SUBSURFACE INVESTIGATION & RECOMMENDATIONS

DES NO: 0710073
PROJECT NO: N/A
LANDSLIDE ON SR 37, RP 11.4
PERRY COUNTY, INDIANA

PREPARED BY:
ALT & WITZIG ENGINEERING, INC.
GEOTECHNICAL DIVISION
PROJECT NO: 07IN0101

PREPARED FOR
INDIANA DEPARTMENT OF TRANSPORTATION
INDIANAPOLIS, INDIANA

AUGUST 27 2007

Alt & Witzig Engineering, Inc.
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August 27, 2007

Indiana Department of Transportation
Office of Geotechnical Engineering
ATTN: Mr. Athar Khan
120 South Shortridge Road
Indianapolis, Indiana 46219

RE: Subsurface Investigation &
Landslide Recommendations
Des No.: 0710073
Landslide on SR 37 at RP 11.4
Perry County, Indiana
Alt & Witzig File: 07IN0101

Gentlemen:

In compliance with your request, we have completed a subsurface investigation and evaluation for the above referenced project. It is our pleasure to transmit herewith a copy of the report.

The results of our test borings, laboratory tests, and engineering analyses are presented in the appendix of the report. Our recommendations for the project are presented in the "Discussion and Recommendations" section of the report.

If you have any questions, or if we can be of further service, please contact us at your convenience.

Very truly yours,

ALT & WITZIG ENGINEERING, INC.

David C. Harness, P.E.

DCH/bkm

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SUMMARY

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A subsurface exploration and evaluation of the subsurface conditions has been conducted at the location of the Landslide at SR 37 in Perry County, Indiana. The landslide was noted in late 2006/early 2007 at RP 11.4 on the west side of the roadway.

General

Our subsurface investigation included reconnaissance of the project site, coordinating with a dozer to access the boring locations, surveying, and drilling seven (7) soil borings. The borings drilled through the existing embankment soil encountered predominantly cohesive soils, characterized as A-6 Clay, Clay Loam, Loam, Silty Clay Loam, and A-7-6 Silty Clay. Gray Clay Shale was encountered at the termination depth of each boring. Groundwater was found to be as shallow as three (3) feet below existing grade in some areas.

Slope Stability-Landslide

The landslide was fully developed at the time of our investigation and appeared to stretch from Station 9+75 to 13+50. Vertical and horizontal movements at the top of the slope at the time of our drilling were twelve (12) feet and sixteen (16) feet, respectively. The guardrail along the west side of SR 37 has been destroyed. The base of the landslide was easily identifiable by a toe bulge at an approximate offset of 240 LT of Line SR 37. The sides of the slide were not as easily identified in the brush and trees. With global stability geometry established, soil strength parameters were altered until a factor of safety of just less than one was achieved.

Landslide Remediation

Based upon the soil conditions and relative cost, we feel that rammed aggregate piers (RAP) will provide the best solution to the current instability. We recommend RAPs be installed at 25% replacement density between offsets 125 LT and 95 LT from Stations 9+75 to 13+50. The composite section of RAPs and soil yields cohesion of 394 psf and an angle of internal friction of 16.6 degrees. It is estimated that 525 to 550 piers, 30 inches in diameter, will be necessary based upon a triangular pattern with a center to center spacing of 4.75 feet. We have assumed a bench elevation of 465 feet between the 125 and 95 LT offsets on which to install the piers. Thus, the RAPs will be twenty-eight (28) to thirty (30) feet in length.

SUBSURFACE INVESTIGATION
AND
GEOTECHNICAL RECOMMENDATIONS

INTRODUCTION

General

This report presents the results of a subsurface investigation for the Landslide Remediation along SR 37 in Perry County, Indiana. This investigation was performed for the Indiana Department of Transportation of Indianapolis, Indiana. Authorization to perform this investigation was in the form of a notice to proceed from Athar A. Khan of the Office of Geotechnical Engineering at the Indiana Department of Transportation (INDOT) to Alt & Witzig Engineering, Inc.

The scope of this investigation included a review of geological maps, review of geologic and related literature, a reconnaissance of the immediate site, subsurface exploration, field and laboratory testing, and engineering analysis and evaluation of the materials.

The purpose of this subsurface investigation was to determine the engineering characteristics of the subsurface materials and to provide a remedial design for the landslide and slope reconstruction.

DESCRIPTION OF SITE

Site Location

The site of landslide is located on the west side of the road at RP 11.4 of SR 37 in Perry County, Indiana. The nearest intersection is SR 70 located approximately ½ mile to the south. The western boundary of the site is adjacent to Hoosier National Forest. The site can be found on the Derby 7.5 Minute Topographic Map in Township 5 South, Range 2 West, Section 22. The location is depicted on the Site Location Plan provided in Appendix A.

Site Topography and Drainage

The site of the landslide is on the west side of an embankment built to carry SR 37 over a valley that used to drain to the west-northwest. The embankment is approximately fifty (50) feet high based upon the cross sections provided by INDOT. The former drainage channel appeared to be a steep, narrow channel trending to the west-northwest, likely cut directly into the shallow bedrock.

Ground cover at the site at the time of our investigation consisted of brush and large trees beyond the guardrail. A portion of the slide exists inside the guardrail and unpaved shoulder of SR 37. The surrounding areas are moderately developed with overhead and underground utilities, paved roadways and occasional residential and commercial structures.

General Geology

The site is located in the Crawford Upland Section of the Shawnee Hills Natural Region of the State of Indiana. The Soil Survey Map of Perry County indicates that the shallow soils over the project area are mostly residual soils of the Zanesville-Wellston-Gilpin Series derived from the underlying bedrock.

The bedrock encountered during the borings consisted of gray clay shale of the Raccoon Creek Group of Pennsylvanian Age. This bedrock unit is comprised of shale, siltstone and limestone and is very near the ground surface near the site.

FIELD INVESTIGATIONS

Scope

Field investigations to determine the engineering characteristics of the subsurface materials included a reconnaissance of the project site, drilling seven (7) borings as shown on the Boring Location Plan (Appendix A), performing standard penetration tests, obtaining soil samples retained in the standard split-spoon samplers, and obtaining samples of the bedrock through coring. The apparent groundwater level at the boring locations was also determined. The field investigations began in late January 2007 and were completed in June 2007.

During the investigation, the weather was partly cloudy to sunny with temperatures ranging between seventy-five (75) and eighty-five (85) degrees Fahrenheit during the day.

Drilling and Sampling Procedures

The soil borings were performed with a drilling rig equipped with a rotary head. Conventional hollow-stem augers were used to advance the holes. Representative samples were obtained employing split-spoon sampling procedures in accordance with ASTM D-1586. Bedrock was sampled with wire line NQ2 coring equipment in accordance with ASTM D 2113.

Field Tests and Measurements

Penetration tests. During the sampling procedure, standard penetration tests were performed at regular intervals to obtain the standard penetration value of the soil. The standard penetration value is defined as the number of blows a 140-pound hammer, falling thirty (30) inches, required to advance the split-spoon sampler one (1) foot into the soil. The results of the standard penetration tests indicate the relative density and comparative consistency of the soils, and thereby provide a basis for estimating the relative strength and compressibility of the subsurface materials.

Water level measurements. Groundwater levels measured during drilling and upon completion of the drilling was found as shallow as five (5) feet in B-6. Most borings were dry to the termination depth of the borings. The groundwater levels measured from each boring location are included in boring logs.

Ground surface elevation. The elevations of the ground surface on the boring logs were determined by surveying the locations with a total station. The actual elevation values were determined using the cross section plans provided by INDOT. The ground surfaces reported on the individual logs are referenced from existing ground surface.

Log of Test Borings. The field data collected during this investigation were recorded on by the drilling crew and field engineer. A copy of the finalized logs, B-1 through B-7 are included in Appendix A along with a General Notes page which describes symbols and notations shown on the boring logs.

LABORATORY INVESTIGATIONS

In addition to the field investigations, a supplemental laboratory investigation was conducted to ascertain additional pertinent engineering characteristics of the subsurface materials necessary in analyzing the landslide remediation.

All phases of the laboratory investigation were conducted in general accordance with applicable AASHTO Specifications and INDOT's Geotechnical Manual.

The laboratory-testing program included supplementary visual classification on all samples. Atterberg limit, moisture content, pH, unit weight, and unconfined compression tests, and grain size analyses were performed on representative soil samples. The results of our testing are located in Appendix B of the report.

DISCUSSION AND RECOMMENDATIONS

Project Description

The project will consist of reconstructing an embankment slope after failures due to slope instability in Perry County, Indiana. At the time of this report, SR 37 is open and the paved shoulder immediately adjacent to the landslide has not failed. However, reconstruction of the slope should take place as soon as possible to avoid further deterioration of the embankment supporting SR 37. Additional movement of the slope at the top of the embankment would likely encroach onto the pavement section of SR 37 and would likely force road closure.

In February 2007 INDOT Office of Geotechnical Engineering provided Alt & Witzig Engineering, Inc. with several cross sections taken along the roadway. These cross sections depicted the roadway embankment and slide features from a surface topography standpoint. These cross sections are provided in Appendix C for reference and were used to establish our cross section used during slope stability analyses. However, it should be noted that over five (5) more feet of vertical movement has occurred since the original survey of the landslide and the writing of this report. Therefore, it is recommended that prior to remedial activities, the slide area be surveyed to provide at least a two-foot contour elevation topographic survey.

Existing Slope Stability

The landslide was fully developed at the time of our investigation and appeared to stretch from Station 9+75 to 13+50. Vertical and horizontal movements at the top of the slope at the time of our drilling were twelve (12) feet and sixteen (16) feet, respectively (measured at the subsurface drainpipe location, as shown on the Boring Location Plan). The guardrail along the west side of SR 37 was well within the landslide mass and has been destroyed. The base of the landslide was easily identifiable by a toe bulge at an approximate offset of 240 feet LT of Line SR 37. The sides of the slide were not as easily identified due to the brush and tree coverage.

The results of our field and laboratory testing were used to model the slope for stability. Since the location of the failure plane at the top of the slope was evident, we were able to assign its location in during our analysis. The exact orientation of the failure plane was changed until a minimum factor of safety was achieved.

Numerous trials were completed using Purdue University's PCSTABL along a cross section through Station 12+50. The cross section showing the soil information can be found in Appendix C. The soil strength parameters within the zone of failure were derived such that the factor of safety reduced below one. In summary, the soil within the zone of failure was assigned a cohesion value of 525 psf, with the failure plane maintained several feet above the bedrock surface. This scenario was considered accurate for the purposes of our investigation and allowed adequate information to design the remedial system. The results of the stability analysis can also be found in Appendix C.

Cause of Landslide

Some thought was given as to the reason for the landslide at this location. Review of topographic maps of the area does indicate a significant drainage valley at this location prior to construction of the embankment. It appears that the embankment soils are sliding along the former ground surface near the bottom of the slope. This would commonly be due to lower than anticipated soil shear strengths, lack of slope stability analysis at this location, or improper benching of the embankment materials during construction. However, the age of the embankment (over 10 years) is an indication of reasonable stability. It is the location of a utility that leads us to the likely conclusion as to the reason for the failure.

A subsurface drainage pipe is evident near the center of the landslide. This 4" PVC pipe at the time of this report terminates through the scarp face near the top of the slope. The concrete splash pad for this pipe rests nearly twelve (12) feet below on the landslide mass. It is most

likely that the trigger for the landslide was saturated soils near the top of the slope. These saturated soils increased the driving force and reduced the available shear strength to resist movement. It is suggested that the underdrain system at the site be inspected for blockage or leakage. It may be necessary to reroute the outfall location of this drain during reconstruction of the slope.

Landslide Remediation

Based upon the soil conditions and relative cost, we feel that rammed aggregate piers (RAPs) will provide the best solution to the current instability and allow INDOT to reconstruct the slope. Slope stability analyses were conducted with different configurations of RAPs to determine the location and density that achieved a factor of safety greater than the minimum of 1.25 in an undrained condition. Our analyses are presented in Appendix C. Based upon these analyses, we recommend RAPs be installed at 25% replacement density between offsets 125 LT and 95 LT from Stations 9+75 to 13+50. The composite section of RAPs and soil yields cohesion of 394 psf and an angle of internal friction of 16.6 degrees.

It is estimated that 525 to 550 piers socketed three (3) feet into the weathered shale bedrock will be necessary. This is based upon a pier diameter of thirty (30) inches with a spacing of 4.75 feet center-to-center in a triangular pattern. We have assumed a bench elevation of 465 feet between the 125 and 95 LT offsets on which to install the piers. The bottom of pier elevation is estimated at 435 feet at the maximum offset to 440 feet as the piers near the 95 LT offset. Therefore, the maximum estimated length of a RAP would be on the order of twenty-eight (28) to thirty (30) feet.

A sketch of the RAP layout and cross section is provided in Appendix C along with our analyses. It is recommended that the specialty contractor installing the RAP system verify the layout and spacing based upon the actual diameter of the stone column to be installed.

The cut material from this bench should be placed on the downward slope as a buttress during the remedial work, not on the upward slope from the work area. Furthermore, it is recommended that runoff from SR 37 be rerouted such that it does not collect on the exposed slope.

Alternatives

Other options were considered but not detailed in this report. They included a rip rap filled shear key, a drilled pier wall (possibly with tiebacks), and removal and replacement of the affected soils. These items were deemed either too expensive or further lowered the factor of safety of the embankment. However, should it be desired to explore these or other options, please contact INDOT's Office of Geotechnical Engineering.

Embankment Reconstruction Recommendations

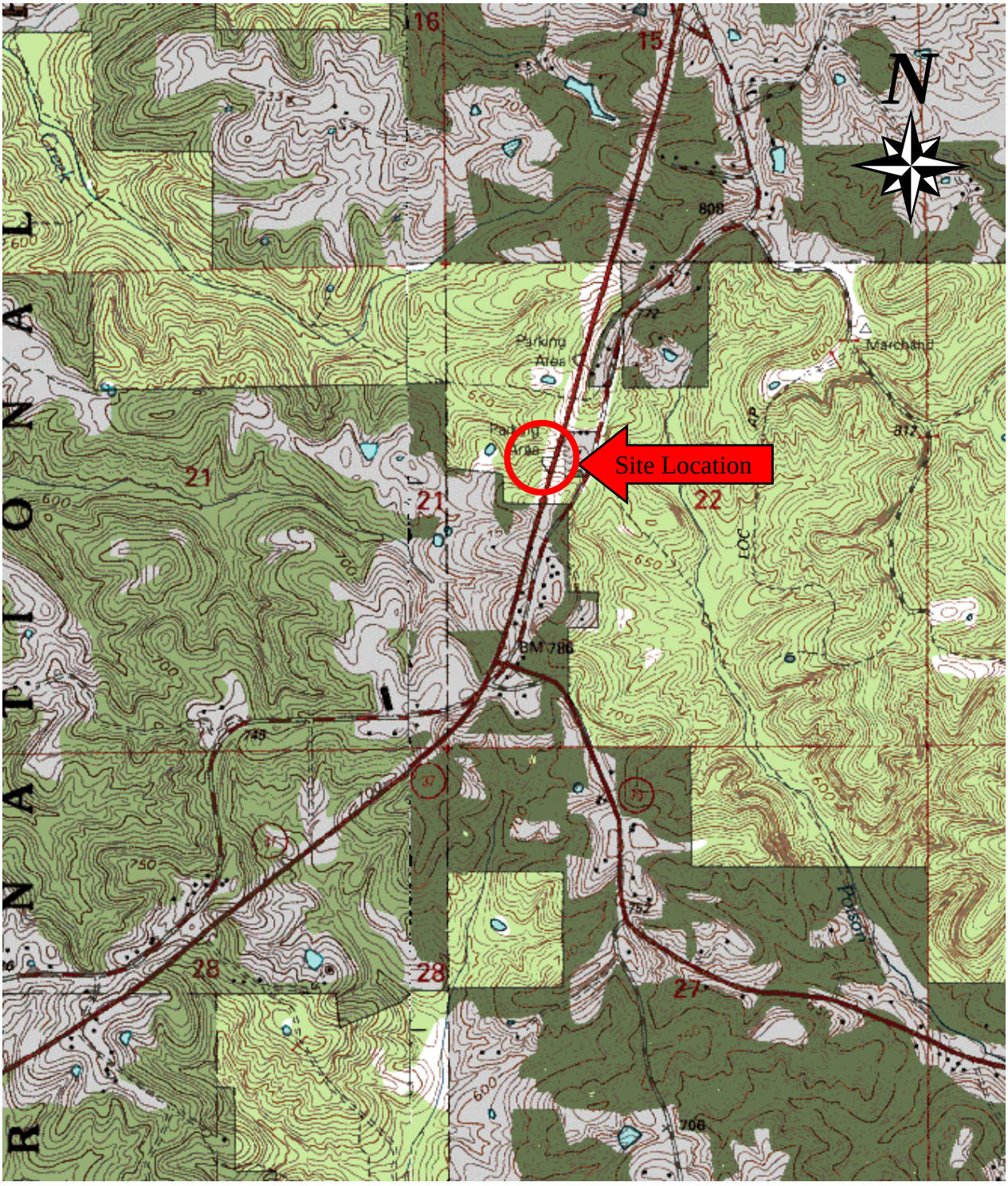
After installation of RAPs, it will be necessary to grade the slope to match adjacent and design grades. The soil materials encountered in our borings can be reused provided proper moisture contents and densities are achieved. Imported granular materials are not recommended to reconstruct the slope. Before fill is placed, topsoil or loose soils encountered during earthwork construction not considered to be suitable embankment material shall be removed.

It is recommended that all soil embankments be compacted to at least ninety-five (95) percent of their maximum dry density. The moisture content shall be within –2 and +1 percentage points of optimum moisture content. Maximum density and optimum moisture content shall be determined in accordance with AASHTO T 99. If the embankment material is too wet or dry, the material should be aerated to remove any excess moisture or watered and disked until the moisture content is within the specified range. The placement of embankment material shall be in accordance with Section 203.23 of INDOT Standard Specifications

Benching will be required as the existing embankment slope is steeper than 4:1. Benching should be performed in accordance with Section 203.21 of the INDOT Standard Specifications.

