CTL Engineering, Inc.
2860 Fisher Road, P.O. Box 44548, Columbus, Ohio 43204-3538
Phone: 614/276-8123 • Fax: 614/276-6377
Email: ctl@ctleng.com

AN EMPLOYEE OWNED COMPANY

Consulting Engineers • Testing • Inspection Services • Analytical Laboratories

Established 1927

November 26, 2024

BG Engineering Group, LLC
5960 Wilcox Place, Suite C
Dublin, OH 43016

Attention: Mr. Greg Boyer, P.E. – Principal

Reference: **Final Roadway Exploration Report**
BRO-62-27.49
PID No. 114435
Eagle Township, Brown County, Ohio
CTL Project No. 23050064COL

Dear Mr. Boyer:

CTL Engineering, Inc. has completed the final roadway exploration report for the above referenced project. We are providing an electronic version (PDF file) of the report via email.

Thank you for the opportunity to be of service to you on this project. If you have any questions, please contact me at our office.

Respectfully submitted,

CTL ENGINEERING, INC.

Sastry Malladi, P.E
Project Manager

FINAL ROADWAY EXPLORATION REPORT

BRO-62-27.49
EAGLE TOWNSHIP
BROWN COUNTY, OHIO

PID NO. 114435

CTL PROJECT NO. 23050064COL

PREPARED FOR:

BG ENGINEERING GROUP, LLC
5960 WILCOX PLACE, SUITE C
DUBLIN, OH 43016

PREPARED BY:

CTL ENGINEERING, INC.
2860 FISHER ROAD
COLUMBUS, OHIO 43204

November 26, 2024

OHIO DEPARTMENT OF TRANSPORTATION

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

The overall project identified as BRO-62-27.49 consists of replacing an existing 72-inch box culvert in Brown County, Ohio. The proposed culvert will be 84-inch pipe culvert with half height headwalls. It is understood that the US Route 62 roadway profile in the vicinity of the culvert will be raised to improve the sag vertical curve. According to the roadway plans, maximum fill along the roadway centerline will approximately 6.6± feet at Station 1451+80.

A total of four (4) soil test borings, designated as B-001-0-23, B-002-0-23, B-002-1-23, and B-003-0-23, were drilled for this project. Three (3) of the four (4) test borings were drilled within the existing roadway. B-002-1-23 was drilled at the toe of the existing roadway embankment, directly north of the existing culvert.

The near surface soils encountered in borings B-001-0-23, B-002-0-23 and B-003-0-23 were classified as fill materials. The fill materials were classified as silt and clay (A-6a) or clay (A-7-6). Beneath the fill or beneath the surficial materials, the test borings encountered both cohesive or granular soils to the boring termination depths. The native soils were classified as gravel and/or stone fragments with sand (A-1-b), sandy silt (A-4a), silt (A-4b), silt and clay (A-6a) or clay (A-7-6).

Groundwater was encountered in boring B-002-1-23 during drilling or at completion at a depth of 10.0 feet below ground surface. No groundwater was noted during or at completion of drilling in any of the remaining borings. Borehole cave-in depths ranged from 4.0 feet to 12.0 below ground surface in the test borings.

Based on the subsurface conditions encountered in the borings, and the results of the subgrade analyses, an estimated CBR value of 5 may be used in the pavement thickness design of the roadway.

Fill placement for the proposed embankment will result in settlement of the underlying soils. In the areas of maximum fill, it is estimated that total settlement will be about 3.0 inches. A majority of settlement will occur shortly after completion of fill placement. No settlement monitoring is required.

According to the cross-section sheets, the proposed embankment slopes will be constructed at a slope rate of 3 horizontal to 1 vertical (H:V) or flatter. Based on the stability analysis, it is expected that the slopes constructed at a rate of 3H: 1V or flatter are considered suitable for this project. Therefore, the proposed slope rates are considered adequate.

II. INTRODUCTION

The overall project identified as BRO-62-27.49 consists of replacing an existing 72-inch box culvert in Brown County, Ohio. The proposed culvert will be 84-inch pipe culvert with half height headwalls. It is understood that the US 62 roadway profile in the vicinity of the culvert will be raised to improve the sag vertical curve. According to the roadway plans, the project begins at Station 1448+25 and ends at Station 1454+50, with maximum fill of approximately 6.6± feet planned along the roadway centerline at Station 1451+80.

This is the Final Roadway Exploration Report.

III. GEOLOGY AND OBSERVATIONS

A. Geology

According to the Ohio Department of Natural Resources (ODNR) mapping, the project site is located within the Illinoian Till Plain physiographic region that is described as rolling ground moraine of older till. It contains many buried valleys, and the modern valleys alternate between broad floodplains and bedrock gorges.

According to the United States Department of Agriculture, Natural Resources Conservation Service's Web Soil Survey, the surficial soils mapped at the project site are described below in *Table 1*.

Table 1. Soil Survey Soil Types and Properties

USDA Soil Unit Name	Soil Unit Symbol	Risk of Corrosion to Concrete	Risk of Corrosion to Steel
Genesee silt loam, 0 to 2 percent slopes, occasionally flooded	Ge	Low	Low
Jessup silt loam, 15 to 25 percent slopes, eroded	JeD2	Moderate	High

Geologic mapping (Quaternary Geology of Ohio, Ohio Division of Geological Survey, Digital Map Series SG-1, 1999) indicates that the overburden soils are mapped to consist of Illinoian-age silty loam till. According to the mapping of bedrock geology in the area, (Ohio Geology Interactive Map, *ODNR GIS & Mapping Services, https://ohiodnr.gov/*), the surficial soil deposits on the site are underlain by Ordovician-age sedimentary bedrock identified as the Waynesville Formation. The Waynesville Formation consists of gray to bluish gray shale-dominant interbedded with limestone.

Mapping of the bedrock topography (Bedrock Topography of Ohio 24K (ODNR-DGS), *Digital Map, ODNR GIS, 2018*), indicates that the bedrock surface elevation in the vicinity of the project area ranges approximately from 960± feet to 980± feet above mean sea level (AMSL).

Based on this mapping and the existing ground surface elevations ranging approximately from 975± feet to 1000± feet within the project limit, the estimated depth to the bedrock surface ranges from approximately 15± feet to 40± feet bgs.

It should be noted that the bedrock surface elevation in the referenced mapping was determined from individual data points in the vicinity of the project site. Therefore, the previously stated estimated depths and elevations to the bedrock surface could have a significant disparity from the actual depths and elevations to the bedrock surface within the project limits.

According to the mapping of karst features (Known and Probable Karst in Ohio, *ODNR Geological Survey Map EG-1, 1999; Revised 2002, 2006*), there is one mapped karst feature (Karst ID: 340159091042) approximately 0.15 miles to the west of the project site. It is classified as a potential karst feature. No karst features were observed at the ground surface within the project limits during our field exploration.

According to the mapping of historic and active mines (ODNR Mines of Ohio), there is one active, industrial minerals surface mine (National ID: OH-IM-1195), approximately 1.5 miles to the northeast of the project site.

B. Observations

Field reconnaissance was completed by CTL personnel on July 6, 2023, and on August 17, 2023. US 62 runs generally north to south. The topography along the roadway within or immediately adjacent to the project site consists mostly of rolling hills with downward slopes immediately adjacent to the roadway. An existing 72-inch box culvert was observed at Station 1451+27 which conveys a tributary of West Fork Ohio Brush Creek from the east side of US 62 to the west side. This 72-inch box culvert will be replaced. The surrounding land usage consists of rural residential, agricultural and wooded.

Extensive erosion of the soils adjacent to the existing concrete box culvert and wingwalls was observed. Pavement cracking was observed along the edge of pavement. Additionally, recent asphalt pavement patching was observed along the edge of pavement. Erosion of the roadway shoulder material was observed predominately on the southern portion of the project site.

IV. EXPLORATION

A total of four (4) test borings were drilled for this project at the approximate locations shown on the plan and profile sheets in *Appendix A*. A summary of boring locations, ground surface elevations and coordinates along with their depths are presented in *Table 2*.

Table 2. Boring Locations, Depths, Elevations, and Coordinates

Boring No.	Ground Surface Elevation (feet)	Latitude	Longitude	Borehole Depth (feet)
B-001-0-23	997.52	38.979559	-83.720436	7.0
B-002-0-23	986.69	38.980280	-83.720077	16.5
B-002-1-23	978.80	38.980336	-83.720212	15.0
B-003-0-23	998.43	38.980836	-83.719770	7.0

The locations of the test borings were determined in the field by CTL personnel. The coordinates and ground surface elevations were determined by the BG Engineering, LLC, which were provided to CTL.

The test borings were drilled by CTL on August 24, 2023, utilizing 3-¼ inch I.D. hollow-stem augers powered by a track-mounted drill rig. Split-barrel (spoon) samples and Standard Penetration Tests (SPTs) were performed in the test borings using a 140-pound automatic hammer falling 30 inches to drive a 2-inch O.D. split barrel sampler for 18 inches. The automatic hammer was calibrated at an energy ratio of 79.3 percent on November 4, 2022.

The recovered split spoon samples obtained during the drilling operations were preserved in glass jars, visually classified in the field, and laboratory and tested for moisture content. Representative samples were subjected to laboratory testing including Atterberg Limits, grain size distribution, hand penetrometer, consolidation and sulfate content tests.

Drilling, sampling, field and laboratory testing were performed according to standard geotechnical engineering practices and current ASTM procedures. Results from field and laboratory tests are shown on the enclosed test boring records in *Appendix B* of this report. The results of the laboratory tests are presented in *Appendix C*.

V. FINDINGS

A. Subsurface Conditions

A general description of the soils encountered during our subsurface exploration is presented below. Further details of the subsurface conditions encountered during CTL's geotechnical exploration are presented in the Test Boring Records in *Appendix B.*

1. Surficial Materials

The surficial material type and thickness for each test boring are presented in *Table 3*.

Table 3. Boring Surficial Material Thicknesses

Boring No.	Asphalt Thickness (inches)	Gravel Base Thickness (inches)	Topsoil Thickness (inches)	Total Thickness (inches)
B-001-0-23	6	6	-	12
B-002-0-23	6	6	-	12
B-002-1-23	-	-	6	6
B-003-0-23	6	6	-	12

2. General Stratigraphy

Beneath the surficial materials, borings B-001-0-23, B-002-0-23 and B-003-0-23 encountered fill materials to depths ranging from 2.5 to 6.0 feet below ground surface (bgs).

The fill materials were classified as (A-6a) or clay (A-7-6). The fill materials encountered in boring B-003-0-23 contained asphalt. Fill materials exhibited corrected SPT N_{60}-values ranging from 13 to 16 blows per foot (bpf), with natural moisture content values ranging from 3 to 20 percent.

Below the topsoil in B-002-1-23 and/or fill materials in B-001-0-23, B-002-0-23 and B-003-0-23, the test borings encountered predominantly fine-grained cohesive soils to the boring termination depths. The fine-grained, cohesive soils were described as stiff to hard, brown, dark brown and gray sandy silt (A-4a), silt (A-4b), silt and clay (A-6a), and clay (A-7-6). SPT N_{60}-values determined within the fine-grained soils ranged from 12 to 49 bpf, with moisture content values ranging from 11 to 21 percent.

A coarse grained, granular soil was encountered in B-002-1-23. This coarse-grained soil was described as medium dense, gray gravel and/or stone fragments with sand (A-1-b). The SPT N_{60}-value within the coarse-grained soil was 29 bpf, with a moisture content value of 10 percent.

3. Groundwater

Table 4 shows the depths at which groundwater was encountered, if any, and the borehole cave-in depth.

Table 4. Groundwater and Cave-in Depths

Boring No.	Boring Surface Elevation (feet)	Groundwater (feet)		Hole Cave-in Depth (feet)
		During Drilling	At Completion	
B-001-0-23	997.52	None	None	4.0
B-002-0-23	986.69	None	None	12.0
B-002-1-23	978.80	10.0	10.0	12.0
B-003-0-23	998.43	None	None	5.0

It should be noted that the groundwater levels encountered during this subsurface exploration are generally not a reliable indication of long-term groundwater levels. Fluctuations in the level of the groundwater table (or saturated soils/perched water levels) will occur due to seasonal variances in rainfall, drainage, types of soils present and other factors. We caution that groundwater can be perched at various elevations above the general static groundwater level after periods of rainfall, especially in the lower elevations and natural drainage paths of the site.

B. Results of Laboratory Tests

Selected soil samples were tested in the laboratory for Atterberg Limits, grain size distribution, and hand penetrometer. The results of the soil laboratory tests are presented on the test borings records in *Appendix B* and are summarized below in *Table 5* and *Table 6*. The sulfate content of the subgrade material obtained within 3 feet of proposed subgrade ranged from less than 100 ppm to 340 ppm. The results of the sulfate tests are presented in *Appendix C* of this report.

Table 5. Soil Laboratory Test Results

Boring No.	Sample ID	Depth (feet)	ODOT	LL	PI	Silt (%)	Clay (%)
B-001-0-23	SS-1	1.0 – 2.5	A-6a	31	14	30	22
B-001-0-23	SS-2	2.5 – 4.0	A-7-6	42	23	23	37
B-002-0-23	SS-1	1.0 – 2.5	A-6a	34	14	49	37
B-002-0-23	SS-3	6.0 – 7.5	A-7-6	41	20	47	39
B-002-0-23	ST-6	13.0 – 15.0	A-6a	28	12	29	27
B-002-1-23	SS-1	1.0 – 2.5	A-6a	31	14	20	22
B-002-1-23	ST-3	4.0 – 6.0	A-4a	20	6	35	21
B-002-1-23	SS-4	6.0 – 7.5	A-4b	19	3	56	15
B-002-1-23	SS-5	8.5 – 10.0	A-1-b	17	4	12	10
B-002-1-23	SS-7	13.5 – 15.0	A-7-6	42	17	26	29
B-003-0-23	SS-2	2.5 – 4.0	A-7-6	45	24	28	41
B-003-0-23	SS-3	4.0 – 5.5	A-7-6	48	25	24	37

SS-# = Split Spoon Sample Number
LL = Liquid Limit
PI = Plasticity Index
Silt Fraction (particle size < 0.075 mm
Clay Fraction (particle size < 0.005 mm)

Table 6. Summary of Consolidation Test Results

Boring No.	Sample Depth, (feet)	Preconsolidation Pressure, (tsf)	Compression Index, (C_c)	Recompression Index, (C_r)	Initial Void Ratio, (e_o)
B-002-1-23	4.0 – 6.0	1.6	0.05	0.013	0.27

VI. ANALYSES AND RECOMMENDATIONS

Based upon the preceding considerations as well as the subsurface information obtained from the field and laboratory testing and CTL's experience with these soil types, the following recommendations are provided for the proposed embankments.

A. Subgrade Considerations

A subgrade analysis was performed utilizing the subsurface information from the drilled borings, ODOT Geotechnical Design Manual (GDM) Section 600, and ODOT's Subgrade Analysis Spreadsheet. A copy of the Subgrade Analysis is provided in *Appendix D*. The proposed pavement thickness of 1.5 feet was utilized for estimating cut/fill in the Subgrade Analysis. *Table 7* summarizes the approximate cut depths at the boring locations along the proposed roadway centerline profile.

Table 7. Summary of Proposed Roadway Cut/Fill Depths

Boring No.	Location	Boring Elevation	Proposed Subgrade Elevation(1), feet	Cut (C) / Fill (F) Depth(2), feet
B-001-0-23	1449+02, 6' RT.	997.5	996.0	0.3 C
B-002-0-23	1451+82, 6' LT	986.7	992.0	5.3 F
B-003-0-23	1454+04, 6' LT	998.4	996.9	0.2 C

(1) Determined from centerline of the proposed roadway profile, and with an 18-inch thick pavement section (asphalt and base materials).

(2) Determined from the test boring ground surface elevation and the centerline of the existing roadway profile and proposed roadway subgrade elevation.

The natural moisture content of the proposed subgrade soils ranged from 3 to 21 percent, averaging 16 percent. The estimated optimum moisture content (OMC) values for these subgrade soils ranged from 14 to 20 percent, averaging 17 percent. The Plasticity Index (PI) values of the soils within the proposed subgrade ranged from 14 to 25 percent, with an average PI of 20 percent. The lowest SPT N_{60L}-value (normalized to equivalent N_{60} values) analyzed for the pavement subgrade was 15 bpf, with an average of 16 bpf.

A design CBR value was calculated using procedures outlined in ODOT's Subgrade Analysis. Group Index values were calculated for the materials

encountered below the proposed subgrade at the test boring locations. These Group Index values ranged from 5 to 16 averaging 12. This average Group Index value corresponds to a design CBR value of 5.

The ODOT Subgrade Analysis did not identify any borings needing subgrade soil improvement due to being unsuitable and/or unstable. Therefore, no subgrade stabilization is anticipated for the project.

B. Embankments

1. Settlement Analysis

According to the Stage 3 plans, approximately 6.6 feet of fill will be placed along the roadway centerline. However, according to the cross-section sheets a maximum of 19.5 feet of fill is planned at Sta. 1451+50, 33’ Lt. (adjacent to the existing culvert). CTL performed the settlement analyses to determine the magnitude of anticipated settlement under 19.5 feet of fill.

The results of the settlement analyses are summarized in Table 8. Settlement calculations are provided in Appendix E.

Table 8. Settlement Analyses

Station/Offset	Boring No’s	Estimated Settlement (inches)
1451+50/33’ Lt.	B-002-0-23, B-002-1-23	3.0

It is estimated that about 50 percent of the total settlement will occur within 1 week of the fill placement. It is estimated that about 90 percent of the total settlement will occur within 4 weeks of the fill placement. No settlement monitoring is anticipated.

An existing 6-inch water line and telecommunication lines are present below the limits of the proposed pavement for US 62. It is understood that these utility lines will be left in place during the construction of the proposed roadway. Due to the placement of the new fill, the existing utilities may experience up to 2.3 inches of differential settlement.

The design team should determine if the existing utilities are flexible enough to withstand the expected differential settlement. If not, options for settlement mitigation should be discussed with District personnel and incorporated into the project plan set.

2. Global Stability Analyses

The global stability of the proposed embankment was analyzed. The dimensions and geometry of the proposed embankment slopes were determined from the cross-section sheets included in the Stage 3 plans

prepared by BG Engineering Group. According to the cross-section sheets, the proposed embankment slopes will be constructed at a slope rate of 3 horizontal to 1 vertical (H:V) or flatter.

Global stability analysis was performed for the new embankment, near station 1452+00. The stability analyses were performed using soil data from the test boring logs B-002-0-23 and B-002-1-23, as well as the geometry obtained from the cross sections. The global stability analysis was performed using the SLIDE program.

The SLIDE program is based on two-dimensional limit equilibrium methods in which the calculation of the factor of safety against instability of a slope is performed by the method of slices. The method used was the Morgenstern-Price method for surfaces of a non-circular shape.

The soil parameters used in the analysis are based on the subsurface conditions encountered in the borings, laboratory test results, and ODOT's Office of Geotechnical Engineering (OGE) criteria for embankment construction. The soil parameters used for the analyses are summarized in the *Table 9*.

Table 9. Soil Parameters for Global Stability Analyses

Consistency	ODOT Material	Effective Stress		Total Stress		Unit Weight (pcf)
		Cohesion (psf)	Angle of Internal Friction (degrees)	Cohesion (psf)	Angle of Internal Friction (degrees)	
N/A	Pavement and Base	50*	0	50*	0	140
N/A	Engineered Fill	2000	0	200	26	125
Stiff	A-6a	1700	0	170	24	121
Stiff	A-4a	1500	0	150	23	130
Very Stiff	A-4b	2700	0	240	25	125
Medium Dense	A-1-b	0	38	0	38	128
Hard	A-7-6	3800	0	290	27	128
Very Stiff	A-6a	3750	0	290	26	128

*****A cohesion of 50 psf was used for pavement in slope stability model for to prevent surficial slip failure.

Results of the stability analyses are summarized below in *Table 10* and are presented in graphical form in Appendix F of this report. The graphs present the geometry of the proposed slope, modeled soil stratums and their corresponding shear strength parameters, and critical failure surfaces along with their corresponding factors of safety. The factor of safety is defined as the ratio of forces resisting movement to forces acting on the slope, generally gravity and applied surface loads such as foundations or vehicular traffic. A

minimum factor of safety of 1.3 is considered acceptable for short term conditions and for slopes that do not support a structure and/or traffic.

Table 10. Results of Global Stability Analyses

Analysis Description	Required Minimum Factor of Safety (FS)	Calculated Factor of Safety	Capacity to Demand Ratio
Long Term – Effective Stress	1.3	2.3	0.57
Short Term – Total Stress	1.3	5.2	0.25

Based on the analysis, it is CTL's opinion that the proposed embankment slope rates are considered adequate.

C. General Construction and Earthwork

1. Site preparation and earthwork should be performed in accordance with ODOT Construction and Material Specifications.

2. Permanent embankment slopes constructed at a rate of 3:1 Horizontal to Vertical or flatter are generally considered safe against sliding and slope failure. Side slopes should be seeded and vegetation growth permitted to limit sloughing and slope failure.

3. Temporary excavations in excess of 4.0 feet in depth should be sloped, benched or shored in accordance with OSHA regulations.

VII. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL should be notified so that our recommendations can be modified, if required.

APPENDIX A

GEOTECHNICAL PROFILE – ROADWAY

PROJECT DESCRIPTION

THE OVERALL PROJECT, IDENTIFIED AS BRO-62-27.49, CONSISTS OF REPLACING AN EXISTING 72-INCH BOX CULVERT ALONG U.S. ROUTE 62 IN EAGLE TOWNSHIP, BROWN COUNTY, OHIO. THE PROPOSED CULVERT WILL BE AN 84- INCH PIPE CULVERT WITH HALF HEIGHT HEADWALLS. IT IS UNDERSTOOD THAT THE U.S. ROUTE 62 ROADWAY PROFILE IN THE VICINITY OF THE CULVERT WILL BE RAISED TO IMPROVE THE SAG VERTICAL CURVE. ACCORDING TO THE ROADWAY PLANS, THE PROJECT BEGINS AT STATION 1448+25 AND ENDS AT STATION 1454+50, WITH MAXIMUM FILL OF APPROXIMATELY 6.6± FEET PLANNED ALONG THE ROADWAY CENTERLINE AT STATION 1451+80.

HISTORIC RECORDS

HISTORIC GEOTECHNICAL RECORDS WERE SEARCHED FOR ON THE ODOT TIMS WEBSITE NO GEOTECHNICAL RECORDS WERE FOUND FOR THIS PROJECT.

GEOLOGY

THE PROJECT SITE IS LOCATED WITHIN THE ILLINOIAN TILL PLAIN PHYSIOGRAPHIC REGION THAT IS DESCRIBED AS ROLLING GROUND MORAINE OF OLDER TILL. IT CONTAINS MANY BURIED VALLEYS, AND THE MODERN VALLEYS ALTERNATE BETWEEN BROAD FLOODPLAINS AND BEDROCK GORGES. THE PROJECT SITE IS COVERED BY HOLOCEN- AGE ALLUVIUM UNDERLAIN BY ILLINOAN- AGE LOAM TILL AND ILLINOAN- AGE SAND AND GRAVEL. THE UNDERLYING BEDROCK CONSISTS OF ORDOVICIAN- AGE INTERBEDDED SHALE AND LIMESTONE IDENTIFIED AS THE ARNHEIM FORMATION.

