.20	9.856	0.001	2.154

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 759 (REMOULDED SAMPLE)
TEST RESULTS START 310585 END 140685

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	1.427	0.285	1.998	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.726	0.368	2.463	9.4	0.3	0.208	0.208
3	66.3	35.1	31.2	45.5	2.156	0.468	3.093	20.2	0.8	0.332	0.540
4	76.3	40.4	35.9	52.4	2.787	0.559	3.905	32.8	1.4	0.518	1.059
5	87.7	46.5	41.2	60.2	3.761	0.582	4.925	47.0	2.4	0.819	1.877
6	100.9	53.5	47.4	69.3	5.196	0.569	6.335	63.5	3.8	1.340	3.218
7	116.0	61.5	54.5	79.7	6.858	0.522	7.902	82.4	5.4	1.748	4.965
8	133.4	70.7	62.7	91.6	8.580	0.428	9.436	104.1	7.2	2.023	6.988
9	159.5	84.8	74.7	109.7	11.137	0.103	11.343	137.0	9.7	3.239	10.227
10	79.9	42.4	37.5	54.9	10.272	-0.124	10.025	37.3	8.9	-1.324	8.904
11	79.8	42.4	37.4	54.9	10.234	-0.163	9.909	37.3	8.8	-0.063	8.840
12	79.8	42.4	37.4	54.9	10.302	-0.222	9.859	37.2	8.9	0.004	8.844
13	75.1	44.0	31.1	54.4	10.299	-0.220	9.859	35.2	8.9	-0.001	8.843
14	71.7	46.8	24.9	55.1	10.279	-0.210	9.859	35.9	8.9	-0.006	8.838
15	68.4	49.7	18.7	55.9	10.253	-0.197	9.859	37.6	8.9	-0.006	8.832
16	65.6	53.1	12.5	57.3	10.215	-0.178	9.859	40.7	8.8	-0.006	8.826
17	62.4	56.2	6.2	58.3	10.159	-0.150	9.859	43.8	8.8	-0.005	8.821
18	59.6	59.6	0.0	59.6	10.079	-0.110	9.859	47.8	8.7	-0.002	8.819
19	59.4	59.4	0.0	59.4	10.034	-0.087	9.859	47.4	8.6	0.0	8.819
20	59.3	59.3	0.0	59.3	9.977	-0.059	9.859	47.3	8.6	0.0	8.819
21	58.9	58.9	0.0	58.9	9.947	-0.044	9.859	46.7	8.5	0.0	8.819
22	58.8	58.8	0.0	58.8	9.924	-0.033	9.859	46.5	8.5	0.0	8.819
23	58.1	58.1	0.0	58.1	9.906	-0.023	9.859	45.4	8.5	0.0	8.819
24	58.2	58.2	0.0	58.2	9.887	-0.014	9.859	45.6	8.5	0.0	8.819
25	58.1	58.1	0.0	58.1	9.864	-0.003	9.859	45.4	8.4	0.0	8.819
26	58.4	58.4	0.0	58.4	9.845	0.007	9.859	45.9	8.4	0.0	8.819
27	58.0	58.0	0.0	58.0	9.830	0.014	9.859	45.2	8.4	0.0	8.819
28	57.8	57.8	0.0	57.8	9.823	0.018	9.859	44.9	8.4	0.0	8.819
29	56.2	56.2	0.0	56.2	9.856	0.001	9.859	42.4	8.4	0.0	8.819

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 759 (REMOULDED SAMPLE)
TEST RESULTS START 310585 END 140685

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.1	26.5	23.6	34.4	1.438	0.290	2.019	0.0	0.0		0.0
2	57.6	30.5	27.1	39.5	1.741	0.376	2.493	9.4	0.3	0.212	0.212
3	66.3	35.1	31.2	45.5	2.180	0.481	3.142	20.2	0.8	0.341	0.553
4	76.3	40.4	35.9	52.4	2.827	0.579	3.984	32.8	1.4	0.535	1.088
5	87.7	46.5	41.2	60.2	3.834	0.608	5.051	47.0	2.4	0.852	1.940
6	100.9	53.5	47.4	69.3	5.336	0.604	6.544	63.5	3.9	1.412	3.352
7	116.0	61.5	54.5	79.7	7.104	0.564	8.232	82.4	5.7	1.871	5.223
8	133.4	70.7	62.7	91.6	8.970	0.470	9.911	104.1	7.5	2.203	7.426
9	159.5	84.8	74.7	109.7	11.807	0.116	12.040	137.0	10.4	3.603	11.029
10	79.9	42.4	37.5	54.9	10.838	-0.137	10.563	37.3	9.4	-1.482	9.547
11	79.8	42.4	37.4	54.9	10.796	-0.181	10.434	37.3	9.4	-0.070	9.477
12	79.8	42.4	37.4	54.9	10.872	-0.246	10.379	37.2	9.5	0.005	9.482
13	75.1	44.0	31.1	54.4	10.869	-0.245	10.379	35.2	9.5	-0.001	9.481
14	71.7	46.8	24.9	55.1	10.847	-0.234	10.379	35.9	9.4	-0.006	9.474
15	68.4	49.7	18.7	55.9	10.817	-0.219	10.379	37.6	9.4	-0.006	9.468
16	65.6	53.1	12.5	57.3	10.775	-0.198	10.379	40.7	9.4	-0.007	9.461
17	62.4	56.2	6.2	58.3	10.712	-0.166	10.379	43.8	9.3	-0.006	9.456
18	59.6	59.6	0.0	59.6	10.624	-0.122	10.379	47.8	9.2	-0.003	9.453
19	59.4	59.4	0.0	59.4	10.573	-0.097	10.379	47.4	9.2	-0.000	9.453
20	59.3	59.3	0.0	59.3	10.511	-0.066	10.379	47.3	9.1	-0.000	9.453
21	58.9	58.9	0.0	58.9	10.477	-0.049	10.379	46.7	9.1	-0.000	9.453
22	58.8	58.8	0.0	58.8	10.452	-0.036	10.379	46.5	9.0	-0.000	9.453
											9.453

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
23	58.1	58.1	0.0	58.1	10.431	-0.026	10.379	45.4	9.0	-0.000	9.453
24	58.2	58.2	0.0	58.2	10.410	-0.015	10.379	45.6	9.0	-0.000	9.453
25	58.1	58.1	0.0	58.1	10.385	-0.003	10.379	45.4	9.0	-0.000	9.453
26	58.4	58.4	0.0	58.4	10.364	0.008	10.379	45.9	8.9	-0.000	9.453
27	58.0	58.0	0.0	58.0	10.347	0.016	10.379	45.2	8.9	-0.000	9.453
28	57.8	57.8	0.0	57.8	10.338	0.020	10.379	44.9	8.9	-0.000	9.453
29	56.2	56.2	0.0	56.2	10.376	0.001	10.379	42.4	8.9	-0.000	9.453

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 759 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION : 11.951 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION : 549.850 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION : 46.009 SQUARE CENTIMETRES

CONSTANT LOAD : 16.52 N .
PROVING RING FACTOR : 1.0225 N ./DIV
PISTON AREA : 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING : 2097.00 DIVISIONS

