A STUDY OF ASPHALTIC STABILIZATION OF LOESS

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INTRODUCTION

One of the naturally occurring materials man must work with is Loess. Loess is defined as a non-stratified deposit of natural mineral grains of silt size. It is commonly homogeneous, buff colored, calcaceous, and porous. This material commonly exhibits low cohesion, medium angle of external friction, low unit weight, and high capillary potential.

The loess deposits are found on all continents and cover broad areas of the central United States. The deposits in the Midwest are commonly found to be thickest and coarsest along streams, thinning and becoming finer to the east and north from the major streams.

Due to the above mentioned characteristics, loess presents serious problems in the construction of highways, air fields and structural foundations. The most serious problem in its use for highways and air fields is the high potential for frost heaving, but almost equally serious is the lack of its ability to react to loading when saturated. Its use as a supporting material for foundations is seriously impaired by its low strength and high compressibility. The loess, on the other hand, is easy to excavate, move, and place in compacted fills. It is friable, breaking easily into individual mineral grains and is easily wetted or dried. The research reported herein was conducted to show the modification of the properties of loess by the addition of asphalt and the effects on its behavior in the engineering structures in which we use it.

Scope

The scope of this study was limited to determining the engineering properties of three Kansas loesses and the effect of an asphalt treatment on these properties. The specimens studied were from Rawlins County, Republic County, and Wyandotte County, Kansas.

The study included a review of the pertinent literature from geological, engineering and agronomy sources for both loess and asphalt. Laboratory testing was used to determine the engineering properties of the loess and the loess and asphalt mixtures.

Purpose

The purpose of this study was as follows:

a. To determine the engineering properties of the raw loess and compare the properties of the raw loess with the engineering properties of loess 24 hours and 60 days after treatment with asphalt;

b. To analyze the changes in the engineering and project the laboratory results to similar field conditions;

c. To study the mechanisms of the observed changes in the engineering properties.

LITERATURE REVIEW

To begin obtaining data for this study the literature available on loess from geology, agronomy, and engineering sources was reviewed. Much of the literature is not directly relevant to this study, but the review of the available literature is in itself a fascinating project. To complete the literature review, familiarity with a broad field of specializations is a must. The literature involved covers the fields of Geology (including Paleontology, Stratigraphy and Mineralogy), Agronomy, and Engineering Soil Mechanics. Basic to the study is an understanding of Chemistry, Physics, and Geography. The resultant broad view of the problems involved will be discussed herein beginning with the geologic history of the state of Kansas.

As Dunbar (1) shows, Kansas like much of the central United States, has a geologic history that is primarily composed of depositional and erosional periods. During the first portion of the Paleozoic Era, Kansas was for the most part an exposed low-lying land mass. Some relatively short periods of marine deposition have occurred, notably during the Ordovician and latter Devonian times. The depositional periods did not necessarily cover the entire state at any one time nor was the depositional period the same length in all portions of the state. The rock formations which are the results of these periods of deposition are buried beneath later sediments.

During the Mississippian, Pennsylvanian, and Permian Periods, Kansas was in an inland seaway that agressed and regressed across the state. From the sediments of these geologic periods come valuable minerals such as the salt in the Wichita area. Many of the Pre-Permian sediments, primarily limestones and shales, have been folded in the Nemaha Anticline and Central Kansas Uplift. These folded sediments are exposed along axes and flanks of the two anticlines. Mississippian, Pennsylvanian, and Permian sediments are exposed in roughly north-sound bands across the eastern end of the state. (See Fig. 1).

Later, during the Cretaceous Period, Kansas was once again submerged under inland seaways. The sediments of this depositional period have been eroded and buried in many places. The Niabrara Chalk and Fort Hayes Limestone, two major formations of this period, are exposed in the northern portions of west-central Kansas. Large quantities of limestone from this period have been used for small construction such as homes. The Fence Post Limestone, Cretaceous Age, was so named because of the large amounts of this stone used by early settlers for fence posts. No significant valuable minerals have been found in the Cretaceous Age rocks.

Most of the state is mantled by Pleistocene age deposits, usually unconformably underlain by Pleiocene deposits of lacustrine, alluvial, and upland origin. Two primary areas of deposition are easily recognized. In northeast Kansas, the glacial till is of early Pleistocene age. Across much of the state, the loess mantle at the surface is also of Pleistocene age. No valuable minerals, such as oil, gas, or gold, have been found in the Pleistocene deposits. However the fields of grain and herds of cattle that are raised on the loess, are annually the greatest assets of the state.

Four major cycles of continental glaciation are recognized in the United States. (See Fig. 2). The Nebraskan and Kansan glacial stages produced the surface

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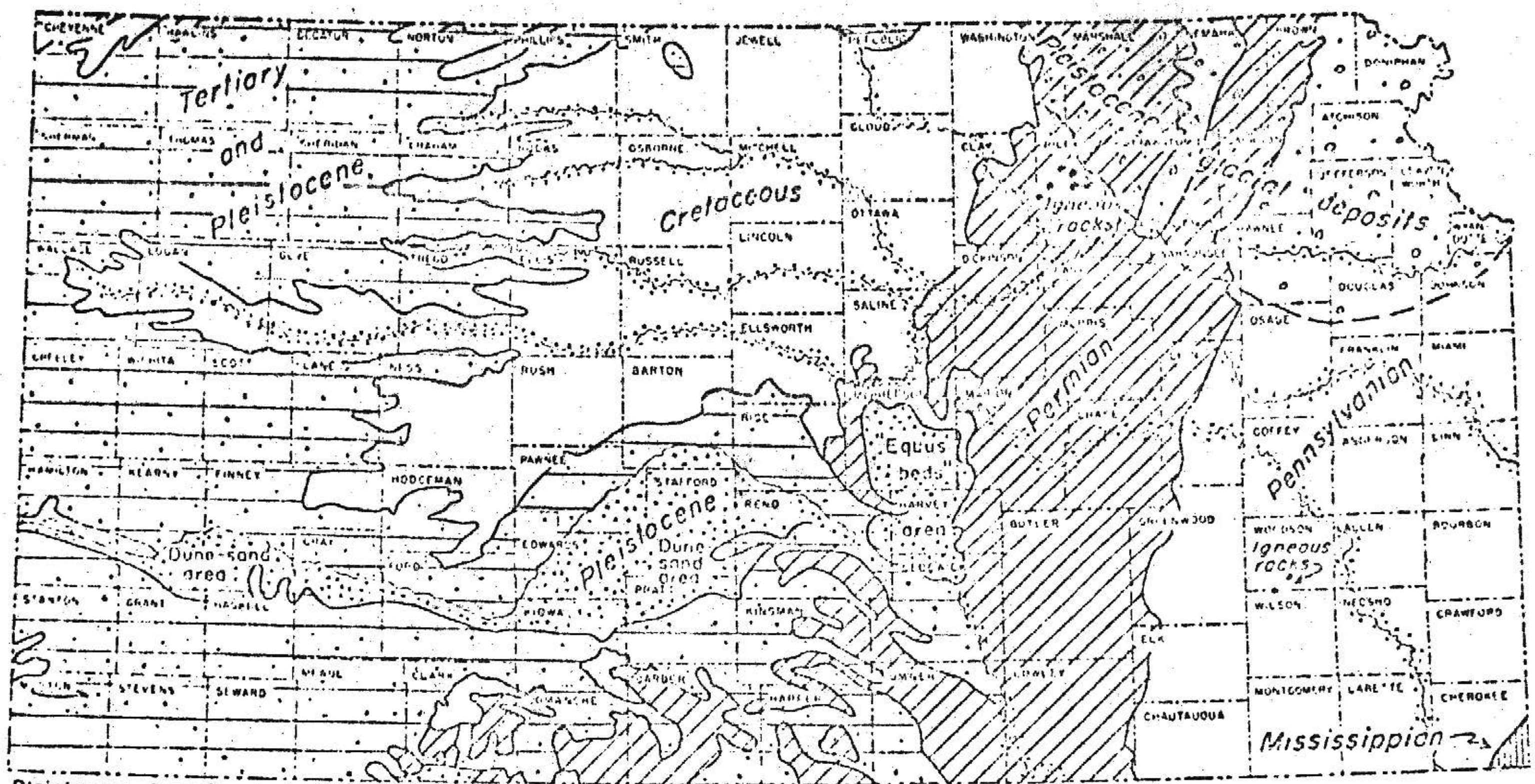
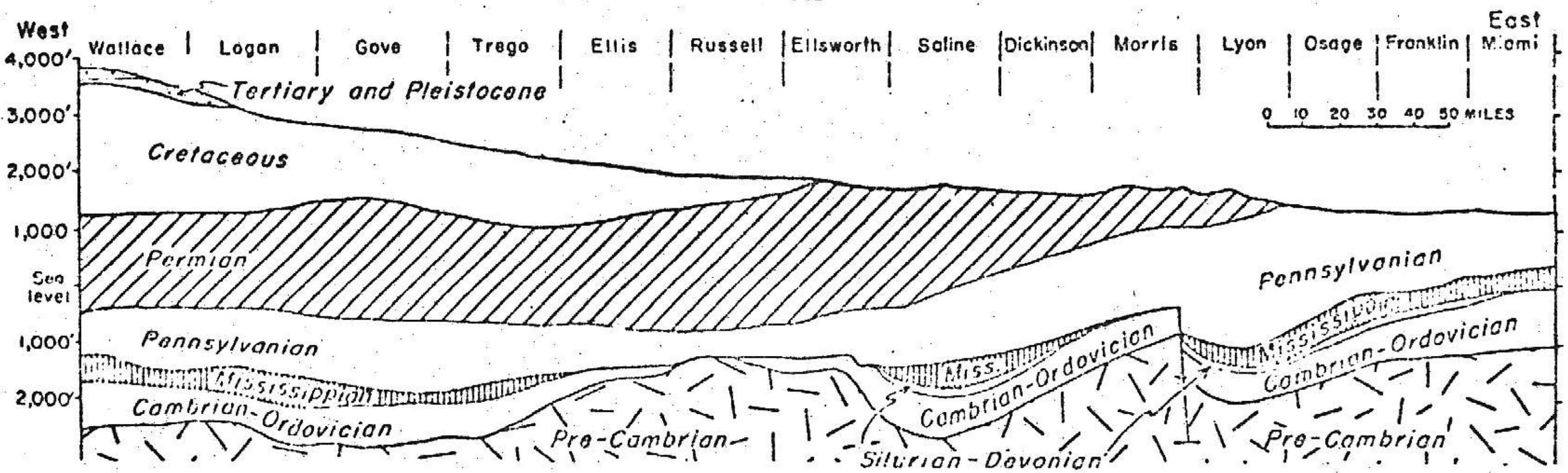


Pleistocene deposits, including present soils, cover most of Kansas

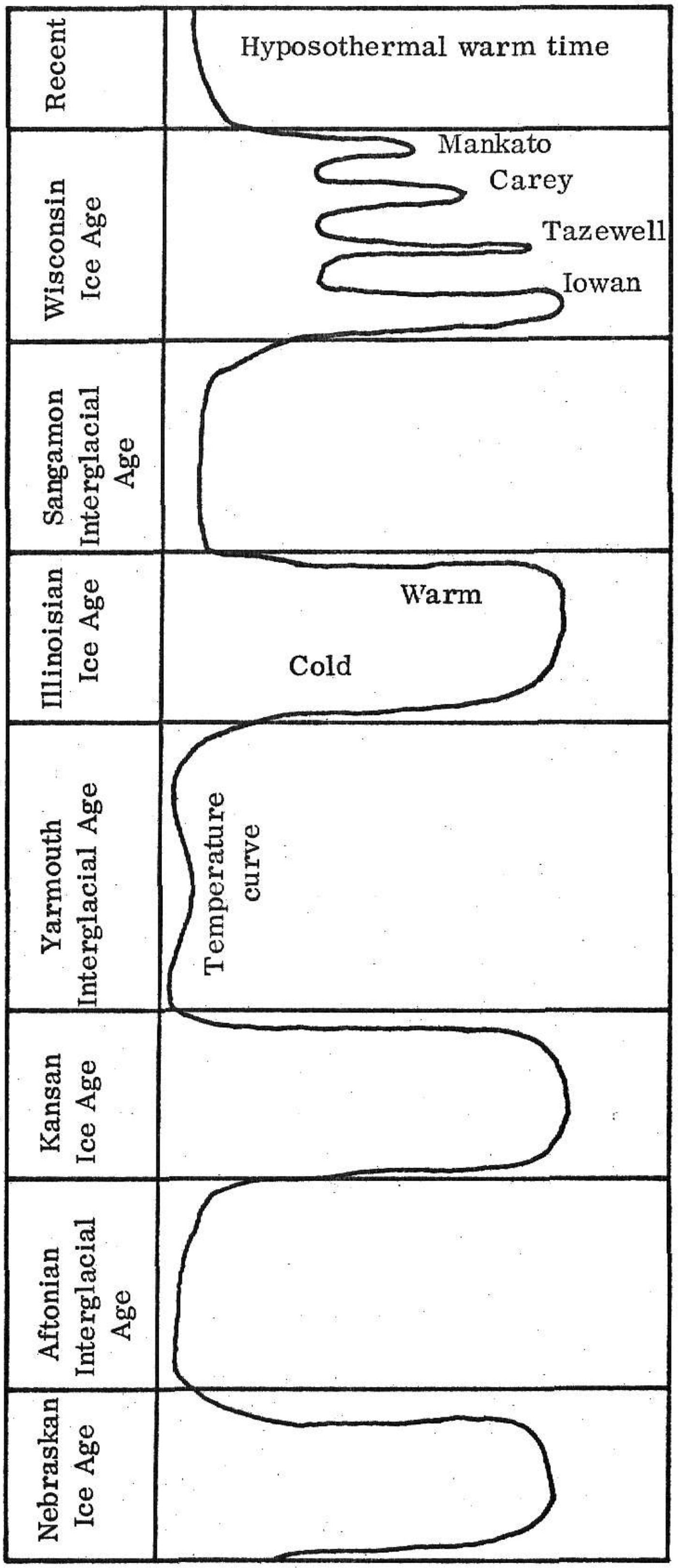


Generalized cross section of Kansas rocks

—State Geological Survey of Kansas

FIGURE 2

THE PLEISTOCENE EPOCH



till in Northeast Kansas. The Illinoisian and Wisconsin glacial stages produced the loess that mantles much of the state. Using the Kansas Stratigraphic sequence as described by Frye (2) the oldest loess is the Loveland Loess which was produced during the retreat of the Illinoisian glacier. During the Sangamon Interglacial stage, a soil profile was developed on the Loveland Loess that has been named the Sangamon Soil. Both the Peoria and Bignell Loesses were the result of Wisconsin glacial sub-stages. The Peoria Loess was deposited during the Iowan and Tazewellian sub-stage and developed the Brady soil during the post-Tazewellian-pre-Caryan sub-stage. As the glaciers retreated for the final time during the Caryan and Makotan substages, the Bignell Loess was deposited and in the time since has developed a soil profile which is the modern soil in areas of Bignell deposition. Figure 3 shows the distribution of loess in Kansas.

There can be little significant debate on the origin and mode of deposition of the Kansas loess. The tremendous quantities of accumulated evidence clearly indicate that the Kansas Loess is a wind deposited material derived from valley-train deposits in Arikaree, Republican, and Missouri River valleys. These valley-train deposits accumulated with seasonal fluctuation as the seasonal temperature changes varied the rate of glacial melting, resulting in seasonal high and low water flows. During low water flows, the sediments were reworked by wind and rede-posited on the valley walls and uplands. The evidence from stratigraphic, petro-graphic, soil mechanics, paleontologic, and physics data clearly prove this mode of deposition and origin of loess.

Swineford and Frye (3) fairly well summarize the evidence for eolian depo-

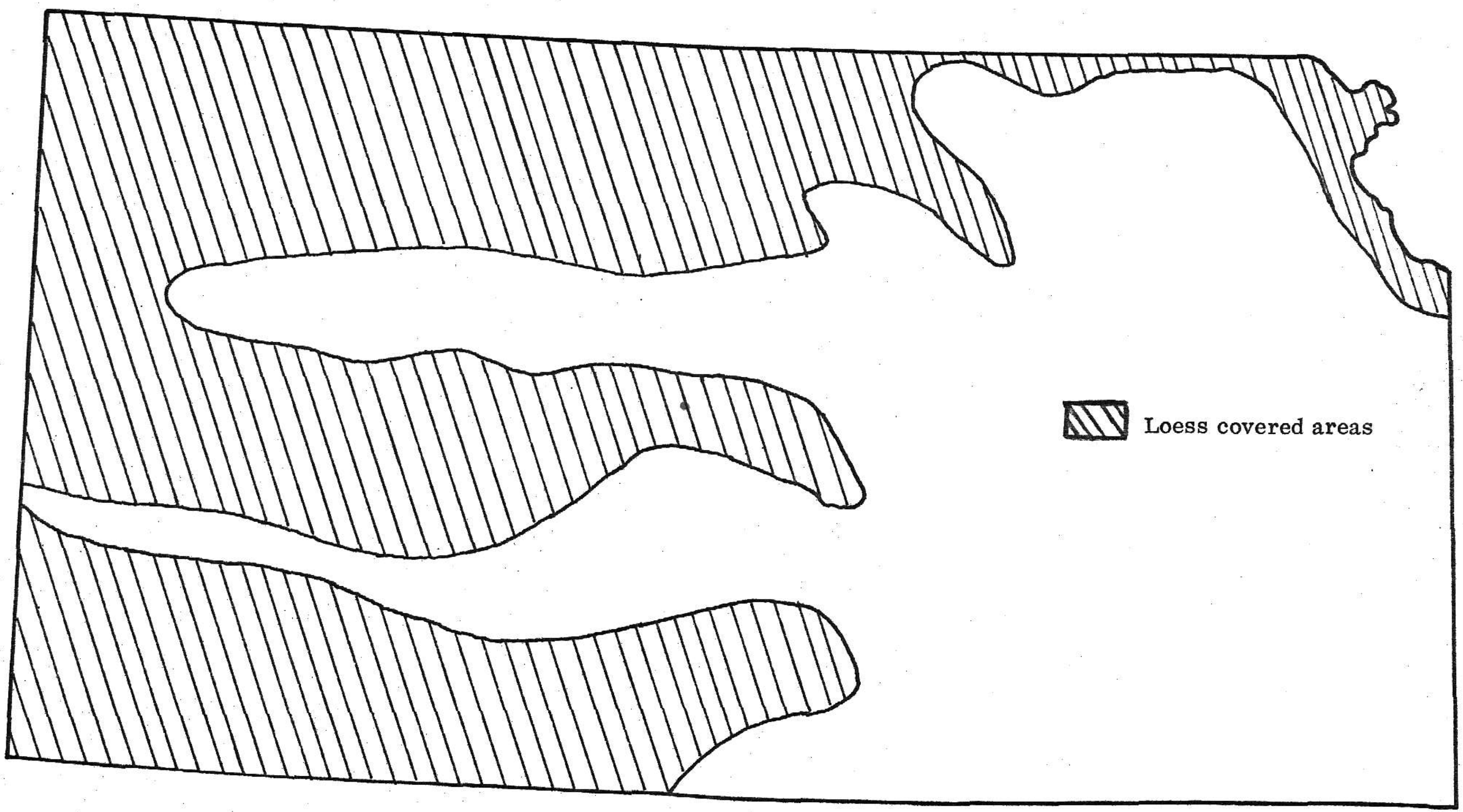


FIGURE 3

GENERALIZED DISTRIBUTION OF LOESS

sition from reworked valley-train deposits. They point out that wind is the only known agent capable of depositing a relatively uniform mantle of material over the highly discordant topography that the loess is deposited on. Not only is the loess deposited on highly discordant topography, it is deposited on sediments of early Pleistocene to Pennsylvanian age over an aerial extent of 30,000 - 40,000 square miles. Assuming an average thickness of 10 feet for the Peorian loess, the volume of the loess is estimated at 57 to 60 cubic miles by Leonard and Frye (4). The loess (particularly the Peorian, which has been the most thoroughly studied) is thickest along the river banks of the Arikaree, Republican and Missouri Rivers. It thins away from the valley-bluffs in a relatively uniform progression. This relationship of thickness to river valley is not shown in modern sand dune deposits along the Saline, Solomon, and Smokey Hill Rivers which are not believed to have had their origin in the respective river valleys. The gradation of the loess shows a similar relationship to the river valleys that served as source areas. Texturally, the loess is similar to modern wind blown silts and becomes progressively finer away from the valleys.

The loess in Kansas has been analyzed by several researchers to determine its chemical and mineralogical composition. Some variation in the chemical and mineralogical analyses exists between different authors. However the variations are primarily in the percentage composition of the loess rather than in the constituent minerals. Some of the variations reported are probably due to the sampling techniques and laboratory methods employed by the particular researcher. Frye et al. (5) noted that there are variations in the loess with respect to geographic location and position in the stratigraphic column. The amount of weathering, slope, vegetation and land use may affect the analytical results. For the most part the reported variations are insignificant enough to be essentially ignored.

One of the most complete and, in this author's opinion, accurate analyses of the Kansas loess was done in the Kansas State Geological Survey Laboratories and reported in two publications by Swineford and Frye (3) and Frye et al. (5). Swineford and Frye (3) in their report limited their study to the Peorian loess while Frye et al. (5) in their 1949 study considered all three loess members. The chemical and mineralogical data reviewed in this paper is, except as otherwise noted, from these two reports.

The primary mineral constitutent of all three loesses is quartz. The quartz occurs primarily in the silt size fraction; though cristobalite, a quartz isomorph, is found in small quantities in some western Kansas samples. Quartz comprises more than 50 percent of the silt fraction. About one-fourth as abundant as quartz in the silt fraction are the feldspars. They occur in the orthoclase, sodic plagioclase, and microcline forms commonly, and occasionally in the calciclageoclase and sanidine forms. The latter two are rare and limited to a few samples where they comprised only a small percentage of the total feldspar. Volcanic-ash shards in the silt fraction were found in all samples in quantities of a trace to as much as ten percent. Micas are also present in the silt fraction where they comprise about three percent of the total. Muscovite is the most common with biotite being more prevalent in western Kansas than further east. Numerous minerals occur as minor accessories in the silt fraction. Among these minerals are chlorites, black and brown opaques, leucoxene, hornblende, epidote, colorless and pink garnet, various pryoxenes, tremolite, actinolite, zircon, tourmaline, red and yellow rutile, staurolite, titanite, sillimanite, and zoisite. Calcite and dolomite also occur in the silt fraction as secondary deposits. Calcite is most common in Western Kansas while dolomite occurs predominately only in extreme North-Eastern Kansas.

The clay fraction is composed of mostly montmorillonite and illite clay minerals. Kaolinite may be present in very small quantities. α-cristobalite, feldspar, calcite, volcanic-ash shards, and quartz are also present in small amounts across the state. Generally, in excess of 50 percent of the clay fraction is montmorillonitic or illitic clay minerals. Kaufman (6) working only in the A horizon of modern soil profiles identified the montmorillonitic mineral to be beidellite. Brophy (7) working in Illinois with loess found vermiculite, particularly in fossil soil profiles. The identification of these two minerals only names two of the members of the illite and montmorillonite families that are or may be present in the loess.

As should be expected from the mineralogical composition of the loess, silica (SiO_2) the prime chemical constituent of the loess comprising 65-79 percent with the higher values occurring in the weathering profiles. Alumina (Al_2O3) is the second most common chemical present, usually in the range of 9 to 15 percent. Lime as CaO occurred in quantities of 1 to 6 percent and magnesia (MgO) and potash (K_2O) usually totaled less than 5 percent. Numerous other chemicals appeared usually in quantities of a trace to 1.5 percent. Among these were titanium (TiO_2), phosphorus (P_2O_5), and sulfur (SO_3). The remaining material was reported as Na_2O which was determined by difference. This difference rarely, if ever, exceeded 4 percent and averaged 1.54 percent for the Peoria loess. Qualitative spectographic analysis indicated the presence of manganese, vanadium, copper, silver, chromium, zinc, and zirconium. The elements determined by spectrographic analysis are present in amounts usually very close to amounts that would commonly be reported as traces. They are not present in all samples and show variations when present. Table 1 shows the chemical analysis of representative specimens across the state.

From the chemical and mineralogical data two trends become apparent. One is a trend of change in an east-west direction across the state. The second is the vertical variation through the section. The vertical trend is more pronounced than the east-west trend. Both are graphically depicted in Figs. 4 and 5. Chemical analysis data are used to most discernably show the trends.

The mineralogical data show the east-west trend most strikingly in the feldspars, micas and carbonates and the vertical trend in the quartz. Orthoclase, sodic plagioclase, and microcline occur in the same order of abundance across the state. However, the abundance of the feldspars and particularly of microcline decreases markedly from west to east. With the micas, the total quantity of mica remains more constant. The variable factor is the ratio of muscovite to biotite which increases in the easterly direction. The carbonates undergo a transformation in dominance from west to east. The carbonates are most abundant in Western Kansas where they appear as calcite. The total carbonate content decreases eastward and in extreme Northeast Kansas dolomite is the predominate carbonate. The vertical trend is best displayed in the quartz. The higher percentage quartz contents are found in the weathering profiles. The carbonate concentration also varies through the vertical profile. The highest carbonate concentrations occur in the B horizon of the developed soil profiles.

The variations that have been noted here in are not the only variations that âre found. They are general trends that may be, for most purposes, used without consideration of the other variations that appear. The other variations are very local and seem to be more nearly geologic oddities, that at present, are unexplained rather than significant evidence of geologic action other than that occurring with the deposition of the loess. A pair of the local variations are presented here as illustrations.

TABLE 1

REPRESENTATIVE CHEMICAL ANALYSIS OF LOESS MEMBERS

Locality	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	MgO	K_2O	Na_2O	Igt. Loss	Calc $CaCO_3$
Peoria Silt									
Logan	72.57	13.63	3.69	1.24	2.08	3.16	1.45	2.37	9.20
Cheyenne	75.37	12.61	3.12	1.03	1.73	3.47	1.02	1.54	8.27
Norton	73.82	14.90	3.40	[1]	2.02	2.64	1.04	2.60	4.56
Rice	76.47	11.48	3.74	0.76	1.10	4.21		2.15	2.33
Republic	71.74	12.83	4.22	0.85	2.28	2.16	2.46	3.40	2.67
Clay	77.14	11.14	3.61	1.02	1.06	3.30	1.81	1.29	2.45
Doniphan	76.08	11.57	2.95	--	2.50	2.32	1.68	2.70	6.13
Average	74.75	12.21	3.53	0.98	1.82	4.39		2.29	5.15
Bignell Silt									
Logan	74.11	13.48	3.29	0.83	1.73	4.50		1.90	7.95
Cheyenne	76.60	12.24	2.79	1.13	1.43	3.33	0.54	1.53	10.90
Norton	74.32	12.83	3.43	0.64	1.66	3.25	0.75	2.96	4.82
Rice	73.98	12.02	3.25	1.43	1.13	4.30		3.89	1.50
Doniphan	75.35	11.86	3.30	--	2.66	4.38		3.27	7.47
Average	74.87	12.88	3.21	1.01	1.72	4.41		2.71	6.53

[1] TiO_2 reported with Al_2O_3

Reproduced from Frye (5)

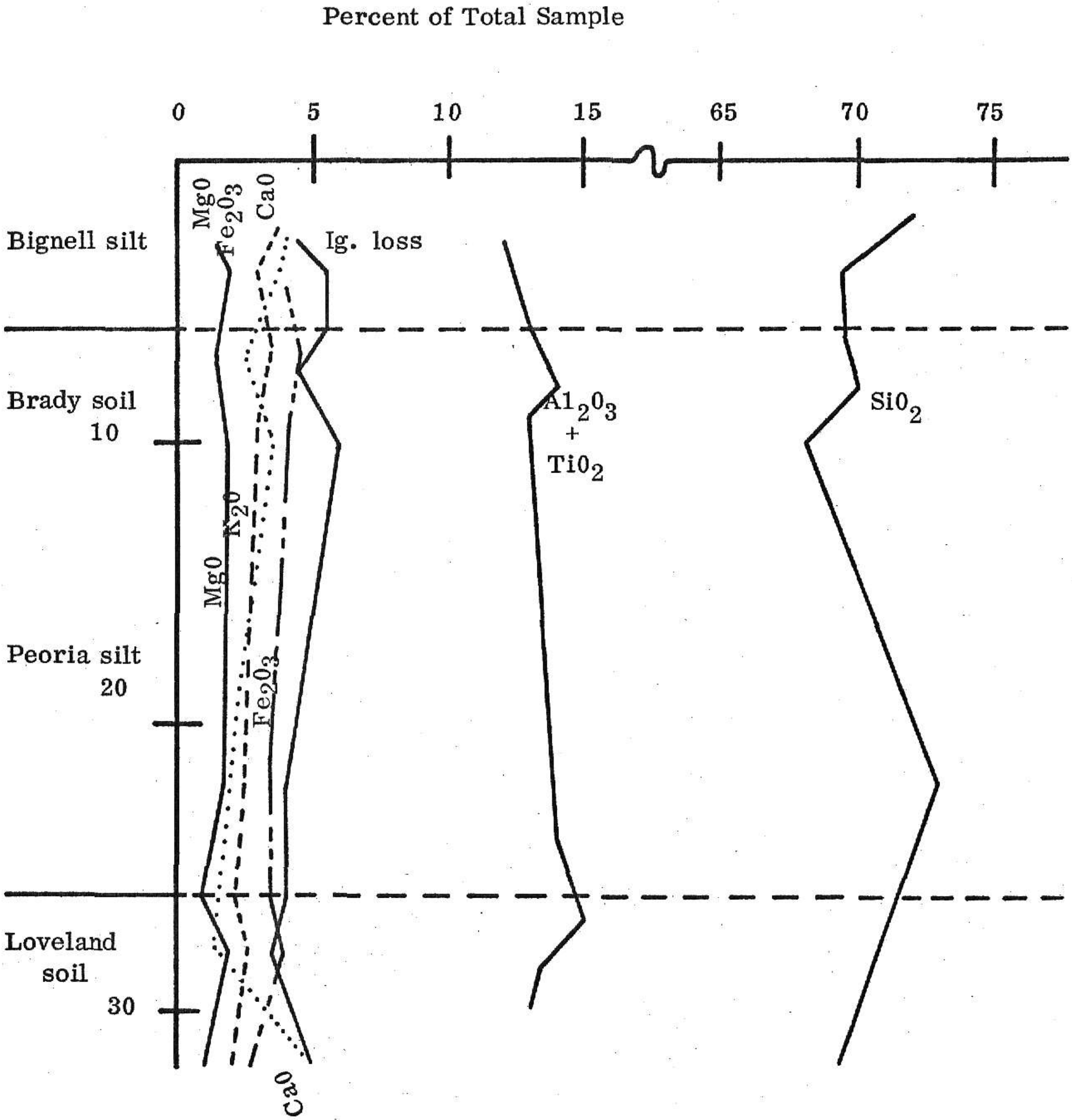


FIGURE 4

TYPICAL VERTICAL CHEMICAL COMPOSITION PROFILE

Reproduced from Frye (5)

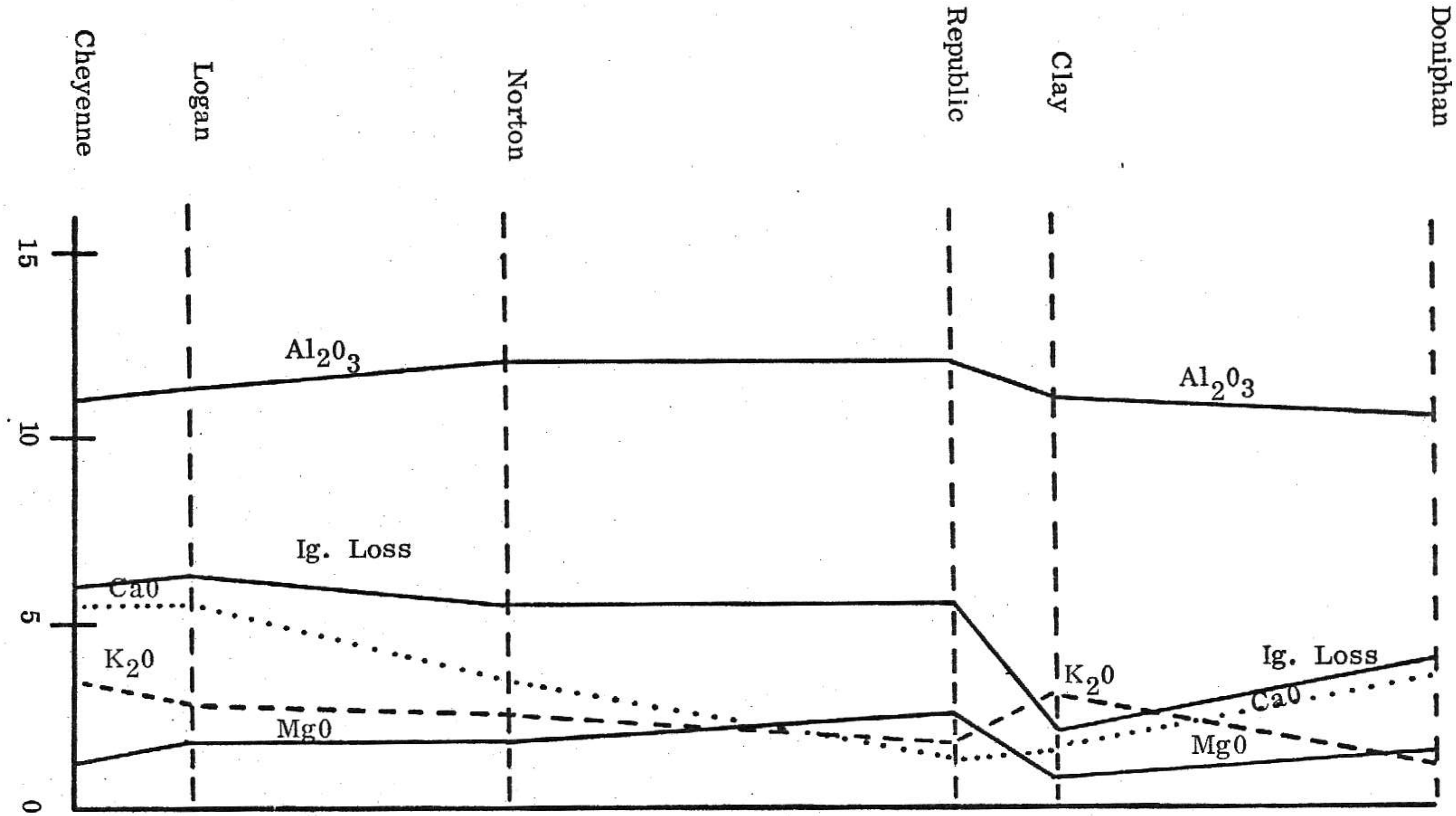


FIGURE 5

REPRESENTATIVE EAST-WEST CHEMICAL COMPOSITION OF THE PEORIA LOESS

Reproduced from Frye (5)

The Peoria loess in Norton County contains rhombical cross section rods measuring approximately 400Å x 400Å in cross section and 0.1-3.0 microns in length. The composition of the structures is not definitely known. They are believed to probably be α-cristobalite. The loess from Finney County contains an unexpectedly large quantity of the coarser fractions. The origin of the coarser material, sand, is the Arkansas River valley which apparently did not carry significant silt sized glacial debris.

