Illinois Department of Transportation

Abbreviated Structure Geotechnical Report

Original Report Date: 5-23-18
Proposed SN: 046-0155
Route: FAU 6176 (Armour Road)
Revised Date: 6-8-18
Existing SN: 046-0063
Section: (79R-VB)R
Geotechnical Engineer: Terry McCleary of McCleary Engineering
County: Kankakee
Structural Engineer: Joe Lowrance of Farnsworth Group
Contract: 66F11

Indicate the proposed structure type, substructure types, and foundation locations (attach plan and elevation drawing): The proposed total structure replacement of existing SN 046-0063 with proposed SN 046-0155 will be 3 span, 200.00 ft Bk. to Bk. abutment, with an 8.25 degree skew. The widened deck will maintain 2 lanes in each direction with a 12 ft. median and a sidewalk on the south side of the structure. The centerspan will be 83.00 ft. and the two equal end spans will each be 58.50 ft. Bk. of abutment to centerline of bearing. The super structure will be a 8 inch concrete slab supported by steel composite beams on stub abutments. Aerial utilities exist at both abutments. Micro Piles are preferred for the proposed abutments because of their ability to be constructed in relatively low clearance situations when compared to driven piling. The proposed pier locations are very close to and on the abutment side of the existing piers. A drilled shaft foundation is preferred at the piers as it can be constructed with less space than a spread footing. The total length of the proposed structure will be longer than existing SN 046-0063 in order to avoid conflicts with the existing piling at the abutments; also the center span will be longer in order to avoid conflicts with the existing spread footings at the piers. There are existing creosoted timber piles supporting the approach slabs approximately 20 ft. in back of the abutments that may conflict with proposed work. The foundation width (based on adding deck width for a sidewalk) will be approximately 73.94 ft. The factored loadings are 1447 kips for each abutment and 2241 kips at each pier. Please refer to the TS&L drawing for further information.

Discuss the existing boring data, existing plans foundation information, new subsurface exploration and need for any additional exploration to be provided with SGR Technical Memo (attach all data and subsurface profile plot): We have information from 9 borings and cores taken in 1962, and the as-built 1962 bridge plans for SN 046-0063. Two more cores were taken in 2017 to verify the condition of the bedrock; note the datum used to report the 1962 elevations is a different datum than the one used for more current work. The surface elevation of the 1962 borings was generally reported in the low 320 ft. elevations; they added about 20 ft. of fill to construct the bridge cones. There is only one boring taken in the existing fill after 1962. The author assumed this to be representative of all the fill materials used to construct the bridge cones in 1962.

The 1962 borings generally report 5 to 8 ft of loose to stiff clay loam and clay fill over stiff to hard clay till over a very dense layer of limestone rubble. The loams and tills had Qu's ranging between 1.4 tsf. and 6.2 tsf.

The underlying limestone was cored in borings 1 through 5. The average recovery was 30%. The top of the limestone was reported between 313.78 and 316.58. The limestone was generally described as thin to medium layers of light buff colored porous Limestone (Dolomite), sometimes with soft layers of rock dust or clay.

The 2000 boring reports about 20 ft. of stiff to hard silty clay till and fill, with Qu's ranging from 1.7 tsf to 4.5 tsf (penetrometer). Note the 2000 boring reported no elevations.

Two more rock cores (B1 west abutment and B2 east abutment) were taken in November 2017. The average recovery was 77%. The top of the rock was reported at 662.73 and 665.04 for the west and east cores (using a conversion based off of P&P sheets shown in the 2016 BCR and the 1962 bridge plans, the 1962 top of rock elevations convert to between 664.11 and 666.91). The top of rock seems to slightly increase in elevation in a southerly direction. The rock was described as buff dolostone, highly porous and vuggy, highly fractured, some rubblized layers, fossiliferous. No water recovery while coring. Due to a low RQD in the west core B1, no strength specimens could be obtained. Although B2 also had a maximum RQD of 20%, three specimens were obtained and gave results ranging from 122.2 tsf to 394.6 tsf. Pictures of the rock cores are included to document the poor condition and the high porosity of the rock.