SHEAR TEST RESULTS START 250685 END 260685

CONSOLIDATED UNDRAINED TRIAXIAL TEST
:::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	909	2097.0	274.0	200.6	0.0	79.8	42.0	18.9	37.8	54.6	1.899	0.0
2	915	2095.6	286.5	202.3	0.01	80.5	39.9	20.3	40.6	53.4	2.017	0.60
3	920	2093.8	296.5	203.2	0.03	81.8	39.0	21.4	42.8	53.3	2.097	0.52
4	925	2091.0	304.5	204.5	0.05	82.7	38.2	22.2	44.5	53.0	2.165	0.58
5	930	2088.5	311.0	205.2	0.07	83.3	37.3	23.0	46.0	52.6	2.232	0.56
6	940	2083.0	321.0	206.2	0.12	84.5	36.4	24.1	48.1	52.4	2.323	0.54
7	950	2075.2	329.0	206.5	0.18	85.6	35.7	25.0	49.9	52.3	2.399	0.48
8	1000	2067.0	334.0	207.6	0.25	85.9	34.9	25.5	51.0	51.9	2.461	0.53
9	1010	2059.0	339.5	207.5	0.32	87.0	34.8	26.1	52.2	52.2	2.499	0.48
10	1020	2051.0	344.0	208.1	0.38	87.5	34.4	26.6	53.1	52.1	2.544	0.49
11	1030	2043.5	348.5	208.4	0.45	88.4	34.3	27.0	54.1	52.3	2.576	0.48
12	1040	2034.8	352.0	208.3	0.52	88.8	34.0	27.4	54.8	52.3	2.613	0.45
13	1050	2026.0	355.2	208.7	0.59	89.3	33.8	27.7	55.5	52.3	2.641	0.46
14	1100	2018.0	358.0	208.8	0.66	89.7	33.6	28.0	56.1	52.3	2.669	0.45
15	1115	2004.5	362.0	208.9	0.77	90.3	33.4	28.5	56.9	52.4	2.704	0.43
16	1130	1991.5	366.5	209.3	0.88	91.0	33.2	28.9	57.8	52.5	2.741	0.43
17	1145	1978.0	370.0	209.7	1.00	91.6	33.1	29.2	58.5	52.6	2.767	0.44
18	1200	1964.5	373.0	209.5	1.11	92.3	33.2	29.6	59.1	52.9	2.780	0.42
19	1215	1952.5	376.5	209.5	1.21	92.8	33.0	29.9	59.8	52.9	2.813	0.40
20	1230	1937.0	378.5	209.6	1.34	93.3	33.1	30.1	60.2	53.2	2.817	0.40
21	1245	1924.5	380.0	209.8	1.44	93.4	33.0	30.2	60.4	53.1	2.830	0.41
22	1300	1909.5	382.5	209.2	1.57	94.2	33.3	30.5	60.9	53.6	2.829	0.37
23	1330	1883.5	385.5	209.4	1.79	94.9	33.5	30.7	61.4	54.0	2.832	0.37
24	1400	1855.5	387.5	208.7	2.02	95.3	33.6	30.9	61.7	54.2	2.837	0.34
25	1430	1828.0	389.0	208.9	2.25	95.9	34.0	30.9	61.9	54.6	2.819	0.34
26	1500	1798.5	390.0	208.5	2.50	96.0	34.0	31.0	62.0	54.7	2.822	0.33
27	1530	1771.5	390.5	208.9	2.72	95.8	33.9	30.9	61.9	54.5	2.826	0.34
28	1600	1742.0	390.5	208.6	2.97	95.9	34.2	30.9	61.7	54.8	2.805	0.33
29	1630	1714.5	391.0	208.3	3.20	95.9	34.2	30.9	61.7	54.8	2.805	0.32
30	1700	1685.0	390.5	208.5	3.45	95.5	34.0	30.7	61.5	54.5	2.808	0.33
31	1801	1627.5	390.5	208.5	3.93	95.2	34.1	30.6	61.1	54.6	2.783	0.34
32	1900	1570.0	388.5	208.7	4.41	94.5	34.1	30.2	60.4	54.2	2.771	0.36
33	2000	1514.5	388.0	208.5	4.87	94.0	34.0	30.0	60.0	54.0	2.765	0.35
34	2101	1455.0	386.5	208.6	5.37	93.4	34.0	29.7	59.4	53.8	2.747	0.37
35	2202	1400.0	385.0	209.0	5.83	92.6	33.8	29.4	58.8	53.4	2.739	0.40
36	2300	1343.0	384.0	209.4	6.31	91.7	33.4	29.1	58.3	52.8	2.744	0.43
37	2416	1270.0	381.5	208.9	6.92	91.1	33.7	28.7	57.4	52.8	2.703	0.42
38	300	1114.0	376.0	208.9	8.23	89.0	33.5	27.7	55.5	52.0	2.656	0.47
39	710	875.0	368.0	209.5	10.23	85.6	32.9	26.3	52.7	50.5	2.601	0.60
40	800	828.0	366.0	209.4	10.62	85.1	33.1	26.0	52.0	50.4	2.572	0.62
41	920	769.0	363.5	208.9	11.11	84.8	33.5	25.6	51.3	50.6	2.530	0.61
42	1000	714.0	360.5	209.2	11.57	83.6	33.2	25.2	50.4	50.0	2.518	0.68
43	1100	655.0	357.5	209.2	12.06	82.7	33.2	24.8	49.5	49.7	2.492	0.73

SAMPLE NO. : T 759 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 79.75 KPA
PRECONSOLIDATION PRESSURE : 159.54 KPA
NORMALIZING STRESS : 159.54 KPA

NORMALIZED SHEAR TEST RESULTS START 250685 END 260685

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.118	1.899	0.342	0.0
2	0.01	0.127	2.017	0.335	0.011
3	0.03	0.134	2.097	0.334	0.016
4	0.05	0.139	2.165	0.332	0.024
5	0.07	0.144	2.232	0.330	0.029
6	0.12	0.151	2.323	0.329	0.035
7	0.18	0.156	2.399	0.328	0.037
8	0.25	0.160	2.461	0.325	0.044
9	0.32	0.164	2.499	0.327	0.043
10	0.38	0.166	2.544	0.327	0.047
11	0.45	0.169	2.576	0.328	0.049
12	0.52	0.172	2.613	0.328	0.048
13	0.59	0.174	2.641	0.328	0.051
14	0.66	0.176	2.669	0.328	0.051
15	0.77	0.178	2.704	0.328	0.052
16	0.88	0.181	2.741	0.329	0.055
17	1.00	0.183	2.767	0.330	0.057
18	1.11	0.185	2.780	0.332	0.056
19	1.21	0.187	2.813	0.332	0.056
20	1.34	0.189	2.817	0.333	0.056
21	1.44	0.189	2.830	0.333	0.058
22	1.57	0.191	2.829	0.336	0.054
23	1.79	0.192	2.832	0.338	0.055
24	2.02	0.193	2.837	0.340	0.051
25	2.25	0.194	2.819	0.342	0.052
26	2.50	0.194	2.822	0.343	0.050
27	2.72	0.194	2.826	0.342	0.052
28	2.97	0.193	2.805	0.343	0.050
29	3.20	0.193	2.805	0.343	0.048
30	3.45	0.193	2.808	0.342	0.050
31	3.93	0.192	2.783	0.341	0.050
32	4.41	0.189	2.771	0.340	0.051
33	4.87	0.188	2.765	0.339	0.050
34	5.37	0.186	2.747	0.337	0.050
35	5.83	0.184	2.739	0.335	0.053
36	6.31	0.183	2.744	0.331	0.055
37	6.92	0.180	2.703	0.331	0.052
38	8.23	0.174	2.656	0.326	0.052
39	10.23	0.165	2.601	0.316	0.056
40	10.62	0.163	2.572	0.316	0.055
41	11.11	0.161	2.530	0.317	0.052
42	11.57	0.158	2.518	0.313	0.054
43	12.06	0.155	2.492	0.312	0.054

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 760 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 51.0 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.392
INITIAL HEIGHT OF SAMPLE : 13.24 CM
INITIAL VOLUME OF SAMPLE : 603.00 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.53
FINAL MOISTURE CONTENT : 42.7 PERCENT

