Professional Service Industries, Inc.
Shilstone Engineering Testing Laboratory Division

March 7, 1984

Cameron County International Bridge
510 E. 14th Street
Brownsville, Texas 78520

Attention: Mr. Louis Henggeler
Manager

Re: Report of Subsurface Exploration and Evaluation
Cameron County International Bridge
Brownsville, Texas
SETL Project No.: 312-45018

Dear Mr. Henggeler:

Professional Service Industries, Inc. has completed a soil exploration and foundation evaluation for the referenced project. The results of this exploration, together with our recommendations are to be found in the accompanying report, 3 copies of which are being transmitted herewith. An additional copy has been forwarded directly to Mr. William Greenslade at Greenslade and Associates, Inc.

Often because of design and construction details which occur on a project, questions arise concerning the soils conditions. If we can be of further service, please contact us at your convenience.

Very truly yours,

PROFESSIONAL SERVICE INDUSTRIES, INC.
(Shilstone Engineering Testing Laboratory Division)

John W. Dougherty, P.E.
Senior Project Engineer

JWD/dr

Three Burwood Lane • San Antonio, TX 78216 • Phone: 512/342-9377

SUBSURFACE EXPLORATION
AND
EVALUATION

PROPOSED FOR THE

CAMERON COUNTY INTERNATIONAL BRIDGE
BROWNSVILLE, TEXAS
SETL PROJECT NO.: 312-45018

PREPARED FOR

CAMERON COUNTY INTERNATIONAL BRIDGE
510 E. 14th Street
Brownsville, Texas 78520

by

PROFESSIONAL SERVICE INDUSTRIES, INC.
(Shilstone Engineering Testing
Laboratory Division)

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SUBSURFACE EXPLORATION
AND
EVALUATION

INTRODUCTION

Project Authorization

The results of a subsurface exploration and foundation analysis for the Cameron County International Bridge in Brownsville are presented in this report. Authorization to perform the exploration and analysis was in the form of Cameron County. Purchase Order No. 23600 dated January 12, 1984. The work was performed in accordance with our January 5, 1984 proposal.

Project Location

The project is located on the Rio Grande River at the termination of International Boulevard in Brownsville, Texas.

Project Description

The International Bridge connecting Brownsville, Texas and Matamoros, Mexico was constructed in the mid 1960's and consists two spans of two lanes each. The intermediate bents consists of single caissons, the lower portions of which are 15 feet in diameter. Deck spans are reinforced concrete beam and girder except those at the abutments which are variable thickness slabs.

The focus of this exploration was Pier No. 5 which is the first bent south of the north abutment on the east or downstream span. This pier is designed to bear at elevation -26.24 feet and the as built drawings do not indicate a change. There are reports, however, that soft soils were encountered and the pier may be somewhat deeper. This pier has settled over the years attaining a significant tilt toward the southeast. Settlement measurements on the pier cap indicate random periodic movements with the southeast corner now several inches below design grade.

Project Description - Cont.

The deck span between Pier No. 5 and the abutment has moved toward the abutment. This span is 20 meter (65.6 feet) in length and is curved on the downstream side. A study and evaluation of the concrete deck slab where distress is occurring at the abutment is also part of the current study. This evaluation will, however, be reported separately.

Purpose and Scope

The purpose of this foundation exploration and evaluation was to determine the various soil profile components and the engineering characteristics of the foundation materials near Pier No. 5, to evaluate the possible causes of the settlement and to evaluate remedial measures.

The scope of the exploration and analysis included a site inspection, a review of the original soil tests and bridge plans, the subsurface exploration, field and laboratory testing, and an engineering analysis and evaluation of the foundation materials.

Two soil test borings were drilled by Professional Service Industries, Inc. at the approximate locations that are shown on the Boring Location Plan in Appendix I. These borings were drilled to depths of approximately 70 feet below the existing grades or to elevation -42 feet. The boring locations were selected by the project engineer and were located in the field by our drilling crew using normal taping procedures.

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers techniques were used to advance the boreholes. Samples of the subsurface soils were obtained using a 2 inch O.D. split-barrel sampler, or 3 inch diameter thin walled sampling tubes. Standard penetration tests were performed at various intervals in the borings in conjunction with the split-barrel sampling. All field testing and sampling were performed substantially in accordance with applicable ASTM specifications. These testing and sampling procedures are described in Appendix II of this report.

All samples of subsurface materials were visually classified by the senior project engineer, who also prepared the Logs of Borings and

Purpose and Scope - Cont.

formulated the laboratory testing program for this project. Laboratory testing included Atterberg limits, grain size analyses, unconfined compressive strength, hand penetrometer compressive strength sieve and hydrometer grain size analyses, and moisture content determinations on selected samples of soils obtained during the field sampling operations. Laboratory testing procedures and test results are included in Appendices IV and V of this report.

The information obtained from the subsurface exploration and laboratory testing was used in engineering studies to determine the causes of the foundation movements and possible remedial measures were evluated.

Subsurface Conditions

The specific types and depths of material encountered in the test borings are shown on the Logs of Borings in Appendix III. The stratification of the soil, as shown on the boring logs, represents the subsurface conditions for that boring location and variations may occur between the borings. Lines of demarcation on the borings logs represent the approximate boundary between the soil types, but this transition may be gradual.

Boring B-1 initially penetrated about 3 feet of silty clayey fine sand. Beneath this sand and from the surface at B-2, soft to stiff sandy silty clays containing gravel and rip-rap (cobbles and boulders) to depths of 11 to 12 feet. Soft to stiff greenish brown and gray sandy silty clays next extend to depths of 26 to 34 feet. A clayey sand lense was noted in this stratum in boring B-2 near the 25 foot depth.

Stiff to very stiff reddish brown silty clays was next penetrated to depths of 45 to 47 feet. Unconfined compressive strengths in this stratum range from 1.74 to 2.76 tons per square foot. A zone of very soft silty clay, also reddish brown in color was next encountered to depths of 49½ to 50 feet and at B-2, additional soft clays exist from 51½ to 52½ feet. Hand penetrometer tests were barely attainable in these very soft clays with two readings being 0.2 tons per square foot. Hydrometer grain size analyses show clay fractions in these

Subsurface Conditions - Cont.

soils to be 15 to 35 percent with the remainder being silt with a small amount of fine sand.

Below the very soft zone, generally stiff to hard reddish brown to brown silty clays extend to the 70 foot depths explored. One zone of fine sandy silt was noted between depths of 49 and 58½ feet. Sand layers similar to those reported in the 1962 borings nearby were not encountered in the current borings. The standard penetration resistance values and hand penetrometer tests indicate that the unconfined compressive strengths in this stratum are in the range of 3 to 3½ tons per square foot. One sample was suitable for laboratory testing and an unconfined compressive strength of 3.31 tons per square foot was measured.

Groundwater

Groundwater was encountered at depths of 48 and 46 feet in borings B-1 and B-2, respectively. In boring B-1, the water level rose almost immediately to a depth of 29 feet. The river level at the time of our field exploration was approximately elevation +11 feet or about 17 feet below the grades at the boring locations. It is noted that water levels will fluctuate with seasonal climatic changes and variations in the river level.

A subsurface profile summarizing the soil and groundwater information is included in Appendix I.

