DEPARTMENT OF TRANSPORTATION
Office of Materials & Road Research
1400 Gervais Avenue, Maplewood, MN 55109

Memo

Date: 21 September 2021

To: Matthew Upgren, Project Management
District 2 Bemidji

From: Jason Hedeen, Senior Engineer
Geotechnical Engineering Section

Jason Hedeen Digitally signed by Jason Hedeen Date: 2021.09.22 13:44:59 -05'00'

Concur: Rich Lamb, Foundations Engineer
Geotechnical Engineering Section

RAL

Subject: SP 0410-50 Overhead Signs
Located at the intersection of TH71 and Anne Street in Bemidji
Foundation Analysis and Design Recommendations

1.0 Project Description

This report provides a Subsurface Investigation and Foundation Recommendations for two overhead signs located on NB and SB TH71 approaching the intersection of Anne Street, in the city of Bemidji. As a part of this project, this intersection is to be reconstructed from a divided signalized intersection, to a roundabout. The District has selected the proposed overhead signs supports to be constructed in accordance with the Monotube Cantilever Design illustrated in MnDOT Standard Plan 5-297.745.

2.0 Subsurface Investigation

Two Cone Penetration Test (CPT) soundings were advanced by MnDOT forces in July at the original sign support locations selected by the District. In early August, it was discovered that each sign support needed to be moved back away from the intersection approximately 300 ft. In effort to verify similar subsurface conditions at the new locations, solid stem auger borings were performed by District forces.

The soundings encountered an upper 20-25 ft. layer of mostly medium dense sands followed by medium dense to dense sands down to roughly 50ft. The solid stem auger borings support the classification indicated by the CPT soundings and also indicated that water may be present around an approximate elevation of 1363. Please note that the elevations provided on the attached District soil logs have been corrected to the approximated value found in the project's Digital Terrain Model (DTM).

3.0 Foundation Analysis

The foundation analysis consisted of verifying that the foundation soil conditions meet the minimum requirements listed in MnDOT Standard Plan 5-297.746 (page 1 of 2). For granular soils, these minimum soil properties include a minimum angle of friction of 30 degrees and a unit weight of at least 125 pounds per cubic foot. Based on our interpretation of the CPT soundings, we concur that the foundation soils meet the minimum soil parameters for the drilled shaft option.

4.0 Foundation Recommendations

Based on review of the existing site and subsurface conditions, along with the preceding foundation analysis, we recommend the following:

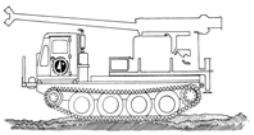
1. The proposed overhead sign structures should be supported with a drilled shaft foundation as detailed in MnDOT Standard Plan 5-297.746 (page 1 of 2).

2. This office be contacted for revised foundation recommendations if the foundation soils differ from those described in this report.

Attachments: CPT Index Sheet; Boring Plan; Sounding Profiles; Sounding Logs; District Soil Logs; MnDOT Standard Plan 5-297.746 (page 1 of 2)

cc: Brad Skow (Geotechnical Section Manager)
Laura Hadrava (District 2 Materials Engineer)

Minnesota Department of Transportation
Geotechnical Section
Cone Penetration Test Index Sheet 1.0 (CPT 1.0)



USER NOTES, ABBREVIATIONS AND DEFINITIONS

This Index sheet accompanies Cone Penetration Test Data. Please refer to the Boring Log Descriptive Terminology Sheet for information relevant to conventional boring logs.

This Cone Penetration Test (CPT) Sounding follows ASTM D 5778 and was made by ordinary and conventional methods and with care deemed adequate for the Department's design purposes. Since this sounding was not taken to gather information relating to the construction of the project, the data noted in the field and recorded may not necessarily be the same as that which a contractor would desire. While the Department believes that the information as to the conditions and materials reported is accurate, it does not warrant that the information is necessarily complete. This information has been edited or abridged and may not reveal all the information which might be useful or of interest to the contractor. Consequently, the Department will make available at its offices, the field logs relating to this sounding.

Since subsurface conditions outside each CPT Sounding are unknown, and soil, rock and water conditions cannot be relied upon to be consistent or uniform, no warrant is made that conditions adjacent to this sounding will necessarily be the same as or similar to those shown on this log. Furthermore, the Department will not be responsible for any interpretations, assumptions, projections or interpolations made by contractors, or other users of this log.

Water pressure measurements and subsequent interpreted water levels shown on this log should be used with discretion since they represent dynamic conditions. Dynamic Pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils. In cohesive soils, water pressures often take extended periods of time to reach equilibrium and thus reflect their true field level. Water levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that this boring was dry or that the contractor will not encounter subsurface water during the course of construction.