RECONNAISSANCE

FIELD RECONNAISSANCE WAS COMPLETED BY CTL PERSONNEL ON JULY 6, 2023 AND AUGUST 17, 2023. US 62 RUNS GENERALLY NORTH TO SOUTH. THE TOPOGRAPHY ALONG THE ROADWAY WITHIN OR IMMEDIATELY ADJACENT TO THE PROJECT SITE CONSISTS MOSTLY OF ROLLING HILLS WITH DOWNWARD SLOPES IMMEDIATELY ADJACENT TO THE ROADWAY. AN EXISTING 72-INCH BOX CULVERT WAS OBSERVED AT STATION 1451+27 WHICH CONVEYS A TRIBUTARY OF WEST FORK OHIO BRUSH CREEK FROM THE EAST SIDE OF US 62 TO THE WEST SIDE. THIS 72- INCH BOX CULVERT WILL BE REPLACED. THE SURROUNDING LAND USAGE CONSISTS OF RURAL RESIDENTIAL, AGRICULTURAL AND WOODED.

EXTENSIVE EROSION OF THE EXISTING CONCRETE BOX CULVERT AND WINGWALLS WERE OBSERVED. PAVEMENT CRACKING WAS OBSERVED ALONG THE EDGE OF PAVEMENT. ADDITIONALLY, RECENT ASPHALT PAVEMENT RESURFACING WAS OBSERVED ALONG THE EDGE OF PAVEMENT. EROSION OF THE ROADWAY SHOULDER MATERIAL WAS OBSERVED PREDOMINATELY ON THE SOUTHERN PORTION OF THE PROJECT SITE.

SUBSURFACE EXPLORATION

FOUR (4) TEST BORINGS, IDENTIFIED AS B-001-0-23, B-002-0-23, B-002-1-23 AND B-003-0-23, WERE COMPLETED FOR THIS SUBSURFACE EXPLORATION. THREE (3) OF THE TEST BORINGS WERE DRILLED WITHIN THE EXISITING ROADWAY PAVEMENT WHILE ONE (1) OF THE TEST BORINGS WERE DRILLED AT THE TOE OF THE EXISTING ROADWAY EMBANKMENT. THE TEST BORINGS WERE DRILLED TO DEPTHS RANGING FROM 7.0 FEET TO 16.5 FEET BELOW THE EXISTING GROUND SURFACE.

THE TEST BORINGS WERE DRILLED ON AUGUST 24, 2023 UTILIZING 3-1/4 INCH I.D. HOLLOW-STEM AUGERS POWERED BY A TRACK-MOUNTED ROTARY DRILL RIG. SPLIT-BARREL (SPOON) DISTURBED SOIL SAMPLES AND STANDARD PENETRATION TEST WERE PERFORMED IN ACCORDANCE WITH AASHTO T206 AT 1.5- TO 2.5-FOOT INTERVALS. THE AUTOMATIC HAMMER WAS CALIBRATED ON NOVEMBER 4, 2022 AND HAD AN ENERGY RATIO OF 79.3 PERCENT.

EXPLORATION FINDINGS

THE THREE (3) TEST BORINGS DRILLED WITHIN THE EXISITING ROADWAY PAVEMENT AND ENCOUNTERED SIX (6) INCHES OF ASPHALT. B-002-1-23 ENCOUNTERED SIX (6) INCHES OF TOPSOIL WITHIN THE SURFICAL LAYER. BELOW THE ASPHALT LAYER, THE THREE (3) TEST BORINGS DRILLED WITHIN THE EXISITING ROADWAY PAVEMENT ENCOUNTERED SIX (6) INCHES OF AGGREGATE BASE.

BELOW THE SURFICIAL MATERIALS, EACH TEST BORING ENCOUNTERED PREDOMINANTLY FINE-GRAINED, COHESIVE SOILS. THE FINE-GRAINED SOILS WERE DESCRIBED AS STIFF TO HARD SANDY SILT (A-4a), SILT (A-4b), SILT AND CLAY (A-6a), AND CLAY (A-7-6). A COARSE-GRAINED, GRANULAR SOIL WAS ENCOUNTERED IN B-002-1-23, AND THIS COARSE-GRAINED SOIL WAS DESCRIBED AS MEDIUM DENSE GRAVEL AND/OR STONE FRAGMENTS WITH SAND (A-1-b).

GROUNDWATER WAS ENCOUNTERED IN ONE (1) OF THE FOUR (4) TEST BORINGS (B-002-1-23) DURING DRILLING OR AT COMPLETION OF DRILLING AT A DEPTH OF 10.0 FEET BELOW GROUND SURFACE.

SPECIFICATIONS

THIS GEOTECHNICAL EXPLORATION WAS PERFORMED IN ACCORDANCE WITH THE STATE OF OHIO, DEPARTMENT OF TRANSPORTATION, OFFICE OF GEOTECHNICAL ENGINEERING, SPECIFICATIONS FOR GEOTECHNICAL EXPLORATIONS, DATED JULY 21, 2023.

LEGEND

DESCRIPTION	ODOT CLASS	CLASSIFIED MECH./VISUAL	
GRAVEL WITH SAND	A-1-b (0)	1	0
SANDY SILT	A-4a (4)	1	1
SILT	A-4b (7)	1	0
SILT AND CLAY	A-6a (6)	4	2
CLAY	A-7-6 (11)	5	7
	TOTAL	12	10
PAVEMENT OR BASE = X = APPROXIMATE THICKNESS	VISUAL		
SOD AND TOPSOIL = X = APPROXIMATE THICKNESS	VISUAL		

EXPLORATION LOCATION - PLAN VIEW

DRIVE SAMPLE AND/OR ROCK CORE BORING PLOTTED TO VERTICAL SCALE ONLY. HORIZONTAL BAR INDICATES A CHANGE IN STRATIGRAPHY.

WC — INDICATES WATER CONTENT IN PERCENT.

N_{60} — INDICATES STANDARD PENETRATION RESISTANCE NORMALIZED TO 60% DRILL ROD ENERGY RATIO.

W — INDICATES FREE WATER ELEVATION.

SS — INDICATES A SPLIT SPOON SAMPLE.

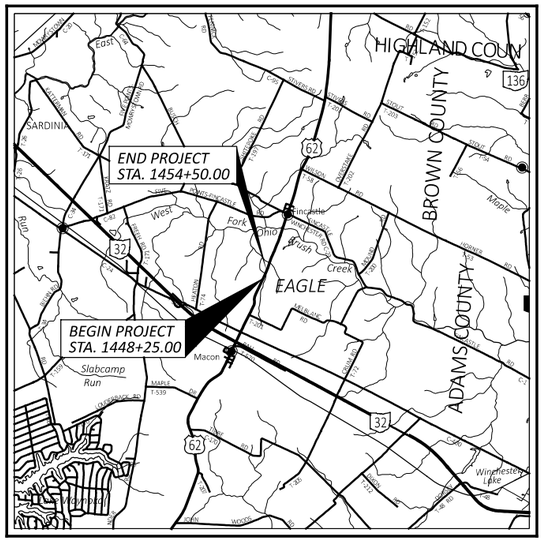
ST — INDICATES A SHELBY TUBE SAMPLE.

AVAILABLE INFORMATION

THE SOIL AND GROUNDWATER INFORMATION COLLECTED FOR THIS SUBSURFACE EXPLORATION THAT CAN BE CONVENIENTLY DISPLAYED ON THE GEOTECHNICAL PROFILE SHEETS HAS BEEN PRESENTED. GEOTECHNICAL REPORTS, IF PREPARED, ARE AVAILABLE FOR REVIEW ON THE OFFICE OF CONTRACT SALES WEBSITE.

INDEX OF SHEETS

LOCATION FROM STA. TO STA.	PLAN VIEW SHEET	PROFILE SHEET	CROSS-SECTION SHEET	CUT MAX.	FILL EMB. MAX.
COVER SHEET 1					
SUMMARY OF SOIL TEST DATA 2					
UNDISTURBED TEST CONSOLIDATION REPORT 3 - 6					
US-62 1445+50.00 1456+50.00	7	7	-	-	-
CROSS SECTION STA. 1452+00.00	-	-	8	-	-



LOCATION MAP

NOT TO SCALE

PARTICLE SIZE DEFINITIONS

12"	3"	2.0 mm	0.42 mm	0.074 mm	0.005 mm
BOULDERS | COBBLES		GRAVEL	COARSE SAND	FINE SAND	SILT | CLAY
		No. 10 SIEVE	No. 40 SIEVE	No. 200 SIEVE	

RECON. - CC 07/06/2023 & 08/17/2023
DRILLING - CTL 08/24/2023
DRAWN - NKS 11/25/2024
REVIEWED - SM 11/25/2024

GEOTECHNICAL PROFILE - ROADWAY

DESIGN AGENCY
GTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S
REVIEWER SM 11-25-24
PROJECT ID 114435
SUBSET 1 TOTAL 8
SHEET P.22 TOTAL 29

BRO-62-27.49

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:18:17 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050084COL_ODOT\Mod_25.11.24111443$fC001.dgn

MODEL: Sheet PAPERSIZE: 11x17 (in.) DATE: 25-11-2024 TIME: 10:21:23 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050064COL_ODOT\Mod_25.11.24\114435ID001.dgn

SUMMARY OF SOIL TEST DATA
US - 62

EXPLORATION NO., STATION & OFFSET	FROM TO	SAMPLE ID	N_{60}	% REC	HP tsf	% GR	% CS	% FS	% SILT	% CLAY	LL	PL	PI	% WC	ODOT CLASS (GI)	ppm SO_4
B-001-0-23	01.00-02.50	SS-1	16	100	4.5	28	9	11	30	22	31	17	14	7	A-6a (5)	<100
STA. 1449+02, 6' RT.	02.50-04.00	SS-2	17	100	4.5	3	8	29	23	37	42	19	23	16	A-7-6 (10)	-
LATITUDE = 38.979559	04.00-05.50	SS-3	15	100	4.5	HARD, BROWN, CLAY								18	A-7-6 (VISUAL)	-
LONGITUDE = -83.720436	05.50-07.00	SS-4	16	100	3.5	VERY STIFF, BROWN, CLAY								18	A-7-6 (VISUAL)	-
B-002-0-23	01.00-02.50	SS-1	13	100	3.0	2	3	9	49	37	34	20	14	20	A-6a (10)	-
STA. 1451+82, 6' LT.	03.50-05.00	SS-2	13	100	2.25	VERY STIFF, BROWN, SILT AND CLAY								18	A-6a (VISUAL)	-
LATITUDE = 38.980280	06.00-07.50	SS-3	15	100	1.0	1	3	10	47	39	41	21	20	18	A-7-6 (12)	-
LONGITUDE = -83.720077	08.50-10.00	SS-4	22	100	2.5	VERY STIFF, BROWN, CLAY								21	A-7-6 (VISUAL)	-
	11.00-12.50	SS-5	24	100	4.5	HARD, BROWN, CLAY								17	A-7-6 (VISUAL)	-
	13.00-15.00	SS-6	-	100	-	12	12	20	29	27	28	16	12	12	A-6a (5)	-
	15.00-16.50	SS-7	30	100	4.5	HARD, BROWN, SILT AND CLAY								10	A-6a (VISUAL)	-
B-002-1-23	01.00-02.50	SS-1	15	100	2.0	16	13	29	20	22	31	17	14	19	A-6a (2)	-
STA. 1451+86, 49' LT.	03.50-05.00	SS-2	12	100	1.5	STIFF, BROWN, SANDY SILT								15	A-4a (VISUAL)	-
LATITUDE = 38.980336	05.00-06.00	ST-3	-	100	-	9	13	22	35	21	20	14	6	11	A-4a (4)	-
LONGITUDE = -83.720212	06.00-07.50	SS-4	22	100	1.5	9	7	13	56	15	19	16	3	13	A-4b (7)	-
	08.50-10.00	SS-5	29	100	-	39	17	22	12	10	17	13	4	10	A-1-b (0)	-
	11.00-12.50	SS-6	42	100	2.25	VERY STIFF, GRAY, CLAY								14	A-7-6 (VISUAL)	-
	13.50-15.00	SS-7	49	100	3.25	10	13	22	26	29	42	25	17	16	A-7-6 (7)	-
B-003-0-23	01.00-02.50	SS-1	15	100	4.5	HARD, BLACK AND GRAY, CLAY								3	A-7-6 (VISUAL)	340
STA. 1454+04, 6' LT.	02.50-04.00	SS-2	16	100	4.5	8	5	18	28	41	45	21	24	15	A-7-6 (13)	-
LATITUDE = 38.980836	04.00-05.50	SS-3	21	100	4.25	10	7	22	24	37	48	23	25	12	A-7-6 (12)	-
LONGITUDE = -83.719770	05.50-07.00	SS-4	16	100	3.0	VERY STIFF, BROWN, CLAY								7	A-7-6 (VISUAL)	-

DESIGN AGENCY
CTL ENGINEERING INC.
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE:(614)276-8123
FAX: (614)276-6377

GEOTECHNICAL PROFILE - ROADWAY
SUMMARY OF SOIL TEST DATA

One Dimensional Consolidation and Swell Properties of Soil - ASTM D 2435

CTL ENGINEERING, INC.

2860 Fisher Road

Columbus, OH 43204

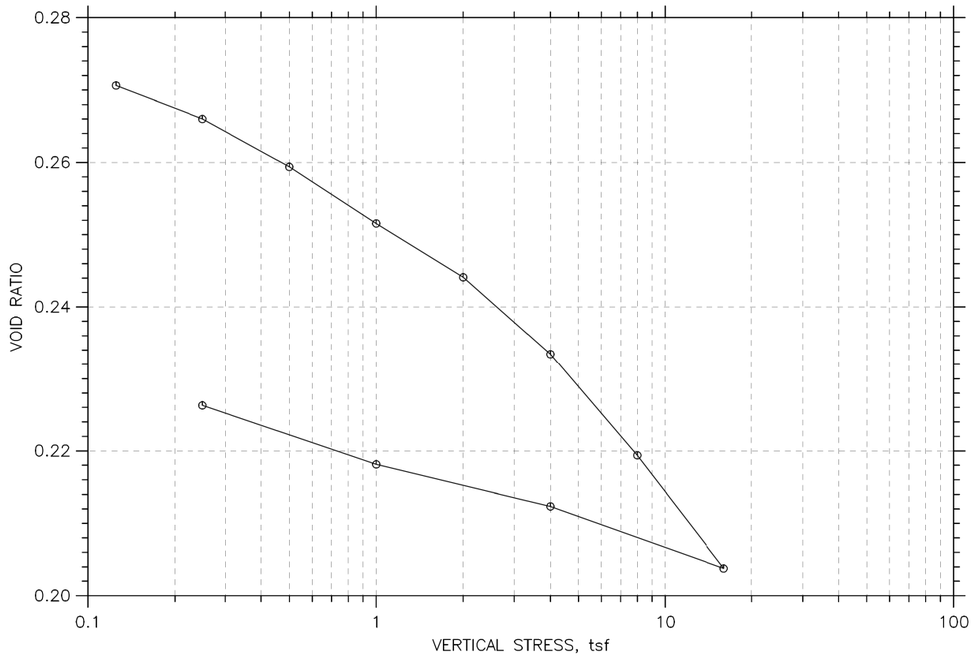
Project No.:	23050064COL		
Project:	BR-62-27.49 Roadway Exploration	Sample Type:	Undisturbed Specimen
Client:	BG Engineering	Test Date:	9/1/2023
Boring No.:	B-002-1-23	Checked By:	SM
Sample No.:	ST-3_4'-6'	Tested By:	MW
Soil Description:	Brown, Sandy Silt (A-4a)	LL:	20
Specific Gravity:	2.659	PL:	14
Initial Dry Unit Weight	130.4 pcf	Initial Moisture	10.9%

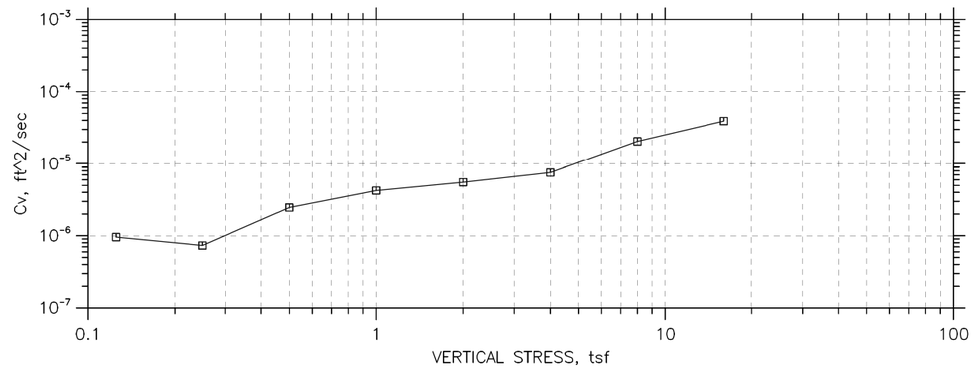
Step No.	Applied Stress (tsf)	Final Displacement (in)	Void Ratio	Strain at End (%)	Sqrt T_{90} (min)	Cv (ft^2/sec)
1	0.125	0.005597	0.271	0.56		
2	0.25	0.009187	0.266	0.93		
3	0.5	0.01433	0.259	1.44		
4	1	0.02041	0.252	2.06		
5	2	0.0262	0.244	2.64	4.7	4.96E-06
6	4	0.03449	0.233	3.47	4.2	5.35E-06
7	8	0.04542	0.219	4.57	2.3	9.88E-06
8	16	0.05755	0.204	5.8	0.8	2.65E-05
9	4	0.05089	0.212	5.12		
10	1	0.04639	0.218	4.67		
11	0.25	0.04005	0.226	4.03		

CONSOLIDATION PARAMETERS	
Preconsolidation Pressure (tsf): 1.60	Initial Void Ratio: 0.27
Compression Index (C_c): 0.05	Compression Ratio : 0.04
Recompression Index (C_r): 0.013	Recompression Ratio: 0.010

CONSOLIDATION TEST DATA

SUMMARY REPORT





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

Wed, 13-SEP-2023 12:47:17

GEOTECHNICAL PROFILE - ROADWAY
UNDISTURBED TEST CONSOLIDATION REPORT

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S

REVIEWER SM 11-25-24

PROJECT ID 114435

SUBSET 3 | TOTAL 8

SHEET P.24 | TOTAL 29

BRO-62-27.49

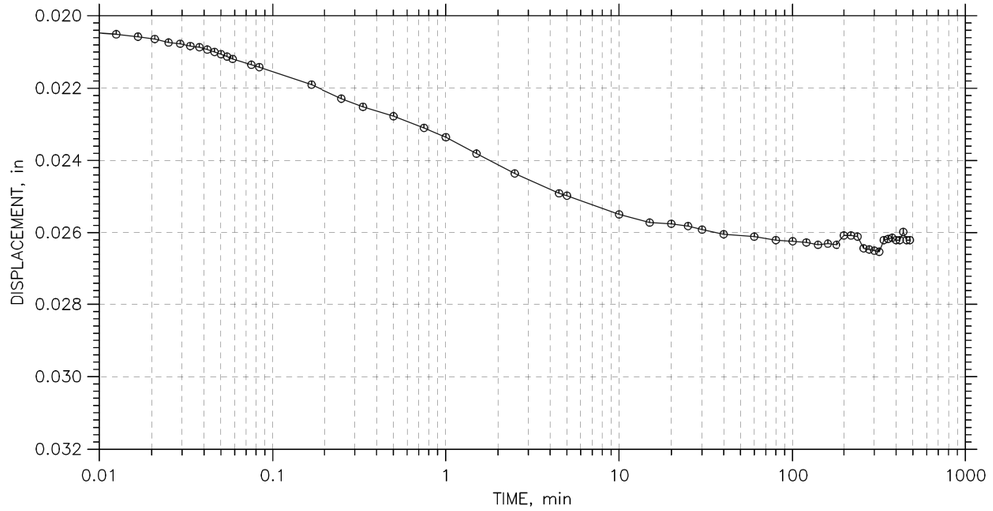
MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:24:16 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050064COL_ODOT\Mod_25.11.24\114435ZD001.dgn

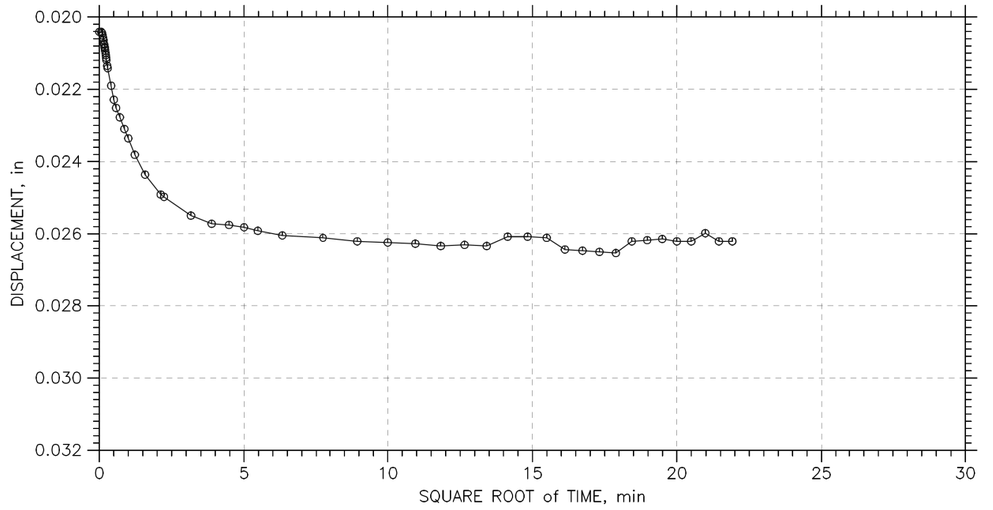
CONSOLIDATION TEST DATA

TIME CURVES

Step: 5 of 11

Stress: 2. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

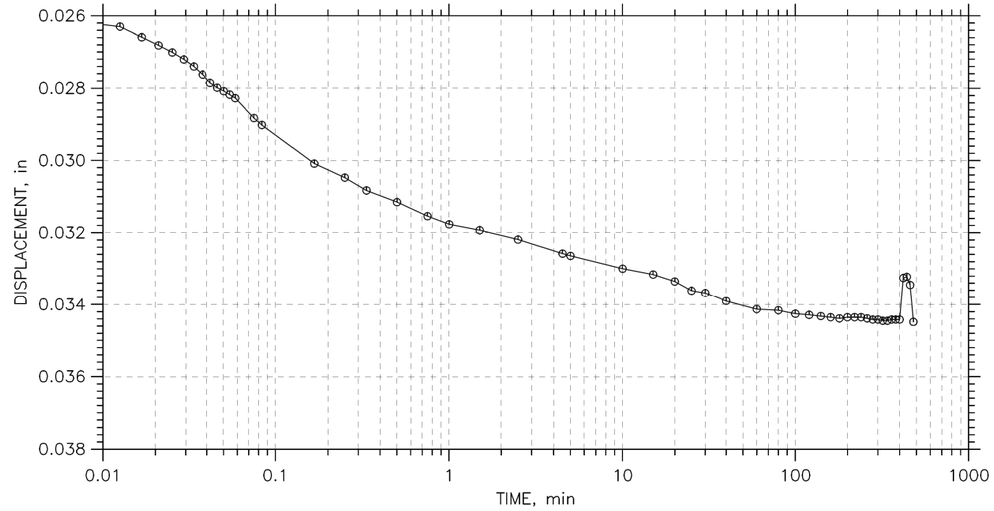
Wed, 13-SEP-2023 12:47:18

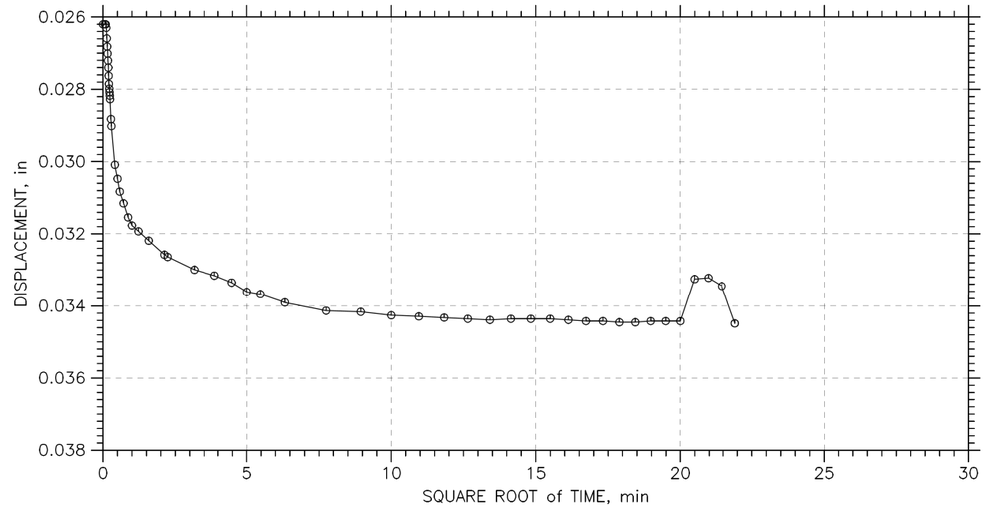
CONSOLIDATION TEST DATA

TIME CURVES

Step: 6 of 11

Stress: 4. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevction:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

