The Geo-Institute

of the American Society of Civil Engineers

Presents

The Competition Rules for the 15th *Annual* National

GeoPREDICTION at

2024 Geo-Congress - Vancouver, BC

Important Dates

GeoPrediction Reports Due……..…….December 15, 2023 6:00PM EST

Invitation to GeoPrediction Finale……...…. January 12, 2024

2024 Geo-Congress…….……February 25 – 28, 2024

Geo-Congress 2024 Information…….…….……https://www.geocongress.org/

GeoPrediction Presentations……..……..February 26, 2024

15th Annual National GeoPrediction Rules – 2024 Geo-Congress

1. Objective: The objective of the GeoPrediction competition is to develop an accurate prediction of geotechnical behavior given information regarding subsurface, boundary, and initial conditions, as well as the geotechnical/ structural/hydraulic loading. The GeoPrediction competition may involve using available geotechnical software, empirical correlations, or developing a simple but accurate computer code for making this prediction.

For the 2024 GeoPrediction, the competing teams will develop the estimated settlement of an embankment.

2. Geotech data: Input data for the problem including problem description, boring logs, and test data are found on the following sheets.

3. Eligibility: A GeoPrediction team will consist of one or two students. Teams of two can include two undergraduate students, or one undergraduate and one graduate student. Two graduate students cannot form a team. However, graduate students can submit their own prediction. Students must be enrolled during the Spring 2024 Semester or Quarter.

4. Submittal: Each GeoPrediction team will submit a GeoPrediction Report that will, at a minimum, contain the following information.

a. The Report shall be no more than three (3) pages long (not including any references and title page). One inch margins, single spacing, and 12 point Time New Roman font are required.
b. Include the provided Table 1 (completed) in your report.
c. The Report shall contain the methods (assumptions, correlations, analytical procedures, numerical procedures, computers software, etc.) that the team employed to develop the GeoPrediction. Methods must be referenced properly.
d. The cover page must include the name of the institution; names, email addresses, and status (i.e., graduate or undergraduate) of each team member; as well as the name and contact information of the faculty that advised the team in developing their prediction.
e. Submit your report electronically in PDF format to Dr. Matthew Sleep (sleepmw@uc.edu) by 6pm Eastern Standard Time on December 15, 2023 with the subject line "2024 Geo-Congress GeoPrediction Submittal – *School Name*". Sender will receive confirmation of receipt by email. Late submissions are not accepted. If you do not receive a confirmation email within 24 hours of submission, please re-send the information.

5. Judging: The submitted GeoPrediction reports will be judged and ranked by an anonymous panel of geotechnical faculty and engineers. Initial judging will be based on criterial (a) through (d) below.

a.	Format, length, grammar, English usage	15%
b.	Clarity of technical presentation	15%
c.	Logical and concise use of appropriate geotechnical methods and principles	20%
d.	Accuracy of GeoPrediction	20%
e.	Presentation at the 2024 Geo-Congress	30%

6. Selection: The winning team will receive the prestigious Mohr's Circle Award. Up to fifteen (15) teams may be invited to the GeoPrediction Presentation based on the ranking of their GeoPrediction reports. The selected teams will be notified by January 12, 2024. The top teams (based total score of items a-d listed in section #5) will receive partial reimbursement for student registration and travel (amount to be determined) for up to two team members.

7. Presentations: Teams invited to present their GeoPrediction Results will prepare an 8 - minute (maximum) presentation that describes their methods and GeoPrediction for viewing by judges and the public. The order and location of the presentations will be determined at the conference site. It is expected that a room with a projector and computer will be used for these presentations.

As noted in Item 5, the Presentation will constitute the final 30% of each invited team's final GeoPrediction score.

8. Questions: Questions should be emailed to Matthew Sleep (sleepmw@uc.edu). It is anticipated that these questions will be uploaded for all to review at the GeoWorld Website (TBD).

Project Description

Compression of soil layers due to the increase in stress caused by construction activities is a fundamental calculation of soil mechanics. The GeoPrediction problem this year asks students to determine the settlement caused by the construction of a roadway embankment.

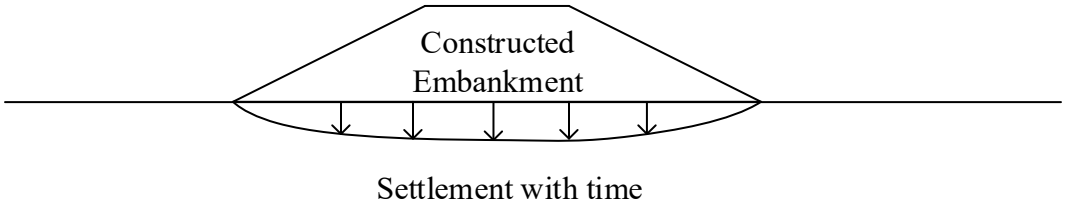


Figure 1 – Schematic of embankment settlement

A roadway embankment was constructed as shown in Figure 2. The cross section of the embankment at two locations, A and B, is shown in Figure 3. At location A, the embankment is 40 feet in height, with a crest width of 130 feet, and side slopes of 2H:1V. The embankment is constructed of rock fill with a 3' thick 'cohesive cap.' At location B, the embankment has the same dimensions, but is 44 feet in height. Settlement was measured at the centerline of the roadway embankment under the constructed embankment.

The ground surface elevation at location A prior to the construction of the embankment was 722.8 ft. At location B, it was 717.9 feet. The construction speed of each embankment is shown in Figure 4.

To speed up settlement, prior to embankment construction, wick drains were installed. These extend the full width from toe to toe of the embankment. These wick drains were 60' long and had a 5' center to center spacing (in all directions). The top of each wick drain is connected to a horizontal drain that allows water to be removed from under the embankment to outside of the embankment. A schematic showing wick drain distribution is shown in Figure 4. The number of wick drains is dictated by the 5' center to center spacing in both dimensions. The wick drains are prefabricated vertical drains (PVD) 4" wide with a formed polypropylene core covered with filter fabric. Ameridrain PVD 407 can be assumed with a typical water flow rate (ASTM D4491) of 70 gpm/ft^2 and a discharge capacity (ASTM D4716) of 1.6 gpm. Other properties can be assumed based on this PVD type.

Soil properties are found in Borings 1, 2, and 3 taken near location A and B. In addition, 1 unconfined compression test (Boring 1) and two consolidation tests (Boring 3) are provided.

Your task is to complete Table 1 and include it in your report. What is the total primary settlement (settlement of the existing ground surface) that occurred from construction of the embankment at location A and location B? Your settlement estimate will be compared to

measured settlement of the original ground surface at location A and B at the end of primary consolidation settlement.

Finally, as extra credit, how long would it take for the end of primary consolidation settlement at location B in days if time 0 was the start of embankment construction? Your time will be compared to measurements of excess water pressure dissipation from embankment construction.

Table 1 – GeoPrediction Estimate

Location	**Settlement Estimate (inches)**
A	
B	
Extra Credit	
Location	**Time to end of primary consolidation settlement (days) *Note day 0 is the start of embankment construction**
B	