CPT Terminology

CPT ..... Cone Penetration Test
CPTU..... Cone Penetration Test with Pore Pressure measurements
SCPTU..... Cone Penetration Test with Pore Pressure and Seismic measurements
Piezocone...Common name for CPTU test

(Note: This test is not related to the Dynamic Cone Penetrometer DCP)

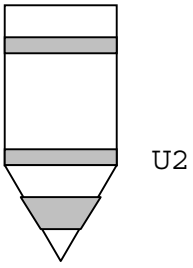
q_T TIP RESISTANCE
The resistance at the cone corrected for water pressure. Data is from cone with 60 degree apex angle and a 10 cm^2 end area.

f_s SLEEVE FRICTION RESISTANCE
The resistance along the sleeve of the penetrometer.

FR Friction Ratio
Ratio of sleeve friction over corrected tip resistance.
FR = fs/qt

V_s Shear Wave Velocity
A measure of the speed at which a siesmic wave travels through soil/rock.

PORE WATER MEASUREMENTS
Pore water measurements reported on CPT Log are representative of water pressures measured at the U2 location, just behind the cone tip, prior to the sleeve, as shown in the figure below. These measurements are considered to be dynamic water pressures due to the local disturbance caused by the cone tip. Dynamic water pressure decay and Static water pressure measurements are reported on a Pore Water Pressure Dissipation Graph.



SBT SOIL BEHAVIOR TYPE
Soil Classification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these classification charts are meant to provide a guide to Soil Behavior Type and should not be used to infer a soil classification based on grain size distribution.

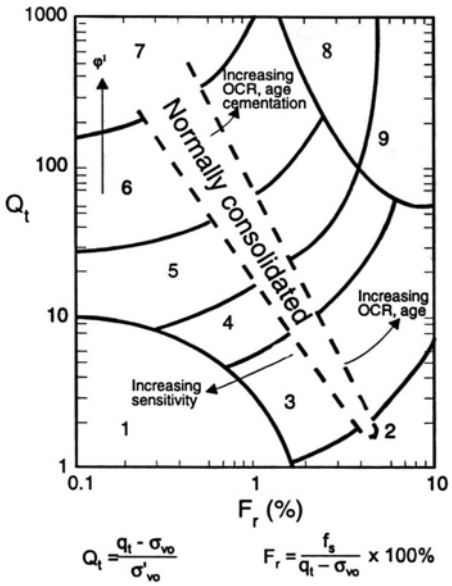
The numbers corresponding to different regions on the charts represent the following soil behavior types:

1. Sensitive, Fine Grained
2. Organic Soils - Peats
3. Clays - Clay to Silty Clay
4. Silt Mixtures - Clayey Silt to Silty Clay
5. Sand Mixtures - Silty Sand to Sandy Silt
6. Sands - Clean Sand to Silty Sand
7. Gravelly Sand to Sand
8. Very Stiff Sand to Clayey Sand
9. Very Stiff, Fine Grained

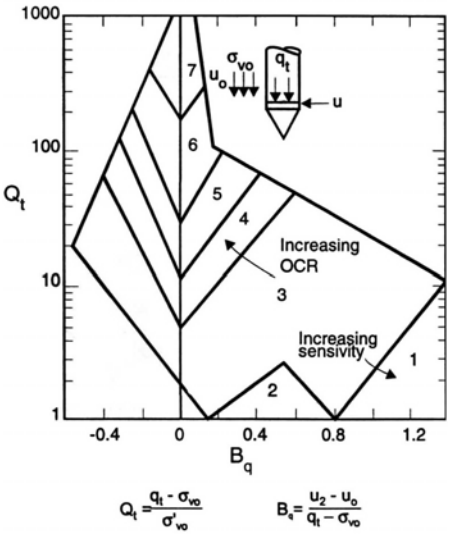
Note that engineering judgment, and comparison with conventional borings is especially important in the proper interpretation of CPT data in certain geo-materials.

The following charts are used to provide a Soil Behavior Type for the CPT Data.