Wed, 13-SEP-2023 12:47:18

GEOTECHNICAL PROFILE - ROADWAY
UNDISTURBED TEST CONSOLIDATION REPORT

DESIGN AGENCY
GTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER	N.K.S
REVIEWER	SM 11-25-24
PROJECT ID	114435
SUBSET / TOTAL	4 / 8
SHEET / TOTAL	P.25 / 29

BRO-62-27.49

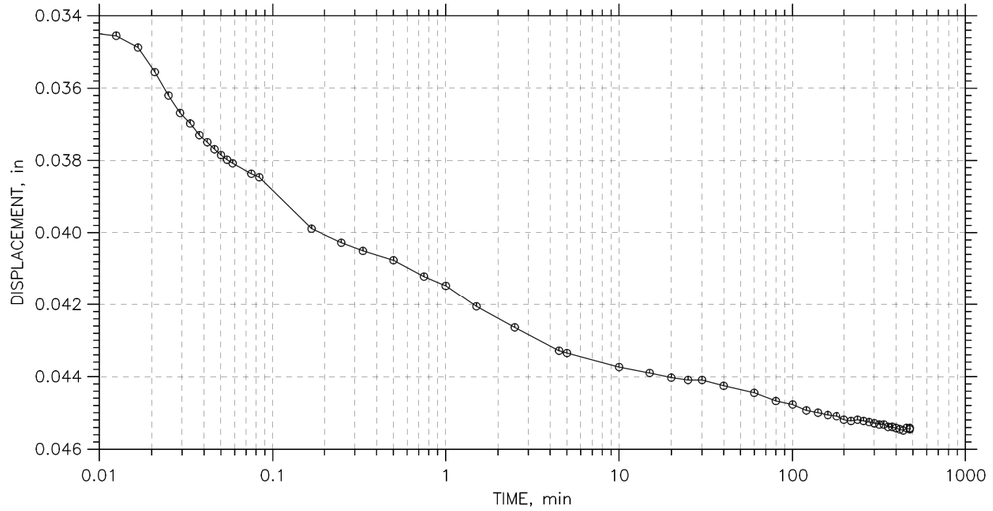
MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:28:53 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050064COL_ODOT\Mod_25.11.24\114435ZD002.dgn

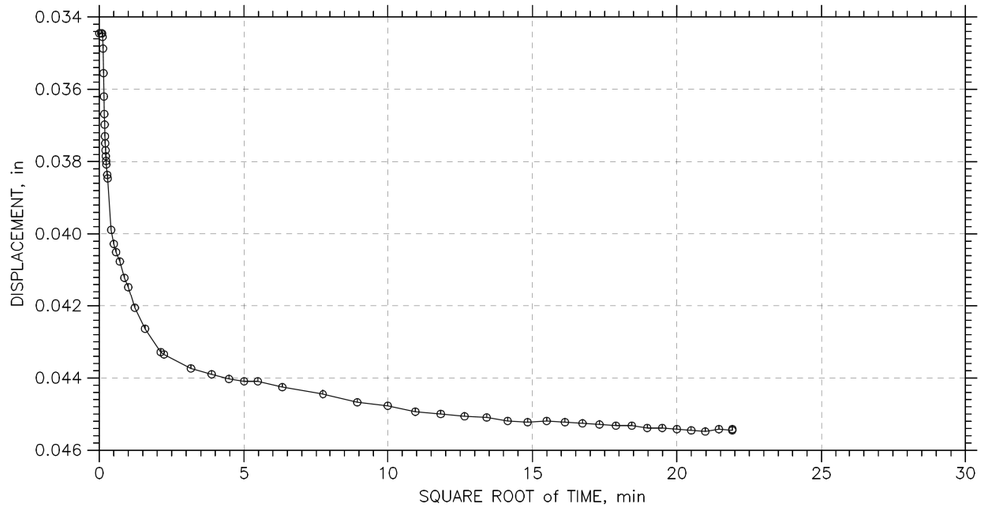
CONSOLIDATION TEST DATA

TIME CURVES

Step: 7 of 11

Stress: 8. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

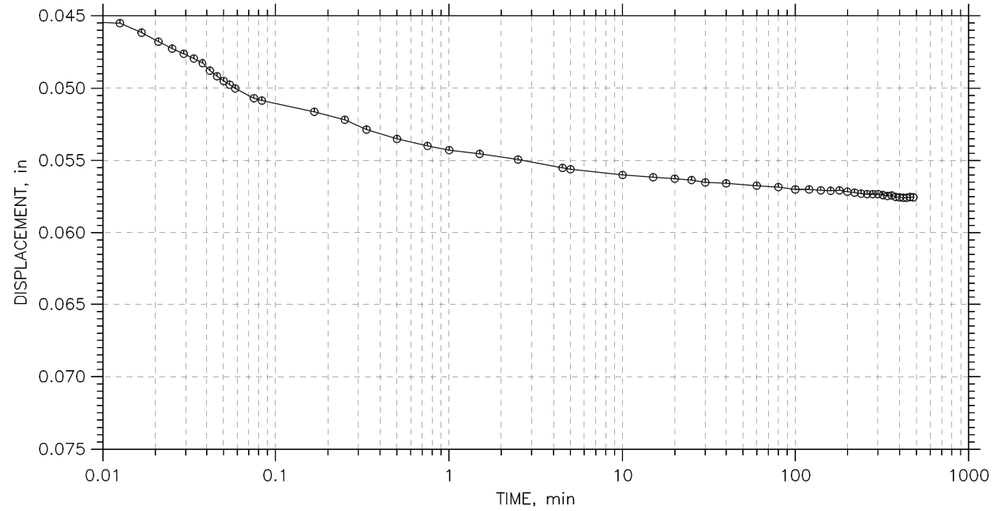
Wed, 13-SEP-2023 12:47:18

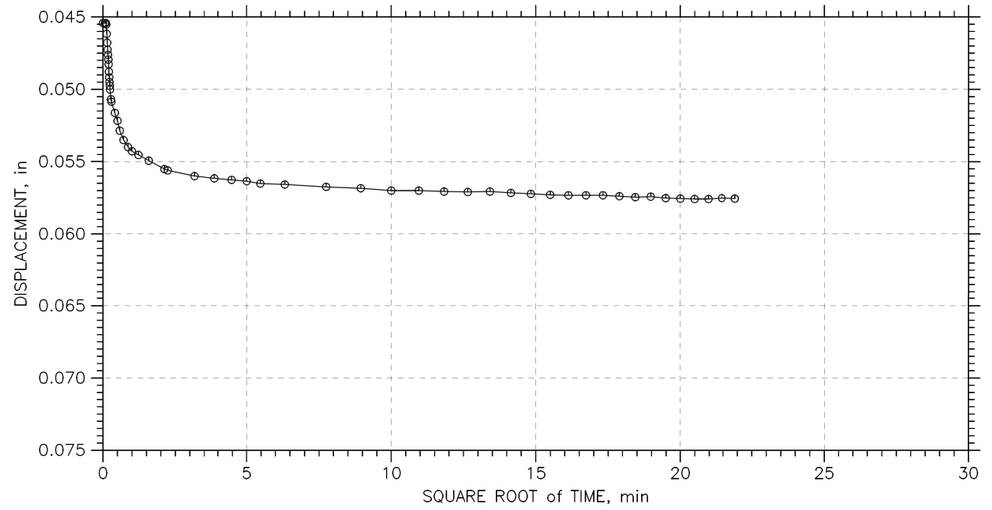
CONSOLIDATION TEST DATA

TIME CURVES

Step: 8 of 11

Stress: 16. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevction:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

Wed, 13-SEP-2023 12:47:18

GEOTECHNICAL PROFILE - ROADWAY
UNDISTURBED TEST CONSOLIDATION REPORT

DESIGN AGENCY
GTL ENGINEERING INC
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER N.K.S

REVIEWER SM 11-25-24

PROJECT ID 114435

SUBSET 5 | TOTAL 8

SHEET P.26 | TOTAL 29

BRO-62-27.49

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:32:41 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050064COL_ODOT\Mod_25.11.24\114435ZD003.dgn

MODEL: Sheet PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:36:57 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050064COL_ODOT\Mod_25.11.24\114435ZD004.dgn

CTL Engineering, Inc.
Specific Gravity
ASTM D 854 / AASHTO T 100
Method B

Client: BG Engineering Group LLC
Project: BRO-62-27.49 Roadway Exploration
Project #: 23050064COL

Date: 9/12/2023
Tech: MW
Reviewed by: SM

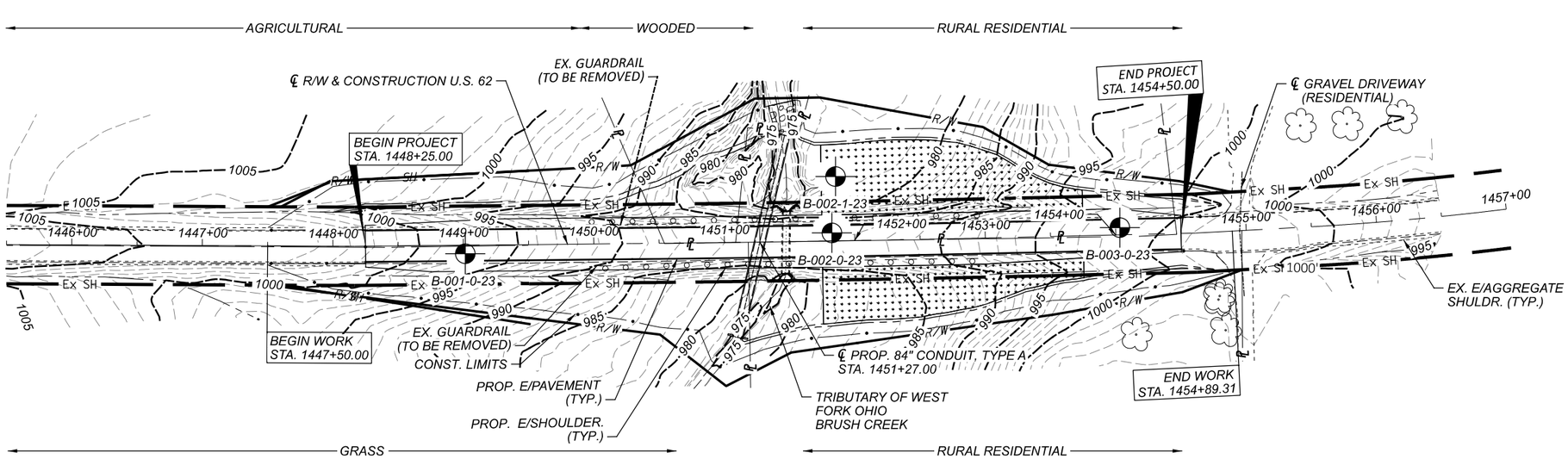
Visual Classification: Brown, Sandy Silt (A-4a)
Weight of Oven Dry Soil passing #4 Sieve (g): 35.2
Material Excluded From Test: None
Mass of Pycnometer ($M_{p)}$): 108.28
Mass of Pyncometer, Water and Soil Solids ($M_{pws,t}$): 379.76

Test Temperature (°C): 20.7

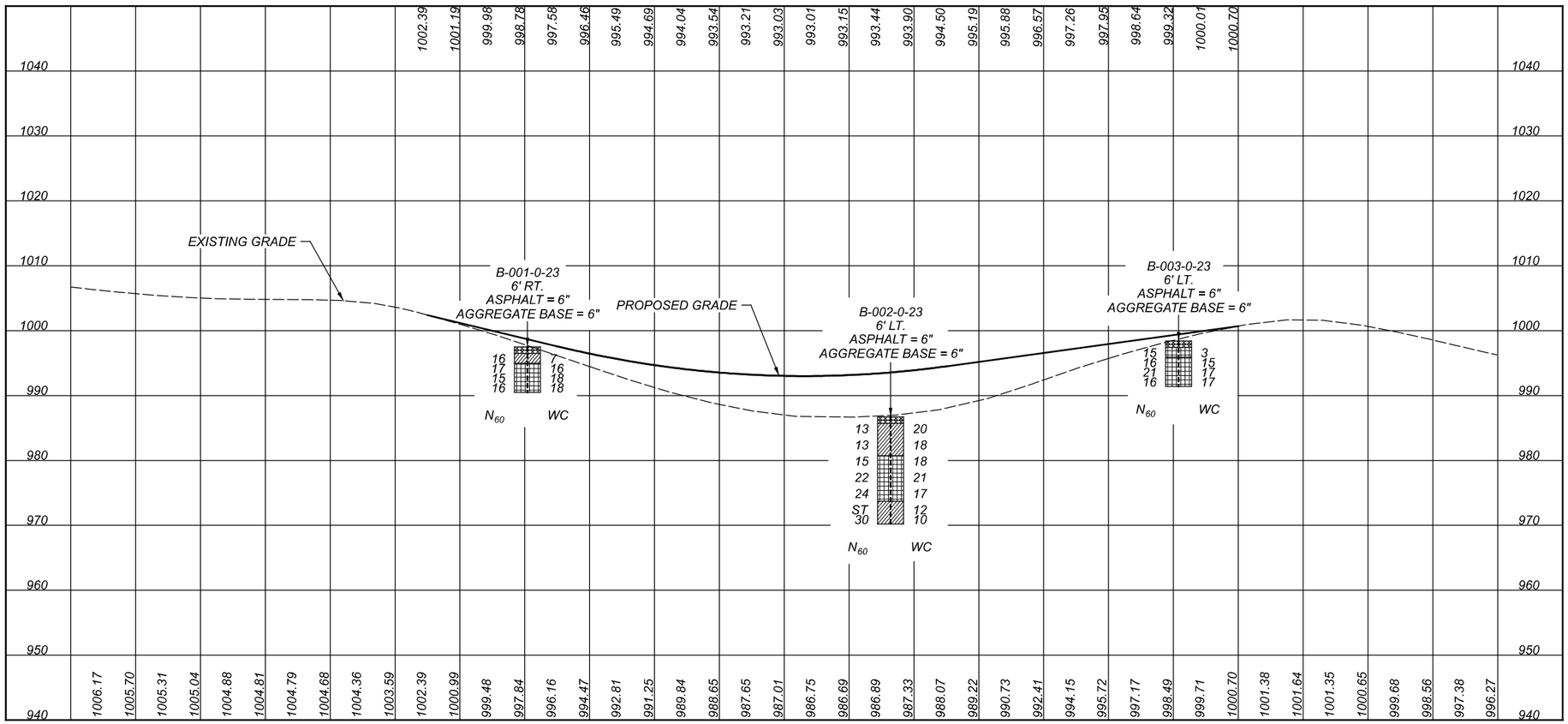
Sample ID	Specific Gravity (20°C)
B-002-1-23, ST-3, 4'-6'	2.659

CTL ENGINEERING INC.

GEOTECHNICAL PROFILE - ROADWAY
UNDISTURBED TEST CONSOLIDATION REPORT



SEE SHEET 8 OF 8 FOR BORING B-002-1-23 SOIL PROFILE.



HORIZONTAL SCALE IN FEET
0 25 50 100

GEOTECHNICAL PROFILE - US 62
STA. 1445+50.00 TO STA. 1456+50.00

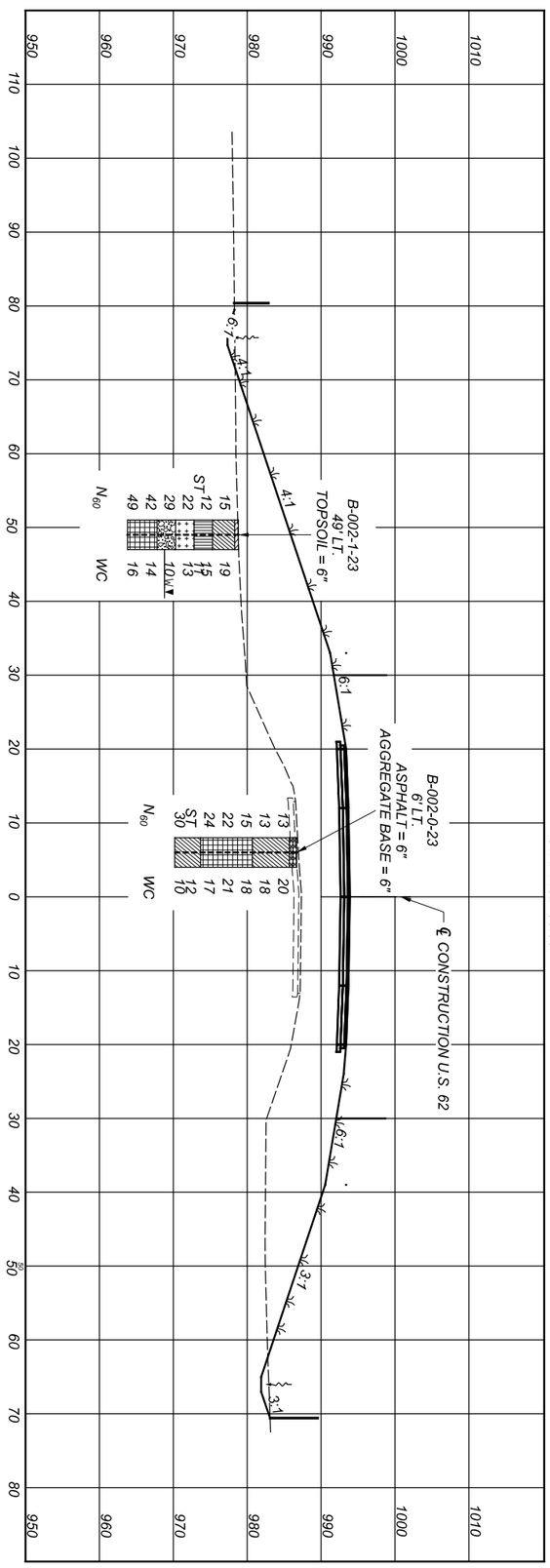
BRO-62-27.49

MODEL: Plan PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:44:28 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\230500064COL_ODOT\Mod_25.11.24\114435GP001.dgn

DESIGN AGENCY
CTL ENGINEERING
2860 FISHER ROAD
COLUMBUS, OHIO 43204
PHONE: (614)276-8123
FAX: (614)276-6377

DESIGNER	
N.K.S	
REVIEWER	
SM	11-25-24
PROJECT ID	
114435	
SUBSET	TOTAL
7	8
SHEET	TOTAL
P.28	29

MODEL: 1452+00.00 PAPERSIZE: 17x11 (in.) DATE: 25-11-2024 TIME: 10:46:32 USER: hp
D:\Drop Box\CTL 2024\November\Dept 05\CIN\Carey\23050064COL_ODOT\Mod_25.11.24\114435XS001.dgn



GEOTECHNICAL PROFILE - ROADWAY
CROSS SECTION STA. 1452+00.00

HORIZONTAL SCALE IN FEET
0 10
5 20

DESIGN AGENCY

CTL ENGINEERING, INC.
CINCINNATI, OHIO 45241
COLUMBUS, OHIO 43204
PHONE (614) 276-8123
FAX (614) 276-8377

DESIGNER N.K.S
REVIEWER SM 11-25-24
PROJECT ID 114435
SUBSET 8 TOTAL 8
SHEET P 29 TOTAL 29

APPENDIX B

TEST BORING RECORDS

PROJECT: BRO-62-27.49	DRILLING FIRM / OPERATOR: CTL / T. MILLER	DRILL RIG: CME 55 #393	STATION / OFFSET: 1449+02, 6' RT.	EXPLORATION ID B-001-0-23
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: CTL / T. MILLER	HAMMER: CME AUTOMATIC	ALIGNMENT: US-62	
PID: 114435 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/4/22	ELEVATION: 997.5 (MSL) EOB: 7.0 ft.	PAGE 1 OF 1
START: 8/24/23 END: 8/24/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79.3	LAT / LONG: 38.979559, -83.720436	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT (6")	997.0																		
AGGREGATE BASE (6")	996.5																		
HARD, BROWN, **SILT AND CLAY**, SOME GRAVEL, LITTLE SAND, FILL, DAMP	995.0	1	5 6 6	16	100	SS-1	4.50	28	9	11	30	22	31	17	14	7	A-6a (5)	<100	
HARD, BROWN, **CLAY**, "AND" SAND, SOME SILT, TRACE GRAVEL, DAMP		2																	
		3	3 6 7	17	100	SS-2	4.50	3	8	29	23	37	42	19	23	16	A-7-6 (10)	-	
		4	5 5 6	15	100	SS-3	4.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
@5.5'; VERY STIFF		5																	
	990.5	6	4 6 6	16	100	SS-4	3.50	-	-	-	-	-	-	-	-	18	A-7-6 (V)	-	
	EOB	7																	

NOTES: BOREHOLE CAVED AT 4'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH AUGER CUTTINGS