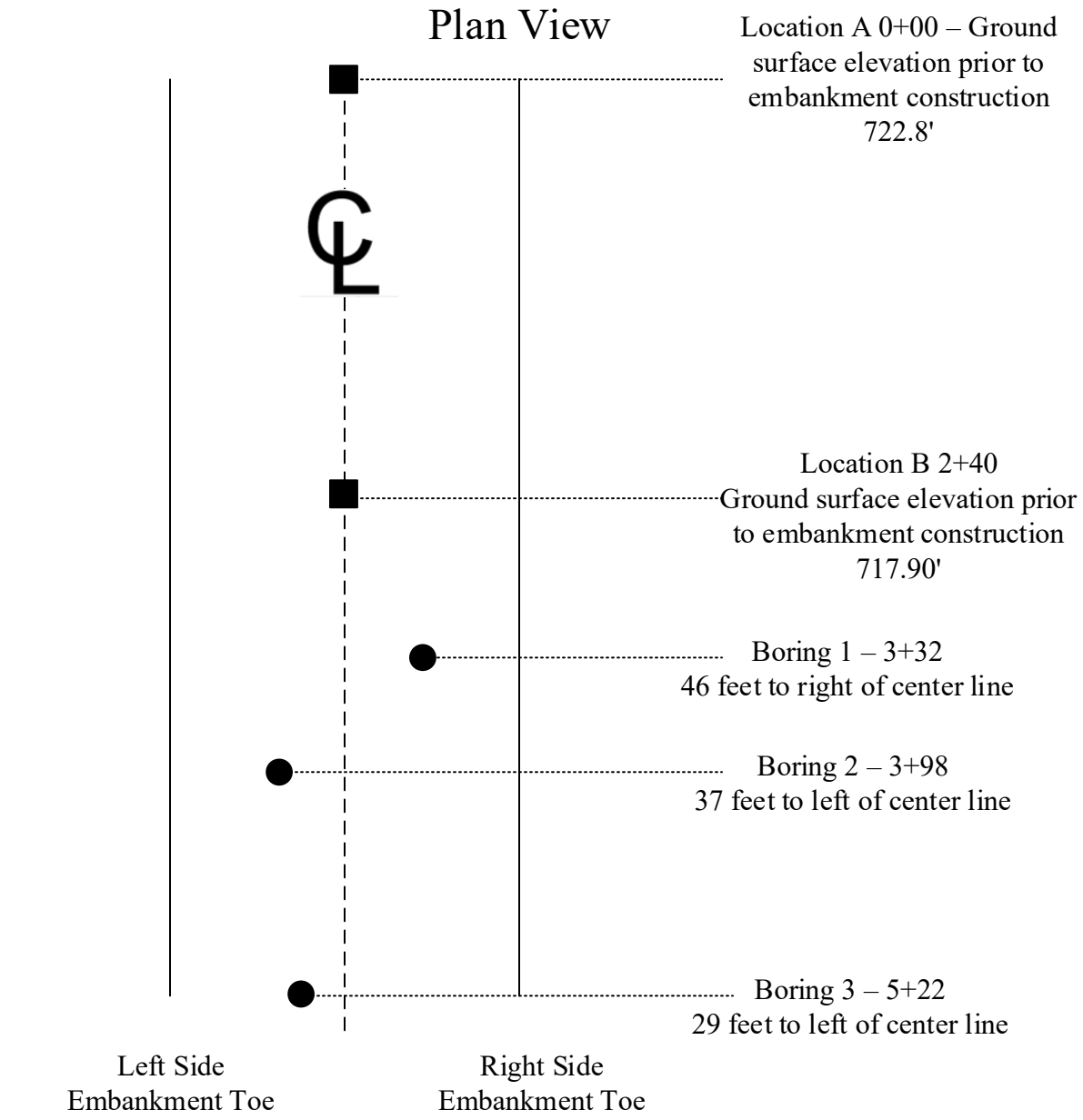
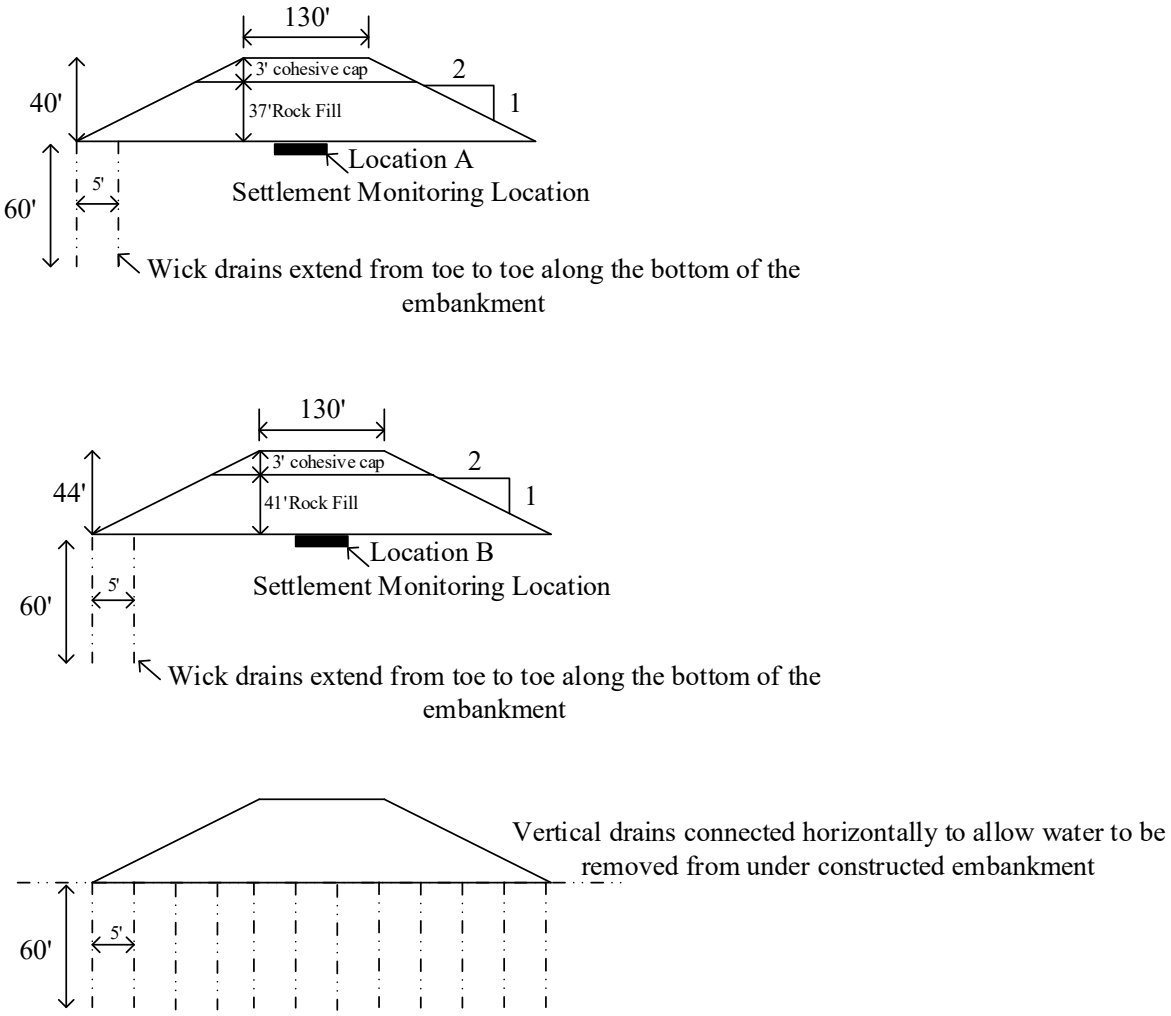


Figure 2 – Plan view of roadway embankment showing location of settlement measurements and soil boring locations *not to scale – dimensions can be taken from indicated stations (for example, location B is 240 feet away from location A at the roadway centerline)

Embankment Cross Sections



Wick drain distribution – Note* not to scale in number

Figure 3 – Cross sections of constructed embankment at location A and location B

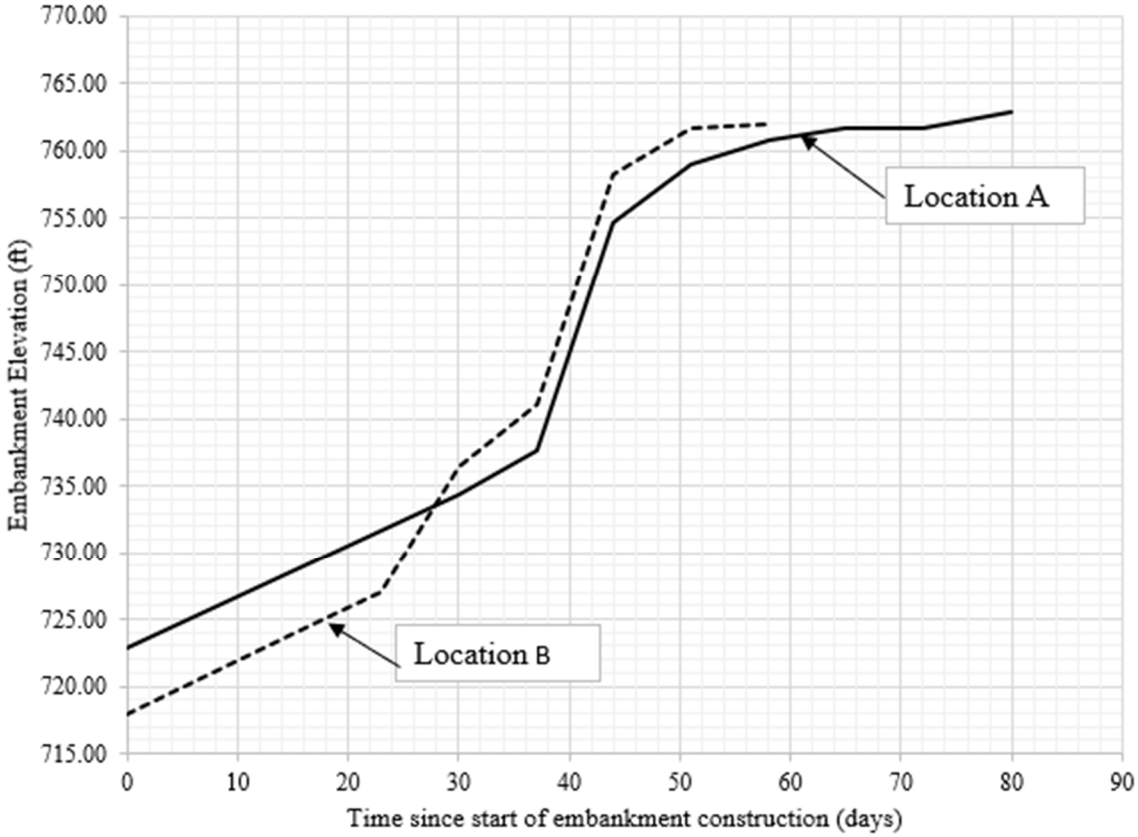
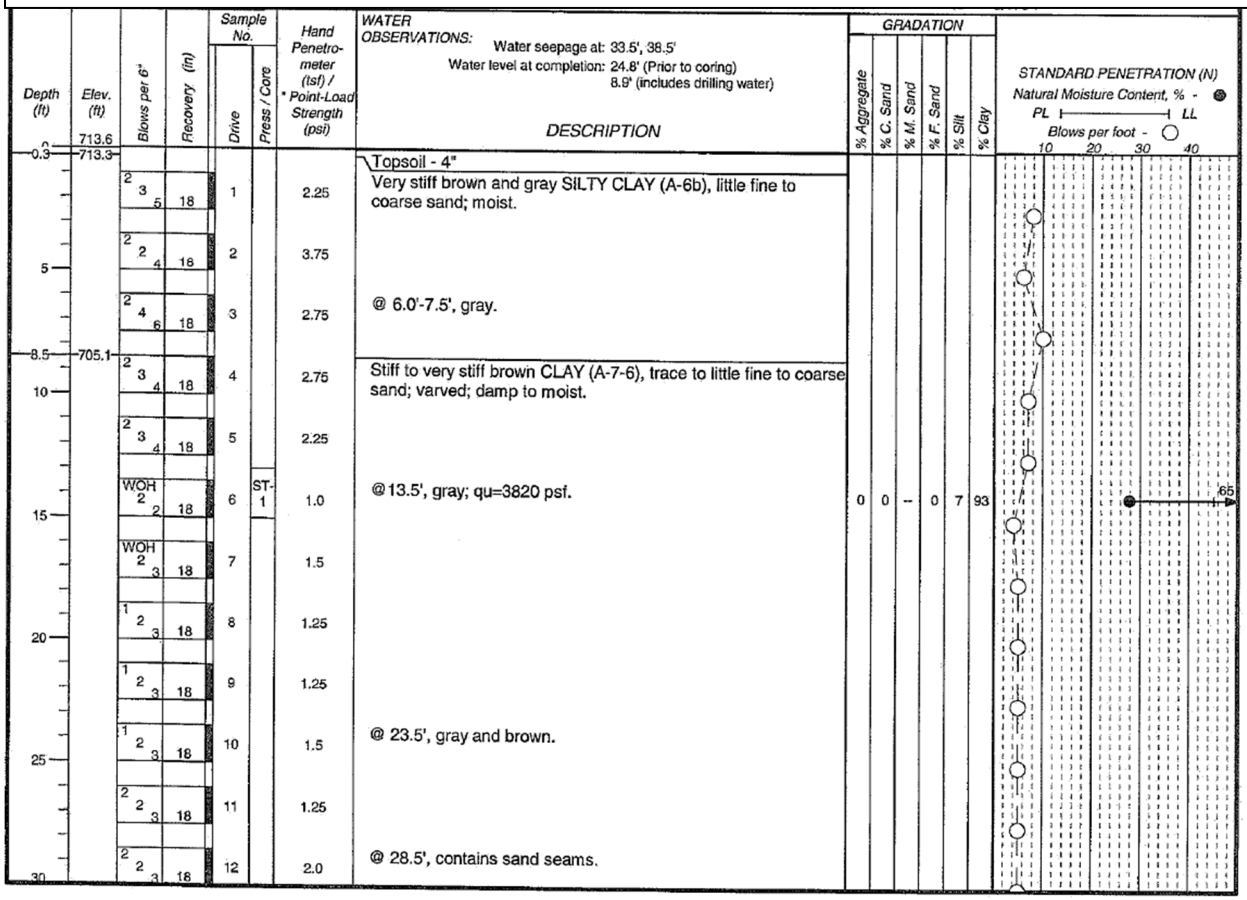