TX. CONSOLIDATION START 30785 END 190785
TRIAXIAL CONSOLIDATION TEST
:::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.93	26.50	1.730	1.410	-0.160	34.31	23.43	1.358	2.358	1.260
2	57.41	30.40	2.088	1.957	-0.066	39.40	27.01	1.345	2.345	1.436
3	66.13	35.00	2.583	2.620	0.019	45.38	31.13	1.329	2.329	1.710
4	76.10	40.30	3.384	3.582	0.099	52.23	35.80	1.306	2.306	2.190
5	87.55	46.40	4.524	4.760	0.118	60.12	41.15	1.278	2.278	2.938
6	100.69	53.40	6.054	6.144	0.045	69.16	47.29	1.245	2.245	4.006
7	115.73	61.40	7.900	7.720	-0.090	79.51	54.33	1.207	2.207	5.327
8	132.85	70.50	9.890	9.370	-0.260	91.28	62.35	1.168	2.168	6.767
9	159.09	84.80	12.893	11.262	-0.820	109.56	74.29	1.123	2.123	9.142
10	79.82	42.40	12.153	10.083	-1.035	54.87	37.42	1.151	2.151	8.792
11	79.79	42.40	12.039	9.900	-1.089	54.86	37.39	1.155	2.155	8.739
12	80.10	42.40	11.775	9.502	-1.136	54.97	37.70	1.165	2.165	8.607

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.93	26.50	1.730	-0.160	2.358
2	57.41	30.40	2.088	-0.066	2.345
3	66.13	35.00	2.583	0.019	2.329
4	76.10	40.30	3.384	0.099	2.306
5	87.55	46.40	4.524	0.118	2.278
6	100.69	53.40	6.054	0.045	2.245
7	115.73	61.40	7.900	-0.090	2.207
8	132.85	70.50	9.890	-0.260	2.168
9	159.09	84.80	12.893	-0.820	2.123
10	79.82	42.40	12.153	-1.035	2.151
11	79.79	42.40	12.039	-1.069	2.155
12	80.10	42.40	11.775	-1.136	2.165

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 760 (REMOULDED SAMPLE)
TEST RESULTS START 30785 END 190785

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	1.730	-0.160	1.410	0.0	0.0		0.0
2	57.4	30.4	27.0	39.4	2.088	-0.066	1.957	9.3	0.4	0.246	0.246
3	66.1	35.0	31.1	45.4	2.583	0.019	2.620	20.2	0.9	0.361	0.607
4	76.1	40.3	35.8	52.2	3.384	0.099	3.582	32.6	1.7	0.630	1.237
5	87.6	46.4	41.2	60.1	4.524	0.118	4.760	47.0	2.8	0.949	2.186
6	100.7	53.4	47.3	69.2	6.054	0.045	6.144	63.4	4.3	1.367	3.554
7	115.7	61.4	54.3	79.5	7.900	-0.090	7.720	82.3	6.2	1.843	5.396
8	132.9	70.5	62.4	91.3	9.890	-0.260	9.370	103.7	8.2	2.249	7.645
9	159.1	84.8	74.3	109.6	12.893	-0.820	11.252	136.8	11.2	3.513	11.158
10	79.8	42.4	37.4	54.9	12.153	-1.035	10.083	37.4	10.5	-1.157	10.001
11	79.8	42.4	37.4	54.9	12.039	-1.069	9.900	37.4	10.4	-0.120	9.881
12	80.1	42.4	37.7	55.0	11.775	-1.136	9.502	37.6	10.1	-0.268	9.613

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 760 (REMOULDED SAMPLE)
TEST RESULTS START 30785 END 190785

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	1.745	-0.163	1.420	0.0	0.0		0.0
2	57.4	30.4	27.0	39.4	2.110	-0.067	1.976	9.3	0.4	0.251	0.251
3	66.1	35.0	31.1	45.4	2.617	0.019	2.655	20.2	0.9	0.369	0.620
4	76.1	40.3	35.8	52.2	3.442	0.103	3.648	32.6	1.7	0.650	1.270
5	87.6	46.4	41.2	60.1	4.630	0.123	4.876	47.0	2.9	0.990	2.259
6	100.7	53.4	47.3	69.2	6.245	0.048	6.341	63.4	4.5	1.445	3.704
7	115.7	61.4	54.3	79.5	8.230	-0.098	8.034	82.3	6.5	1.980	5.684
8	132.9	70.5	62.4	91.3	10.414	-0.288	9.838	103.7	8.7	2.464	8.149
9	159.1	84.8	74.3	109.6	13.802	-0.933	11.937	136.8	12.1	3.944	12.093
10	79.8	42.4	37.4	54.9	12.956	-1.164	10.628	37.4	11.3	-1.305	10.788
11	79.8	42.4	37.4	54.9	12.827	-1.201	10.425	37.4	11.2	-0.134	10.654
12	80.1	42.4	37.7	55.0	12.527	-1.271	9.985	37.6	10.9	-0.300	10.355

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 780 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION = 11.641 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION = 545.700 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION = 46.877 SQUARE CENTIMETRES

CONSTANT LOAD = 16.47 N .
PROVING RING FACTOR = 1.2365 N ./DIV
PISTON AREA = 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING = 2188.00 DIVISIONS