EVALUATION

The observed pattern of pier movements indicates that the pier has experienced base failure with periodic side shear failure as the frictional capacity of the pier is exceeded under transitory live loads.

A large layer of very soft clay was encountered in the borings just above the estimated pier bearing level. Groundwater was also encountered just above the bearing level and the rapid rise in the level in boring B-1 indicates that water is freely flowing in more permeable silt or sandy lenses and will produce unbalanced hydrostatic forces in excavations such as the borehole or a pier excavation. We

EVALUATION - Cont.

assume that the pier excavation was extended below the very soft soils. The conditions, however, offer two possibilities for disturbrance of the excavation bottom, these being heave of the bottom due to excess hydrostatics pressure, and general disturbrance or blow in of the excavation as the concrete was placed. Either would produce a major reduction in the end bearing capacity.

Whatever the original cause of the loss of end bearing, the pier in its present condition appears to have a factor of safety of about 1.0 or on the verge of failure. Failure is excessive settlement interfering with the function of the pier rather than total failure.

RECOMMENDATIONS

We recommend that a new foundation support be provided to replace the questionable pier. No load carrying value should be assigned to the existing pier in the design of the underpinning. Due to potential installation difficulties similar to those presumed to have occurred originially, we do not recommend that caissons or drilled piers be used. Rather, a driven or augercast pile foundation is recommended.

The very stiff to hard silty clays below elevation -33 are competent to support pile members. In addition significant frictional capacity can be developed between the tip elevation and elevation -5. The soils above -5 must be neglected since it is proposed to dredge the river to this level.

A variety of driven pile types would be suitable including precast concrete, concrete filled steel shell, and concrete filled steel pipe. Augered, pressure grouted or augercast piles would also be suitable and offer some advantages over driven members. The augercast piles can be placed at a specific tip elevation, without risk of overdriving, and can be installed in low headroom conditions.

It is estimated that piles will develop design capacities of 40 to 60 tons with tips driven or augered to about elevation -35 feet. The actual capacity will depend upon the material and dimensions of the pile and the installation procedure. These estimates are based

RECOMMENDATIONS - Cont.

upon an ultimate end bearing capacity of 27 kips per square foot and shaft friction of one kip per square foot in the stiff clays below elevation -5 feet. The approximately 5 foot thick very soft clay layer was neglected.

The installation of driven piles should be governed by an appropriate dynamic driving criteria such as the Hiley or Danish equations or wave equation analysis. A safety factor of 2 to 2.5 should be used. Augered piles should be installed to a preselected tip elevation. Since static analysis and the dynamic criteria are subject to wide variation, the actual pile capacities should be confirmed by conducting at least one full scale pile load test. The test should be performed in accordance with ASTM Designation D-1143.

CONSTRUCTION CONSIDERATIONS

Foundation Inspection

We recommend that the installation of all piles and the pile load test be observed by the geotechnical engineer. Complete driving records should be maintained for all driven piles. Observation of the installation of augercast piles is especially important as the normal driving criteria and inspection procedures do not apply. The successful installation of augercast piles depends upon the experience of the contractor and the use of accepted procedures. The installation must be monitored to assure that accepted practices for rate of auger retraction, pump pressures, grout mixing, grout quantity and others are uniformy followed.

Site Conditions

Pier No. 5 is located partway up the north slope. There is a dirt road passing under the span just north of the pier with 12 to 15 feet of clearance. Beginning at the north face of the pier, the river bank slopes to the water level at about a 1.1 slope. Temporary shoring and regrading will, therefore, be necessary for pile installation.

GENERAL COMMENTS

The exploration and evaluation of the foundation conditions reported herein are considered sufficient in detail and scope to form a reasonable basis for the evaluation. The recommendations submitted are based upon the available soil information and the design details furnished by the owner for the existing structure. If deviations from the noted subsurface conditions are encountered during repairs, they should also be brought to the attention of the soils engineer.

The soils engineer warrants that the findings, recommendations, specifications or professional advice contained herein, have been made after being prepared in accordance with generally accepted professional engineering practice in the fields of foundation engineering, soil mechanics and engineering geology. No other warranties are implied or expressed.

This report has been prepared for the exclusive use of Cameron County for the specific application to the Cameron County International Bridge in accordance with generally accepted soils and foundation engineering practice.

Very truly yours,

PROFESSIONAL SERVICE INDUSTRIES, INC.
(Shilstone Engineering Testing
Laboratory Division)

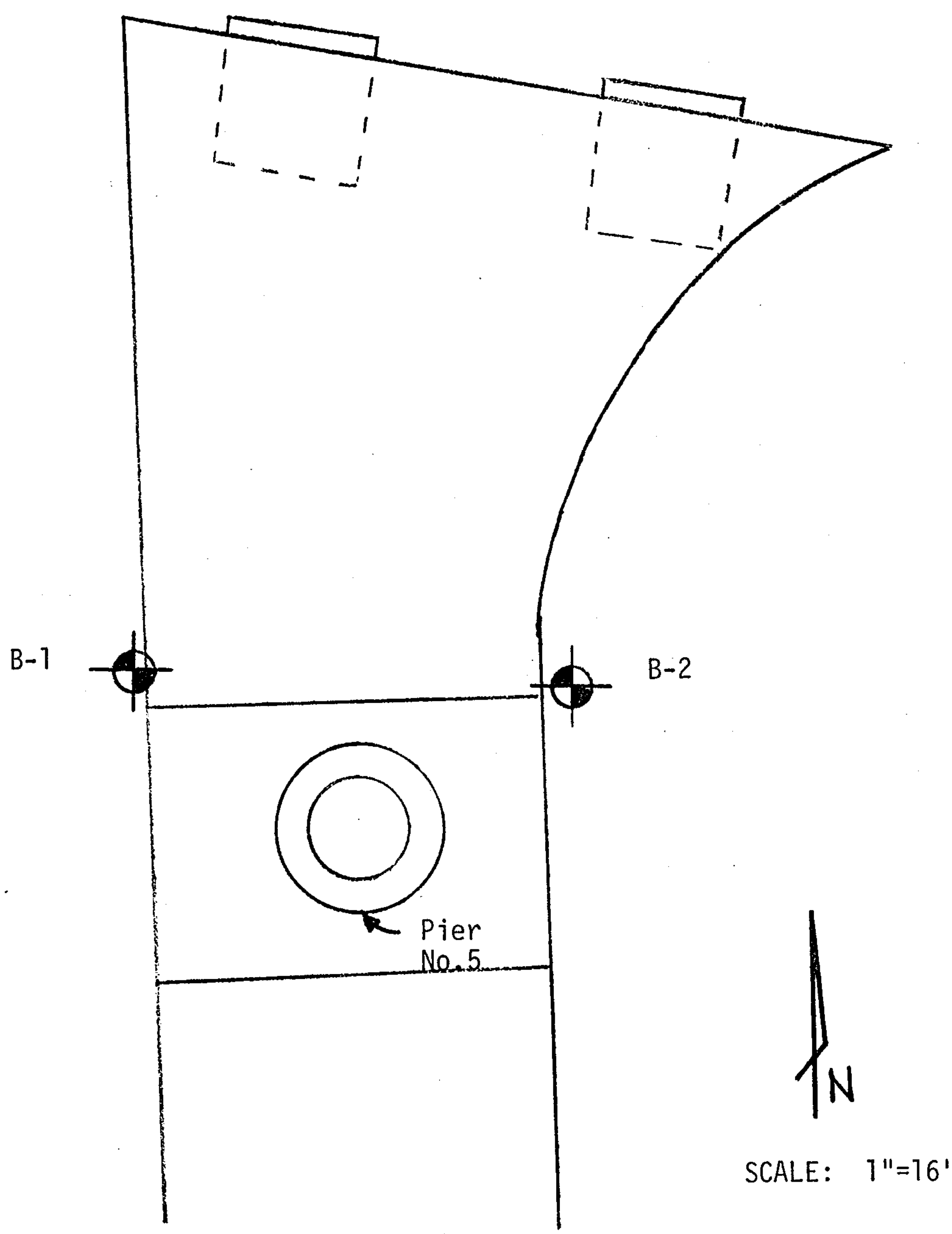
John W. Dougherty, P.E.
Senior Project Engineer