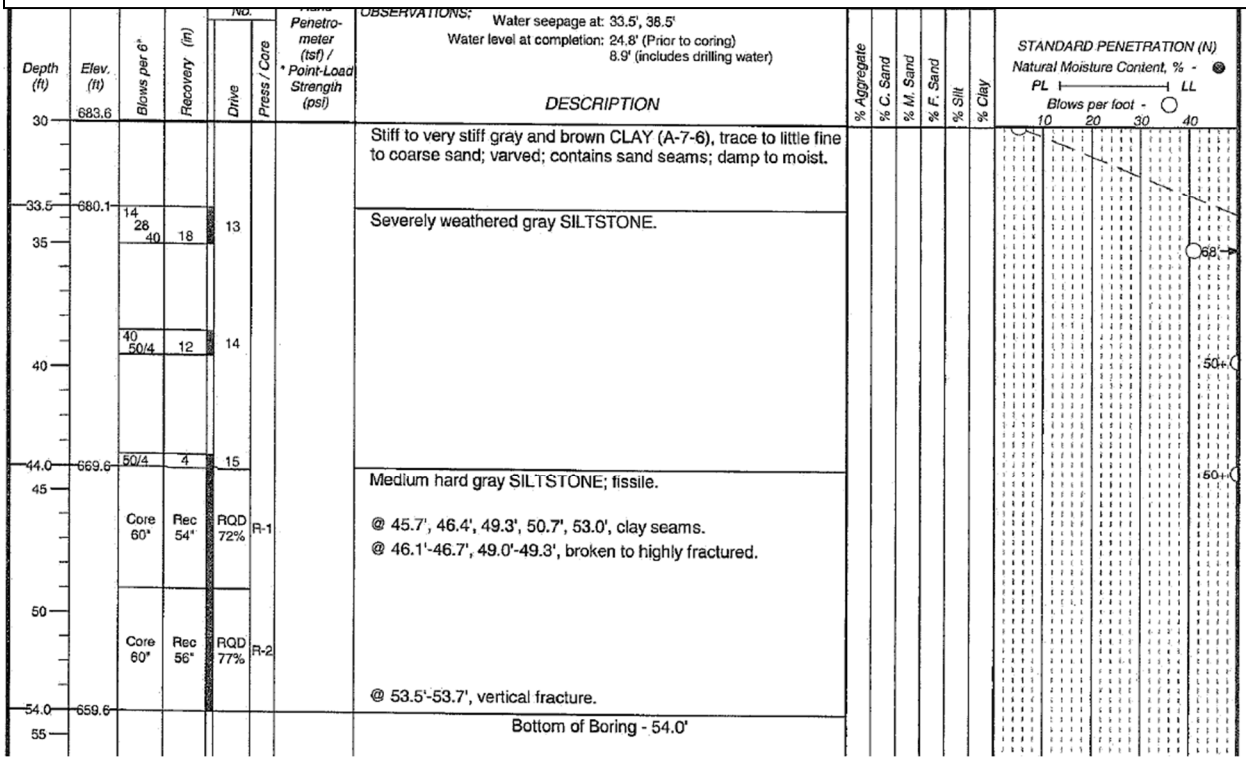
Figure 4 – Speed of embankment construction at location A and B