PROJECT: BRO-62-27.49	DRILLING FIRM / OPERATOR: CTL / T. MILLER	DRILL RIG: CME 55 #393	STATION / OFFSET: 1451+82, 6' LT.	EXPLORATION ID B-002-0-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: CTL / T. MILLER	HAMMER: CME AUTOMATIC	ALIGNMENT: US-62	
PID: 114435 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/4/22	ELEVATION: 986.7 (MSL) EOB: 16.5 ft.	PAGE 1 OF 1
START: 8/24/23 END: 8/24/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79.3	LAT / LONG: 38.980280, -83.720077	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT (6")	986.2																		
AGGREGATE BASE (6")	985.7																		
VERY STIFF, BROWN, **SILT AND CLAY**, LITTLE SAND, TRACE GRAVEL, FILL, DAMP		1	4 5 5	13	100	SS-1	3.00	2	3	9	49	37	34	20	14	20	A-6a (10)	-	
		2																	
		3																	
		4	3 5 5	13	100	SS-2	2.25	-	-	-	-	-	-	-	-	18	A-6a (V)	-	
		5																	
	980.7	6																	
STIFF, BROWN, **CLAY**, "AND" SILT, LITTLE SAND, TRACE GRAVEL, DAMP		7	4 5 6	15	100	SS-3	1.00	1	3	10	47	39	41	21	20	18	A-7-6 (12)	-	
		8																	
@8.5'; VERY STIFF		9	8 8 9	22	100	SS-4	2.50	-	-	-	-	-	-	-	-	21	A-7-6 (V)	-	
		10																	
@11.0'; HARD		11	7 9 9	24	100	SS-5	4.50	-	-	-	-	-	-	-	-	17	A-7-6 (V)	-	
	973.7	12																	
HARD, BROWN, **SILT AND CLAY**, SOME SAND, LITTLE GRAVEL, DAMP		13			100	ST-6	-	12	12	20	29	27	28	16	12	12	A-6a (5)	-	
		14																	
		15	10 11 12	30	100	SS-7	4.50	-	-	-	-	-	-	-	-	10	A-6a (V)	-	
	970.2	16																	
		EOB																	

NOTES: BOREHOLE CAVED AT 12'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH AUGER CUTTINGS

PROJECT: BRO-62-27.49	DRILLING FIRM / OPERATOR: CTL / T. MILLER	DRILL RIG: CME 55 #393	STATION / OFFSET: 1451+86, 49' LT.	EXPLORATION ID B-002-1-23
TYPE: ROADWAY	SAMPLING FIRM / LOGGER: CTL / T. MILLER	HAMMER: CME AUTOMATIC	ALIGNMENT: US-62	
PID: 114435 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/4/22	ELEVATION: 978.8 (MSL) EOB: 15.0 ft.	PAGE 1 OF 1
START: 8/24/23 END: 8/24/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79.3	LAT / LONG: 38.980336, -83.720212	

MATERIAL DESCRIPTION AND NOTES	ELEV. 978.8	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
TOPSOIL (6")	978.3																		
STIFF, BROWN, **SILT AND CLAY**, "AND" SAND, LITTLE GRAVEL, MOIST	975.3	1	4 5 6	15	100	SS-1	2.00	16	13	29	20	22	31	17	14	19	A-6a (2)	-	
STIFF, BROWN, **SANDY SILT**, SOME CLAY, TRACE GRAVEL, DAMP	972.8	4	5 4 5	12	100	SS-2	1.50	-	-	-	-	-	-	-	-	15	A-4a (V)	-	
		5			100	ST-3	-	9	13	22	35	21	20	14	6	11	A-4a (4)	-	
STIFF, BROWN, **SILT**, LITTLE CLAY, LITTLE SAND, TRACE GRAVEL, DAMP	970.3	7	9 8 9	22	100	SS-4	1.50	9	7	13	56	15	19	16	3	13	A-4b (7)	-	
MEDIUM DENSE, GRAY, **GRAVEL AND/OR STONE FRAGMENTS WITH SAND**, LITTLE SILT, TRACE CLAY, MOIST	967.8	968.8 10	10 11 11	29	100	SS-5	-	39	17	22	12	10	17	13	4	10	A-1-b (0)	-	
VERY STIFF, GRAY, **CLAY**, SOME SAND, SOME SILT, TRACE GRAVEL, DAMP	963.8	12	12 15 17	42	100	SS-6	2.25	-	-	-	-	-	-	-	-	14	A-7-6 (V)	-	
	EOB	15	15 18 19	49	100	SS-7	3.25	10	13	22	26	29	42	25	17	16	A-7-6 (7)	-	

NOTES:

- SS-2 WAS SAMPLED AND OBTAINED IN BORING B-002-1-23 FROM A DEPTH OF 3.5' TO 5.0'.

- ST-3 WAS SAMPLED AND OBTAINED IN AN OFFSET BORING FROM A DEPTH OF 4.0' TO 6.0'.

NOTES: BOREHOLE CAVED AT 12'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH AUGER CUTTINGS

PROJECT: BRO-62-27.49	DRILLING FIRM / OPERATOR: CTL / T. MILLER	DRILL RIG: CME 55 #393	STATION / OFFSET: 1454+04, 6' LT.	EXPLORATION ID B-003-0-23
TYPE: SUBGRADE	SAMPLING FIRM / LOGGER: CTL / T. MILLER	HAMMER: CME AUTOMATIC	ALIGNMENT: US-62	
PID: 114435 SFN: N/A	DRILLING METHOD: 3.25" HSA	CALIBRATION DATE: 11/4/22	ELEVATION: 998.4 (MSL) EOB: 7.0 ft.	PAGE 1 OF 1
START: 8/24/23 END: 8/24/23	SAMPLING METHOD: SPT	ENERGY RATIO (%): 79.3	LAT / LONG: 38.980836, -83.719770	

MATERIAL DESCRIPTION AND NOTES	ELEV.	DEPTHS	SPT/ RQD	N_{60}	REC (%)	SAMPLE ID	HP (tsf)	GRADATION (%) GR	CS	FS	SI	CL	ATTERBERG LL	PL	PI	WC	ODOT CLASS (GI)	SO4 ppm	BACK FILL
ASPHALT (6")	998.4																		
AGGREGATE BASE (6")	997.9																		
HARD, BLACK AND GRAY, **CLAY**, SOME GRAVEL, SOME SAND, CONTAINS ASPHALT, DRY **(FILL)**	997.4	1	5 6 5	15	100	SS-1	4.50	-	-	-	-	-	-	-	-	3	A-7-6 (V)	340	
HARD, BROWN, **CLAY**, SOME SAND, SOME SILT, TRACE GRAVEL, DAMP	995.9	2																	
		3	4 6 6	16	100	SS-2	4.50	8	5	18	28	41	45	21	24	15	A-7-6 (13)	-	
		4																	
		5	6 8 8	21	100	SS-3	4.25	10	7	22	24	37	48	23	25	17	A-7-6 (12)	-	
@5.5'; VERY STIFF	991.4	6	3 5 7	16	100	SS-4	3.00	-	-	-	-	-	-	-	-	17	A-7-6 (V)	-	
EOB		7																	

NOTES: BOREHOLE CAVED AT 5'

ABANDONMENT METHODS, MATERIALS, QUANTITIES: PLACED ASPHALT PATCH; BACKFILLED WITH AUGER CUTTINGS

APPENDIX C

LABORATORY TEST RESULTS

One Dimensional Consolidation and Swell Properties of Soil - ASTM D 2435

CTL ENGINEERING, INC.
2860 Fisher Road
Columbus, OH 43204

Project No.:	23050064COL		
Project:	BR-62-27.49 Roadway Exploration	Sample Type:	Undisturbed Specimen
Client:	BG Engineering	Test Date:	9/1/2023
Boring No.:	B-002-1-23	Checked By:	SM
Sample No.:	ST-3_4'-6'	Tested By:	MW
Soil Description:	Brown, Sandy Silt (A-4a)	LL:	20
Specific Gravity:	2.659	PL:	14
Initial Dry Unit Weight	130.4 pcf	Initial Moisture	10.9%

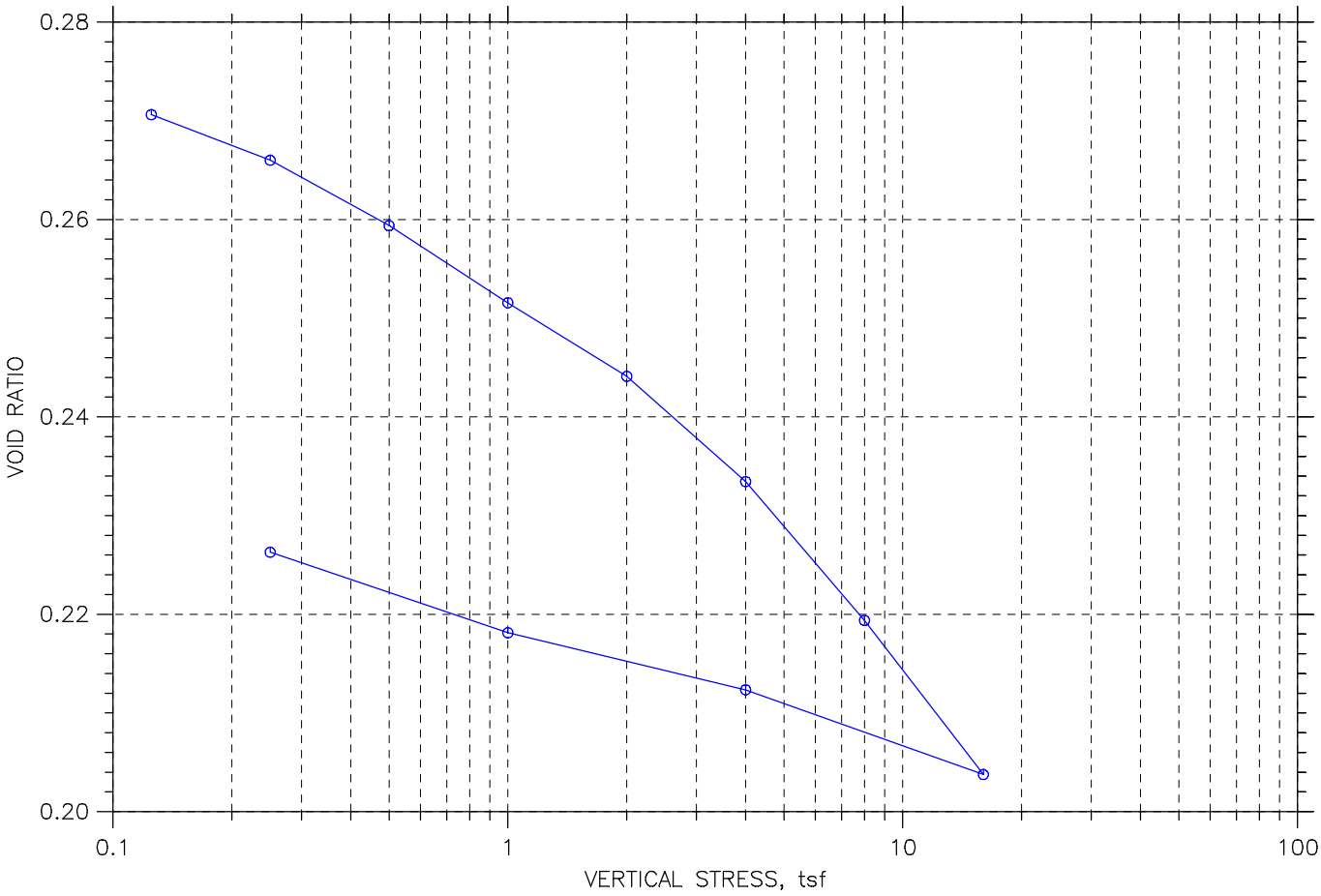
Step No.	Applied Stress (tsf)	Final Displacement (in)	Void Ratio	Strain at End (%)	Sqrt T_{90} (min)	Cv (ft^2/sec)
1	0.125	0.005597	0.271	0.56		
2	0.25	0.009187	0.266	0.93		
3	0.5	0.01433	0.259	1.44		
4	1	0.02041	0.252	2.06		
5	2	0.0262	0.244	2.64	4.7	4.96E-06
6	4	0.03449	0.233	3.47	4.2	5.35E-06
7	8	0.04542	0.219	4.57	2.3	9.88E-06
8	16	0.05755	0.204	5.8	0.8	2.65E-05
9	4	0.05089	0.212	5.12		
10	1	0.04639	0.218	4.67		
11	0.25	0.04005	0.226	4.03		

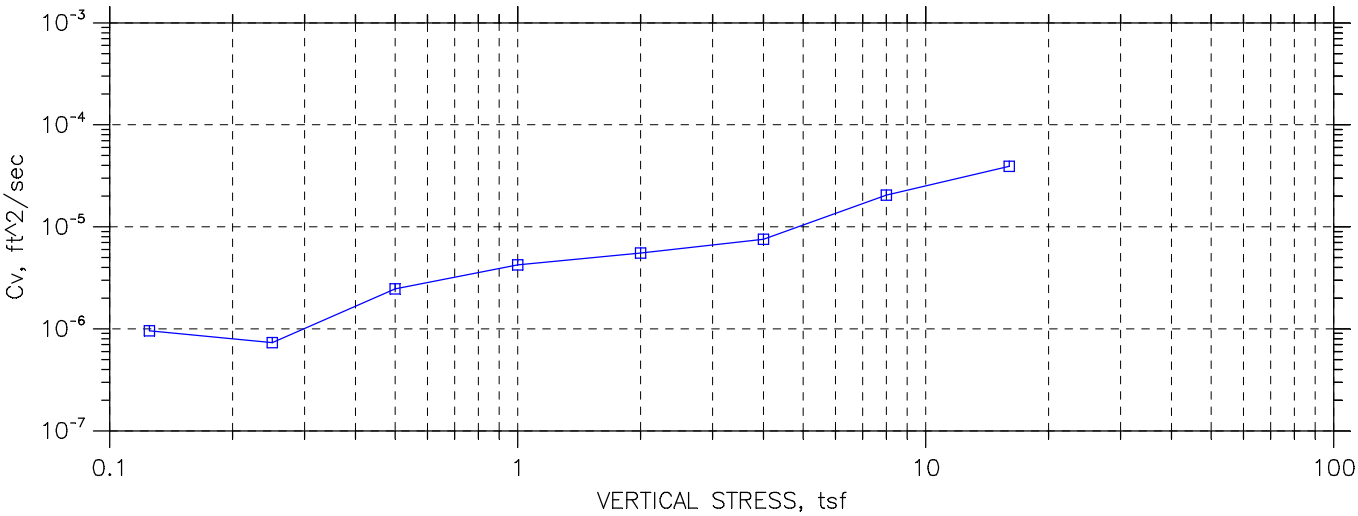
CONSOLIDATION PARAMETERS

Preconsolidation Pressure (tsf):	1.60	Initial Void Ratio:	0.27
Compression Index (C_c):	0.05	Compression Ratio :	0.04
Recompression Index (C_r):	0.013	Recompression Ratio:	0.010