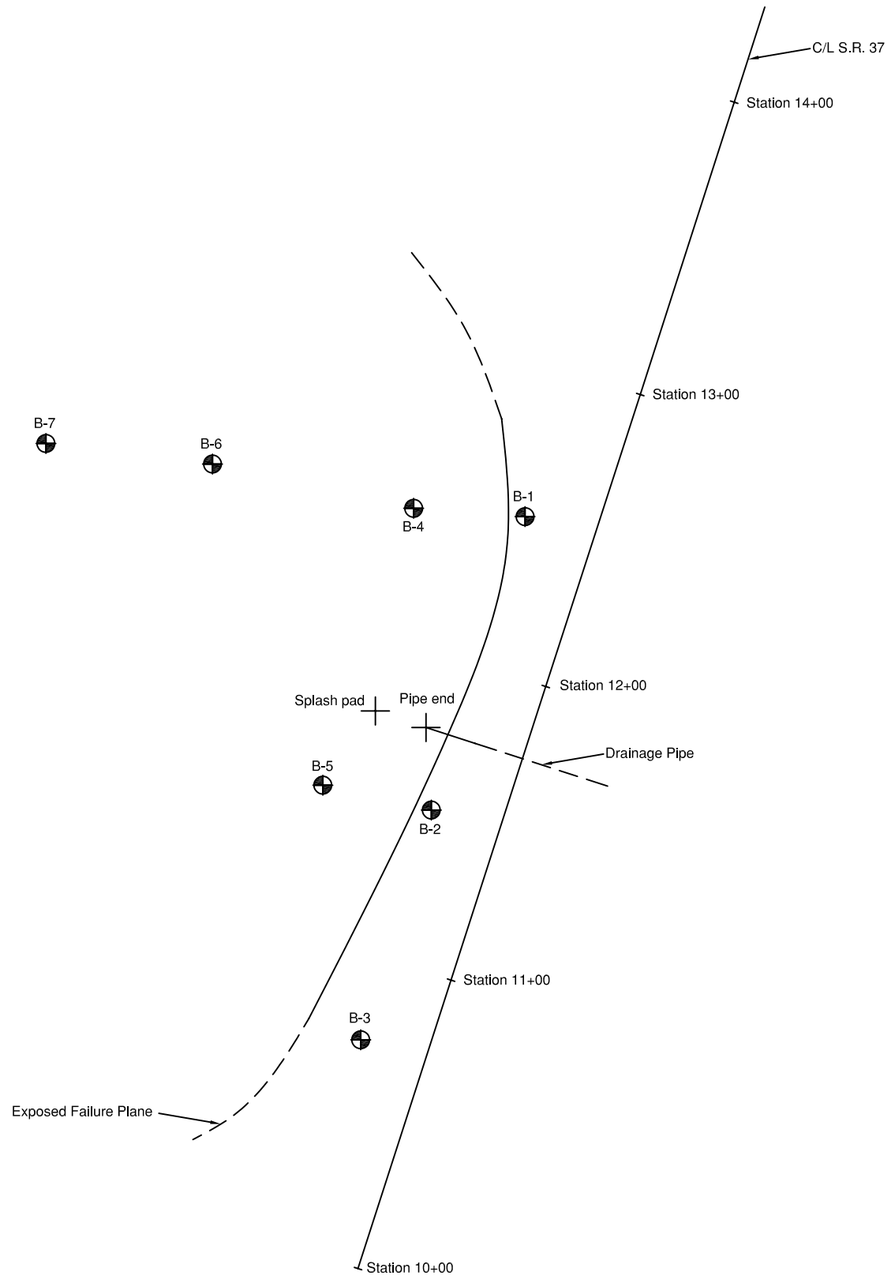
APPENDICES

FIGURE 1: SITE LOCATION MAP



Prepared For: INDOT - Geotechnical Section		**Prepared By:** Alt & Witzig Engineering, Inc.	
Project Name: SR 37 Landslide		**Project No:** 07IN0101	**Date:** 08/07

BORING LOCATION PLAN



N

Scale: 1" = 50'

0 25 50

Prepared For: INDOT-Geotechnical Section		Prepared By: Alt & Witzig Engineering, Inc.	
Project Name: S.R. 37 Landslide		Project No: 07IN0101	Date: 08/07

LOG OF TEST BORING

BORING NO.: **B-1**
STRUCTURE NO.: **N/A**
SHEET 1 OF 1

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073 PROJECT NO.: SR 37 Landslide

DATE STARTED : 06-25-07
DATE COMPLETED : 06-25-07
A&W PROJECT NO.: 07IN0101

ELEVATION	: 502.4	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 12+51	RIG TYPE	: B-57 Truck	DRILLER/INSP	: M.Rose/D. Harness
OFFSET	: 23.5ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Sunny
DEPTH	: 59.0ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion Dry ▼ 18.0 ft After 24 hours

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
		Brown, Moist, Medium Stiff CLAY **A-6(15)** (Test #1)	SS 1	3-4-4	50	18.9			TEST #1 LL=38, PL=19, PI=19 pH=6.69
	5		SS 2	4-4-6	50	12.3	110.5	11	
494.9		7.5	SS 3	4-3-4	10	7.2			
		Brown to Gray, Moist, Medium Stiff to Very Stiff CLAY LOAM **A-6(10)** (Test #2)	SS 4	2-5-5	40	16.0			TEST #2 LL=36, PL=21, PI=15 pH=6.83
	10		SS 5	4-5-7	5	13.2			
	15		SS 6	4-3-4	100				
	20		SS 7	4-5-7	20	16.0			
477.4	25	25.0	SS 8	6-7-9	100	13.7			
		Gray, Moist, Stiff LOAM **A-6(5)** (Test #3)	SS 9	3-6-8	90	13.1	121.0	5.18	TEST #3 LL=29, PL=17, PI=12 pH=5.81
	30								
	35		SS 10	6-18-13	100	13.6			Driving on a Rock @ SS10
462.4	40	40.0	SS 11	4-5-8	80	14.0	116.9	6.31	
		Gray, Slightly Moist, Hard Silty CLAY LOAM **A-6(11)** (Highly Weathered Bedrock) (Test #4)	SS 12	18-38-50/3"	80	11.4			TEST #4 LL=37, PL=23, PI=14 pH=6.65
	45								
454.4		48.0	RC 1		100				Auger Refusal @ 48.0' Begin Rock Coring
	50	Dark Gray, Slightly Moist, Soft Clay SHALE (Visual)	RQD= 40%						
			RC 2		100				
	55		RQD= 33%						
			RC 3		100				
443.4		59.0	RQD= 20%						
	60	Bottom of Boring at 59.0 ft							
	65								

LOG OF TEST BORING

BORING NO.: B-2
STRUCTURE NO.: N/A
SHEET 1 OF 1

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073 PROJECT NO.: SR 37 Landslide

DATE STARTED : 06-26-07
DATE COMPLETED : 06-26-07
A&W PROJECT NO.: 07IN0101

ELEVATION	: 503.8	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 11+51	RIG TYPE	: B-57 Truck	DRILLER/INSP	: M.Rose/D. Harness
OFFSET	: 23.5ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Cloudy
DEPTH	: 60.0ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion Dry ▼ 55.0 ft After 7 hours

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
		Brown, Moist, Medium Stiff CLAY **A-6** (Test #1)	SS 1	4-4-6	75	14.0			
	5		SS 2	5-4-5	10				
			SS 3	5-4-5	60	18.2			
493.8	10	10.0	SS 4	3-4-5	0				2 Attempts at SS4 and SS5
		Brown to Gray, Moist, Medium Stiff to Stiff CLAY LOAM **A-6** (Test #2)	SS 5	4-5-5	5				
	15		SS 6	3-4-6	20	15.1	114.2	5.53	
	20		SS 7	3-4-5	100	15.5			
478.8	25	25.0	SS 8	3-4-7	90	15.6			
		Gray, Moist, Very Stiff to Stiff LOAM **A-6** (Test #3)							
	30		SS 9	5-6-11	75	8.0			
	35		SS 10	6-6-10	75	19.6	105.4	5.81	
	40		SS 11	4-5-6	60	12.7			
	45		SS 12	4-6-8	75	16.6	114.4	2.85	
453.8	50	50.0	SS 13	11-9-13	5				2 Attempts at SS13
		Gray, Moist, Hard Silty CLAY LOAM **A-6 (11)** (Highly Weathered Bedrock) (Test #4)							
	▼ 55		SS 14	9-20-36	75	12.2			
	60		SS 15	9-21-28	100	15.9	112.0	13.1	
442.8		61.0							
		Bottom of Boring at 60.0 ft							
	65								

LOG OF TEST BORING

BORING NO.: B-3
STRUCTURE NO.: N/A
SHEET 1 OF 1

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073 PROJECT NO.: SR 37 Landslide

DATE STARTED : 06-26-07
DATE COMPLETED : 06-26-07
A&W PROJECT NO.: 07IN0101

ELEVATION	: 504.8	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 10+72	RIG TYPE	: B-57 Truck	DRILLER/INSP	: M.Rose/D. Harness
OFFSET	: 22.5ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Cloudy
DEPTH	: 60.0ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion Dry ▼ 57.0 ft After 2 hours

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
		Brown, Moist, Medium Stiff to Stiff CLAY **A-6** (Test #1)	SS 1	3-3-5	50	14.5			
	5		SS 2	3-5-5	60	22.5			
497.3		7.5	SS 3	4-5-8	5	11.0			
		Brown to Gray, Moist, Medium Stiff to Very Stiff CLAY LOAM **A-6** (Test #2)	SS 4	2-4-6	30	10.9			
	10		SS 5	4-4-7	80	14.9			
	15		SS 6	40-9-8	60	6.0			
484.8	20	20.0	SS 7	5-5-10	50	20.0			
		Gray, Moist, Stiff to Very Stiff LOAM **A-6** (Test #3)	SS 8	4-6-9	60	18.5	114.3	4.95	
	25								
	30		SS 9	5-7-40	60	10.3	104.0	4.06	Driving on a Rock
469.8	35	35.0	SS 10	8-9-11	100	15.1			
		Gray, Slightly Moist, Very Stiff to Stiff CLAY LOAM **A-6** (Test #4)	SS 11	5-9-10	50	6.0			
	40								
459.8	45	45.0	SS 12	5-6-6	15	7.3			
		Gray, Moist, Stiff to Very Stiff LOAM **A-6** (Test #3)	SS 13	5-6-8	40	16.1			
	50								
	55		SS 14	6-7-9	80	11.3	123.9	4.89	
		▼							
	60		SS 15	7-9-12	60	16.5			
443.8		61.0							
		Bottom of Boring at 60.0 ft							
	65								

LOG OF TEST BORING

BORING NO.: B-4
STRUCTURE NO.: N/A
SHEET 1 OF 1

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073 PROJECT NO.: SR 37 Landslide

DATE STARTED : 06-26-07
DATE COMPLETED : 06-26-07
A&W PROJECT NO.: 07IN0101

ELEVATION	: 485.9	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 12+43	RIG TYPE	: CME 45 Skid	DRILLER/INSP	: J. Sanders/D. Harness
OFFSET	: 70.0ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Rain
DEPTH	: 42.5ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion Dry

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
		Brown, Moist, Very Soft to Soft CLAY **A-6** (Test #1)	SS 1	1-1-1-2	60	18.9	101.6	1.57	
			SS 2	2-1-2-4	100	17.3			
	5		SS 3	1-2-3-3	60	13.4			
			SS 4	1-3-3-3	60				Medium Stiff @ SS4
	10		SS 5	2-2-2-3	60	12.4			
			SS 6	1-2-1-3	60	17.0			
471.9		14.0	SS 7	1-1-2-2	60	13.1			
	15	Brown, Moist, Very Soft to Soft Silty CLAY LOAM **A-6** (Test #5)	SS 8	1-1-1-2	30	20.6			TEST #5 LL=37, PL=23, PI=14 pH=6.65
467.9		18.0	SS 9	1-1-3-5	100	17.8			
	20	Brown to Gray, Moist, Stiff CLAY LOAM **A-6** (Test #2)	SS 10	4-6-5-7	60	20.3			
	25								
458.4		27.5	SS 11	3-5-6	100	15.2			
		Gray, Moist, Hard Silty CLAY LOAM **A-6** (Test #4)							
	30		SS 12	11-22-30	100	11.6	119.1	6.81	
	35								
449.9		36.0							
		Gray, Slightly Moist, Hard to Very Stiff Clay SHALE (Visual)	SS 13	6-15-17	100	13.6			
	40								
443.4		42.5	SS 14	7-11-15	100	14.3	118.4	11.4	
		Bottom of Boring at 42.5 ft							
	45								
	50								

LOG OF TEST BORING

BORING NO.: B-5
STRUCTURE NO.: N/A
SHEET 1 OF 1

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073 PROJECT NO.: SR 37 Landslide

DATE STARTED : 06-25-07
DATE COMPLETED : 06-25-07
A&W PROJECT NO.: 07IN0101

ELEVATION	: 485.0	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 11+48	RIG TYPE	: CME 45 Skid	DRILLER/INSP	: J. Sanders/D. Harness
OFFSET	: 70.0ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Sunny
DEPTH	: 42.5ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion Dry

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
		Brown, Moist, Medium Stiff to Stiff CLAY **A-6** (Test #1)	SS 1	1-2-4-4	60	11.7			
			SS 2	1-6-6-5	100	12.2			
	5		SS 3	1-3-5-5	100	15.8			
479.0		6.0							
		Brown and Gray, Moist, Soft to Very Soft CLAY LOAM **A-6** (Test #2)	SS 4	2-2-2-2	60	16.6			
			SS 5	1-2-2-3	60	15.3			
	10		SS 6	1-1-2-2	100	17.7			
			SS 7	1-1-2-3	100	10.6			
471.0		14.0							
	15	Gray, Very Moist, Soft to Medium Stiff LOAM **A-6** (Test #3)	SS 8	1-2-3-3	60	22.6			
			SS 9	3-3-4-5	80				
467.0		18.0							
		Gray, Moist, Medium Stiff to Stiff Silty CLAY LOAM **A-6** (Test #4)	SS 10	1-5-4-6	60	12.5			
	20								
	25		SS 11	4-6-6	100	16.3			
	30								
454.0		31.0							
		Dark Gray, Moist, Stiff to Very Stiff Clay SHALE (Visual)	SS 12	9-7-9	100	12.7	123.9	6.14	
	35		SS 13	5-7-8	100	12.7			
	40								
442.5		42.5	SS 14	5-7-15	100	18.3			
		Bottom of Boring at 42.5 ft							
	45								
	50								

LOG OF TEST BORING

BORING NO.: **B-6**
STRUCTURE NO.: **N/A**
SHEET 1 OF 1
DATE STARTED : 06-26-07
DATE COMPLETED : 06-26-07
A&W PROJECT NO.: 07IN0101

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073
PROJECT NO.: SR 37 Landslide

ELEVATION	: 469.3	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 12+36	RIG TYPE	: CME 45 Skid	DRILLER/INSP	: J. Sanders/D. Harness
OFFSET	: 127.0ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Cloudy
DEPTH	: 39.0ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion 5.0 ft ▼ 5.0 ft After

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
465.3		Gray, Moist, Very Soft to Medium Stiff LOAM **A-6** (Test #3)	SS 1	1-1-2-2	60	15.6			
			SS 2	2-2-7-7	30	9.5			
	5	4.0 Gray, Moist, Medium Stiff to Soft Silty CLAY LOAM **A-6** (Test #4)	SS 3	2-5-4-4	0				2 Attempts, No Recovery
			SS 4	1-2-50/0"	30	10.9			Driving on a Rock
	10		SS 5	2-3-3-4	60	17.7	110.1	4.21	
			SS 6	1-2-4-4	60	15.7			
455.3		14.0	SS 7	1-2-3-4	5				
	15	Gray, Moist, Medium Stiff CLAY with Shale Fragments (Visual)	SS 8	1-2-4-4	80	9.9			
			SS 9	2-3-3-4	100	11.0			
451.3		18.0							
	20	Gray, Moist, Medium Stiff Silty CLAY **A-7-6(17)** (Test #6)	SS 10	2-5-5-6	100	12.9			TEST #6 LL=41, PL=22, PI=19 pH=6.85
	25								
443.3		26.0							
		Gray, Moist, Very Stiff Silty CLAY LOAM **A-6** (Test #4)	SS 11	4-5-11	100	17.4	112.7	2.93	
	30		SS 12	10-18-20	100				
438.3		31.0 Gray, Moist, Hard Clay SHALE (Visual)							
	35		SS 13	8-14-20	100				
			RC 1		50	15.6			Auger Refusal @ 36.0'
430.3		39.0	RQD= 40%						
	40	Bottom of Boring at 39.0 ft							
	45								
	50								

LOG OF TEST BORING

BORING NO.: **B-7**
STRUCTURE NO.: **N/A**
SHEET 1 OF 1

CLIENT : INDOT - Geotechnical Section
PROJECT : S.R. 37 Landslide
LOCATION : Tell City, Indiana
DES NO. : 0710073 PROJECT NO.: SR 37 Landslide

DATE STARTED : 06-25-07
DATE COMPLETED : 06-25-07
A&W PROJECT NO.: 07IN0101

ELEVATION	: 449.9	BORING METHOD	: HSA	HAMMER	: Auto
STATION	: 12+26	RIG TYPE	: CME 45 Skid	DRILLER/INSP	: J. Sanders/D. Harness
OFFSET	: 182.0ft Lt	CASING DIA.	:	TEMPERATURE	: 80 °F
LINE	: SR 37	CORE SIZE	:	WEATHER	: Sunny
DEPTH	: 15.5ft				

GROUNDWATER: ▽ While Drilling Dry ▼ At completion Dry

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	UNIT WEIGHT, pcf	UNCONF. COMP., tsf	REMARKS
		Brown, Moist, Medium Stiff LOAM **A-6** (Test #3)	SS 1	1-2-4-5	60	18.1			
	2.5		SS 2	0-5-5-6	100	15.6			
445.9		4.0							
		Gray to Brown, Very Moist, Medium Stiff to Very Stiff Silty CLAY LOAM **A-6** (Test #4)							
	5.0		SS 3	1-4-4-6	100	24.2	119.2	5.39	
	7.5		SS 4	3-4-6-7	100	15.9	111.1	4.12	
			SS 5	1-6-7-10	100	14.5			
	10.0		SS 6	1-5-6-8	100	16.8			
437.9		12.0							
	12.5	Dark Gray, Moist, Hard Highly Weathered, Clay SHALE (Visual)	SS 7	1-9-24-33	10	13.9			
	15.0		SS 8	1-6-20-17	100	14.7			
434.4		15.5							
		Bottom of Boring at 15.5 ft							Auger Refusal @ 15.5'
	17.5								
	20.0								

GENERAL NOTES

SAMPLE IDENTIFICATION

The AASHTO M-145 Soil Classification System is used to identify the soils 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 using rope and cathead
qu:	Unconfined Compressive Strength, TSF
ɣ:	Natural Dry Density, PCF
W:	Water content, %
LL:	Liquid Limit, %
PL:	Plastic Limit, %
PI:	Plasticity Index, %
▽:	Apparent groundwater level at time noted while drilling
▼:	Apparent groundwater level at time noted upon completion of drilling
▼:	Apparent groundwater level at time noted 24 hours after completion of drilling

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
RC: Rock Core, 2" 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)	BLOWS PER FOOT
Very loose	0 - 5
Loose	6 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very dense	51 or more

TERM (COHESIVE SOILS	BLOWS PER FOOT
Very soft	0 - 3
Soft	4 - 5
Medium	6 - 10
Stiff	11 -15
Very stiff	16 - 30
Hard	31 or more

Boring	Sample	Depth	Textural Classification	AASHTO Classification	Gravel %	Sand %	Silt %	Clay %	Colloid %	LL	PL	PI	LOI %	Ca/Mg %	Moisture %	pH
B-1	SS1	1 - 2.5	CLAY (Test #1)	A-6 (15)	3.1	15.2	45.0	36.2		38	19	19			18.9	
B-1	SS4	8.5 - 10	CLAY LOAM, Test #2 (Test #2)	A-6 (10)	11.1	15.3	48.9	23.9		36	21	15			16.0	6.8
B-1	SS9	28.5 - 30	LOAM, Test #3 (Test #3)	A-6 (5)	4.6	27.2	44.1	19.5		29	17	12			13.1	5.8
B-1	SS12	43.5 - 45	SILTY CLAY LOAM, Test #4 (Test #4)	A-6 (11)	2.3	15.2	54.3	28.2		37	23	14			11.4	6.7
B-4	SS8	14 - 16	SILTY CLAY LOAM (Test # 5)	A-6 (14)	1.4	9.6	60.1	28.7		34	17	17			20.6	6.7
B-6	SS10	18 - 20	SILTY CLAY (Test #6)	A-7-6 (17)	4.6	5.9	54.7	32.2		41	22	19			12.9	6.9