JWD/dr

APPENDIX I

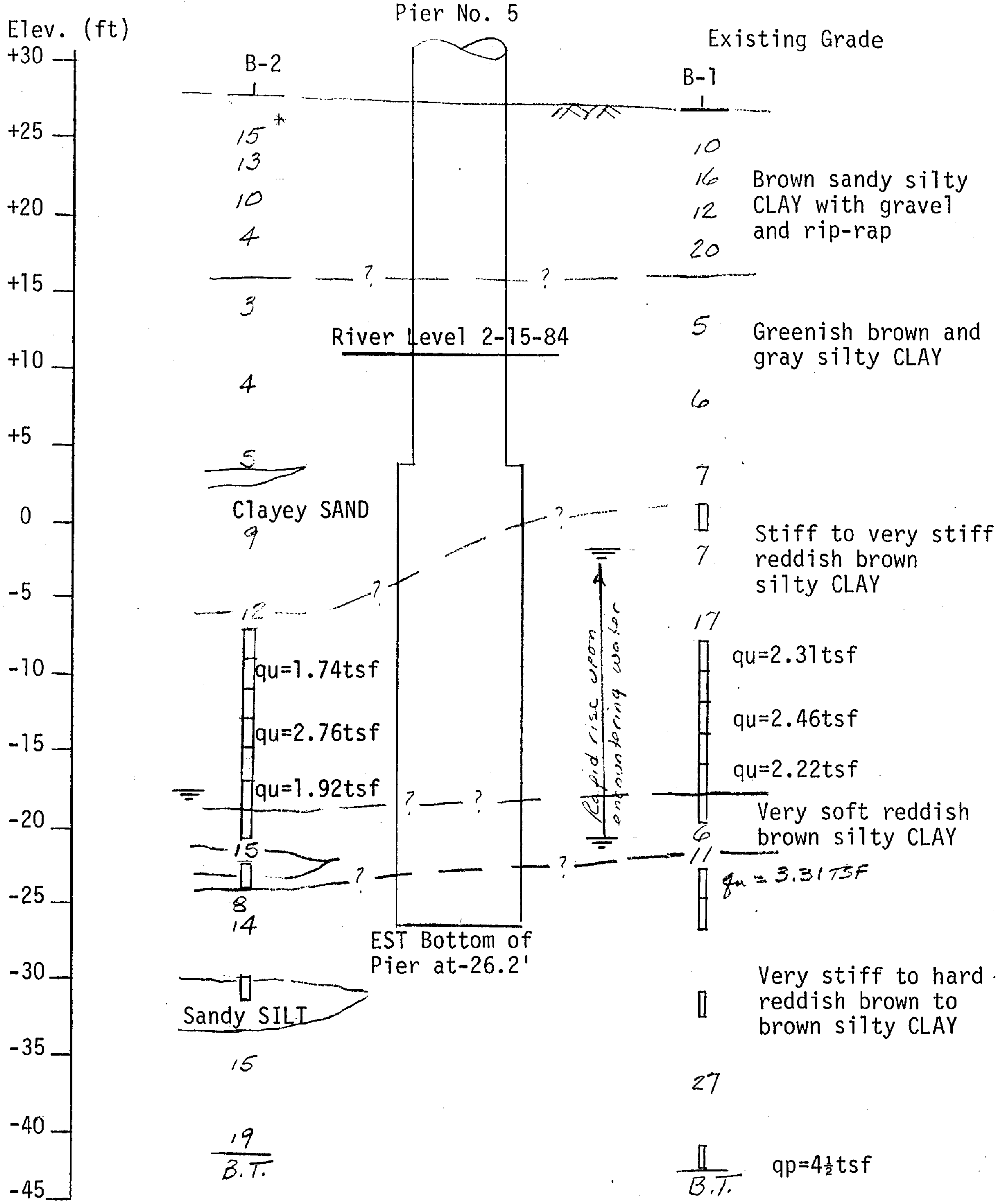
Drawings

Professional Service Industries



PROJECT NAME	BORING LOCATION PLAN	
CAMERON COUNTY INTERNATIONAL BRIDGE BROWNSVILLE, TEXAS	PROJECT NO. 312-45018	DATE 3-7-84

Professional Service Industries



* Standard Penetration Resistance

[] 3" Shelby Tube Sample

PROJECT NAME	
CAMERON COUNTY INTERNATIONAL BRIDGE BROWNSVILLE, TEXAS	GENERALIZED SUBSURFACE PROFILE PROJECT NO. 312-45018 — DATE 2-14-84

APPENDIX II

Field Testing Procedures

TESTING PROCEDURE

PENETRATION TESTS AND SPLIT-BARREL SAMPLING OF SOILS

REFERENCES: ASTM Specification D-1586

SCOPE This procedure briefly describes the methods and procedures used by Shilstone Engineering Testing Laboratory, Inc. to obtain representative soil samples from small diameter borings for identification, testing and measuring the resistance of the soil to the penetration of the sampler.

EQUIPMENT: The equipment used includes a modern drilling machine, with pumps and accessories, capable of drilling to the required depths and cleaning out the boring for the insertion of the sampler, having dimensions and designed according to ASTM Specification D-1586; a drive assembly consisting of a 140 pound weight, a driving head, and a guide permitting a free fall of 30 inches; and accessory equipment including labels, sample jars, data sheets and other essential equipment for soil sampling.

PROCEDURE: The hole is initially drilled to the desired sampling level, using augers or rotary methods, as shown on the DRILLING SUMMARY SHEET. After cleaning the loose cuttings from the boring, the sampler is then carefully lowered to the bottom. The sampler is then driven with blows from the 140 pound hammer falling 30 inches, until either 18 inches have been penetrated, or 100 blows have been applied. The number of blows required for driving each six-inch increments is then recorded. The first six inches are considered a seating drive and the second and third increments are added to give a value termed, the penetration resistance, N, (blows per foot). In the event the blows required to drive the first six inches exceeds 50 blows per foot, the sampler is then driven only a distance of one foot or until the total blows equal 100. If only a fraction of a foot is driven, the distance driven and the number of blows are recorded, example, 100/7".

After completion of driving the sampler is brought to the surface and opened. The soils are then examined and classified. Representative portions are then sealed in glass jars, labeled, and shipped to our laboratory for review and storage.