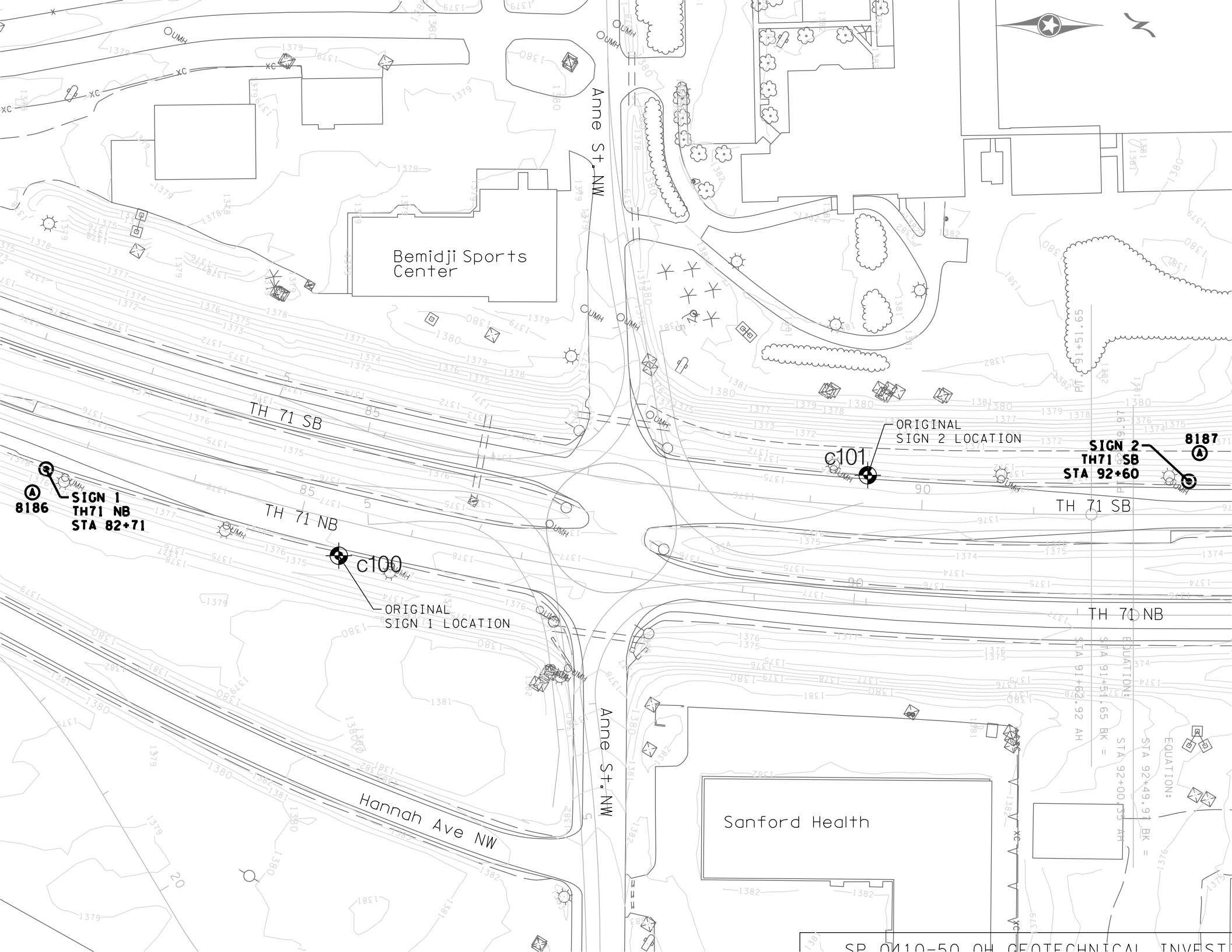
Robertson CPT 1990
Soil Behavior type based on friction ratio