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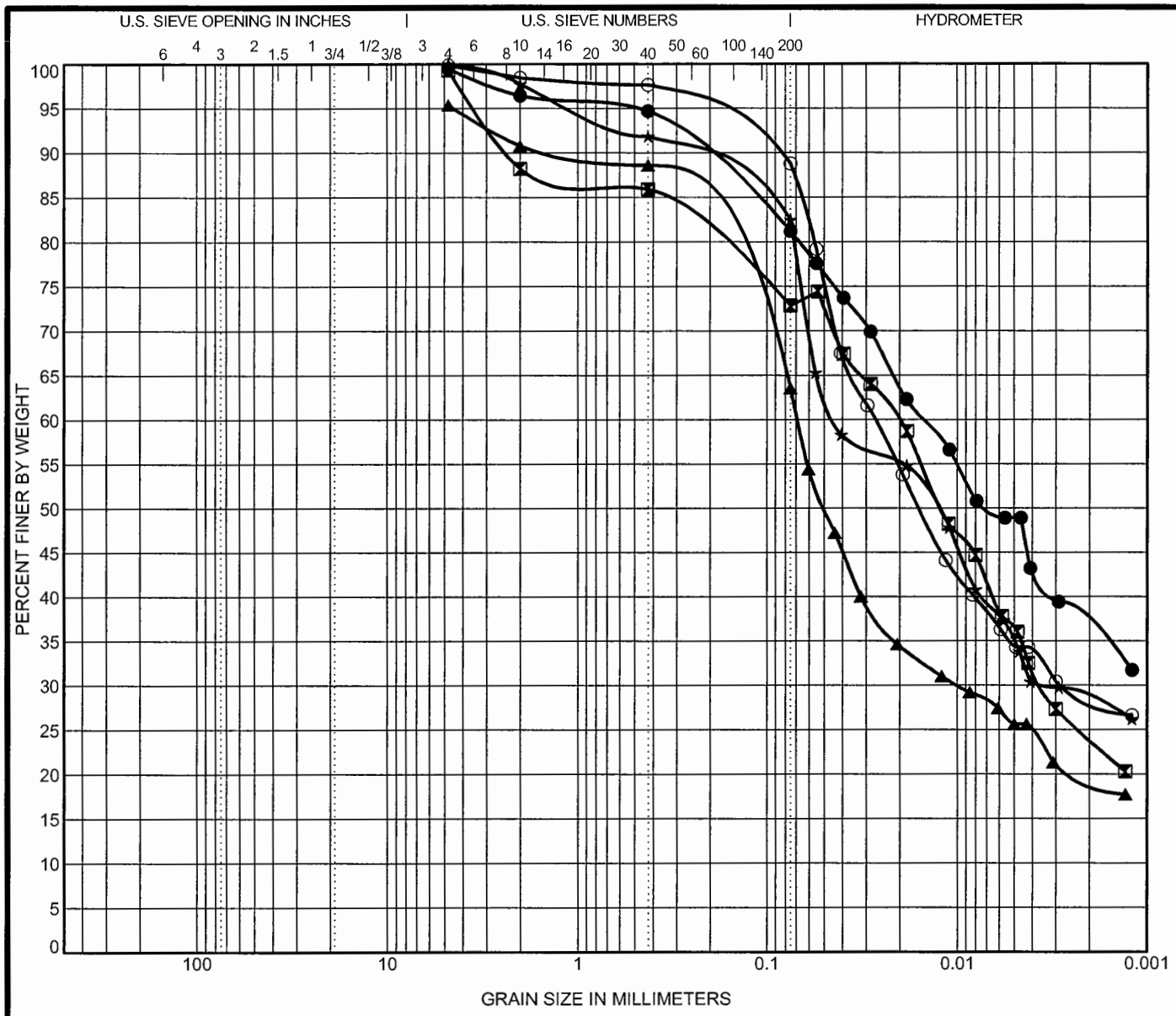
Summary of Classification Tests

Project: S.R. 37 Landslide

Location: Tell City, Indiana

Number: 07IN0101



COBBLES	GRAVEL	SAND		SILT	Clay
		coarse	fine		

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	B-1 SS1 1.0 to 2.5	A-6 (15) CLAY (Test #1)	38	19	19		
⊠	B-1 SS4 8.5 to 10.0	A-6 (10) CLAY LOAM (Test #2)	36	21	15		
▲	B-1 SS9 28.5 to 30.0	A-6 (5) LOAM (Test #3)	29	17	12		
★	B-1 SS12 43.5 to 45.0	A-6 (11) SILTY CLAY LOAM (Test #4)	37	23	14		
⊙	B-4 SS8 14.0 to 16.0	A-6 (14) SILTY CLAY LOAM (Test # 5)	34	17	17		

	Specimen Identification	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	%Colloid
●	B-1 SS1 1.0 to 2.5	0.015			3.1	15.2	45.0	36.2	
⊠	B-1 SS4 8.5 to 10.0	0.02	0.004		11.1	15.3	48.9	23.9	20.3
▲	B-1 SS9 28.5 to 30.0	0.069	0.01		4.6	27.2	44.1	19.5	17.7
★	B-1 SS12 43.5 to 45.0	0.044	0.003		2.3	15.2	54.3	28.2	
⊙	B-4 SS8 14.0 to 16.0	0.027	0.003		1.4	9.6	60.1	28.7	

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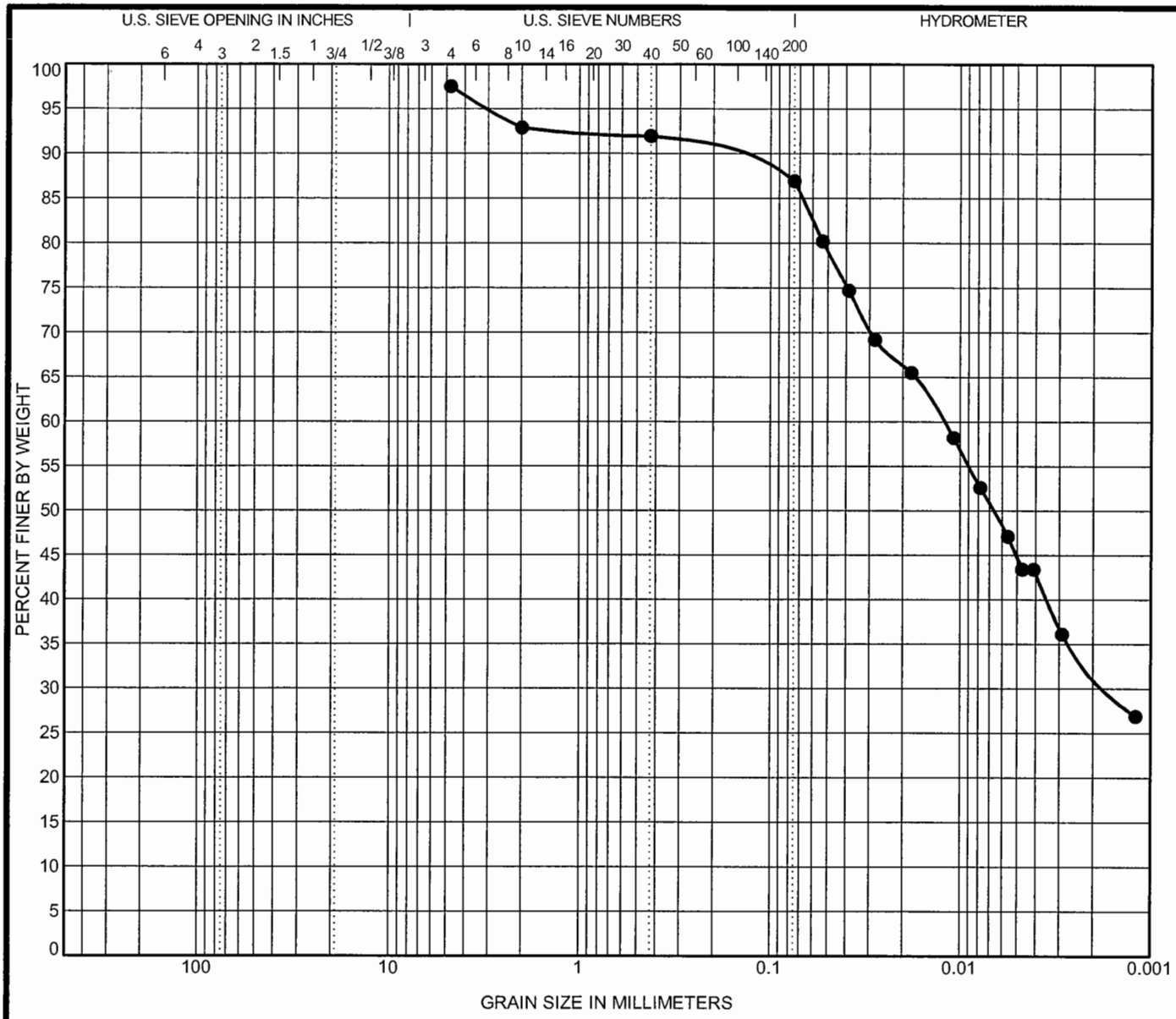
GRAIN SIZE DISTRIBUTION TEST REPORT

DES #: 0710073 Structure #:
Project #: SR 37 Landslide
Location: Tell City, Indiana
Alt & Witzig Project #:07IN0101



COBBLES	GRAVEL	SAND		SILT	Clay
		coarse	fine		

	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**B-6 SS10 18.0 to 20.0**	**A-7-6 (17) SILTY CLAY (Test #6)**	**41**	**22**	**19**		

	Specimen Identification	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay	%Colloid
●	**B-6 SS10 18.0 to 20.0**	**0.012**	**0.002**		**4.6**	**5.9**	**54.7**	**32.2**	

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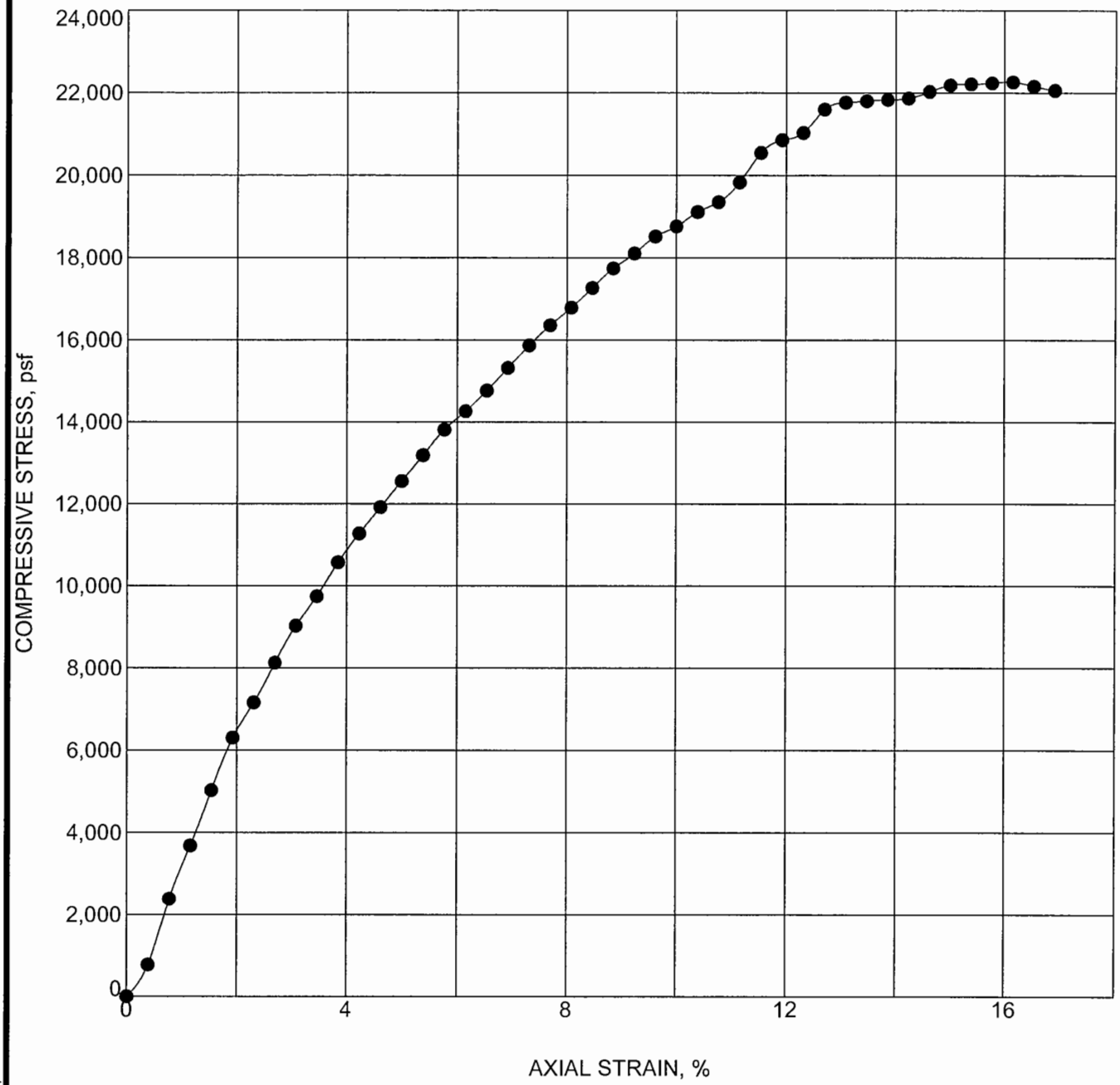

Boring	Sample	Depth	Classification
B-1	SS2	3.5 - 5	CLAY, Test #1

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
12.3	124.1	110.5	22184	1.0	15.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
11092	64	0.510	35.56	66.04	1.9

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UNCONFINED COMPRESSION TEST

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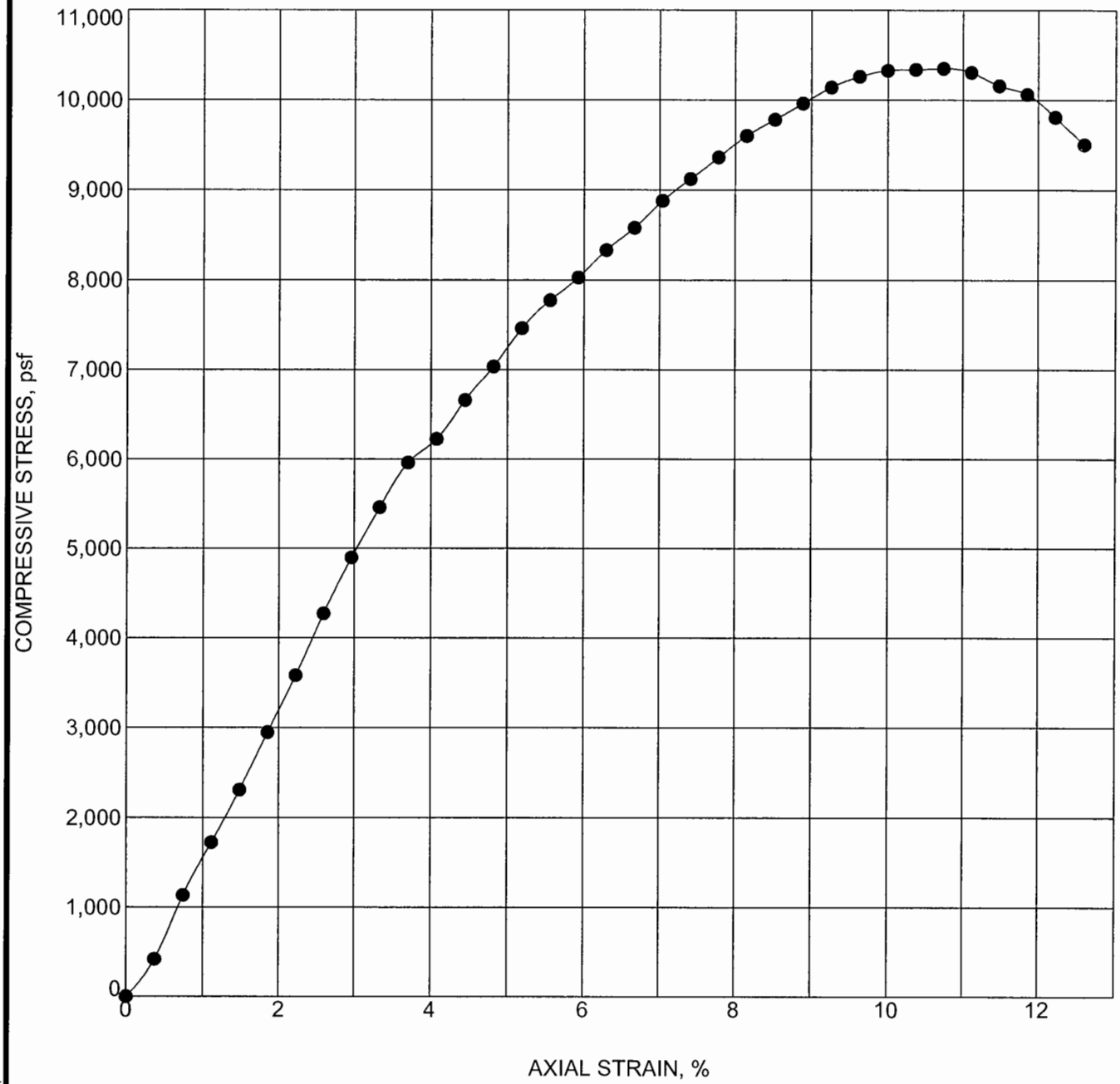
Alt & Witzig Project #:07IN0101



Boring	Sample	Depth	Classification
B-1	SS9	28.5 - 30	LOAM, Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
13.1	135.8	121.0	10350	1.0	10.7
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
5175	92	0.379	35.56	68.58	1.9