Boring Logs and Lab Data

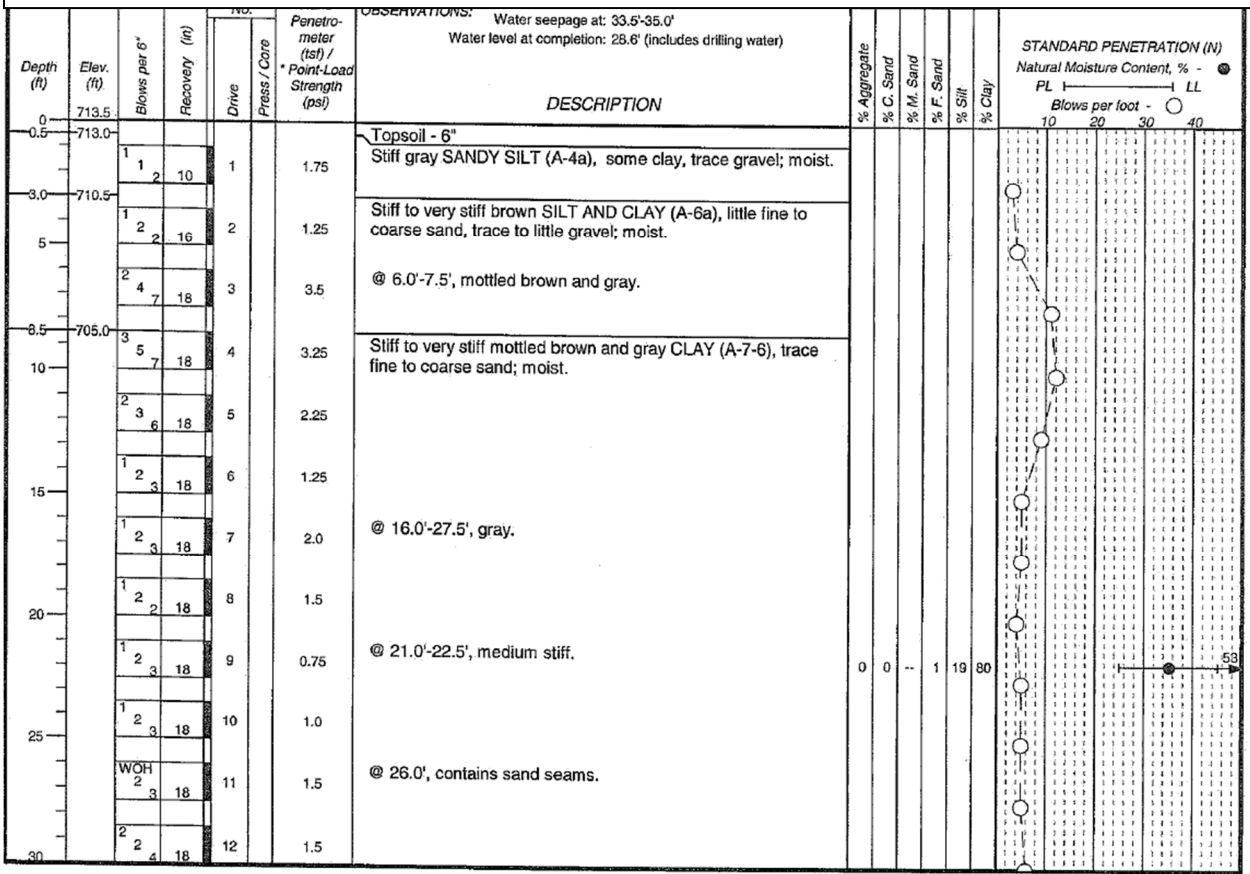
Boring 1

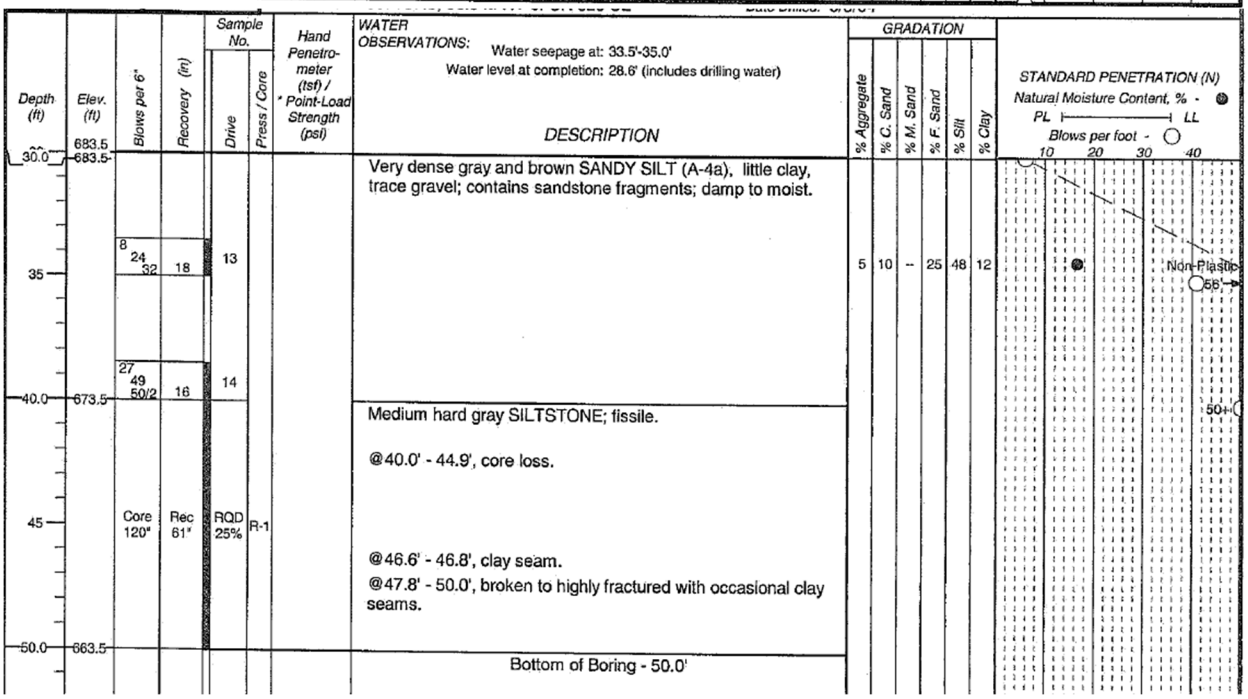

Depth (ft)
Elev. (ft)
Blows per 6"
Recovery (in)
Sample No.
Drive
Press / Core
Hand Penetrometer (tsf) / * Point-Load Strength (psi)
WATER OBSERVATIONS:
Water seepage at: 33.5', 38.5'
Water level at completion: 24.8' (Prior to coring)
8.9' (includes drilling water)
DESCRIPTION
GRADATION
% Aggregate
% C. Sand
% M. Sand
% F. Sand
% Silt
% Clay
STANDARD PENETRATION (N)
Natural Moisture Content, % -
PL
LL
Blows per foot -
0
0.3
713.6
713.3
8.5
705.1
30
Topsoil - 4"
Very stiff brown and gray SILTY CLAY (A-6b), little fine to coarse sand; moist.
@ 6.0'-7.5', gray.
Stiff to very stiff brown CLAY (A-7-6), trace to little fine to coarse sand; varved; damp to moist.
@13.5', gray; qu=3820 psf.
@ 23.5', gray and brown.
@ 28.5', contains sand seams.
ST-1
65

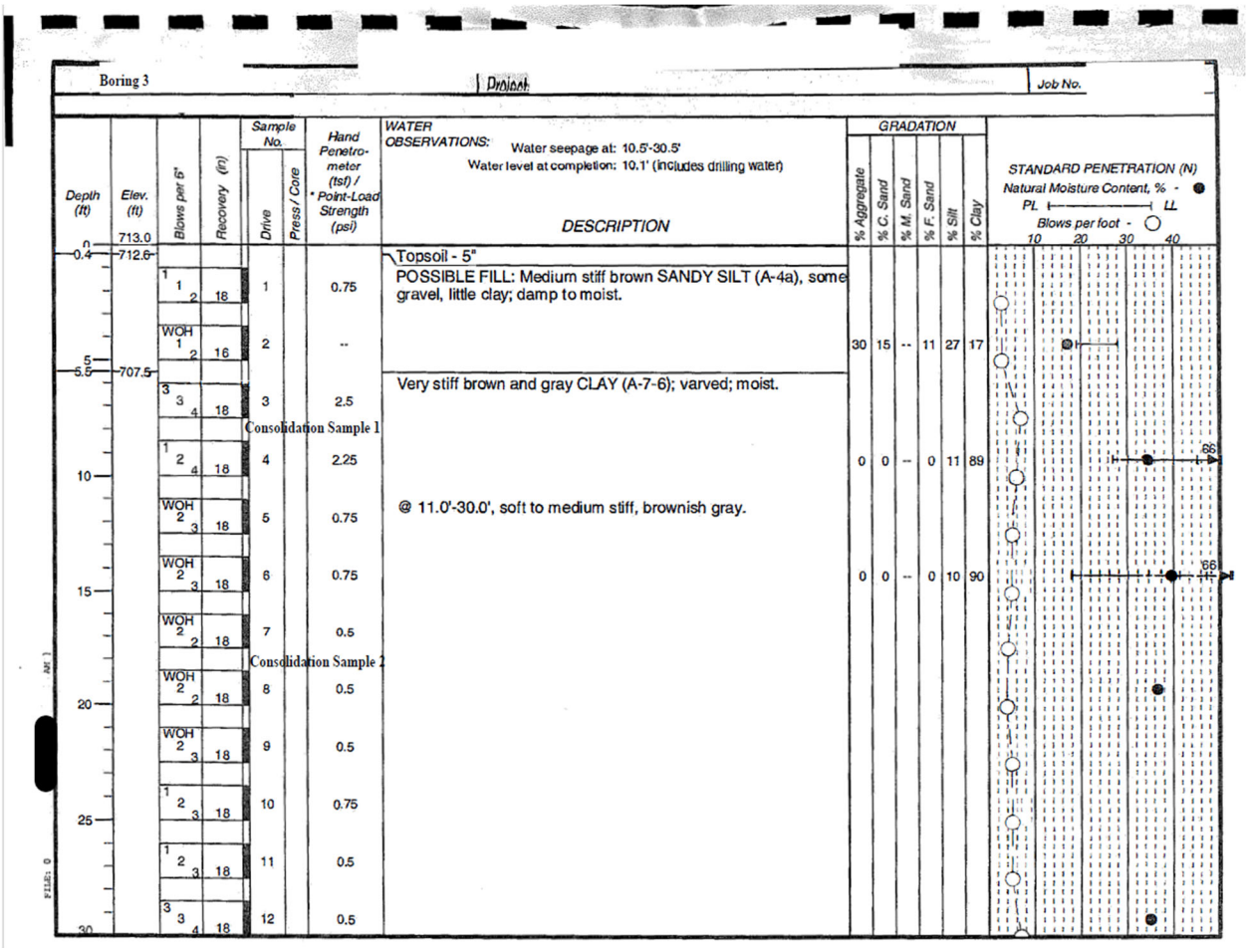
Boring 1 Cont.



Boring 2


OBSERVATIONS: Water seepage at: 33.5'-35.0'
Water level at completion: 28.6' (includes drilling water)
Depth (ft)
Elev. (ft)
Blows per 6"
Recovery (in)
Sample No.
Drive
Press / Core
Penetrometer (tsf) / * Point-Load Strength (psi)
DESCRIPTION
% Aggregate
% C. Sand
% M. Sand
% F. Sand
% Silt
% Clay
STANDARD PENETRATION (N)
Natural Moisture Content, % -
PL
LL
Blows per foot -
Topsoil - 6"
Stiff gray SANDY SILT (A-4a), some clay, trace gravel; moist.
Stiff to very stiff brown SILT AND CLAY (A-6a), little fine to coarse sand, trace to little gravel; moist.
@ 6.0'-7.5', mottled brown and gray.
Stiff to very stiff mottled brown and gray CLAY (A-7-6), trace fine to coarse sand; moist.
@ 16.0'-27.5', gray.
@ 21.0'-22.5', medium stiff.
@ 26.0', contains sand seams.
0 0 -- 1 19 80
53