SHEAR TEST RESULTS START 190785 END 200785

CONSOLIDATED UNDRAINED TRIAXIAL TEST
:::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	838	2188.0	352.0	500.0	0.0	80.1	42.4	18.8	37.7	55.0	1.889	0.0
2	845	2187.8	381.0	500.7	0.00	87.1	41.8	22.7	45.3	55.9	2.085	0.09
3	855	2186.5	408.0	502.4	0.01	92.5	40.0	26.2	52.5	57.5	2.312	0.16
4	900	2184.5	421.5	503.6	0.03	94.8	38.8	28.0	56.0	57.5	2.444	0.20
5	910	2181.0	439.0	505.3	0.06	97.9	37.3	30.3	60.6	57.5	2.624	0.23
6	920	2156.0	454.0	506.1	0.10	101.0	36.5	32.3	64.5	58.0	2.768	0.23
7	930	2150.0	465.5	506.4	0.15	103.8	36.3	33.8	67.5	58.8	2.880	0.21
8	940	2144.0	475.0	506.5	0.21	106.1	36.1	35.0	70.0	59.4	2.938	0.20
9	950	2137.5	481.0	506.4	0.28	107.5	36.0	35.8	71.5	59.8	2.987	0.19
10	1000	2130.0	487.5	505.8	0.33	109.8	36.8	36.6	73.2	61.0	3.000	0.18
11	1010	2126.5	491.5	505.8	0.36	111.0	36.8	37.1	74.2	61.5	3.017	0.18
12	1020	2124.5	498.5	505.4	0.37	112.4	36.9	37.8	75.5	62.1	3.047	0.14
13	1030	2121.5	500.0	504.7	0.40	114.3	37.9	38.2	76.4	63.4	3.016	0.12
14	1040	2118.0	504.0	504.3	0.43	115.9	38.5	38.7	77.4	64.3	3.011	0.11
15	1050	2116.0	505.0	503.9	0.45	116.2	38.5	38.9	77.7	64.4	3.016	0.10
16	1100	2109.5	507.5	503.4	0.50	117.4	39.1	39.2	78.3	65.2	3.003	0.08
17	1110	2102.0	509.0	503.3	0.57	118.1	39.5	39.3	78.6	65.7	2.990	0.08
18	1120	2093.0	510.5	502.8	0.64	119.0	40.0	39.5	79.0	66.3	2.974	0.07
19	1130	2083.5	511.5	502.3	0.73	119.3	40.1	39.6	79.2	66.5	2.975	0.06
20	1140	2074.5	512.5	502.1	0.80	120.0	40.6	39.7	79.4	67.1	2.955	0.05
21	1150	2065.0	513.0	501.7	0.88	120.5	41.1	39.7	79.4	67.6	2.932	0.04
22	1200	2055.5	514.5	501.2	0.97	121.0	41.2	39.9	79.8	67.8	2.937	0.03
23	1210	2046.5	514.5	501.4	1.04	121.1	41.4	39.8	79.7	68.0	2.925	0.03
24	1220	2037.0	514.5	501.1	1.13	121.4	41.6	39.8	79.6	68.3	2.904	0.03
25	1230	2027.0	515.5	501.0	1.21	121.8	41.8	39.9	79.8	68.4	2.909	0.02
26	1245	2013.5	515.5	501.4	1.33	121.3	41.6	39.8	79.7	68.2	2.918	0.03
27	1300	1999.0	516.0	501.9	1.46	120.8	40.8	39.9	79.8	67.4	2.955	0.05
28	1329	1973.0	516.0	501.3	1.66	120.9	41.3	39.8	79.8	67.8	2.927	0.03
29	1400	1944.0	516.5	501.0	1.82	121.1	41.6	39.8	79.5	68.1	2.911	0.02
30	1433	1913.0	516.5	501.1	2.19	121.0	41.7	39.6	79.3	68.1	2.901	0.03
31	1504	1883.5	516.0	500.4	2.44	121.6	42.7	39.5	78.9	69.0	2.848	0.01
32	1530	1850.0	516.5	500.5	2.86	121.8	42.7	39.4	78.9	69.0	2.847	0.01
33	1801	1829.0	514.0	500.5	2.91	120.6	42.6	39.0	78.0	68.8	2.822	0.01
34	1830	1804.0	512.5	500.5	3.13	120.4	43.0	38.7	77.4	68.8	2.800	0.01
35	1707	1771.0	512.0	500.7	3.41	119.9	42.8	38.5	77.1	68.5	2.801	0.02
36	1800	1721.0	510.2	500.6	3.84	119.3	43.0	38.1	76.3	68.4	2.773	0.02
37	1900	1663.5	509.0	500.7	4.33	118.6	43.1	37.8	75.5	68.3	2.753	0.02
38	2000	1607.5	508.5	501.0	4.81	117.9	42.9	37.5	75.0	67.9	2.749	0.03
39	2100	1549.5	508.5	501.4	5.31	117.1	42.5	37.3	74.6	67.4	2.756	0.04
40	2208	1484.5	505.5	500.9	5.87	116.2	42.7	36.7	73.5	67.2	2.721	0.03
41	2302	1433.0	504.0	500.6	6.31	115.4	42.6	36.4	72.8	66.9	2.708	0.02
42	2400	1376.0	501.5	501.0	6.79	114.6	42.9	35.9	71.7	66.8	2.672	0.03
43	823	1013.5	494.0	501.1	9.92	110.1	42.6	33.8	67.6	65.0	2.590	0.04
44	800	922.5	494.0	501.3	10.70	108.9	41.9	33.5	67.0	64.2	2.600	0.04
45	900	865.0	492.0	501.2	11.19	108.5	42.3	33.1	66.2	64.4	2.564	0.04
46	945	822.0	491.0	501.3	11.56	107.6	41.9	32.8	65.7	63.8	2.566	0.05
47	1101	747.0	490.0	501.2	12.21	107.0	42.0	32.5	65.0	63.7	2.547	0.04

SAMPLE NO. • T 760 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS • 80.48 KPA
PRECONSOLIDATION PRESSURE • 159.09 KPA
NORMALIZING STRESS • 159.09 KPA

NORMALIZED SHEAR TEST RESULTS START 190785 END 200785

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.118	1.889	0.346	0.0
2	0.00	0.142	2.086	0.358	0.004
3	0.01	0.165	2.312	0.361	0.015
4	0.03	0.176	2.444	0.361	0.023
5	0.06	0.190	2.624	0.361	0.033
6	0.10	0.203	2.768	0.365	0.038
7	0.15	0.212	2.860	0.370	0.040
8	0.21	0.220	2.938	0.374	0.041
9	0.26	0.225	2.987	0.378	0.040
10	0.33	0.230	3.000	0.383	0.038
11	0.36	0.233	3.017	0.387	0.036
12	0.37	0.237	3.047	0.390	0.034
13	0.40	0.240	3.016	0.398	0.030
14	0.43	0.243	3.011	0.404	0.027
15	0.45	0.244	3.018	0.405	0.025
16	0.50	0.246	3.003	0.410	0.021
17	0.57	0.247	2.990	0.413	0.021
18	0.64	0.248	2.974	0.417	0.018
19	0.73	0.248	2.975	0.418	0.014
20	0.80	0.249	2.955	0.421	0.013
21	0.88	0.250	2.932	0.425	0.011
22	0.97	0.251	2.937	0.426	0.008
23	1.04	0.250	2.926	0.427	0.009
24	1.13	0.250	2.904	0.420	0.007
25	1.21	0.251	2.909	0.430	0.008
26	1.33	0.250	2.918	0.428	0.009
27	1.45	0.251	2.955	0.424	0.012
28	1.68	0.250	2.927	0.426	0.008
29	1.92	0.250	2.911	0.428	0.008
30	2.19	0.249	2.901	0.428	0.007
31	2.44	0.248	2.848	0.434	0.003
32	2.65	0.248	2.847	0.434	0.003
33	2.91	0.245	2.822	0.432	0.003
34	3.13	0.243	2.800	0.432	0.003
35	3.41	0.242	2.801	0.430	0.004
36	3.84	0.240	2.773	0.430	0.004
37	4.33	0.237	2.753	0.429	0.004
38	4.81	0.236	2.749	0.427	0.008
39	5.31	0.235	2.758	0.424	0.009
40	5.87	0.231	2.721	0.422	0.008
41	6.31	0.229	2.708	0.420	0.005
42	6.79	0.225	2.672	0.420	0.008
43	8.82	0.212	2.590	0.409	0.007
44	10.70	0.211	2.600	0.404	0.008
45	11.19	0.208	2.564	0.405	0.008
46	11.56	0.206	2.568	0.401	0.008
47	12.21	0.204	2.547	0.400	0.008

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

387

SAMPLE NO. : T 761 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 51.5 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.405
INITIAL HEIGHT OF SAMPLE : 13.26 CM
INITIAL VOLUME OF SAMPLE : 603.91 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.53
FINAL MOISTURE CONTENT : 42.1 PERCENT

TX. CONSOLIDATION START 40785 END 180785
TRIAXIAL CONSOLIDATION TEST

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.96	26.50	2.036	1.813	-0.112	34.32	23.46	1.362	2.362	1.432
2	57.44	30.40	2.413	2.376	-0.019	39.41	27.04	1.348	2.348	1.621
3	66.11	35.00	3.002	3.196	0.097	45.37	31.11	1.328	2.328	1.936
4	76.16	40.30	3.873	4.206	0.167	52.25	35.86	1.304	2.304	2.471
5	87.63	46.40	5.053	5.456	0.202	60.14	41.23	1.274	2.274	3.234
6	100.70	53.40	6.614	6.905	0.146	69.17	47.30	1.239	2.239	4.312
7	115.72	61.40	8.394	8.519	0.063	79.51	54.32	1.200	2.200	5.554
8	132.91	70.50	10.113	9.952	-0.081	91.30	62.41	1.166	2.166	6.796
9	159.10	84.80	13.341	12.055	-0.643	109.57	74.30	1.115	2.115	9.323
10	79.86	42.40	12.481	10.738	-0.871	54.89	37.46	1.147	2.147	8.902
11	79.84	42.40	12.459	10.656	-0.902	54.88	37.44	1.149	2.149	8.907
12	79.29	41.90	12.572	10.664	-0.954	54.36	37.39	1.149	2.149	9.017