REPORT: The name of the job and location are given on the attached BORING PLAN; the date of boring, type and size of sampler, type and make of machine, rod size, size of casing (if required), names of crewman and weather are included on the DRILLING SUMMARY SHEET. The attached LOGS OF BORINGS depict the soil description, approximate layer thickness, penetration resistance, groundwater data and any significant notations made during drilling.

TESTING PROCEDURE

THIN-WALLED TUBE SAMPLING OF SOILS "SHELBY TUBE METHOD"

REFERENCES: ASTM Specification D-1587
Hvorslev, M.J., Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes, East 47 Street - New York, New York 10017

SCOPE: This procedure briefly describes the methods and procedures used by Shilstone Engineering Testing Laboratory, Inc. to secure relatively undisturbed soil samples from small diameter borings, which are suitable for laboratory testing. This procedure describes only the open tube type sampler, often referred to as the "Shelby Tube" method.

EQUIPMENT: The equipment used includes a modern drill, with pumps and accessories capable of drilling and cleaning out a hole extending to the desired sampling level; rods and accessories to connect to the tube sampler; a properly designed sampling head with vents and including a check valve and set screws or other reliable measures for tube connection; thin-walled, steel tubes, meeting the requirements of ASTM Specification D-1587 and essential sampling, sealing, and shipping supplies.

PROCEDURE: The hole is initially drilled to the desired sampling level, using augers or rotary methods as described on the attached DRILLING SUMMARY SHEET. After cleaning the cuttings, the sampler is then carefully lowered to the bottom. The hydraulic feed of the rig is then used to push the tube the desired distance. The tube is forced in a continuous and rapid manner without impact or twisting. The depth of sampling, hydraulic pressure exerted, and length of push are then recorded. In the event hard soils are encountered, the sampler may be driven with a 140 pound hammer. In this case, the hammer weight, height of drop, number of blows and length of penetration are recorded. Before pulling the tube, the tube is rotated at least two complete turns to shear the sample from the bottom.

Upon removal, the sample and tube are examined and cleaned of sludge of cuttings. The length of sample recovered is then measured and recorded, and a small representative sample removed from both ends for identification purposes. The sample is extruded and placed in a sealed polyethylene bag for return to the laboratory for review, testing and storage.

REPORT: The sampling depths and recoveries are given on the LOGS OF BORINGS Additional information concerning crews, methods, equipment and weather are included on the DRILLING SUMMARY SHEET.

APPENDIX III

Subsurface Materials and Drilling Conditions

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-1 (Page 1 of 2 pages)

Project Name: Cameron County International Bridge   Date of Boring: 2-14-84

Site: Brownsville, Texas   Project No.: 312-45018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
SURFACE							4" Topsoil
Medium dense brown silty clayey fine SAND		SS 1	10			17	
Stiff brown sandy silty CLAY with gravel and rip-rap to 10'		SS 2	16		1.6	19	
	5	SS 3	12		1.3	13	
	10	SS 4	20		2.0	24	
Stiff greenish gray sandy silty CLAY	15	SS 5	5		1.0	28	
	20	SS 6	6			24	
	25	SS 7	7		1.5	25	
Stiff to very stiff reddish brown silty CLAY		ST 8	-				
	30	ST 9	7				
		ST10	17				
	35	ST11	-	2.31	3.0	29	γ_d=98.6pcf
		ST12	-				
	40	ST13	-	2.46	3.5	27	γ_d=101.6pcf
		ST14	-				
		ST15	-	2.22	1.5	23	γ_d=104.3pcf
Continued on page 2	45						

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-1 (Page 2 of 2 pages)

Project Name: Cameron County International Bridge   Date of Boring: 2-14-84

Site: Brownsville, Texas   Project No.: 312-45018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
Very soft reddish brown silty CLAY		ST16	-		0.2	28	LL=32 PI=19
		SS17	6		0.2	28	
Very stiff reddish brown silty CLAY	50	SS18	11				
		ST19	-	3.31	4.5	26	γ_d=97.8pcf
		ST20	-				
	55						
	60	ST21	-				
Hard brown silty CLAY	65	SS22	27				
		ST23	-	1.18	4.5	23	γ_d=102.1pcf
Boring Terminated	70						

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-2

Project Name: Cameron County International Bridge   Date of Boring: 2-15-84

Site: Brownsville, Texas   Project No.: 312-45018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
SURFACE							4" Topsoil
Stiff to soft greenish gray fine sandy silty CLAY with gravel and rip-rap to 8'		SS 1	15				
	5	SS 2	13				
		SS 3	10				
	10	SS 4	4				
Soft greenish brown silty CLAY	15	SS 5	3				
	20	SS 6	4				
Loose dark gray clayey SAND	25	SS 7	5				
Stiff greenish brown silty CLAY	30	SS 8	9				
Very stiff reddish brown silty CLAY		SS 9	12				
	35	ST10	-				
		ST11	-	1.74	4.0	27	γ_d =98.6pcf
	40	ST12	-				
		ST13	-	2.76	3.1	30	γ_d =97.4pcf
		ST14	-				
Continued on page 2	45						

Professional Service Industries, Inc.

RECORD OF SUBSURFACE EXPLORATION

Boring B-2 (Page 2 of 2 pages)

Project Name: Cameron County International Bridge   Date of Boring: 2-15-84

Site: Brownsville, Texas   Project No.: 312-45018

DESCRIPTION	DEPTH	SAMPLE	N	Q_u	Q_p	M_c	REMARKS
Very stiff reddish brown silty CLAY		ST15	-	1.92	3.0	27	γ_d=104.5pcf
Very soft reddish brown silty CLAY		ST16	-			29	
	50	SS17	15				
Very stiff reddish brown silty CLAY							
Soft to firm reddish brown silty CLAY		ST18	-		3.5	27	
		SS19	8				
Stiff brown silty CLAY	55	SS20	14				
Stiff brown fine sandy SILT		ST21	-			31	
	60						
Very stiff reddish brown silty CLAY		SS22	15				
	65						
		SS23	19				
	70						
Boring Terminated							

DRILLING SUMMARY SHEET

CREW: C. Jones, C.R. Weust

RIG MAKE: CME-55

METHOD OF DRILLING: Hollow Stem Auger

SAMPLING METHOD & ROD SIZE: ASTM D-1586, D-1587, AW Drill Rod

DRILLING DATA:

Date	Boring No.	Soil Test Boring (lf)	Casing (lf)	Rock Coring (lf)	UD	Spt.
2-14-84	B-1	70	-	-	11	12
2-15-84	B-2	70	-	-	9	14

WEATHER DATA:

Date	Weather	Temperature	Borings Drilled
2-14-84	Clear	73°F	B-1
2-15-84	Partly Cloudy	70°F	B-2

Prepared by: JWD Date: 3-5-84 Remarks:

Page 1 of 1 Job No.: 312-45018

APPENDIX IV

Laboratory Testing Procedures

TESTING PROCEDURE

PLASTICITY INDEX OF SOILS

REFERENCES: ASTM Specification D-423
ASTM Specification D-424
T.W. Lamb, Soil Testing for Engineers, John Wiley and Sons, Inc., 1962, Chapter 3, "Atterberg Limits and Indices",pp. 22-28

PURPOSE AND SCOPE: Atterberg limits or plasticity tests are performed to determine the soil classification and plasticity properties of the soil specimen. These properties can be correlated to values of permeability, strength, compressibility and shrink or swell.