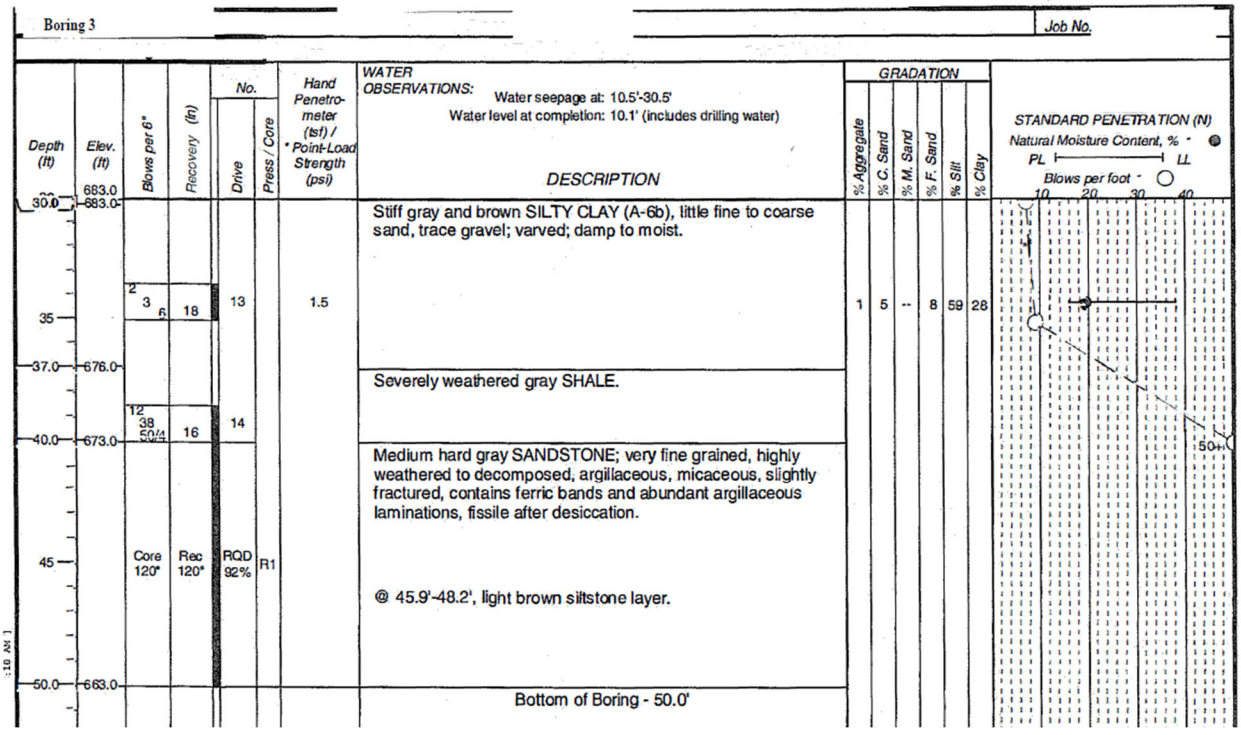

WATER OBSERVATIONS: Water seepage at: 33.5'-35.0'
Water level at completion: 28.6' (includes drilling water)
GRADATION
Depth (ft)
Elev. (ft)
Blows per 6"
Recovery (in)
Sample No.
Drive
Press / Core
Hand Penetrometer (tsf) / * Point-Load Strength (psi)
DESCRIPTION
% Aggregate
% C. Sand
% M. Sand
% F. Sand
% Silt
% Clay
STANDARD PENETRATION (N)
Natural Moisture Content, % -
PL
LL
Blows per foot -
Very dense gray and brown SANDY SILT (A-4a), little clay, trace gravel; contains sandstone fragments; damp to moist.
Medium hard gray SILTSTONE; fissile.
@40.0' - 44.9', core loss.
@46.6' - 46.8', clay seam.
@47.8' - 50.0', broken to highly fractured with occasional clay seams.
Bottom of Boring - 50.0'
Core 120"
Rec 61"
RQD 25%
R-1
5 10 -- 25 48 12
Non-Plastic
58
50+



Boring 3 | Project | Job No.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	713.0						WATER OBSERVATIONS: Water seepage at: 10.5'-30.5' Water level at completion: 10.1' (includes drilling water)						
0.4	712.6						Topsoil - 5"						
		1 1 2	18	1		0.75	POSSIBLE FILL: Medium stiff brown SANDY SILT (A-4a), some gravel, little clay; damp to moist.						
		WOH 1 2	16	2		--		30	15	--	11	27	17
5.5	707.5						Very stiff brown and gray CLAY (A-7-6); varved; moist.						
		3 3 4	18	3		2.5							
							Consolidation Sample 1						
		1 2 4	18	4		2.25		0	0	--	0	11	89
		WOH 2 3	18	5		0.75	@ 11.0'-30.0', soft to medium stiff, brownish gray.						
		WOH 2 3	18	6		0.75		0	0	--	0	10	90
		WOH 2 2	18	7		0.5							
							Consolidation Sample 2						
		WOH 2 2	18	8		0.5							
		WOH 2 3	18	9		0.5							
		1 2 3	18	10		0.75							
		1 2 3	18	11		0.5							
30		3 3 4	18	12		0.5							

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○
10 20 30 40
66
66

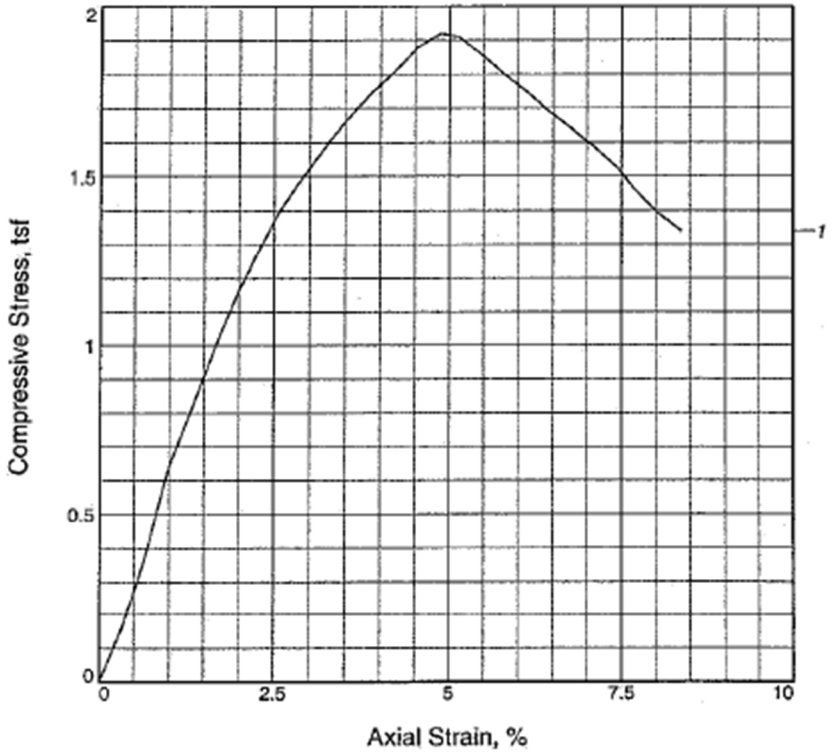


Boring 3 | Job No.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	No. Drive	No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30.0	683.0						WATER OBSERVATIONS: Water seepage at: 10.5'-30.5' Water level at completion: 10.1' (includes drilling water)						
		2 3 6	18	13		1.5	Stiff gray and brown SILTY CLAY (A-6b), little fine to coarse sand, trace gravel; varved; damp to moist.	1	5	--	8	59	28
37.0	676.0						Severely weathered gray SHALE.						
		12 38 50/4	16	14									
40.0	673.0						Medium hard gray SANDSTONE; very fine grained, highly weathered to decomposed, argillaceous, micaceous, slightly fractured, contains ferric bands and abundant argillaceous laminations, fissile after desiccation.						
		Core 120"	Rec 120"	RQD 92%	R1		@ 45.9'-48.2', light brown siltstone layer.						
50.0	663.0						Bottom of Boring - 50.0'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢—⊣ LL
Blows per foot - ○
10 20 30 40
50+

UNCONFINED COMPRESSION TEST

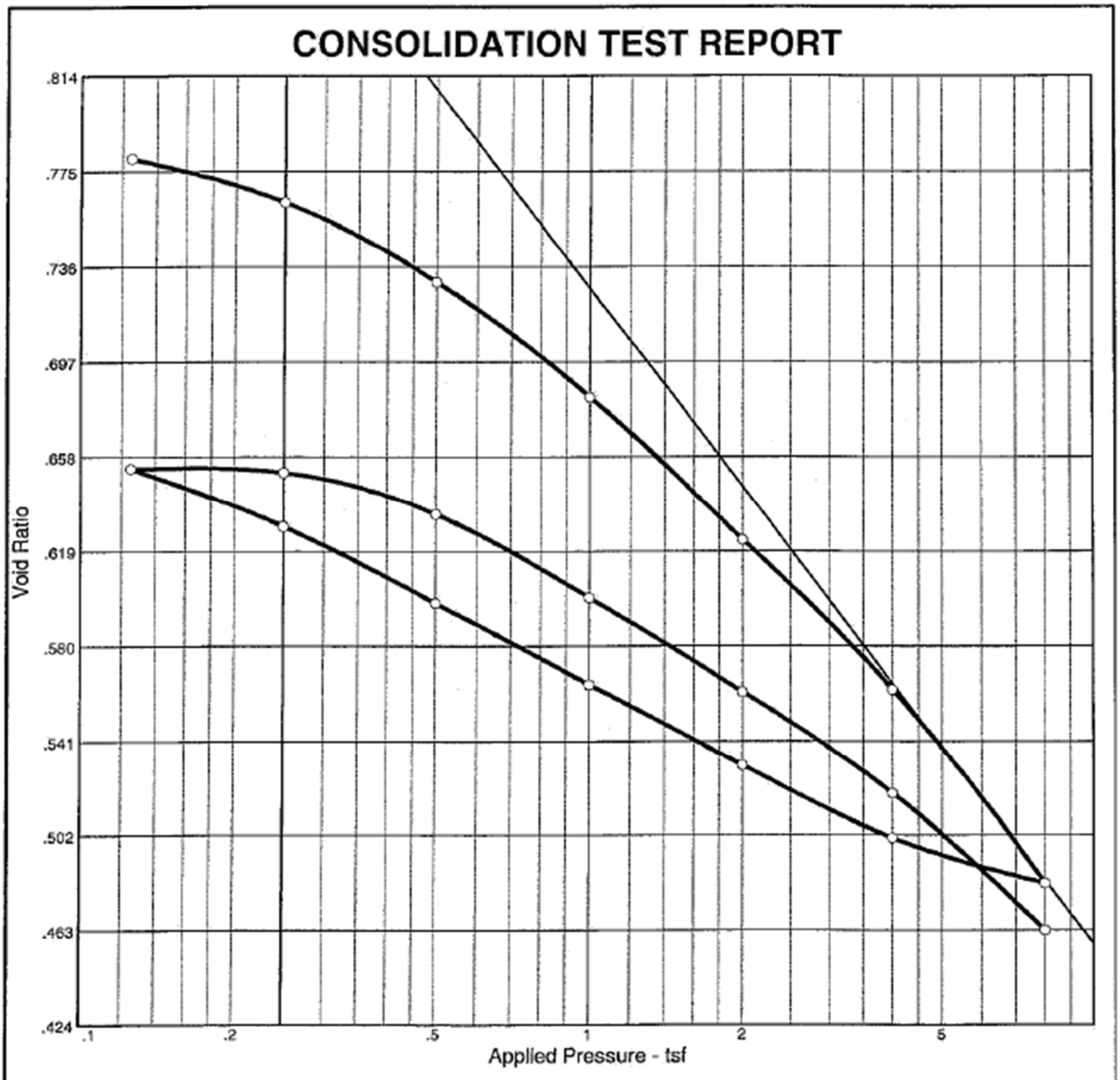


Sample No.	1			
Unconfined strength, tsf	1.911			
Undrained shear strength, tsf	0.955			
Failure strain,	5.1			
Strain rate, in./min.	0.06			
Water content, %	38.5			
Wet density, pcf	116.9			
Dry density, pcf	84.4			
Saturation, %	100.0			
Void ratio	1.0865			
Specimen diameter, in.	2.85			
Specimen height, in.	6.26			
Height/diameter ratio	2.20			