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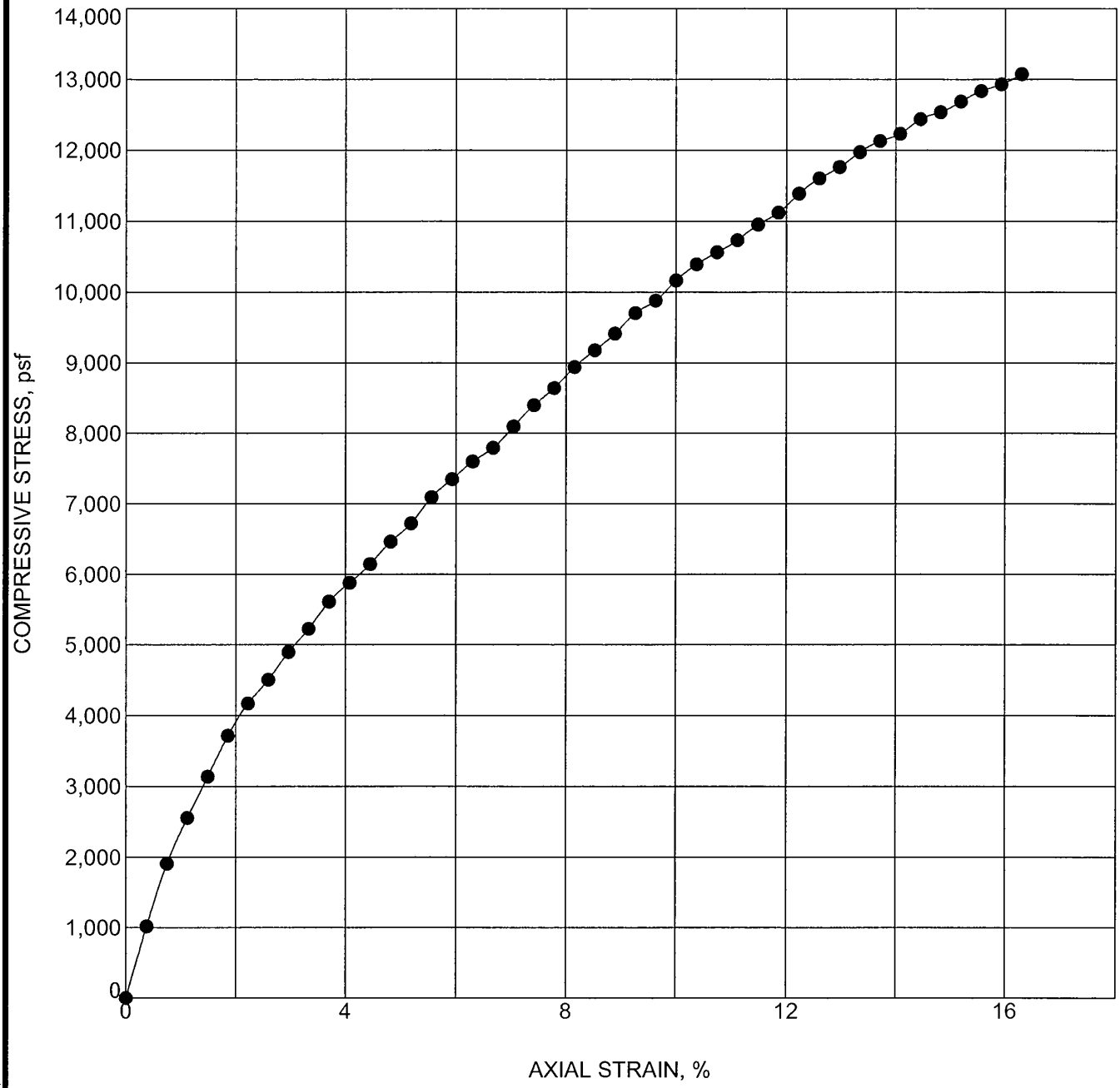
Alt & Witzig Project #:07IN0101



Boring	Sample	Depth	Classification
B-1	SS11	38.5 - 40	LOAM. Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
14.0	133.2	116.9	12611	1.0	15.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
6305	87	0.428	35.56	68.56	1.9

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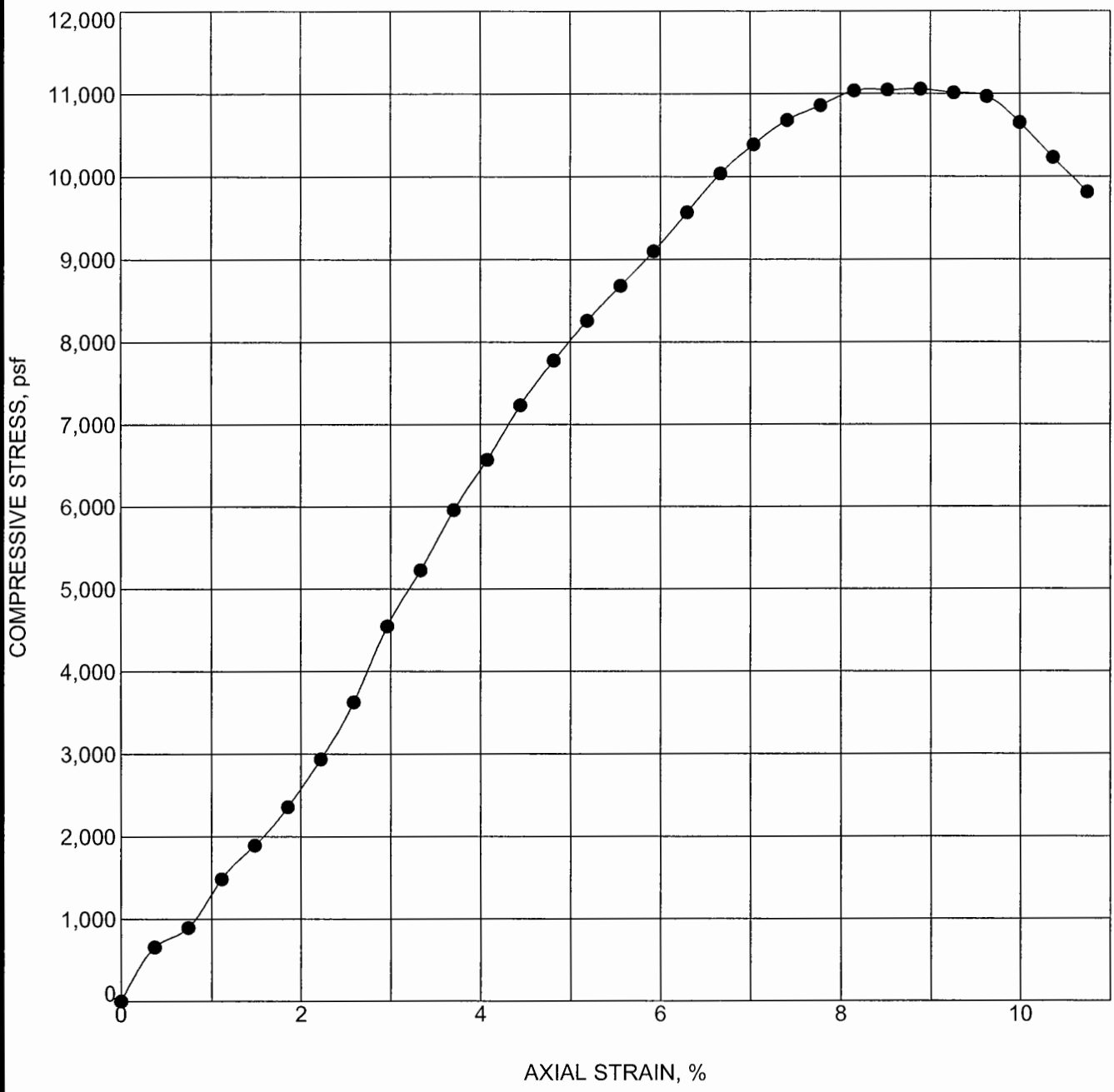

Boring	Sample	Depth	Classification
B-2	SS6	13.5 - 15	CLAY LOAM, Test #2

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
15.1	131.5	114.2	11057	1.0	8.9
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
5529	88	0.461	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

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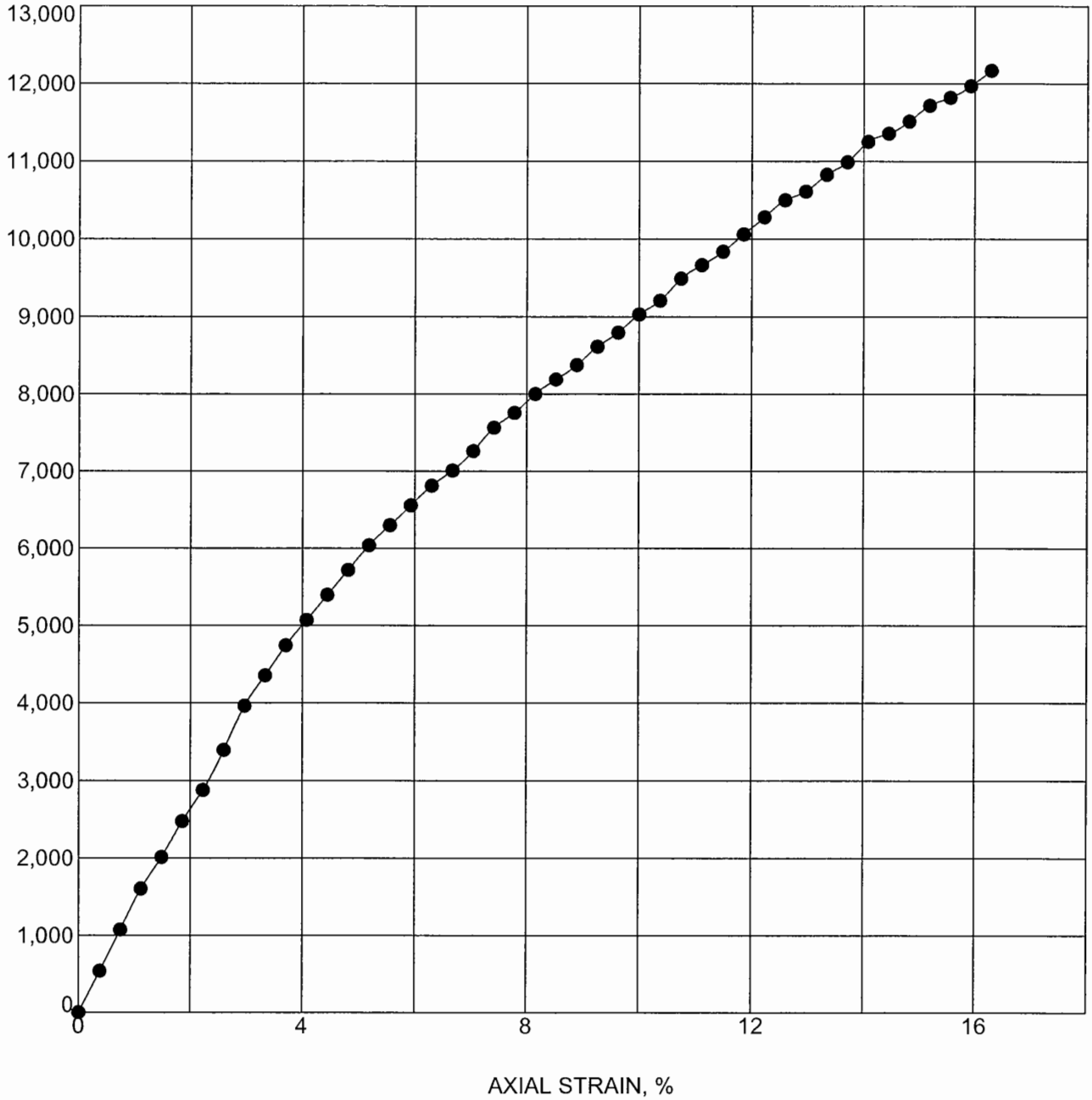

Boring	Sample	Depth	Classification
B-2	SS10	33.5 - 35	LOAM, Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
19.6	126.0	105.4	11614	1.0	15.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
5807	90	0.584	35.56	68.56	1.9

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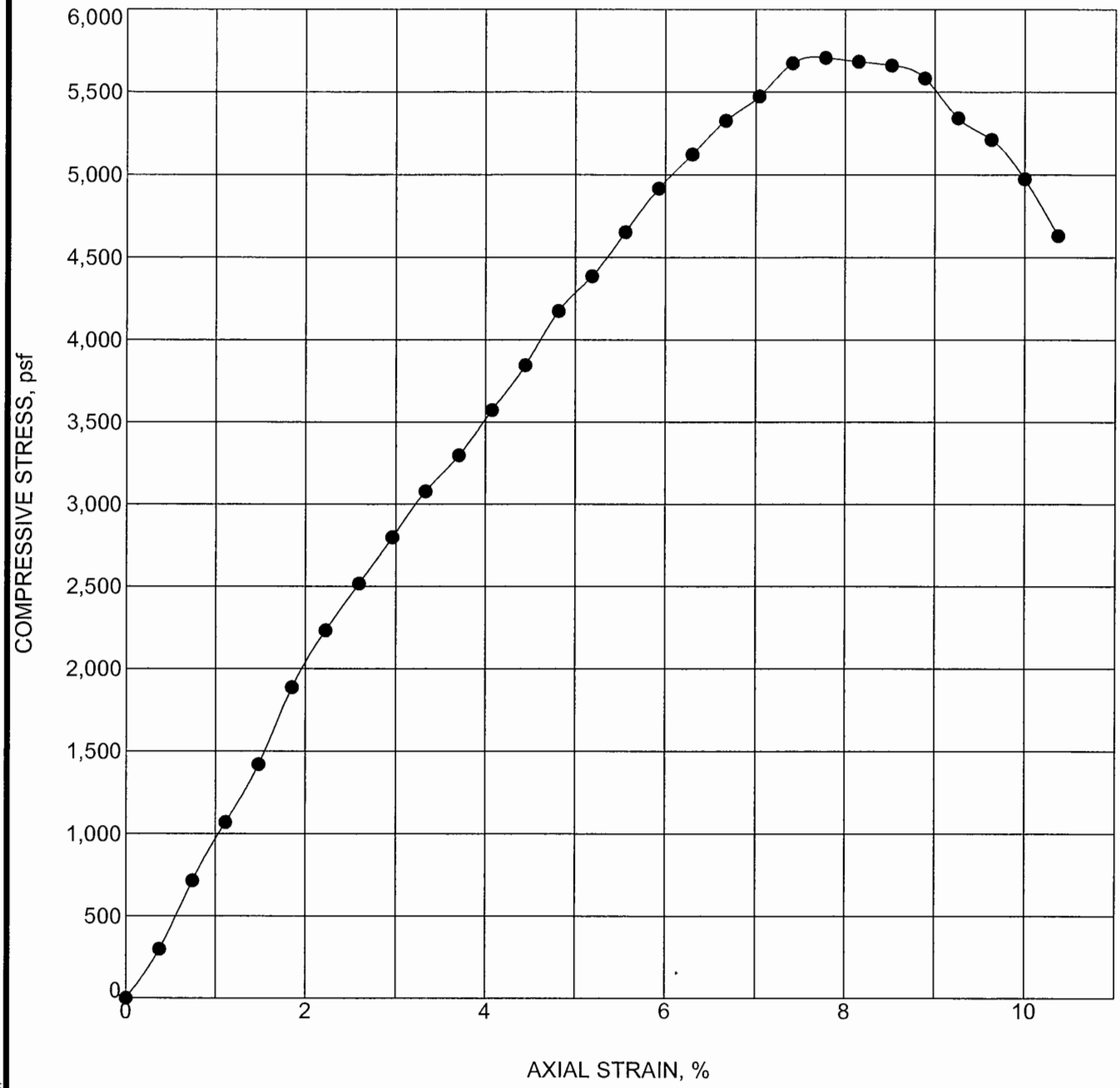

Boring	Sample	Depth	Classification
B-2	SS12	43.5 - 45	LOAM, Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
16.6	133.4	114.4	5707	1.0	7.8
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
2853	97	0.459	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

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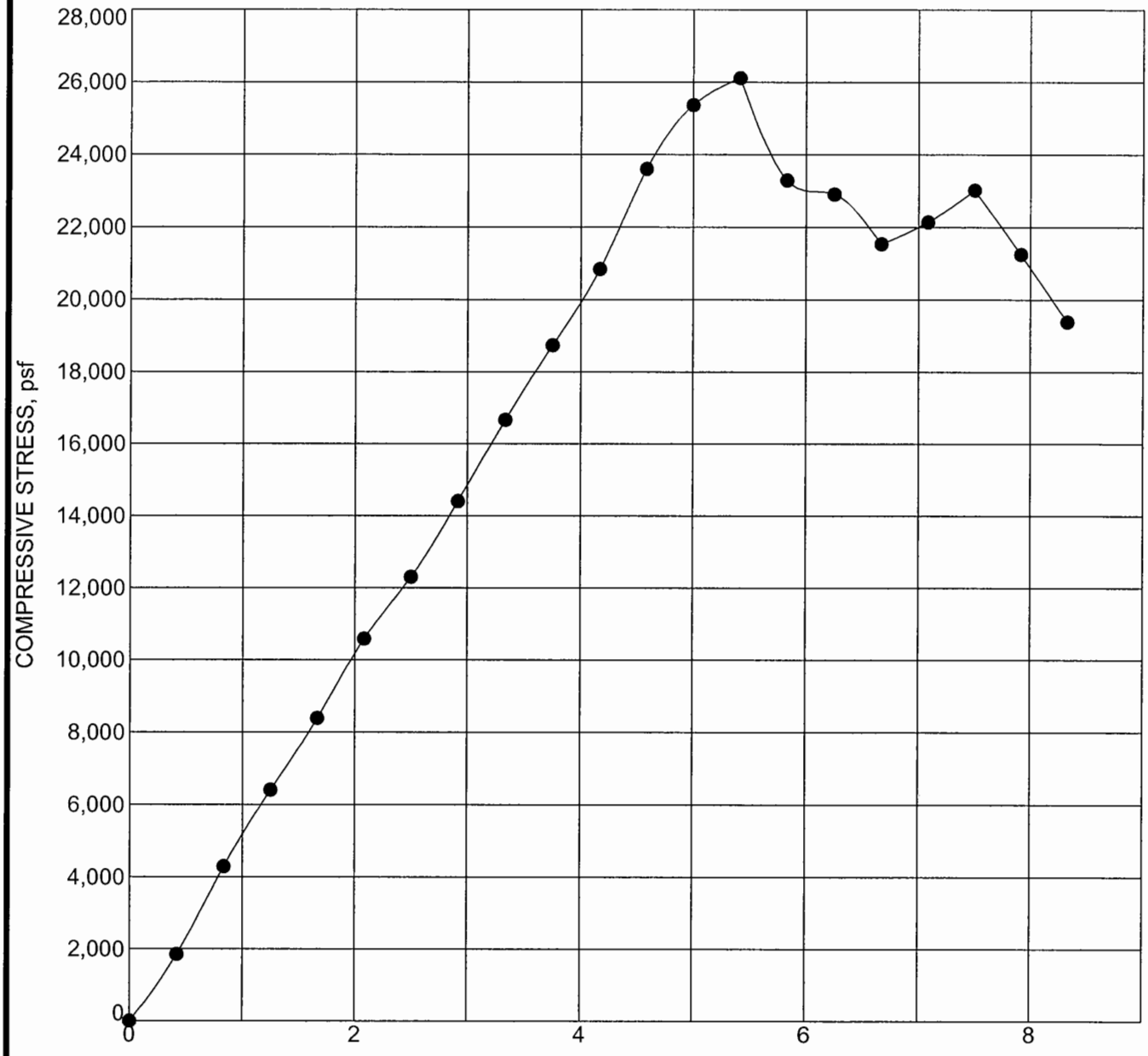

Boring	Sample	Depth	Classification
B-2	SS15	58.5 - 60	CLAY LOAM, Test #4

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
15.9	129.8	112.0	26114	1.0	5.4
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
13057	87	0.490	35.56	60.96	1.7