EQUIPMENT: The equipment includes a liquid limit device, grooving tools, spatula, balances, evaporating dish, ovens and other apparatus as described by the reference specifications.

PROCEDURE: The liquid limit of a soil is the water content, expressed as a percentage of the weight of the oven dry soil, at the boundary between the liquid and plastic states. The plastic limit is the water content expressed as a percentage of the oven dry soil weight, at the boundary between the plastic and semisolid states. The difference between these two values is the plasticity index (PI).

The liquid limit is determined, as described by ASTM Specification D-423, by obtaining the water content at which the soil will flow under a specified dynamic force. The soil is wetted, placed in a special liquid limit device and grooved into two halves. The device is then dropped a specified distance 25 times. The liquid limit is defined as the water content at which the two halves flow together.

The plastic limit is determined, as described by ASTM Specification D-424, by obtaining the water content at which the soil can be rolled into thin threads by hand on a ground glass or non-absorption paper. The plastic limit is defined as the moisture content at which the soil can be rolled to a thread one-eighth inch in thickness.

REPORT: The Atterberg limits, including the sample number, liquid limit, plastic limit and plasticity indices are given on either the attached Grain Size Distribution Sheet or the SUMMARY OF LABORATORY TEST RESULTS.

TESTING PROCEDURE

PARTICLE SIZE ANALYSIS OF SOILS

REFERENCES ASTM Specification D-421
ASTM Specification D-422
ASTM Specification D-2217

SCOPE: This procedure briefly describes the laboratory procedures followed by Shilstone Engineering Testing Laboratory, Inc. in the determination of the grain size distribution of soils. The grain size data are often applied to correlate other important properties of permeability, compressibility and strength.

EQUIPMENT: The equipment used includes sieves, balances, hydrometers, mixers, thermometers and assorted laboratory equipment and agents as noted in the various references.

PROCEDURE: The test samples can be prepared using either the dry method or wet method as described in the various references. After preparation, the test can be divided into two parts, the determination of the size and distribution of the fines. The division between the two tests is the No. 200 sieve. The coarse fraction is tested using the sieve method whereas the fines are tested using the hydrometer method. If both tests are performed, the test is referred to as the combined analysis.

In the sieve analysis of the coarse fraction, the soil is passed through a series of sieves, and the weight retained on each sieve is determined. The distribution of weights is then computed and the percent passing is plotted for display.

In the hydrometer method, the particle size is determined by Stoke's equation. The soil is mixed in a heavy slurry and the rate of sedimentation is measured with a hydrometer. The data can then be reduced to a distribution of particle size and percent finer as in the sieve analysis.

REPORT: The data is reported on the attached Grain Size Distribution Sheets or Laboratory Tests Data Sheet.

TESTING PROCEDURE

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL

REFERENCES: ASTM Specification D-2166
Lamb, T.W., Soil Testing for Engineers, John Wiley and Sons, Inc.

SCOPE This procedure briefly describes the procedures used by Shilstone Engineering Testing Laboratory, Inc. to test the unconfined compressive strength of undisturbed and/or remolded cohesive soil samples.

EQUIPMENT: The equipment required for this test includes: unconfined compression machine, specimen trimmer and accessories, membranes, balance, drying oven, moisture content cans and spatula.

PROCEDURE: Single sections of representative undisturbed or remolded samples of soil are trimmed to a diameter of 2-7/8 inches and an approximate height of 6 inches. The sample is then placed in the compression machine and, after obtaining the initial readings on the proving ring and vertical deflection dial gauge, the sample is loaded in compression. The vertical compression load is increased continuously to produce a selected constant rate of strain (between 0.5% and 2.0%, depending upon the soil type). Periodically, the proving ring and deflection dial gauges are read and recorded. The vertical load is continually increased until a shear failure occurs in the sample or until the total strain is equal to 20 percent, whichever occurs first.

REPORT: The sample identification, maximum axial stress produced, unit weight and natural water content are included on the LOGS OF BORINGS.