Geological studies oriented toward the petrography of the loess deposits have been conducted by the Kansas Geological Survey (3) and by Gibbs and Holland (8) of the Army Corp of Engineers. The Corp of Engineers studies were conducted primarily in Nebraska, south of the Republican River. All studies found that the silt sized and larger particles were subangular to rounded in shape. The particles were found to be partially to completely encased in plate shaped clay mineral particles. The clay coatings were found to be extremely difficult to remove. The larger grains were found to form a matrix with the clay particles acting as the bonding agent rather than, as had been earlier proposed, carbonates acting as the bonding agent.

The carbonates were found to be chiefly secondary deposits, with few detrital carbonates present. There have been several sources suggested for the carbonates, including fossil land mollusk remains and leaching products. The carbonates tended to be formed in the void spaces between particles as discrete units seperate from the silt particles. The presence of carbonate particles has probably more influence on permeability than on the inter particle bonding and shearing characteristics.

The voids in the matrix were found to be indistinct and irregular in shape. The voids tended to be more pronounced along vertical axes than along horizontal axes at the same location. In many of the void spaces chemical linings attributed to plant roots and root hairs were found. The hypothesis has been that the greatest portion of the voids are the result of organic agents within the loess deposits. Laboratory permeability tests on undisturbed oriented specimens have shown that the permeability is greater in the vertical direction than in the horizontal direction, which tends to confirm the petrofabric analyses.

The geological studies show the loess deposits to be three distinct units of unconsolidated material of primarily silt size. These units have been named, oldest to youngest, Loveland Loess, Peoria Loess, Bignell Loess. The loess is an eolian deposit derived from the valley-train deposits of the retreating glacial stages. It is composed of quartz, feldspar, mica, volcanic-ash shards and numerous other minerals. The Loess deposits are massive in nature, being composed of discrete grains with the clay minerals acting as the bonding agent in an open matrix containing appreciable void space.

Engineering Properties

Loess is by engineering definition a soil. It is a loose, unconsolidated material that is moveable by conventional earth-moving equipment. It generally behaves as a slightly cohesive soil. The loess does have its own identifying soil mechanic's properties. The engineering properties of the loess, including gradation, Atterberg limits, moisture-density relationships, permeability, consolidation and shear characteristics will be discussed.

The properties of the loess are interrelated and the various relationships have been reasonably well documented. The unique interplay of the various properties occurring in the loess make it, in many respects, a difficult material to work with from a design viewpoint. Many of the difficulties encountered are due to a lack of appreciation of the interrelation of the various properties and their resultant reaction in soils engineering problems. The discussion of the properties of the loess will be oriented toward explaining the various properties and their interactions.

The loess is primarily composed of silt size particles. From samples taken across the state and in all three loess members, Frye (5) reported that from 50-75 percent of the particles fell in the 0.01-0.05 mm. range and that 2-8 percent of the particles had diameters of less than 0.00195 mm. Significant quantities of larger than 0.125 mm. particles were rarely found. Gibbs and Holland (8) found 76 percent of their samples to be silty loess, 18 percent clayey loess, and six percent sandy loess. Davidson (9) working in Iowa found the sand (0.074-2.0 mm.) content to vary with depth and geographic location and to average between 0.7 and 3.2 percent. The clay (0.005 mm) content varied also and averaged between 15.3 and 25.8 percent. The various size analyses reported show the effects of location on the gradation of the loess.

Jumikis (10) points out that a soil mass may exist in a solid, semi-solid, plastic, or liquid state depending on cohesion (adhesion) and water content as the primary factors determining in which state it will exist. These consistency limits have come to be called the Atterberg Limits, after the Swedish scientist who first proposed them. They have since become one of the most popular methods for describing and classifying soils.

Since the Atterberg Limits are dependent on cohesion (10) which implies clay content, it would be expected that the limits would vary due to the variations in clay content found in the gradational analyses. Gibbs (8) found extreme values for the Liquid Limit (L. L.) of 20-44 percent and for the Plasticity Index (P. I.) of 0-21 percent. His results showed the effect of clay content as the upper values of the L.L. and P. I. were found in the clayey loesses. Frye (3) found "Water of Plasticity" values, which according to methods described by Plummer (11) compare favorably with ASTM (12) method for Plastic Limit (P. L.), of 15. 86-29.48 percent. The values (5) seem to reflect stratigraphic and geographic differences in clay content. Davidson (13) found that the P. I. range of 5.7-26. 6 percent increased with increasing clay content away from the assumed source area. The Shrinkage Limit (S. L.) range of 17. 8-24. 7 percent decreased with increasing clay content and distance from source area.

The Atterberg Limits of loess vary with clay content which is a function of location with respect to the source area. As a generalized rule, the coarser graded loesses will have low P. I. and L. L. values and will have high S. L. and P. L. values;

while finer graded loesses will have higher P. I. and L. L. and lower S. L. and P. L. values.

Two moisture-density relationships are important to loess. They are the in-place density and moisture content relationship and the reworked moisture-density relationship, usually specified as a standard test such as ASTM standard D 1557 Method A (12). The insitu density-moisture is primarily useful in foundations and other undisturbed uses of loess. The reworked moisture-density relationships are used in many earthwork projects such as fills, embankments, levees, and subgrades.

Loess, as previously noted occurs, in an open matrix particle arrangement with considerable void space. Hence the loess generally has a relatively low insitu density. Dry densities as low as 69.4 lbs./cu. ft. have been reported (13). Dry densities in the 70-90 lbs./cu. ft. range being more common. Insitu moisture contents of less than ten percent were reported as occurring frequently in Western Kansas and Nebraska (8). Maximum insitu moisture contents possible have not been reported, though Crumpton (14) states that open test holes near the Sangamon-Peoria interface had a tendency to "flow" shut. This would indicate insitu moisture contents above the Liquid Limit.

The remolded moisture-density relationship is used in almost all earth construction. The Standard Proctor density for loess generally is 100-112 lbs./cu. ft. dry density. The maximum density is usually obtained at 15-18 percent water content by weight. The higher densities are usually associated with higher clay contents.

The permeability of the loess is dependent on the gradation and density. The higher sand contents are associated with higher coefficients of permeability. The density of the loess is inversely related to the coefficient of permeability. Values of the coefficient of permeability for undisturbed specimens from 0.5-100 ft./year. Values for densified (maximum Proctor) are 0.1-0.5 ft./year (8).

The coefficient of permeability is not a true coefficient. It has dimensions of length/unit time, while a true coefficient has no dimensions. The coefficient of permeability (K) is usually determined experimentally by either variable head or constant head permeability tests. Both tests are based on the equation $Q=KAt/L$, where Q is the volume of water flowing through the specimen; A is the specimen area; t is the time required for Q to flow through the specimen; and L is the length of the specimen. The variable head test is probably somewhat more like natural conditions than the constant head test.

The consolidation characteristics of loess seem to be directly related to the insitu moisture content and density. The load applied does have a definite effect on consolidation. However, under a specific load the rate and amount of consolidation is dependent on the insitu moisture and density. The rate of consolidation is apparently increased by increasing moisture contents. This trend is particularly noticeable as the insitu moisture content approaches the P.L. The amount of consolidation is influenced by the insitu density. The more dense loess tend to consolidate less than loesses of lower insitu density. The natural occurring denser loesses may be considered as partially preconsolidated for design purposes. The maximum consolidation that will occur, will under normal conditions, take place within a year. Changes in water content under a foundation after a period of time may cause additional consolidation. This consolidation is the difference between the amounts of consolidation that would occur at the two sets of conditions.

The shear characteristics of the loess are controlled by two processes. These processes are cohesion and friction. The shear seems to first be resisted by a cohesive force caused clay particle bonding forces. After the shear force has exceeded the cohesion, a volume change occurs and friction resists the shear force. The cohesive force is usually about 5-10 psi with values as high as 15 psi reported (8). The angle of internal friction (0) is usually about 20^o-25^o though values in excess of 30^o have been reported (8).

Insitu moisture content and density affect the shear characteristics of the loess. Low moisture contents of about 10 percent produce maximum shear resistance due to apparent cohesion. The mechanics of the apparent cohesive forces is dependent on the thickness of the water film bound up by the clay particles. The water films reach their minimum thickness when the water content is approximately 10 percent. Increased water content, increases the water film thickness and reduces the associated tension forces. Hence the cohesion is decreased to essentially zero at about the Plastic Limit.

The initial density affects the shear characteristics by particle rearrangement.

Higher densities cause more particle to particle contacts which cause the friction forces to be immediately activated by an applied shear force.

The engineering properties of the loess are interrelated. The insitu moisture content and density of the loess may serve as indicators of the properties of the loess. High moisture contents and low densities indicate relatively high permeability, low shear resistance, and a potential for considerable, relatively rapid consolidation. Low moisture contents and high densities indicate low permeability, high shear resistance, and lesser, slower consolidation.

Agronomy

Loess that mantles large sections of the midwestern United States is the parent material for many of the highly productive soils of this area. Hence, it is of interest to the agronomist to determine certain properties of the loessial soils. Several definitions are required before undertaking a discussion of the literature.

Soil, to an agronomist, refers to the material composed of finely divided mineral fragments and organic matter capable of supporting plant life. Soil is divided into units, called horizons, for purposes of description, classification, and naming. Three horizons, the A, B, and C, are the basic units of vertical delineation. The three principle horizons and appropriate subdivisions, such as A_1, A_2, B_1, and B_3, comprise the soil profile. The A horizon, commonly called the topsoil, is the most altered material in the soil profile. The B horizon, commonly called the subsoil, is a zone of clay accumulation. The C horizon or parent material is the material that has weathered to form the A and B horizons.

Much of the work of the agronomists has been directed toward defining, naming, and mapping the soils of the United States. This task has largely been completed as evidenced by the Soil Surveys now available on a county by county basis in every state. These Soil Surveys, when properly used, are of immense value to the Soils Engineer.

The agronomists have devoted much time and numerous publications to such things as: the cation exchange capacity, pH measurements, chemical analyses, fertility, mineralogical analyses, erosion and erosion control, and infiltration rates and capacities of the soil mass. Much of this material is of little interest to the engineer and it tends to be somewhat local in nature. However, chemical and mineralogical analyses, cation exchange capacities, infiltration rates and capacities and erosion and erosion control information gathered by the agronomists is of interest to the engineer.

The chemical and mineralogical analyses of the soil mass, such as Kaufman (6) and Brophy (7), are of value in predicting the behavior of a soil for engineering purposes. Attempts have been made to relate the cation exchange capacity to engineering properties. These attempts have been largely unsuccessful. The method employed determines to a large extent what the results will be. Further the test does not measure the cation exchange capacity of the clay minerals, but rather the cation exchange capacity of the pore fluid. The normal values for different clay minerals overlap, making any determination of clay materials at best a guess. The relationship of cation exchange capacity to engineering properties is too nebulous to be significantly useful.

The infiltration rates and capacities are of interest to both agronomists and engineers. Infiltration and associated run-off are of particular interest to hydrologists. Much of the work that has been done in this area, has been done on the basis of the soil series classification comparing the infiltration rates and capacities of several soil series. Some studies have been limited to loessial soils.

Results from these studies, particularly Duley (15), (16) and McCalla (17), show that loessially derived soils, though highly porous, have no special properties which give them unique infiltration rates or capacities. They found that loessial soils, like all other soils, form a compressed layer that impedes infiltration if unprotected by a vegetative cover or mulch. They also found that the parent material tended to form the protective cover faster than did the developed A horizon. Infiltration capacities ranged from 1.05-2.43 (mean 1.39) inches/1.5 hours for initial infiltration and 0.37-0.76 (mean 0.51) inches/1.5 hours for infiltration capacity after 24 hours from the initial test (15). These values are about the same as those for soils of similar textural composition.

Likewise, the erosional behavior and erosion control practices applicable to loess are about the same as those for any soil with similar texture and structure. The loess itself may be slightly more susceptible to erosion due to its relatively loose framework than other denser soils. However tolerable rates of erosion are somewhat higher also in the loess. Generally it may be treated like any other silty or silty clay soil.

Agronomists have done some work of interest to engineers. It usually requires that the reader be aware of certain differences in terminology and purpose and that he use his judgment in applying the published results. With proper understanding of their scope and purpose, the County Soil Surveys and soil constituent analysis done by agronomists may be of invaluable assistance to the engineer.

Soil Stabilization

Soil stabilization is not a development of the twentieth century. McDowell (19) reports that the Shensi pyramids in the Tibetian-Mongolian Plateau, constructed over 5,000 years ago, were constructed from compacted clay and lime. China, India, and Rome used lime as an aid in construction and stabilization of dams, underground chambers, massive bridge footings and road sub bases. Despite primitive methods, lime stabilization has continued in use to the present time.

The use of other stabilizing agents, notably asphalt and portland cement, have gained popularity only in the last few years. Both agents required the development of technology to the point that the material could be used economically as a stabilizing agent. Even more recently additional chemicals have been used as ad mixtures and as independent stabilizing agents. Most of the chemicals used have been organic or organic derivatives.

Yoder (20) explains that soil stabilization is accomplished by two basic mechanisms. One is the cementation of soil particles to form stronger aggregates which are more stable under adverse conditions. The second are waterproofing agents which protect the soils natural cohesion from detrimental increases in water content. Lime and protland cement are of the first type, while asphalt is primarily a waterproofing agent.

Puzinauskas and Kallas (21) divide soil stabilizing agents into three classes, cementing agents, soil modifiers or conditioners, and waterproofing agents. They point out that the cementing agents are susceptible to detrimental effects from freeze-thaw cycles and in fine-grained soils often economically prohibitive. They also point out that the soil conditioners are similarily limited.

Loess Stabilization

Loessial soils have been stabilized by many means. Asphalt, lime, and cement in various forms and with various additives have been studied by various researchers among them Puzinauskas and Kallas (21), Hoover and Davidson (22), Goecker et al. (23), Brand and Schoenberg (24), and Handy et al. (25). The investigations conducted by these authors are typical of many and are reviewed herein because they present the basics for understanding stabilization of loess.

In most stabilization problems, loess behaves in much the same manner as a fine-grained soil of similar mineralogical composition. Asphalt stabilization is a waterproofing process. The density and strength of well graded soils are reduced by low concentrations of asphalt. In more poorly graded soils, much higher concentrations of asphalt are required to reduce density and strength. Soil-asphalt-additive systems, where the additive was a cementing material other than portland cement, showed improved strength, density and durability. Additives which are of the soil modifying or waterproofing types have much less effect than a cementing additive and, in some cases, may be detrimental to the system. Extensive laboratory testing is necessary to determine the proper mixture of asphalt, additive and water to give the best results (21).

Among the materials which could be classed as soil modifiers are organic compounds such as Arquad 2HT, Arquad 25, Armeen Residue, and Crude Amine. These chemicals produced the largest increases in strength of many tested. However there are several problems as yet unsolved in the use of this type chemical among which are the effects of soil bacteria on the stabilizing agent and the development of construction techniques using these additives to maximum advantage (22).

As previously mentioned, lime stabilization is one of the oldest methods of soil stabilization known to man. In the past 25 years many significant improvements have been made in the use of lime for soil stabilization. Fly-ash and chemical additives have been investigated as methods of improving the lime-soil system. Fine and coarse-grained soils (23), field investigation (24) and trace chemical additives to life-flyash systems (25) have been studied in some detail.

Lime stabilization consists of a two step process. The first step is a base exchange reaction in which the cations replace the weaker monovalent cations, thus causing floculation of the soil particles and the development of aggregates. The second step is the pozzolonic reaction. The reaction causes calcium silicates and aluminates to develop which cement the soil particles in a manner similar to portland cement (19, 23, 24). Sufficient lime for these reactions must be present in the soil mass. The pozzolonic reaction rate is very slow and sufficient time must be allowed for curing, i.e., the pozzolonic reaction to take place. Various chemicals, in trace amounts, tend to speed the reaction. Among the more effective are sodium sulfite (solution), sodium bicarbonate (solution), lithium fluoride (suspension), manganous cloride (solution), potassium dichromate (solution) when used in an Ottawa sand-lime-flyash mortar treated with 0.5 percent of each chemical in the mix water. The listed chemicals caused strength gains of 100 psi or greater after a 4-month cure and 24-hour immersion (25).

Cement stabilization is accomplished in the same manner as concrete is set. The soil particles replace the aggregate in concrete to form the soil-cement mixture. The clay content and silica-sesquioxide ratio are two of the most important factors in determining the effectiveness of cement as a soil stabilizing agent (26). In soils that are highly responsive to cement-stabilization, the degree and uniformity of mixing may be the controlling factors in how the stabilized soil preforms (27). Organic matter in the soil is usually detrimental to the effect of soil-cement stabilization (26).

Soil-cement mixtures give best results when compacted to Proctor Density at moisture contents near optimum. High cement contents, usually 8-14 percent are most effective for stabilization. Various types of cement (I, IA, III) preform very well in soil-cement mixtures and behave much the same as in concrete. Care in construction to assure optimum conditions for the soil cement mixture is of great importance to the quality of the final product.

In the area of soil stabilization, loess behaves in the same manner as any similar fine-grained soil material. It may be stabilized by any of the methods discussed in this section.

Asphalt Stabilization

Asphalt, a general name for heavy hydrocarbon cementing materials, is used in many ways in modern technological societies. One of the most familiar is asphalt pavement on highways. Less familiar to the average citizen but at least as important, is the use of asphalt to stabilize soils. Most of the work in this area is directly related to transportation facilities, particularly stabilization of highway bases.

Asphalt is a waterproofing agent that retards or blocks the movement of water through a soil mass, thus protecting the natural strength of the soil from adverse effects of moisture-content increases. The asphalt acts by coating individual particles in the soil mass. Ideally, every soil particle would be coated, however this is not possible in real life. Hence the asphalt must be mixed with the soil in such a manner that the ideal situation is approximated.

For soil stabilization, asphalt is prepared by two basic methods, solution or emulsion. Preparation of asphalt by solution is accomplished by dissolving the asphalt in an organic solvent, such as gasoline, kerosene, naptha, n-hexane and carbon tetracloride (28). Emulsion preparation of asphalt is usually completed using water as the carrying agent. Other agents may be used, though water is the cheapest and easiest to handle. Other methods, such as foams and batch plant mixing, have been tried with little practical success.

Three primary factors influence the asphalt's behavior. These are as follows: (1) Asphalt type; (2) Cutback solvent or emulsifier; (3) Additive. In any one particular soil, a variation in any of the three factors will cause a variation in the effectiveness of the stabilization. Various authors (21, 28, 29, 30, 31) have investigated the effects of variations in one of the three factors. Herrin (32) found that the drying phase was also significant in the performance of asphalt stabilized soils. He found that the best results were obtained from letting the soil-asphalt mix dry before compaction.

Several suggested indexes for determining the usability of asphalt stabilization have been proposed. These indexes use the percent passing the No. 200 sieve and the P. I. as controlling variables. Various authors (33, 34, 35, 36, 37, 38) have suggested, based on cut back asphalts, that minimum values of 0-8 percent and maximum values of 15-50 percent passing the No. 200 sieve be used in conjunction with P. I. values of 0-18 percent. Two authors (36, 37) suggested that the value of the P. I. x Percent Passing No. 200 sieve be less than 60 and 72 respectively. The Air Force said stabilization index system (39) recommends asphalt stabilization be used if less than 25 percent passes the No. 200 sieve, the P. I. is less than 6 and the P. I. x percent passing No. 200 sieve is less than 60.

If 35-100 percent passes the No. 200 sieve and the P. I. is greater than 10, it recommends that lime be used to reduce the P. I. to less than six before using asphalt to stabilize the soil.

Laboratory testing of a proposed asphalt-carrier-additive mix for a particular soil and service conditions is the surest method of obtaining the required information to predict the results of asphalt soil stabilization.

EXPERIMENTAL DESIGN AND PROCEDURES

Three loess samples were used in the experimental work. The samples were from the following locations: (1) NE 1/4, Sec. 27, T 35, R 34W Rawlins County, Kansas; (2) NE 1/4, Sec. 5, T 35, R 4W Republic County, Kansas; (3) Sec. 12, T 115, R 23E, Wyandotte County, Kansas. The samples from Rawlins and Republic Counties were obtained from mineral filler pits operated by the Kansas Highway Commission. The Wyandotte County sample was obtained from a cut on I-70 near the west edge of Kansas City.

The experimental work consisted of three test series on each Loess. The test series included specific gravity, Atterberg limits, gradation, Proctor density, permeability, triaxial shear, X-ray diffraction, and Infrared spectrometer. One test series was run on each raw loess, one test series was run on each loess 24 hours after it had been treated with a CRS1-H emulsified asphalt so that three percent by weight asphaltic cement remained in the sample, and the third test series was run 60 days after treatment of the loess with the asphalt. The test series run 24 hours after treatment of the sample did not include specific gravity. The gradation run 24 hours and 60 days after treatment was a modified gradation which is described in Appendix B.

An analysis of the emulsified asphalt used can be found in Table 2. The asphalt was provided by Phillips Petroleum Company, who also provided the analysis.

TABLE 2

PROPERTIES OF CRS1-H ASPHALT

API Gravity, 60°F	8.1
Specific Gravity @ 60°F/60°F	1.0136
Specific Gravity @ 77°F/77°F	1.0098
Saybolt Furol Viscosity @ 122°F, Sec.	23.1
Residue by Dist., Wt.%	67.6
Tests on Residue from Distillation:	
Penetration of Residue, 100 gm. 5 Sec.	93
Ductility of Residue, 5 cm/min. @ 77°F	145+
CCl_4 Solubility on Residue, Wt.%	99.5
Sieve Test, Wt.%	.037
Particle Charge	Positive
5 Day Settlement	.8
Cement Mixing Test	--

Prior to beginning experimental work, it was necessary to build a usable triaxial shear machine and to calibrate the equipment. Details of the triaxial shear machine are contained in Appendix B. The permeameter, which had been built previously by the author, was used. Details and operational procedure for it are contained in Appendix B.

Mixing of the soil and asphalt was accomplished by use of a cement mixer. The asphalt and enough additional water to bring the water content to approximately optimum plus 10 percent for the raw soil was slowly added to the soil in the mixer. The mixer was then operated for an additional five minutes to insure maximum uniformity in the mix. The water content used for mixing was determined by several attempts to mix the soil and asphalt under various conditions, during which the mixing of the soil and asphalt and the final mixed product were closely observed. The method used showed the least tendency to form superaggregates cemented by the asphalt.

The samples were mixed using 4. 0 kg. of minus 20 loess which had been cleaned of all visible foreign matter such as mollusk shells. To the soil were added 178. 0 grams of the emulsified asphalt, which contained 120. 0 grams of asphaltic cement. Approximately 900 grams of water were also mixed with the specimen to facilitate mixing. The resultant mixture contains three percent asphaltic cement by weight.

The samples to be tested in 24 hours were cured and then oven dried to allow exact moisture content controls for individual test specimens. The sample to be tested in 60 days were placed in metal sample pans, covered, and periodically resaturated by adding water. They were then oven dried to insure moisture content control on individual specimens.

The individual specimens for triaxial shear and permeability were molded at 95 percent maximum dry density and 105% of optimum water content, based on the Proctor density determined for that particular sample. This requires that two batches of soil-asphalt mix be prepared for each loess-asphalt-curing period combination. Care was taken to insure that each batch was subjected to identical conditions.

Individual test specimens were mixed in single specimen mixes by hand. The water was slowly added as the mixture was stirred. The amount of time to mix a specimen varied somewhat but would average about 15 minutes. The specimen was molded and placed in the appropriate test chamber and tested. The test data was recorded and the results computed. The computer programs in Appendix C were used to expedite the calculations.

Specimens for the mineralogical testing were prepared from the prepared samples. The KBr pellet technique, using a minipress, was employed for the Infra-red Spectrometer analysis. The back-filling technique was used to prepare the random powder samples and the slurry technique was used to prepare the oriented slides for the X-ray diffraction testing.