Description: Fat clay

LL = 65	**PL** = 28	**PI** = 37	**Assumed GS**= 2.82	**Type:** 2.8" press tube

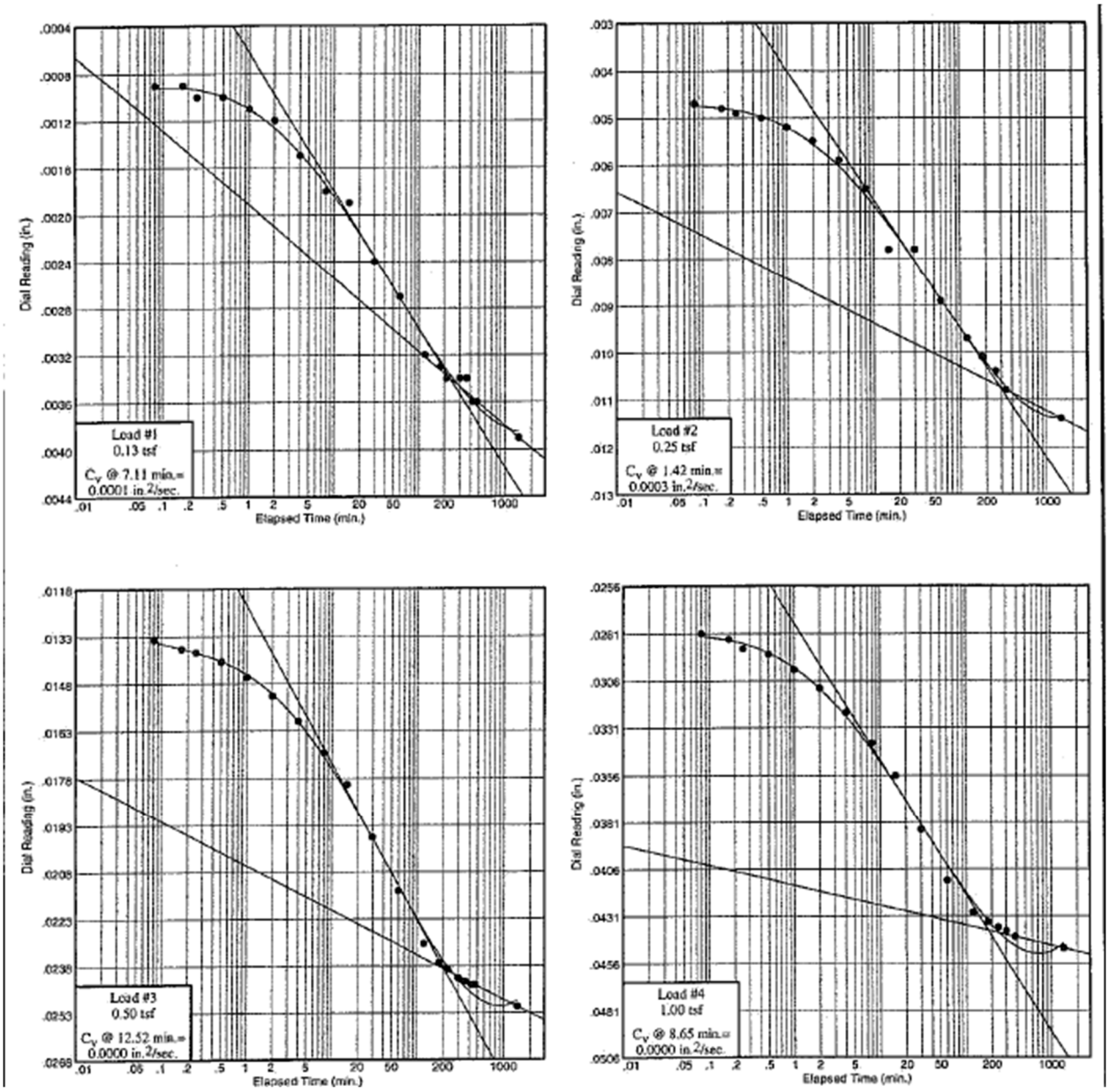
Boring 1, Sample ST – 1



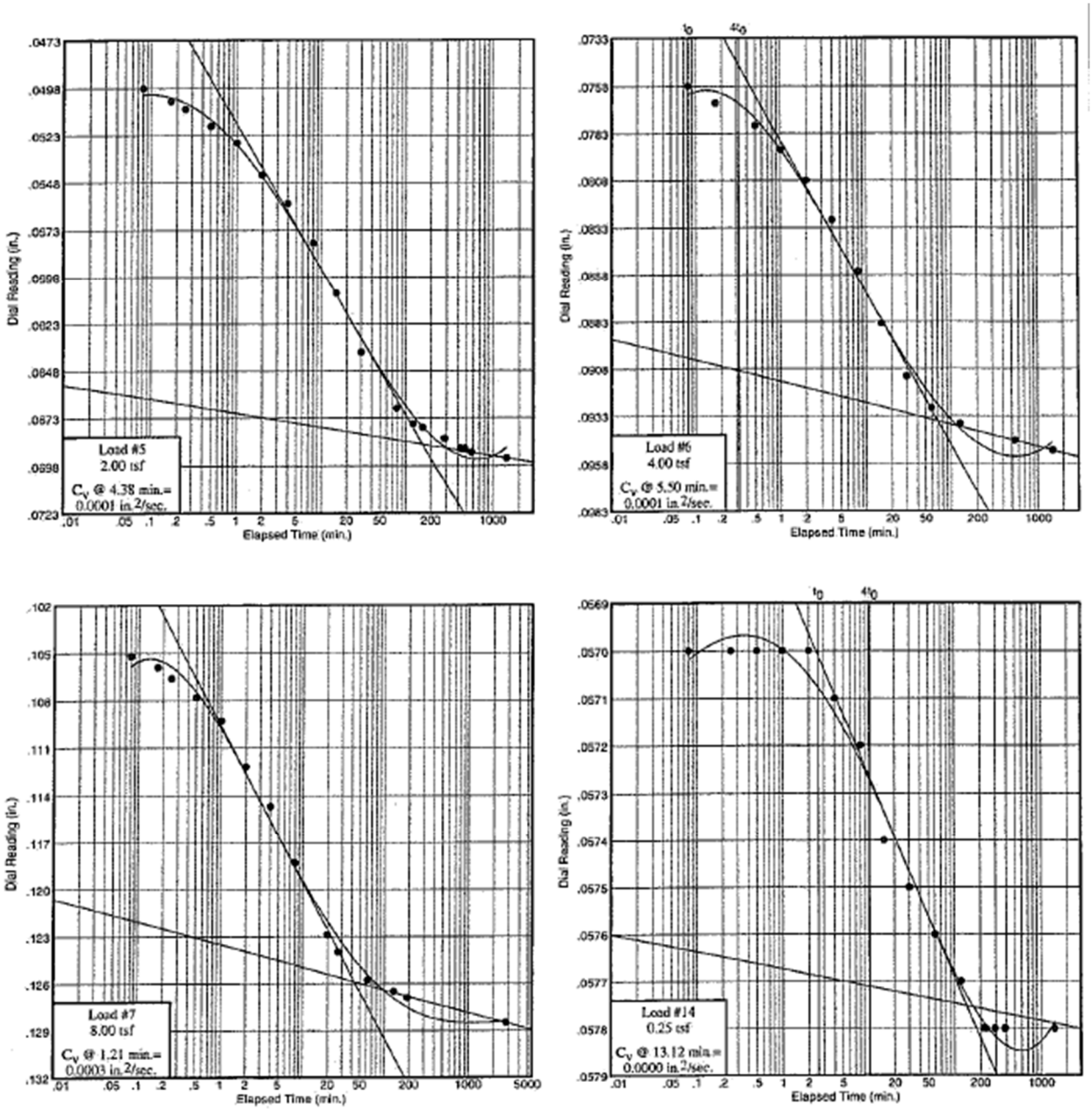
Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
100.0 %	28.7 %	95.9	57	31	2.75	CH	A-7-6(36	0.790