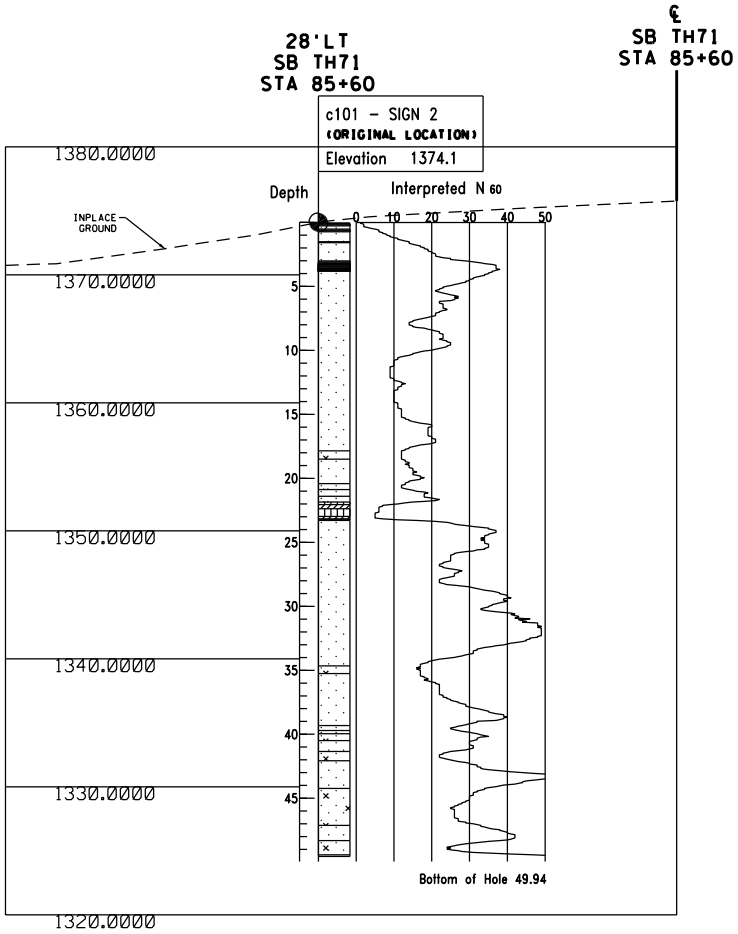


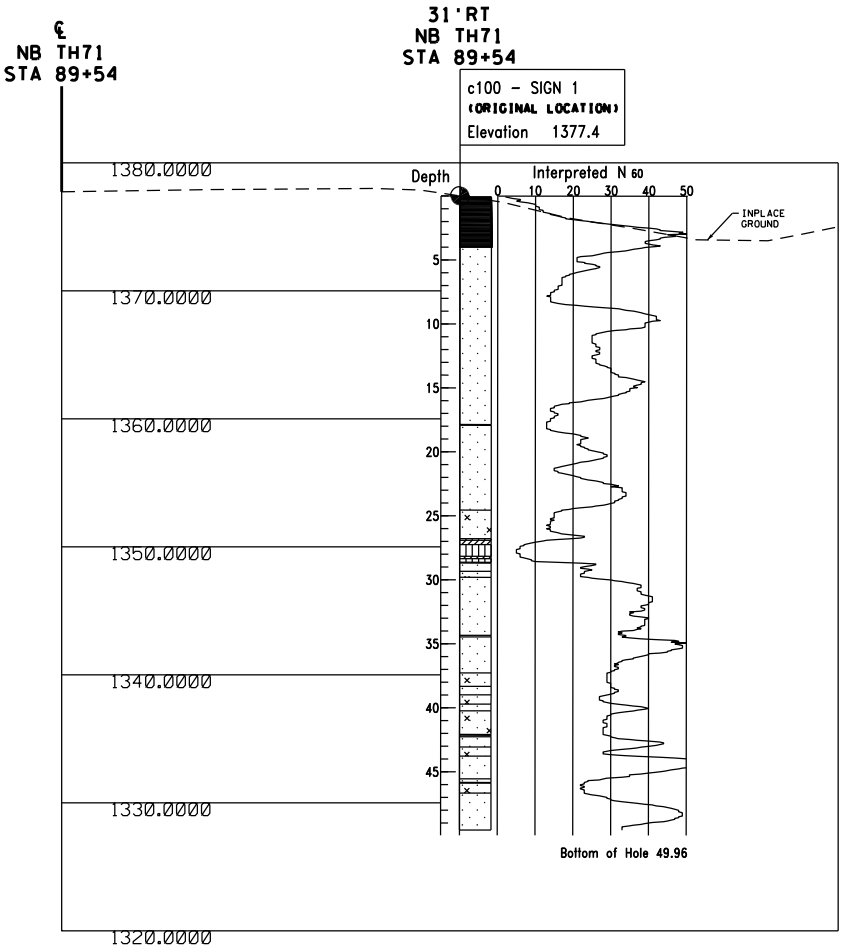
Robertson CPTU 1990
Soil Behavior type based on pore pressure



where ...
Q_T ..... normalized cone resistance
B_q ..... pore pressure ratio
F_r ..... Normalized friction ratio
σ_{vo} ..... overburden pressure
σ'_{vo} ..... effective over burden pressure
u_2 ..... measured pore pressure
u_0 ..... equilibrium pore pressure


Anne St. NW
Bemidji Sports Center
TH 71 SB
TH 71 NB
c101
ORIGINAL SIGN 2 LOCATION
SIGN 2
TH71 SB
STA 92+60
8187
SIGN 1
TH71 NB
STA 82+71
8186
c100
ORIGINAL SIGN 1 LOCATION
Hannah Ave NW
Sanford Health
EQUATION:
STA 91+51.65 BK =
STA 91+62.92 AH
EQUATION:
STA 92+49.91 BK =
STA 92+00.33 AH


28'LT
SB TH71
STA 85+60
℄
SB TH71
STA 85+60
c101 - SIGN 2
(ORIGINAL LOCATION)
Elevation 1374.1
Depth
Interpreted N 60
0 10 20 30 40 50
INPLACE GROUND
1380.0000
1370.0000
1360.0000
1350.0000
1340.0000
1330.0000
1320.0000
5
10
15
20
25
30
35
40
45
Bottom of Hole 49.94


℄
NB TH71
STA 89+54
31'RT
NB TH71
STA 89+54
c100 - SIGN 1
(ORIGINAL LOCATION)
Elevation 1377.4
Depth
Interpreted N 60
0 10 20 30 40 50
INPLACE GROUND
1380.0000
1370.0000
1360.0000
1350.0000
1340.0000
1330.0000
1320.0000
5
10
15
20
25
30
35
40
45
Bottom of Hole 49.96