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UNCONFINED COMPRESSION TEST

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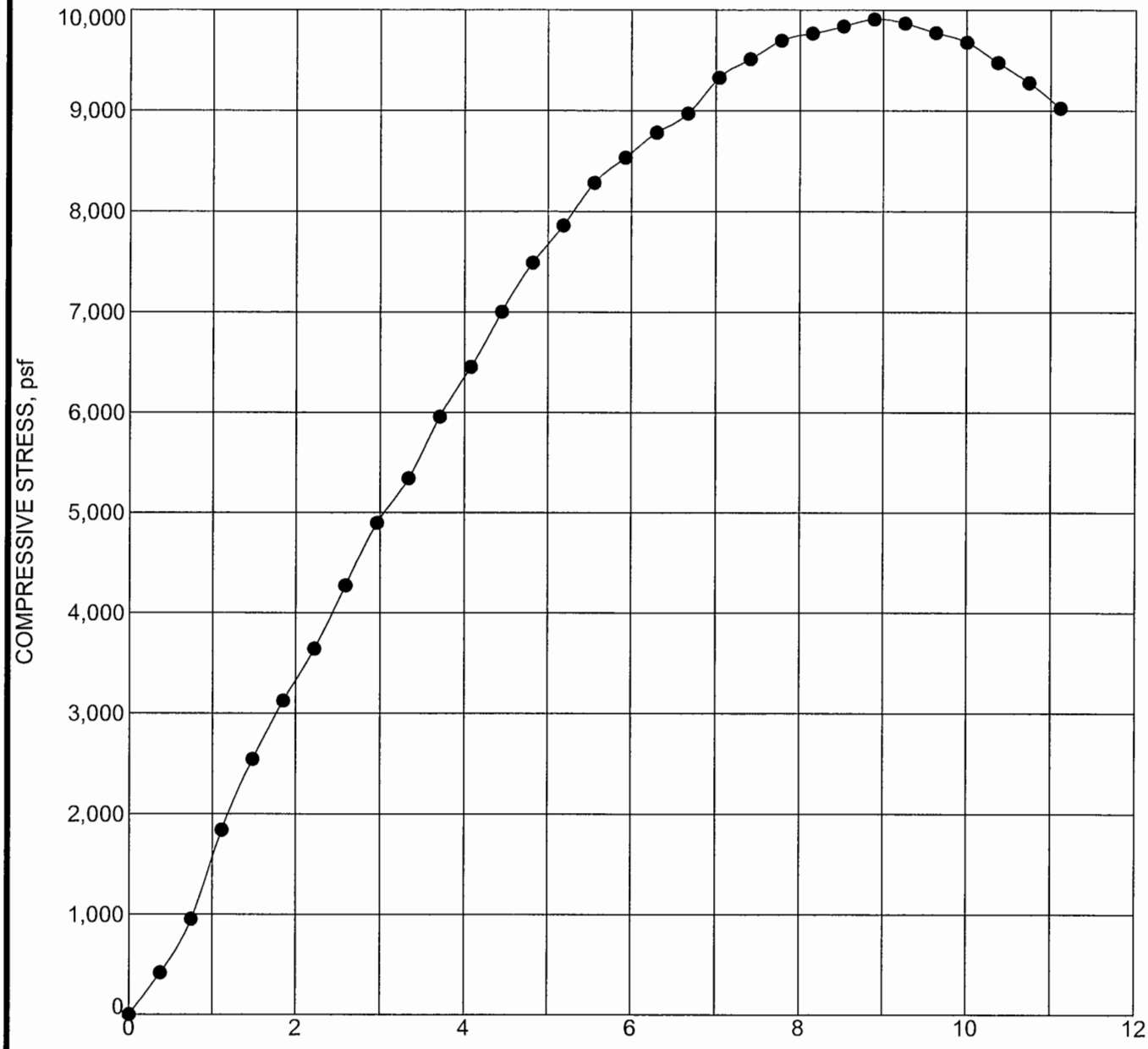

Boring	Sample	Depth	Classification
B-3	SS8	23.5 - 25	LOAM, Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
18.5	134.0	114.3	9907	1.0	8.9
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
4954	107	0.460	35.56	68.56	1.9

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UNCONFINED COMPRESSION TEST

DES #: 0710073 Structure #:
Project #: SR 37 Landslide
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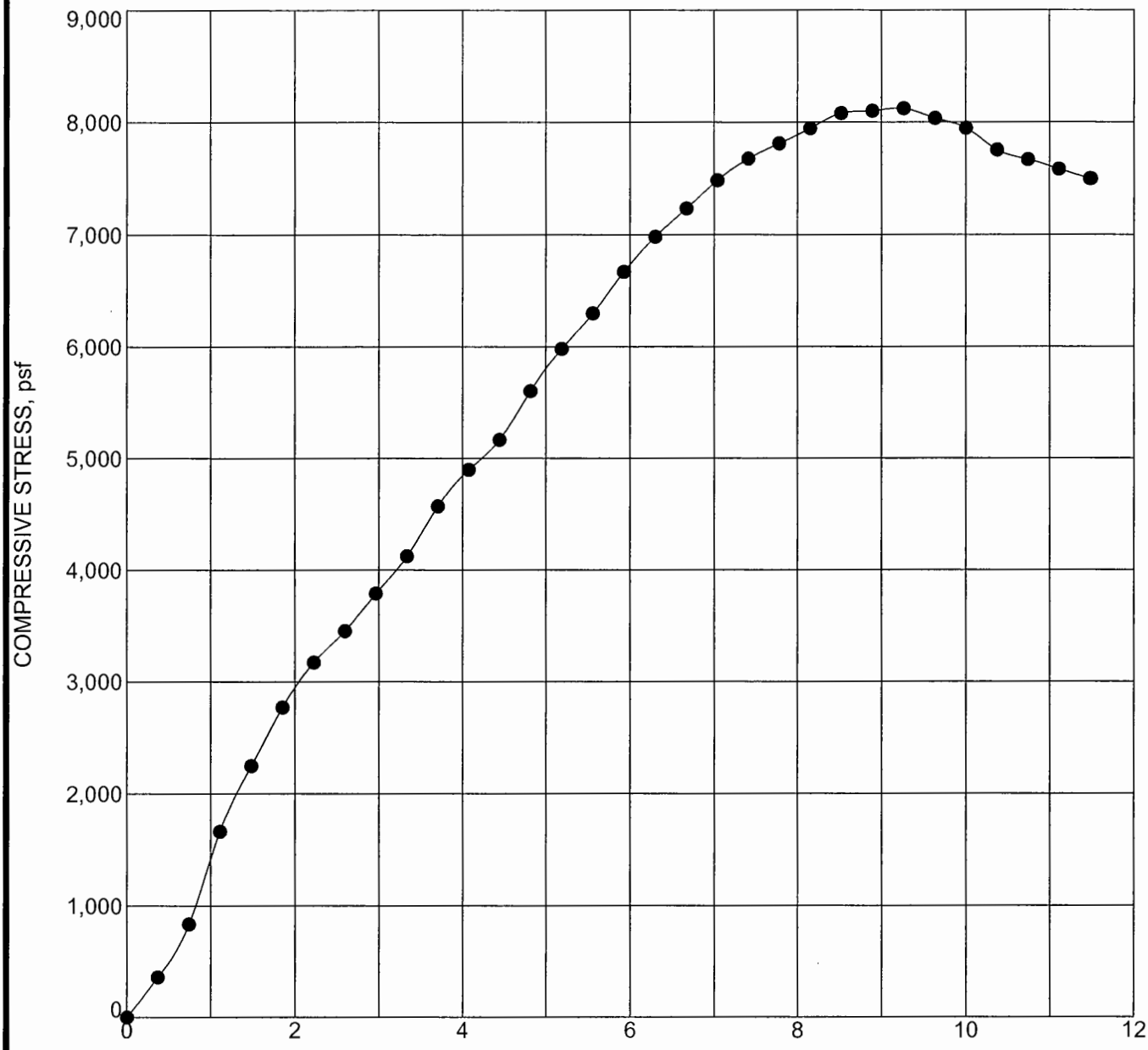

Boring	Sample	Depth	Classification
B-3	SS9	28.5 - 30	LOAM, Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
10.3	114.7	104.0	8123	1.0	9.3
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
4061	46	0.605	35.56	68.56	1.9

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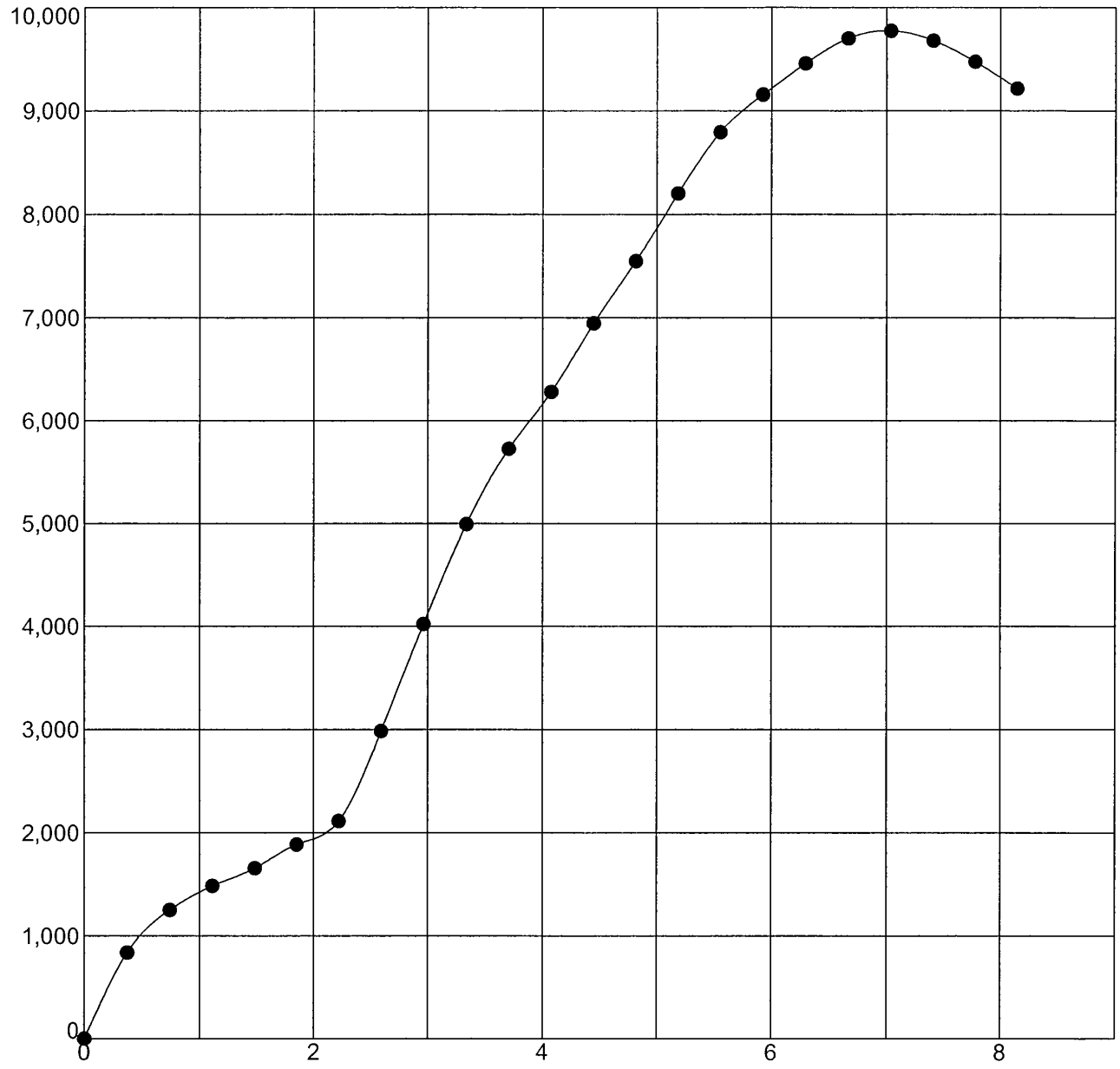

Boring	Sample	Depth	Classification
B-3	SS14	53.5 - 55	LOAM, Test #3

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
11.3	137.9	123.9	9774	1.0	7.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
4887	87	0.347	35.56	68.58	1.9

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Carmel, Indiana 46032
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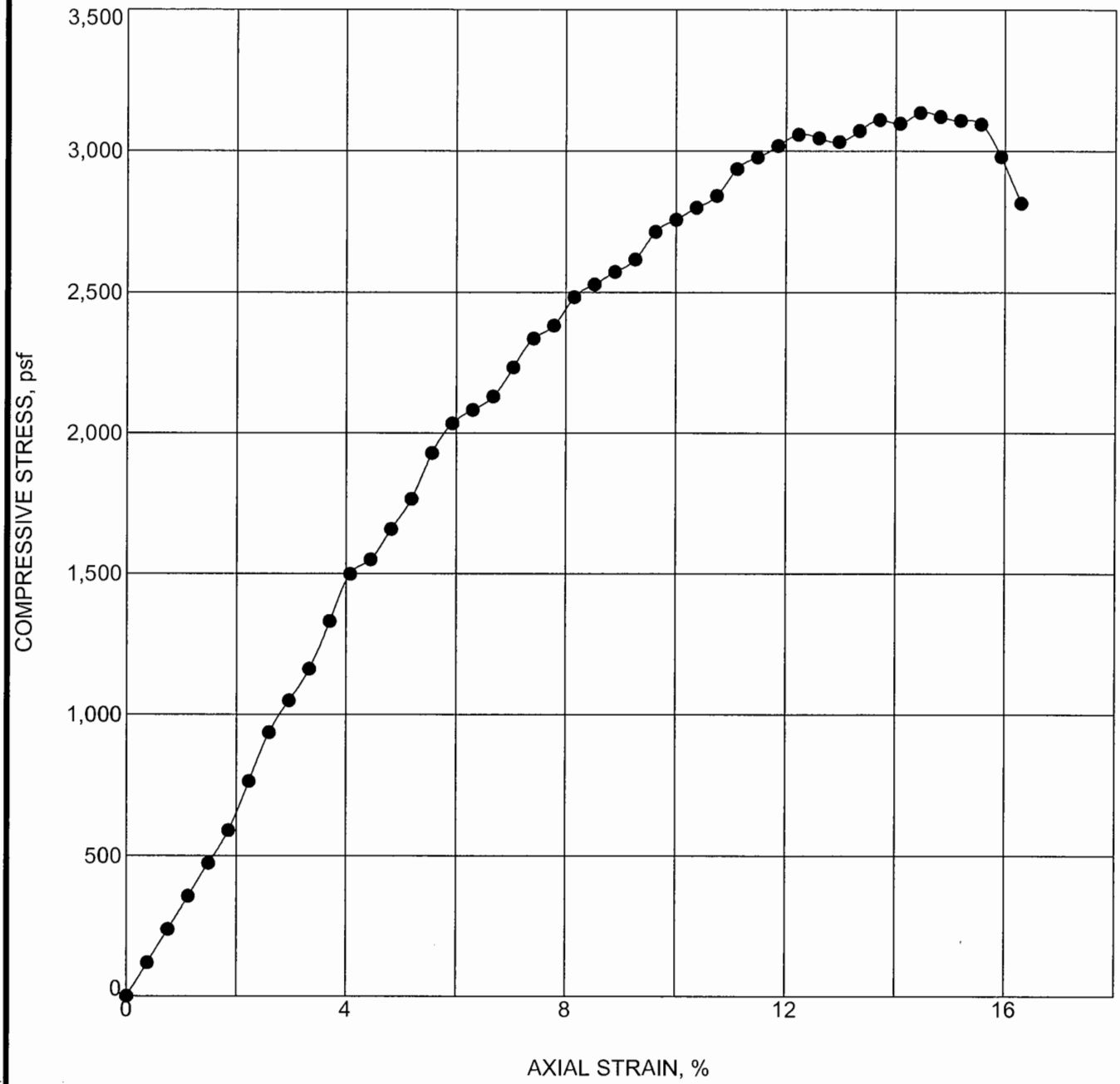
UNCONFINED COMPRESSION TEST

DES #: 0710073 Structure #:
Project #: SR 37 Landslide
Location: Tell City, Indiana
Alt & Witzig Project #:07IN0101



Boring	Sample	Depth	Classification
B-4	SS1	0 - 2	CLAY, Test #1

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
18.9	120.8	101.6	3135	1.0	14.4
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
1568	79	0.643	35.56	68.56	1.9

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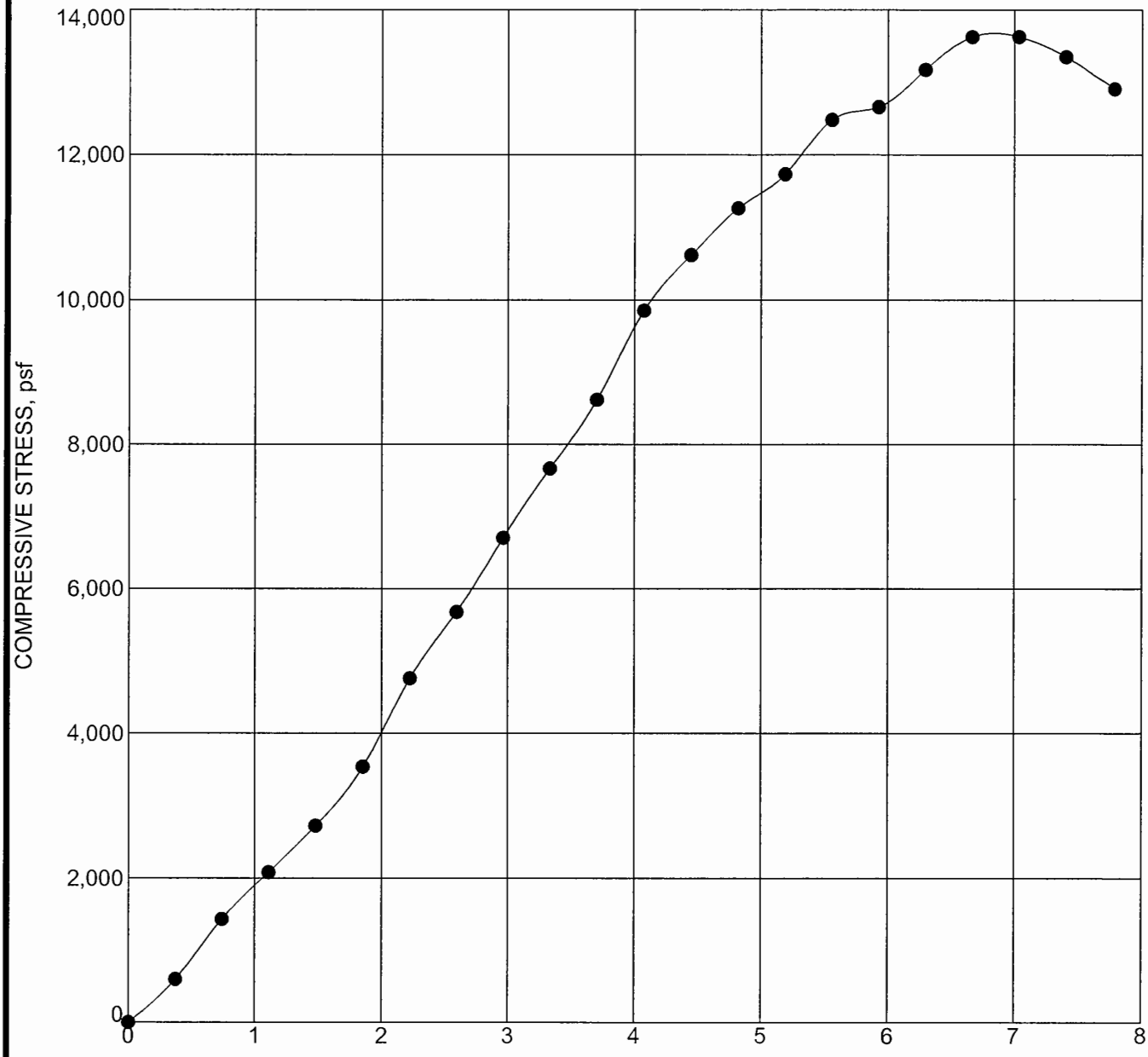