CONSOLIDATION TEST DATA

SUMMARY REPORT





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

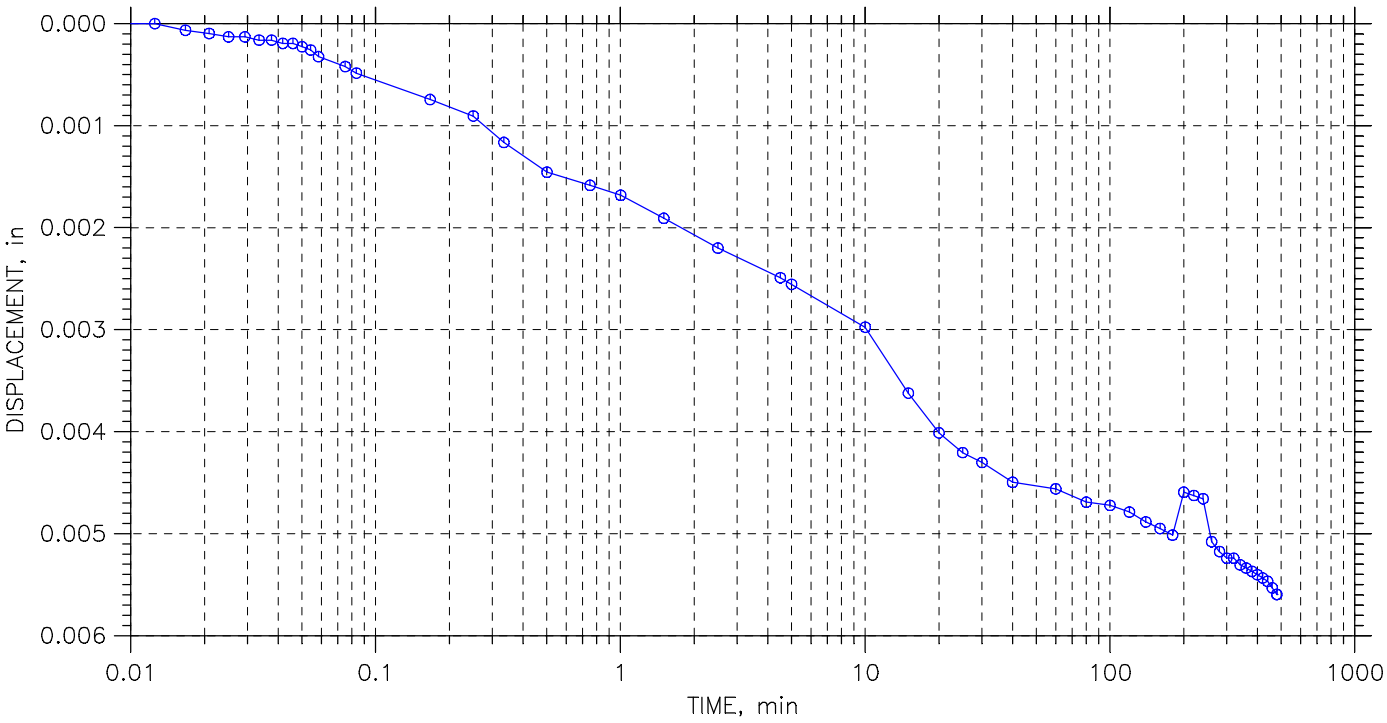
Wed, 13-SEP-2023 12:47:17

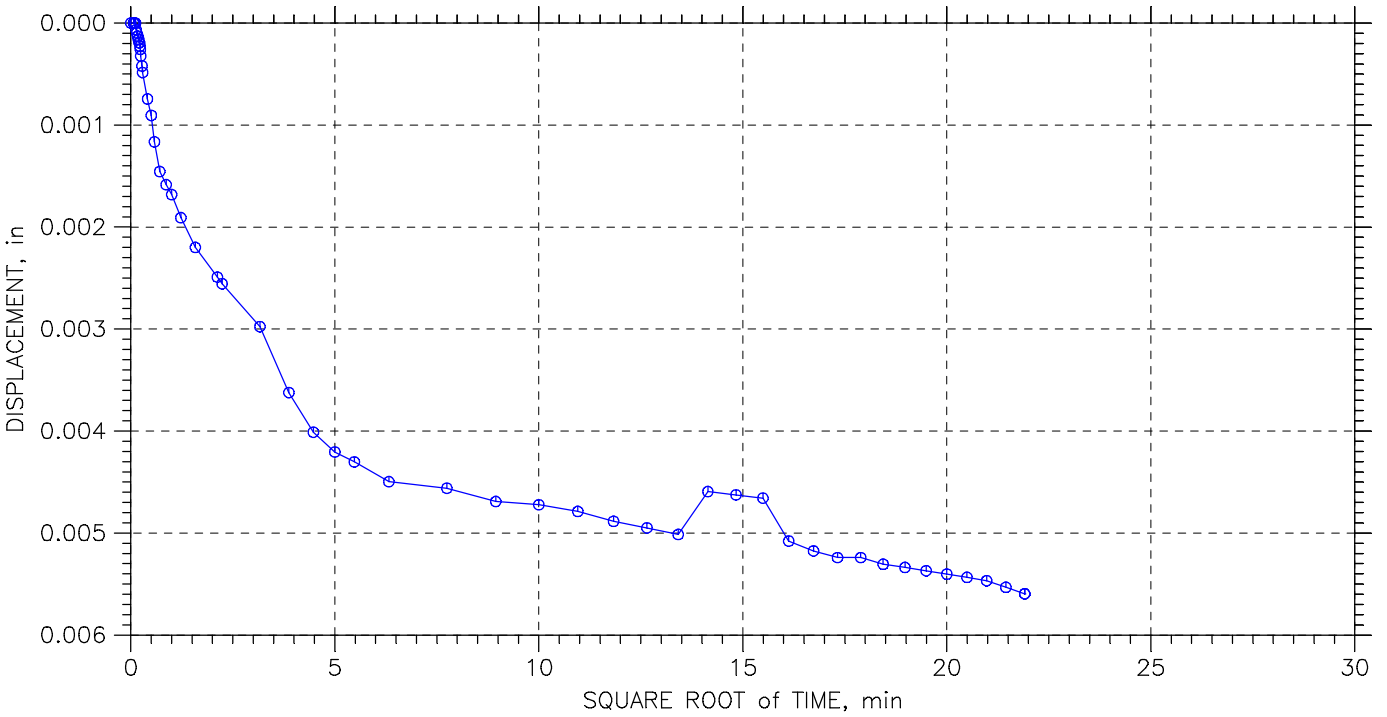
CONSOLIDATION TEST DATA

TIME CURVES

Step: 1 of 11

Stress: 0.125 tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

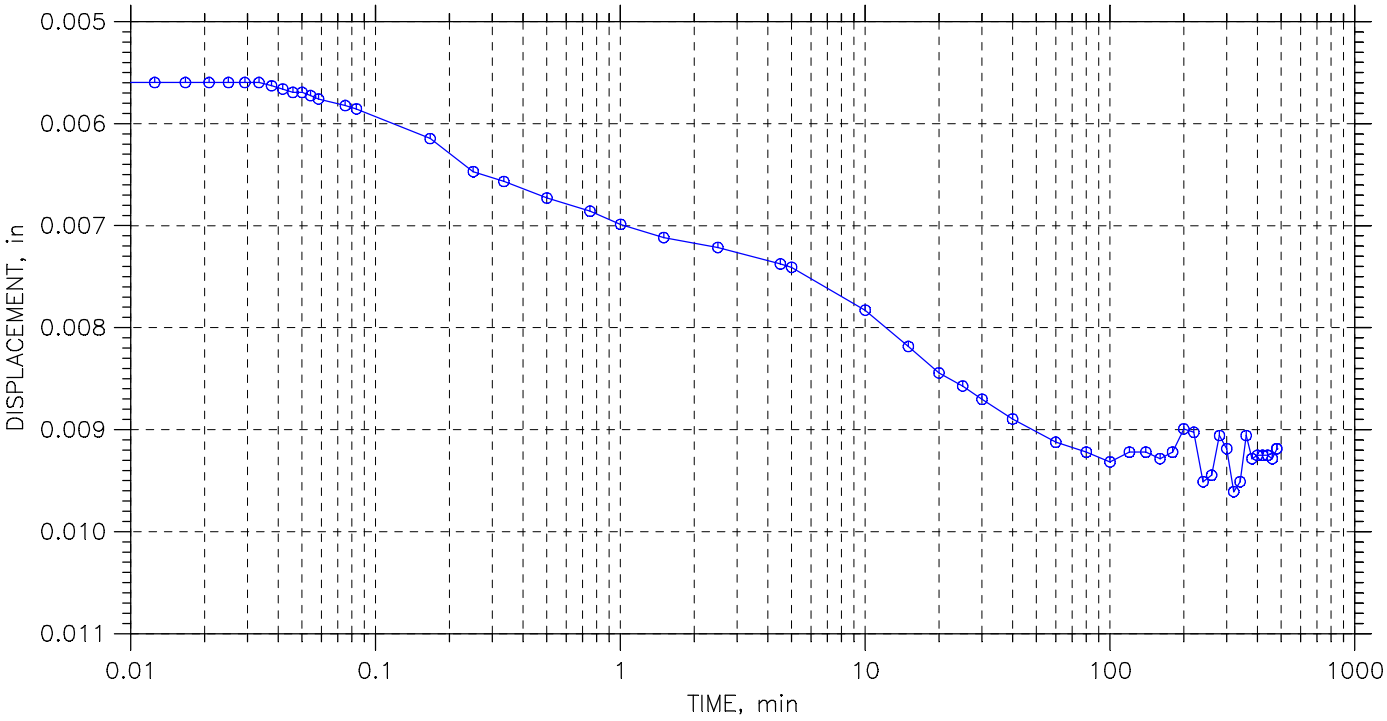
Wed, 13-SEP-2023 12:47:17

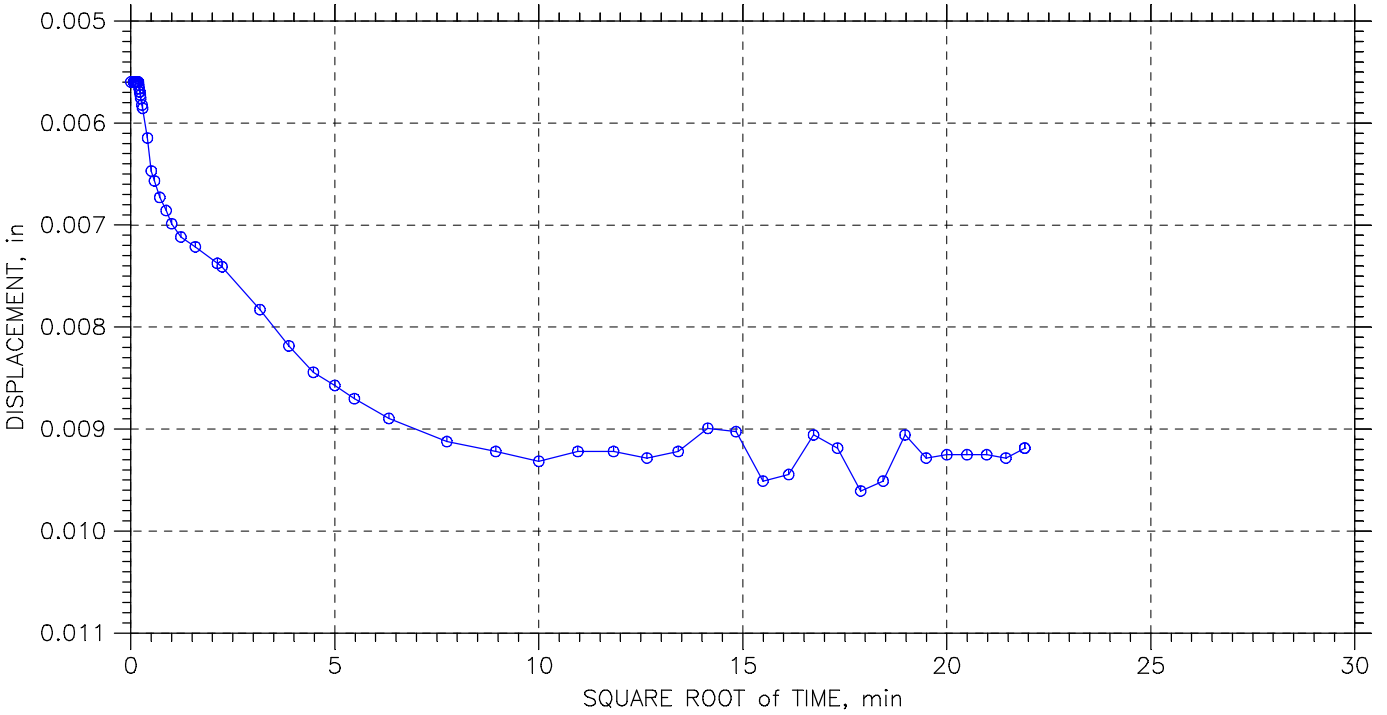
CONSOLIDATION TEST DATA

TIME CURVES

Step: 2 of 11

Stress: 0.25 tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

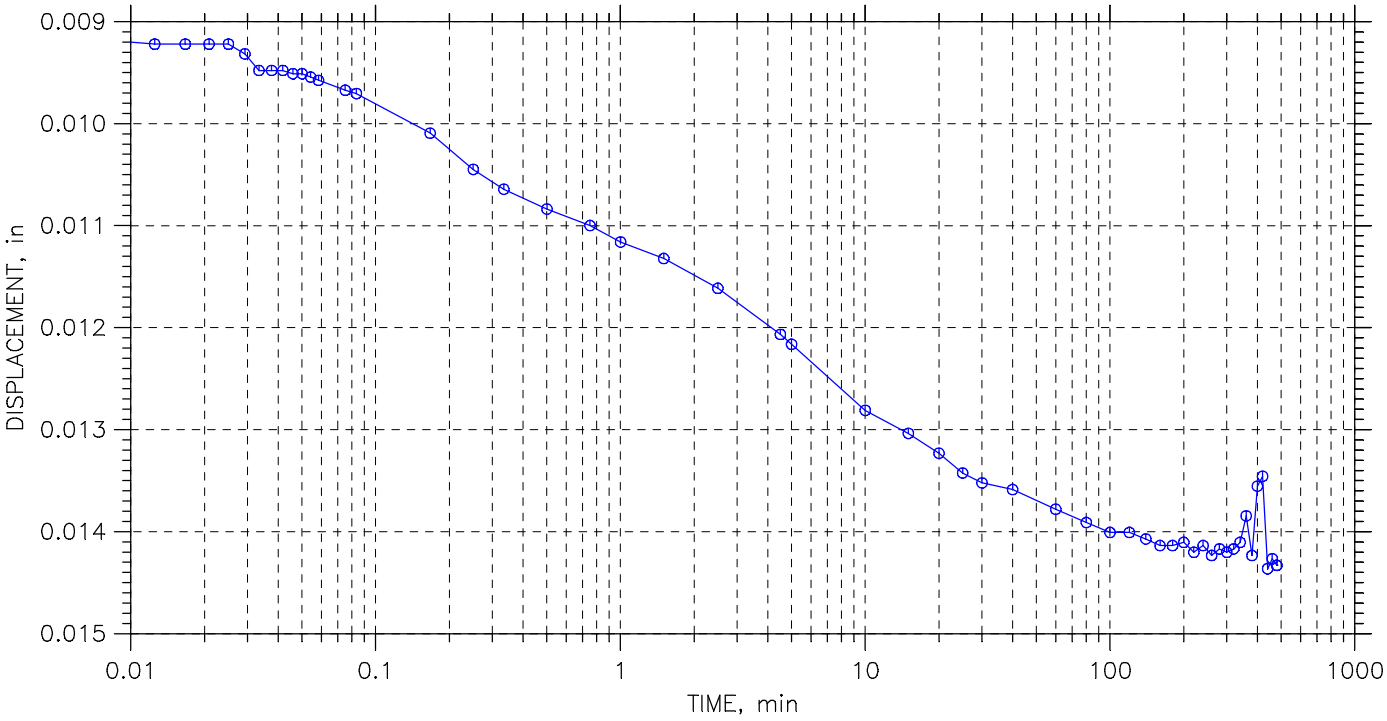
Wed, 13-SEP-2023 12:47:17

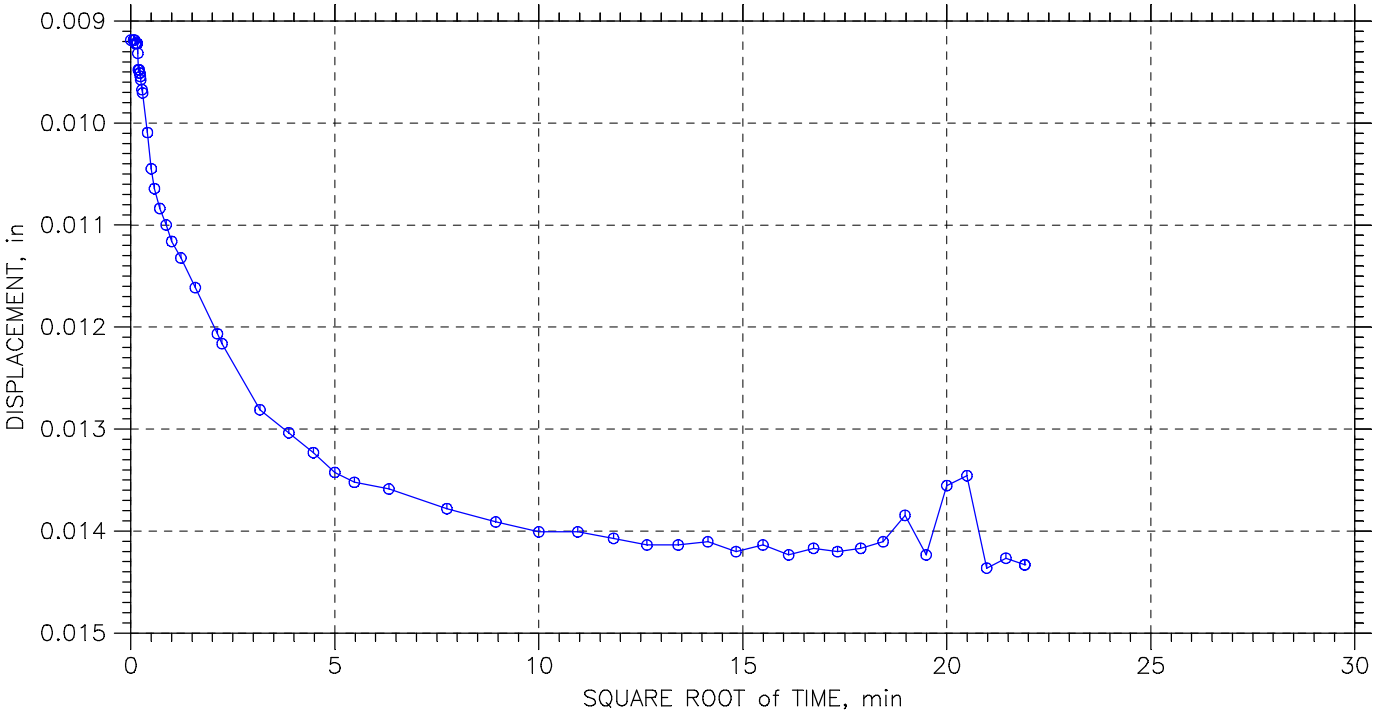
CONSOLIDATION TEST DATA

TIME CURVES

Step: 3 of 11

Stress: 0.5 tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

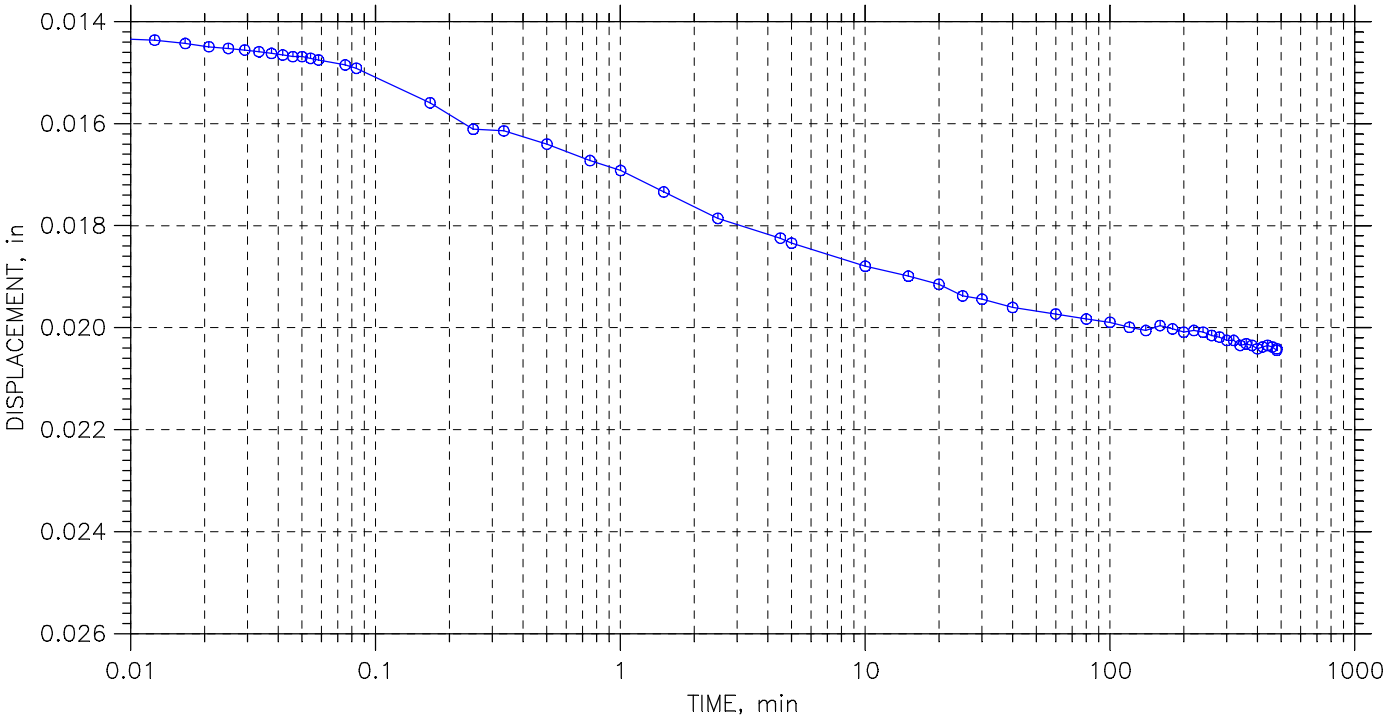
Wed, 13-SEP-2023 12:47:17

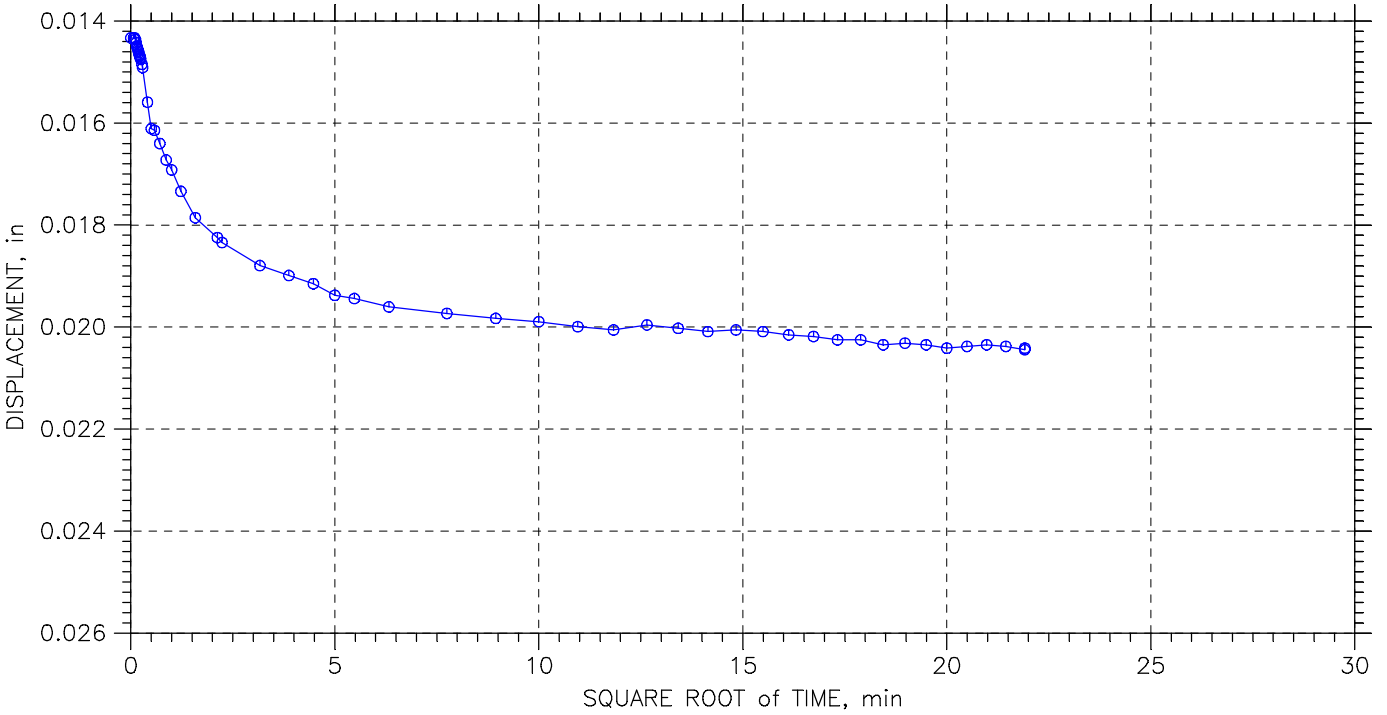
CONSOLIDATION TEST DATA

TIME CURVES

Step: 4 of 11

Stress: 1. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

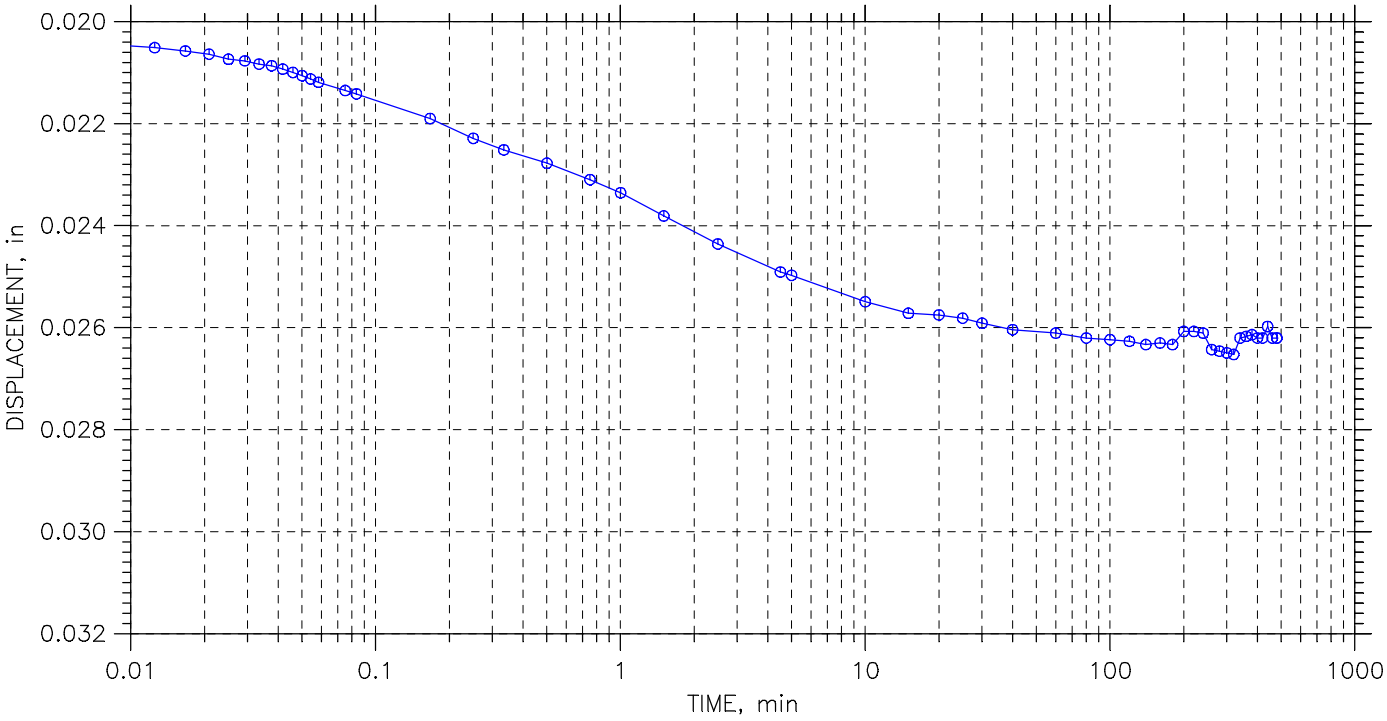
Wed, 13-SEP-2023 12:47:17

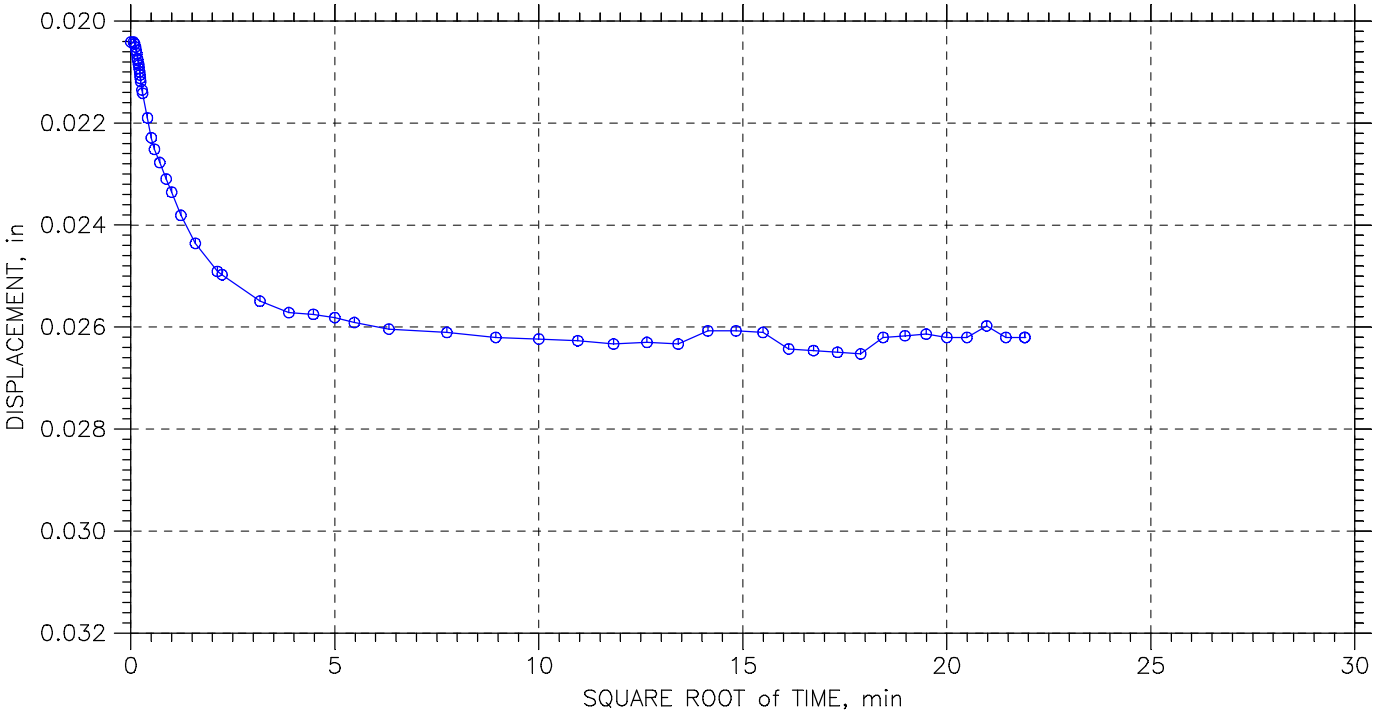
CONSOLIDATION TEST DATA

TIME CURVES

Step: 5 of 11

Stress: 2. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

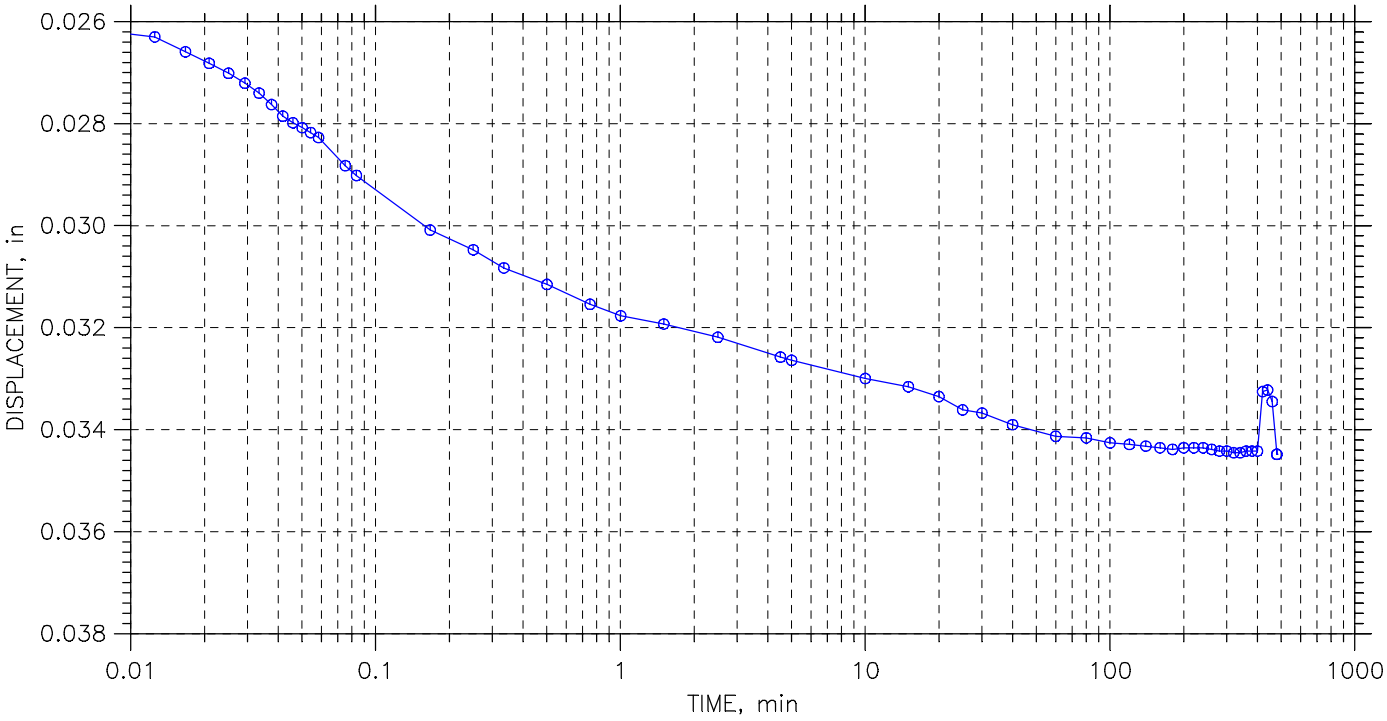
Wed, 13-SEP-2023 12:47:18

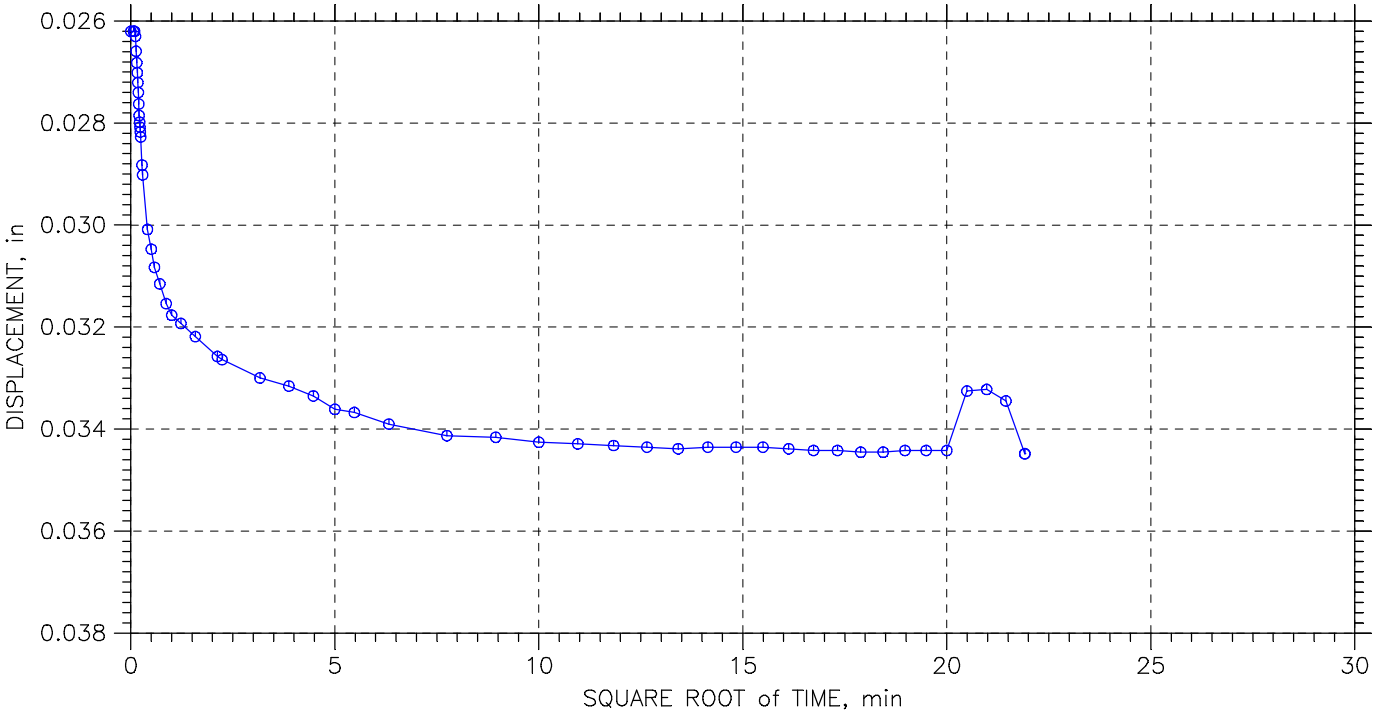
CONSOLIDATION TEST DATA

TIME CURVES

Step: 6 of 11

Stress: 4. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

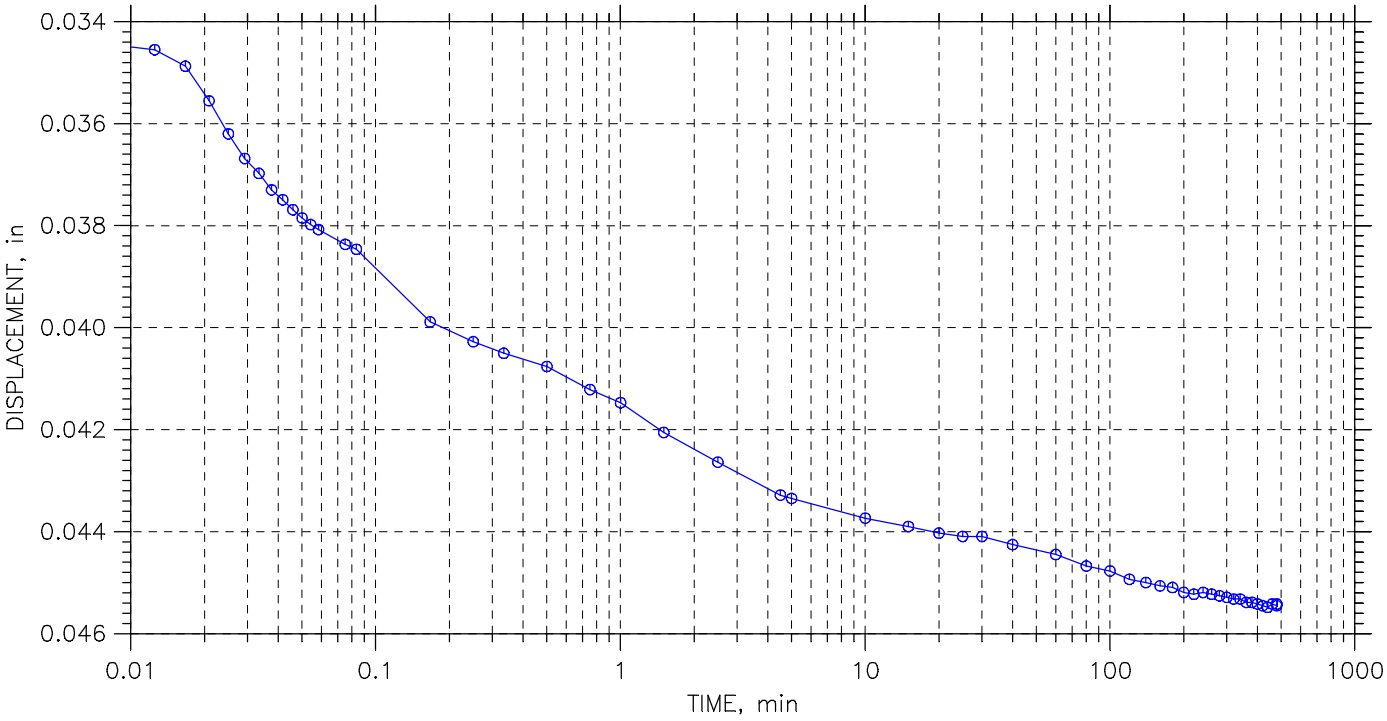
Wed, 13-SEP-2023 12:47:18

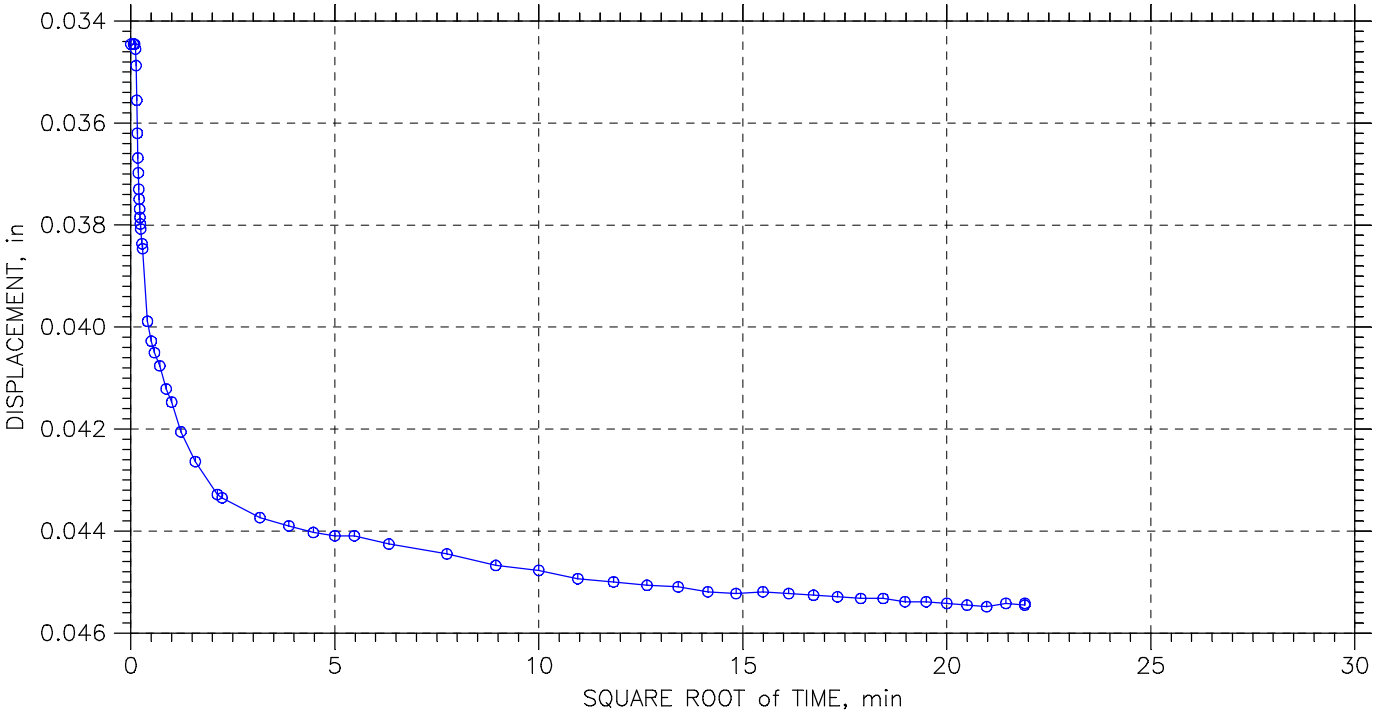
CONSOLIDATION TEST DATA

TIME CURVES

Step: 7 of 11

Stress: 8. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

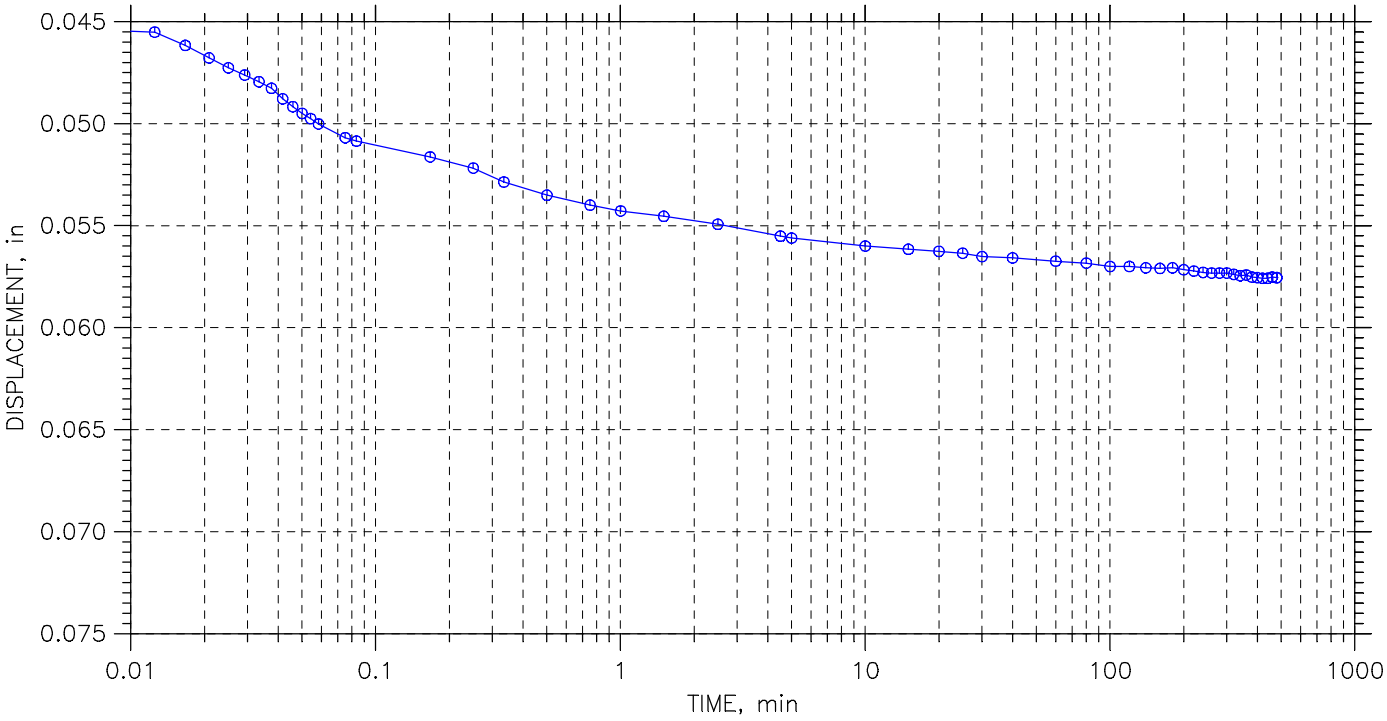
Wed, 13-SEP-2023 12:47:18

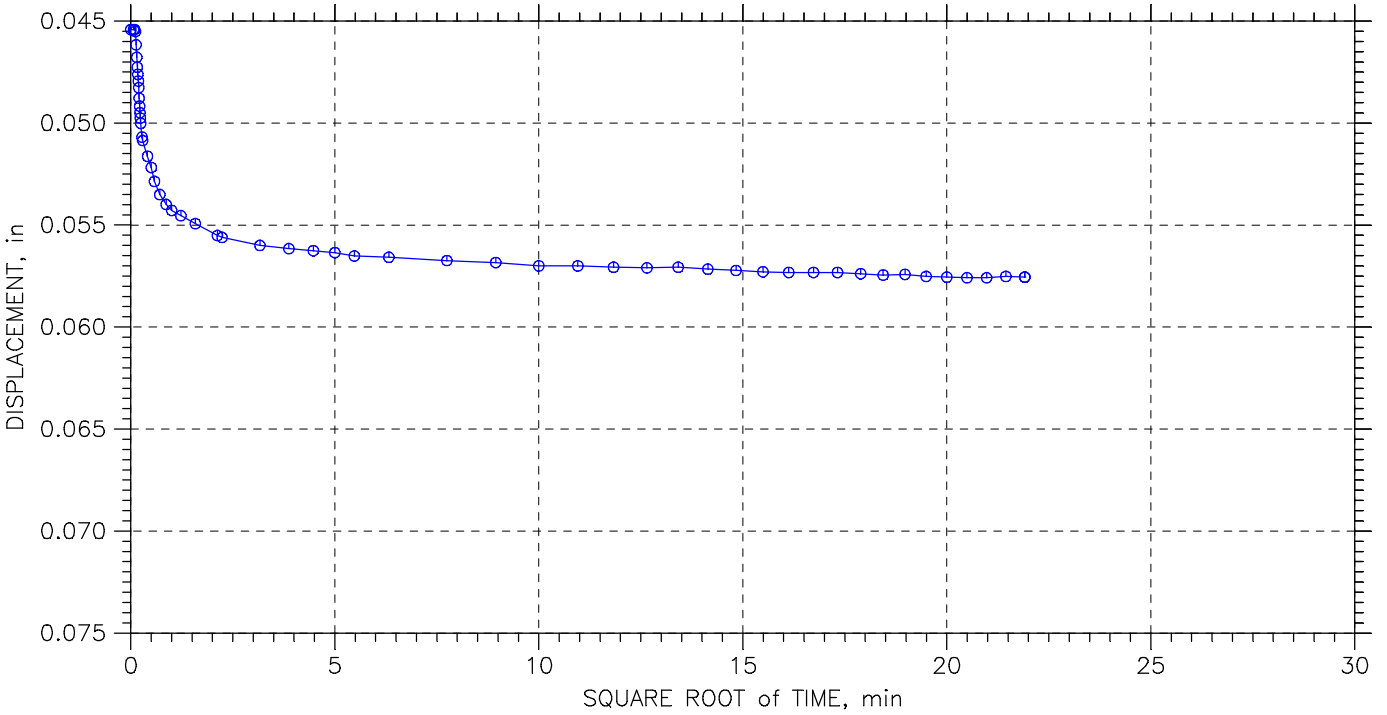
CONSOLIDATION TEST DATA

TIME CURVES

Step: 8 of 11

Stress: 16. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

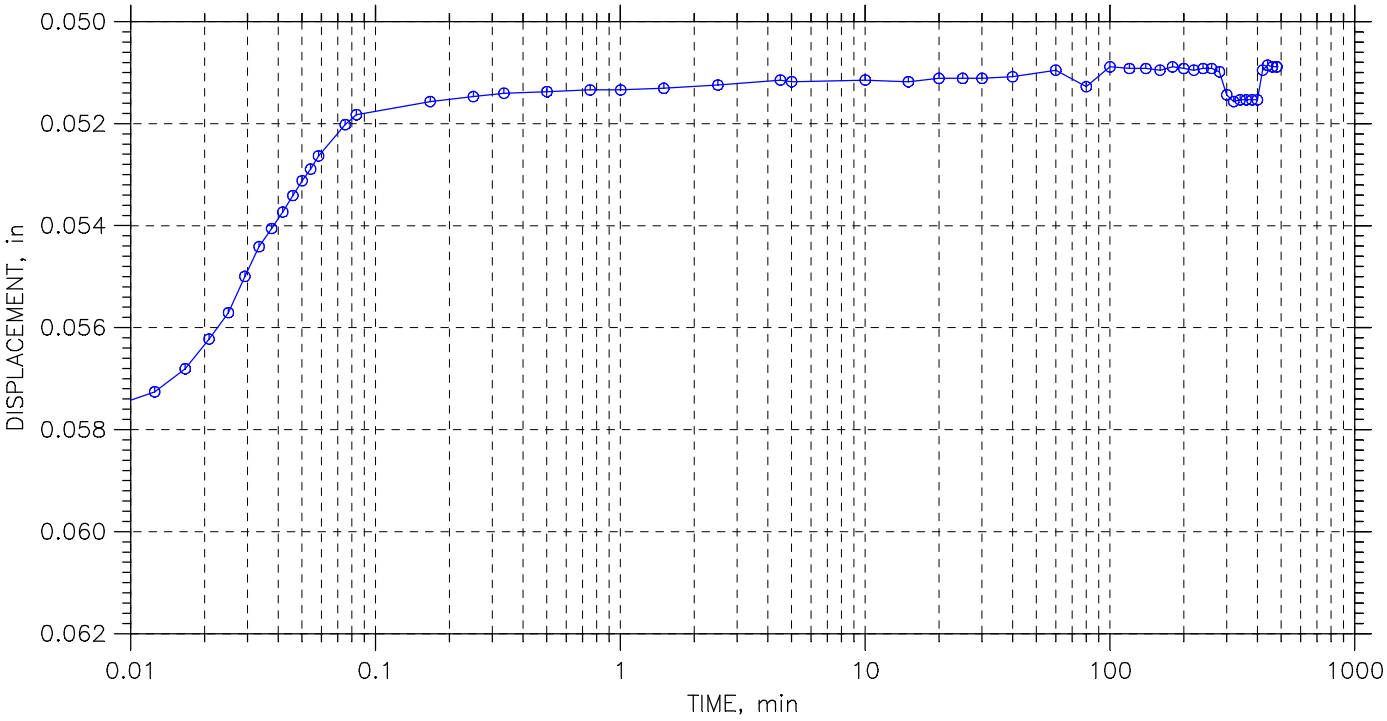
Wed, 13-SEP-2023 12:47:18

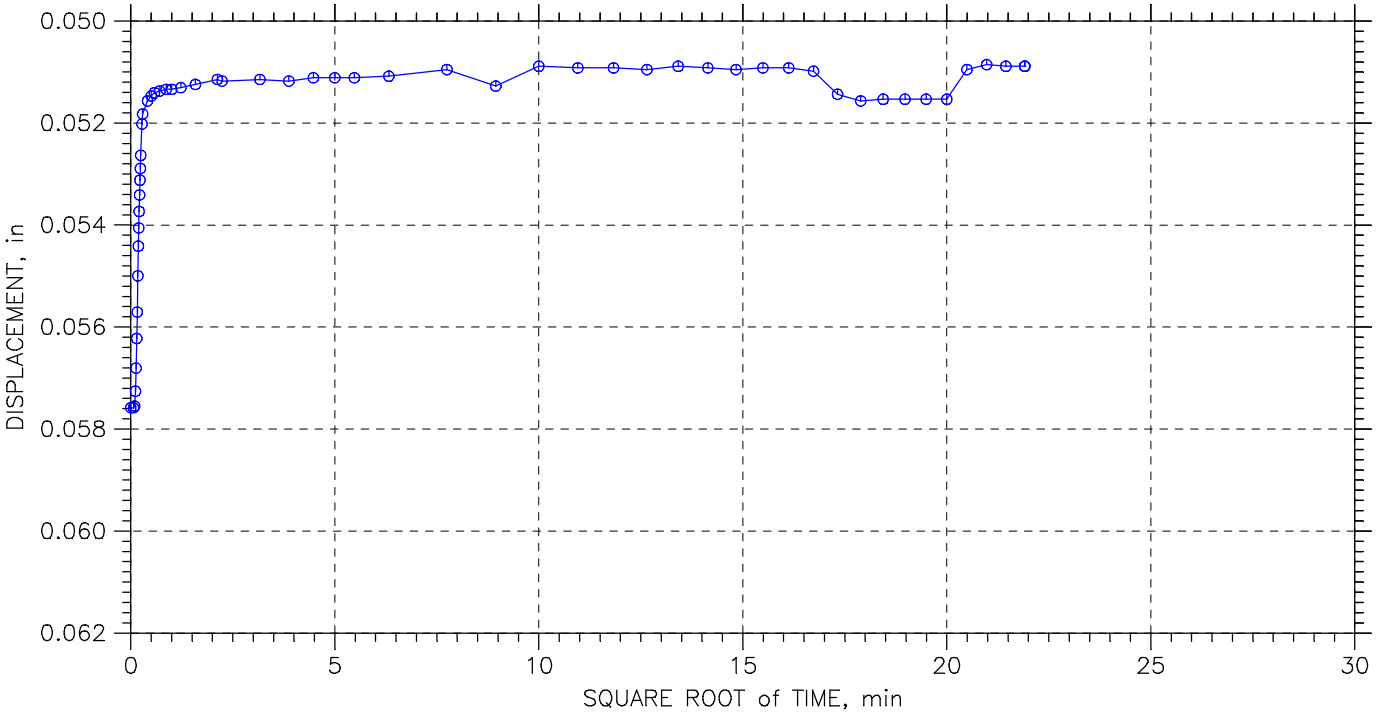
CONSOLIDATION TEST DATA

TIME CURVES

Step: 9 of 11

Stress: 4. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

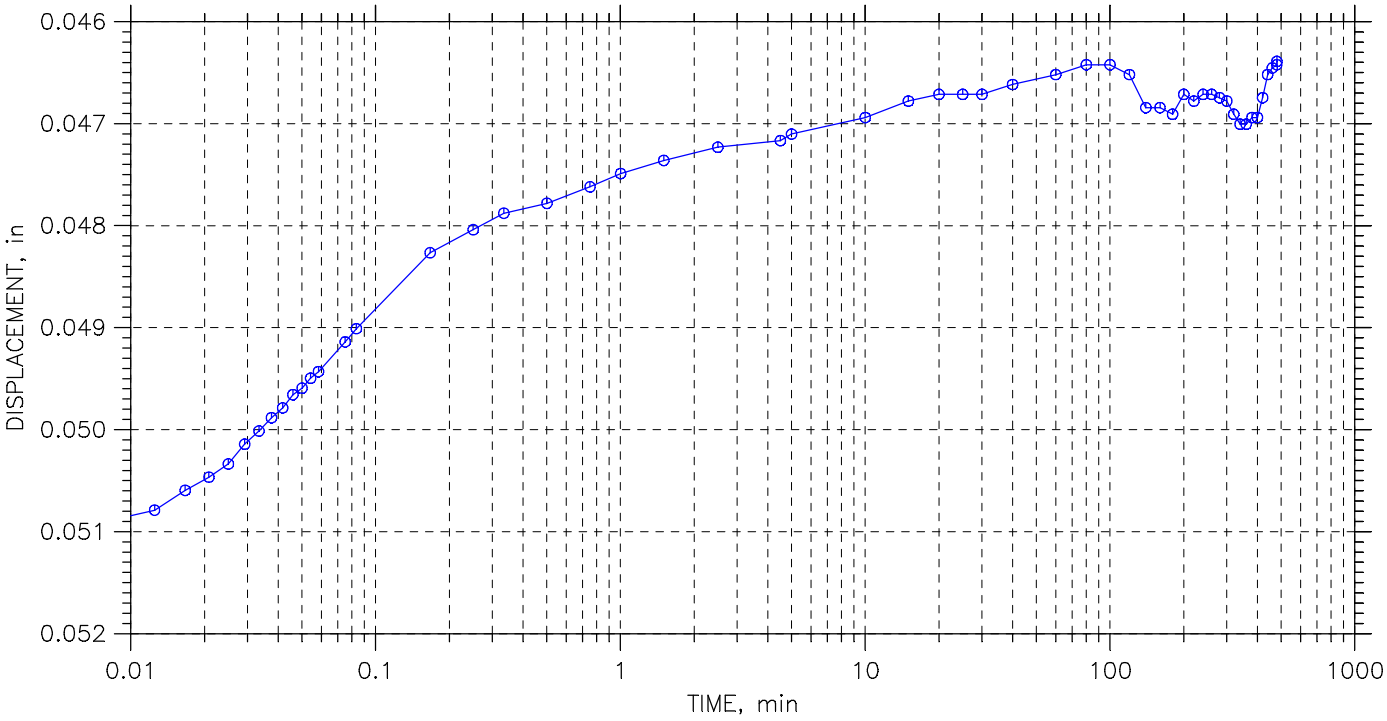
Wed, 13-SEP-2023 12:47:18

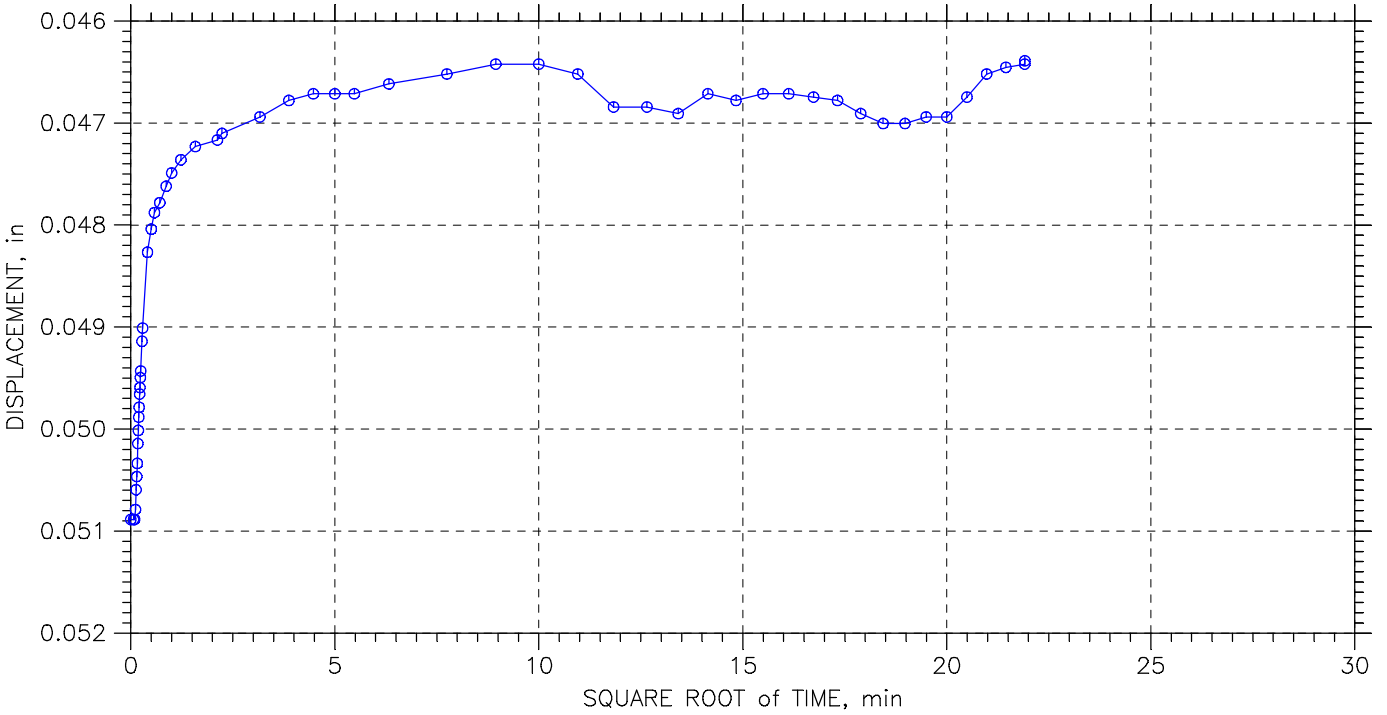
CONSOLIDATION TEST DATA

TIME CURVES

Step: 10 of 11

Stress: 1. tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

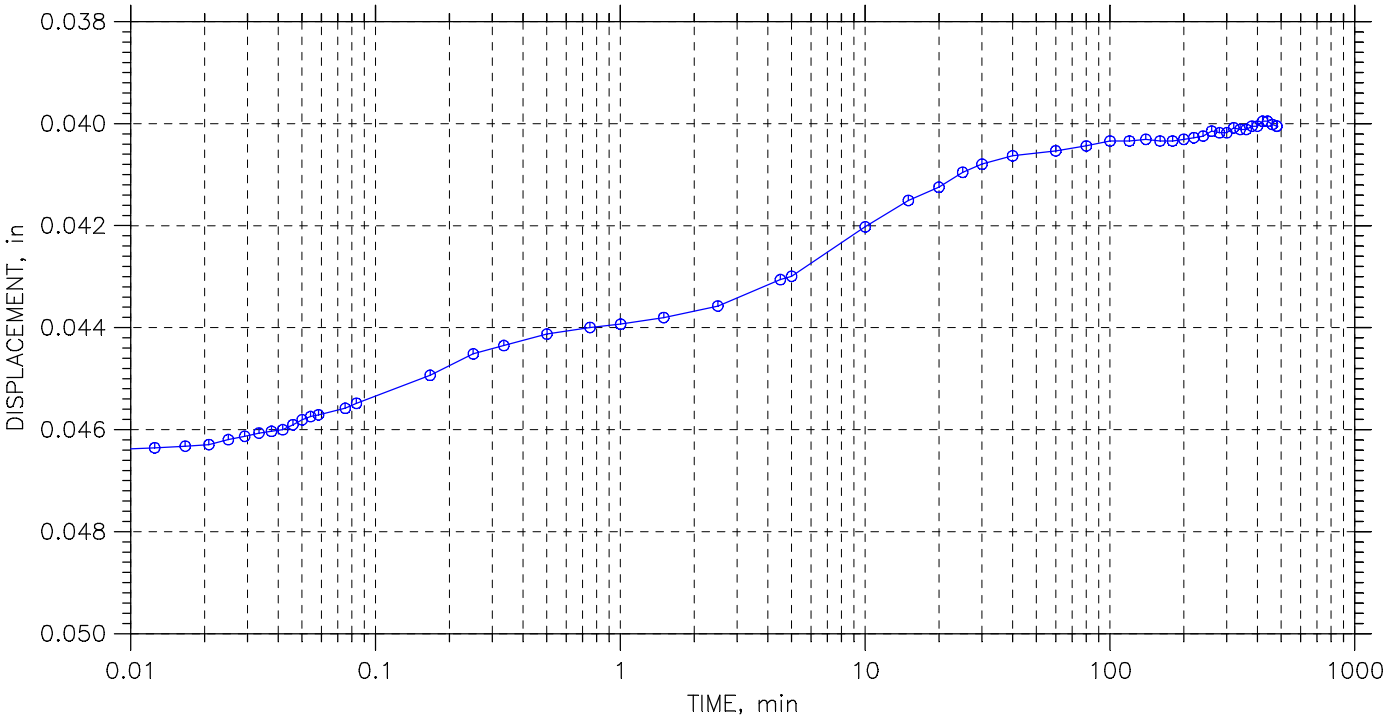
Wed, 13-SEP-2023 12:47:18

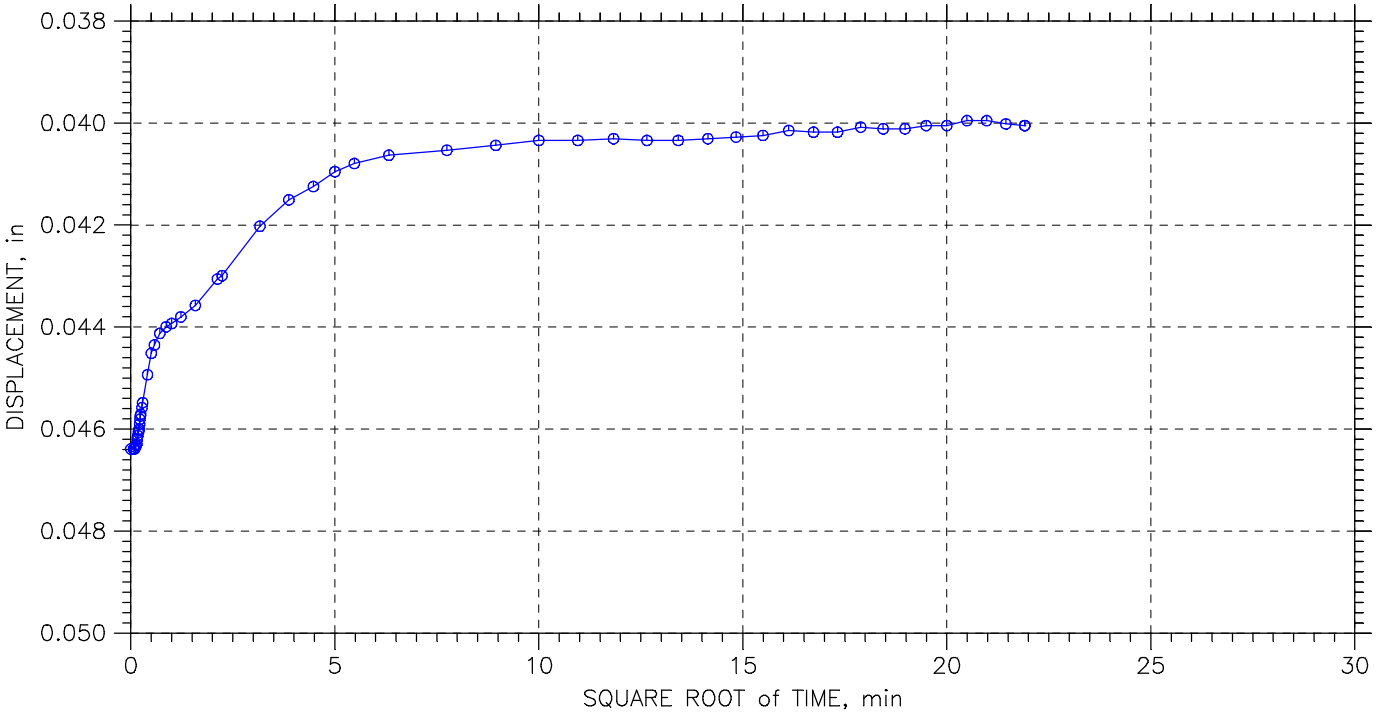
CONSOLIDATION TEST DATA

TIME CURVES

Step: 11 of 11

Stress: 0.25 tsf





Project: BRO-62-27.49 Roadway Expl	Location:	Project No.: 23050064COL