DEPARTMENT OF TRANSPORTATION

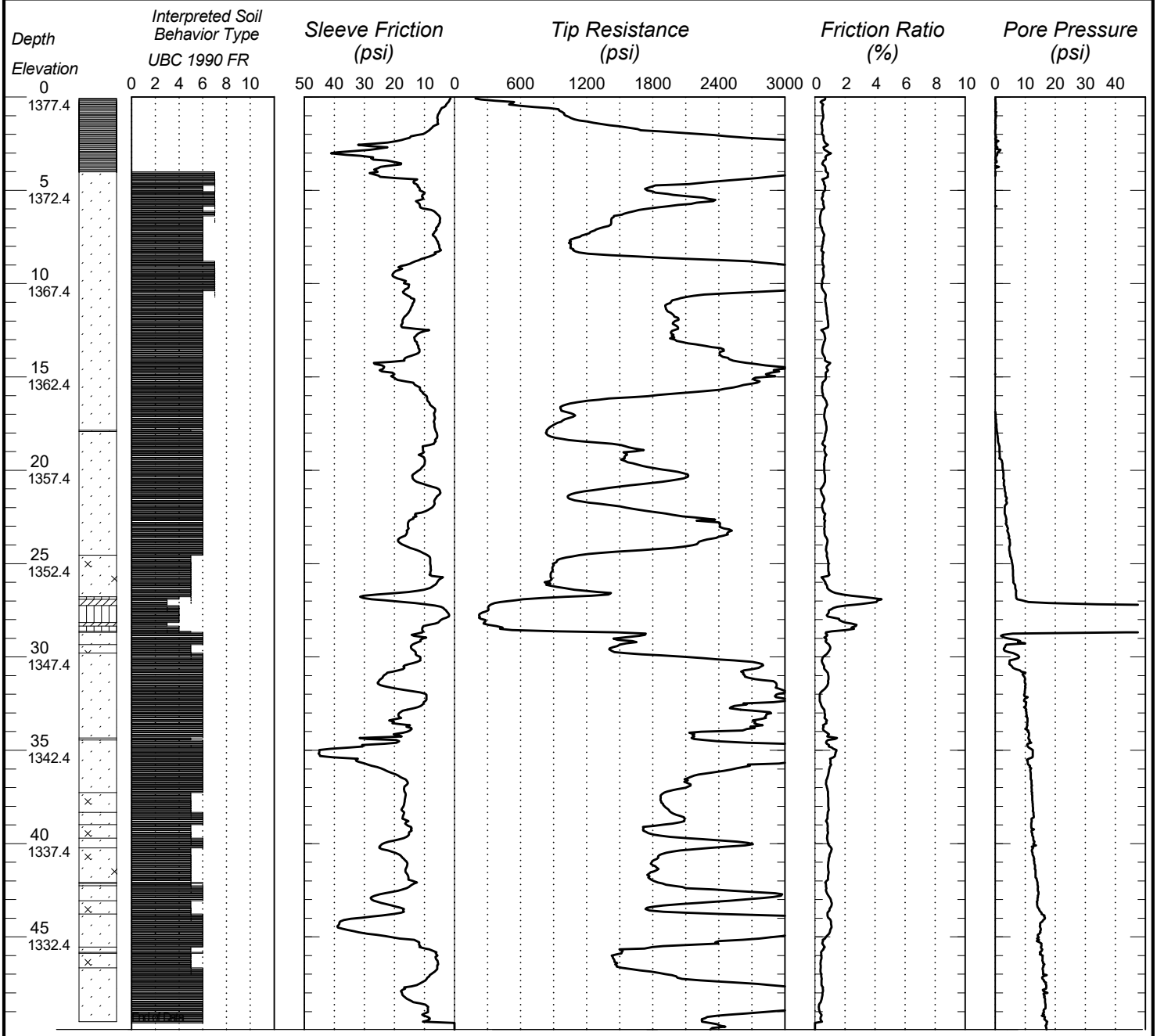
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 86042

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0410-50	**Over Head Sign**	**71**	**c100**	**1377.4** *(DTM)*

Location Beltrami/South Zone County Coordinate System	*CPT Machine* **219328 CPT Western Star**	*SHEET 1 of 1*
X=486085 Y=133542	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=47°30'15.97" Longitude (West)=94°54'22.66"	*Hole Type* **CPT-STD**	**7/28/21**



Bottom of Hole 49.96

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DEPARTMENT OF TRANSPORTATION