The as built 1962 plans show the abutments and approach pavement suppported by piles, the piers are supported on spread footings, embedded 6 inches minimum into rock. The plans show 314.09 (664.42 using the 2016 datum) for Pier 1 and 314.12 (664.45) for Pier 2.

See attached borings, cores, and subsurface profiles. Note that we converted all the 1962 boring data to the current datum in the attached subsurface profiles.

Provide the location and maximum height of any new soil fill or magnitude of footing bearing pressure. Estimate the amount and time of the expected settlement. Indicate if further testing, analysis, and/or ground improvement/treatment is necessary: Preliminary plans show there will be minimal new fill required except at the far edges of the bridge cone to allow for any widening. At this time there are no cross sections. There will be fill (we assumed a 10' top and an 8.5' thickness for settlement analysis) added to the south side of the existing embankment to construct widening for the sidewalk. Using standard construction procedures to bench the new embankment into the existing embankment, minimal settlement, 0.5 inches, is expected in the area of this widening. A very slight raising of the profile grade is expected; no settlement is anticipated to occur from this work. No further testing, analysis, and/or ground improvement/treatment is necessary. See attached spreadsheet.

Identify any new cuts or fill slope angles and heights. Estimate the factor of safety against slope failure. Indicate if further testing, analysis or ground improvement/treatment is necessary: We analyzed an assumed 10 ft. of cohesive fill widening with a 2:1 sideslope to allow for the addition of a sidewalk. The analysis for a short term (undrained) condition yields a factor of safety of 3.8. See the attached analyses for more information.

Indicate at each substructure, the 100-year and 200-year total scour depths in the Hydraulics report, the non-granular scour depth reduction, the proposed ground surface, and the recommended foundation design scour elevations: Not Applicable

Determining the seismic soil site class, the seismic performance zone, the 0.2 and 1.0 second design spectral accelerations and indicate if that the soils are liquefiable: This site has seismic soil site class of "C", the seismic performance zone, SPZ =1. The SDs = 0.125 g and the SD1 = 0.072 g. Because the SD1 is less than 0.15 g a liquifaction analysis is NOT required.

Confirm feasibility of the proposed foundation or wall type and provide design parameters. Attach a pile design table indicating feasible pile types, various nominal required bearings, factored resistances available and corresponding estimated lengths at locations where piles will be used. Provide factored bearing resistance and unit sliding resistance at various elevations and confirm no ground improvement/treatment is necessary where spread footings are proposed. Estimated top of rock elevations as well as preliminary factored unit side and tip resistance values shall be indicated when drilled shafts are proposed: Micropiles are being considered for the abutments because of the presence of overhead utilities and drilled shafts for the piers because of the close proximity of the railroad tracks. A minimum bond length based on the geotechnical grout-to-ground bond capacity was estimated for the micropiles. Unit side and tip resistance values were calculated to aid in the design of the drilled shafts. Estimated top of rock elevations shown on the TS&L are 662.7 at the west abutment and pier and 665.0 at the east abutment and pier. See the attached micropile and drilled shaft discussions for additional information. A table of soil parameters is attached to be used in a lateral load analysis. Please contact the author if you would like McCleary Engineering to perform this analysis.

Calculate the estimated water surface elevation and determine the need for cofferdams (type 1 or 2), and seal coat: Not Applicable

Assess the need for sheeting or soil retention or temporary construction slope and provide recommendation for other construction concerns: Temporary sheet piling will be required to maintain traffic during stage construction. Some of the soils reported in the 2000 boring were hard and would not be conducive to driving sheet piling. We feel the the pay item for Temporary Soil Retention System should be included in the plans. Soil retention will also be needed at the piers if a spread footing foundation would be used. For the preferred drilled shaft foundation at the piers a temporary casing is recommended to keep the material from the sides from falling in. If during construction the soils remain stable and the shaft stays open, then the temporary casing may be eliminated for drilling operations and while filling the shaft with concrete.