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.96	26.50	2.036	-0.112	2.362
2	57.44	30.40	2.413	-0.019	2.348
3	66.11	35.00	3.002	0.097	2.328
4	76.16	40.30	3.873	0.167	2.304
5	87.63	46.40	5.053	0.202	2.274
6	100.70	53.40	6.614	0.146	2.239
7	115.72	61.40	8.394	0.063	2.200
8	132.91	70.50	10.113	-0.081	2.166
9	159.10	84.80	13.341	-0.643	2.115
10	79.86	42.40	12.481	-0.871	2.147
11	79.84	42.40	12.459	-0.902	2.149
12	79.29	41.90	12.572	-0.954	2.149

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. = T 761 (REMOULDED SAMPLE)
TEST RESULTS START 40785 END 180785

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	2.036	-0.112	1.813	0.0	0.0		0.0
										0.255	
2	57.4	30.4	27.0	39.4	2.413	-0.019	2.376	9.3	0.4		0.255
										0.439	
3	66.1	35.0	31.1	45.4	3.002	0.097	3.196	20.1	1.0		0.694
										0.672	
4	76.2	40.3	35.9	52.3	3.873	0.167	4.206	32.7	1.9		1.366
										0.997	
5	87.6	46.4	41.2	60.1	5.053	0.202	5.456	47.0	3.0		2.363
										1.414	
6	100.7	53.4	47.3	69.2	6.614	0.146	6.905	63.4	4.6		3.777
										1.831	
7	115.7	61.4	54.3	79.5	8.394	0.063	8.519	82.2	6.4		5.608
										1.948	
8	132.9	70.5	62.4	91.3	10.113	-0.081	9.952	103.7	8.1		7.556
										3.839	
9	159.1	84.8	74.3	109.6	13.341	-0.643	12.055	136.8	11.3		11.396
										-1.318	
10	79.9	42.4	37.5	54.9	12.481	-0.871	10.738	37.4	10.5		10.078
										-0.044	
11	79.8	42.4	37.4	54.9	12.459	-0.902	10.656	37.4	10.5		10.035
										0.046	
12	79.3	41.9	37.4	54.4	12.572	-0.954	10.664	36.5	10.6		10.080

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. = T 761 (REMOULDED SAMPLE)
TEST RESULTS START 40785 END 180785

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	50.0	26.5	23.5	34.3	2.057	-0.114	1.830	0.0	0.0		0.0
										0.261	
2	57.4	30.4	27.0	39.4	2.443	-0.019	2.405	9.3	0.4		0.261
										0.451	
3	66.1	35.0	31.1	45.4	3.047	0.100	3.248	20.1	1.0		0.712
										0.697	
4	76.2	40.3	35.9	52.3	3.949	0.174	4.297	32.7	1.9		1.409
										1.046	
5	87.6	46.4	41.2	60.1	5.185	0.213	5.610	47.0	3.2		2.455
										1.504	
6	100.7	53.4	47.3	69.2	6.843	0.156	7.155	63.4	4.8		3.960
										1.882	
7	115.7	61.4	54.3	79.5	8.767	0.069	8.904	82.2	6.7		5.841
										2.147	
8	132.9	70.5	62.4	91.3	10.662	-0.090	10.482	103.7	8.6		8.088
										4.334	
9	159.1	84.8	74.3	109.6	14.318	-0.736	12.845	136.8	12.3		12.422
										-1.497	
10	79.9	42.4	37.5	54.9	13.331	-0.986	11.359	37.4	11.3		10.926
										-0.049	
11	79.8	42.4	37.4	54.9	13.305	-1.019	11.267	37.4	11.3		10.877
										0.052	
12	79.3	41.9	37.4	54.4	13.434	-1.079	11.276	36.5	11.5		10.929

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 761 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION = 11.593 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION = 539.513 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION = 46.538 SQUARE CENTIMETRES

CONSTANT LOAD = 15.00 N .
PROVING RING FACTOR = 1.3970 N ./DIV
PISTON AREA = 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING = 2038.00 DIVISIONS