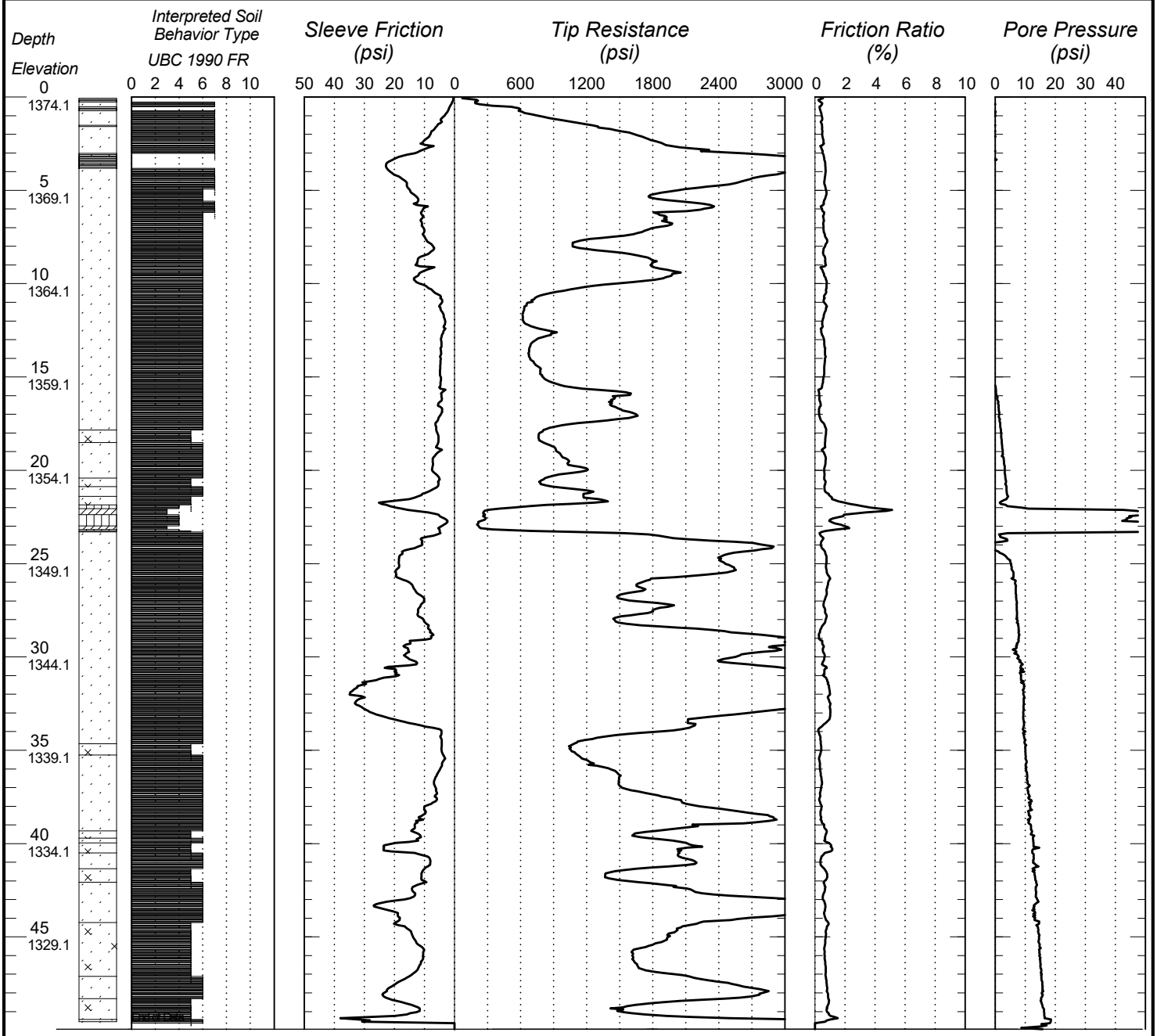
MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER 86043

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
0410-50	**Over Head Sign**	**71**	**c101**	**1374.1** *(DTM)*

Location Beltrami/South Zone County Coordinate System	*CPT Machine* **219328 CPT Western Star**	*SHEET 1 of 1*
X=486013 Y=134014	*CPT Operator* **ODonnel**	*Date Completed*
Latitude (North)=47°30'20.63" Longitude (West)=94°54'23.71"	*Hole Type* **CPT-STD**	**7/28/21**



Bottom of Hole 49.94

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Mn/DOT Soil's Log Report

N:\Soils\Field Data by TH\TH 71\0410-50\0410-50 Overhead Sign Borings.mdb

Project Number 0410-50 **TH 71** **Beltrami County**

Borehole 8186 **Sta.** 313.000 **Off.** 57.0 **Chain Name**
Driller Brett Adam **Unit #** 215007 **Water Depth** **Refusal Depth**
Date Drilled 8/18/2021 **X:** 486028.3650 **Y:** 133268.4540 **ELEV:** ~~1295.8~~ ~1375
Borehole Comments , Loc=Ditch , LaneDir=NB

Top	Bottom	Description
0.00	0.30	ts brn damp
0.30	5.00	LS&FG brn damp
5.00	14.90	S brn damp moist at 10.0 sat at 12.5

Borehole 8187 **Sta.** 313.191 **Off.** -53.0 **Chain Name**
Driller Brett Adam **Unit #** 215007 **Water Depth** **Refusal Depth**
Date Drilled 8/18/2021 **X:** 485993.1830 **Y:** 134310.9070 **ELEV:** ~~1284.3~~ ~1370
Borehole Comments , Loc=Ditch , LaneDir=SB

Top	Bottom	Description
0.00	0.30	ts brn damp
0.30	14.90	S dkbrn moist wet ltbrn at 7.5

GEOTECHNICAL PARAMETERS:

FOR DRILLED SHAFTS, THE WATER TABLE SHALL BE 1.5' BELOW FINISHED GRADE OR LOWER.

THE FOUNDATION DIMENSIONS SHOWN ON THIS SHEET HAVE BEEN DESIGNED WITH THE FOLLOWING ASSUMED SOIL PROPERTIES:

DRILLED SHAFTS:

COHESIVE SOILS:

MINIMUM SHEAR STRENGTH:	C = 1.0 ksf
UNIT WEIGHT OF SOIL:	γ = 125±10 pcf

GRANULAR SOILS:

MINIMUM ANGLE OF FRICTION:	Ø = 30°
UNIT WEIGHT OF SOIL:	γ = 125 pcf
MAX. COEFFICIENT OF FRICTION:	μ = 0.70

A SPECIAL FOUNDATION DESIGN IS REQUIRED IN CASES WHERE THE REQUIRED VALUES AND/OR CONDITIONS LISTED ABOVE ARE NOT MET.