Boring No.: B-002-1-23	Tested By: MW	Checked By: SM
Sample No.: ST-3	Test Date: 09/01/23	Depth: 4'-6'
Test No.: 1	Sample Type: Shelby Tube	Elevation:
Description: Brown, Sandy Silt (A-4a)		
Remarks:		

Wed, 13-SEP-2023 12:47:18

CTL Engineering, Inc.
Specific Gravity
ASTM D 854 / AASHTO T 100
Method B

Client: BG Engineering Group LLC
Project: BRO-62-27.49 Roadway Exploration
Project #: 23050064COL

Date: 9/12/2023
Tech: MW
Reviewed by: SM

Visual Classification: Brown, Sandy Silt (A-4a)
Weight of Oven Dry Soil passing #4 Sieve (g): 35.2
Material Excluded From Test: None
Mass of Pycnometer ($M_{p)}$: 108.28
Mass of Pyncometer, Water and Soil Solids ($M_{pws,t}$): 379.76

Test Temperature (°C): 20.7

Sample ID	Specific Gravity (20℃)
B-002-1-23, ST-3, 4'-6'	2.659

CTL ENGINEERING INC

OHIO DEPARTMENT OF TRANSPORTATION

DETERMINING SULFATE CONTENT IN SOILS
SUPPLEMENT 1122

Project C-R-S: BRO-62-27.49

PID No: 114435

Report Date: 9/11/2023

Consultant: CTL Engineering, Inc.

Technician: RV

Sample or Boring ID	Station	Offset	Latitude & Longitude (°)		Elevation (feet)	Soaking Time (hr)	Replicate Sample Readings						Sulfate Content (ppm)
							1		2		3		
							Dilution	Reading	Dilution	Reading	Dilution	Reading	
B-1, SS-1	1449+02	6' RT	38.979559	-83.720436	997.5	22	20	< 5	20	< 5	20	< 5	< 100
B-3, SS-1	1454+04	6' LT	38.980836	-83.719770	998.4	22	20	17	20	17	20	17	340

APPENDIX D

ROADWAY SUBGRADE ANALYSIS

OHIO DEPARTMENT OF TRANSPORTATION

OFFICE OF GEOTECHNICAL ENGINEERING

PLAN SUBGRADES
Geotechnical Design Manual Section 600

Instructions: Enter data in the shaded cells only.
(Enter state route number, project description,county, consultant's name, prepared by name, and date prepared. This information will be transferred to all other sheets. The date prepared must be entered in the appropriate cell on this sheet to remove these instructions prior to printing.)

BRO-62-27.49
114435

BRO-62-27.49 ROADWAY SUBGRADE ANALYSIS

CTL ENGINEERING, INC.

Prepared By: CDC/SM
Date prepared: Wednesday, May 1, 2024

CTL Engineering
2860 Fisher Road
Columbus, Ohio 43204
614-276-8123
614-276-6377
ctl@ctleng.com

NO. OF BORINGS: 3

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

#	Boring ID	Alignment	Station	Offset	Dir	Drill Rig	ER	Boring EL.	Proposed Subgrade EL	Cut Fill
1	B-001-0-23	US-62	1449+02	6'	RT	CME 55 #393	79	997.5	997.2	0.3 C
2	B-002-0-23	US-62	1451+82	6'	LT	CME 55 #393	79	986.7	992.0	5.3 F
3	B-003-0-23	US-62	1454+04	6'	LT	CME 55 #393	79	998.4	997.9	0.5 C

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