APPENDIX V

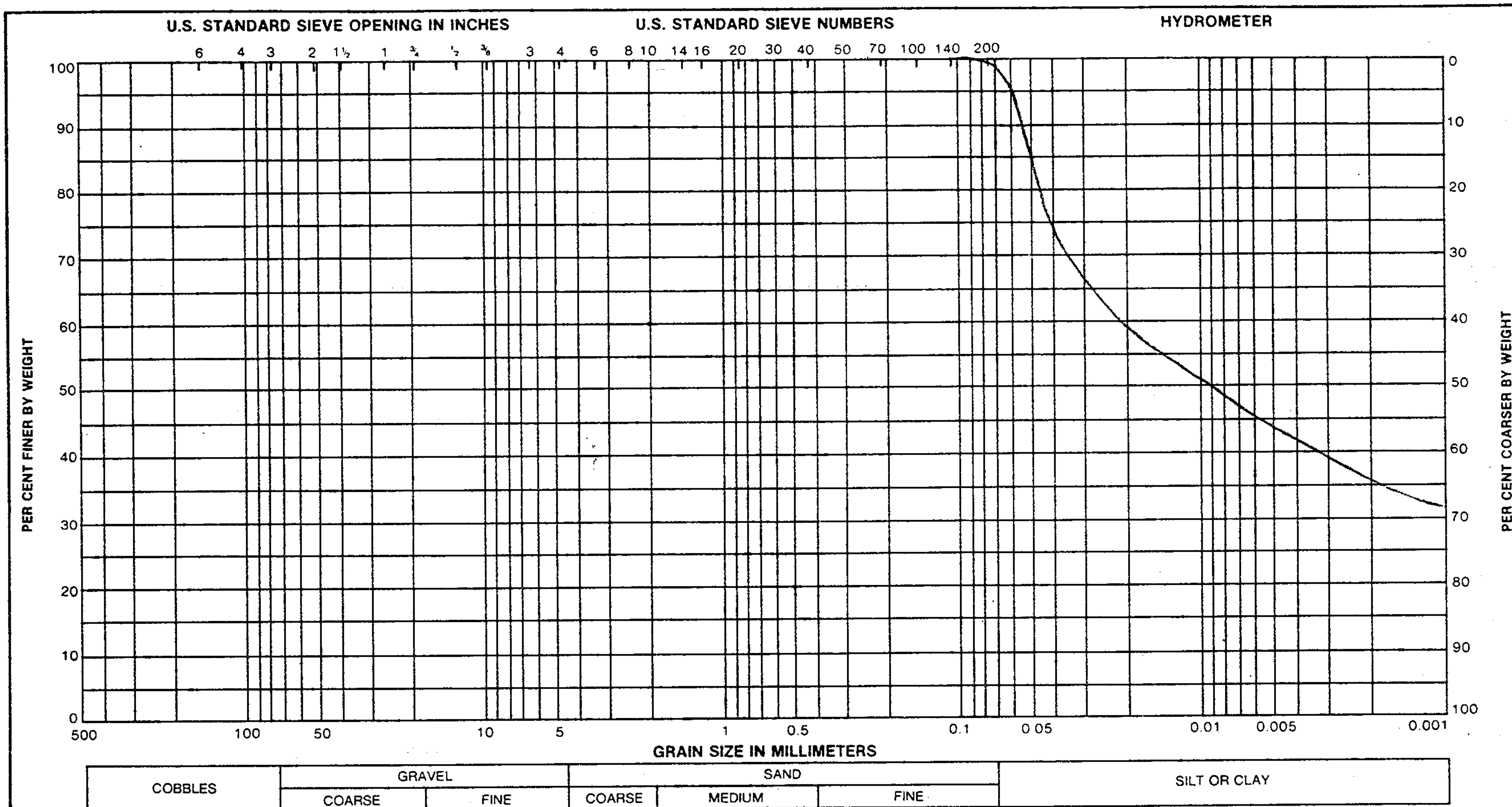
Laboratory Test Results

312-45018

SUMMARY OF TEST RESULTS

ATTERBERG LIMITS & GRADATION

Test Hole No.	Depth in Feet	LL	PI	LS	% Passing Sieve #4	% Passing Sieve #40	% Passing Sieve #200	Description
B-1	45-47	32	19	11	100	100	97	Reddish brown silty CLAY (CL)
B-2	47-49	26	11	6	-	-	-	Reddish brown silty CLAY (CL)
B-2	58½-60	-	-	-	100	99	62	Brown fine sandy SILT (ML)

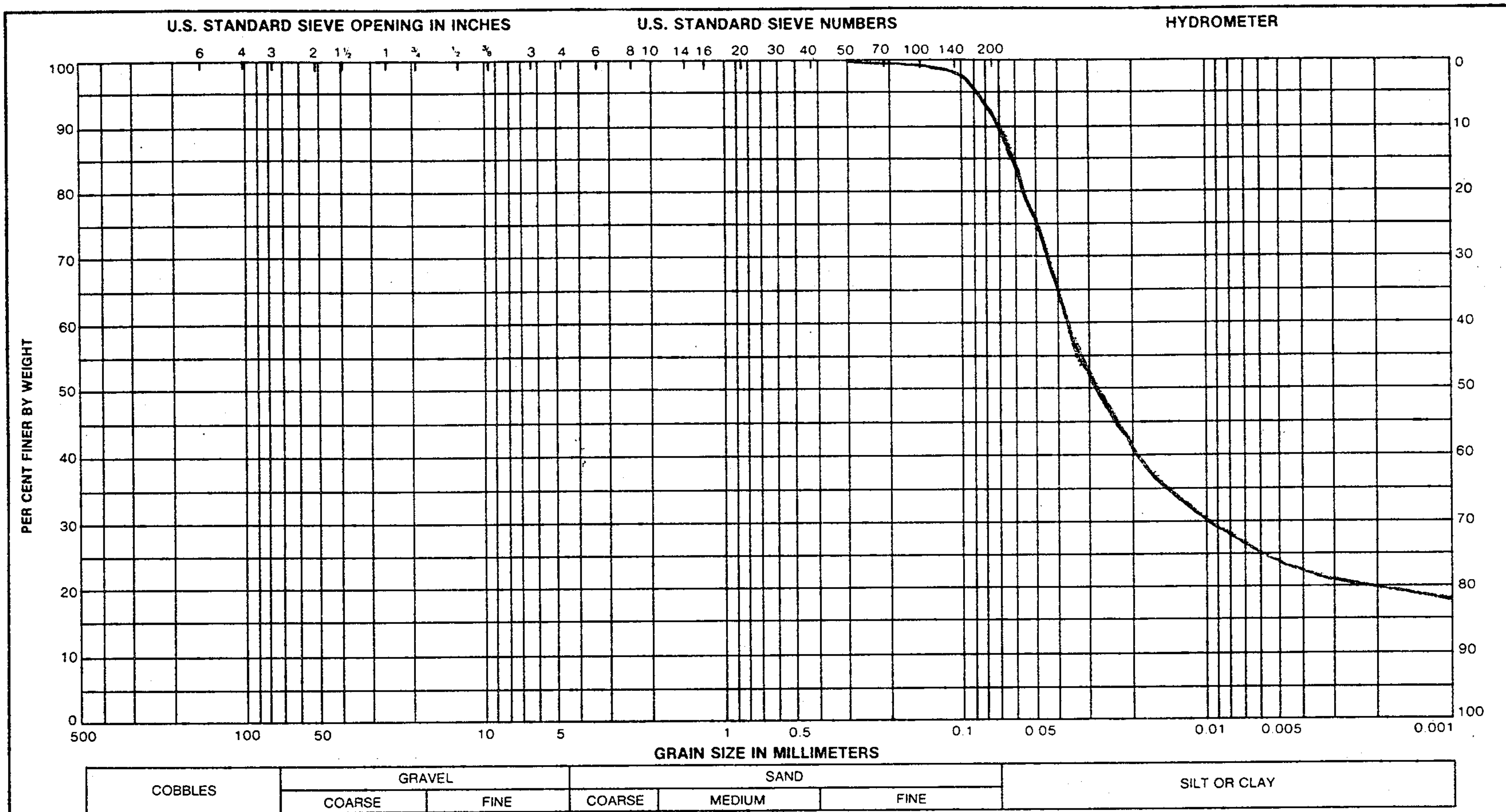


Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
B-1	SS17	48-5	Reddish brown silty CLAY					CAMERON COUNTY INTERNATIONAL BRIDGE BROWNSVILLE, TEXAS