Boring	Sample	Depth	Classification
B-4	SS12	31 - 32.5	CLAY LOAM, Test #4

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
11.6	133.0	119.1	13628	1.0	7.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
6814	77	0.401	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

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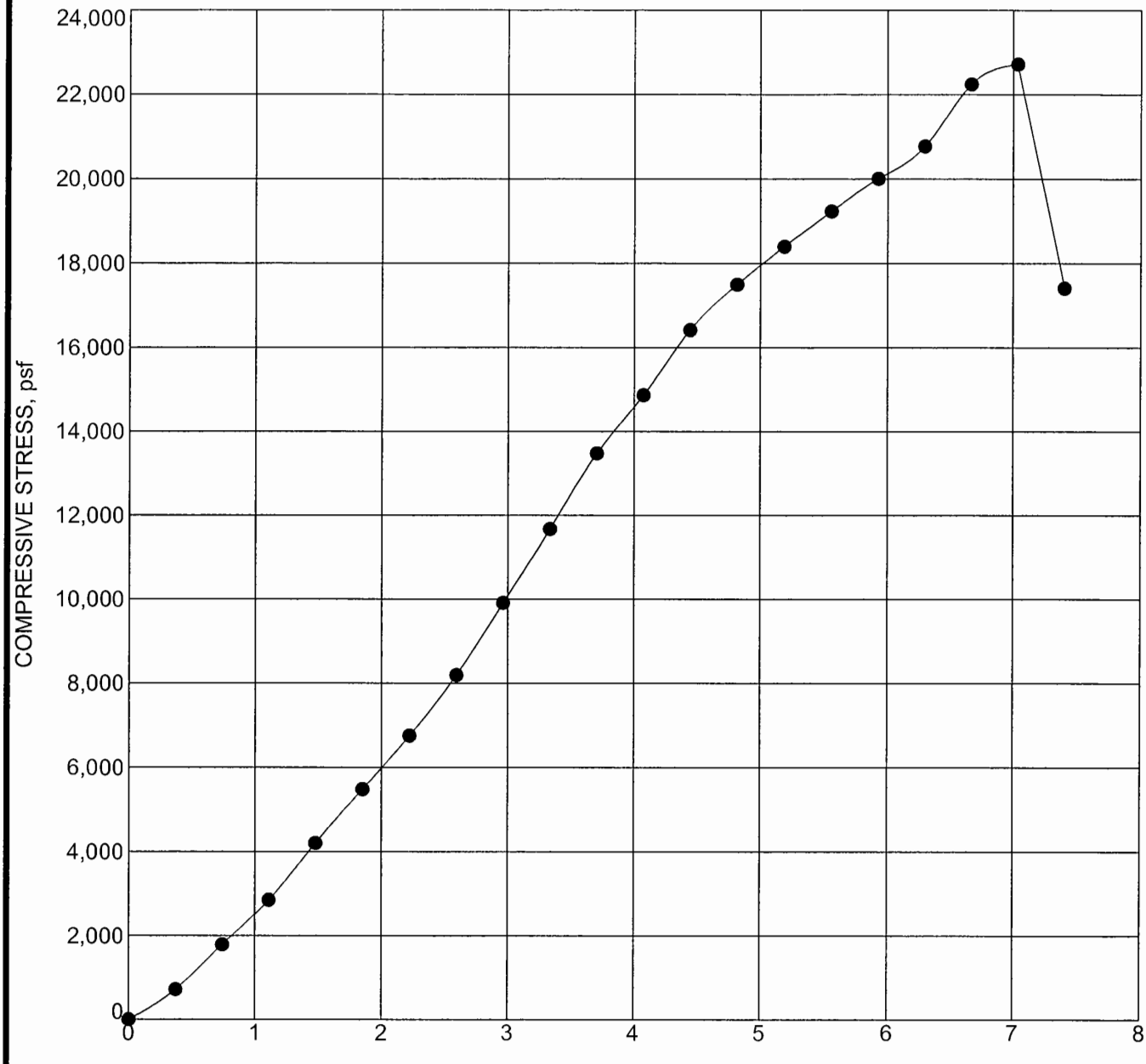

Boring	Sample	Depth	Classification
B-4	SS14	41 - 42.5	CLAY SHALE (visual)

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
14.3	135.4	118.4	22717	1.0	7.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
11359	93	0.410	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

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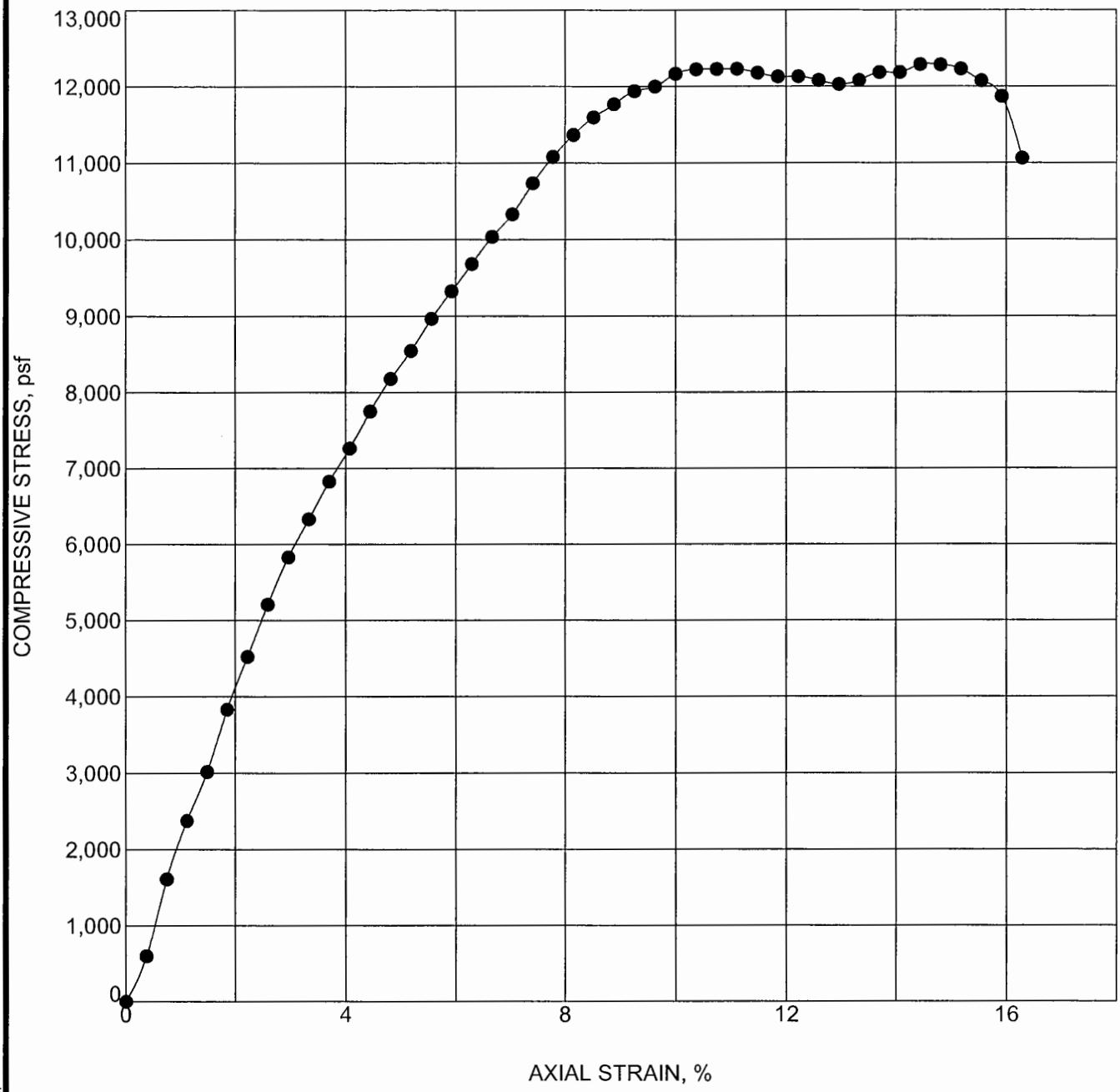

Boring	Sample	Depth	Classification
B-5	SS12	31 - 32.5	CLAY SHALE (visual)

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
12.7	139.6	123.9	12285	1.0	14.4
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
6142	98	0.347	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

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Project #: SR 37 Landslide
Location: Tell City, Indiana
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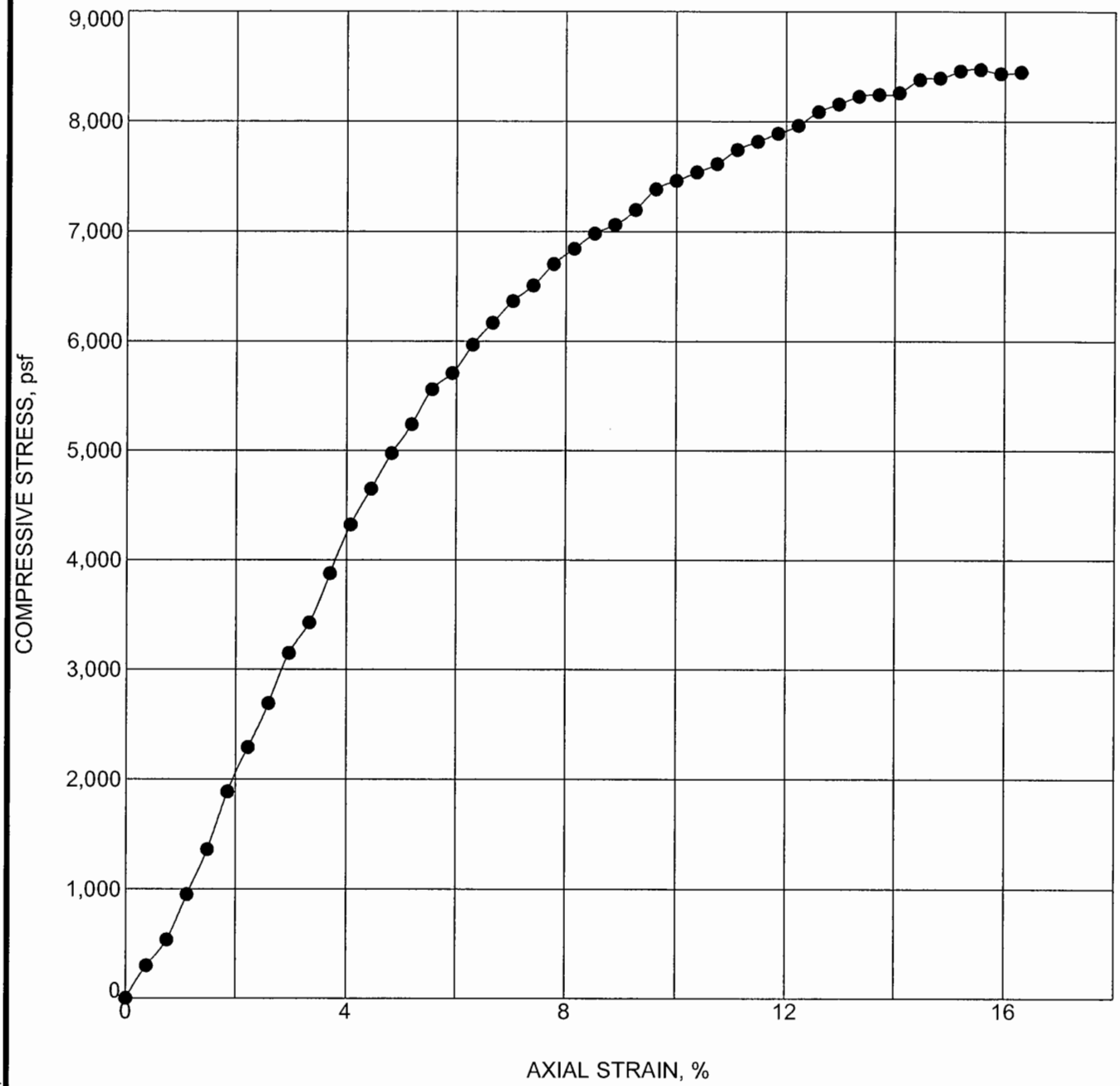

Boring	Sample	Depth	Classification
B-6	SS5	8 - 10	CLAY LOAM, Test #4

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
17.7	129.6	110.1	8426	1.0	15.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
4213	92	0.516	35.56	68.58	1.9

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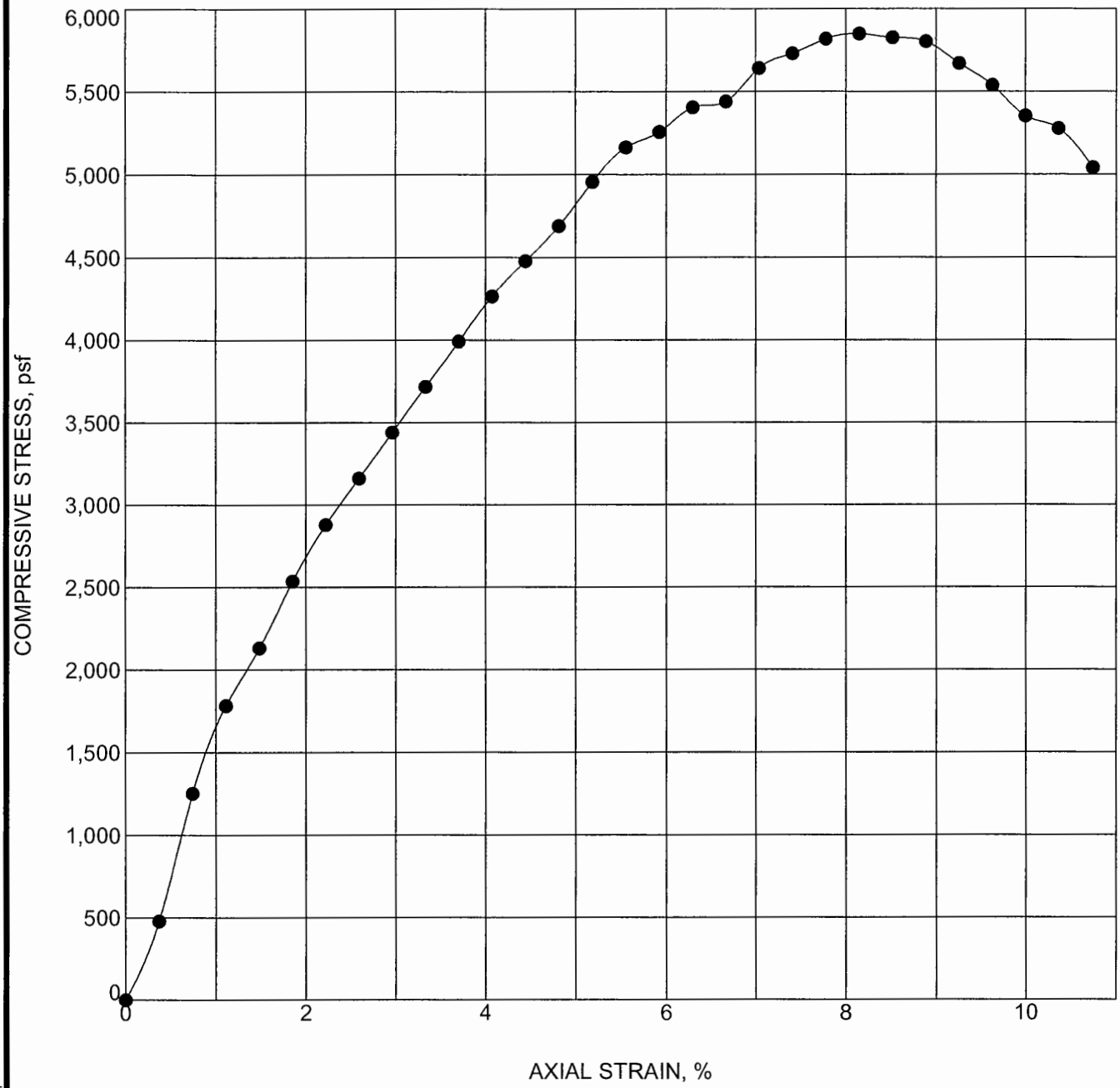
UNCONFINED COMPRESSION TEST

DES #: 0710073 Structure #:
Project #: SR 37 Landslide
Location: Tell City, Indiana
Alt & Witzig Project #:07IN0101



Boring	Sample	Depth	Classification
B-6	SS11	26 - 27.5	CLAY LOAM, Test #4

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
17.4	132.3	112.7	5849	1.0	8.1
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
2925	97	0.481	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

DES #: 0710073 Structure #:
Project #: SR 37 Landslide
Location: Tell City, Indiana
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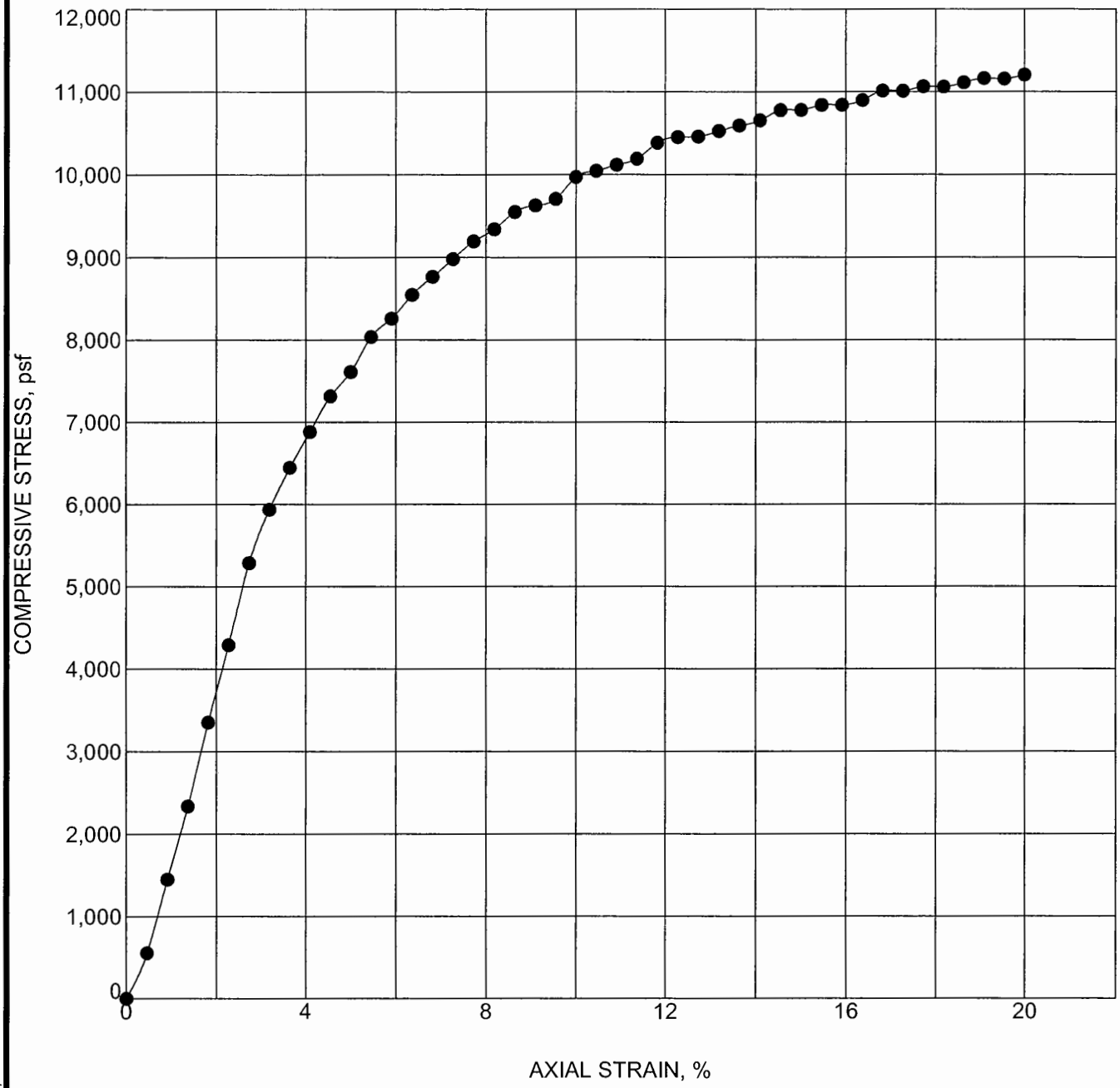