RESULTS

TABLE 3

ENGINEERING PROPERTIES OF RAWLINS COUNTY LOESS

ID NO 2	Raw	24 Hr Cured	60 Da Cured
Specific Gravity	2.59	N.D.	2.57
Plastic Limit	23.9	23.9	24.4
Liquid Limit	30.9	31.4	28.4
Permeability cm/sec	2.36×10^{-7}	9.61×10^{-8}	3.39×10^{-7}
ø degrees	32.5	23.6	23.0
c psi	2.0	4.0	3.5
Proctor Density			
Dry Density	109.8	105.6	101.7
Water Content	15.0	17.0	18.1

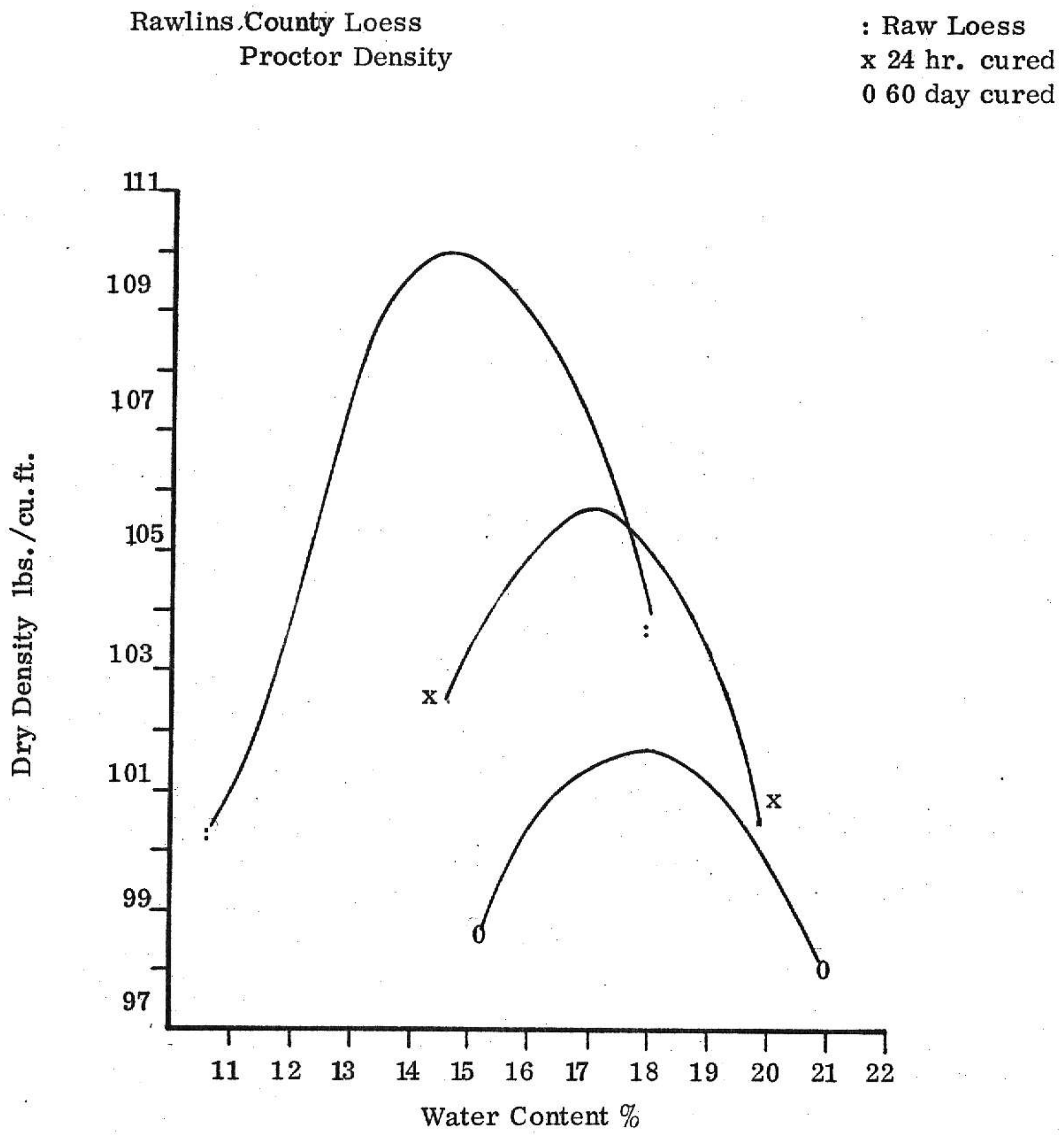


FIGURE 6

MOISTURE-DENSITY CURVES

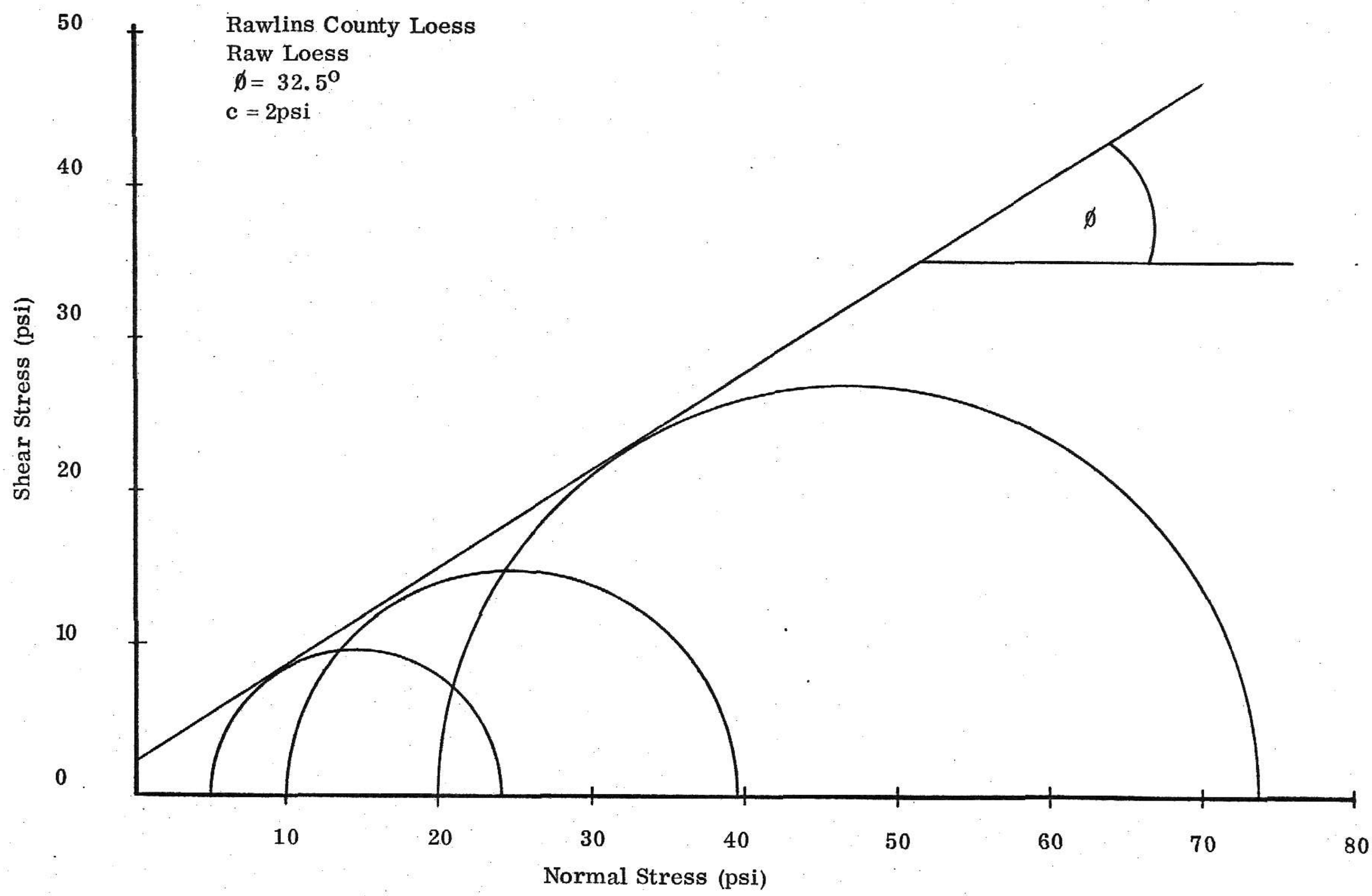


FIGURE 7

TRIAXIAL SHEAR PLOT

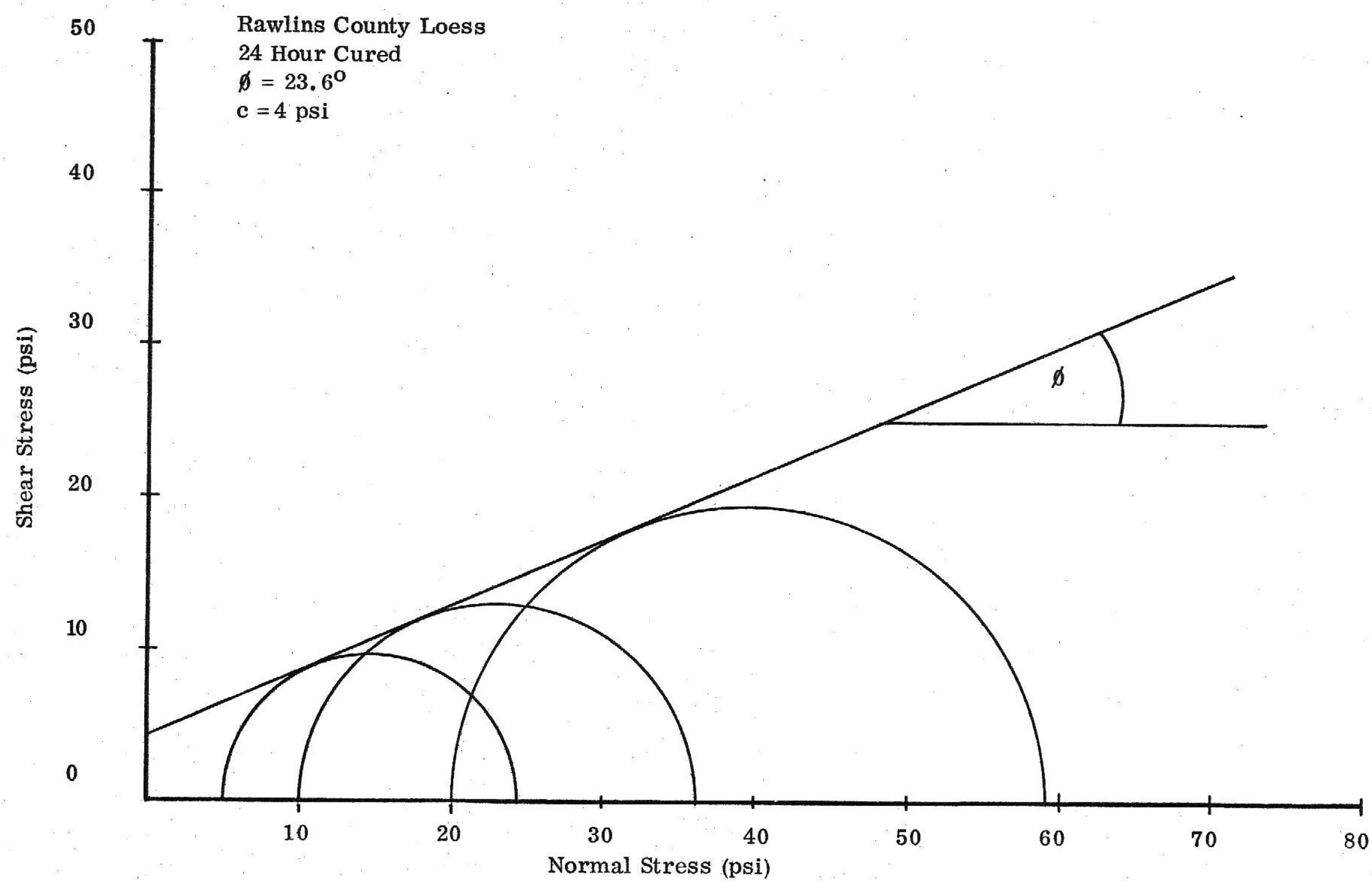


FIGURE 8

TRIAXIAL SHEAR PLOT

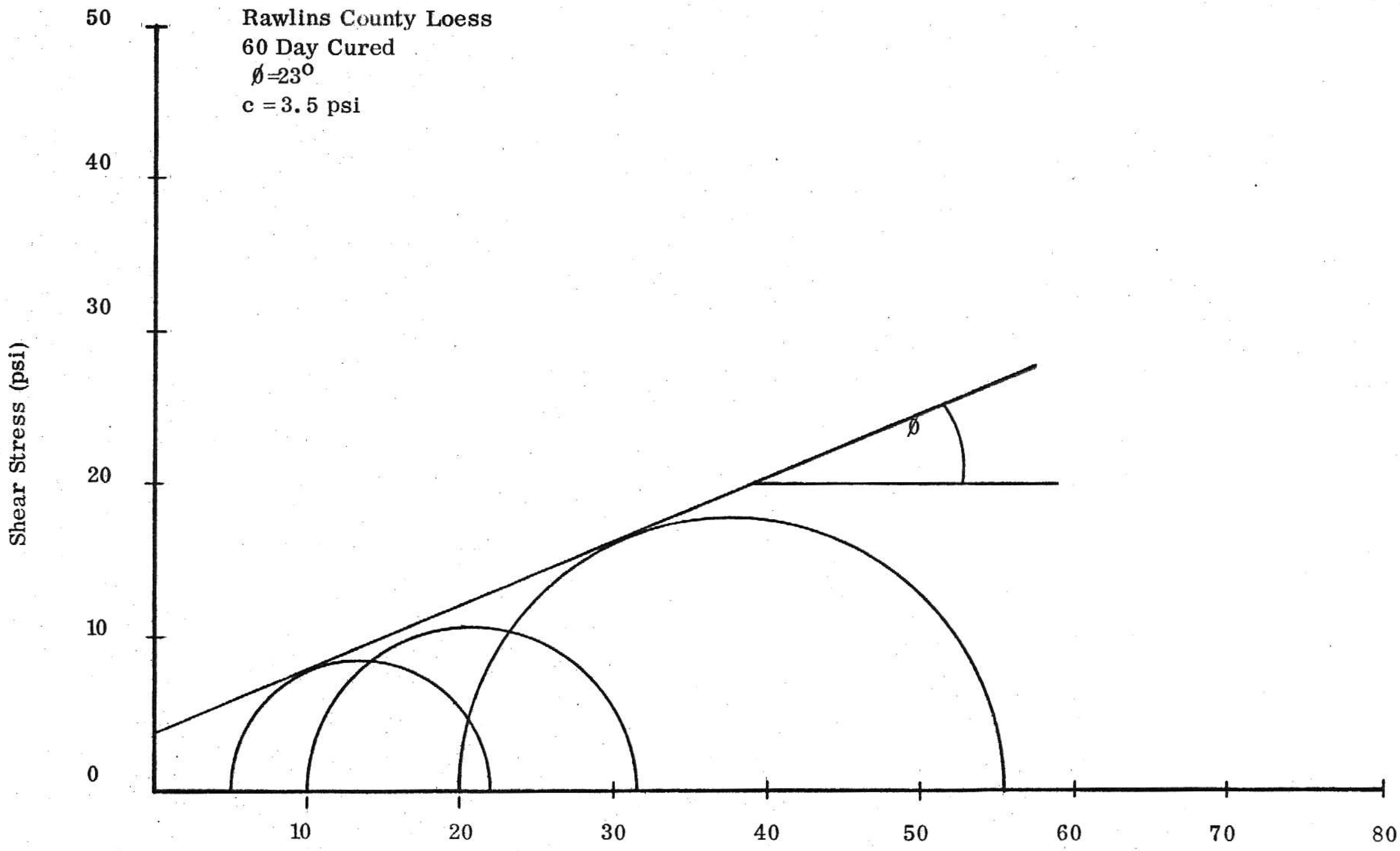


FIGURE 9

TRIAXIAL SHEAR PLOT

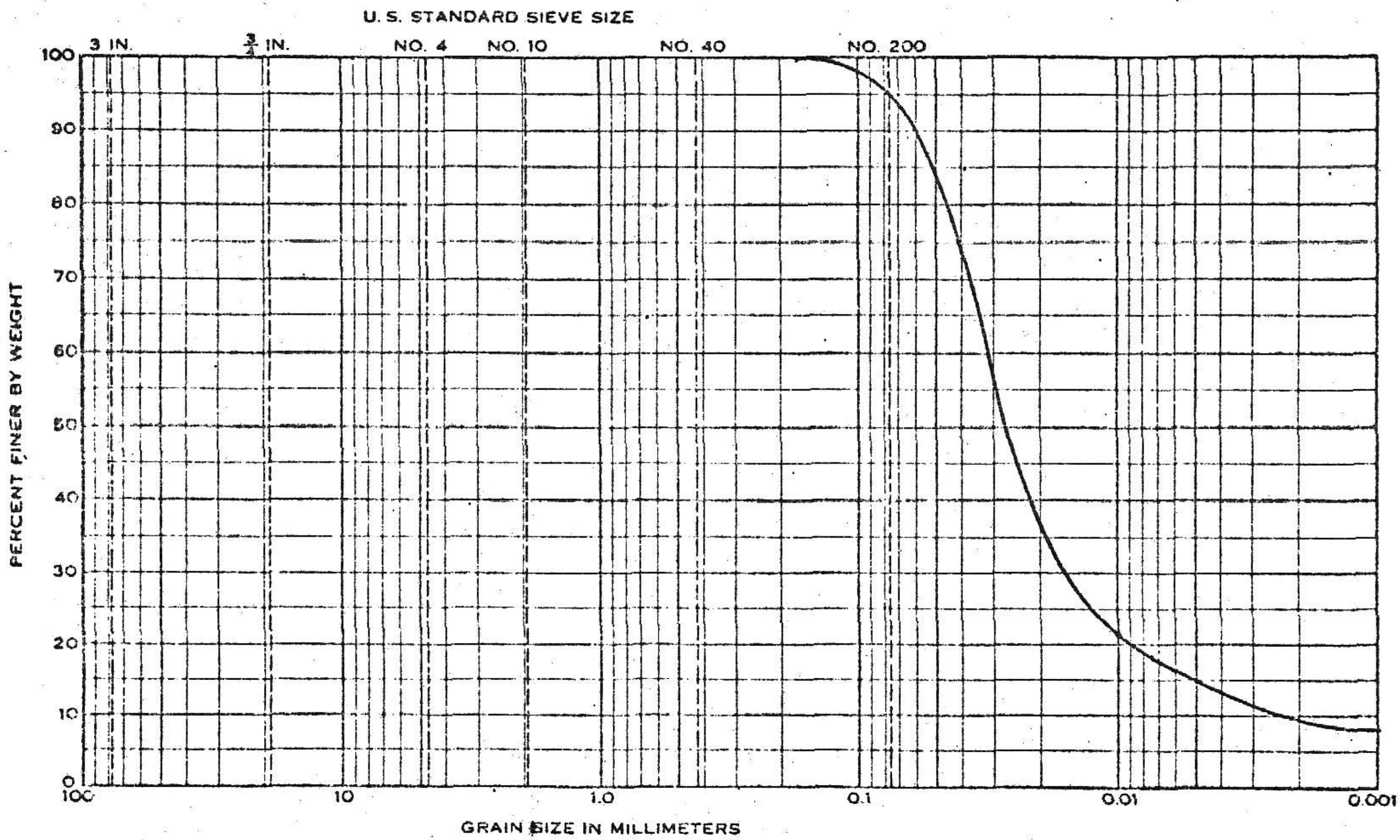


FIGURE 10

GRADATION CURVES

Rawlins County
Raw Loess

TABLE 4

ENGINEERING PROPERTIES OF REPUBLIC COUNTY LOESS

ID NO 3	Raw	24 Hr Cured	60 Da Cured
Specific Gravity	2.67	N.D.	2.64
Plastic Limit	Not Determinable		
Liquid Limit	Not Determinable		
Permeability cm/sec	1.754×10^{-5}	8.50×10^{-6}	1.856×10^{-6}
ø degrees	35.0	31.5	33.5
c psi	1.5	2.5	1.5
Proctor Density			
Dry Density	103.6	104.2	101.3
Water Content	16.5	13.5	14.9

Republic County Loess
Proctor Density

: Raw loess
x 24 hr. cured mixture
0 60 day cured mixture

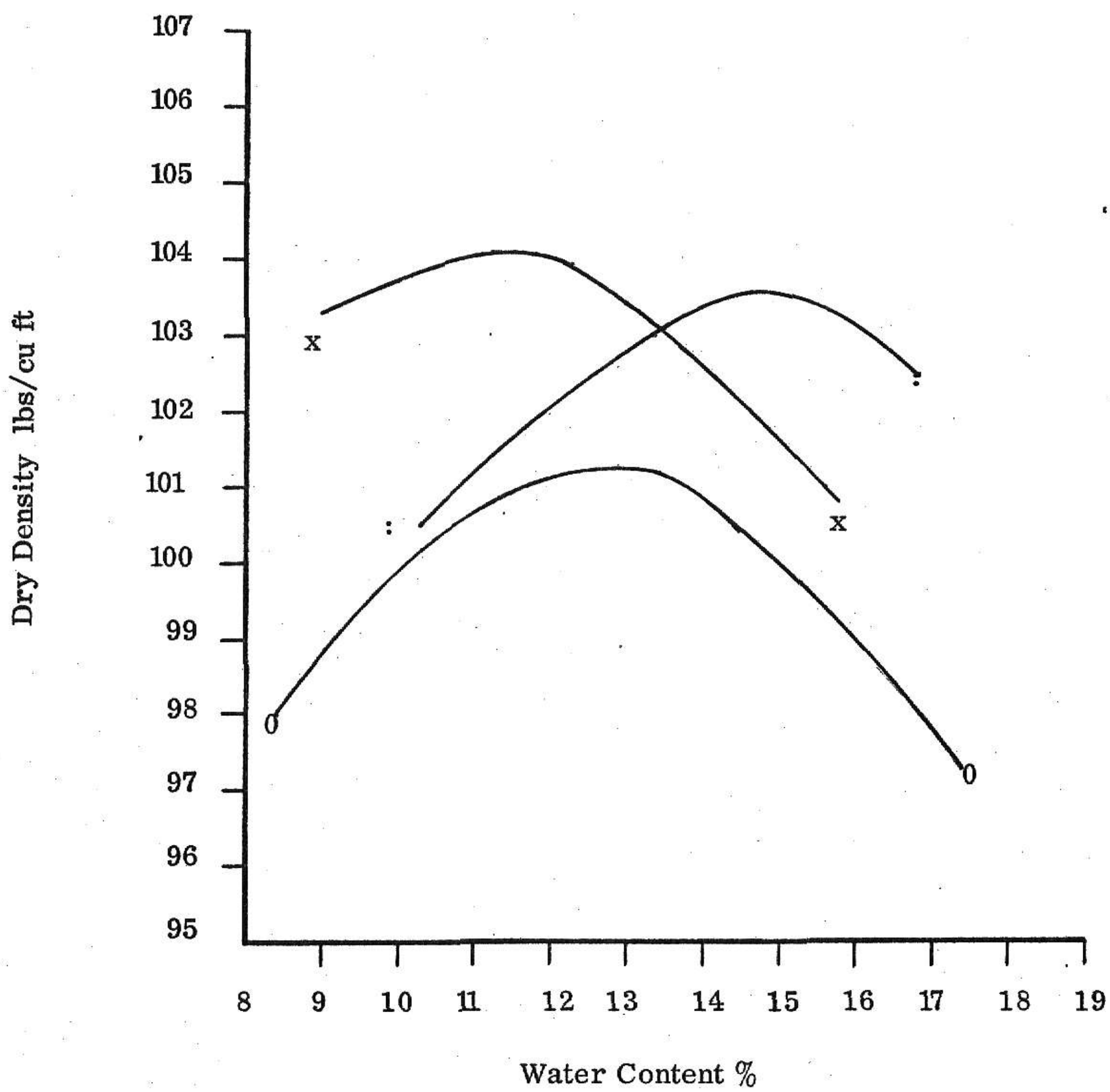


FIGURE 11

MOISTURE-DENSITY CURVES

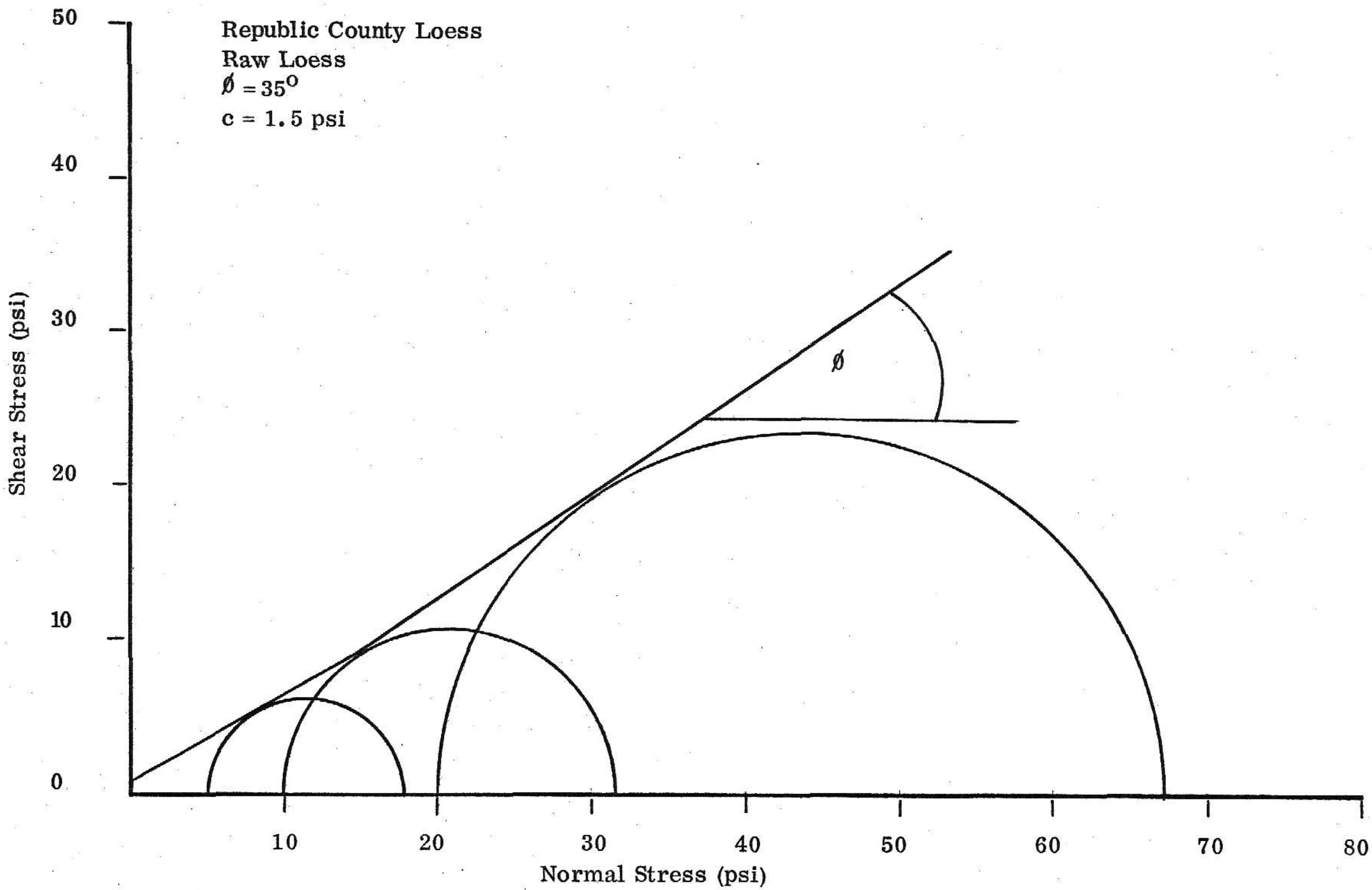


FIGURE 12

TRIAXIAL SHEAR PLOT

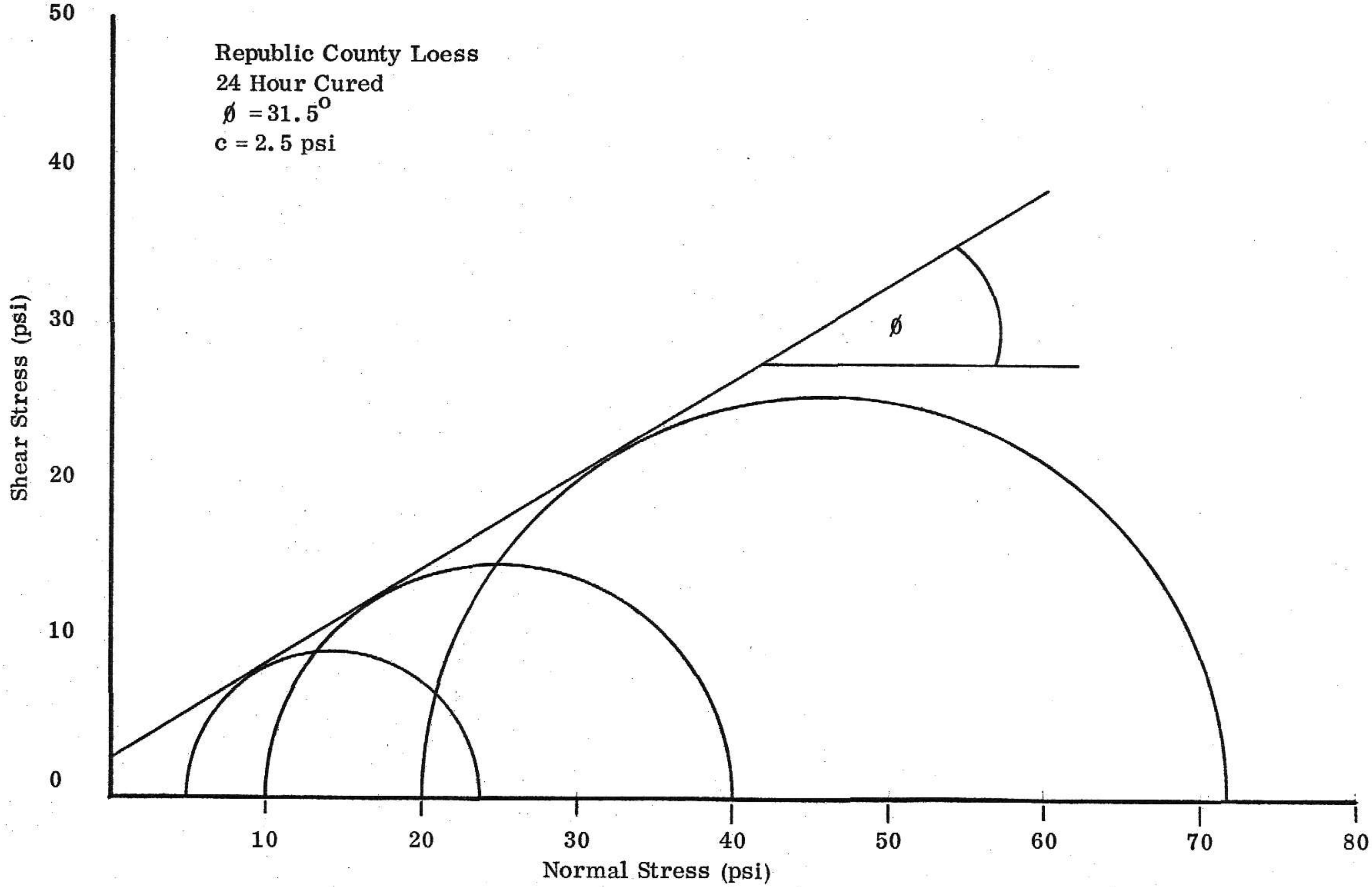


FIGURE 13

TRIAXIAL SHEAR PLOT

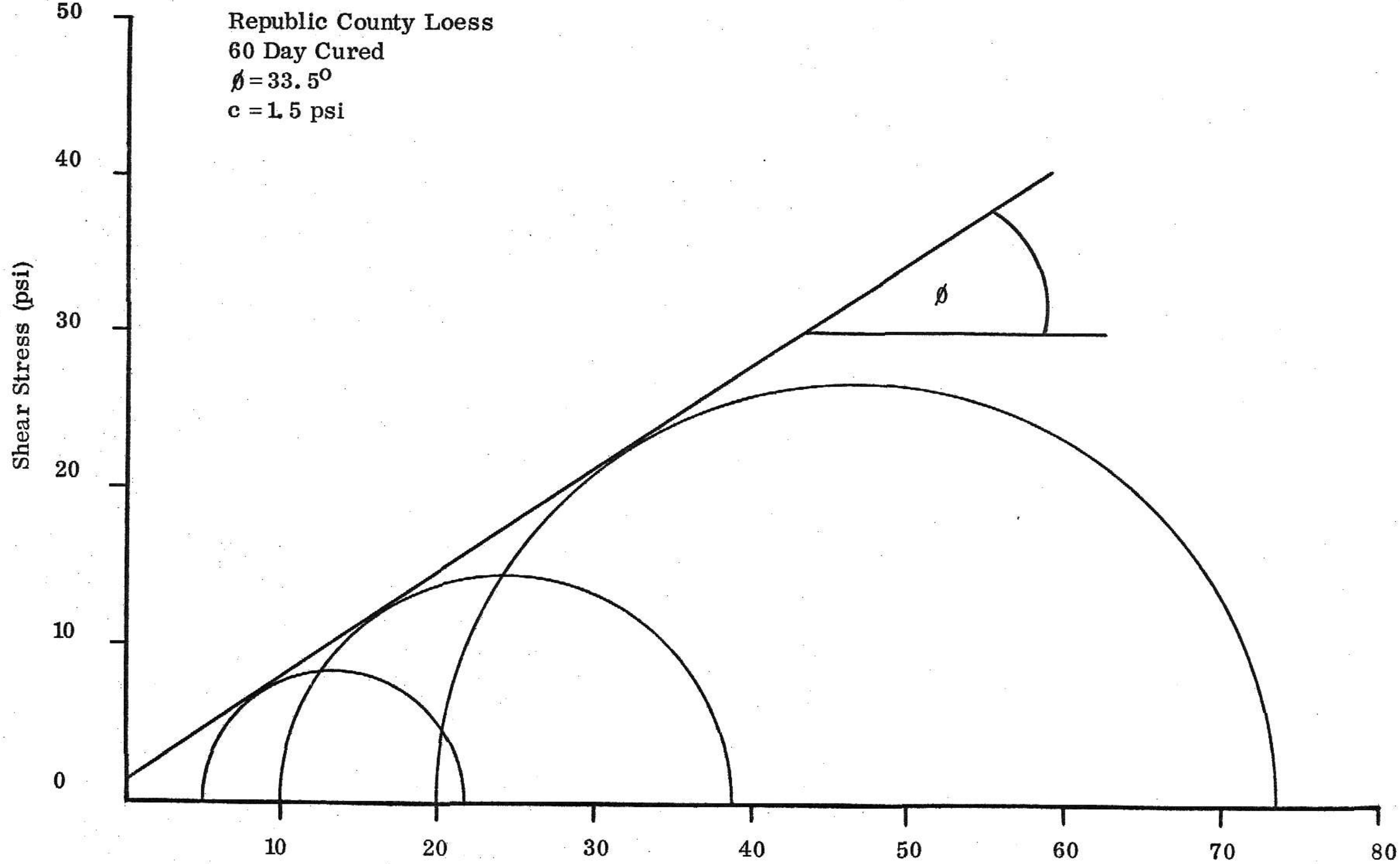


FIGURE 14

TRIAXIAL SHEAR PLOT

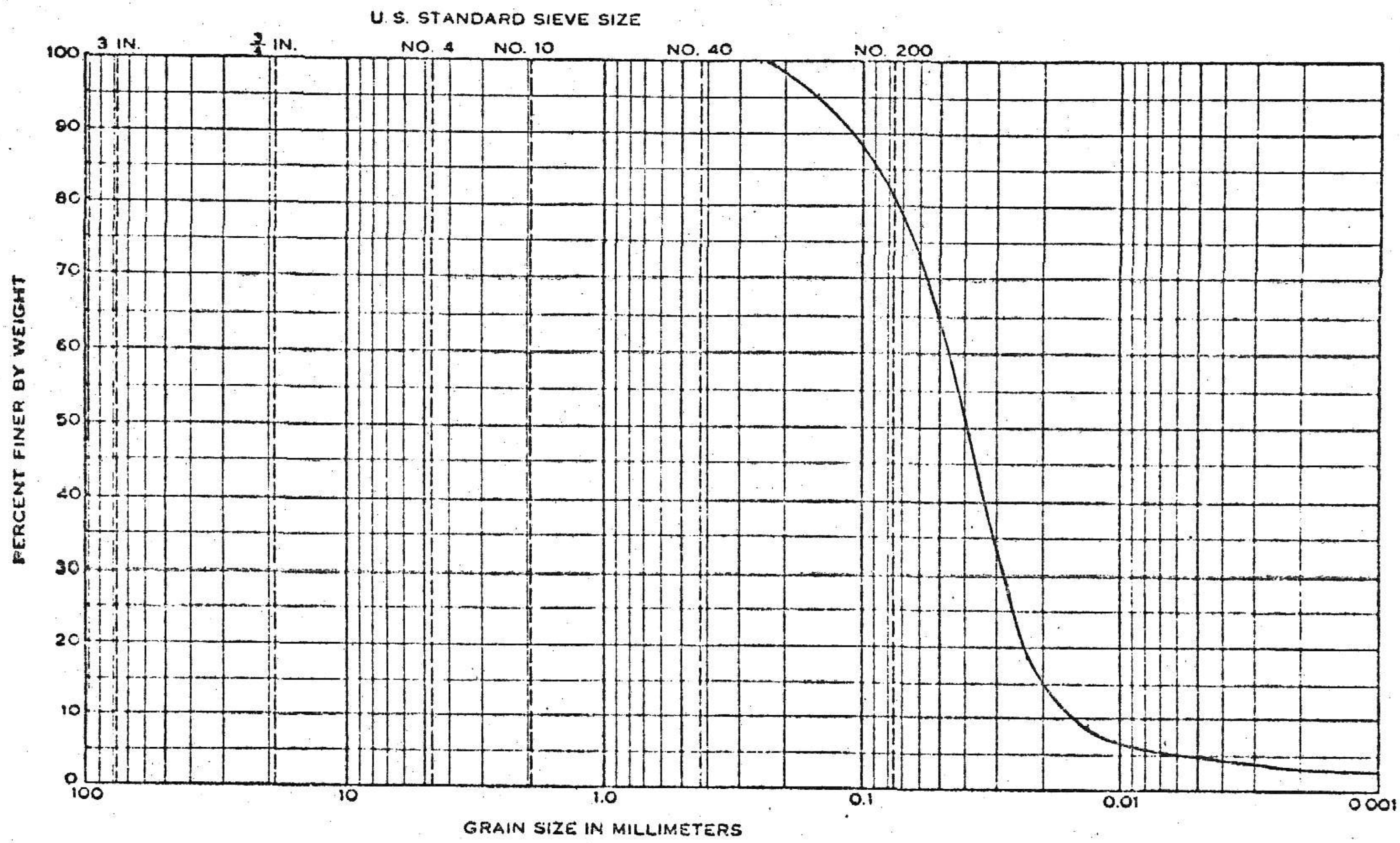


FIGURE 15

GRADATION CURVES

Republic County
Raw Loess

TABLE 5

ENGINEERING PROPERTIES OF WYANDOTTE COUNTY LOESS

ID NO 5	Raw	24 Hr Cured	60 Da Cured
Specific Gravity	2.63	N. D.	2.62
Plastic Limit	18.9	18.8	20.6
Liquid Limit	24.7	24.2	27.2
Permeability	9.23×10^{-7}	2.07×10^{-6}	1.82×10^{-7}
ϕ degrees	19.4	20.8	14.0
c psi	0.5	4.5	4.5
Proctor Density			
Dry Density	110.0	108.2	107.5
Water Content	15.0	14.4	14.1