#	Boring	Sample	Sample Depth		Subgrade Depth		Standard Penetration		HP (tsf)	Physical Characteristics						Moisture		Ohio DOT		Sulfate Content (ppm)	Problem		Excavate and Replace (Item 204)		Recommendation (Enter depth in inches)
			From	To	From	To	N_{60}	N_{60L}		LL	PL	PI	% Silt	% Clay	P200	M_C	M_{OPT}	Class	GI		Unsuitable	Unstable	Unsuitable	Unstable	
1	B	SS-1	1.0	2.5	0.7	2.2	16		4.5	31	17	14	30	22	52	7	14	A-6a	5	99					
	001-0	SS-2	2.5	4.0	2.2	3.7	17		4.5	42	19	23	23	37	60	16	18	A-7-6	10						
	23	SS-3	4.0	5.5	3.7	5.2	15		4.5							18	18	A-7-6	16						
		SS-4	5.5	7.0	5.2	6.7	16	16	3.5							18	18	A-7-6							
2	B	SS-1	1.0	2.5	6.3	7.8	13		3	34	20	14	49	37	86	20	15	A-6a							
	002-0	SS-2	3.5	5.0	8.8	10.3	13		2.25							18	14	A-6a							
	23	SS-3	6.0	7.5	11.3	12.8	15		1	41	21	20	47	39	86	18	18	A-7-6							
		SS-4	8.5	10.0	13.8	15.3	22		2.5							21	18	A-7-6							
3	B	SS-1	1.0	2.5	0.5	2.0	15		4.5							3	18	A-7-6	16	340					
	003-0	SS-2	2.5	4.0	2.0	3.5	16		4.5	45	21	24	28	41	69	15	18	A-7-6	13						
	23	SS-3	4.0	5.5	3.5	5.0	21		4.25	48	23	25	24	37	61	17	20	A-7-6	12						
		SS-4	5.5	7.0	5.0	6.5	16	15	3							17	18	A-7-6							

OHIO DEPARTMENT OF TRANSPORTATION

Subgrade Analysis

V. 14.7 4/4/2024

PID: 114435

County-Route-Section: BRO-62-27.49
No. of Borings: 3

Geotechnical Consultant: CTL ENGINEERING, INC.
Prepared By: CDC/SM
Date prepared: 5/1/2024

Chemical Stabilization Options		
320	Rubblize & Roll	Option
206	Cement Stabilization	Option
	Lime Stabilization	Option
206	Depth	12''

Excavate and Replace Stabilization Options	
Global Geotextile Average(N60L):	12''
Average(HP):	0''
Global Geogrid Average(N60L):	0''
Average(HP):	0''

Design CBR	5

% Samples within 3 feet of subgrade			
$N_{60} \leq 5$	0%	HP ≤ 0.5	0%
$N_{60} < 12$	0%	0.5 < HP ≤ 1	0%
$12 \leq N_{60} < 15$	0%	1 < HP ≤ 2	0%
$N_{60} \geq 20$	0%	HP > 2	50%
M+	0%		
Rock	0%		
Unsuitable Soil	0%		

Excavate and Replace at Surface	
Average	0''
Maximum	0''
Minimum	0''

% Proposed Subgrade Surface	
Unstable & Unsuitable	0%
Unstable	0%
Unsuitable (Soil & Rock)	0%

	N_{60}	N_{60L}	HP	LL	PL	PI	Silt	Clay	P 200	M_C	M_{OPT}	GI
Average	16	16	3.50	40	20	20	34	36	69	16	17	12
Maximum	22	16	4.50	48	23	25	49	41	86	21	20	16
Minimum	13	15	1.00	31	17	14	23	22	52	3	14	5

Classification Counts by Sample

ODOT Class	UCF	Rock	A-1-a	A-1-b	A-2-4	A-2-5	A-2-6	A-2-7	A-3	A-3a	A-4a	A-4b	A-5	A-6a	A-6b	A-7-5	A-7-6	A-8a	A-8b	Totals
Count	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	9	0	0	12
Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	0%	0%	75%	0%	0%	100%
% Rock|Granular|Cohesive	0%	0%	0%									100%								100%
Surface Class Count	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	4
Surface Class Percent	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	0%	0%	75%	0%	0%	100%