REPORT OF SOIL ANALYSIS

File No. 312-45018

Professional Servi[...]dustries

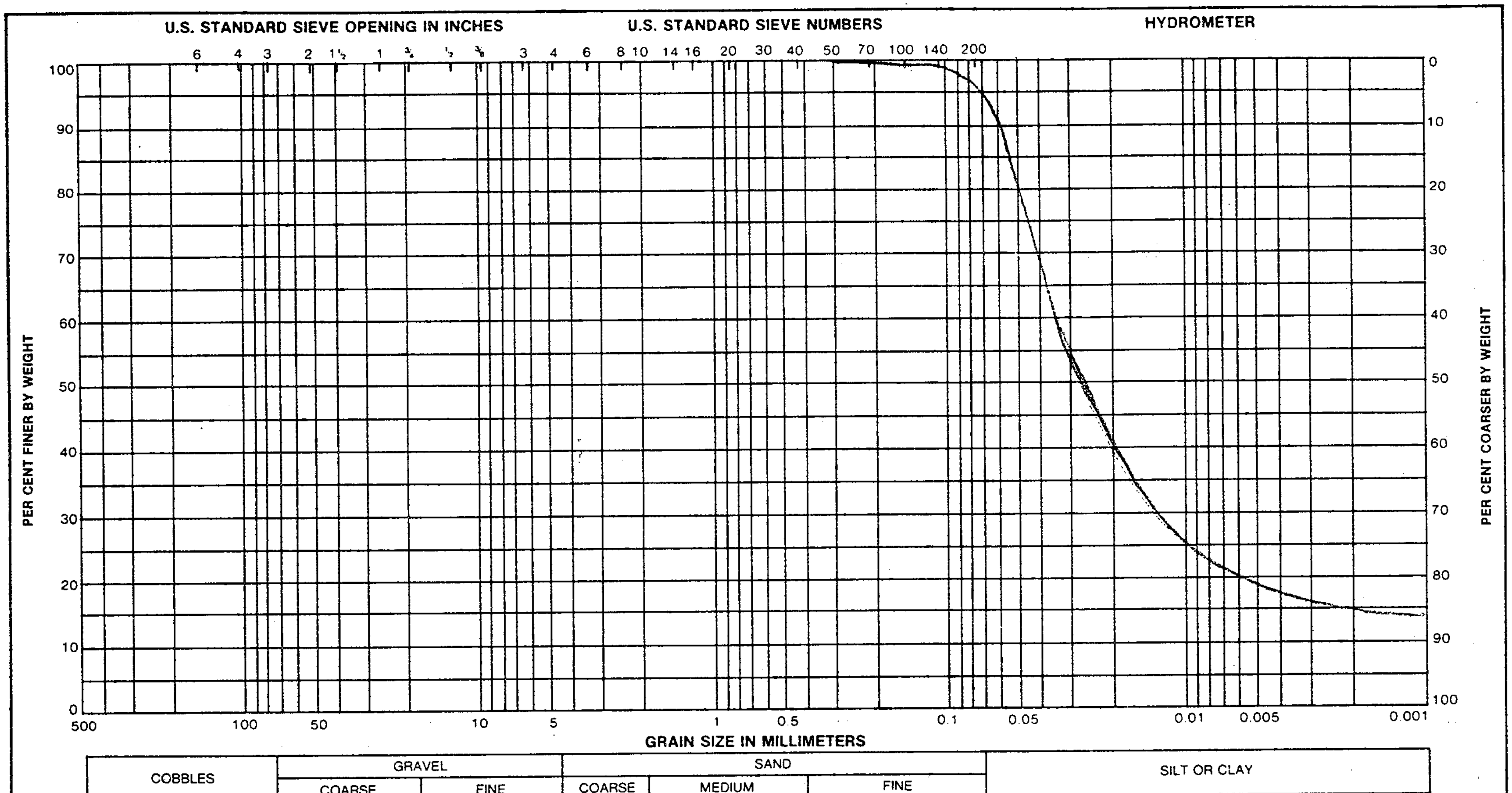


Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
B-2	ST16	47-49	Reddish brown silty CLAY		26	15	11	CAMERON COUNTY
								INTERNATIONAL BRIDGE
								BROWNSVILLE, TEXAS

REPORT OF SOIL ANALYSIS

File No. 312-45018

Professional Servi dustries



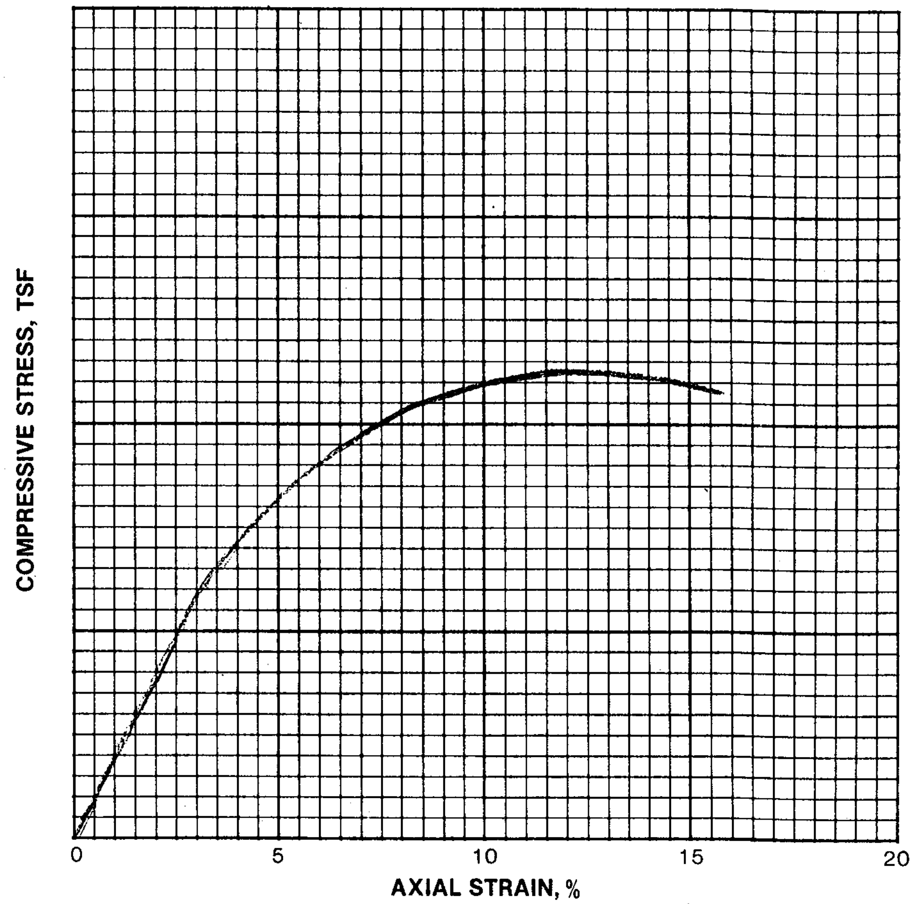
Boring No.	Sample No.	Elev. or Depth	Classification	Nat w %	LL	PL	PI	Project
B-2	SS19	50 to 51.5	Reddish brown clayey SILT					CAMERON COUNTY INTERNATIONAL BRIDGE BROWNSVILLE, TEXAS

REPORT OF SOIL ANALYSIS

File No. 312-45018

Professional Servic.. ndustries

FAILURE SKETCHES



☐ Controlled stress

☐ Controlled strain

Boring No.		B-1
Sample No.		15
Depth, Ft.		45'
Type of specimen		ST
Initial specimen diameter, in.		2.8
Initial specimen height, in.		6.0
Initial	Water content %	22.9
	Void ratio	
	Saturation, %	
	Dry density, pcf	104.3
Time to failure, min.		7.5
Unconfined compressive strength, tsf		2.22
Undrained shear strength, tsf		1.11
Classification		