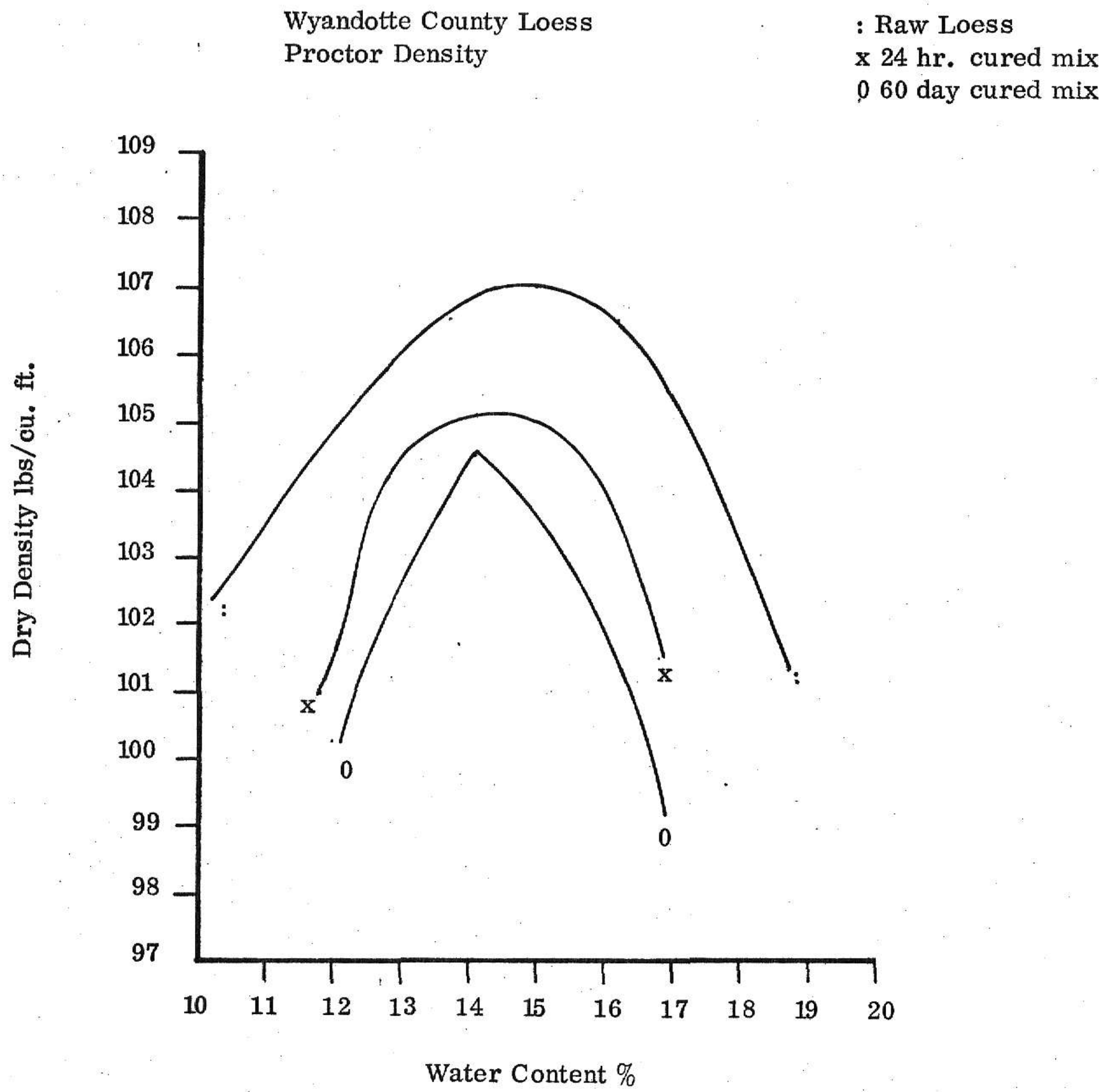


FIGURE 16

MOISTURE-DENSITY CURVES

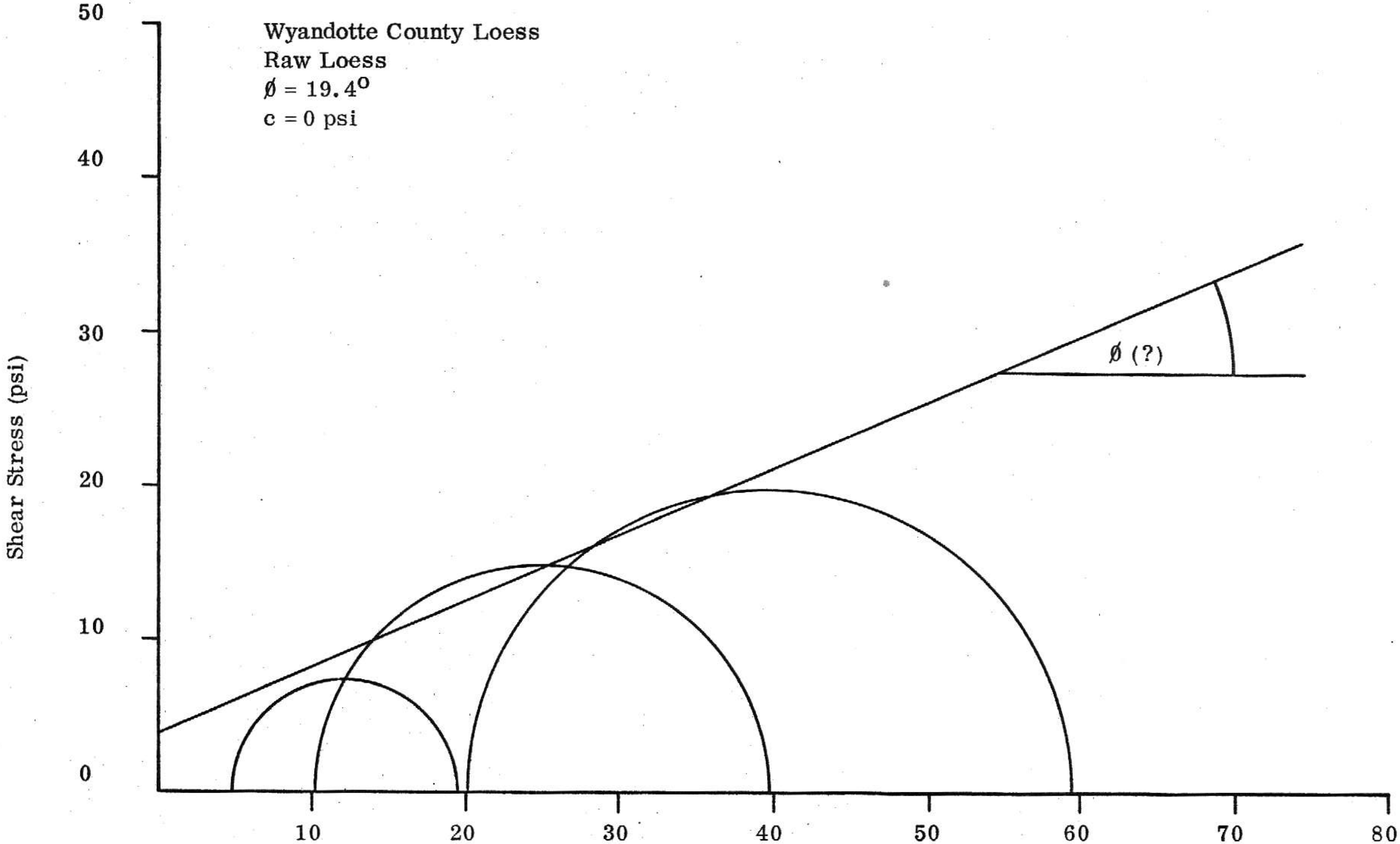


FIGURE 17

TRIAXIAL SHEAR PLOT

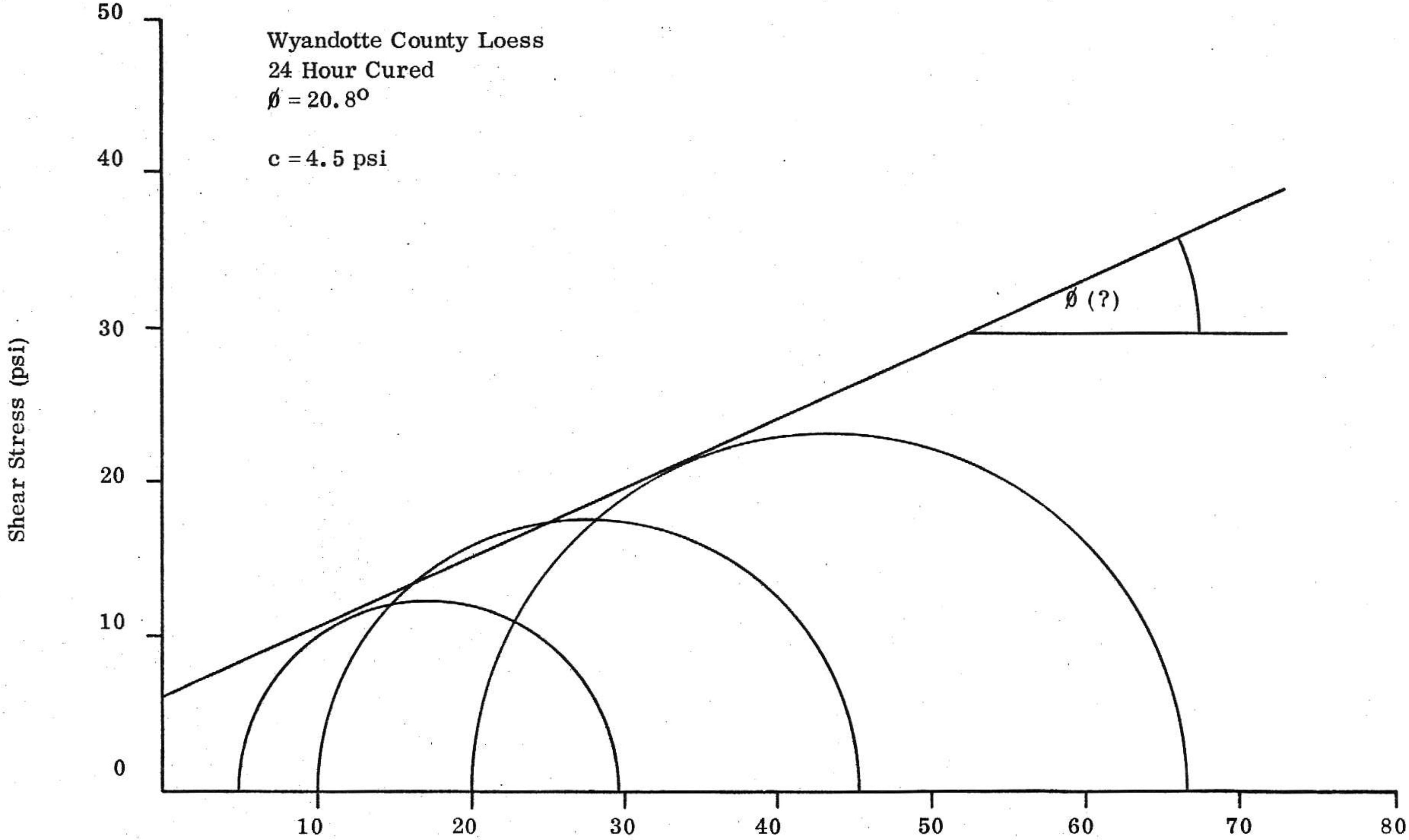


FIGURE 18

TRIAXIAL SHEAR PLOT

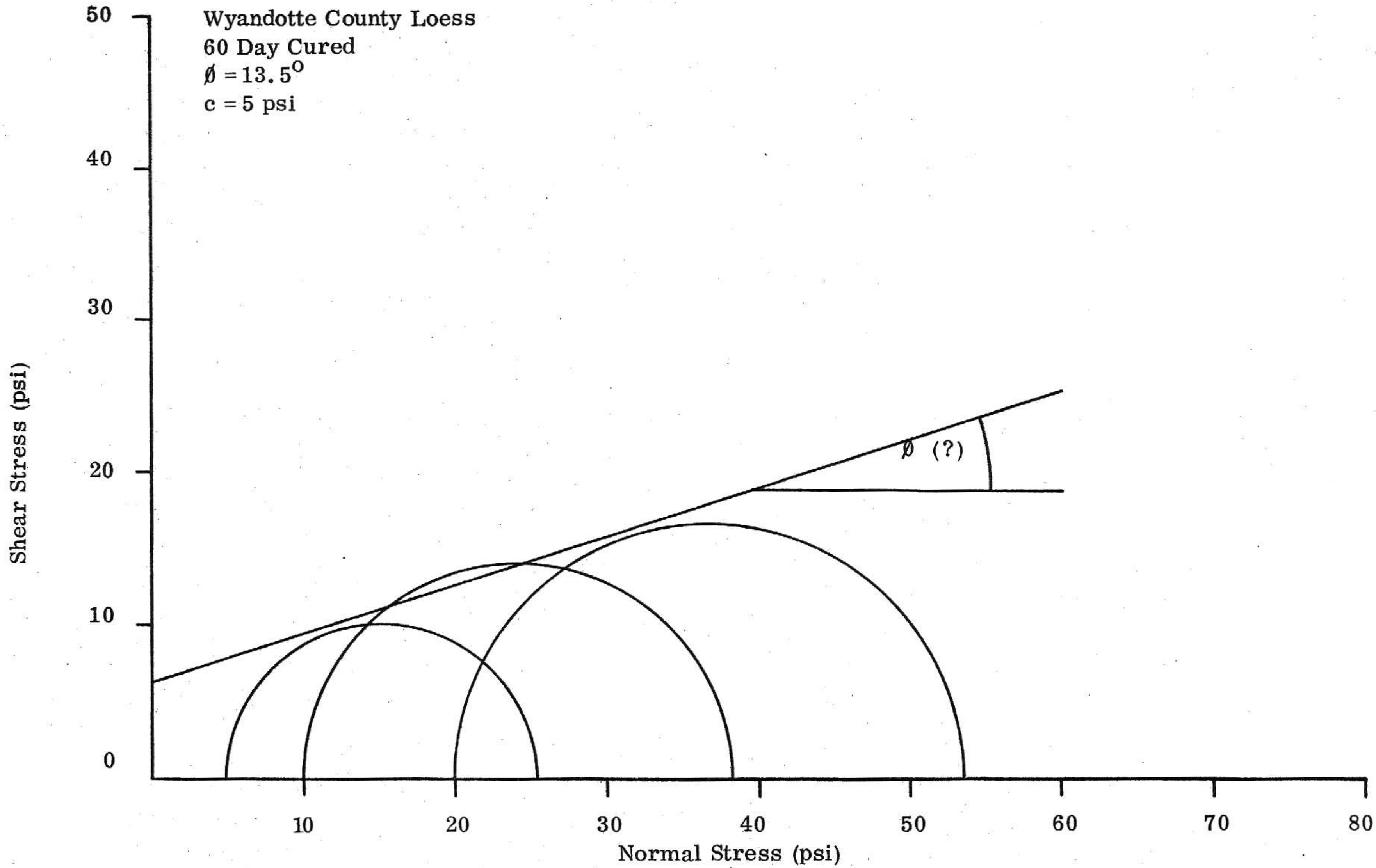


FIGURE 19

TRIAXIAL SHEAR PLOT

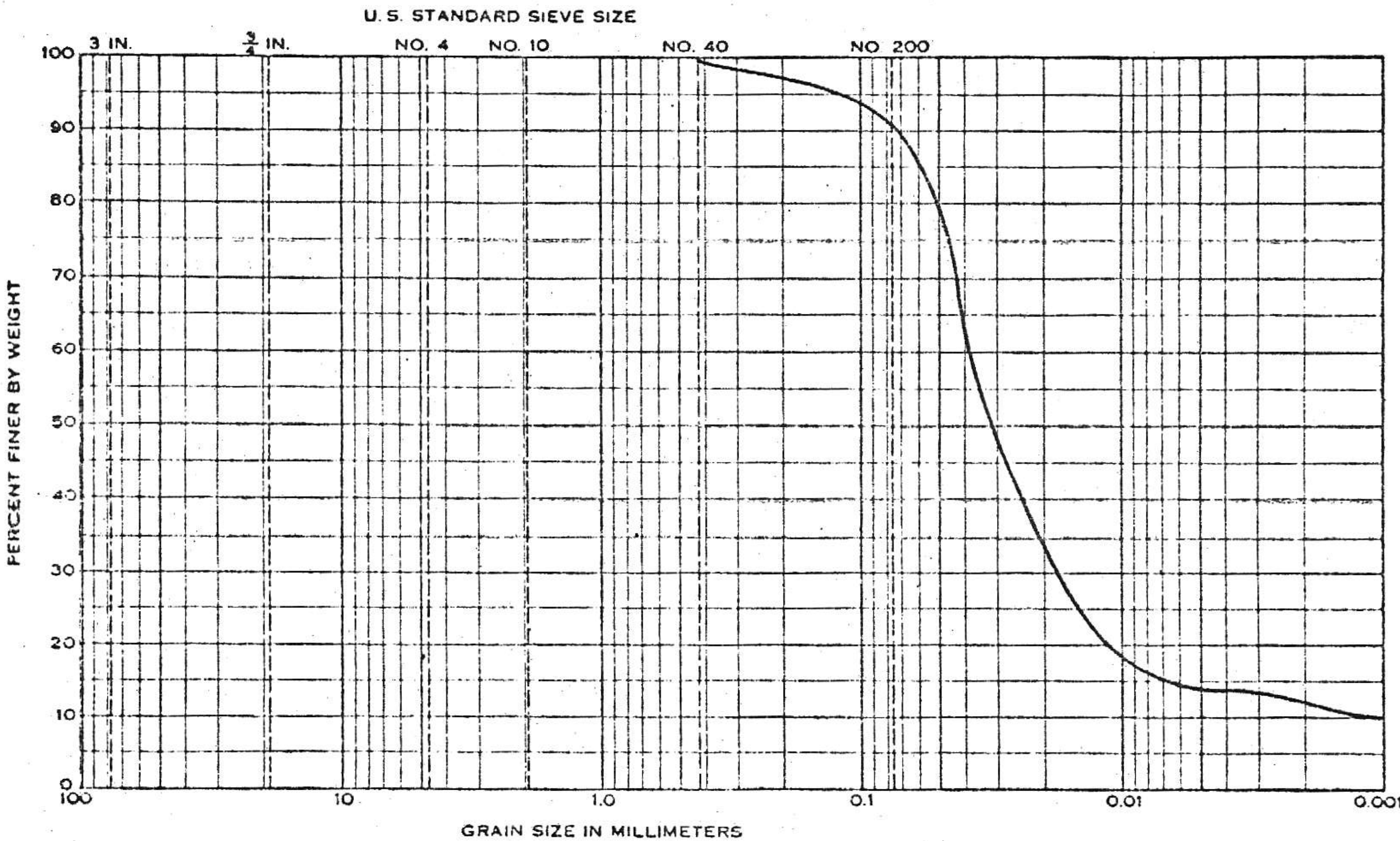


FIGURE 20

GRADATION CURVES

Wyandotte County
Raw Loess

DISCUSSION OF RESULTS

The results discussed in this section are presented in the preceding section. Each loess will be discussed separately and then some characteristics that are common to all three specimens will be briefly discussed.

The behavior of the Rawlins County loess changed with the addition of the asphalt. During the first 24 hours, and after 60 days, significant changes take place in the engineering properties. The initial changes that take place tend to make the loess more cohesive, the angle of internal friction is reduced, increases are shown in the Plastic Index and the optimum water content, and the permeability and maximum dry density are significantly reduced. Thus, this soil acquires some of the behavior characteristics of a clayey soil.

After 60 days the loess undergoes a reversion to behavior more characteristic of a granular material. The reduction of the plastic index, cohesion and maximum dry density with the increase in permeability indicate that the aggregation shown by the gradation analysis is sufficiently strong so as to cause the material to behave as a more granular material. The change is apparently related to the curing of the asphalt. The increased hardness of the aggregation caused by the asphalt is apparently caused by the decrease in ductility of the asphalt as it cures. The reduction in specific gravity is the effect of the mixture of soil and asphalt and is entirely expectable.

The Republic County loess was initially fairly sandy. At no time did it act as anything except a fine grained granular material. The loess was too sandy at all times to make determination of liquid and plastic limits possible. The loess showed a more cohesive behavior at 24 hours as indicated by an increase in the cohesion and decrease in the angle of internal friction. The more cohesive behavior was largely lost at the end of 60 days when the cohesion had fallen to its original value and the angle of internal friction had regained in excess of 50 percent of the initial loss. The moisture-density relationships show no particular pattern. After 24 hours the dry density was slightly increased with a reduction in water content. After 60 days the water content again increased while the dry density decreased. The reduction in the coefficient of permeability at both 24 hours and 60 days tends to indicate that asphalt-loess mixture formed a less dense, less porous mass than did the raw loess.

The Wyandotte County loess initially behaved as a slightly cohesive fine granular material with low plasticity characteristics. The plasticity characteristics remained essentially constant after the addition of the asphalt. The most significant change was in the angle of internal friction which showed a slight increase at 24 hours and a drastic reduction in 60 days. The cohesion was drastically increased and remained constant to the end of the testing, 60 days after mixing. The behavior of the Wyandotte County loess at 60 days is very similar to that of a fine grained cohesive soil. The moisture-density relationships did not follow this pattern. The maximum dry density decreased as did the optimum water content. The overall behavior is definitely unique to the loess-asphalt mixture.

Each of the loess showed a reduction in specific gravity, in the angle of internal friction, and in the maximum dry density. Each loess also showed a tendency to aggregate into larger aggregates of significant durability. Each loess showed that its engineering properties were modified by the addition of the asphalt. Each loess showed a tendency to be less friable and slightly more difficult to work with after mixing with asphalt.

The three loess samples had characteristics that were unique to each sample. Due to these characteristics it was possible to rapidly identify each sample. These characteristics were maintained throughout the test. Color, feel, and general appearance remained basically constant. The loess showed individual behavior in their plasticity characteristics and in the permeability and optimum water content. The pattern and amount of change in the cohesion was also different in each loess.

The results from the X-ray Diffraction and Infra-red Spectrometer were inconclusive and yielded no information on the behavior of a loess-asphalt mixture nor on the mechanisms by which the asphalt affects the properties of the loess.

CONCLUSIONS

The results of this study yield three main conclusions. First, three percent emulsified asphalt will alter the engineering properties of loessial soils. Second, the modification of the engineering properties is dependent on the physical characteristics of the original loess. Third, laboratory testing is necessary to determine if low concentrations of emulsified asphalt will produce the desired modifications in the engineering properties.

Three percent emulsified asphalt will alter the engineering properties of loessial soils. The alteration in the engineering properties is time dependent. The asphalt caused the loess to form larger aggregates and in the fine grained loesses to increase cohesion and to reduce the P. I. The angle of internal friction is reduced, but the overall effect of the asphalt on the fine grained loesses is to produce a small increase in the strength and stability of the soil. Sandy loess is somewhat weakened by the addition of three percent emulsified asphalt, but the permeability is significanfly reduced.

The modification in the engineering properties is dependent on the physical characteristics of the original loess. Loessial soils that have a P. I., in the raw state, such that the P. I. x Percent Passing No. 200 Sieve is approximately 60 respond favorably to emulsified asphalt stabilization. Loess that is completely non plastic does not respond favorably to low concentration emulsified asphalt stabilization. Both P. I. and gradation affect the success of emulsified asphalt stabilization of loess.

Laboratory testing is necessary to determine if low concentrations of emulsified asphalt will produce the desired modifications in the engineering properties of loess. Loess varies in many of its engineering properties with respect to geographical location. This study has shown that loesses from different geographical locations respond differently to low concentrations of emulsified asphalt. It is therefore necessary to test the asphalt stabilized loess in the laboratory to assure acceptable performance in the field.

AREAS FOR FURTHER RESEARCH

Two areas of further research appear to be of significant interest. The first area is to study and catalogue the relationship of mineralogy to the effectiveness of soil stabilizing agents. If definite relationships between mineralogy and the effectiveness of soil stabilizing agents were found, it would provide a valuable guide to engineers faced with a soil stabilization problem. The second area is an investigation of the effects of various additives used with asphalt to determine the effect of the additive on the mineralogical properties of the soil mass, with respect to the changes caused by asphalt alone.

APPENDIX A

TEST SPECIFICATIONS

The testing required to determine the engineering properties of the raw loess and loess-asphalt mixtures were conducted according to the following ASTM Standards or to the procedures explained in this Appendix. The ASTM Standards used are as follows: Specific Gravity D854-58; Gradation D421-58 and D422-63; Liquid Limit D422-66; Plastic Limit 424-59; and Moisture Density D698-667. The procedure for the Modified Gradation is explained on page 83 of this Appendix. The procedure and description of equipment for the Permeability Test begins on page 88 and for the Triaxial Compression, page 99. The data for the Proctor Density are on the following three pages.

For use with the computer it was necessary to be able to numerically identify specimens. For this use a three digit code was employed. The first digit identifies the loess being tested: 2 is Rawlins County, 3 is Republic County, and 5 is Wyandotte County. The second digit identifies the specimen as raw loess, 0; 24 hour cured mixture, 2; or 60 day cured mixture, 6. The third digit identifies the test. Five (5) is permeability and 6 is triaxial compression.

RAWLINS COUNTY LOESS

Raw Loess

Det. No	1	2	3	4	5	6
Weight	100.4	104.0	108.4	109.5	104.0	99.3
Moisture Content	10.7	12.0	13.2	15.4	18.0	19.9

24 Hour Cured

Det. No	1	2	3	4	5	6
Weight	102.5	105.0	105.2	103.1	100.5	
Moisture Content	14.6	16.1	17.5	19.0	19.8	

60 Day Cured

Det. No	1	2	3	4	5	6
Weight	98.8	101.0	101.7	101.1	98.3	
Moisture Content	15.2	16.5	18.2	19.2	20.8	

REPUBLIC COUNTY LOESS

Raw Loess

Det. No	1	2	3	4	5
Weight	103.5	104.0	103.9	103.2	101.0
Moisture Content	11.4	12.8	14.3	15.3	17.6

24 Hour Cured

Det. No	1	2	3	4	5
Weight	100.5	102.0	103.0	103.5	102.5
Moisture Content	12.3	14.0	15.3	17.4	18.8

60 Day Cured

Det. No	1	2	3	4	5
Weight	98.0	100.8	101.2	99.4	97.3
Moisture Content	10.4	13.2	14.9	17.5	19.4

WYANDOTTE COUNTY LOESS

Raw Loess

Det. No	1	2	3	4	5	6
Weight	102.2	105.4	109.5	109.5	104.3	99.4
Moisture Content	7.5	10.2	13.7	16.2	18.7	22.4

24 Hour Cured

Det. No	1	2	3	4	5	6
Weight	104.0	107.3	108.1	108.0	107.0	104.5
Moisture Content	11.8	13.1	14.1	15.0	16.0	16.8

60 Day Cured

Det. No	1	2	3	4	5	6
Weight	103.3	105.3	107.5	105.9	104.2	102.2
Moisture Content	12.0	12.9	14.1	15.5	16.1	17.0

Modified Gradation

The Modified Gradation Test is designed to show the increase in aggregate dimensions accomplished by treatment with asphalt. It is a simplified gradation test patterned after similar ASTM Standard Tests.

A 100 gm. sample of loose treated soil will be crushed to basic aggregates by use of a ceramic mortar and a rubber tipped pestel. The sample will be hand sieved on the U. S. Standard #40 and #100 sieves until all material that will has passed the #40 sieve. The percentage retained on the #40 and #100 sieves will be recorded. Modified Gradation Report Forms are used to report the data. The data collected are reported on the following three pages.

Modified Gradation

Sample: Rawlins County 24 hr. cured Date: 23/2/1971

Wt. of sample 100 gms.