NOTES:

PERMANENT CASINGS ARE NOT ALLOWED FOR DRILLED SHAFT FOUNDATIONS.

USE PREFORMED JOINT FILLER BETWEEN THE FOUNDATION AND SIDEWALK OR OTHER CONCRETE AREAS.

COLD CONCRETE CONSTRUCTION JOINTS ARE NOT PERMITTED.

PROVIDE CONCRETE IN ACCORDANCE WITH SPEC. 2461, MIX 3G52.

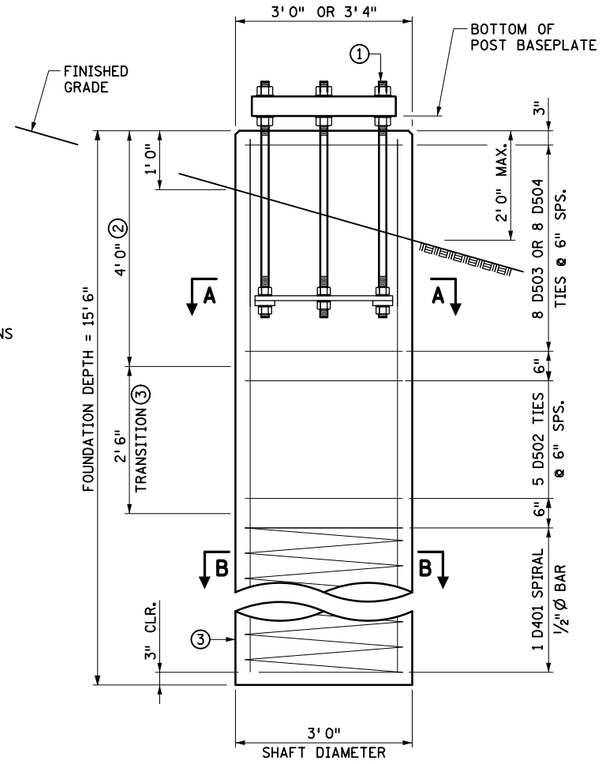
PROVIDE ¾" CHAMFER ON EXPOSED CORNERS.

(EF) DENOTES EACH FACE.

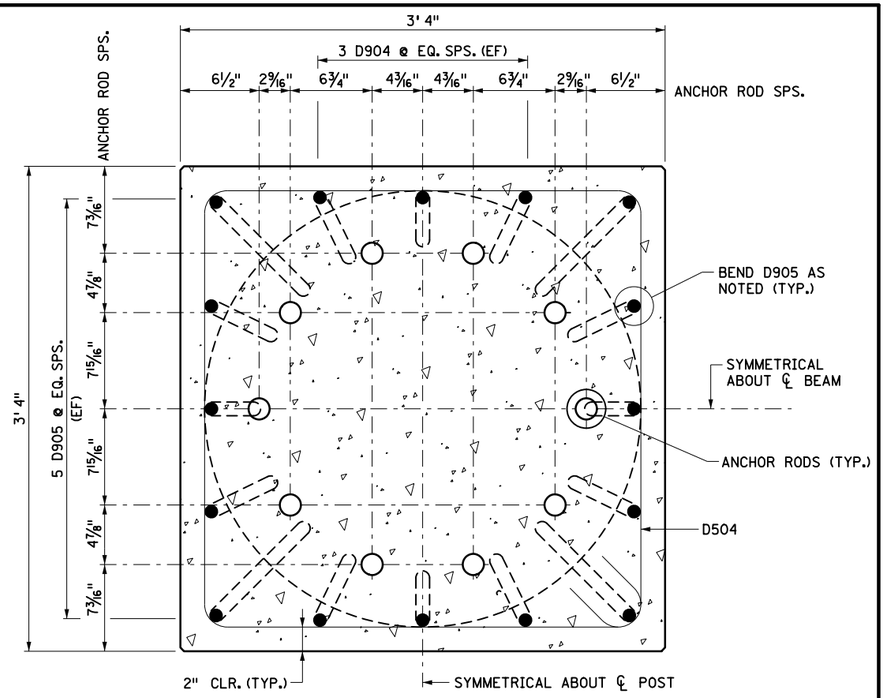
① ANCHOR ROD ASSEMBLY. GALVANIZE ANCHOR RODS IN ACCORDANCE WITH SPEC. 3392.

② FORM A MINIMUM OF 6" BELOW THE GROUND SURFACE. BACKFILL AND TAMP THE EXCAVATIONS REQUIRED FOR FORMING PER SPEC. 2105.3.F.2. BACKFILL MATERIAL AND COMPACTION TO BE EQUIVALENT TO THE SURROUNDING MATERIAL.