Boring	Sample	Depth	Classification
B-7	SS3	4 - 6	CLAY LOAM, Test #4

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
24.2	148.0	119.2	10779	1.0	15.0
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
5390	162	0.401	33.02	55.88	1.7

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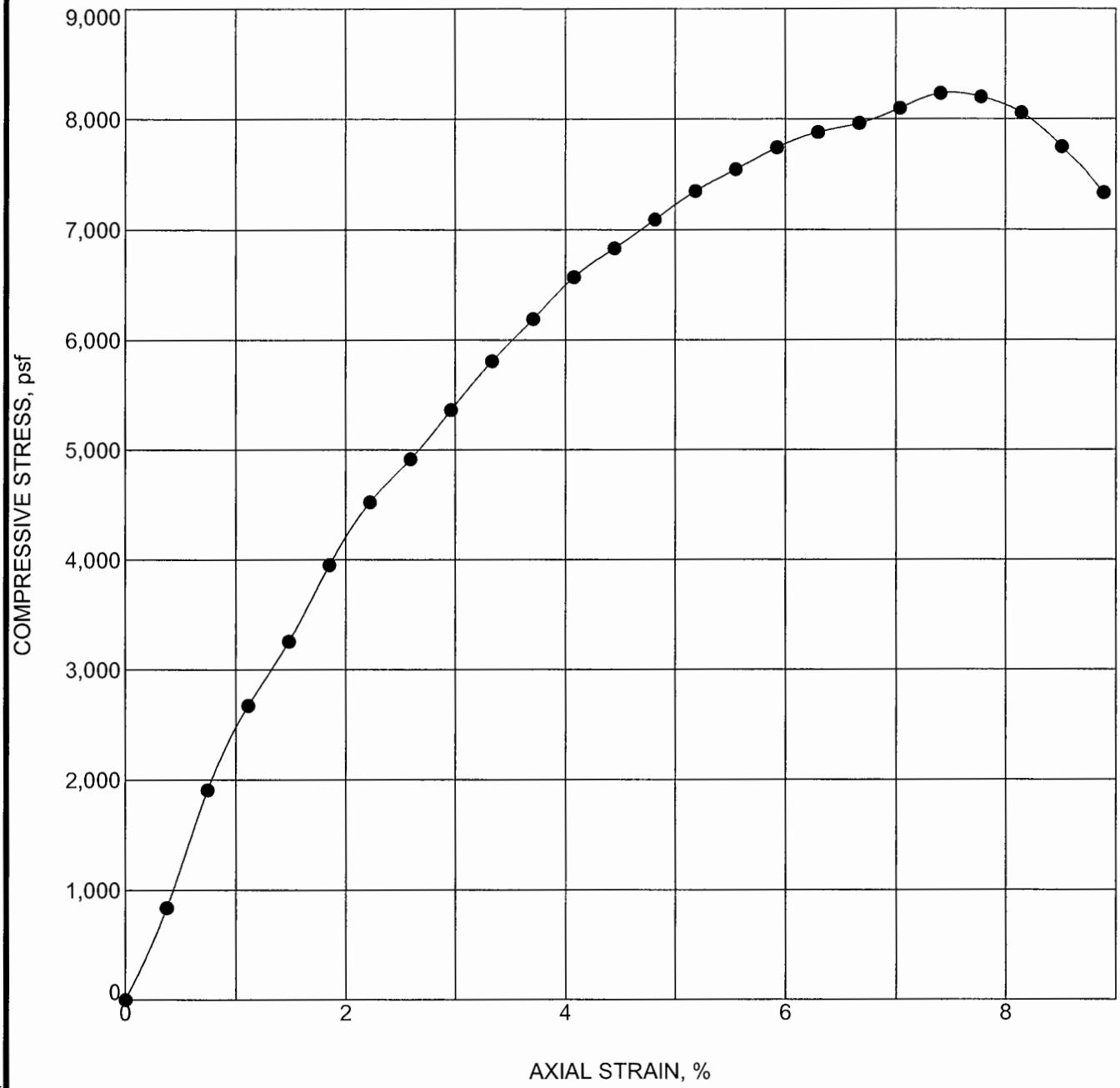

Boring	Sample	Depth	Classification
B-7	SS4	6 - 8	CLAY LOAM, Test #4

Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Unconfined Strength (psf)	Strain Rate (%)	Failure Strain (%)
15.9	128.8	111.1	8233	1.0	7.4
Shear Strength (psf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
4117	85	0.502	35.56	68.58	1.9

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UNCONFINED COMPRESSION TEST

DES #: 0710073 Structure #:
Project #: SR 37 Landslide
Location: Tell City, Indiana
Alt & Witzig Project #:07IN0101

Boring	Sample	Depth	Specific Gravity	Natural Density (pcf)	Moisture Content (%)	LOI (%)	pH	Liquid Limit	Plastic Limit	Max Dry Density (pcf)	Opt. Moisture %	CBR 90%	CBR 95%	CBR 100%	Void Ratio	qu (tsf)	Recovery (%)	RQD
B-1	SS2	3.5 - 5					6.69								0.51	11	50	
B-1	SS9	28.5 - 30			13.1		5.81	29.3	16.5						0.38	5.18	90	
B-1	SS11	38.5 - 40													0.43	6.31	80	
B-2	SS6	13.5 - 15													0.46	5.53	20	
B-2	SS10	33.5 - 35													0.58	5.81	75	
B-2	SS12	43.5 - 45													0.46	2.85	75	
B-2	SS15	58.5 - 60													0.49	13.1	100	
B-3	SS8	23.5 - 25			18.5										0.46	4.95	60	
B-3	SS9	28.5 - 30													0.61	4.06	60	
B-3	SS14	53.5 - 55													0.35	4.89	80	
B-4	SS1	0 - 2													0.64	1.57	60	
B-4	SS12	31 - 32.5													0.40	6.81	100	
B-4	SS14	41 - 42.5													0.41	11.4	100	
B-5	SS12	31 - 32.5													0.35	6.14	100	
B-6	SS5	8 - 10													0.52	4.21	60	
B-6	SS11	26 - 27.5													0.48	2.93	100	
B-7	SS3	4 - 6													0.40	5.39	100	
B-7	SS4	6 - 8													0.50	4.12	100	

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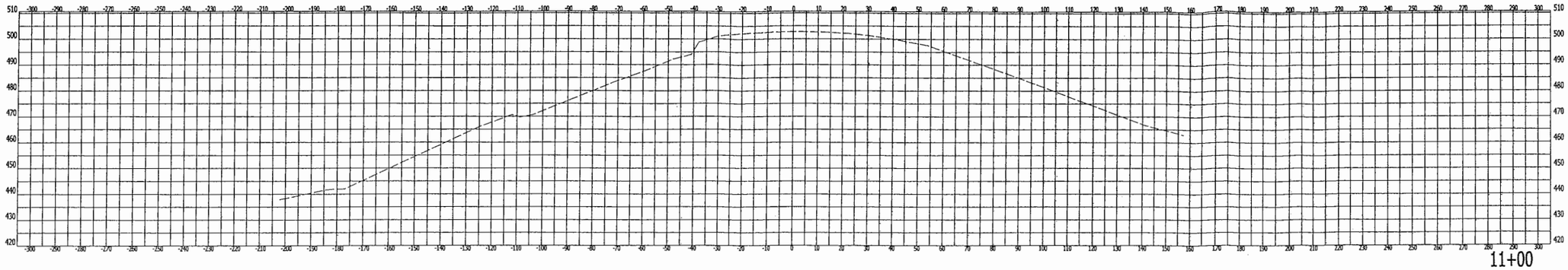
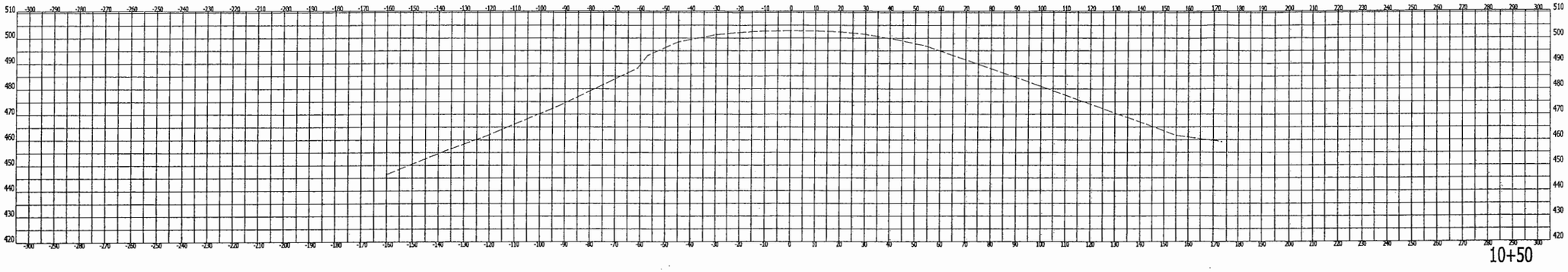
Summary of Special Lab Tests

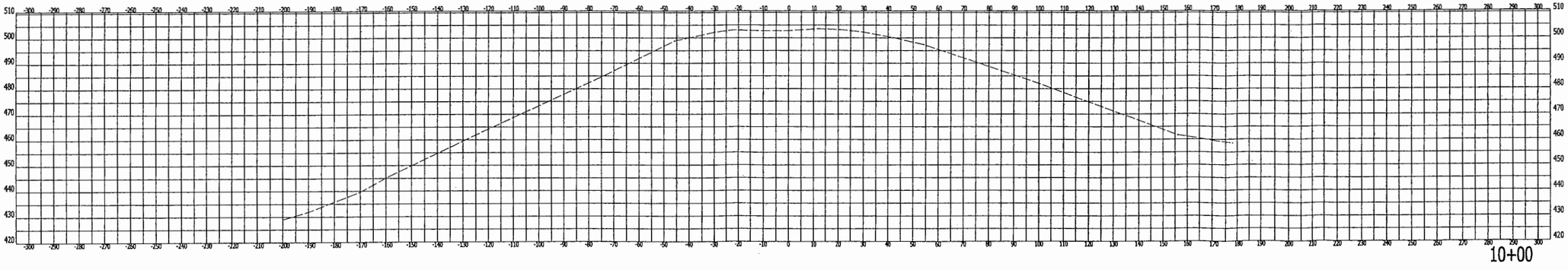
Project: S.R. 37 Landslide

Location: Tell City, Indiana

Number: 07IN0101





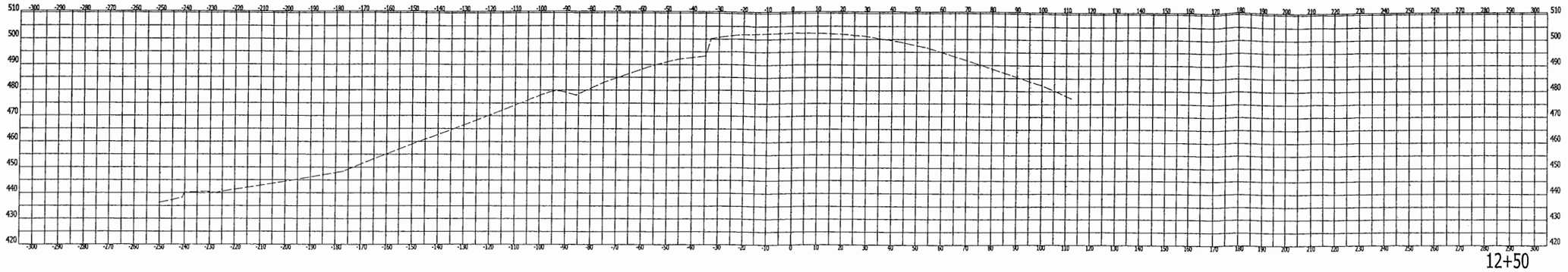


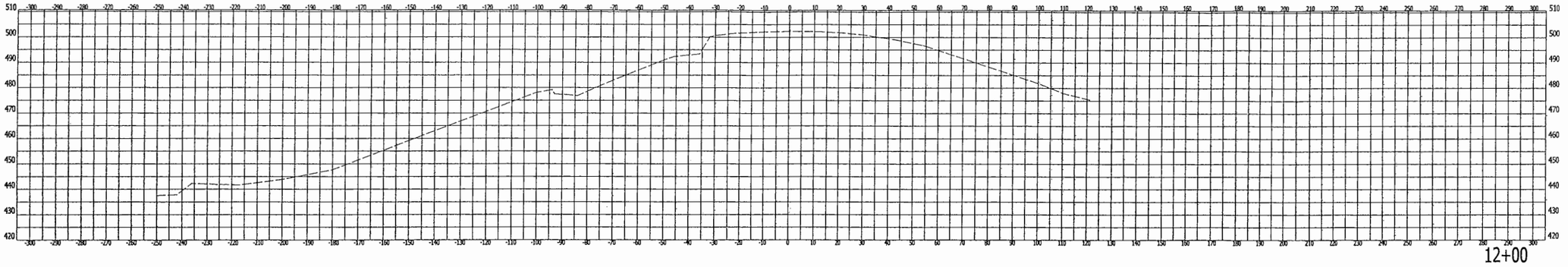
INDIANA
DEPARTMENT OF TRANSPORTATION

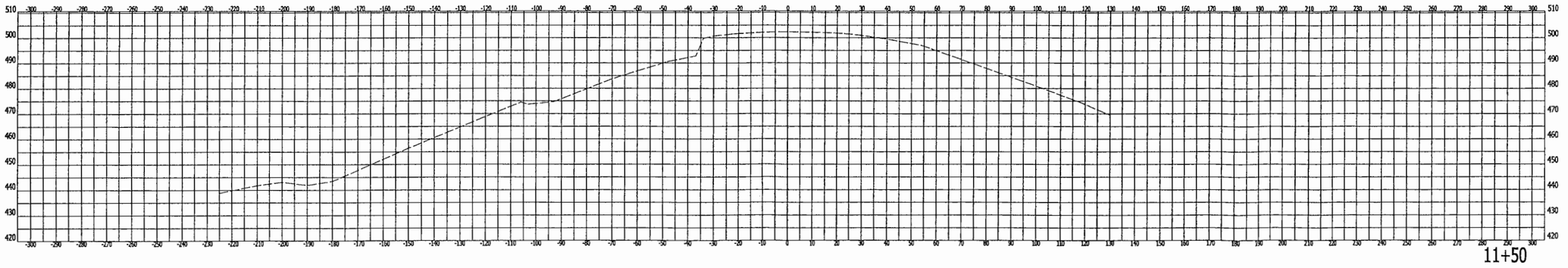
CROSS SECTIONS
S.R. 37 - Slide

DESIGNED:	DRAWN:
CHECKED:	CHECKED:

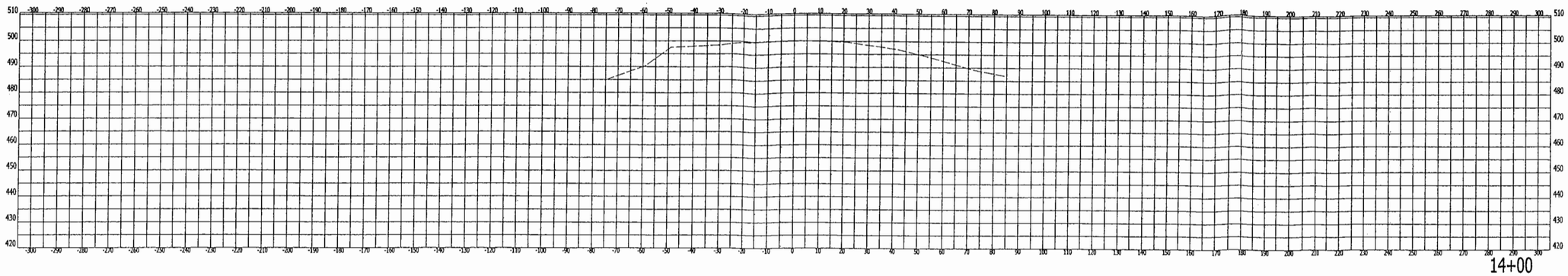
SCALE	BRIDGE FILE
1" = 20'	
LINE	DESIGNATION
SURVEY BOOK	SHEETS
	of $TOTAL_PAGES$
CONTRACT	PROJECT

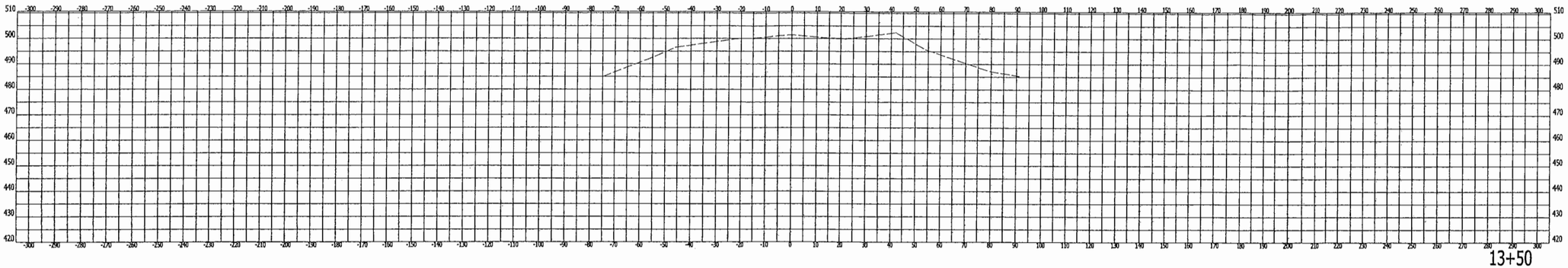


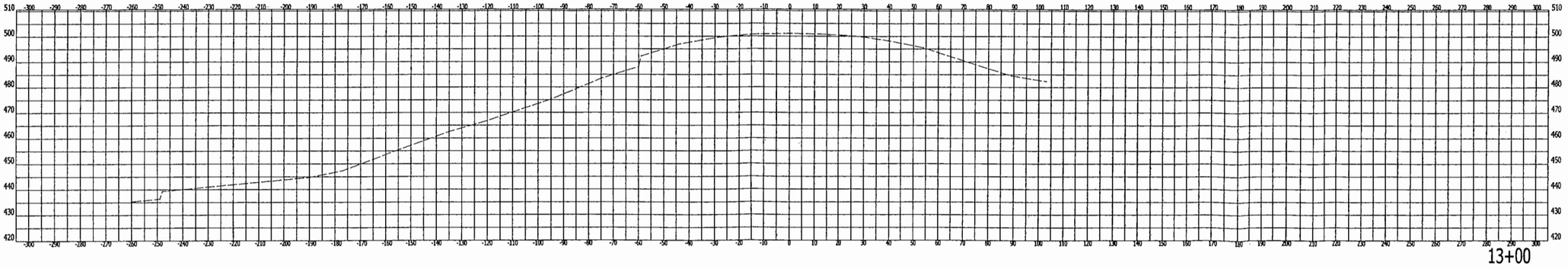




		INDIANA DEPARTMENT OF TRANSPORTATION	SCALE: 1" = 20' / LINE: — BRIDGE FILE: — DESIGNATION: —
DESIGNED: _____ DRAWN: _____ CHECKED: _____ CHECKED: _____		CROSS SECTIONS S.R. 37 - Slide	SURVEY BOOK: — SHEETS: of $TOTAL_PAGES$ CONTRACT: — PROJECT: —