Sieve No.	Wt. Retained	Cumulative % Retained
40	21.2	21.2
100	44.9	66.1
Pam	33.9	100.0

Sample: Rawlins County 60-day cured Date 23/4/1971

Wt. of sample 100 gms.

Sieve No.	Wt. Retained	Cumulative % Retained
40	18.1	18.1
100	15.2	33.3
Pam	66.7	100.0

Modified Gradation

Sample: Republic County 24 hr. cured   Date:

Wt. of Sample 100 gms.

Sieve No.	Wt. Retained	Cumulative % Retained
40	30.5	30.5
100	33.7	64.2
Pam	35.8	100.0

Sample: Republic County 60 day cured   Date: 24/4/1971

Wt. of Sample 100 gms.

Sieve No.	Wt. Retained	Cumulative % Retained
40	39.95	39.95
100	14.90	54.85
Pam	45.15	100.00

Modified Gradation

Sample: Wyandotte County 24 hr. cured Date:

Wt. of Sample: 100.0 gms.

Sieve No.	Wt. Retained	Cumulative % Retained
40	62.3	62.3
100	8.6	70.9
Pam	29.1	100.0

Sample: Wyandotte County 60 day cured Date:

Wt. of sample: 100.0 gms

Sieve No.	Wt. Retained	Cumulative % Retained
40	36.1	36.1
100	10.2	46.3
Pam	53.7	100.0

APPENDIX B

PERMEAMETER AND TRIAXIAL OPERATIONAL DATA

PERMEABILITY TEST

SOIL SAMPLE 205 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .500 Cm. AREA .19634 Cm^2

HO = 190.00 Cm. H1 = 180.00 DATE: 1-5-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	26.00	11 20.60	11 22.60	8.75
2	2.54	26.00	1118.70	11 18.70	8.75
3	2.54	26.00	11 18.00	11 20.70	8.75

AVERAGE PERMEABILITY AT 20^{0}C .00000023605436737 23997169

****

SOIL SAMPLE 225 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .600 Cm. AREA .28274 Cm^2

HO = 191.00 Cm. H1 = 180.00 DATE: 2-24-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	21.80	5010.00	5010.00	9.65

AVERAGE PERMEABILITY AT 20^{0}C .0000000961245232073985581

****

SOIL SAMPLE 265 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .600 Cm. AREA .28274 Cm^2

HO = 190.00 Cm. H1 = 180.00 DATE: 4-24-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	22.50	1245.00	1170.00	9.45
2	2.54	22.50	1245.00	1187.20	9.45

AVERAGE PERMEABILITY AT 20°C .0000003392696844172316085

****

SOIL SAMPLE 305 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .500 Cm. AREA .19634 Cm^2

HO = 190.00 Cm. H1 = 180.00 DATE: 1-5-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	26.30	14.90	15.00	8.69
2	2.54	26.30	15.00	15.00	8.69
3	2.54	26.30	14.80	15.10	8.69

AVERAGE PERMEABILITY AT 20°C .0000175417129512873827355

****

SOIL SAMPLE 325 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .600 Cm. AREA .28274 Cm^2

HO = 190.00 Cm. H1 = 180.00 Cm. DATE: 2-6-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	21.80	47.70	49.80	9.65
2	2.54	21.80	49.30	50.80	9.65
3	2.54	21.80	48.80	49.70	9.65

AVERAGE PERMEABILITY AT 20°C .0000085080465263017404685

****

SOIL SAMPLE 365 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .600 Cm. AREA .28274 Cm^2

HO = 190.00 Cm. H1 = 180.00 Cm. DATE: 4-25-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	22.50	220.60	220.60	9.45
2	2.54	22.50	222.40	222.40	9.45

AVERAGE PERMEABILITY AT 20°C .0000018561111263435860550

****

SOIL SAMPLE 505 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .500 Cm. AREA .19634 Cm^2

HO = 190.00 Cm. H1 = 180.00 Cm. DATE: 1-5-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME Ti	T2	UT
1	2.54	23.60	303.00	303.40	9.25
2	2.54	23.60	302.00	303.80	9.25
3	2.54	23.60	301.50	301.60	9.25

AVERAGE PERMEABILITY AT 20°C .0000009236836502418360989

****

SOIL SAMPLE 525 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .600 Cm. AREA .28274 Cm^2

HO = 190.00 Cm. H1 = 180.00 Cm. DATE: 2-27-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	26.00	125.00	175.00	7.06
2	2.54	26.00	141.00	143.00	7.06
3	2.54	26.00	147.00	143.00	7.06
4	2.54	26.00	155.00	155.00	7.06

AVERAGE PERMEABILITY AT 20°C .0000020776119700273412176

****

SOIL SAMPLE 565 TESTED BY: JDC

PERMEAMETER DIAMETER 7.500 Cm. AREA 44.17864 Cm^2

STANDPIPE DIAMETER .600 Cm. AREA .28274 Cm^2

HO = 190.00 Cm. H1 = 180.00 DATE: 4-26-71

DET. NUM	SAMPLE LENGTH	TEMP DEG C	TIME T1	T2	UT
1	2.54	23.20	2231.00	2231.00	9.34

AVERAGE PERMEABILITY AT 20°C .0000001967570588283433207

****

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 206 LOADING CELL CALIBRATION FACTOR .19170 Lbs./ Div. DATE 2-15-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 25- 0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI.	S1/S3	TCR PSI
5.00	320.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	345.00	.010	.200	4.91	4.79	.97	5.97	1.19	.48
5.00	438.00	.020	.400	4.92	22.62	4.58	9.58	1.91	2.17
5.00	477.00	.030	.600	4.93	30.09	6.09	11.09	2.21	2.82
5.00	520.00	.040	.800	4.94	38.34	7.74	12.74	2.54	3.48
5.00	562.00	.050	1.000	4.95	46.39	9.35	14.35	2.87	4.09
5.00	600.00	.060	1.200	4.96	53.67	10.80	15.80	3.16	4.61
5.00	633.00	.070	1.400	4.97	60.00	12.05	17.05	3.41	5.04
5.00	648.00	.080	1.600	4.98	62.87	12.60	17.60	3.52	5.23
5.00	685.00	.090	1.800	4.99	69.97	13.99	18.99	3.79	5.68
5.00	695.00	.100	2.000	5.00	71.88	14.35	19.35	3.87	5.79
5.00	718.00	.110	2.200	5.01	76.29	15.20	20.20	4.04	6.06
5.00	738.00	.120	2.400	5.02	80.13	15.93	20.93	4.18	6.28
5.00	747.00	.130	2.600	5.03	81.85	16.24	21.24	4.24	6.37
5.00	762.00	.140	2.800	5.05	84.73	16.77	21.77	4.35	6.53
5.00	770.00	.150	3.000	5.06	86.26	17.04	22.04	4.40	6.61
5.00	778.00	.160	3.200	5.07	87.79	17.31	22.31	4.46	6.69
5.00	784.00	.170	3.400	5.08	88.94	17.50	22.50	4.50	6.75
5.00	788.00	.180	3.600	5.09	89.71	17.61	22.61	4.52	6.78
5.00	792.00	.190	3.800	5.10	90.48	17.73	22.73	4.54	6.81
5.00	795.00	.200	4.000	5.11	91.05	17.80	22.80	4.56	6.83
5.00	798.00	.210	4.200	5.12	91.63	17.88	22.88	4.57	6.86
5.00	800.00	.220	4.400	5.13	92.01	17.92	22.92	4.58	6.87

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA AQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	803.00	.230	4.600	5.14	92.59	17.99	22.99	4.59	6.89
5.00	805.00	.240	4.800	5.15	92.97	18.03	23.03	4.60	6.90
5.00	809.00	.250	5.000	5.16	93.74	18.14	23.14	4.62	6.93
5.00	811.00	.260	5.200	5.17	94.12	18.17	23.17	4.63	6.94
5.00	822.00	.280	5.600	5.19	96.23	18.50	23.50	4.70	7.03
5.00	828.00	.300	6.000	5.22	97.38	18.64	23.64	4.72	7.07
5.00	832.00	.320	6.400	5.24	98.15	18.71	23.71	4.74	7.09
5.00	836.00	.340	6.800	5.26	98.91	18.78	23.78	4.75	7.11
5.00	840.00	.380	7.600	5.31	99.68	18.76	23.76	4.75	7.11
5.00	850.00	.400	8.000	5.33	101.60	19.04	24.04	4.80	7.18
5.00	850.00	.420	8.400	5.35	101.60	18.95	23.95	4.79	7.16
5.00	850.00	.440	8.800	5.38	101.60	18.87	23.87	4.77	7.14
5.00	850.00	.460	9.200	5.40	101.60	18.79	23.79	4.75	7.11
5.00	850.00	.480	9.600	5.43	101.60	18.71	23.71	4.74	7.09
5.00	850.00	.500	10.000	5.45	101.60	18.62	23.62	4.72	7.07

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 206 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-15-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 67-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	320.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	445.00	.010	.200	4.91	23.96	4.87	14.87	1.48	2.38
10.00	505.00	.020	.400	4.92	35.46	7.19	17.19	1.71	3.46
10.00	555.00	.030	.600	4.93	45.04	9.12	19.12	1.91	4.33
10.00	608.00	.040	.800	4.94	55.20	11.15	21.15	2.11	5.20
10.00	651.00	.050	1.000	4.95	63.45	12.79	22.79	2.27	5.89
10.00	680.00	.060	1.200	4.96	69.01	13.89	23.89	2.38	6.33
10.00	701.00	.070	1.400	4.97	73.03	14.67	24.67	2.46	6.64
10.00	721.00	.080	1.600	4.98	76.87	15.40	25.40	2.54	6.93
10.00	742.00	.090	1.800	4.99	80.89	16.18	26.18	2.61	7.23
10.00	753.00	.100	2.000	5.00	83.00	16.57	26.57	2.65	7.38
10.00	770.00	.110	2.200	5.01	86.26	17.18	27.18	2.71	7.62
10.00	785.00	.120	2.400	5.02	89.14	17.72	27.72	2.77	7.82
10.00	798.00	.130	2.600	5.03	91.63	18.18	28.18	2.81	7.99
10.00	810.00	.140	2.800	5.05	93.93	18.60	28.60	2.86	8.14
10.00	821.00	.150	3.000	5.06	96.04	18.97	28.97	2.89	8.28
10.00	832.00	.160	3.200	5.07	98.15	19.35	29.35	2.93	8.42
10.00	840.00	.170	3.400	5.08	99.68	19.61	29.61	2.96	8.52
10.00	851.00	.180	3.600	5.09	101.79	19.99	29.99	2.99	8.65
10.00	852.00	.190	3.800	5.10	101.98	19.98	29.98	2.99	8.65
10.00	862.00	.200	4.000	5.11	103.90	20.31	30.31	3.03	8.77
10.00	871.00	.210	4.200	5.12	105.62	20.61	30.61	3.06	8.88
10.00	882.00	.220	4.400	5.13	107.73	20.98	30.98	3.09	9.01

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	896.00	.230	4.600	5.14	110.41	21.45	31.45	3.14	9.18
10.00	906.00	.250	5.000	5.16	112.33	21.74	31.74	3.17	9.27
10.00	920.00	.260	5.200	5.17	115.02	22.21	32.21	3.22	9.44
10.00	938.00	.280	5.600	5.19	118.47	22.78	32.78	3.27	9.64
10.00	952.00	.300	6.000	5.22	121.15	23.20	33.20	3.32	9.78
10.00	965.00	.320	6.400	5.24	123.64	23.57	33.57	3.35	9.91
10.00	979.00	.340	6.800	5.26	126.33	23.98	33.98	3.39	10.05
10.00	993.00	.360	7.200	5.28	129.01	24.39	34.39	3.43	10.18
10.00	1002.00	.380	7.600	5.31	130.73	24.60	34.60	3.46	10.26
10.00	1014.00	.400	8.000	5.33	133.03	24.93	34.93	3.49	10.37
10.00	1027.00	.420	8.400	5.35	135.53	25.29	35.29	3.52	10.49
10.00	1040.00	.440	8.800	5.38	138.02	25.64	35.64	3.56	10.60
10.00	1050.00	.460	9.200	5.40	139.94	25.88	35.88	3.58	10.68
10.00	1060.00	.480	9.600	5.43	141.85	26.12	36.12	3.61	10.76
10.00	1069.00	.500	10.000	5.45	143.58	26.32	36.32	3.63	10.83
10.00	1078.00	.520	10.400	5.47	145.30	26.52	36.52	3.65	10.89
10.00	1088.00	.540	10.800	5.50	147.22	26.75	36.75	3.67	10.97
10.00	1098.00	.560	11.200	5.52	149.14	26.98	36.98	3.69	11.04
10.00	1107.00	.580	11.600	5.55	150.86	27.16	37.16	3.71	11.10
10.00	1115.00	.600	12.000	5.57	152.40	27.32	37.32	3.73	11.15
10.00	1138.00	.650	13.000	5.64	156.81	27.79	37.79	3.77	11.30
10.00	1156.00	.700	14.000	5.70	160.26	28.07	38.07	3.80	11.39
10.00	1176.00	.750	15.000	5.77	164.09	28.41	38.41	3.84	11.50
10.00	1195.00	.800	16.000	5.84	167.73	28.70	38.70	3.87	11.59
10.00	1213.00	.850	17.000	5.91	171.18	28.94	38.94	3.89	11.67
10.00	1231.00	.900	18.000	5.98	174.63	29.17	39.17	3.91	11.74
10.00	1246.00	.950	19.000	6.06	177.51	29.29	39.29	3.92	11.77
10.00	1262.00	1.000	20.000	6.13	180.58	29.43	39.43	3.94	11.82
10.00	1280.00	1.050	21.000	6.21	184.03	29.61	39.61	3.96	11.88

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1291.00	1.100	22.000	6.29	186.14	29.57	39.57	3.95	11.86
10.00	1302.00	1.150	23.000	6.37	188.24	29.52	39.52	3.95	11.85
10.00	1313.00	1.200	24.000	6.45	190.35	29.47	39.47	3.94	11.83
10.00	1324.00	1.250	25.000	6.54	192.46	29.40	39.40	3.94	11.81
10.00	1334.00	1.300	26.000	6.63	194.38	29.30	39.30	3.93	11.78
10.00	1344.00	1.350	27.000	6.72	196.30	29.19	39.19	3.91	11.74

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 206 LOADING CELL CALIBRATION FACTOR .19170 Lbs/Div. DATE 2-15-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 80 - 0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	320.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	600.00	.010	.200	4.91	53.67	10.91	30.91	1.54	5.32
20.00	748.00	.020	.400	4.92	82.04	16.64	36.64	1.83	7.95
20.00	848.00	.030	.600	4.93	101.21	20.49	40.49	2.02	9.64
20.00	860.00	.040	.800	4.94	103.51	20.91	40.91	2.04	9.82
20.00	990.00	.060	1.200	4.96	128.43	25.85	45.85	2.29	11.88
20.00	1060.00	.070	1.400	4.97	141.85	28.49	48.49	2.42	12.95
20.00	1112.00	.080	1.600	4.98	151.82	30.43	50.43	2.52	13.72
20.00	1142.00	.090	1.800	4.99	157.57	31.52	51.52	2.57	14.14
20.00	1172.00	.100	2.000	5.00	163.32	32.60	52.60	2.63	14.56
20.00	1201.00	.110	2.200	5.01	168.88	33.64	53.64	2.68	14.96
20.00	1224.00	.120	2.400	5.02	173.29	34.45	54.45	2.72	15.27

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1250.00	.130	2.600	5.03	178.28	35.37	55.37	2.76	15.61
20.00	1270.00	.140	2.800	5.05	182.11	36.06	56.06	2.80	15.87
20.00	1288.00	.150	3.000	5.06	185.56	36.66	56.66	2.83	16.10
20.00	1306.00	.160	3.200	5.07	189.01	37.27	57.27	2.86	16.32
20.00	1324.00	.170	3.400	5.08	192.46	37.87	57.87	2.89	16.54
20.00	1342.00	.180	3.600	5.09	195.91	38.47	58.47	2.92	16.76
20.00	1361.00	.190	3.800	5.10	199.55	39.10	59.10	2.95	16.99
20.00	1380.00	.200	4.000	5.11	203.20	39.74	59.74	2.98	17.22
20.00	1398.00	.210	4.200	5.12	206.65	40.33	60.33	3.01	17.43
20.00	1417.00	.220	4.400	5.13	210.29	40.95	60.95	3.04	17.66
20.00	1432.00	.230	4.600	5.14	213.17	41.42	61.42	3.07	17.83
20.00	1445.00	.240	4.800	5.15	215.66	41.82	61.82	3.09	17.97
20.00	1458.00	.250	5.000	5.16	218.15	42.21	62.21	3.11	18.11
20.00	1471.00	.260	5.200	5.17	220.64	42.61	62.61	3.13	18.25
20.00	1500.00	.280	5.600	5.19	226.20	43.50	63.50	3.17	18.56
20.00	1526.00	.300	6.000	5.22	231.19	44.27	64.27	3.21	18.83
20.00	1553.00	.320	6.400	5.24	236.36	45.07	65.07	3.25	19.11
20.00	1575.00	.340	6.800	5.26	240.58	45.67	65.67	3.28	19.32
20.00	1598.00	.360	7.200	5.28	244.99	46.31	66.31	3.31	19.54
20.00	1618.00	.380	7.600	5.31	248.82	46.83	66.83	3.34	19.72
20.00	1638.00	.400	8.000	5.33	252.66	47.35	67.35	3.36	19.89
20.00	1660.00	.420	8.400	5.35	256.87	47.93	67.93	3.39	20.09
20.00	1675.00	.440	8.800	5.38	259.75	48.25	68.25	3.41	20.20
20.00	1696.00	.460	9.200	5.40	263.77	48.79	68.79	3.43	20.38
20.00	1712.00	.480	9.600	5.43	266.84	49.14	69.14	3.45	20.50
20.00	1730.00	.500	10.000	5.45	270.29	49.55	69.55	3.47	20.63
20.00	1770.00	.550	11.000	5.51	277.96	50.39	70.39	3.51	20.91
20.00	1808.00	.600	12.000	5.57	285.24	51.13	71.13	3.55	21.16
20.00	1832.00	.650	13.000	5.64	289.85	51.37	71.37	3.56	21.24

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1856.00	.700	14.000	5.70	294.45	51.58	71.58	3.57	21.31
20.00	1888.00	.750	15.000	5.77	300.58	52.04	72.04	3.60	21.46
20.00	1922.00	.800	16.000	5.84	307.10	52.55	72.55	3.62	21.62
20.00	1952.00	.850	17.000	5.91	312.85	52.89	72.89	3.64	21.74
20.00	1984.00	.900	18.000	5.98	318.98	53.28	73.28	3.66	21.86
20.00	2010.00	.950	19.000	6.06	323.97	53.45	73.45	3.67	21.92
20.00	2032.00	1.000	20.000	6.13	328.19	53.48	73.48	3.67	21.93
20.00	2058.00	1.050	21.000	6.21	333.17	53.62	73.62	3.68	21.97
20.00	2080.00	1.100	22.000	6.29	337.39	53.61	73.61	3.68	21.97
20.00	2104.00	1.150	23.000	6.37	341.99	53.64	73.64	3.68	21.98
20.00	2122.00	1.200	24.000	6.45	345.44	53.48	73.48	3.67	21.93
20.00	2140.00	1.250	25.000	6.54	348.89	53.30	73.30	3.66	21.87
20.00	2152.00	1.300	26.000	6.63	351.19	52.94	72.94	3.64	21.75
20.00	2163.00	1.350	27.000	6.72	353.30	52.54	72.54	3.62	21.62
20.00	2176.00	1.400	28.000	6.81	355.79	52.18	72.18	3.60	21.50
20.00	2192.00	1.450	29.000	6.91	358.86	51.90	71.90	3.59	21.41
20.00	2198.00	1.500	30.000	7.01	360.01	51.33	71.33	3.56	21.23
20.00	2210.00	1.550	31.000	7.11	362.31	50.92	70.92	3.54	21.09
20.00	2212.00	1.575	31.500	7.16	362.69	50.61	70.61	3.53	20.99
20.00	2216.00	1.600	32.000	7.21	363.46	50.34	70.34	3.51	20.90

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 306 LOADING CELL CALIBRATION FACTOR .19170 Lbs./ Div. DATE 2-4-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 8 - 0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	320.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	393.00	.010	.200	4.91	13.99	2.84	7.84	1.56	1.38
5.00	451.00	.020	.400	4.92	25.11	5.09	10.09	2.01	2.39
5.00	510.00	.030	.600	4.93	36.42	7.37	12.37	2.47	3.33
5.00	559.00	.040	.800	4.94	45.81	9.25	14.25	2.85	4.05
5.00	594.00	.050	1.000	4.95	52.52	10.59	15.59	3.11	4.54
5.00	612.00	.060	1.200	4.96	55.97	11.26	16.26	3.25	4.77
5.00	630.00	.070	1.400	4.97	59.42	11.93	16.93	3.38	5.00
5.00	637.00	.080	1.600	4.98	60.76	12.18	17.18	3.43	5.09
5.00	643.00	.090	1.800	4.99	61.91	12.38	17.38	3.47	5.15
5.00	648.00	.100	2.000	5.00	62.87	12.55	17.55	3.51	5.21
5.00	653.00	.110	2.200	5.01	63.83	12.71	17.71	3.54	5.26
5.00	653.00	.125	2.500	5.03	63.83	12.67	17.67	3.53	5.25
5.00	653.00	.130	2.600	5.03	63.83	12.66	17.66	3.53	5.25
5.00	653.00	.140	2.800	5.05	63.83	12.64	17.64	3.52	5.24
5.00	648.00	.160	3.200	5.07	62.87	12.39	17.39	3.47	5.16

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 306 LOADING CELL CALIBRATION FACTOR .19120 Lbs./Div. DATE 3-21-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 65 - 0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	325.00	.000	0.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	404.00	.020	.400	4.92	15.10	3.06	13.06	1.30	1.51
10.00	470.00	.040	.800	4.94	27.72	5.60	15.60	1.56	2.73
10.00	538.00	.060	1.200	4.96	40.72	8.19	18.19	1.81	3.92
10.00	695.00	.080	1.600	4.98	70.74	14.18	24.18	2.41	6.45
10.00	780.00	.100	2.000	5.00	86.99	17.36	27.36	2.73	7.68
10.00	820.00	.120	2.400	5.02	94.64	18.81	28.81	2.88	8.22
10.00	848.00	.140	2.800	5.05	99.99	19.80	29.80	2.98	8.58
10.00	925.00	.180	3.600	5.09	114.72	22.52	32.52	3.25	9.55
10.00	963.00	.200	4.000	5.11	121.98	23.85	33.85	3.38	10.00
10.00	988.00	.220	4.400	5.13	126.76	24.68	34.68	3.46	10.28
10.00	1009.00	.240	4.800	5.15	130.78	25.36	35.36	3.53	10.51
10.00	1021.00	.260	5.200	5.17	133.07	25.70	35.70	3.57	10.62
10.00	1040.00	.280	5.600	5.19	136.70	26.29	36.29	3.62	10.81
10.00	1055.00	.300	6.000	5.22	139.57	26.72	36.72	3.67	10.96
10.00	1073.00	.325	6.500	5.24	143.01	27.24	37.24	3.72	11.12
10.00	1092.00	.350	7.000	5.27	146.65	27.78	37.78	3.77	11.30
10.00	1110.00	.375	7.500	5.30	150.09	28.28	38.28	3.82	11.46
10.00	1125.00	.400	8.000	5.33	152.96	28.66	38.66	3.86	11.58
10.00	1140.00	.425	8.500	5.36	155.82	29.04	39.04	3.90	11.70
10.00	1152.00	.450	9.000	5.39	158.12	29.31	39.31	3.93	11.78
10.00	1168.00	.475	9.500	5.42	161.18	29.71	39.71	3.97	11.91
10.00	1180.00	.500	10.000	5.45	163.47	29.97	39.97	3.99	11.99

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN Cl/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1202.00	.550	11.000	5.51	167.68	30.40	40.40	4.04	12.12
10.00	1220.00	.600	12.000	5.57	171.12	30.67	40.67	4.06	12.20
10.00	1239.00	.650	13.000	5.64	174.75	30.97	40.97	4.09	12.29
10.00	1255.00	.700	14.000	5.70	177.81	31.15	41.15	4.11	12.35
10.00	1272.00	.750	15.000	5.77	181.06	31.35	41.35	4.13	12.41
10.00	1283.00	.800	16.000	5.84	183.16	31.34	41.34	4.12	12.38
10.00	1292.00	.850	17.000	5.91	184.89	31.26	41.26	4.12	12.38
10.00	1299.00	.900	18.000	5.98	186.22	31.10	41.10	4.11	12.34
10.00	1310.00	.950	19.000	6.06	188.33	31.07	41.07	4.10	12.33
10.00	1317.00	1.000	20.000	6.13	189.67	30.91	40.91	4.09	12.28
10.00	1326.00	1.050	21.000	6.21	191.39	30.80	40.80	4.08	12.24
10.00	1333.00	1.100	22.000	6.29	192.72	30.62	40.62	4.06	12.19
10.00	1338.00	1.150	23.000	6.37	193.68	30.38	40.38	4.03	12.11
10.00	1342.00	1.200	24.000	6.45	194.45	30.10	40.10	4.01	12.03
10.00	1345.00	1.150	23.000	6.37	195.02	30.59	40.59	4.05	12.18
10.00	1346.00	1.300	26.000	6.63	195.21	29.42	39.42	3.94	11.82

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 306   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div.   DATE 2-16-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00 In.   ELAPSED TIME 70 - 0   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	322.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	474.00	.010	.200	4.91	29.13	5.92	25.92	1.29	2.93
20.00	568.00	.020	.400	4.92	47.15	9.56	29.56	1.47	4.69
20.00	738.00	.030	.600	4.93	79.74	16.14	36.14	1.80	7.73
20.00	848.00	.040	.800	4.94	100.83	20.37	40.37	2.01	9.59
20.00	920.00	.050	1.000	4.95	114.63	23.12	43.12	2.15	10.75
20.00	1000.00	.060	1.200	4.96	129.97	26.16	46.16	2.30	12.01
20.00	1048.00	.070	1.400	4.97	139.17	27.95	47.95	2.39	12.74
20.00	1086.00	.080	1.600	4.98	146.45	29.35	49.35	2.46	13.29
20.00	1124.00	.090	1.800	4.99	153.74	30.75	50.75	2.53	13.84
20.00	1150.00	.100	2.000	5.00	158.72	31.68	51.68	2.58	14.21
20.00	1177.00	.110	2.200	5.01	163.90	32.65	52.65	2.63	14.58
20.00	1202.00	.120	2.400	5.02	168.69	33.54	53.54	2.67	14.92
20.00	1220.00	.130	2.600	5.03	172.14	34.15	54.15	2.70	15.15
20.00	1244.00	.140	2.800	5.05	176.74	34.99	54.99	2.74	15.47
20.00	1262.00	.150	3.000	5.06	180.19	35.60	55.60	2.78	15.70
20.00	1276.00	.160	3.200	5.07	182.88	36.06	56.06	2.80	15.87
20.00	1291.00	.170	3.400	5.08	185.75	36.55	56.55	2.82	16.05
20.00	1319.00	.180	3.600	5.09	191.12	37.53	57.53	2.87	16.42
20.00	1331.00	.190	3.800	5.10	193.42	37.90	57.90	2.89	16.55
20.00	1343.00	.200	4.000	5.11	195.72	38.27	58.27	2.91	16.69
20.00	1357.00	.210	4.200	5.12	198.40	38.72	58.72	2.93	16.85
20.00	1371.00	.220	4.400	5.13	201.09	39.16	59.16	2.95	17.01

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1385.00	.230	4.600	5.14	203.77	39.60	59.60	2.98	17.17
20.00	1405.00	.250	5.000	5.16	207.61	40.17	60.17	3.00	17.38
20.00	1418.00	.260	5.200	5.17	210.10	40.57	60.57	3.02	17.52
20.00	1437.00	.280	5.600	5.19	213.74	41.10	61.10	3.05	17.71
20.00	1453.00	.300	6.000	5.22	216.81	41.51	61.51	3.07	17.86
20.00	1471.00	.320	6.400	5.24	220.26	41.99	61.99	3.09	18.03
20.00	1488.00	.340	6.800	5.26	223.52	42.43	62.43	3.12	18.19
20.00	1504.00	.360	7.200	5.28	226.58	42.83	62.83	3.14	18.33
20.00	1519.00	.380	7.600	5.31	229.46	43.19	63.19	3.15	18.45
20.00	1533.00	.400	8.000	5.33	232.14	43.50	63.50	3.17	18.56
20.00	1550.00	.420	8.400	5.35	235.40	43.92	63.92	3.19	18.71
20.00	1562.00	.440	8.800	5.38	237.70	44.16	64.16	3.20	18.79
20.00	1575.00	.460	9.200	5.40	240.20	44.43	64.43	3.22	18.89
20.00	1590.00	.480	9.600	5.43	243.07	44.76	64.76	3.23	19.00
20.00	1602.00	.500	10.000	5.45	245.37	44.98	64.98	3.24	19.08
20.00	1628.00	.550	11.000	5.51	250.36	45.39	65.39	3.26	19.22
20.00	1656.00	.600	12.000	5.57	255.72	45.84	65.84	3.29	19.37
20.00	1677.00	.650	13.000	5.64	259.75	46.03	66.03	3.30	19.44
20.00	1703.00	.700	14.000	5.70	264.73	46.38	66.38	3.31	19.56
20.00	1722.00	.750	15.000	5.77	268.38	46.47	66.47	3.32	19.59
20.00	1742.00	.800	16.000	5.84	272.21	46.58	66.58	3.33	19.67
20.00	1763.00	.850	17.000	5.91	276.23	46.70	66.70	3.33	19.67
20.00	1785.00	.900	18.000	5.98	280.45	46.85	66.85	3.34	19.72
20.00	1800.00	.950	19.000	6.06	283.33	46.75	66.75	3.33	19.69
20.00	1815.00	1.000	20.000	6.13	286.20	46.64	66.64	3.33	19.65
20.00	1850.00	1.050	21.000	6.21	292.91	47.14	67.14	3.35	19.82
20.00	1862.00	1.100	22.000	6.29	295.21	46.91	66.91	3.34	19.74
20.00	1875.00	1.150	23.000	6.37	297.71	46.69	66.69	3.33	19.67
20.00	1874.00	1.200	24.000	6.45	297.51	46.06	66.06	3.30	19.45

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1877.00	1.250	25.000	6.54	289.09	45.54	65.54	3.27	19.27
20.00	1875.00	1.300	26.000	6.63	297.71	44.88	64.88	3.24	19.04
20.00	1873.00	1.350	27.000	6.72	297.32	44.21	64.21	3.21	18.81
20.00	1875.00	1.400	28.000	6.81	297.71	43.66	63.66	3.18	18.62

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 506 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-15-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 82 - 0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	320.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	348.00	.010	.200	4.91	5.36	1.09	6.09	1.21	.54
5.00	384.00	.020	.400	4.92	12.26	2.48	7.48	1.49	1.21
5.00	412.00	.030	.600	4.93	17.63	3.57	8.57	1.71	1.72
5.00	430.00	.040	.800	4.94	21.08	4.26	9.26	1.85	2.03
5.00	447.00	.050	1.000	4.95	24.34	4.91	9.91	1.98	2.31
5.00	461.00	.060	1.200	4.96	27.02	5.44	10.44	2.08	2.54
5.00	472.00	.070	1.400	4.97	29.13	5.85	10.85	2.17	2.71
5.00	486.00	.080	1.600	4.98	31.82	6.37	11.37	2.27	2.93
5.00	498.00	.090	1.800	4.99	34.12	6.82	11.82	2.36	3.11
5.00	508.00	.100	2.000	5.00	36.03	7.19	12.19	2.43	3.26
5.00	516.00	.110	2.200	5.01	37.57	7.48	12.48	2.49	3.38
5.00	524.00	.120	2.400	5.02	39.10	7.77	12.77	2.55	3.49
5.00	531.00	.130	2.600	5.03	40.44	8.02	13.02	2.60	3.59