SHEAR TEST RESULTS START 180785 END 190785

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	839	2038.0	310.7	500.6	0.0	79.3	41.9	18.7	37.4	54.4	1.892	0.0
2	845	2037.0	325.2	502.6	0.01	82.3	40.7	20.8	41.6	54.6	2.023	0.47
3	850	2035.4	337.0	504.4	0.02	83.3	38.0	22.6	45.3	53.1	2.192	0.48
4	855	2033.5	348.0	505.7	0.04	85.2	36.6	24.3	48.6	52.8	2.328	0.46
5	900	2031.5	356.5	507.1	0.06	86.5	35.4	25.6	51.1	52.4	2.444	0.47
6	910	2027.5	369.5	508.7	0.09	88.7	33.7	27.5	55.0	52.0	2.632	0.46
7	920	2022.0	379.0	509.4	0.14	90.8	33.0	28.9	57.8	52.3	2.752	0.43
8	930	2015.5	389.5	510.1	0.19	93.2	32.3	30.5	60.9	52.6	2.887	0.40
9	940	2009.5	395.5	510.4	0.25	94.7	32.0	31.3	62.7	52.9	2.959	0.39
10	950	2003.5	400.5	510.4	0.30	96.2	32.0	32.1	64.2	53.4	3.005	0.37
11	1000	1996.5	404.5	510.1	0.36	97.6	32.3	32.7	65.3	54.1	3.022	0.34
12	1010	1989.5	407.5	509.9	0.42	98.7	32.5	33.1	66.2	54.6	3.036	0.32
13	1020	1983.5	411.0	509.8	0.47	99.8	32.6	33.6	67.2	55.0	3.061	0.31
14	1030	1976.0	414.0	509.6	0.53	100.8	32.8	34.0	68.0	55.5	3.074	0.29
15	1040	1968.5	417.0	509.7	0.60	101.8	32.9	34.4	68.9	55.9	3.093	0.29
16	1050	1960.8	418.8	508.8	0.67	102.6	33.2	34.7	69.4	56.3	3.091	0.26
17	1100	1954.0	420.2	508.8	0.72	103.3	33.5	34.9	69.8	56.8	3.083	0.25
18	1111	1946.0	422.0	508.2	0.79	104.3	34.0	35.1	70.3	57.4	3.067	0.23
19	1120	1939.0	423.5	508.5	0.85	104.6	34.0	35.3	70.6	57.5	3.078	0.24
20	1131	1931.0	424.8	507.9	0.92	105.5	34.5	35.5	71.0	58.2	3.058	0.22
21	1140	1925.0	426.0	507.6	0.97	106.0	34.7	35.7	71.3	58.5	3.055	0.21
22	1150	1918.0	427.0	507.6	1.04	106.2	34.6	35.8	71.6	58.5	3.069	0.20
23	1200	1910.0	427.8	507.0	1.10	106.9	35.1	35.9	71.8	59.0	3.045	0.19
24	1217	1898.0	428.8	506.8	1.21	107.4	35.4	36.0	72.0	59.4	3.034	0.18
25	1230	1888.0	429.5	506.6	1.29	107.7	35.6	36.1	72.1	59.6	3.026	0.17
26	1245	1877.0	430.2	506.8	1.39	108.1	35.9	36.1	72.2	60.0	3.012	0.18
27	1300	1865.0	430.2	506.7	1.49	108.0	35.8	36.1	72.2	59.9	3.016	0.18
28	1315	1854.0	430.2	505.9	1.59	108.5	36.4	36.1	72.1	60.4	2.981	0.16
29	1330	1842.0	430.5	506.0	1.69	108.4	36.3	36.1	72.1	60.3	2.987	0.16
30	1345	1830.5	430.5	506.0	1.79	108.4	36.3	36.0	72.1	60.3	2.985	0.16
31	1400	1819.5	431.0	505.7	1.88	108.6	36.5	36.1	72.1	60.5	2.977	0.15
32	1430	1798.0	431.2	505.2	2.07	109.0	36.9	36.0	72.1	60.9	2.953	0.13
33	1500	1774.8	432.2	505.2	2.27	109.3	37.1	36.1	72.2	61.2	2.946	0.13
34	1530	1753.0	432.5	505.0	2.46	109.5	37.4	36.1	72.1	61.4	2.929	0.13
35	1600	1730.0	433.0	505.0	2.66	109.5	37.3	36.1	72.2	61.4	2.934	0.13
36	1630	1707.0	434.0	504.7	2.86	110.0	37.7	36.1	72.3	61.8	2.917	0.12
37	1700	1685.0	434.4	504.7	3.04	110.0	37.7	36.1	72.3	61.8	2.917	0.12
38	1800	1638.0	434.2	504.7	3.45	109.6	37.7	36.0	71.9	61.7	2.907	0.12
39	1900	1593.0	433.5	504.8	3.84	109.1	37.7	35.7	71.4	61.5	2.894	0.12
40	2000	1548.5	431.2	504.7	4.24	108.2	37.7	35.2	70.5	61.2	2.889	0.12
41	2100	1502.5	430.0	504.7	4.62	107.6	37.8	34.9	69.8	61.1	2.847	0.13
42	2200	1457.0	429.8	504.7	5.01	107.3	37.8	34.7	69.5	61.0	2.838	0.13
43	2300	1412.0	429.9	504.8	5.40	106.8	37.6	34.6	69.2	60.7	2.841	0.13
44	2400	1366.0	429.2	504.9	5.80	106.3	37.6	34.4	68.7	60.5	2.828	0.14
45	530	1115.0	427.5	506.2	7.86	102.9	36.2	33.3	66.7	58.4	2.842	0.19
46	800	1002.0	427.5	506.1	8.94	102.1	36.1	33.0	66.0	58.1	2.828	0.19
47	902	954.0	425.8	506.2	9.35	101.5	36.0	32.8	65.5	57.8	2.820	0.20
48	1002	908.0	424.5	506.4	9.75	100.6	36.0	32.3	64.6	57.5	2.794	0.21
49	1104	862.0	425.0	507.1	10.14	99.6	35.2	32.2	64.4	56.7	2.831	0.24
50	1203	817.0	424.0	507.6	10.53	98.7	34.8	31.9	63.9	56.1	2.836	0.26
51	1300	775.0	424.0	507.9	10.89	98.0	34.4	31.8	63.6	55.6	2.850	0.28
52	1400	730.5	424.5	507.7	11.28	98.0	34.5	31.8	63.5	55.7	2.841	0.27
53	1500	683.5	424.5	508.8	11.68	97.2	34.0	31.6	63.2	55.1	2.858	0.32
54	1600	630.5	424.0	508.7	12.14	96.9	34.2	31.3	62.7	55.1	2.833	0.32

SAMPLE NO. = T 761 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS = 79.30 KPA
PRECONSOLIDATION PRESSURE = 159.10 KPA
NORMALIZING STRESS = 159.10 KPA

NORMALIZED SHEAR TEST RESULTS START 180785 END 190785

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.117	1.892	0.342	0.0
2	0.01	0.131	2.023	0.343	0.013
3	0.02	0.142	2.192	0.334	0.024
4	0.04	0.153	2.328	0.332	0.032
5	0.06	0.161	2.444	0.330	0.041
6	0.09	0.173	2.632	0.327	0.051
7	0.14	0.182	2.752	0.329	0.055
8	0.19	0.191	2.887	0.331	0.060
9	0.25	0.197	2.959	0.332	0.062
10	0.30	0.202	3.005	0.336	0.062
11	0.36	0.205	3.022	0.340	0.060
12	0.42	0.208	3.036	0.343	0.058
13	0.47	0.211	3.061	0.346	0.058
14	0.53	0.214	3.074	0.349	0.057
15	0.60	0.216	3.093	0.351	0.057
16	0.67	0.218	3.091	0.354	0.052
17	0.72	0.219	3.083	0.357	0.052
18	0.79	0.221	3.067	0.361	0.048
19	0.85	0.222	3.078	0.362	0.050
20	0.92	0.223	3.058	0.366	0.046
21	0.97	0.224	3.055	0.368	0.044
22	1.04	0.225	3.069	0.367	0.044
23	1.10	0.226	3.045	0.371	0.040
24	1.21	0.228	3.034	0.373	0.039
25	1.29	0.227	3.026	0.375	0.038
26	1.39	0.227	3.012	0.377	0.039
27	1.49	0.227	3.016	0.376	0.038
28	1.59	0.227	2.981	0.380	0.033
29	1.69	0.227	2.987	0.379	0.034
30	1.79	0.226	2.985	0.379	0.034
31	1.88	0.227	2.977	0.381	0.032
32	2.07	0.227	2.953	0.383	0.029
33	2.27	0.227	2.946	0.384	0.029
34	2.46	0.227	2.929	0.386	0.028
35	2.66	0.227	2.934	0.386	0.028
36	2.86	0.227	2.917	0.388	0.026
37	3.04	0.227	2.917	0.388	0.026
38	3.45	0.226	2.907	0.388	0.026
39	3.84	0.224	2.894	0.387	0.026
40	4.24	0.221	2.869	0.385	0.026
41	4.62	0.219	2.847	0.384	0.026
42	5.01	0.218	2.838	0.383	0.026
43	5.40	0.218	2.841	0.381	0.026
44	5.80	0.216	2.828	0.380	0.027
45	7.96	0.210	2.842	0.367	0.035
46	8.94	0.207	2.828	0.365	0.035
47	9.35	0.206	2.820	0.364	0.035
48	9.75	0.203	2.794	0.362	0.036
49	10.14	0.203	2.831	0.356	0.041
50	10.53	0.201	2.836	0.353	0.044
51	10.89	0.200	2.850	0.350	0.046
52	11.28	0.200	2.841	0.350	0.045
53	11.68	0.198	2.858	0.346	0.052
54	12.14	0.197	2.833	0.346	0.051

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. : T 762 (REMOULDED SAMPLE)
INITIAL MOISTURE CONTENT : 51.4 PERCENT
SPECIFIC GRAVITY OF SOIL : 2.73
INITIAL VOID RATIO : 1.404
INITIAL HEIGHT OF SAMPLE : 13.25 CM
INITIAL VOLUME OF SAMPLE : 603.46 CC
EFFECTIVE PRINCIPAL STRESS RATIO : 0.53
FINAL MOISTURE CONTENT : 42.0 PERCENT

TX. CONSOLIDATION START 50785 END 190785
TRIAXIAL CONSOLIDATION TEST
::::::::::::::::::::::::::