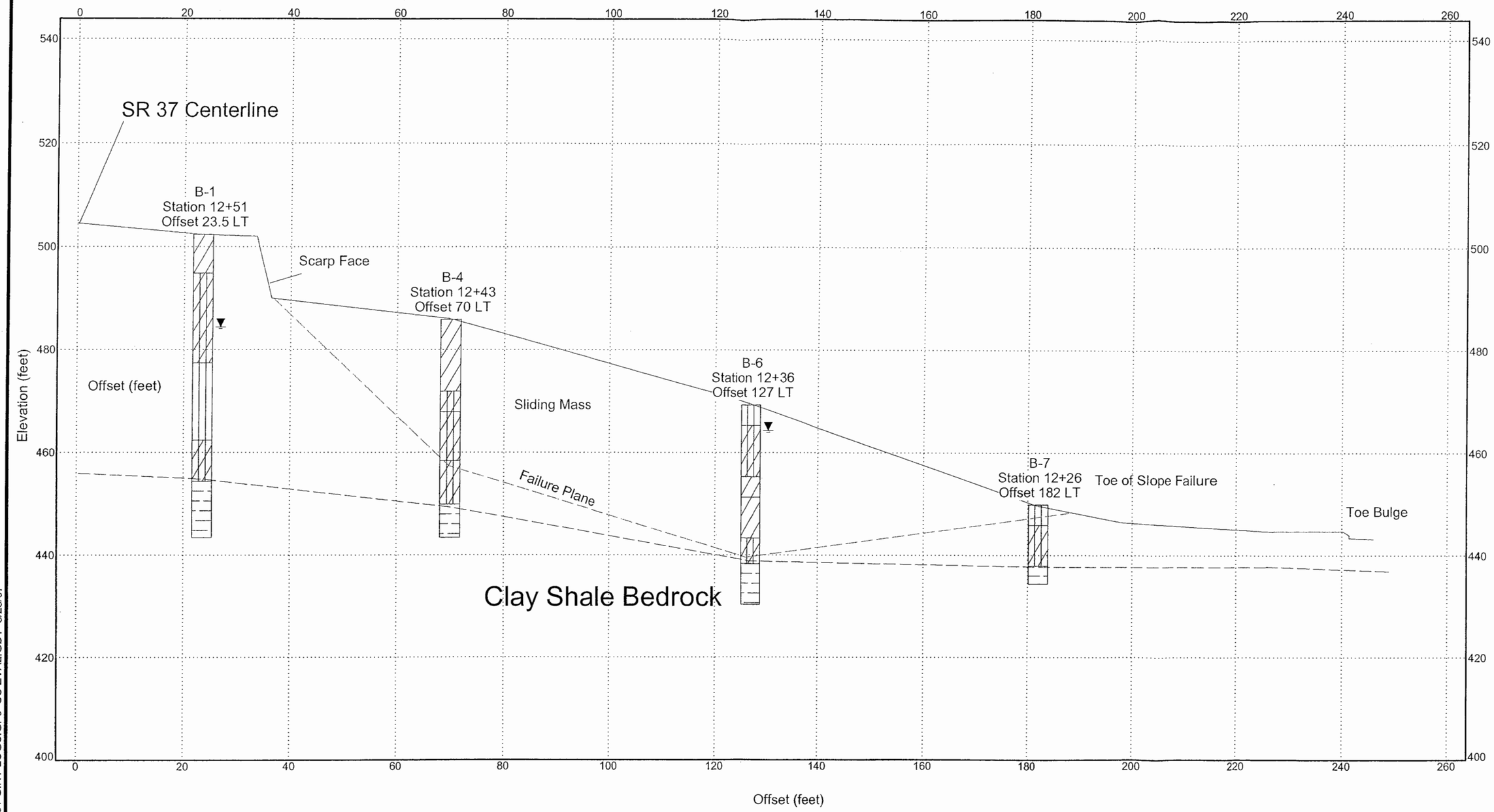
INDIANA
DEPARTMENT OF TRANSPORTATION

CROSS SECTIONS
S.R. 37 - Slide

SCALE	BRIDGE FILE
1" = 20'	
LINE	DESIGNATION
SURVEY BOOK	SHEETS
	of $TOTAL_PAGES$
CONTRACT	PROJECT

DESIGNED: _____ DRAWN: _____

CHECKED: _____ CHECKED: _____



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Subsurface Profile along Station 12+50

Project: S.R. 37 Landslide
Location: Tell City, Indiana
Number: 07IN0101

** PCSTABL5M **

by
Purdue University

Existing Slope

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	08-28-07
Time of Run:	8:31am
Run By:	David Harness
Input Data Filename:	F:07IN0101
Output Filename:	F:07IN0101.OUT
Unit:	ENGLISH
Plotted Output Filename:	F:07IN0101.PLT

PROBLEM DESCRIPTION SR 37 Landslide
Perry County, Indiana

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -280.00 to X values and 420.00 to Y values listed.

9 Top Boundaries
14 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	30.00	16.00	39.00	18.00	1
2	39.00	18.00	40.00	20.00	1
3	40.00	20.00	54.00	20.00	1
4	54.00	20.00	98.00	27.00	1
5	98.00	27.00	185.00	61.00	1
6	185.00	61.00	195.00	55.00	1
7	195.00	55.00	245.00	72.00	1
8	245.00	72.00	247.00	80.00	1
9	247.00	80.00	280.00	82.00	2
10	30.00	10.00	100.00	19.00	3
11	100.00	19.00	155.00	17.00	3
12	155.00	17.00	210.00	35.00	3
13	210.00	35.00	245.00	72.00	2
14	210.00	35.00	280.00	43.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	130.0	135.0	525.0	.0	.00	.0	1
2	135.0	140.0	2000.0	.0	.00	.0	1
3	145.0	150.0	8000.0	.0	.00	.0	1

---

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	30.00	12.00
2	280.00	70.00

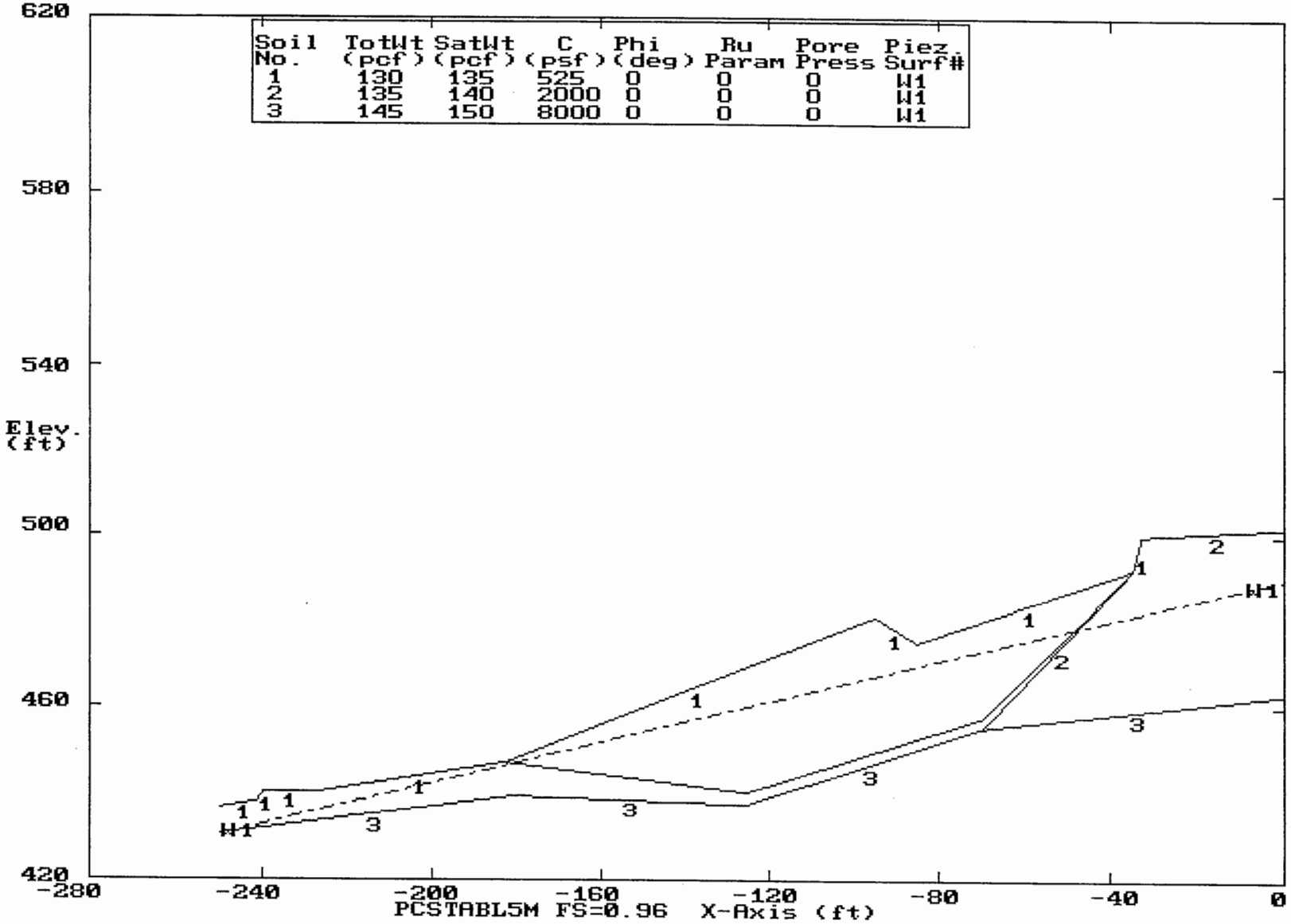
Trial Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	98.00	27.00
2	155.00	20.00
3	210.00	37.00
4	245.00	72.00

Factor Of Safety For The Preceding Specified Surface = .961

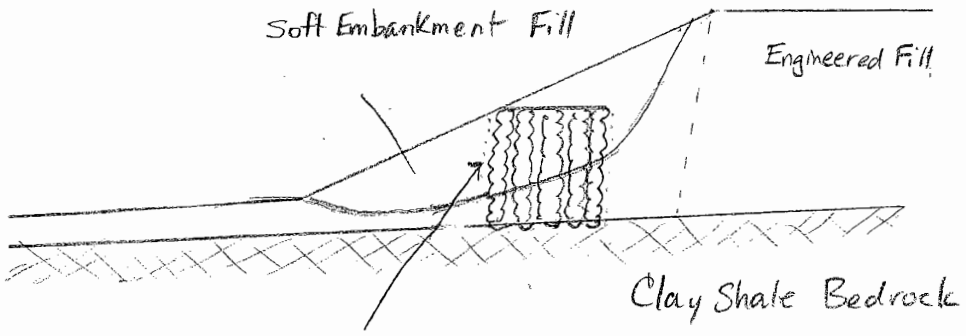
SR 37 Landslide Perry County, Indiana
Specified Surface. F:07IN0101.PLT By: David Harness 08-28-07 8:31am

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	130	135	525	0	0	0	W1
2	135	140	2000	0	0	0	W1
3	145	150	8000	0	0	0	W1



PCSTABL5M FS=0.96 X-Axis (ft)

Calculation of required replacement percentage to satisfy Factor of Safety.



RAP Composite Section

Assumed Undrained Condition (Worst Case)

Soft Embankment Fill: $C = 525$ psf (from existing slope stability)
$\phi = 0°$

RAP Elements: $C_g = 0$
$\phi_g = 50°$

Calculate composite section parameters, C_{comp} and ϕ_{comp}

$C_{comp} = C(1 - R_a)$ where R_a is replacement area

$\phi_{comp} = \arctan[R_a \tan \phi_g]$

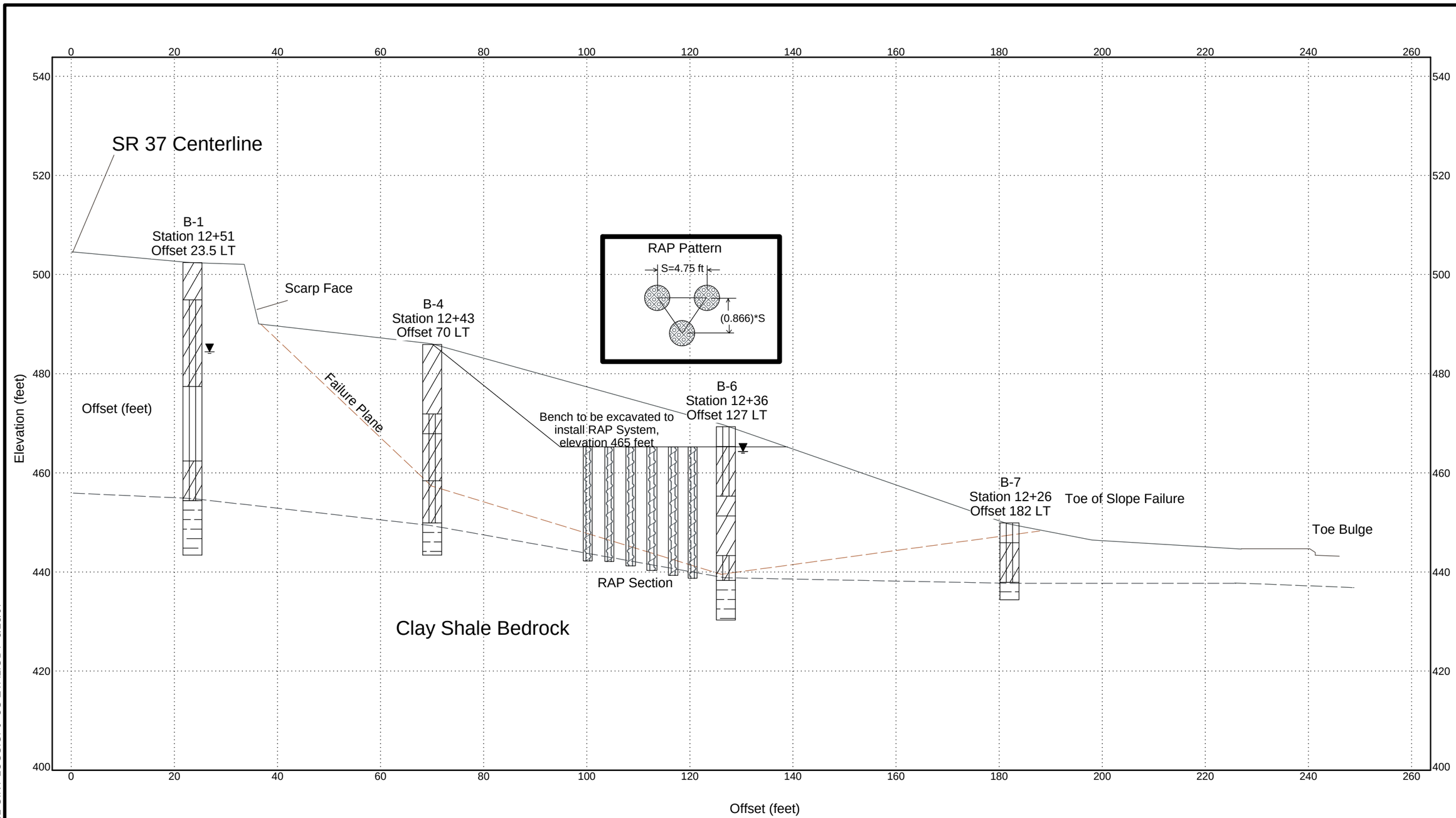
Try a replacement area of 25%

$C_{comp} = (525\text{ psf})(1 - 0.25) = \underline{394\text{ psf}}$

$\phi_{comp} = \arctan[(0.25)(\tan 50)] = \underline{16.6°}$

When these parameters are used in the slope stability analysis an adequate factor of safety (1.35) is achieved.

TMD



AW FENCE 11 X 17 07IN0101 GINT LOGS.GPJ US EVAL.GDT 8/28/07

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Subsurface Profile STA 12+50 showing RAP Section

Project: S.R. 37 Landslide
Location: Tell City, Indiana
Number: 07IN0101

** PCSTABL5M **

by
Purdue University

Slope Remediated by RAP

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	08-28-07
Time of Run:	8:37am
Run By:	David Harness
Input Data Filename:	F:7IN101FX
Output Filename:	F:7IN101FX.OUT
Unit:	ENGLISH
Plotted Output Filename:	F:7IN101FX.PLT

PROBLEM DESCRIPTION SR 37 Landslide
Perry County, Indiana

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add -280.00 to X values and 420.00 to Y values listed.

7 Top Boundaries
17 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
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2	39.00	18.00	40.00	20.00	1
3	40.00	20.00	54.00	20.00	1
4	54.00	20.00	98.00	27.00	1
5	98.00	27.00	156.00	40.00	1
6	156.00	40.00	245.00	80.00	2
7	245.00	80.00	280.00	83.00	2
8	156.00	40.00	185.00	40.00	4
9	185.00	40.00	243.00	70.00	1
10	243.00	70.00	245.00	80.00	2
11	30.00	10.00	100.00	19.00	3
12	100.00	19.00	155.00	17.00	3
13	155.00	17.00	156.00	40.00	4
14	185.00	40.00	186.00	25.00	4
15	186.00	25.00	210.00	35.00	3
16	210.00	35.00	280.00	43.00	3
17	155.00	17.00	186.00	25.00	3

ISOTROPIC SOIL PARAMETERS

4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	130.0	135.0	525.0	.0	.00	.0	1
2	135.0	140.0	2000.0	.0	.00	.0	1
3	145.0	150.0	8000.0	.0	.00	.0	1
4	135.0	140.0	394.0	16.6	.00	.0	1

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1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 2 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	30.00	12.00
2	280.00	70.00

Trial Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	98.00	27.00
2	155.00	20.00
3	210.00	37.00
4	245.00	80.00

Factor Of Safety For The Preceding Specified Surface = 1.350

SR 37 Landslide Perry County, Indiana
Specified Surface. F:7IN101FX.PLT By: David Harness 08-28-07 8:37am

Soil No.	TotWt (pcf)	SatWt (pcf)	C (psf)	Phi (deg)	Ru Param	Pore Press	Piez. Surf#
1	130	135	525	0	0	0	W1
2	135	140	2000	0	0	0	W1
3	145	150	8000	0	0	0	W1
4	135	140	394	16.6	0	0	W1