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	538.00	.140	2.800	5.05	41.79	8.27	13.27	2.65	3.68
5.00	542.00	.150	3.000	5.06	42.55	8.40	13.40	2.68	3.74
5.00	548.00	.160	3.200	5.07	43.70	8.61	13.61	2.72	3.81
5.00	554.00	.170	3.400	5.08	44.85	8.82	13.82	2.76	3.89
5.00	560.00	.180	3.600	5.09	46.00	9.03	14.03	2.80	3.97
5.00	566.00	.190	3.800	5.10	47.15	9.24	14.24	2.84	4.05
5.00	572.00	.200	4.000	5.11	48.30	9.44	14.44	2.88	4.12
5.00	577.00	.210	4.200	5.12	49.26	9.61	14.61	2.92	4.19
5.00	582.00	.220	4.400	5.13	50.22	9.78	14.78	2.95	4.25
5.00	574.00	.230	4.600	5.14	48.69	9.46	14.46	2.89	4.13
5.00	574.00	.240	4.800	5.15	48.69	9.44	14.44	2.88	4.12
5.00	582.00	.250	5.000	5.16	50.22	9.72	14.72	2.94	4.22
5.00	584.00	.260	5.200	5.17	50.60	9.77	14.77	2.95	4.24
5.00	592.00	.280	5.600	5.19	52.14	10.02	15.02	3.00	4.34
5.00	600.00	.300	6.000	5.22	53.67	10.27	15.27	3.05	4.43
5.00	609.00	.320	6.400	5.24	55.40	10.56	15.56	3.11	4.53
5.00	614.00	.340	6.800	5.26	56.35	10.70	15.70	3.14	4.58
5.00	619.00	.360	7.200	5.28	57.31	10.83	15.83	3.16	4.62
5.00	623.00	.380	7.600	5.31	58.08	10.93	15.93	3.18	4.66
5.00	627.00	.400	8.000	5.33	58.85	11.03	16.03	3.20	4.69
5.00	631.00	.420	8.400	5.35	59.61	11.12	16.12	3.22	4.72
5.00	637.00	.440	8.800	5.38	60.76	11.29	16.29	3.25	4.78
5.00	643.00	.460	9.200	5.40	61.91	11.45	16.45	3.29	4.84
5.00	646.00	.480	9.600	5.43	62.49	11.50	16.50	3.30	4.86
5.00	659.00	.500	10.000	5.45	64.98	11.91	16.91	3.38	5.00
5.00	678.00	.550	11.000	5.51	68.62	12.44	17.44	3.48	5.17
5.00	689.00	.600	12.000	5.57	70.73	12.68	17.68	3.53	5.25
5.00	716.00	.650	13.000	5.64	75.91	13.45	18.45	3.69	5.51
5.00	731.00	.700	14.000	5.70	78.78	13.80	18.80	3.76	5.62

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCH PSI
5.00	744.00	.750	15.000	5.77	81.28	14.07	19.07	3.81	5.70
5.00	752.00	.800	16.000	5.84	82.81	14.17	19.17	3.83	5.74
5.00	765.00	.850	17.000	5.91	85.30	14.42	19.42	3.88	5.82
5.00	777.00	.900	18.000	5.98	87.60	14.63	19.63	3.92	5.88
5.00	783.00	.950	19.000	6.06	88.75	14.64	19.64	3.92	5.88
5.00	792.00	1.000	20.000	6.13	90.48	14.74	19.74	3.94	5.92
5.00	794.00	1.050	21.000	6.21	90.86	14.62	19.62	3.92	5.88
5.00	796.00	1.100	22.000	6.29	91.24	14.49	19.49	3.89	5.84
5.00	801.00	1.150	23.000	6.37	92.20	14.46	19.46	3.89	5.83
5.00	803.00	1.200	24.000	6.45	92.59	14.33	19.33	3.86	5.79
5.00	808.00	1.250	25.000	6.54	93.54	14.29	19.29	3.85	5.77
5.00	812.00	1.300	26.000	6.63	94.31	14.21	19.21	3.84	5.75
5.00	819.00	1.400	28.000	6.81	95.65	14.03	19.03	3.80	5.69
5.00	827.00	1.500	30.000	7.01	97.19	13.85	18.85	3.77	5.64
5.00	832.00	1.600	32.000	7.21	98.15	13.59	18.59	3.71	5.55
5.00	845.00	1.650	33.000	7.32	100.64	13.73	18.73	3.74	5.60

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 506 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 1-29-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 10-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCH PSI
10.00	320.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	415.00	.010	.200	4.91	18.21	3.70	13.70	1.37	1.82

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCH PSI
10.00	572.00	.020	.400	4.92	48.30	9.80	19.80	1.98	4.62
10.00	662.00	.030	.600	4.93	65.56	13.27	23.27	2.32	6.08
10.00	740.00	.043	.860	4.95	80.51	16.26	26.26	2.62	7.26
10.00	790.00	.050	1.000	4.95	90.09	18.17	28.17	2.81	7.99
10.00	832.00	.060	1.200	4.96	98.15	19.75	29.75	2.97	8.57
10.00	850.00	.070	1.400	4.97	101.60	20.40	30.40	3.04	8.80
10.00	905.00	.080	1.600	4.98	112.14	22.48	32.48	3.24	9.53
10.00	932.00	.100	2.000	5.00	117.32	23.42	33.42	3.34	9.86
10.00	960.00	.120	2.400	5.02	122.68	24.39	34.39	3.43	10.19
10.00	968.00	.130	2.600	5.03	124.22	24.64	34.64	3.46	10.27
10.00	995.00	.154	3.080	5.06	129.39	25.54	35.54	3.55	10.57
10.00	1002.00	.160	3.200	5.07	130.73	25.78	35.78	3.57	10.65
10.00	1012.00	.170	3.400	5.08	132.65	26.10	36.10	3.61	10.75
10.00	1018.00	.180	3.600	5.09	133.80	26.27	36.27	3.62	10.81
10.00	1028.00	.190	3.800	5.10	135.72	26.59	36.59	3.65	10.91
10.00	1032.00	.200	4.000	5.11	136.49	26.69	36.69	3.66	10.95
10.00	1045.00	.210	4.200	5.12	138.98	27.12	37.12	3.71	11.09
10.00	1050.00	.220	4.400	5.13	139.94	27.25	37.25	3.72	11.13
10.00	1055.00	.230	4.600	5.14	140.89	27.38	37.38	3.73	11.17
10.00	1065.00	.240	4.800	5.15	142.81	27.69	37.69	3.76	11.27
10.00	1075.00	.250	5.000	5.16	144.73	28.01	38.01	3.80	11.37
10.00	1082.00	.260	5.200	5.17	146.07	28.21	38.21	3.82	11.43
10.00	1090.00	.270	5.400	5.18	147.60	28.44	38.44	3.84	11.51
10.00	1091.00	.280	5.600	5.19	147.80	28.42	38.42	3.84	11.50
10.00	1101.00	.290	5.800	5.21	149.71	28.73	38.73	3.87	11.60
10.00	1109.00	.300	6.000	5.22	151.25	28.96	38.96	3.89	11.67
10.00	1112.00	.310	6.200	5.23	151.82	29.01	39.01	3.90	11.69
10.00	1115.00	.320	6.400	5.24	152.40	29.05	39.05	3,90	11.70
10.00	1122.00	.330	6.600	5.25	153.74	29.25	39.25	3.92	11.76
10.00	1127.00	.340	6.800	5.26	154.70	29.37	39.37	3.93	11.80

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1132.00	.350	7.000	5.27	155.66	29.49	39.49	3.94	11.84
10.00	1095.00	.370	7.400	5.30	148.56	28.02	38.02	3.80	11.37
10.00	1090.00	.390	7.800	5.32	147.60	27.72	37.72	3.77	11.28
10.00	1070.00	.410	8.200	5.34	143.77	26.88	36.88	3.68	11.01

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 506 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 3-21-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 75-0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	325.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	385.00	.020	.400	4.92	11.50	2.33	12.33	1.23	1.16
10.00	490.00	.040	.800	4.94	31.63	6.39	16.39	1.63	3.10
10.00	570.00	.060	1.200	4.96	46.96	9.45	19.45	1.94	4.47
10.00	632.00	.080	1.600	4.98	58.85	11.79	21.79	2.17	5.47
10.00	685.00	.100	2.000	5.00	69.01	13.77	23.77	2.37	6.28
10.00	705.00	.120	2.400	5.02	72.84	14.48	24.48	2.44	6.57
10.00	730.00	.140	2.800	5.05	77.63	15.37	25.37	2.53	6.92
10.00	750.00	.160	3.200	5.07	81.47	16.06	26.06	2.60	7.19
10.00	768.00	.180	3.600	5.09	84.92	16.67	26.67	2.66	7.42
10.00	785.00	.200	4.000	5.11	88.18	17.24	27.24	2.72	7.64
10.00	804.00	.220	4.400	5.13	91.82	17.88	27.88	2.78	7.88
10.00	832.00	.260	5.200	5.17	97.19	18.77	28.77	2.87	8.21
10.00	843.00	.280	5.600	5.19	99.30	19.09	29.09	2.90	8.33
10.00	858.00	.300	6.000	5.22	102.17	19.56	29.56	2.95	8.50

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	878.00	.325	6.500	5.24	106.01	20.19	30.19	3.01	8.72
10.00	898.00	.350	7.000	5.27	109.84	20.81	30.81	3.08	8.95
10.00	915.00	.375	7.500	5.30	113.10	21.31	31.31	3.13	9.12
10.00	940.00	.400	8.000	5.33	117.89	22.09	32.09	3.20	9.40
10.00	958.00	.425	8.500	5.36	121.34	22.61	32.61	3.26	9.58
10.00	970.00	.450	9.000	5.39	123.64	22.92	32.92	3.29	9.68
10.00	982.00	.475	9.500	5.42	125.94	23.22	33.22	3.32	9.79
10.00	1000.00	.500	10.000	5.45	129.39	23.72	33.72	3.37	9.96
10.00	1028.00	.550	11.000	5.51	134.76	24.43	34.43	3.44	10.20
10.00	1053.00	.600	12.000	5.57	139.55	25.01	35.01	3.50	10.39
10.00	1070.00	.650	13.000	5.64	142.81	25.31	35.31	3.53	10.49
10.00	1085.00	.700	14.000	5.70	145.69	25.52	35.52	3.55	10.56
10.00	1108.00	.750	15.000	5.77	150.10	25.99	35.99	3.59	10.72
10.00	1122.00	.800	16.000	5.84	152.78	26.14	36.14	3.61	10.77
10.00	1140.00	.850	17.000	5.91	156.23	26.41	36.41	3.64	10.86
10.00	1157.00	.900	18.000	5.98	159.49	26.64	36.64	3.66	10.93
10.00	1172.00	.950	19.000	6.06	162.36	26.79	36.79	3.67	10.98
10.00	1187.00	1.000	20.000	6.13	165.24	26.93	36.93	3.69	11.02
10.00	1193.00	1.050	21.000	6.21	166.39	26.77	36.77	3.67	10.97
10.00	1200.00	1.100	22.000	6.29	167.73	26.65	36.65	3.66	10.93
10.00	1206.00	1.150	23.000	6.37	168.88	26.49	36.49	3.64	10.88
10.00	1211.00	1.200	24.000	6.45	169.84	26.29	36.29	3.62	10.82
10.00	1215.00	1.250	25.000	6.54	170.61	26.06	36.06	3.60	10.74
10.00	1218.00	1.300	26.000	6.63	171.18	25.80	35.80	3.58	10.66
10.00	1223.00	1.350	27.000	6.72	172.14	25.60	35.60	3.56	10.59
10.00	1228.00	1.400	28.000	6.81	173.10	25.39	35.39	3.53	10.52
10.00	1235.00	1.450	29.000	6.91	174.44	25.23	35.23	3.52	10.47
10.00	1236.00	1.500	30.000	7.01	174.63	24.90	34.90	3.49	10.36

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 506 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-15-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 82-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	325.00	.010	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	425.00	.020	.200	4.91	19.17	3.89	23.89	1.19	1.94
20.00	475.00	.030	.400	4.92	28.75	5.83	25.83	1.29	2.89
20.00	520.00	.040	.600	4.93	37.38	7.56	27.56	1.37	3.73
20.00	570.00	.050	.800	4.94	46.96	9.49	29.49	1.47	4.65
20.00	612.00	.060	1.000	4.95	55.01	11.09	31.09	1.55	5.41
20.00	650.00	.070	1.200	4.96	62.30	12.53	32.53	1.62	6.08
20.00	686.00	.080	1.400	4.97	69.20	13.90	33.90	1.69	6.71
20.00	720.00	.090	1.600	4.98	75.72	15.17	35.17	1.75	7.29
20.00	748.00	.100	1.800	4.99	81.08	16.22	36.22	1.81	7.76
20.00	778.00	.110	2.000	5.00	86.84	17.33	37.33	1.86	8.26
20.00	802.00	.120	2.200	5.01	91.44	18.21	38.21	1.91	8.65
20.00	824.00	.130	2.400	5.02	95.65	19.01	39.01	1.95	9.00
20.00	842.00	.140	2.600	5.03	99.10	19.66	39.66	1.98	9.28
20.00	853.00	.150	2.800	5.05	101.21	20.04	40.04	2.00	9.44
20.00	904.00	.175	3.300	5.07	110.99	21.86	41.86	2.09	10.22
20.00	950.00	.190	3.600	5.09	119.81	23.52	43.52	2.17	10.92
20.00	965.00	.200	3.800	5.10	122.68	24.04	44.04	2.20	11.14
20.00	978.00	.210	4.000	5.11	125.18	24.48	44.48	2.22	11.32
20.00	993.00	.220	4.200	5.12	128.05	24.99	44.99	2.24	11.53
20.00	1004.00	.230	4.400	5.13	130.16	25.35	45.35	2.26	11.68
20.00	1016.00	.240	4.600	5.14	132.46	25.74	45.74	2.28	11.84
20.00	1032.00	.250	4.800	5.15	135.53	26.28	46.28	2.31	12.06
20.00	1044.00	.260	5.000	5.16	137.83	26.67	46.67	2.33	12.22

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1067.00	.280	5.400	5.18	142.24	27.41	47.41	2.37	12.52
20.00	1094.00	.300	5.800	5.21	147.41	28.28	48.28	2.41	12.87
20.00	1120.00	.320	6.200	5.23	152.40	29.12	49.12	2.45	13.20
20.00	1142.00	.340	6.600	5.25	156.61	29.80	49.80	2.49	13.47
20.00	1167.00	.360	7.000	5.27	161.41	30.58	50.58	2.52	13.78
20.00	1190.00	.380	7.400	5.30	165.82	31.28	51.28	2.56	14.05
20.00	1210.00	.400	7.800	5.32	169.65	31.86	51.86	2.59	14.28
20.00	1231.00	.420	8.200	5.34	173.68	32.48	52.48	2.62	14.51
20.00	1253.00	.440	8.600	5.37	177.89	33.12	53.12	2.65	14.76
20.00	1272.00	.460	9.000	5.39	181.53	33.65	53.65	2.68	14.96
20.00	1312.00	.500	9.800	5.44	189.20	34.76	54.76	2.73	15.39
20.00	1320.00	.510	10.000	5.45	190.74	34.97	54.97	2.74	15.46
20.00	1362.00	.560	11.000	5.51	198.79	36.04	56.04	2.80	15.86
20.00	1388.00	.610	12.000	5.57	203.77	36.53	56.53	2.82	16.05
20.00	1422.00	.660	13.000	5.64	210.29	37.27	57.27	2.86	16.32
20.00	1450.00	.710	14.000	5.40	215.66	37.78	57.78	2.88	16.51
20.00	1478.00	.760	15.000	5.77	221.03	38.27	58.27	2.91	16.69
20.00	1505.00	.810	16.000	5.84	226.20	38.70	58.70	2.93	16.85
20.00	1528.00	.860	17.000	5.91	230.61	38.99	58.99	2.94	16.95
20.00	1545.00	.910	18.000	5.98	233.87	39.06	59.06	2.95	16.98
20.00	1567.00	.960	19.000	6.06	238.09	39.28	59.28	2.96	17.06
20.00	1581.00	1.010	20.000	6.13	240.77	39.24	59.24	2.96	17.04
20.00	1596.00	1.060	21.000	6.21	243.65	39.21	59.21	2.96	17.03
20.00	1600.00	1.110	22.000	6.29	244.41	38.83	58.83	2.94	16.89
20.00	1609.00	1.160	23.000	6.37	246.14	38.61	58.61	2.93	16.81
20.00	1620.00	1.210	24.000	6.45	248.25	38.43	58.43	2.92	16.75
20.00	1626.00	1.260	25.000	6.54	249.40	38.10	58.10	2.90	16.63
20.00	1631.00	1.310	26.000	6.63	250.36	37.74	57.74	2.88	16.49
20.00	1660.00	1.360	27.000	6.72	255.91	38.05	58.05	2.90	16.61
20.00	1664.00	1.410	28.000	6.81	257.45	37.23	57.23	2.86	16.31

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1668.00	1.460	29.000	6.91	257.45	37.23	57.23	2.86	16.31
20.00	1674.00	1.510	30.000	7.01	258.60	36.87	56.87	2.84	16.17
20.00	1697.00	1.560	31.000	7.11	263.01	36.97	56.97	2.84	16.21
20.00	1708.00	1.660	33.000	7.32	267.03	36.44	56.44	2.82	16.01

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 226 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-23-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 67-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	320.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	422.00	.040	.800	4.94	19.55	3.95	8.95	1.79	1.89
5.00	468.00	.060	1.200	4.96	28.37	5.71	10.71	2.14	2.65
5.00	508.00	.080	1.600	4.98	36.03	7.22	12.22	2.44	3.27
5.00	540.00	.100	2.000	5.00	42.17	8.41	13.41	2.68	3.74
5.00	561.00	.120	2.400	5.02	46.19	9.18	14.18	2.83	4.03
5.00	583.00	.140	2.800	5.05	50.41	9.98	14.98	2.99	4.32
5.00	605.00	.160	3.200	5.07	54.63	10.77	15.77	3.15	4.60
5.00	624.00	.180	3.600	5.09	58.27	11.44	16.44	3.28	4.83
5.00	637.00	.200	4.000	5.11	60.76	11.88	16.88	3.37	4.98
5.00	651.00	.220	4.400	5.13	63.45	12.35	17.35	3.47	5.14
5.00	662.00	.240	4.800	5.15	65.56	12.71	17.71	3.54	5.26
5.00	677.00	.260	5.200	5.17	68.43	13.21	18.21	3.64	5.43
5.00	688.00	.280	5.600	5.19	70.54	13.56	18.56	3.71	5.54
5.00	699.00	.300	6.000	5.22	72.65	13.91	18.91	3.78	5.65
5.00	710.00	.320	6.400	5.24	74.76	14.25	19.25	3.85	5.76

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	723.00	.350	7.000	5.27	77.25	14.63	19.63	3.92	5.88
5.00	734.00	.375	7.500	5.30	79.36	14.95	19.95	3.99	5.98
5.00	745.00	.400	8.000	5.33	81.47	15.26	20.26	4.05	6.08
5.00	755.00	.425	8.500	5.36	83.38	15.54	20.54	4.10	6.16
5.00	765.00	.450	9.000	5.39	85.30	15.81	20.81	4.16	6.24
5.00	777.00	.475	9.500	5.42	87.60	16.15	21.15	4.23	6.35
5.00	788.00	.500	10.000	5.45	89.71	16.44	21.44	4.28	6.44
5.00	806.00	.550	11.000	5.51	93.16	16.89	21.89	4.37	6.57
5.00	817.00	.600	12.000	5.57	95.27	17.08	22.08	4.41	6.62
5.00	830.00	.650	13.000	5.64	97.76	17.32	22.32	4.46	6.69
5.00	845.00	.700	14.000	5.70	100.64	17.63	22.63	4.52	6.78
5.00	863.00	.750	15.000	5.77	104.09	18.02	23.02	4.60	6.90
5.00	881.00	.800	16.000	5.84	107.54	18.40	23.40	4.68	7.00
5.00	898.00	.850	17.000	5.91	110.80	18.73	23.73	4.74	7.10
5.00	915.00	.900	18.000	5.98	114.06	19.05	24.05	4.81	7.19
5.00	928.00	.950	19.000	6.06	116.55	19.23	24.23	4.84	7.24
5.00	940.00	1.000	20.000	6.13	118.85	19.37	24.37	4.87	7.28
5.00	949.00	1.050	21.000	6.21	120.57	19.40	24.40	4.88	7.29
5.00	957.00	1.100	22.000	6.29	122.11	19.40	24.40	4.88	7.28
5.00	962.00	1.150	23.000	6.37	123.07	19.30	24.30	4.86	7.26
5.00	965.00	1.200	24.000	6.45	123.64	19.14	24.14	4.82	7.21
5.00	969.00	1.300	26.000	6.63	124.41	18.75	23.75	4.75	7.10
5.00	972.00	1.350	27.000	6.72	124.98	18.58	23.58	4.71	7.06

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 226 LOADING CELL CALIBRATION FACTOR .19170 Lbs/Div. DATE 2-23-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 72-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	320.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	357.00	.020	.400	4.92	7.09	1.43	11.43	1.14	.71
10.00	394.00	.040	.800	4.94	14.18	2.86	12.86	1.28	1.42
10.00	445.00	.060	1.200	4.98	23.96	4.82	14.82	1.48	2.36
10.00	511.00	.080	1.600	4.98	36.61	7.33	17.33	1.73	3.53
10.00	563.00	.100	2.000	5.00	46.58	9.30	19.30	1.93	4.40
10.00	603.00	.120	2.400	5.02	54.25	10.78	20.78	2.07	5.05
10.00	630.00	.140	2.800	5.05	59.42	11.76	21.76	2.17	5.46
10.00	652.00	.160	3.200	5.07	63.64	12.55	22.55	2.25	5.79
10.00	673.00	.180	3.600	5.09	67.67	13.28	23.28	2.32	6.09
10.00	692.00	.200	4.000	5.11	71.31	13.94	23.94	2.39	6.35
10.00	708.00	.220	4.400	5.13	74.37	14.48	24.48	2.44	6.57
10.00	725.00	.240	4.800	5.15	77.63	15.05	25.05	2.50	6.79
10.00	741.00	.260	5.200	5.17	80.70	15.58	25.58	2.55	7.00
10.00	756.00	.280	5.600	5.19	83.58	16.07	26.07	2.60	7.19
10.00	772.00	.300	6.000	5.22	86.64	16.59	26.59	2.65	7.39
10.00	792.00	.320	6.400	5.24	90.48	17.25	27.25	2.72	7.64
10.00	808.00	.340	6.800	5.26	93.54	17.76	27.76	2.77	7.83
10.00	823.00	.360	7.200	5.28	96.42	18.22	28.22	2.82	8.01
10.00	834.00	.380	7.600	5.31	98.53	18.54	28.54	2.85	8.12
10.00	845.00	.400	8.000	5.33	100.64	18.86	28.86	2.88	8.24
10.00	850.00	.425	8.500	5.36	101.60	18.93	28.93	2.89	8.27
10.00	880.00	.475	9.500	5.42	107.35	19.79	29.79	2.97	8.58
10.00	915.00	.525	10.500	5.48	114.06	20.79	30.79	3.07	8.94

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	940.00	.550	11.000	5.51	118.85	21.54	31.54	3.15	9.21
10.00	960.00	.600	12.000	5.57	122.68	21.99	31.99	3.19	9.36
10.00	990.00	.650	13.000	5.64	128.43	22.76	32.76	3.27	9.63
10.00	1007.00	.700	14.000	5.70	131.69	23.07	33.07	3.30	9.74
10.00	1030.00	.750	15.000	5.77	136.10	23.56	33.56	3.35	9.91
10.00	1049.00	.800	16.000	5.84	139.74	23.91	33.91	3.39	10.02
10.00	1070.00	.850	17.000	5.91	143.77	24.31	34.31	3.43	10.16
10.00	1090.00	.900	18.000	5.98	147.60	24.65	34.65	3.46	10.27
10.00	1108.00	.950	19.000	6.06	151.05	24.92	34.92	3.49	10.36
10.00	1128.00	1.000	20.000	6.13	154.89	25.24	35.24	3.52	10.47
10.00	1144.00	1.050	21.000	6.21	157.96	25.42	35.42	3.54	10.53
10.00	1163.00	1.100	22.000	6.29	161.60	25.67	35.67	3.56	10.61
10.00	1182.00	1.150	23.000	6.37	165.24	25.92	35.92	3.59	10.69
10.00	1202.00	1.200	24.000	6.45	169.07	26.17	36.17	3.61	10.78
10.00	1223.00	1.250	25.000	6.54	173.10	26.44	36.44	3.64	10.87
10.00	1242.00	1.300	26.000	6.63	176.74	26.64	36.64	3.66	10.93
10.00	1262.00	1.350	27.000	6.72	180.58	26.85	36.85	3.68	11.00
10.00	1281.00	1.400	28.000	6.81	184.22	27.02	37.02	3.70	11.05
10.00	1302.00	1.450	29.000	6.91	188.24	27.22	37.22	3.72	11.12

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 226 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-23-71

INITIAL DIAMETER 2.50 In INITIAL LENGTH 5.00 In. ELAPSED TIME 75-0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	320.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	428.00	.020	.400	4.92	20.70	4.20	24.20	1.21	2.09
20.00	497.00	.040	.800	4.94	33.93	6.85	26.85	1.34	3.39
20.00	550.00	.060	1.200	4.96	44.09	8.87	28.87	1.44	4.36
20.00	591.00	.080	1.600	4.98	51.95	10.41	30.41	1.52	5.09
20.00	627.00	.100	2.000	5.00	58.85	11.74	31.74	1.58	5.72
20.00	660.00	.120	2.400	5.02	65.17	12.95	32.95	1.64	6.28
20.00	692.00	.140	2.800	5.05	71.31	14.12	34.12	1.70	6.81
20.00	723.00	.160	3.200	5.07	77.25	15.23	35.23	1.76	7.32
20.00	752.00	.180	3.600	5.09	82.81	16.26	36.26	1.81	7.78
20.00	780.00	.200	4.000	5.11	88.18	17.24	37.24	1.86	8.22
20.00	804.00	.220	4.400	5.13	92.78	18.06	38.06	1.90	8.58
20.00	829.00	.240	4.800	5.15	97.57	18.92	38.92	1.94	8.96
20.00	848.00	.260	5.200	5.17	101.21	19.54	39.54	1.97	9.23
20.00	882.00	.280	5.600	5.19	107.73	20.71	40.71	2.03	9.73
20.00	910.00	.300	6.000	5.22	113.10	21.65	41.65	2.08	10.13
20.00	960.00	.350	7.000	5.27	122.68	23.24	43.24	2.16	10.80
20.00	985.00	.375	7.500	5.30	127.48	24.02	44.02	2.20	11.13
20.00	1012.00	.400	8.000	5.33	132.65	24.86	44.86	2.24	11.48
20.00	1037.00	.425	8.500	5.36	137.44	25.62	45.62	2.28	11.79
20.00	1062.00	.450	9.000	5.39	142.24	26.36	46.36	2.31	12.09
20.00	1116.00	.500	10.000	5.45	152.59	27.97	47.97	2.39	12.74
20.00	1157.00	.550	11.000	5.51	160.45	29.09	49.09	2.45	13.19
20.00	1199.00	.600	12.000	5.57	168.50	30.20	50.20	2.51	13.63

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1234.00	.650	13.000	5.64	175.21	31.05	51.05	2.55	13.96
20.00	1272.00	.700	14.000	5.70	182.49	31.97	51.97	2.59	14.32
20.00	1308.00	.750	15.000	5.77	189.39	32.79	52.79	2.63	14.63
20.00	1417.00	.900	18.000	5.98	210.29	35.12	55.12	2.75	15.52
20.00	1451.00	.950	19.000	6.06	216.81	35.77	55.77	2.78	15.76
20.00	1487.00	1.000	20.000	6.13	223.71	36.45	56.45	2.82	16.02
20.00	1519.00	1.050	21.000	6.21	229.84	36.99	56.99	2.84	16.22
20.00	1557.00	1.100	22.000	6.29	237.13	37.68	57.68	2.88	16.47
20.00	1590.00	1.150	23.000	6.37	243.45	38.18	58.18	2.90	16.66
20.00	1622.00	1.200	24.000	6.45	249.59	38.64	58.64	2.93	16.82
20.00	1652.00	1.250	25.000	6.54	255.34	39.01	59.01	2.95	16.96
20.00	1679.00	1.300	26.000	6.63	260.52	39.27	59.27	2.96	17.05
20.00	1715.00	1.350	27.000	6.72	267.42	39.76	59.76	2.98	17.23
20.00	1739.00	1.400	28.000	6.81	272.02	39.89	59.89	2.99	17.28
20.00	1762.00	1.450	29.000	6.91	276.43	39.98	59.98	2.99	17.31
20.00	1788.00	1.500	30.000	7.01	281.41	40.13	60.13	3.00	17.36

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 326 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-24-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 32-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	322.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	420.00	.020	.400	4.92	18.78	3.81	8.81	1.76	1.83
5.00	508.00	.040	.800	4.94	35.65	7.20	12.20	2.44	3.27

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	565.00	.060	1.200	4.96	46.58	9.37	14.37	2.87	4.10
5.00	595.00	.080	1.600	4.98	52.33	10.49	15.49	3.09	4.50
5.00	607.00	.100	2.000	5.00	54.63	10.90	15.90	3.18	4.65
5.00	635.00	.120	2.400	5.02	60.00	11.93	16.93	3.38	5.00
5.00	662.00	.140	2.800	5.05	65.17	12.90	17.90	3.58	5.33
5.00	682.00	.160	3.200	5.07	69.01	13.60	18.60	3.72	5.56
5.00	700.00	.180	3.600	5.09	72.46	14.23	19.23	3.84	5.75
5.00	717.00	.200	4.000	5.11	75.72	14.80	19.80	3.96	5.94
5.00	732.00	.220	4.400	5.13	78.59	15.30	20.30	4.06	6.09
5.00	745.00	.240	4.800	5.15	81.08	15.72	20.72	4.14	6.22
5.00	760.00	.260	5.200	5.17	83.96	16.21	21.21	4.24	6.37
5.00	772.00	.280	5.600	5.19	86.26	16.58	21.58	4.31	6.48
5.00	783.00	.300	6.000	5.22	88.37	16.92	21.92	4.38	6.58
5.00	797.00	.325	6.500	5.24	91.05	17.34	22.34	4.46	6.70
5.00	808.00	.350	7.000	5.27	93.16	17,65	22.65	4.53	6.79
5.00	821.00	.375	7.500	5.30	95.65	18.02	23.02	4.60	6.90
5.00	831.00	.400	8.000	5.33	97.57	18.28	23.28	4.65	6.97
5.00	840.00	.425	8.500	5.36	99.30	18.50	23.50	4.70	7.03
5.00	845.00	.450	9.000	5.39	100.25	18.58	23.58	4.71	7.06
5.00	850.00	.475	9.500	5.42	101.21	18.66	23.66	4.73	7.08
5.00	855.00	.500	10.000	5.45	102.17	18.73	23.73	4.74	7.10
5.00	860.00	.550	11.000	5.51	103.13	18.69	23.69	4.73	7.09
5.00	860.00	.600	12.000	5.57	103.13	18.48	23.48	4.69	7.03
5.00	860.00	.650	13.000	5.64	103.13	18.27	23.27	4.65	6.97

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 326   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div.   DATE 2-24-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00   ELAPSED TIME 57-30   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	322.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	462.00	.020	.400	4.92	26.83	5.44	15.44	1.54	2.65
10.00	617.00	.040	.800	4.94	56.55	11.42	21.42	2.14	5.32
10.00	655.00	.060	1.200	4.96	63.83	12.84	22.84	2.28	5.91
10.00	719.00	.080	1.600	4.98	76.10	15.25	25.25	2.52	6.87
10.00	766.00	.100	2.000	5.00	85.11	16.99	26.99	2.69	7.54
10.00	806.00	.120	2.400	5.02	92.78	18.44	28.44	2.84	8.09
10.00	838.00	.140	2.800	5.05	98.91	19.58	29.58	2.95	8.51
10.00	859.00	.160	3.200	5.07	102.94	20.30	30.30	3.03	8.76
10.00	865.00	.180	3.600	5.09	104.09	20.44	30.44	3.04	8.81
10.00	952.00	.240	4.800	5.15	120.77	23.42	33.42	3.34	9.86
10.00	965.00	.260	5.200	5.17	123.26	23.80	33.80	3.38	9.99
10.00	980.00	.280	5.600	5.19	126.13	24.25	34.25	3.42	10.14
10.00	992.00	.300	6.000	5.22	128.43	24.59	34.59	3.45	10.25
10.00	1005.00	.320	6.400	5.24	130.93	24.96	34.96	3.49	10.38
10.00	1022.00	.340	6.800	5.26	134.19	25.47	35.47	3.54	10.55
10.00	1039.00	.360	7.200	5.28	137.44	25.98	35.98	3.59	10.71
10.00	1058.00	.380	7.600	5.31	141.09	26.55	36.55	3.65	10.90
10.00	1068.00	.400	8.000	5.33	143.00	26.80	36.80	3.68	10.98
10.00	1085.00	.425	8.500	5.36	146.26	27.26	37.26	3,72	11.13
10.00	1100.00	.450	9.000	5.39	149.14	27.64	37.64	3.76	11.25
10.00	1115.00	.475	9.500	5.42	152.01	28.02	38.02	3.80	11.37
10.00	1130.00	.500	10.000	5.45	154.89	28.39	38.39	3.83	11.49
10.00	1157.00	.550	11.000	5.51	160.06	29.02	39.02	3.90	11.69
10.00	1180.00	.600	12.000	5.57	164.47	29.48	39.48	3.94	11.84

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1197.00	.650	13.000	5.64	167.73	29.72	39.72	3.97	11.91
10.00	1213.00	.700	14.000	5.70	170.80	29.92	39.92	3.99	11.97
10.00	1228.00	.750	15.000	5.77	173.68	30.07	40.07	4.00	12.02
10.00	1235.00	.800	16.000	5.84	175.02	29.95	39.95	3.99	11.98
10.00	1240.00	.850	17.000	5.91	175.98	29.75	39.75	3.97	11.92
10.00	1245.00	.900	18.000	5.98	176.93	29.55	39.55	3.95	11.86
10.00	1248.00	.950	19.000	6.06	177.51	29.29	39.29	3.92	11.77
10.00	1253.00	1.000	20.000	6.13	178.47	29.08	39.08	3.90	11.71
10.00	1257.00	1.050	21.000	6.21	179.23	28.84	38.84	3.88	11.63
10.00	1260.00	1.100	22.000	6.29	179.81	28.57	38.57	3.85	11.55
10.00	1260.00	1.150	23.000	6.37	179.81	28.20	38.20	3.82	11.43

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 326   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div.   DATE 2-24-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00 In.   ELAPSED TIME 55-0   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	322.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	580.00	.020	.400	4.92	49.45	10.03	30.03	1.50	4.91
20.00	790.00	.040	.800	4.94	89.71	18.13	38.13	1.90	8.61
20.00	865.00	.060	1.200	4.96	104.09	20.95	40.95	2.04	9.83
20.00	1132.00	.100	2.000	5.00	155.27	31.00	51.00	2.55	13.94
20.00	1142.00	.120	2.400	5.02	157.19	31.25	51.25	2.56	14.04
20.00	1183.00	.140	2.800	5.05	165.05	32.68	52.68	2.63	14.59

THIS BOOK WAS BOUND WITHOUT PAGES 106-109.