PT	EFFECT SIGMA1	EFFECT SIGMA3	STRAIN1	VOLUME STRAIN	STRAIN3	EFFECT P	Q	VOID RATIO	V	SHEAR STRAIN
1	49.91	26.50	2.008	1.757	-0.126	34.30	23.41	1.362	2.362	1.422
2	57.50	30.40	2.423	2.353	-0.035	39.43	27.10	1.347	2.347	1.638
3	66.13	35.00	2.996	3.107	0.056	45.38	31.13	1.329	2.329	1.961
4	76.08	40.30	3.857	4.085	0.114	52.23	35.78	1.306	2.306	2.495
5	87.51	46.40	5.125	5.326	0.102	60.10	41.11	1.276	2.276	3.349
6	100.53	53.30	6.785	6.786	0.000	69.04	47.23	1.241	2.241	4.523
7	115.45	61.30	8.415	8 136	-0.139	79.35	54.15	1.208	2.208	5.703
8	132.64	70.40	10.596	10.075	-0.260	91.15	62.24	1.162	2.162	7.238
9	159.57	84.80	13.147	12.114	-0.517	109.72	74.77	1.113	2.113	9.109
10	79.93	42.40	12.204	10.995	-0.604	54.91	37.53	1.140	2.140	8.539
11	80.01	42.50	12.185	10.945	-0.620	55.00	37.51	1.141	2.141	8.536
12	80.09	42.60	12.325	10.763	-0.781	55.10	37.49	1.145	2.145	8.737

SUMMARY OF ESSENTIAL RESULTS STORED IN FILE

PT	SIGMA1	SIGMA3	STRAIN1	STRAIN3	V
1	49.91	26.50	2.008	-0.126	2.362
2	57.50	30.40	2.423	-0.035	2.347
3	66.13	35.00	2.996	0.055	2.329
4	76.08	40.30	3.857	0.114	2.306
5	87.51	46.40	5.125	0.102	2.276
6	100.53	53.30	6.785	0.000	2.241
7	115.45	61.30	8.415	-0.139	2.208
8	132.64	70.40	10.596	-0.260	2.162
9	159.57	84.80	13.147	-0.517	2.113
10	79.93	42.40	12.204	-0.604	2.140
11	80.01	42.50	12.185	-0.620	2.141
12	80.09	42.60	12.325	-0.781	2.145

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** ENGINEERING STRAIN ****

SAMPLE NO. : T 762 (REMOULDED SAMPLE)
TEST RESULTS START 50785 END 190785

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	2.008	-0.126	1.757	0.0	0.0		0.0
2	57.5	30.4	27.1	39.4	2.423	-0.035	2.353	9.4	0.4	0.275	0.275
3	66.1	35.0	31.1	45.4	2.996	0.055	3.107	20.2	1.0	0.414	0.688
4	76.1	40.3	35.8	52.2	3.857	0.114	4.085	32.6	1.9	0.656	1.344
5	87.5	46.4	41.1	60.1	5.125	0.102	5.328	47.0	3.1	1.026	2.370
6	100.5	53.3	47.2	69.0	6.785	0.000	6.786	63.2	4.8	1.460	3.831
7	115.4	61.3	54.1	79.3	8.415	-0.139	8.136	82.0	6.4	1.600	5,431
8	132.6	70.4	62.2	91.1	10.596	-0.260	10.075	103.4	8.6	2.546	7.977
9	159.6	84.8	74.8	109.7	13.147	-0.517	12.114	137.2	11.2	3.329	11.306
10	79.9	42.4	37.5	54.9	12.204	-0.604	10.995	37.5	10.2	-1.241	10.065
11	80.0	42.5	37.5	55.0	12.185	-0.620	10.945	37.7	10.2	-0.028	10.037
12	80.1	42.6	37.5	55.1	12.325	-0.781	10.763	37.8	10.4	-0.025	10.012

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

ENERGY CALCULATIONS

**** NATURAL STRAIN ****

SAMPLE NO. : T 762 (REMOULDED SAMPLE)
TEST RESULTS START 50785 END 190785

PT	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	AXIAL STRAIN %	RADIAL STRAIN %	VOL STRAIN %	LSSV KPA	LSNV %	DELTA ENERGY KN-M/VOL	TOTAL ENERGY KN-M/VOL
1	49.9	26.5	23.4	34.3	2.028	-0.128	1.772	0.0	0.0		0.0
2	57.5	30.4	27.1	39.4	2.452	-0.036	2.381	9.4	0.4	0.280	0.280
3	66.1	35.0	31.1	45.4	3.042	0.057	3.156	20.2	1.0	0.425	0.706
4	76.1	40.3	35.8	52.2	3.933	0.119	4.170	32.6	1.9	0.680	1.385
5	87.5	46.4	41.1	60.1	5.260	0.107	5.475	47.0	3.2	1.076	2.461
6	100.5	53.3	47.2	69.0	7.026	0.001	7.027	63.2	5.0	1.554	4.015
7	115.4	61.3	54.1	79.3	8.790	-0.152	8.486	82.0	6.8	1.731	5.745
8	132.6	70.4	62.2	91.1	11.200	-0.290	10.619	103.4	9.2	2.807	8.553
9	159.6	84.8	74.8	109.7	14.095	-0.591	12.912	137.2	12.1	3.762	12.315
10	79.9	42.4	37.5	54.9	13.015	-0.684	11.647	37.5	11.0	-1.411	10.904
11	80.0	42.5	37.5	55.0	12.993	-0.701	11.592	37.7	11.0	-0.032	10.872
12	80.1	42.6	37.5	55.1	13.152	-0.883	11.387	37.8	11.2	-0.027	10.845

UNIVERSITY OF MANITOBA
SOIL MECHANICS LABORATORY

SAMPLE NO. = T 762 (REMOULDED SAMPLE)

SAMPLE HEIGHT AFTER CONSOLIDATION = 11.617 CENTIMETRES
SAMPLE VOLUME AFTER CONSOLIDATION = 538.508 CUBIC CENTIMETRES
SAMPLE AREA AFTER CONSOLIDATION = 46.355 SQUARE CENTIMETRES

CONSTANT LOAD = 16.49 N .
PROVING RING FACTOR = 1.0225 N ./DIV
PISTON AREA = 5.0700 SQUARE CENTIMETRES

INITIAL DIAL READING = 2075.00 DIVISIONS

SHEAR TEST RESULTS START 190785 END 200785

CONSOLIDATED UNDRAINED TRIAXIAL TEST
::::::::::::::::::::::::::::::::::::