LL	PL	PI	G_s

PROJECT NAME

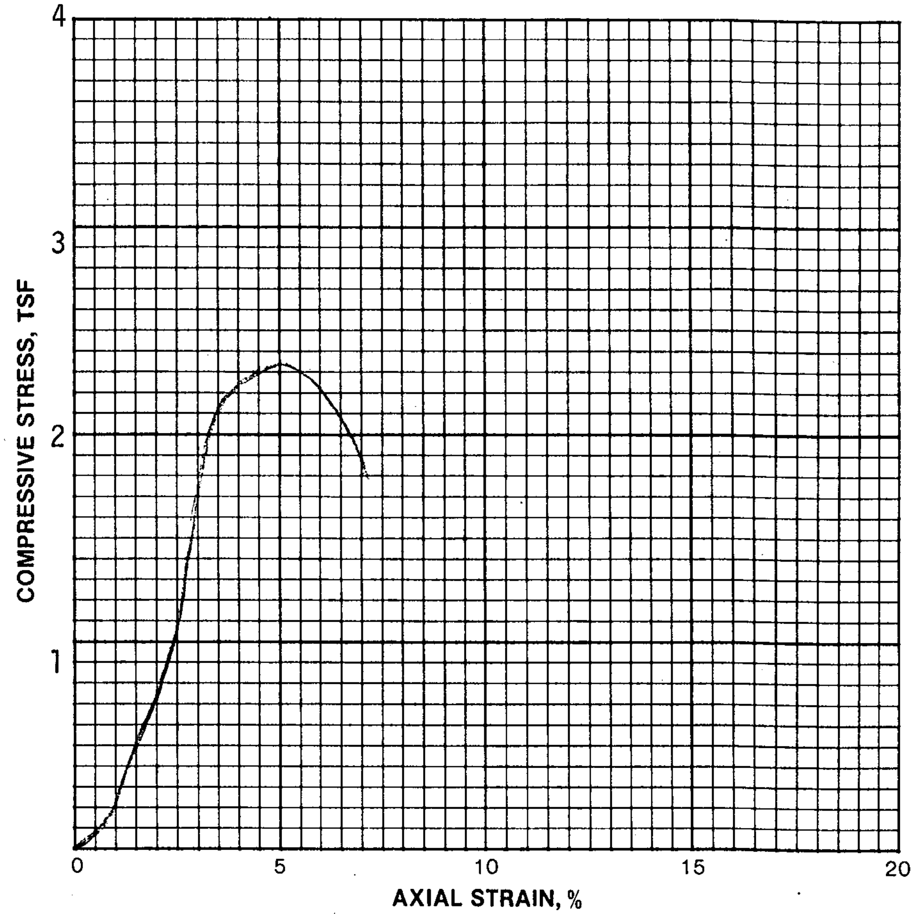
CAMERON COUNTY
INTERNATIONAL BRIDGE
BROWNSVILLE, TEXAS

UNCONFINED COMPRESSION TEST

PROJECT NO.	DATE
312-45018	2-22-84

Professional Service Industries

FAILURE SKETCHES



☐ Controlled stress

☐ Controlled strain

Boring No.		B-1
Sample No.		11
Depth, Ft.		37
Type of specimen		ST
Initial specimen diameter, in.		2.8
Initial specimen height, in.		6.1
Initial	Water content %	28.7
	Void ratio	
	Saturation, %	
	Dry density, pcf	98.61
Time to failure, min.		2.5
Unconfined compressive strength, tsf		2.31
Undrained shear strength, tsf		1.16
Classification		

LL	PL	PI	G_S

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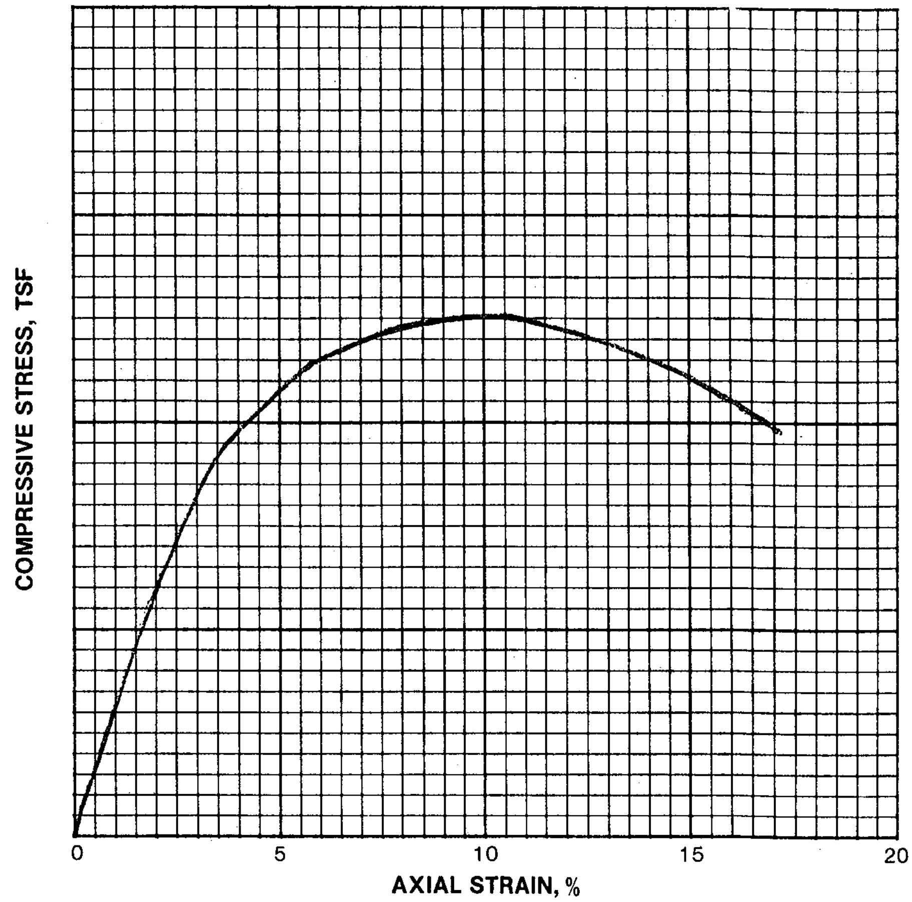
FAILURE SKETCHES



☐ Controlled stress

☐ Controlled strain

Boring No.		B-1
Sample No.		13
Depth, Ft.		41'
Type of specimen		ST
Initial specimen diameter, in.		2.8
Initial specimen height, in.		6.1
Initial	Water content %	27.2
	Void ratio	
	Saturation, %	
	Dry density, pcf	101.6
Time to failure, min.		5.5
Unconfined compressive strength, tsf		2.46
Undrained shear strength, tsf		1.23
Classification		

LL	PL	PI	G_S

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GENERAL NOTES

SAMPLE IDENTIFICATION

The Unified Soil Classification System is used to identify the soil unless otherwise noted.

SOIL PROPERTY SYMBOLS

N: Standard "N" penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split-spoon.

Qu: Unconfined compressive strength, TSF

Qp: Penetrometer value, unconfined compressive strength, TSF

Mc: Water content, %

LL: Liquid limit, %

PI: Plasticity Index, %

δ d: Natural dry density, PCF

▼: Apparent groundwater level at time noted after completion.

DRILLING AND SAMPLING SYMBOLS

SS: Split-Spoon - 1 3/8" I.D., 2" O.D., except where noted.
ST: Shelby Tube - 3" O.D., except where noted.
AU: Auger Sample.
DB: Diamond Bit.
CB: Carbide Bit.
WS: Washed Sample.

RELATIVE DENSITY AND CONSISTENCY CLASSIFICATION

TERM (NON-COHESIVE SOILS)	STANDARD PENETRATION RESISTANCE
Very Loose	0 - 2
Loose	2 - 4
Slightly Compact	4 - 8
Medium Dense	8 - 16
Dense	16 - 26
Very Dense	Over 26

TERM (COHESIVE SOILS)	Qu - (TSF)
Very Soft	0 - 0.25
Soft	0.25 - 0.50
Firm (Medium)	0.50 - 1.00
Stiff	1.00 - 2.00
Very Stiff	2.00 - 4.00
Hard	4.00+

PARTICLE SIZE

Boulders	8 in. +	Coarse Sand	5mm-0.6mm	Silt	0.074mm-0.005mm
Cobbles	8 in.-3 in.	Medium Sand	0.6mm-0.2mm	Clay	-0.005mm
Gravel	3 in.-5mm	Fine Sand	0.2mm-0.074mm		