THIS IS AS RECEIVED FROM CUSTOMER.

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1240.00	.160	3.200	5.07	175.98	34.70	54.70	2.73	15.36
20.00	1295.00	.180	3.600	5.09	186.52	36.63	56.63	2.83	16.08
20.00	1345.00	.200	4.000	5.11	196.10	38.35	58.35	2.91	16.72
20.00	1382.00	.220	4.400	5.13	203.20	39.57	59.57	2.97	17.16
20.00	1438.00	.260	5.200	5.17	213.93	41.31	61.31	3.06	17.79
20.00	1468.00	.260	5.200	5.17	219.68	42.42	62.42	3.12	18.18
20.00	1493.00	.280	5.600	5.19	224.48	43.16	63.16	3.15	18.44
20.00	1523.00	.300	6.000	5.22	230.23	44.08	64.08	3.20	18.77
20.00	1548.00	.320	6.400	5.24	235.02	44.81	64.81	3.24	19.02
20.00	1576.00	.340	6.800	5.26	240.39	45.64	65.64	3.28	19.31
20.00	1600.00	.360	7.200	5.28	244.99	46.31	66.31	3.31	19.54
20.00	1623.00	.380	7.600	5.31	249.40	46.94	66.94	3.34	19.75
20.00	1642.00	.400	8.000	5.33	253.04	47.42	67.42	3.37	19.92
20.00	1675.00	.425	8.500	5.36	259.37	48.34	68.34	3.41	20.23
20.00	1700.00	.450	9.000	5.39	264.16	48.97	68.97	3.44	20.44
20.00	1722.00	.475	9.500	5.42	266.38	49.47	69.47	3.47	20.61
20.00	1742.00	.500	10.000	5.45	272.21	49.90	69.90	3.49	20.75
20.00	1783.00	.550	11.000	5.51	280.07	50.77	70.77	3.53	21.04
20.00	1811.00	.600	12.000	5.57	285.44	51.17	71.17	3.55	21.17
20.00	1835.00	.650	13.000	5.64	290.04	51.40	71.40	3.57	21.25
20.00	1858.00	.700	14.000	5.70	294.45	51.58	71.58	3.57	21.31
20.00	1872.00	.750	15.000	5.77	297.13	51.45	71.45	3.57	21.26
20.00	1900.00	.850	17.000	5.91	302.50	51.14	71.14	3.55	21.16
20.00	1922.00	.900	18.000	5.98	304.22	50.82	70.82	3.54	21.05
20.00	1925.00	.950	19.000	6.06	306.72	50.61	70.61	3.53	20.99
20.00	1925.00	1.000	20.000	6.13	307.29	50.08	70.08	3.50	20.81
20.00	1920.00	1.100	22.000	6.29	306.33	48.67	68.67	3.43	20.34

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 526 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-26-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 70-0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	325.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	442.00	.020	.400	4.92	22.42	4.55	9.55	1.91	2.16
5.00	576.00	.040	.800	4.94	48.11	9.72	14.72	2.94	4.23
5.00	642.00	.060	1.200	4.96	60.76	12.23	17.23	3.44	5.10
5.00	696.00	.080	1.600	4.98	71.12	14.25	19.25	3.85	5.76
5.00	735.00	.100	2.000	5.00	78.59	15.69	20.69	4.13	6.21
5.00	770.00	.120	2.400	5.02	85.30	16.96	21.96	4.39	6.59
5.00	796.00	.140	2.800	5.05	90.29	17.87	22.87	4.57	6.85
5.00	819.00	.160	3.200	5.07	94.69	18.67	23.67	4.73	7.08
5.00	838.00	.180	3.600	5.09	98.34	19.31	24.31	4.86	7.26
5.00	852.00	.200	4.000	5.11	101.02	19.75	24.75	4.95	7.38
5.00	863.00	.220	4.400	5.13	103.13	20.08	25.08	5.01	7.47
5.00	875.00	.240	4.800	5.15	105.43	20.44	25.44	5.08	7.57
5.00	890.00	.260	5.200	5.17	108.31	20.91	25.91	5.18	7.70
5.00	904.00	.280	5.600	5.19	110.99	21.34	26.34	5.26	7.81
5.00	915.00	.300	6.000	5.22	113.10	21.65	26.65	5.33	7.89
5.00	928.00	.325	6.500	5.24	115.59	22.01	27.01	5.40	7.99
5.00	943.00	.350	7.000	5.27	118.47	22.44	27.44	5.48	8.10
5.00	961.00	.375	7.500	5.30	121.92	22.97	27.97	5.59	8.24
5.00	968.00	.400	8.000	5.33	123.26	23.10	28.10	5.62	8.27
5.00	973.00	.425	8.500	5.36	124.22	23.15	28.15	5.63	8.28
5.00	980.00	.450	9.000	5.39	125.56	23.27	28.27	5.65	8.31
5.00	987.00	.475	9.500	5.42	126.90	23.39	28.39	5.67	8.34
5.00	993.00	.500	10.000	5.45	128.05	23.47	28.47	5.69	8.36

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CI/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	1002.00	.550	11.000	5.51	129.78	23.53	28.53	5.70	8.38
5.00	1009.00	.600	12.000	5.57	131.12	23.50	28.50	5.70	8.37
5.00	1017.00	.650	13.000	5.64	132.65	23.51	28.51	5.70	8.37
5.00	1021.00	.700	14.000	5.70	133.42	23.37	28.37	5.67	8.34
5.00	1024.00	.750	15.000	5.77	133.99	23.20	28.20	5.64	8.29
5.00	1027.00	.800	16.000	5.84	134.57	23.02	28.02	5.60	8.25
5.00	1028.00	.850	17.000	5.91	134.76	22.78	27.78	5.55	8.19
5.00	1029.00	.900	18.000	5.98	134.95	22.54	27.54	5.50	8.12
5.00	1031.00	.950	19.000	6.06	135.34	22.33	27.33	5.46	8.07
5.00	1033.00	1.000	20.000	6.13	135.72	22.11	27.11	5.42	8.01
5.00	1035.00	1.050	21.000	6.21	136.10	21.90	26.90	5.38	7.96
5.00	1037.00	1.100	22.000	6.29	136.49	21.68	26.68	5.33	7.90
5.00	1039.00	1.150	23.000	6.37	136.87	21.47	26.47	5.29	7.84
5.00	1041.00	1.200	24.000	6.45	137.25	21.25	26.25	5.25	7.79
5.00	1043.00	1.250	25.000	6.54	137.64	21.02	26.02	5.20	7.73
5.00	1043.00	1.300	26.000	6.63	137.64	20.74	25.74	5.14	7.65
5.00	1044.00	1.350	27.000	6.72	137.83	20.49	25.49	5.09	7.58
5.00	1044.00	1.400	28.000	6.81	137.83	20.21	25.21	5.04	7.51

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 526 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 2-26-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 71-15 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	325.00	.000	.000	4.90	0.00	0.00	10.00	1.00	00.00
10.00	442.00	.020	.400	4.92	22.42	4.55	14.55	1.45	2.23
10.00	535.00	.040	.800	4.94	40.25	8.13	18.13	1.81	3.89
10.00	637.00	.060	1.200	4.96	59.81	12.03	22.03	2.20	5.57
10.00	710.00	.080	1.600	4.98	73.80	14.79	24.79	2.47	6.69
10.00	768.00	.100	2.000	5.00	84.92	16.95	26.95	2.69	7.53
10.00	812.00	.120	2.400	5.02	93.35	18.56	28.56	2.85	8.13
10.00	844.00	.140	2.800	5.05	99.49	19.70	29.70	2.97	8.55
10.00	861.00	.160	3.200	5.07	102.75	20.26	30.26	3.02	8.75
10.00	952.00	.200	4.000	5.11	120.19	23.50	33.50	3.35	9.89
10.00	969.00	.225	4.500	5.14	123.45	24.01	34.01	3.40	10.06
10.00	1006.00	.250	5.000	5.16	130.54	25.26	35.26	3.52	10.48
10.00	1038.00	.275	5.500	5.19	136.68	26.31	36.31	3.63	10.82
10.00	1064.00	.300	6.000	5.22	141.66	27.12	37.12	3.71	11.09
10.00	1089.00	.325	6.500	5.24	146.45	27.89	37.89	3.78	11.33
10.00	1114.00	.350	7.000	5.27	151.25	28.65	38.65	3.86	11.57
10.00	1134.00	.375	7.500	5.30	155.08	29.22	39.22	3.92	11.75
10.00	1157.00	.400	8.000	5.33	159.49	29.89	39.89	3.98	11.96
10.00	1176.00	.425	8.500	5.36	163.13	30.40	40.40	4.04	12.12
10.00	1193.00	.450	9.000	5.39	166.39	30.84	40.84	4.08	12.26
10.00	1215.00	.475	9.500	5.42	170.61	31.45	41.45	4.14	12.44
10.00	1233.00	.500	10.000	5.45	174.06	31.91	41.91	4.19	12.58
10.00	1268.00	.550	11.000	5.51	180.77	32.77	42.77	4.27	12.84

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1302.00	.600	12.000	5.57	187.29	33.57	43.57	4.35	13.08
10.00	1334.00	.650	13.000	5.64	193.42	34.28	44.28	4.42	13.28
10.00	1358.00	.700	14.000	5.70	198.02	34.69	44.69	4.46	13.41
10.00	1377.00	.750	15.000	5.77	201.66	34.92	44.92	4.49	13.47
10.00	1390.00	.800	16.000	5.84	204.16	34.93	44.93	4.49	13.48
10.00	1407.00	.850	17.000	5.91	207.41	35.07	45.07	4.50	13.52
10.00	1422.00	.900	18.000	5.98	210.29	35.12	45.12	4.51	13.53
10.00	1435.00	.950	19.000	6.06	212.78	35.11	45.11	4.51	13.53
10.00	1442.00	1.000	20.000	6.13	214.12	34.89	44.89	4.48	13.46
10.00	1449.00	1.050	21.000	6.21	215.47	34.67	44.67	4.46	13.40
10.00	1451.00	1.100	22.000	6.29	215.85	34.29	44.29	4.42	13.29
10.00	1452.00	1.150	23.000	6.37	216.04	33.88	43.88	4.38	13.17
10.00	1453.00	1.200	24.000	6.45	216.23	33.47	43.47	4.34	13.05
10.00	1453.00	1.250	25.000	6.54	216.23	33.03	43.03	4.30	12.92
10.00	1469.00	1.300	26.000	6.63	219.30	33.06	43.06	4.30	12.92
10.00	1475.00	1.350	27.000	6.72	220.45	32.78	42.78	4.27	12.84
10.00	1479.00	1.400	28.000	6.81	221.41	32.25	42.25	4.22	12.68

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 526   LOADING CELL CALIBRATION FACTOR .19120 Lbs./Div.   DATE 3-21-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00 In.   ELAPSED TIME 63-45   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	325.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	336.00	.020	.400	4.92	2.10	.42	20.42	1.02	.21
20.00	344.00	.040	.800	4.94	3.63	.73	20.73	1.03	.36
20.00	611.00	.060	1.200	4.96	54.68	11.00	31.00	1.55	5.37
20.00	748.00	.080	1.600	4.98	80.87	16.21	36.21	1.81	7.76
20.00	822.00	.100	2.000	5.00	95.02	18.97	38.97	1.94	8.98
20.00	862.00	.120	2.400	5.02	102.67	20.41	40.41	2.02	9.60
20.00	1032.00	.160	3.200	5.07	135.17	26.65	46.65	2.33	12.21
20.00	1050.00	.180	3.600	5.09	138.62	27.22	47.22	2.36	12.44
20.00	1082.00	.200	4.000	5.11	144.73	28.30	48.30	2.41	12.88
20.00	1128.00	.220	4.400	5.13	153.53	29.90	49.90	2.49	13.51
20.00	1172.00	.240	4.800	5.15	161.94	31.40	51.40	2.57	14.10
20.00	1212.00	.260	5.200	5.17	169.59	32.75	52.75	2.63	14.62
20.00	1240.00	.280	5.600	5.19	174.94	33.64	53.64	2.68	14.96
20.00	1262.00	.300	6.000	5.22	179.15	34.30	54.30	2.71	15.21
20.00	1290.00	.325	6.500	5.24	184.50	35.14	55.14	2.75	15.53
20.00	1312.00	.350	7.000	5.27	188.71	35.75	55.75	2.78	15.76
20.00	1345.00	.375	7.500	5.30	195.02	36.75	56.75	2.83	16.13
20.00	1370.00	.400	8.000	5.33	199.80	37.44	57.44	2.87	16.38
20.00	1395.00	.425	8.500	5.36	204.58	38.13	58.13	2.90	16.64
20.00	1442.00	.475	9.500	5.42	213.57	39.37	59.37	2.96	17.09
20.00	1455.00	.500	10.000	5.45	216.05	39.61	59.61	2.98	17.18
20.00	1460.00	.525	10.500	5.48	217.01	39.56	59.56	2.97	17.16

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1487.00	.550	11.000	5.51	222.17	40.28	60.28	3.01	17.42
20.00	1538.00	.600	12.000	5.57	231.92	41.57	61.57	3.07	17.88
20.00	1582.00	.650	13.000	5.64	240.33	42.59	62.59	3.12	18.24
20.00	1620.00	.700	14.000	5.70	247.60	43.37	63.37	3.16	18.52
20.00	1660.00	.750	15.000	5.77	255.25	44.19	64.19	3.20	18.81
20.00	1690.00	.800	16.000	5.84	260.98	44.66	64.66	3.23	18.97
20.00	1728.00	.850	17.000	5.91	268.25	45.35	65.35	3.26	19.21
20.00	1758.00	.900	18.000	5.98	273.98	45.76	65.76	3.28	19.35
20.00	1790.00	.950	19.000	6.06	280.10	46.22	66.22	3.31	19.50
20.00	1818.00	1.000	20.000	6.13	285.46	46.52	66.52	3.32	19.61
20.00	1840.00	1.050	21.000	6.21	289.66	46.61	66.61	3.33	19.64
20.00	1861.00	1.100	22.000	6.29	293.68	46.66	66.66	3.33	19.66
20.00	1875.00	1.150	23.000	6.37	296.36	46.48	66.48	3.32	19.60
20.00	1888.00	1.200	24.000	6.45	298.84	46.26	66.26	3.31	19.52
20.00	1905.00	1.250	25.000	6.54	302.09	46.15	66.15	3.30	19.48
20.00	1920.00	1.300	26.000	6.63	304.96	45.97	65.97	3.29	19.42
20.00	1930.00	1.350	27.000	6.72	306.87	45.63	65.63	3.28	19.30

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 266 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 4-20-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 52-30 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	325.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	445.00	.020	.400	4.92	23.00	4.66	9.66	1.93	2.21
5.00	485.00	.060	1.200	4.96	30.67	6.17	11.17	2.23	2.85
5.00	547.00	.080	1.600	4.98	42.55	8.53	13.53	2.70	3.78
5.00	567.00	.100	2.000	5.00	46.39	9.26	14.26	2.85	4.06
5.00	567.00	.120	2.400	5.02	46.39	9.22	14.22	2.84	4.04
5.00	597.00	.140	2.800	5.05	52.14	10.32	15.32	3.06	4.44
5.00	611.00	.160	3.200	5.07	54.82	10.81	15.81	3.16	4.61
5.00	626.00	.180	3.600	5.09	57.70	11.33	16.33	3.26	4.80
5.00	635.00	.200	4.000	5.11	59.42	11.62	16.62	3.32	4.90
5.00	646.00	.220	4.400	5.13	61.53	11.98	16.98	3.39	5.02
5.00	658.00	.240	4.800	5.15	63.83	12.38	17.38	3.47	5.15
5.00	669.00	.260	5.200	5.17	65.94	12.73	17.73	3.54	5.27
5.00	678.00	.280	5.600	5.19	67.67	13.01	18.01	3.60	5.36
5.00	687.00	.300	6.000	5.22	69.39	13.28	18.28	3.65	5.45
5.00	698.00	.325	6.500	5.24	71.50	13.61	18.61	3.72	5.56
5.00	710.00	.350	7.000	5.27	73.80	13.98	18.98	3.79	5.68
5.00	721.00	.375	7.500	5.30	75.91	14.30	19.30	3.86	5.78
5.00	732.00	.400	8.000	5.33	78.02	14.62	19.62	3.92	5.88
5.00	742.00	.425	8.500	5.36	79.93	14.90	19.90	3.98	5.96
5.00	752.00	.450	9.000	5.39	81.85	15.17	20.17	4.03	6.05
5.00	761.00	.475	9.500	5.42	83.58	15.40	20.40	4.08	6.12
5.00	770.00	.500	10.000	5.45	85.30	15.64	20.64	4.12	6.19

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	788.00	.550	11.000	5.51	88.75	16.09	21.09	4.21	6.33
5.00	804.00	.600	12.000	5.57	91.82	16.46	21.46	4.29	6.44
5.00	814.00	.650	13.000	5.64	93.74	16.61	21.61	4.32	6.48
5.00	822.00	.700	14.000	5.70	95.27	16.69	21.69	4.33	6.51
5.00	832.00	.750	15.000	5.77	97.19	16.82	21.82	4.36	6.55
5.00	841.00	.800	16.000	5.84	98.91	16.92	21.92	4.38	6.58
5.00	850.00	.850	17.000	5.91	100.64	17.01	22.01	4.40	6.60
5.00	859.00	.900	18.000	5.98	102.36	17.10	22.10	4.42	6.63
5.00	865.00	.950	19.000	6.06	103.51	17.08	22.08	4.41	6.62
5.00	870.00	1.000	20.000	6.13	104.47	17.02	22.02	4.40	6.61
5.00	870.00	1.050	21.000	6.21	104.47	16.81	21.81	4.36	6.54

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 266 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 4-20-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 75-0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	340.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	415.00	.020	.400	4.92	14.37	2.91	12.91	1.29	1.44
10.00	465.00	.040	.800	4.94	23.96	4.84	14.84	1.48	2.37
10.00	497.00	.060	1.200	4.96	30.09	6.05	16.05	1.60	2.94
10.00	520.00	.080	1.600	4.98	34.50	6.91	16.91	1.69	3.34
10.00	537.00	.100	2.000	5.00	37.76	7.53	17.53	1.75	3.62
10.00	555.00	.120	2.400	5.02	41.21	8.19	18.19	1.81	3.92

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	569.00	.140	2.800	5.05	43.89	8.69	18.69	1.86	4.14
10.00	583.00	.160	3.200	5.07	46.58	9.18	19.18	1.91	4.35
10.00	592.00	.180	3.600	5.09	48.30	9.48	19.48	1.94	4.49
10.00	604.00	.200	4.000	5.11	50.60	9.89	19.89	1.98	4.66
10.00	617.00	.225	4.500	5.14	53.10	10.33	20.33	2.03	4.85
10.00	628.00	.250	5.000	5.16	55.20	10.68	20.68	2.06	5.00
10.00	640.00	.275	5.500	5.19	57.51	11.07	21.07	2.10	5.17
10.00	650.00	.300	6.000	5.22	59.42	11.37	21.37	2.13	5.30
10.00	662.00	.325	6.500	5.24	61.72	11.75	21.75	2.17	5.46
10.00	673.00	.350	7.000	5.27	63.83	12.09	22.09	2.20	5.60
10.00	686.00	.375	7.500	5.30	66.32	12.49	22.49	2.24	5.76
10.00	698.00	.400	8.000	5.33	68.62	12.86	22.86	2.28	5.91
10.00	709.00	.425	8.500	5.36	70.73	13.18	23.18	2.31	6.05
10.00	721.00	.450	9.000	5.39	73.03	13.53	23.53	2.35	6.19
10.00	731.00	.475	9.500	5.42	74.95	13.81	23.81	2.38	6.30
10.00	743.00	.500	10.000	5.45	77.25	14.16	24.16	2.41	6.44
10.00	765.00	.550	11.000	5.51	81.47	14.77	24.77	2.47	6.68
10.00	787.00	.600	12.000	5.57	85.68	15.36	25.36	2.53	6.91
10.00	804.00	.650	13.000	5.64	88.94	15.76	25.76	2.57	7.07
10.00	822.00	.700	14.000	5.70	92.39	16.18	26.18	2.61	7.23
10.00	742.00	.750	15.000	5.77	77.06	13.34	23.34	2.33	6.11
10.00	860.00	.800	16.000	5.84	99.68	17.05	27.05	2.70	7.57
10.00	885.00	.850	17.000	5.91	104.47	17.66	27.66	2.76	7.80
10.00	914.00	.900	18.000	5.98	110.03	18.38	28.38	2.83	8.06
10.00	928.00	.950	19.000	6.06	112.71	18.60	28.60	2.86	8.14
10.00	950.00	1.000	20.000	6.13	116.93	19.05	29.05	2.90	8.31
10.00	972.00	1.050	21.000	6.21	121.15	19.49	29.49	2.94	8.47
10.00	993.00	1.100	22.000	6.29	125.18	19.89	29.89	2.98	8.62
10.00	1012.00	1.150	23.000	6.37	128.82	20.20	30.20	3.02	8.73

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1028.00	1.200	24.000	6.45	131.88	20.41	30.41	3.04	8.81
10.00	1042.00	1.250	25.000	6.54	134.57	20.56	30.56	3.05	8.86
10.00	1060.00	1.300	26.000	6.63	138.02	20.80	30.80	3.08	8.94
10.00	1080.00	1.350	27.000	6.72	141.85	21.09	31.09	3.10	9.05
10.00	1098.00	1.400	28.000	6.81	145.30	21.31	31.31	3.13	9.12
10.00	1115.00	1.450	29.000	6.91	148.56	21.48	31.48	3.14	9.19
10.00	1128.00	1.500	30.000	7.01	151.05	21.54	31.54	3.15	9.20

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 266 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 4-20-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 75-0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	335.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	392.00	.020	.400	4.92	10.92	2.21	22.21	1.11	1.10
20.00	455.00	.080	1.600	4.98	23.00	4.61	24.61	1.23	2.29
20.00	502.00	.100	2.000	5.00	32.01	6.39	26.39	1.31	3.16
20.00	535.00	.120	2.400	5.02	38.34	7.62	27.62	1.38	3.76
20.00	554.00	.140	2.800	5.05	41.98	8.31	28.31	1.41	4.09
20.00	572.00	.160	3.200	5.07	45.43	8.95	28.95	1.44	4.40
20.00	592.00	.180	3.600	5.09	49.26	9.67	29.67	1.48	4.74
20.00	610.00	.200	4.000	5.11	52.71	10.30	30.30	1.51	5.04
20.00	624.00	.220	4.400	5.13	55.40	10.78	30.78	1.53	5.27
20.00	644.00	.240	4.800	5.15	59.23	11.48	31.48	1.57	5.59

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	665.00	.260	5.200	5.17	63.26	12.21	32.21	1.61	5.93
20.00	685.00	.280	5.600	5.19	67.09	12.90	32.90	1.64	6.25
20.00	703.00	.300	6.000	5.22	70.54	13.50	33.50	1.67	6.53
20.00	725.00	.325	6.500	5.24	74.76	14.24	34.24	1.71	6.87
20.00	750.00	.350	7.000	5.27	79.55	15.07	35.07	1.75	7.24
20.00	775.00	.375	7.500	5.30	84.34	15.89	35.89	1.79	7.61
20.00	799.00	.400	8.000	5.33	88.94	16.67	36.67	1.83	7.96
20.00	819.00	.425	8.500	5.36	92.78	17.29	37.29	1.86	8.24
20.00	842.00	.450	9.000	5.39	97.19	18.01	38.01	1.90	8.56
20.00	860.00	.475	9.500	5.42	100.64	18.55	38.55	1.92	8.79
20.00	880.00	.500	10.000	5.45	104.47	19.15	39.15	1.95	9.06
20.00	922.00	.550	11.000	5.51	112.52	20.40	40.40	2.02	9.60
20.00	963.00	.600	12.000	5.57	120.38	21.58	41.58	2.07	10.10
20.00	1005.00	.650	13.000	5.64	128.43	22.76	42.76	2.13	10.60
20.00	1046.00	.700	14.000	5.70	136.29	23.87	43.87	2.19	11.07
20.00	1089.00	.750	15.000	5.77	144.54	25.02	45.02	2.25	11.55
20.00	1132.00	.800	16.000	5.84	152.78	26.14	46.14	2.30	12.00
20.00	1168.00	.850	17.000	5.91	159.68	27.00	47.00	2.35	12.35
20.00	1217.00	.900	18.000	5.98	169.07	28.24	48.24	2.41	12.85
20.00	1257.00	.950	19.000	6.06	176.74	29.16	49.16	2.45	13.22
20.00	1303.00	1.000	20.000	6.13	185.56	30.24	50.24	2.51	13.64
20.00	1345.00	1.050	21.000	6.21	193.61	31.16	51.16	2.55	14.00
20.00	1390.00	1.100	22.000	6.29	202.24	32.13	52.13	2.60	14.38
20.00	1492.00	1.150	23.000	6.37	221.79	34.79	54.79	2.73	15.39
20.00	1465.00	1.200	24.000	6.45	216.62	33.53	53.53	2.67	14.92
20.00	1502.00	1.250	25.000	6.54	223.71	34.18	54.18	2.70	15.16
20.00	1537.00	1.300	26.000	6.63	230.42	34.73	54.73	2.73	15.37
20.00	1570.00	1.350	27.000	6.72	236.74	35.20	55.20	2.76	15.55
20.00	1598.00	1.400	28.000	6.81	242.11	35.51	55.51	2.77	15.67
20.00	1628.00	1.450	29.000	6.91	247.86	35.85	55.85	2.79	15.79
20.00	1645.00	1.500	30.000	7.01	251.12	35.81	55.81	2.79	15.78

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 366   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div   DATE 4-21.71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00 In.   ELAPSED TIME 75-0   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	335.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	411.00	.020	.400	4.92	14.56	2.95	7.95	1.59	1.43
5.00	462.00	.040	.800	4.94	24.34	4.92	9.92	1.98	2.32
5.00	493.00	.060	1.200	4.96	30.28	6.09	11.09	2.21	2.82
5.00	523.00	.080	1.600	4.98	36.03	7.22	12.22	2.44	3.27
5.00	546.00	.100	2.000	5.00	40.44	8.07	13.07	2.61	3.61
5.00	570.00	.120	2.400	5.02	45.04	8.95	13.95	2.79	3.94
5.00	588.00	.140	2.800	5.05	48.50	9.60	14.60	2.92	4.18
5.00	609.00	.160	3.200	5.07	52.52	10.35	15.35	3.07	4.45
5.00	627.00	.180	3.600	5.09	55.97	10.99	15.99	3.19	4.68
5.00	642.00	.200	4.000	5.11	58.85	11.50	16.50	3.30	4.86
5.00	658.00	.220	4.400	5.13	61.91	12.05	17.05	3.41	5.04
5.00	671.00	.240	4.800	5.15	64.41	12.49	17.49	3.49	5.19
5.00	683.00	.260	5.200	5.17	66.71	12.88	17.88	3.57	5.32
5.00	693.00	.280	5.600	5.19	68.62	13.19	18.19	3.63	5.42
5.00	706.00	.300	6.000	5.22	71.12	13.61	18.61	3.72	5.56
5.00	719.00	.325	6.500	5.24	73.61	14.02	19.02	3.80	5.69
5.00	730.00	.350	7.000	5.27	75.72	14.34	19.34	3.86	5.79
5.00	742.00	.375	7.500	5.30	78.02	14.70	19.70	3.94	5.90
5.00	751.00	.400	8.000	5.33	79.74	14.94	19.94	3.98	5.98
5.00	761.00	.425	8.500	5.36	81.66	15.22	20.22	4.04	6.06
5.00	770.00	.450	9.000	5.39	83.38	15.45	20.45	4.09	6.14
5.00	778.00	.475	9.500	5.42	84.92	15.65	20.65	4.13	6.20