MATERIAL DESCRIPTION
Fat clay

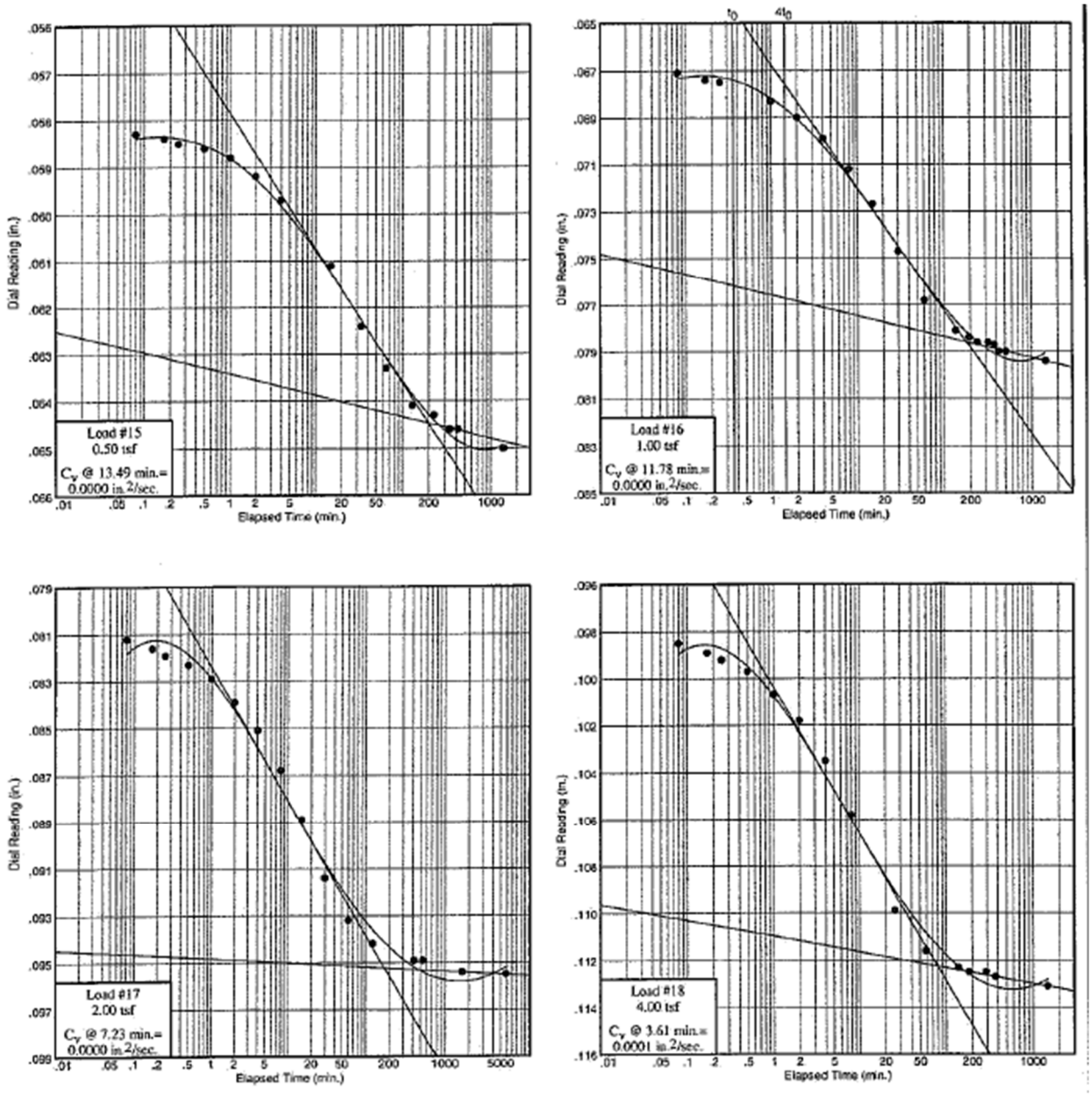
Boring 3, Consolidation Sample 1 – Depth 8’



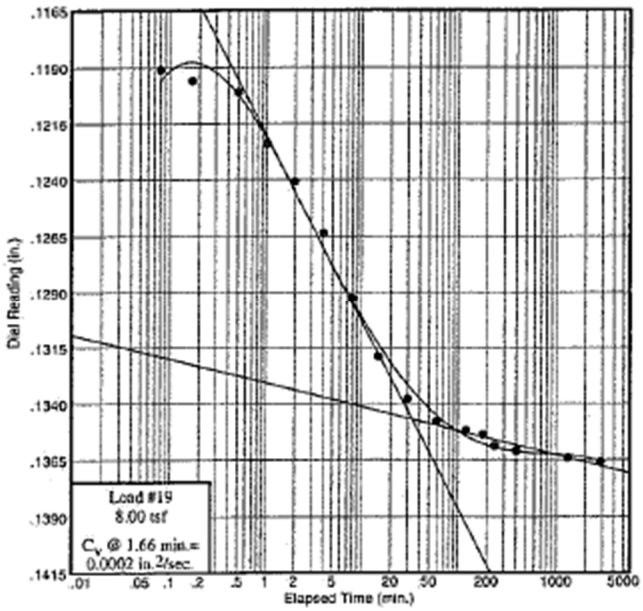
Boring 3, Consolidation Sample 1 – Depth 8'



Boring 3, Consolidation Sample 1 – Depth 8'



Boring 3, Consolidation Sample 1 – Depth 8’



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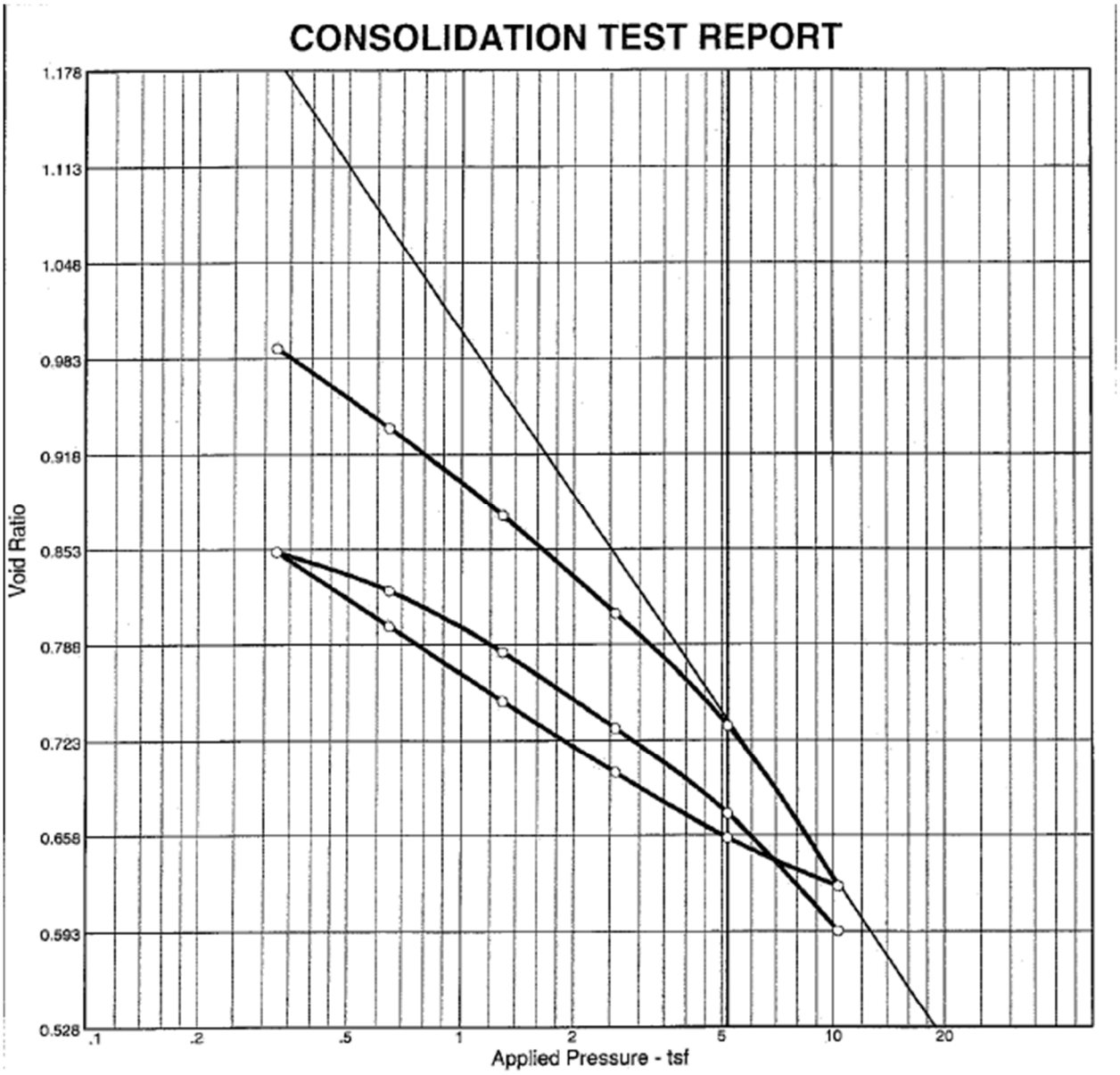
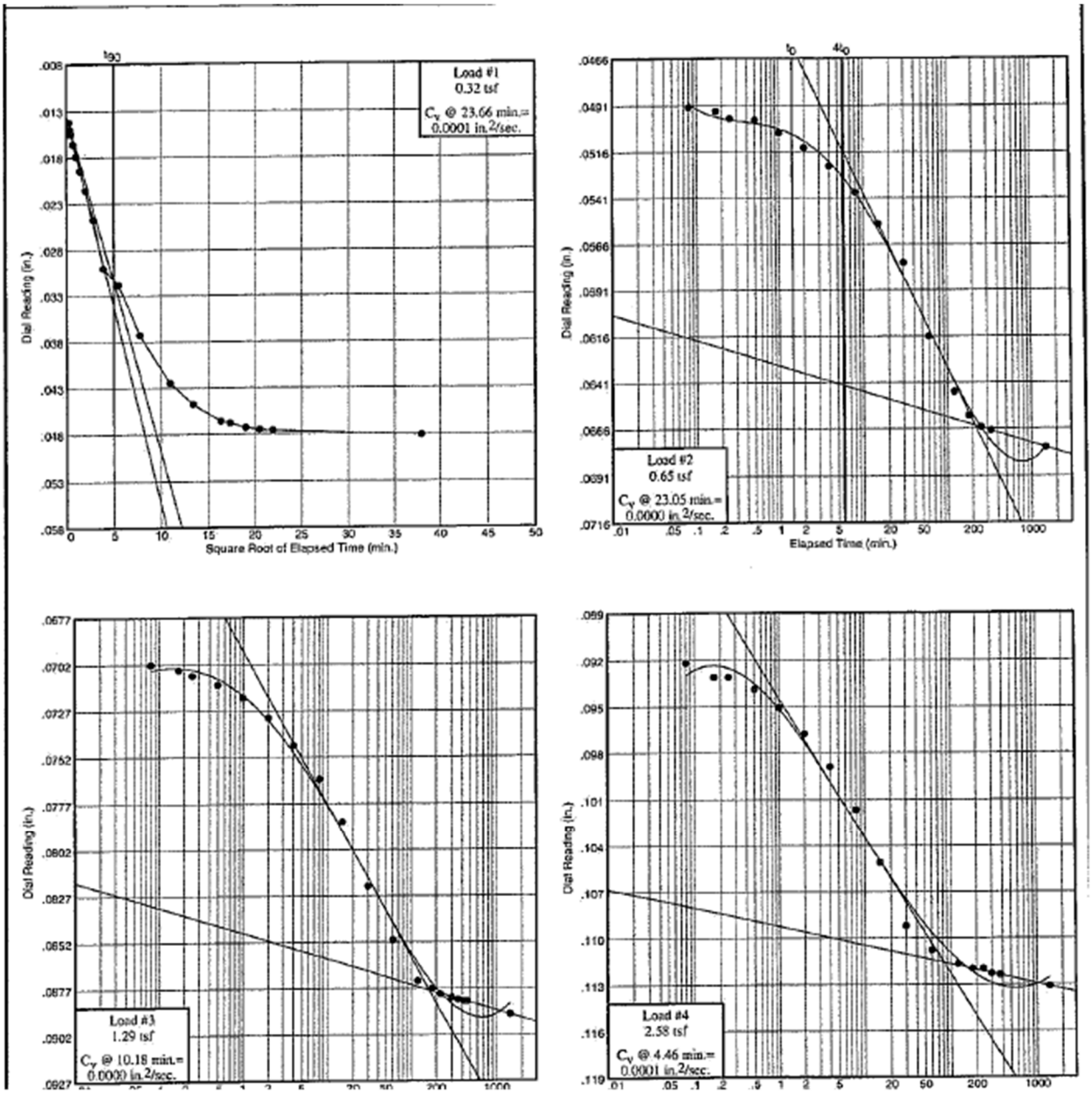


Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	USCS	AASHTO	Initial Void Ratio
Saturation	Moisture							
100.3 %	40.4 %	82.0	67	41	2.79	CH	A-7-6(48	1.124

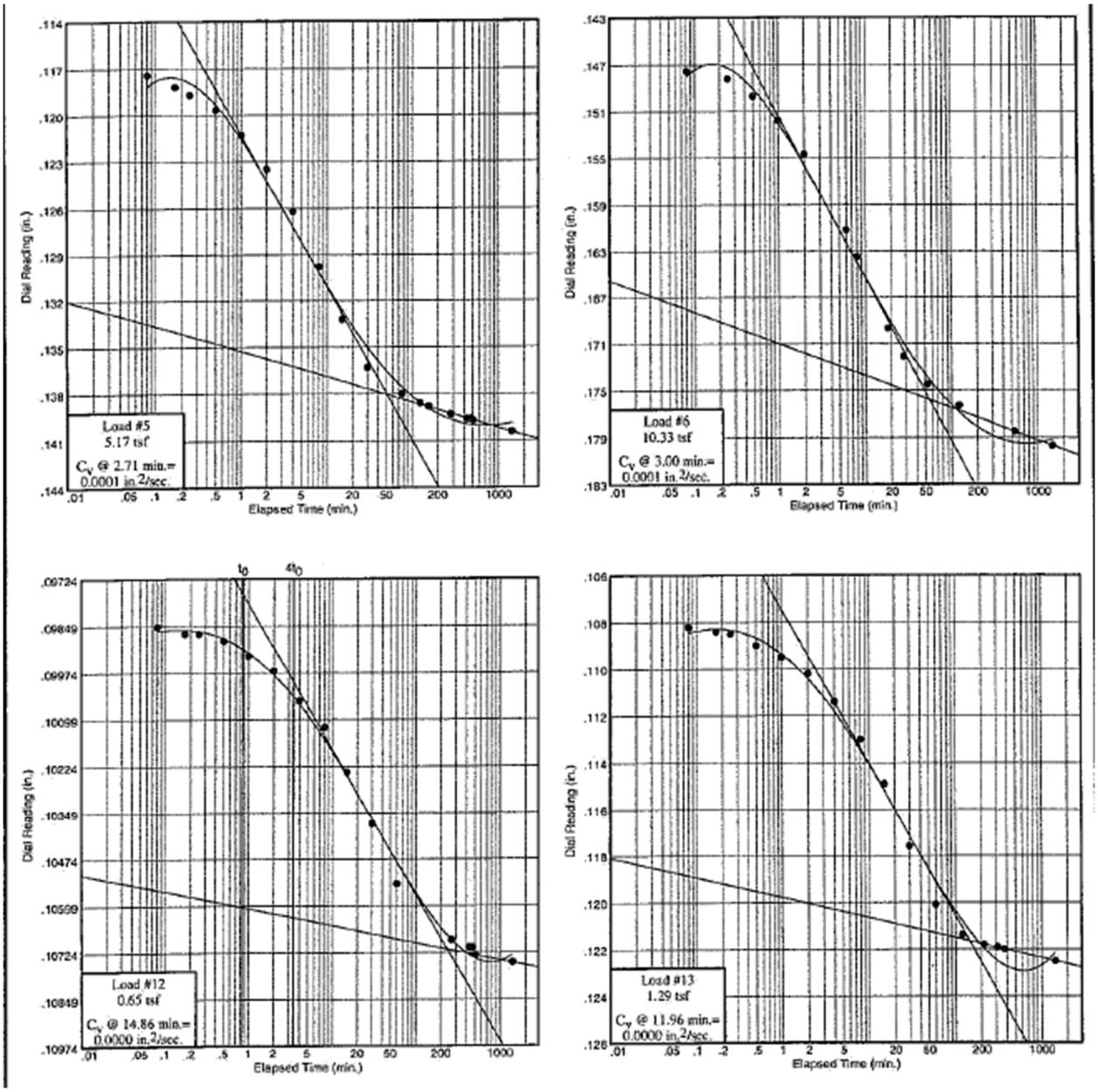
MATERIAL DESCRIPTION

Fat clay

Boring 3, Consolidation Sample 2 – Depth 18’



Boring 3, Consolidation Sample 2 – Depth 18'



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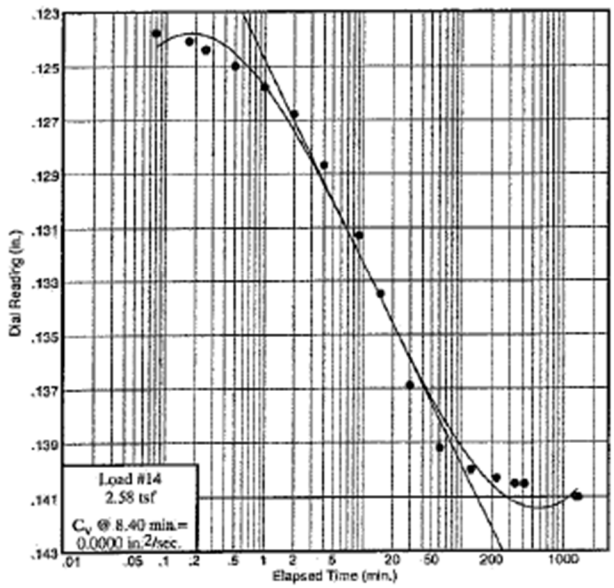

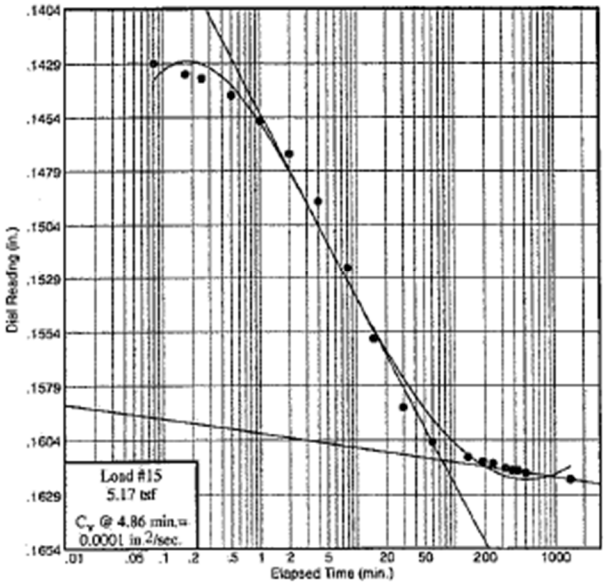

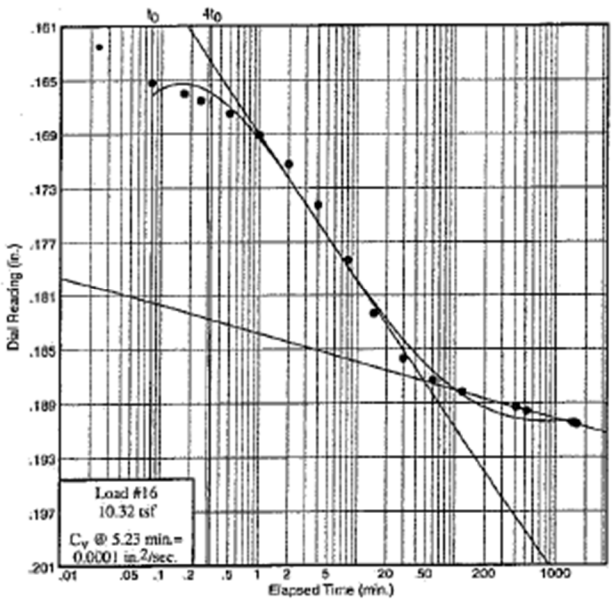

Boring 3, Consolidation Sample 2 – Depth 18’