PT	TIME	DISPL DIAL RDG	PRING DIAL RDG	PORE PRESS KPA	PER CENT PCSTRN	EFFECT SIGMA1 KPA	EFFECT SIGMA3 KPA	HALF DEV STRESS KPA	DEV STRESS KPA	EFFECT OCT STRESS KPA	RATIO OF EFF SIGMA1 EFF SIFMA3	A
1	810	2075.0	422.7	499.7	0.0	80.1	42.6	18.7	37.5	55.1	1.880	0.0
2	820	2074.0	447.0	501.5	0.01	83.6	40.8	21.4	42.8	55.1	2.050	0.34
3	830	2071.0	468.5	503.9	0.03	86.2	38.7	23.8	47.6	54.6	2.228	0.42
4	835	2069.0	481.0	504.8	0.05	88.2	37.9	25.1	50.3	54.7	2.327	0.40
5	840	2067.0	491.0	505.2	0.07	89.9	37.4	26.2	52.5	54.9	2.403	0.37
6	845	2064.5	500.0	505.8	0.09	91.2	36.7	27.2	54.5	54.9	2.484	0.36
7	850	2061.5	507.5	505.8	0.12	92.6	36.5	28.1	56.1	55.2	2.538	0.33
8	855	2059.0	514.0	506.2	0.14	93.8	36.3	28.8	57.5	55.5	2.585	0.32
9	900	2055.5	520.5	506.4	0.17	95.0	36.1	29.5	58.9	55.7	2.633	0.31
10	910	2049.5	529.0	506.9	0.22	96.6	35.9	30.4	60.7	56.1	2.692	0.31
11	920	2043.0	539.0	506.6	0.28	99.0	36.1	31.5	62.9	57.1	2.743	0.27
12	930	2034.5	546.5	506.2	0.35	100.8	36.2	32.3	64.6	57.7	2.783	0.24
13	940	2026.0	554.0	506.0	0.42	102.6	36.4	33.1	66.2	58.5	2.818	0.22
14	950	2018.0	558.0	506.0	0.49	103.5	36.5	33.5	67.0	58.8	2.835	0.21
15	1000	2009.0	563.0	505.6	0.57	104.8	36.8	34.0	68.0	59.5	2.849	0.19
16	1010	2002.0	567.0	505.5	0.63	106.0	37.1	34.4	68.9	60.1	2.856	0.18
17	1020	1992.0	570.0	504.8	0.71	107.2	37.7	34.7	69.5	60.9	2.842	0.16
18	1030	1986.0	572.0	504.5	0.77	107.9	38.0	34.9	69.9	61.3	2.838	0.15
19	1042	1974.0	574.5	504.3	0.87	108.4	38.1	35.2	70.3	61.5	2.846	0.14
20	1050	1967.0	575.0	504.6	0.93	108.7	38.4	35.2	70.3	61.8	2.832	0.15
21	1100	1957.8	577.0	503.8	1.01	109.6	38.8	35.4	70.8	62.4	2.824	0.12
22	1115	1943.0	578.5	503.6	1.14	110.2	39.2	35.5	71.0	62.9	2.811	0.12
23	1130	1929.0	578.0	502.9	1.26	110.8	40.0	35.4	70.8	63.6	2.769	0.10
24	1145	1916.0	578.5	503.0	1.37	110.6	39.8	35.4	70.8	63.4	2.779	0.10
25	1200	1901.0	579.0	501.7	1.50	111.5	40.6	35.4	70.9	64.2	2.746	0.06
26	1215	1887.0	579.5	502.2	1.62	111.6	40.6	35.4	70.9	64.2	2.745	0.07
27	1235	1867.5	579.5	502.2	1.79	111.2	40.5	35.4	70.7	64.1	2.747	0.08
28	1245	1858.5	578.5	502.9	1.86	110.4	39.9	35.2	70.5	63.4	2.766	0.10
29	1305	1840.0	576.5	503.2	2.02	109.5	39.6	35.0	69.9	62.9	2.766	0.11
30	1335	1811.0	573.5	502.8	2.27	109.1	40.0	34.5	69.1	63.0	2.727	0.10
31	1400	1784.0	568.0	502.3	2.50	108.2	40.5	33.9	67.7	63.1	2.673	0.09
32	1430	1755.0	564.0	501.8	2.75	107.9	41.2	33.3	66.7	63.4	2.619	0.07
33	1502	1724.0	558.0	501.7	3.02	106.5	41.3	32.6	65.2	63.0	2.579	0.07
34	1530	1698.0	552.5	501.1	3.25	105.3	41.3	32.0	64.0	62.6	2.549	0.05
35	1600	1667.0	545.0	501.8	3.51	103.8	41.7	31.0	62.1	62.4	2.489	0.09
36	1631	1636.0	540.0	501.8	3.78	102.8	42.0	30.4	60.8	62.3	2.448	0.09
37	1705	1602.0	535.0	501.8	4.07	100.9	41.2	29.8	59.7	61.1	2.448	0.09
38	1800	1548.0	527.0	501.1	4.54	100.1	42.5	28.8	57.6	61.7	2.356	0.07
39	1900	1490.5	520.0	500.8	5.03	97.8	41.9	28.0	55.9	60.5	2.335	0.06
40	2000	1433.0	515.0	500.7	5.53	96.6	42.0	27.3	54.6	60.2	2.300	0.06
41	2100	1374.0	513.5	501.2	6.03	95.8	41.8	27.0	54.0	59.8	2.291	0.09
42	2209	1309.0	510.0	501.7	6.59	94.2	41.3	26.5	52.9	58.9	2.282	0.13
43	2301	1260.5	510.0	501.8	7.01	93.5	40.8	26.4	52.7	58.4	2.283	0.14
44	2400	1205.0	508.5	502.2	7.49	93.4	41.3	26.0	52.1	58.7	2.261	0.17
45	621	846.0	510.5	503.5	10.58	90.5	39.8	25.4	50.7	56.7	2.275	0.29
46	800	752.0	513.0	503.8	11.39	90.2	39.4	25.4	50.8	56.3	2.289	0.31
47	900	698.0	512.0	503.8	11.85	89.7	39.4	25.2	50.3	56.2	2.277	0.32

SAMPLE NO. : T 762 (REMOULDED SAMPLE)

CONSOLIDATION AXIAL STRESS : 80.09 KPA
PRECONSOLIDATION PRESSURE : 159.57 KPA
NORMALIZING STRESS : 159.57 KPA

NORMALIZED SHEAR TEST RESULTS START 190785 END 200785

PT	PER CENT PCSTRN	NRMLZD HALF DEV STRESS KPA	EFFECT RATIO SIGMA1 SIGMA3	NRMLZD OCT STRESS KPA	NRMLZD CHANGE IN PWP KPA
1	0.0	0.117	1.880	0.345	0.0
2	0.01	0.134	2.050	0.345	0.011
3	0.03	0.149	2.228	0.342	0.026
4	0.05	0.158	2.327	0.343	0.032
5	0.07	0.164	2.403	0.344	0.034
6	0.09	0.171	2.484	0.344	0.038
7	0.12	0.176	2.538	0.346	0.038
8	0.14	0.180	2.585	0.348	0.041
9	0.17	0.185	2.633	0.349	0.042
10	0.22	0.190	2.692	0.352	0.045
11	0.28	0.197	2.743	0.358	0.043
12	0.35	0.202	2.783	0.362	0.041
13	0.42	0.207	2.818	0.366	0.039
14	0.49	0.210	2.835	0.369	0.039
15	0.57	0.213	2.849	0.373	0.037
16	0.63	0.216	2.856	0.376	0.036
17	0.71	0.218	2.842	0.381	0.032
18	0.77	0.219	2.838	0.384	0.030
19	0.87	0.220	2.846	0.386	0.029
20	0.93	0.220	2.832	0.388	0.031
21	1.01	0.222	2.824	0.391	0.026
22	1.14	0.222	2.811	0.394	0.024
23	1.26	0.222	2.769	0.399	0.020
24	1.37	0.222	2.779	0.397	0.021
25	1.50	0.222	2.746	0.403	0.013
26	1.62	0.222	2.745	0.402	0.016
27	1.79	0.222	2.747	0.402	0.016
28	1.86	0.221	2.766	0.397	0.020
29	2.02	0.219	2.766	0.394	0.022
30	2.27	0.216	2.727	0.395	0.019
31	2.50	0.212	2.673	0.395	0.016
32	2.76	0.209	2.619	0.398	0.013
33	3.02	0.204	2.579	0.395	0.013
34	3.25	0.200	2.549	0.392	0.009
35	3.51	0.195	2.489	0.391	0.013
36	3.78	0.191	2.448	0.390	0.013
37	4.07	0.187	2.446	0.383	0.013
38	4.54	0.181	2.356	0.387	0.009
39	5.03	0.175	2.335	0.379	0.007
40	5.53	0.171	2.300	0.377	0.006
41	6.03	0.169	2.291	0.375	0.009
42	6.59	0.166	2.282	0.369	0.013
43	7.01	0.165	2.293	0.366	0.013
44	7.49	0.163	2.261	0.368	0.016
45	10.58	0.159	2.275	0.355	0.024
46	11.39	0.159	2.289	0.353	0.026
47	11.85	0.158	2.277	0.352	0.026