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	783.00	.500	10.000	5.45	85.88	15.74	20.74	4.14	6.22
5.00	790.00	.525	10.500	5.48	87.22	15.90	20.90	4.18	6.27
5.00	795.00	.550	11.000	5.51	88.18	15.98	20.98	4.19	6.30
5.00	805.00	.600	12.000	5.57	90.09	16.15	21.15	4.23	6.35
5.00	815.00	.650	13.000	5.64	92.01	16.30	21.30	4.26	6.39
5.00	830.00	.700	14.000	5.70	94.89	16.62	21.62	4.32	6.49
5.00	840.00	.750	15.000	5.77	96.80	16.76	21.76	4.35	6.53
5.00	850.00	.800	16.000	5.84	98.72	16.89	21.89	4.37	6.57
5.00	855.00	.850	17.000	5.91	99.68	16.85	21.85	4.37	6.56
5.00	858.00	.900	18.000	5.98	100.25	16.74	21.74	4.34	6.52
5.00	867.00	.950	19.000	6.06	101.98	16.82	21.82	4.36	6.55
5.00	875.00	1.000	20.000	6.13	103.51	16.87	21.87	4.37	6.56
5.00	882.00	1.050	21.000	6.21	104.85	16.87	21.87	4.37	6.56
5.00	888.00	1.100	22.000	6.29	106.01	16.84	21.84	4.36	6.55
5.00	893.00	1.150	23.000	6.37	106.96	16.77	21.77	4.35	6.53
5.00	898.00	1.200	24.000	6.45	107.92	16.70	21.70	4.34	6.51
5.00	908.00	1.250	25.000	6.54	109.84	16.78	21.78	4.35	6.53
5.00	918.00	1.300	26.000	6.63	111.76	16.84	21.84	4.36	6.55
5.00	926.00	1.350	27.000	6.72	113.29	16.84	21.84	4.36	6.55
5.00	932.00	1.400	28.000	6.81	114.44	16.78	21.78	4.35	6.54
5.00	938.00	1.450	29.000	6.91	115.59	16.71	21.71	4.34	6.52
5.00	943.00	1.500	30.000	7.01	116.55	16.62	21.62	4.32	6.49

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 366 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 4-21-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 40-0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	335.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	417.00	.020	.400	4.92	15.71	3.18	13.18	1.31	1.57
10.00	490.00	.040	.800	4.94	29.71	6.00	16.00	1.60	2.92
10.00	545.00	.060	1.200	4.96	40.25	8.10	18.10	1.81	3.87
10.00	585.00	.080	1.600	4.98	47.92	9.60	19.60	1.96	4.54
10.00	629.00	.100	2.000	5.00	56.35	11.25	21.25	2.12	5.24
10.00	685.00	.120	2.400	5.02	67.09	13.34	23.34	2.33	6.11
10.00	720.00	.140	2.800	5.05	73.80	14.61	24.61	2.46	6.62
10.00	752.00	.160	3.200	5.07	79.93	15.76	25.76	2.57	7.07
10.00	784.00	.180	3.600	5.09	86.07	16.90	26.90	2.69	7.51
10.00	810.00	.200	4.000	5.11	91.05	17.80	27.80	2.78	7.85
10.00	835.00	.220	4.400	5.13	95.85	18.66	28.66	2.86	8.17
10.00	853.00	.240	4.800	5.15	99.30	19.25	29.25	2.92	8.39
10.00	880.00	.260	5.200	5.17	104.47	20.17	30.17	3.01	8.72
10.00	910.00	.280	5.600	5.19	110.22	21.19	31.19	3.11	9.08
10.00	940.00	.300	6.000	5.22	115.97	22.20	32.20	3.22	9.44
10.00	970.00	.325	6.500	5.24	121.72	23.18	33.18	3.31	9.78
10.00	1010.00	.350	7.000	5.27	129.39	24.51	34.51	3.45	10.23
10.00	1038.00	.375	7.500	5.30	134.76	25.39	35.39	3.53	10.52
10.00	1070.00	.400	8.000	5.33	140.89	26.40	36.40	3.64	10.85
10.00	1100.00	.450	9.000	5.39	146.65	27.18	37.18	3.71	11.11
10.00	1115.00	.475	9.500	5.42	149.52	27.56	37.56	3.75	11.23
10.00	1129.00	.500	10.000	5.45	152.20	27.90	37.90	3.79	11.34

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	1157.00	.550	11.000	5.51	157.57	28.57	38.57	3.85	11.55
10.00	1178.00	.600	12.000	5.57	161.60	28.97	38.97	3.89	11.67
10.00	1186.00	.650	13.000	5.64	163.13	28.91	38.91	3.89	11.66
10.00	1194.00	.700	14.000	5.70	164.67	28.84	38.84	3.88	11.64
10.00	1208.00	.750	15.000	5.77	167.35	28.97	38.97	3.89	11.68
10.00	1215.00	.800	16.000	5.84	168.69	28.86	38.86	3.88	11.64

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 366   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div.   DATE 4-21-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00   ELAPSED TIME 46-30   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES	S1 PSI	S1/S3	TCR PSI
20.00	333.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	408.00	.020	.400	4.92	14.37	2.91	22.91	1.14	1.45
20.00	550.00	.040	.800	4.94	41.59	8.40	28.40	1.42	4.13
20.00	688.00	.060	1.200	4.96	68.05	13.69	33.69	1.68	6.62
20.00	800.00	.080	1.600	4.98	89.52	17.94	37.94	1.89	8.53
20.00	880.00	.100	2.000	5.00	104.85	20.93	40.93	2.04	9.83
20.00	945.00	.120	2.400	5.02	117.32	23.32	43.32	2.16	10.84
20.00	1020.00	.140	2.800	5.05	131.69	26.07	46.07	2.30	11.98
20.00	1180.00	.180	3.600	5.09	162.36	31.88	51.88	2.59	14.28
20.00	1235.00	.200	4.000	5.11	172.91	33.81	53.81	2.69	15.02
20.00	1295.00	.220	4.400	5.13	184.41	35.91	55.91	2.79	15.82
20.00	1352.00	.240	4.800	5.15	195.34	37.88	57.88	2.89	16.55
20.00	1404.00	.260	5.200	5.17	205.31	39.65	59.65	2.98	17.19
20.00	1452.00	.280	5.600	5.19	214.51	41.25	61.25	3.06	17.77

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	1502.00	.300	6.000	5.22	224.09	42.91	62.91	3.14	18.35
20.00	1545.00	.320	6.400	5.24	232.34	44.30	64.30	3.21	18.84
20.00	1618.00	.350	7.000	5.27	246.33	46.67	66.67	3.33	19.66
20.00	1687.00	.400	8.000	5.33	259.56	48.64	68.64	3.43	20.33
20.00	1748.00	.450	9.000	5.39	271.25	50.28	70.28	3.51	20.88
20.00	1808.00	.500	10.000	5.45	282.75	51.84	71.84	3.59	21.39
20.00	1827.00	.550	11.000	5.51	286.39	51.92	71.92	3.59	21.42
20.00	1862.00	.600	12.000	5.57	293.10	52.54	72.54	3.62	21.62
20.00	1891.00	.650	13.000	5.64	298.66	52.93	72.93	3.64	21.75
20.00	1915.00	.700	14.000	5.70	303.26	53.13	73.13	3.65	21.81
20.00	1943.00	.750	15.000	5.77	308.63	53.44	73.44	3.67	21.91
20.00	1962.00	.800	16.000	5.84	312.27	53.43	73.43	3.67	21.91
20.00	1970.00	.850	17.000	5.91	313.81	53.06	73.06	3.65	21.79
20.00	1977.00	.900	18.000	5.98	315.15	52.64	72.64	3.63	21.66
20.00	1978.00	.925	18.500	6.02	315.34	52.35	72.35	3.61	21.56

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 566 LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div. DATE 4-22-71

INITIAL DIAMETER 2.50 In. INITIAL LENGTH 5.00 In. ELAPSED TIME 60 -0 TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	335.00	.000	.000	4.90	0.00	0.00	5.00	1.00	0.00
5.00	428.00	.020	.400	4.92	17.82	3.61	8.61	1.72	1.74
5.00	490.00	.040	.800	4.94	29.71	6.00	11.00	2.20	2.78
5.00	535.00	.060	1.200	4.96	38.34	7.71	12.71	2.54	3.47
5.00	572.00	.080	1.600	4.98	45.43	9.10	14.10	2.82	4.00

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	591.00	.100	2.000	5.00	49.07	9.79	14.79	2.95	4.25
5.00	615.00	.120	2.400	5.02	53.67	10.67	15.67	3.13	4.57
5.00	632.00	.140	2.800	5.05	56.93	11.27	16.27	3.25	4.78
5.00	650.00	.160	3.200	5.07	60.38	11.90	16.90	3.38	4.99
5.00	665.00	.180	3.600	5.09	63.26	12.42	17.42	3.48	5.17
5.00	680.00	.200	4.000	5.11	66.13	12.93	17.93	3.58	5.34
5.00	694.00	.220	4.400	5.13	68.82	13.40	18.40	3.68	5.49
5.00	705.00	.240	4.800	5.15	70.92	13.75	18.75	3.75	5.60
5.00	719.00	.260	5.200	5.17	73.61	14.21	19.21	3.84	5.75
5.00	731.00	.280	5.600	5.19	75.91	14.59	19.59	3.91	5.87
5.00	743.00	.300	6.000	5.22	78.21	14.97	19.97	3.99	5.99
5.00	762.00	.330	6.600	5.25	81.85	15.57	20.57	4.11	6.17
5.00	773.00	.350	7.000	5.27	83.96	15.90	20.90	4.18	6.27
5.00	788.00	.375	7.500	5.30	86.84	16.36	21.36	4.27	6.41
5.00	802.00	.400	8.000	5.33	89.52	16.77	21.77	4.35	6.53
5.00	813.00	.425	8.500	5.36	91.63	17.08	22.08	4.41	6.62
5.00	827.00	.450	9.000	5.39	94.31	17.48	22.48	4.49	6.74
5.00	837.00	.475	9.500	5.42	96.23	17.74	22.74	4.54	6.81
5.00	848.00	.500	10.000	5.45	98.34	18.03	23.03	4.60	6.90
5.00	875.00	.550	11.000	5.51	103.51	18.76	23.76	4.75	7.11
5.00	905.00	.600	12.000	5.57	109.26	19.58	24.58	4.91	7.34
5.00	931.00	.650	13.000	5.64	114.25	20.24	25.24	5.04	7.52
5.00	940.00	.700	14.000	5.70	115.97	20.31	25.31	5.06	7.54
5.00	950.00	.750	15.000	5.77	117.89	20.41	25.41	5.08	7.56
5.00	960.00	.800	16.000	5.84	119.81	20.50	25.50	5.10	7.59
5.00	970.00	.850	17.000	5.91	121.72	20.58	25.58	5.11	7.61
5.00	980.00	.900	18.000	5.98	123.64	20.65	25.65	5.13	7.63
5.00	990.00	.950	19.000	6.06	125.56	20.71	25.71	5.14	7.64
5.00	998.00	1.000	20.000	6.13	127.09	20.71	25.71	5.14	7.64
5.00	1003.00	1.050	21.000	6.21	128.05	20.60	25.60	5.12	7.61

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
5.00	1009.00	1.100	22.000	6.29	129.20	20.53	25.53	5.10	7.59
5.00	1012.00	1.150	23.000	6.37	129.78	20.35	25.35	5.07	7.55
5.00	1012.00	1.200	24.000	6.45	129.78	20.09	25.09	5.01	7.47

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 566   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div.   DATE 4-22-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00 In.   ELAPSED TIME 68-30   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	335.00	.000	.000	4.90	0.00	0.00	10.00	1.00	0.00
10.00	461.00	.020	.400	4.92	24.15	4.90	14.90	1.49	2.40
10.00	526.00	.040	.800	4.94	36.61	7.39	17.39	1.73	3.56
10.00	572.00	.060	1.200	4.96	45.43	9.14	19.14	1.91	4.34
10.00	610.00	.080	1.600	4.98	52.71	10.56	20.56	2.05	4.95
10.00	642.00	.100	2.000	5.00	58.85	11.74	21.74	2.17	5.45
10.00	670.00	.120	2.400	5.02	64.21	12.76	22.76	2.27	5.87
10.00	694.00	.140	2.800	5.05	68.82	13.62	23.62	2.36	6.22
10.00	717.00	.160	3.200	5.07	73.22	14.44	24.44	2.44	6.55
10.00	737.00	.180	3.600	5.09	77.06	15.13	25.13	2.51	6.82
10.00	758.00	.200	4.000	5.11	81.08	15.85	25.85	2.58	7.11
10.00	777.00	.220	4.400	5.13	84.73	16.50	26.50	2.65	7.35
10.00	795.00	.240	4.800	5.15	88.18	17.10	27.10	2.71	7.58
10.00	811.00	.260	5.200	5.17	91.24	17.62	27.62	2.76	7.78
10.00	828.00	.280	5.600	5.19	94.50	18.17	28.17	2.81	7.99
10.00	847.00	.300	6.000	5.22	98.15	18.79	28.79	2.87	8.22

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
10.00	859.00	.325	6.500	5.24	100.45	19.13	29.13	2.91	8.34
10.00	910.00	.375	7.500	5.30	110.22	20.77	30.77	3.07	8.93
10.00	939.00	.400	8.000	5.33	115.78	21.70	31.70	3.17	9.26
10.00	950.00	.425	8.500	5.36	117.89	21.97	31.97	3.19	9.36
10.00	972.00	.450	9.000	5.39	122.11	22.63	32.63	3.26	9.59
10.00	992.00	.475	9.500	5.42	125.94	23.22	33.22	3.32	9.79
10.00	1022.00	.500	10.000	5.45	131.69	24.14	34.14	3.41	10.10
10.00	1062.00	.600	12.000	5.57	139.36	24.98	34.98	3.49	10.38
10.00	1082.00	.650	13.000	5.64	143.19	25.38	35.38	3.53	10.51
10.00	1106.00	.700	14.000	5.70	147.80	25.89	35.89	3.58	10.68
10.00	1132.00	.750	15.000	5.77	152.78	26:45	36.45	3.64	10.87
10.00	1161.00	.800	16.000	5.84	158.34	27.09	37.09	3.70	11.08
10.00	1178.00	.850	17.000	5.91	161.60	27.32	37.32	3.73	11.15
10.00	1200.00	.900	18.000	5.98	165.82	27.70	37.70	3.77	11.27
10.00	1218.00	.950	19.000	6.06	169.27	27.93	37.93	3.79	11.34
10.00	1233.00	1.000	20.000	6.13	172.14	28.05	38.05	3.80	11.38
10.00	1245.00	1.050	21.000	6.21	174.44	28.07	38.07	3.80	11.39
10.00	1253.00	1.100	22.000	6.29	175.98	27.96	37.96	3.79	11.35
10.00	1262.00	1.150	23.000	6.37	177.70	27.87	37.87	3.78	11.33
10.00	1272.00	1.200	24.000	6.45	179.62	27.81	37.81	3.78	11.31
10.00	1280.00	1.250	25.000	6.54	181.15	27.67	37.67	3.76	11.26
10.00	1285.00	1.300	26.000	6.63	182.11	27.45	37.45	3.74	11.19
10.00	1289.00	1.350	27.000	6.72	182.88	27.19	37.19	3.71	11.11
10.00	1289.00	1.370	27.400	6.76	182.88	27.04	37.04	3.70	11.06

TRIAXIAL COMPRESSION TEST RESULTS

SPECIMEN IDENTIFICATION 566   LOADING CELL CALIBRATION FACTOR .19170 Lbs./Div.   DATE 4-22-71

INITIAL DIAMETER 2.50 In.   INITIAL LENGTH 5.00   ELAPSED TIME 30-30   TESTED BY: JDC

CHAM. PRES.	LOADING DIAL	STRAIN GAGE	STRAIN CL/DL	AREA SQIN	AXIAL LOAD	AXIAL PRES.	S1 PSI	S1/S3	TCR PSI
20.00	335.00	.000	.000	4.90	0.00	0.00	20.00	1.00	0.00
20.00	430.00	.020	.400	4.92	18.21	3.69	23.69	1.18	1.84
20.00	495.00	.040	.800	4.94	30.67	6.19	26.19	1.30	3.07
20.00	550.00	.060	1.200	4.96	41.21	8.29	28.29	1.41	4.08
20.00	590.00	.080	1.600	4.98	48.88	9.79	29.79	1.48	4.80
20.00	629.00	.100	2.000	5.00	56.35	11.25	31.25	1.56	5.48
20.00	655.00	.120	2.400	5.02	61.34	12.19	32.19	1.60	5.92
20.00	695.00	.140	2.800	5.05	69.01	13.66	33.66	1.68	6.60
20.00	728.00	.160	3.200	5.07	75.33	14.85	34.85	1.74	7.15
20.00	756.00	.180	3.600	5.09	80.70	15.84	35.84	1.79	7.59
20.00	788.00	.200	4.000	5.11	86.84	16.98	36.98	1.84	8.10
20.00	820.00	.225	4.500	5.14	92.97	18.08	38.08	1.90	8.59
20.00	855.00	.250	5.000	5.16	99.68	19.29	39.29	1.96	9.12
20.00	930.00	.300	6.000	5.22	114.06	21.84	41.84	2.09	10.21
20.00	982.00	.325	6.500	5.24	124.02	23.62	43.62	2.18	10.96
20.00	1010.00	.350	7.000	5.27	129.39	24.51	44.51	2.22	11.33
20.00	1045.00	.375	7.500	5.30	136.10	25.64	45.64	2.28	11.80
20.00	1082.00	.400	8.000	5.33	143.19	26.83	46.83	2.34	12.28
20.00	1160.00	.450	9.000	5.39	158.15	29.31	49.31	2.46	13.28
20.00	1235.00	.500	10.000	5.45	172.53	31.63	51.63	2.58	14.19
20.00	1290.00	.550	11.000	5.51	183.07	33.19	53.19	2.65	14.79
20.00	1310.00	.600	12.000	5.57	186.90	33.50	53.50	2.67	14.91
20.00	1312.00	.610	12.200	5.59	187.29	33.49	53.49	2.67	14.90

APPENDIX C

IBM 1620 PROGRAMS FOR DEVELOPMENT OF TEST DATA

THIS BOOK CONTAINS NUMEROUS PAGES WITH COPY LINES RUNNING THROUGH THEM.

THIS IS AS RECEIVED FROM CUSTOMER.

```
34000320070136000320070249024025119636113001O2      MONITOR COLD START
ZZJOB
ZZFORX
*FANDK2610
C  C  PROGRAM TO COMPUTE COEFFICIENT OF PERMEABILITY
C     IDN IS THE SOIL SPECIMEN IDENTIFICATION NUMBER
C     I IS THE NUMBER OF DATA SETS
C     NUM IS THE NUMBER OF SEPERATE SAMPLES
C     WD IS THE WEIGHT OF DRY SOIL
C     WW IS THE WEIGHT OF CONTAINED FLUIDS
C     ID,IM, AND IY ARE THE DAY, MONTH, AND YEAR
C     DP IS THE PERMEAMETER DIAMETER
C     DS IS THE STANDPIPE DIAMETER
C     HO IS THE INITIAL WATER HEAD AT THE START OF THE TEST
C     H1 IS THE FINAL WATER HEAD AT THE END OF THE TEST
C     T1 IS THE TIME TO REDUCE THE HEAD FROM HO TO THE SQRT HOXH1
C     AP IS THE AREA OF THE PERMEAMETER
C     AS IS THE AREA OF THE STANDPIPE
C     T2 IS THE TIME TO REDUCE THE HEAD FROM SQRT HOXH1 TO H1
C     TEMP IS THE TEMPERATURE OF THE TEST SPECIMEN AT TIME OF TESTING
C     ALL TEMPERATURES ARE IN DEGREES CENTIGRADE
C     U20 AND UT ARE RESPECTIVE VISCOSITIES OF WATER
C     SL IS THE LENGTH OF THE SAMPLE
C     P IS THE COEFFICIENT OF PERMEABILITY AT ANY TEMPERATURE
C     P20 IS THE COEFFICIENT OF PERMEABILITY AT 20 DEG. CENTIGRADE
    1 FORMAT(22X,17HPERMEABILITY TEST//)
    2 FORMAT(12HSOIL SAMPLE-,4X,I3,10X,21HSOIL SPECIMEN WEIGHT-  /)
    3 FORMAT(32X,12HWT. DRY SOIL,6XF7.2,4HGMS.)
    4 FORMAT(32X,9HWT. WATER,9XF7.2,4HGMS.)
    5 FORMAT(32X,18HTOTAL WT. SPECIMEN,F7.2,4HGMS.)
    6 FORMAT(11HPERMEAMETER,5X,10HDIAMETER  ,F6.3,5H  CM.,5X,6HAREA  ,F9
     1.5,6H  CM.2//)
    7 FORMAT(11HSTANDPIPE  ,5X,10HDIAMETER  ,F6.3,5H  CM.,5X,6HAREA  ,F9
     1.5,6H  CM.2//)
    8 FORMAT(6HDATE  ,I2,1H-,I2,1H-,I4,26X,9HTESTED BY  )
    9 FORMAT(38HDET.  SAMPLE     TEMP              TIME   )
   10 FORMAT(38HNUM   LENGTH     DEG C     T1         T2//)
   11 FORMAT(3I3,2F6.2,2I2,I4)
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```
12 FORMAT(F6.3,4XF6.3,4XF5.2,F5.2)
13 FORMAT(F7.2,3XF7.2,3XF5.2,5XF7.2,3XF7.2)
14 FORMAT(I3,3XF6.2,3XF7.2,3XF8.2,2XF8.2,5XF7.2)
15 FORMAT(41HDET.                                PERMEABILITY)
16 FORMAT(4HNUM.,6X,14HCM/SEC AT TEMP,18X,13HCM/SEC AT 20C    //)
17 FORMAT(I3,3XF28.25,3XF28.25)
21 FORMAT(//50H**************************************************,30H
  1******************************//)
22 FORMAT(5HHO =  ,F7.2,4H CM.,10X,5HH1 =  ,F7.2,4H CM.//)
24 FORMAT(I3,3XF28.25)
25 FORMAT(37XI3,3XF9.6)
27 FORMAT(50HSAM.  AVERAGE PERMEABILITY            DET.  PERCENT)
28 FORMAT(50HNUM.  OF SAMPLE FROM VALUES OF P20   NUM.   ERROR //)
18 CONTINUE
   READ11,IDN,I,NUM,WD,WW,ID,IM,IY
   READ12,DP,DS,HO,H1
   AP=3.1415927*((DP**2)/4.)
   AS=3.1415927*((DS**2)/4.)
   TWS=WD+WW
   PUNCH1
   PUNCH2,IDN
   PUNCH3,WD
   PUNCH4,WW
   PUNCH5,TWS
   PUNCH6,DP,AP
   PUNCH7,DS,AS
   PUNCH22,HO,H1
   PUNCH8,ID,IM,IY
   PUNCH21
   PUNCH9
   PUNCH10
   DIMENSION P(50),P20(50)
   N=0
   DO19J=1,I,1
   READ13,T1,T2,TEMP,UT,SL
   P(J)=(2.3*(AS*SL)/(AP*(T1+T2)))*(LOG(HO/H1)*0.4342944819)
   U20=10.09
   P20(J)=((P(J)*UT)/U20)
```

```
      N=N+1
      PUNCH14,N,SL,TEMP,TI,T2,UT
   19 CONTINUE
      PUNCH21
      PUNCH15
      PUNCH16
      DO20K=1,I,1
      PUNCH17,K,P(K),P20(K)
   20 CONTINUE
      PUNCH21
C     PROGRAM PHASE TO COMPUTE PERCENT ERROR IN INDIVIDUAL SAMPLES
C     TP20 IS THE SUM OF P20 VALUED FOR THE SAMPLE
C     AP20 IS THE AVERAGE OF THEP20 VALUES FOR THE SAMPLE
C     DP20 US THE PERCENT ERROR IN THE P20 VALUES
C     I/NUM MUST BE AN INTEGER
      DIMENSION TP20(50),AP20(50),DP20(50)
      IF(NUM)29,29,26
   26 ND=I/NUM
      IF(ND-1)29,29,32
   32 AF=0.
      DO31NC=1,ND,1
   31 AF=AF+1.
      NI=ND-1
      PUNCH27
      PUNCH28
      DO23M=1,NUM,1
      TP20(M)=0.00
      DO30L=1,ND,1
      LA=ND*(M-1)+L
   30 TP20(M)=TP20(M)+P20(LA)
      AP20(M)=TP20(M)/AF
      PUNCH24,M,AP20(M)
      DO23NOI=1,ND,1
      LN=ND*(M-1)+NOI
      DP20(LN)=((P20(LN)-AP20(M))/AP20(M))*100.0
   23 PUNCH25,LN,DP20(LN)
      PUNCH21
   29 PAUSE
      GO TO 18
      END
```

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3400032007013600032007024902402511963611300102      MONITOR COLD START
ZZFORX
C  C  GENERALIZED SOIL MECHANIC S SHEAR PROGRAM.
C     TRIAXIAL COMPREESION IS LIMITED TO DRAINED SPECIMENS, IE. PORE PRE
C     SSURE IS EQUEAL TO ZERO.
C     UNCONFINED COMPRESSION IS NOT YET PROGRAMED.
C     ITN IS THE TEST IDENTIFICATION NUMBER. 1 IS TRIAXIAL. 2 IS DIRECT
C     SHEAR. 3 IS UNCONFINED COMPRESSION.
C     NDP IS THE NUMBER OF DATA POINTS.
C     ID,IM,IY ARE THE DAY, MONTH, AND YEAR.
C     IT AND OT ARE THE TIME ELAPSED IN MINUTES AND SECONDS.
C     PRCFIS THE PROVING RING CALIBRATION FACTOR.
C     DI IS THE INITIAL DIAMETER.
C     DL IS THE INITIAL LENGTH.
C     PD IS THE PROVING DIAL READING.
C     SG IS THE STRAIN GAGE READING.
C     CHD IS THE CHAMBER PRESSURE OR THE NORMAL LOAD.
C     AO IS THE INITIAL AREA , CONSTANT FOR DIRECT SHEAR.
C     A IS THE AREA AT ANY TIME IN THE TEST.
C     AP IS THE AXIAL LOAD INDUCED STRESS.
C     S1 IS SIGMA 1.
C     CH IS THE ABSOLUTE CHAMBER PRESSEURE.
C     T IS THE SHEAR STRESS(DIRECT SHEAR) OR THE CRITICAL STRESS(3-AXIL)
C     S IS THE DIRECT SHEAR NORMAL STRESS.
C      DS IS THE SHEAR/NORMAL RATIO FOR DIRECT SHEAR TESTS AND THE SIGMA
C     1/SIGMA 3 RATIO FOR TRIAXIAL TESTS.
    1 FORMAT(23X,33HTRIAXIAL COMPRESSION TEST RESULTS   ///)
    2 FORMAT(25HSPECIMEN IDENTIFICATION   ,I3,20X,6HDATE   ,I2,1H-,I2,1H-,
     1I4  /)
    3 FORMAT(31HPROVING RING CALIBRATION FACTOR,2XF7.5,10H LBS./DIV.)
    4 FORMAT(/19HSPECIMEN DIMENSIONS,26X,9HTESTED BY)
    5 FORMAT(3X,16HINITIAL DIAMETER,3XF7.2,3HIN.)
    6 FORMAT(5X,14HINITIAL LENGTH,3XF7.2,3HIN.)
    7 FORMAT(F7.5,3XF7.2,3XF7.2)
    8 FORMAT(//50H--------------------------------------------------,30
     1H------------------------------//)
    9 FORMAT(31HLOADING CELL CALIBRATION FACTOR,2XF7.5,10H LBS./DIV.)
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 10 FORMAT(27X,25HDIRECT SHEAR TEST RESULTS  ///)
 11 FORMAT(2I3,2I2,I4,I1,2I2)
 12 FORMAT(45HCHAM.  LOADING   STRAIN  STRAIN  AREA   AXIAL,4X,30HAXIA
   3L    S1        S1/S3     TCR)
 13 FORMAT(44HPRES.  DIAL        GAGE    CL/DL   SQIN   LOAD,5X,30HPRES.
   4    PSI.               PSI)
 14 FORMAT(46HSHEAR      SHEAR      PROVING     SHEAR      SHEAR,5X,26HNOR
   6MAL    NORMAL    SHEAR/       )
 15 FORMAT(47HDIAL       DISC.      DIAL        FORCE      STRESS,4X,26HLO
   2AD      STRESS   NORMAL        )
 16 FORMAT(F6.2,1XF8.2,2XF6.3,1XF7.3,2XF5.2,2XF7.2,2XF7.2,2XF7.2,2XF5.
   52,2XF6.2)
 17 FORMAT(F8.2,1XF7.5,2XF7.3)
 18 FORMAT(F7.3,3XF7.3,3XF8.2,3XF7.2,3XF7.2,3XF7.2,3XF7.2,3XF7.3)
 19 FORMAT(14HELAPSED TIME   ,I2,1H-,I2/)
100 READ11,IDN,NDP,ID,IM,IY,ITN,IT,CT
    READ7,PRCF,DI,DL
    IF(ITN-2)101,102,103
101 PUNCH1
    PUNCH2,IDN,ID,IM,IY
    PUNCH9,PRCF
    GO TO 104
102 PUNCH10
    PUNCH2,IDN,ID,IM,IY
    PUNCH3,PRCF
    GO TO 104
103 PAUSE
104 PUNCH4
    PUNCH5,DI
    PUNCH6,DL
    PUNCH8
    PUNCH19,IT,CT
    IF(ITN-2)105,106,103
105 PUNCH12
    PUNCH13
    GO TO 107
106 PUNCH14
    PUNCH15
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107 PUNCH8
    DIMENSION PD(90),SG(90),CHD(90),AL(90),CL(90),E(90),A(90),AP(90)
    DIMENSION CH(90),S1(90),DS(90),T(90),S(90)
    READ17,(PD(N),SG(N),CHD(N),N=1,NDP)
    AC=3.1415927*(DI**2)/4.
    DO110 I=1,NDP,1
    AL(I)=PRCF*(PD(I)-PD(1))
    CL(I)=SG(I)-SG(1)
    IF(ITN-2)108,109,103
108 E(I)=(CL(I)/DL)*100.
    A(I)=AC/(1.-(E(I)*0.01))
    AP(I)=AL(I)/A(I)
    CH(I)=CHD(I)+14.7
    S1(I)=CH(I)+AP(I)
    DS(I)=S1(I)/CH(I)
    T(I)=(AP(I)*SQRT(S1(I)*CH(I)))/(S1(I)+CH(I))
    PUNCH16,CH(I),PD(I),SG(I),E(I),A(I),AL(I),AP(I),S1(I),DS(I),T(I)
    GO TO 110
109 T(I)=AL(I)/AC
    S(I)=CHD(I)/AC
    DS(I)=T(I)/S(I)
    PUNCH18,SG(I),CL(I),PD(I),AL(I),T(I),CHD(I),S(I),DS(I)
110 CONTINUE
    PUNCH8
    PAUSE
    GO TO 100
    END
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A STUDY OF ASPHALTIC STABILIZATION OF LOESS

by

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B. S., Kansas State University, 1970

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

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Department of Civil Engineering

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

The study was undertaken to determine the engineering properties of three Kansas loesses and the effect of three percent asphalt by weight added to the loess in the form of a cationic emulsified asphalt. The loess-asphalt mixtures were tested at 24 hours and 60 days after mixing.

The engineering properties were evaluated by using specific gravity, gradation, Proctor density, plastic limit, liquid limit, permeability and triaxial shear tests. Testing was conducted in the Kansas State University Civil Engineering Soils Laboratory.

The study showed that asphalt stabilization improves the strength and plasticity characteristics of fine grained loesses and was detrimental to the strength of sandy loesses. It was also shown that the effectiveness of asphalt stabilization was dependent on the physical characteristics of the raw loess. It was further shown that laboratory testing was necessary to assure satisfactory performance of an asphalt stabilized loess in the field.