APPENDIX E

SETTLEMENT ANALYSIS

Settlement Soil Parameters

Project: BRO-62-27.49 (PID No. 114435)
Boring No.: B-002-0-23, B-002-1-23
Location: Eagle Township, Brown County, Ohio
Station/Offset: 1451+50/33' Lt.
Date: 11/26/2024

Layer No.	Top Elev	Bottom Elev	Thickness (feet)	ODOT Soil Type	Total Weight (pcf)	N_{60} value (bpf)	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Liquidity Index (W-PL)/PI	Gs	Bearing Capacity Index (BCI)	Sand Fraction (BCI)	Clay Fraction (BCI)	$e_0 = G_s*w/100$	C_c	C_r	C_v (cm^2/sec)	Su (psf)	Pre-Consolidation Stress Ó'p (psf)	Reference
1	987.33	980	7.33	A-6a	122	13 13	20 18	34	20	0.0	2.7										
			Avg	A-6a	122	13	19	34	20	-0.1	2.7	40.3	0.4	0.6	0.51	0.18919	0.038	0.0200	1625	10043.3	1,2,5
2	980	975.3	4.7	A-6a	122	15 12	15 11	20	14	0.2	2.7										
			Avg	A-6a	122	14	13	20	14	0.2	2.7	58.6	0.7	0.3	0.35	0.08108	0.016	0.0200	1750	13237.5	1,2,5
3	975.3	972.8	2.5	A-4b	130	12	15 11	19	16	-0.3	2.7										
			Avg	A-4b	130	12	13	19	16	-1.0	2.7				0.27	0.05	0.013	0.0047	1500	3200.0	3
4	972.8	967.8	5.0	A-1-b	128	29	10	17	13	-0.8	2.7										
			Avg	A-1-b	128	29	10	17	13	-0.8	2.7	106.6	0.8	0.2	0.27	0.05405	0.011	0.0105		0.0	4
5	967.8	963.8	4.0	A-7-6	132	42	14				2.7										
				A-7-6	135	49	16	42	25	-0.5	2.7										
			Avg	A-7-6	134	46	15	42	25	-0.5	2.7	132.56	0.6	0.4	0.41	0.22973	0.046	0.0025	5750	33256.2	1,2,5

Note: Soil parameters for layer 1 were taken from boring B-002-0-0-23 and parameters for layer 3,4 and 5 were taken from boring B-002-1-23

1 Skempton (1957), FHWA-IF-03-017- GEC-N0.7, TABLE 3.7 used for computing Ó'p if no consolidation data is available
2 Kulhawy and Mayne (1990) per GEC 5 (2016), Figure 6-36 used for computing C_c and C_r if no consolidation data is available
3 Laboratory Consolidation Test Results B-002-1-23, ST-3_4'-6'
4 FHWA GEC 5 (2016) Figure 6-37, Virgin Compression used for C_v computation of granular soils if no consolidation data is available
5 FHWA GEC 5 (2016) Figure 6-37, Reloading (lower bound) curve used for C_v computation of Cohesive soil if no consolidation data is available

Settlement Calculations

Project: BRO-62-27.49 (PID No. 114435)
Boring No.: B-002-0-23, B-002-1-23
Location: Eagle Township, Brown County, Ohio
Station/Offset: 1451+50/33' Lt.
Date: 11/26/2024

Embankment Geometry

B_1 = 20 ft Width of top of embankment
B_2 = 45 ft Width of the side slopes

Embankment Fill Height = 19.5 feet Height of Embankment
Unit Weight. = 125 pcf
q = 2437.5 psf

	Elevation			
Top of Embankment	993.1			
		Emb. Fill	12	ft
		Unit Wt. =	125	pcf
Existing Grade	987.3			
		N_{60} Avg =	13	bpf
		Layer A Unit Wt. =	122	pcf
	980			
		N_{60} Avg =	14	bpf
		Layer B Unit Wt. =	122	pcf
	975.3			
		N_{60} Avg =	12	bpf
		Layer C Unit Wt. =	130	pcf
	972.8			
		N_{60} Avg =	29	bpf
		Layer D Unit Wt. =	128	pcf
	967.8			
		N_{60} Avg =	46	bpf
		Layer E Unit Wt. =	134	pcf
	963.8			

Layer	Thickness (H_c) (ft)	Unit Weight(pcf)	z (ft)	$Ó'_o$ (psf)	B_1 / z	B_2 / z	I*	N_{60} Avg	Coarse Fraction	Fine Fraction	BCI	$Ó'_p$ (psf)	$Ó'_f$ (psf)	Consolidation	Settlement (in) **
A	7.3	122	3.665	447.13	5.5	12.3	1.00	13	0.4	0.6	40.28	10,043	2,885	OC	1.78
B	4.7	122	9.68	1180.96	2.1	4.6	1.00	14	0.7	0.3	58.6	13,238	3,618	OC	0.44
C	2.5	130	13.28	1630.16	1.5	3.4	1.00	12				3,200	4,068	OC	0.15
D	5	128	17.03	2112.66	1.2	2.6	1.00	29	0.8	0.2	106.6	-	4,550	NC	0.19
E	4	134	21.53	2699.66	0.9	2.1	0.96	46	0.6	0.4	132.6	33,256	5,040	OC	0.42
														Total	3.00

*The influence value (I) for embankment loading was computed based on “Influence Values for Vertical Stresses in Semi-Infinite Loading” charts (After Osterberg 1957).
**The settlement value of granular soils is computed based on the Hough Method and LRFD Equation 10.6.2.4.2b-2.
**The settlement value of Cohesive soils is computed based on LRFD Equation 10.6.2.4.3

Time Rate of Settlement Determination

Project: BRO-62-27.49 (PID No. 114435)
Boring No.: B-002-1-23
Location: Eagle Township, Brown County, Ohio
Station/Offset: 1451+50/33' Lt.
Date: 11/26/2024

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
987.33	980	1	1.78	7.33	0.0200	1.86	5	0.173091	0.47	0.9	
980	975.3	1	0.44	4.7	0.0200	1.86	5	0.421005	0.71	0.1	
975.3	972.8	2	0.15	1.25	0.0047	0.43585	5	1.394721	0.97	0.0	
972.8	967.8	2	0.19	2.5	0.0105	0.976592	5	0.781274	0.88	0.0	
967.8	963.8	1	0.42	4	0.0025	0.229653	5	0.071767	0.32	0.3	
	Net=		3.00	in					Total	1.4	in

Top Elev	Bottom Elev	1 or 2 sides Drained	Total Settlement (in)	H (feet)	Cv (cm2/sec)	Cv (ft2/day)	t (days)	Tv	U (%)	Settlement Remaining (in)	
987.33	980	1	1.78	7.33	0.0200	1.86	25	0.865456	0.90	0.2	
980	975.3	1	0.44	4.7	0.0200	1.86	25	2.105025	1.00	0.0	
975.3	972.8	2	0.15	1.25	0.0047	0.43585	25	6.973604	1.00	0.0	
972.8	967.8	2	0.19	2.5	0.0105	0.976592	25	3.906368	1.00	0.0	
967.8	963.8	1	0.42	4	0.0025	0.229653	25	0.358833	0.67	0.1	
	Net=		3.00	in					Total	0.3	in

APPENDIX F

GLOBAL STABILITY ANALYSIS

Soil Parameters

Project: BRO-62-27.49 (PID No. 114435)
Boring No.: B-002-0-23
Location: Eagle Township, Brown County, Ohio
Station 1452+00
Date: 5/6/2024

								Total Stress		Effective Stress		
Layer No.	Top Elev	Bottom Elev	Thickness (feet)	ODOT Soil Type	N60 value (bpf)	Moisture Content (%)	Total Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)	Reference
1	985.7	980.7	5	A-6a	13	20	120					
				A-6a	13	18	120					
			Avg	A-6a	13	19	120	1625	0	160	23	1,2,3
2	980.7	978.2	2.5	A-7-6	15	18	122					
			Avg	A-7-6	15	18	122	1875	0	180	24	1,2,3
3	978.2	973.7	4.5	A-7-6	22	21	125					
				A-7-6	24	17	125					
			Avg	A-7-6	23	19	125	2875	0	250	25	1,2,3
4	973.7	970.2	3.5	A-6a		12						
					30	10	128					
			Avg	A-6a	30	11	128	3750	0	290	26	1,2,3

Reference Key

1 Total stress and effective stress cohesion estimated according to ODOT GDM Section 404.1
2 Total stess friction angle of cohesive soils estimated to be 0
3 Effective stress friction angle for cohesive soils estimated using GB7 Table 2

Soil Parameters

Project: BRO-62-27.49 (PID No. 114435)
Boring No.: B-002-1-23
Location: Eagle Township, Brown County, Ohio
Station 1452+00
Date: 5/6/24

								Total Stress		Effective Stress		
Layer No.	Top Elev	Bottom Elev	Thickness (feet)	ODOT Soil Type	N60 value (bpf)	Moisture Content (%)	Total Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)	Reference
1	978.3	975.3	3	A-6a	15	19	122					
			Avg	A-6a	15	19	122	1875	0	180	24	1,2,3
2	975.3	972.8	2.5	A-4a	12	15	120					
						11	130.4					
			Avg	A-4a	12	13	130.4	1500	0	150	23	1,2,3,5
3	972.8	970.3	2.5	A-4b	22	13	125					
			Avg	A-4b	22	13	125	2750	0	240	25	1,2,3
4	970.3	967.8	2.5	A-1-b	29	10	128					
			Avg	A-1-b	29	10	128	0	38	0	38	4
5	967.8	963.8	4.0	A-7-6	42	14	132					
				A-7-6	49	16	135					
			Avg	A-7-6	46	15	134	5750	0	390	28	1,2,3

Reference Key

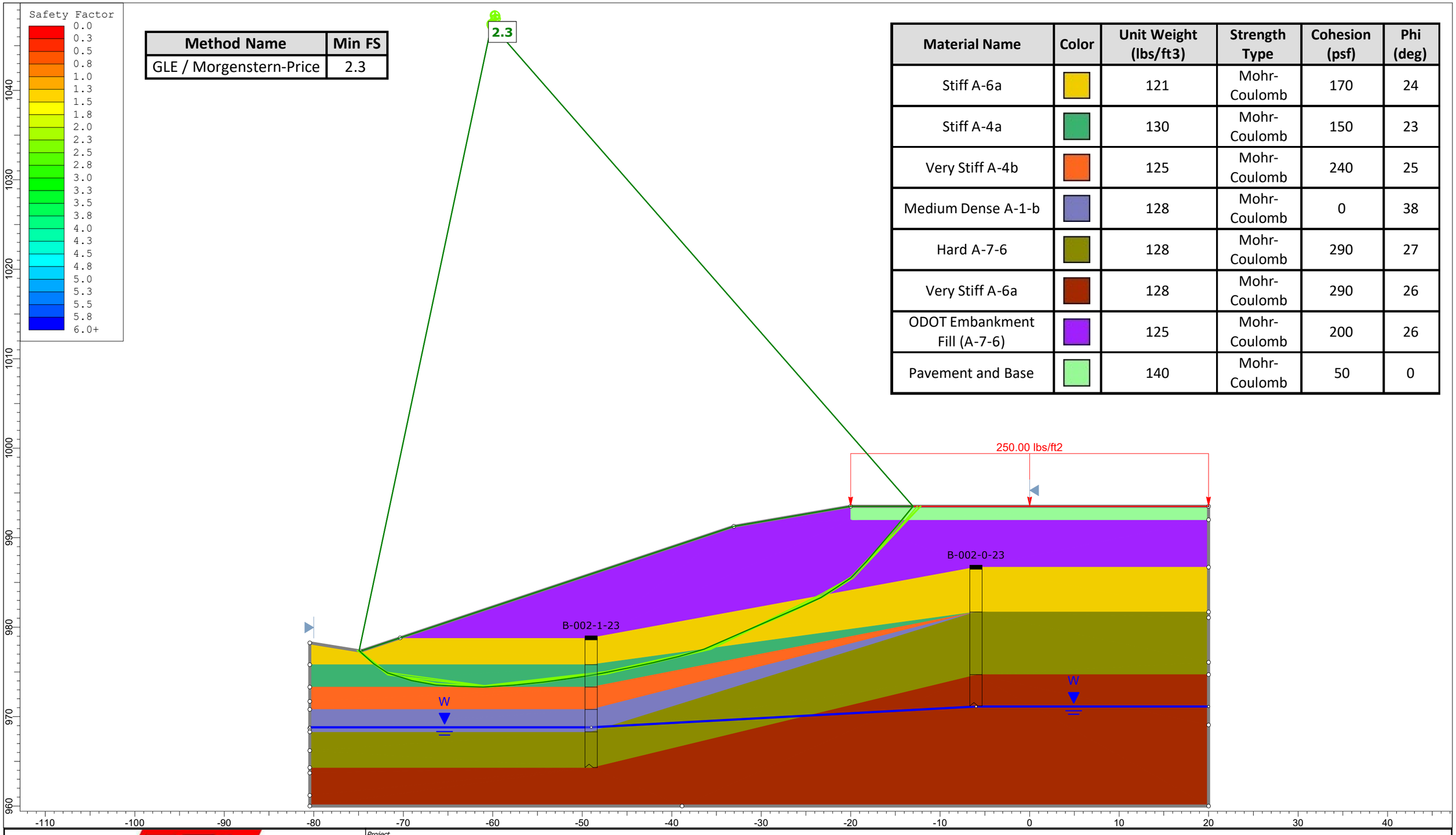
1 Total stress and effective stress cohesion estimated according to ODOT GDM Section 404.1
2 Total stess friction angle of cohesive soils estimated to be 0
3 Effective stress friction angle for cohesive soils estimated using GB7 Table 2
4 Non plastic soils - Friction angle estimated from AASHTO Table 10.4.6.2.4-1
5 B-002-1-23 ST-3, 4.0' - 6.0' Unit Weight Testing

Slope Stability Parameters

Project: BRO-62-27.49 (PID No. 114435)
Boring No.: B-002-0-23 & B-002-1-23
Location: Eagle Township, Brown County, Ohio
Station 1452+00
Date: 5/6/24

				Total Stress		Effective Stress	
Layer No.	Consistency	ODOT Soil Type	Total Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)	Cohesion (psf)	Friction Angle (degrees)
1	Stiff	A-6a	121	1700	0	170	24
2	Stiff	A-4a	130	1500	0	150	23
3	Very Stiff	A-4b	125	2700	0	240	25
4	Medium Dense	A-1-b	128	0	38	0	38
5	Hard	A-7-6	128	3800	0	290	27
6	Very Stiff	A-6a	128	3750	0	290	26
7	ODOT Embankment Material (A-7-6)		125	2000	0	200	26
8	Pavement and Base		140	0	0	50	0

Method Name	Min FS
GLE / Morgenstern-Price	2.3

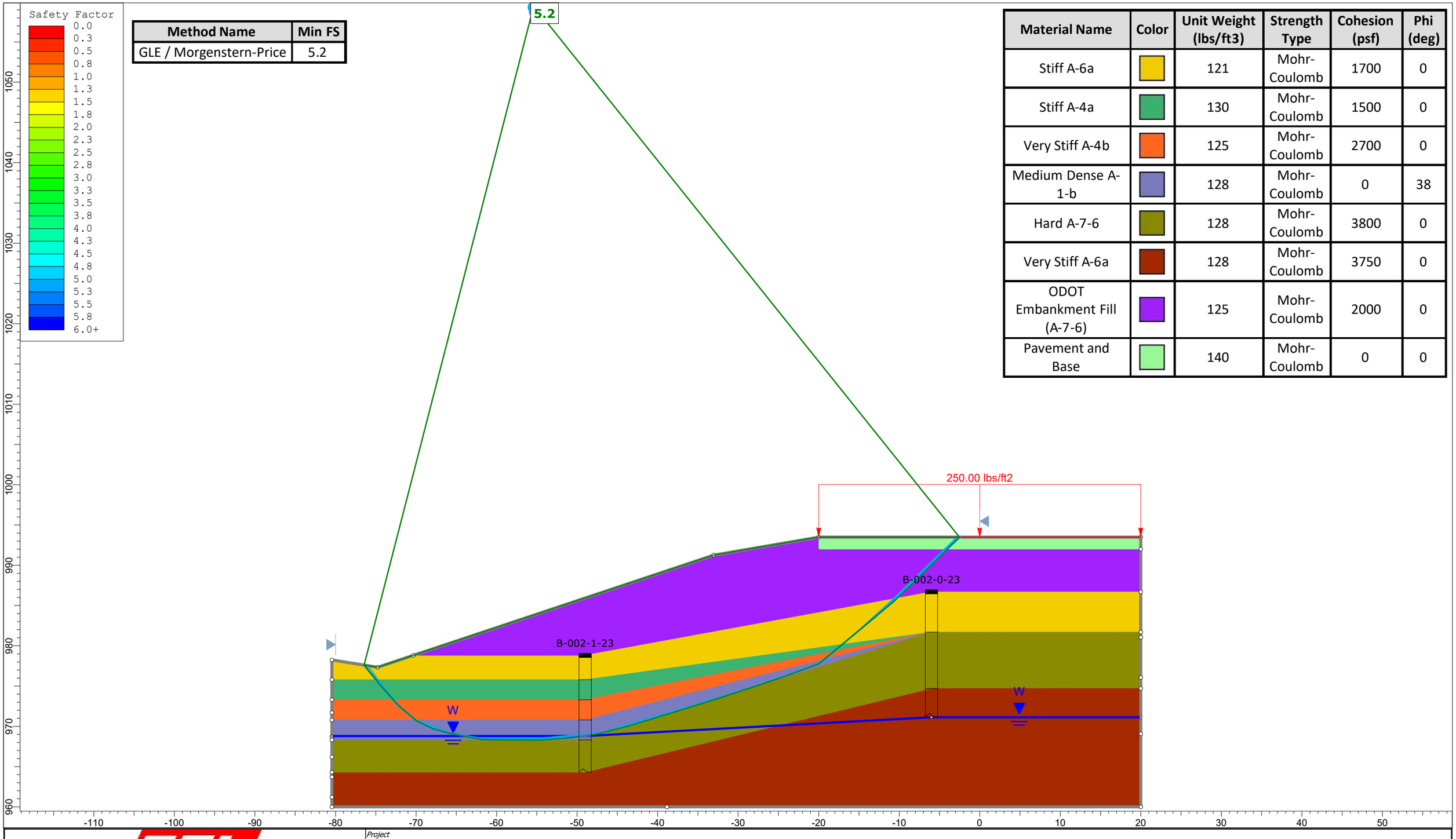


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Stiff A-6a		121	Mohr-Coulomb	170	24
Stiff A-4a		130	Mohr-Coulomb	150	23
Very Stiff A-4b		125	Mohr-Coulomb	240	25
Medium Dense A-1-b		128	Mohr-Coulomb	0	38
Hard A-7-6		128	Mohr-Coulomb	290	27
Very Stiff A-6a		128	Mohr-Coulomb	290	26
ODOT Embankment Fill (A-7-6)		125	Mohr-Coulomb	200	26
Pavement and Base		140	Mohr-Coulomb	50	0

CTL ENGINEERING

SLIDEINTERPRET 9.025

Project	BRO-62-27.49 (PID: 114435)		
Group	Effective Stress_Proposed Grading.slim	*Scenario*	Effective Stress_Proposed Grading.slim
Drawn By	CDC	*Company*	CTL Engineering, Inc.
Date	5/6/2024	*File Name*	Effective Stress_Proposed Grading.slim



Method Name	Min FS
GLE / Morgenstern-Price	5.2

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Stiff A-6a		121	Mohr-Coulomb	1700	0
Stiff A-4a		130	Mohr-Coulomb	1500	0
Very Stiff A-4b		125	Mohr-Coulomb	2700	0
Medium Dense A-1-b		128	Mohr-Coulomb	0	38
Hard A-7-6		128	Mohr-Coulomb	3800	0
Very Stiff A-6a		128	Mohr-Coulomb	3750	0
ODOT Embankment Fill (A-7-6)		125	Mohr-Coulomb	2000	0
Pavement and Base		140	Mohr-Coulomb	0	0

CTL ENGINEERING INC.

SLIDEINTERPRET 9.025

Project	BRO-62-27.49 (PID: 114435)		
Group	Total Stress_Proposed Grading.slim	*Scenario*	Total Stress_Proposed Grading.slim
Drawn By	CDC	*Company*	CTL Engineering, Inc.
Date	5/6/2024	*File Name*	Total Stress_Proposed Grading.slim

APPENDIX G

RESPONSE TO STAGE 2 COMMENTS

CTL Engineering , Inc.
2860 Fisher Road, P.O. Box 44548, Columbus, Ohio 43204-3538
Phone: 614/276-8123 Fax: 614/276-6377
Email: ctl@ctleng.com

Comments received from ODOT District 9 on Geotechnical Roadway Exploration Draft Report

1. Draft Roadway Exploration Report:

    a. The report narrative discusses a maximum fill height of 6.6 feet, which matches the Stage 2 plans. But the settlement analysis lists 12 feet as the embankment height?

    CTL Response: According to the Stage 3 plans, approximately 6.6 feet of fill will be placed along the roadway centerline at Station 1451+50. However, according to the cross-sections, a maximum of 19.5 feet of fill is planned at Station 1451+50, 33' Lt. (adjacent to the existing culvert). CTL performed a settlement analysis to determine the magnitude of anticipated settlement in this area.

    Results are included in the Final Geotechnical Report.

    b. In the future, when reviewing ODOT's Geotechnical Data in the TIMS – make sure to also turn on the Department's geohazard inventory layers. Within the project limits, there is a Tier 1 landslide in ODOT's inventory that should have been mentioned, even if CTL then stated disagreement with the finding. (After viewing the photos from the last inspection by PSI-Intertek, OGE staff will likely recommend the site be retired due to not being a landslide per the ODOT Manual for Landslide Inventory)

    CTL Response: Noted. CTL will make sure to turn on the geohazard inventory layers in future while reviewing the ODOT's Geotechnical Data in TIMS.

    c. OGE concurs with the report recommendation to not include subgrade stabilization quantities in the plans based on the results of the ODOT Subgrade Analysis Spreadsheet.

    CTL Response: Noted

2. Geotechnical Profile:
    a. Sheet 7 - for future reference, showing an offset boring in a cross section (as was done on the next sheet) is OGE's typical practice (as opposed to also duplicating the graphical log for B-002-1-23 in an offset box on the plan/profile sheet).

    CTL Response: The offset boring has been removed from Sheet 7 of the final soil profile sheets.

VIII. TESTING AND OBSERVATION

During the design process, it is recommended that CTL work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on this project. If CTL is not retained for these services, CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.

IX. CLOSING

This report has been prepared for the exclusive use by the client for use only on this project. Our services have been performed in accordance with generally accepted Geotechnical Engineering principles and practices. No warranty is either expressed or implied.

CTL Engineering's assignment does not include, nor does this geotechnical report address the environmental aspects of this particular site.

Specific design and construction recommendations have been provided in this report. Therefore, the report should be used in its entirety.

Respectfully Submitted,

CTL ENGINEERING, INC.

Christopher D. Carey, E.I.
Project Engineer

Sastry Malladi, P.E.
Project Engineer

Joe Grani, P.E
Project Engineer