③ EXCAVATE TO NEAT LINES AND PLACE CONCRETE AGAINST UNDISTURBED SOIL.

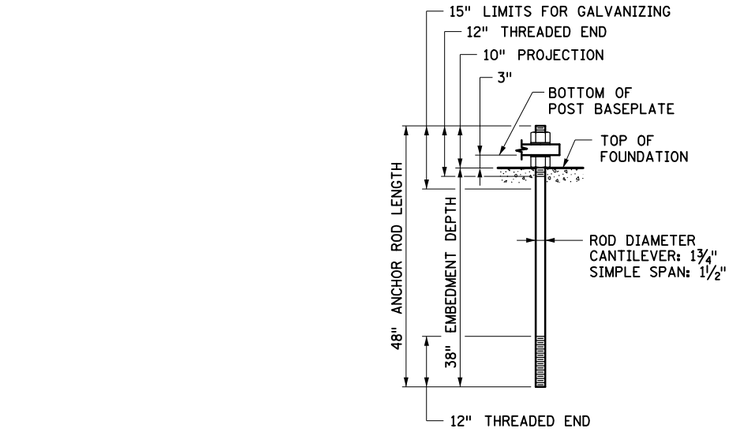


ELEVATION



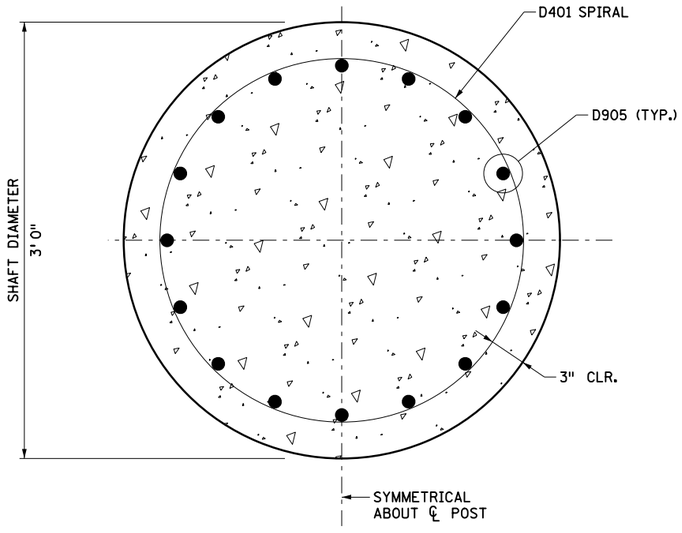
SECTION A-A

CANTILEVER STRUCTURE

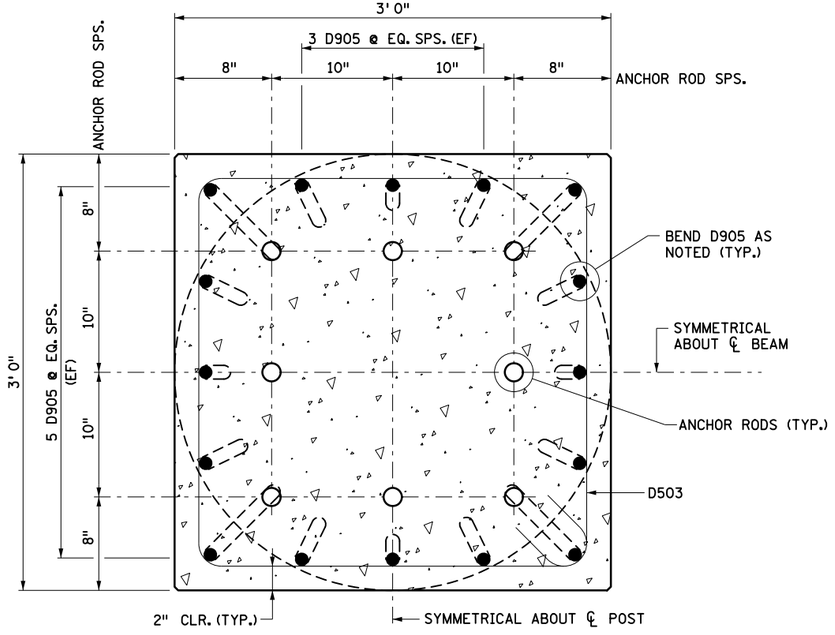


ANCHOR ROD DETAIL

ROD MATERIAL IN ACCORDANCE WITH SPEC. 3385 TYPE B



SECTION B-B



SECTION A-A

SIMPLE SPAN STRUCTURE

REVISION:

APPROVED: 01-15-2021
Kevin Western
KEVIN WESTERN
STATE BRIDGE ENGINEER

MINNESOTA DEPARTMENT OF TRANSPORTATION

STANDARD PLAN 5-297.746 | 1 OF 2

APPROVED: 01-15-2021
REVISED:

Tom Styrbicki
THOMAS STYRBICKI
STATE DESIGN ENGINEER

MONOTUBE OVERHEAD SIGN STRUCTURES

FOUNDATION DETAILS

STATE PROJ. NO. (TH) SHEET NO. OF SHEETS