The presence of overhead power lines will be a significant concern during construction of the micropiles at the abutments. The power lines should be, at a minimum, sheathed to prevent arcing or accidental contact. While the overhead powerlines are a concern, it is the authors opinion that the use of micropiles at the abutments will minimize the influence of the powerlines on the construction of the bridge when compared with driven piling or drilled shafts. Note there are also aerial lines above Pier 2, however, the additional vertical clearance (20 ft. plus) at the piers makes contact less of a concern.

McCleary Engineering
Terry McCleary. PE
Prepared by Mark Jones, PE
815-780-8486

Terrence L. McCleary

STATE OF ILLINOIS
062-050019
TERRENCE L.
MC CLEARY
LICENSED ENGINEER

Drilled Shaft Discussion

We made two assumptions regarding the drilled shaft analysis.

1. We assumed settlement of the drilled shafts in the porous Dolostone which would mobilize side resistance in the upper layers; therefore, we included values of unit side resistance for the rock socket portion of the drilled shafts. Settlement in the Dolostone is assumed to be immediate and about 0.3 inches at a tip depth of 7 ft. This was estimated using the IDOT spreadsheet and adjusting the inputs to gain a more realistic and positive settlement.

2. The 2017 rock cores show the Dolostone to be highly porous and highly fractured with some rubblized layers. The RQD percentage was zero in B1 and ranged from zero to 20% in B2. These low values produced unrealistic negative settlement results in the IDOT Drilled Shaft spreadsheet. Hand calculations were performed treating the rock as very fractured as well as a dense and very angular gravel. The dense and very angular gravel option, because of the high N-values produced a tip resistance greater than that recommended by AASHTO, which limits the tip resistance to 30 tsf (60 ksf).

Using the formulas found in Section 10.8.3.5.4 “Estimation of Drilled Shaft Resistance in Rock” of the AASHTO Bridge Manual for fractured rock, the results are more conservative. At this point, because of the possible void space in the fractured rock that would likely not be seen in a dense, high N-value gravel, the author recommends treating the rock formation as a fracture rock and not as a gravel and use the more conservative values shown in the summary below. See the attached hand calculations.

Summary of Factored Results:

The factored side resistance (friction) value for the 2017 Dolostone cores = 3.63 ksf.

The factored base resistance value for the 2017 Dolostone cores = 12.75 ksf

Micropile Discussion

Several assumptions were required to develop a minimum bond length for the micropiles.

1. The single boring from 2000 taken through the existing embankment is representative of all the fills used during the 1962 construction of SN 046-0063. The bottom soil layer reported in the boring is Stiff Black Silty Clay Loam with Limestone

pieces and Organics. The “Organics” were discounted because they were not reported in any other boring; if further testing (see no. 3) shows otherwise, mitigation or a reduction in bond strength may be required.

2. The elevations of the 1962 borings convert accurately to the current datum used to design SN 046-0155 and that the soils reported in the 1962 borings are representative of the soils that will be encountered during the current construction.

3. There was no Atterburg Limits Testing reported for any soil borings. Certain soil deposits are not generally suitable in the bond zone, including (1) cohesive soils with an average liquidity index greater than 0.2; (2) cohesive soils with an average liquid limit greater than 50; and (3) cohesive soils with an average plastic index greater than 20. These soils are susceptible to excessive creep deformations at testing and working loads. We recommend further testing of on site soils to determine if this is an issue that needs mitigation such as using a higher factor of safety.

Design Methodology

We used the procedures found in the FHWA Report No. FHWA-NHI-05-039, Micropile Design and Construction (December 2005) to develop estimated bond lengths for the micropiles. The FHWA report recommends using the average α_{bond} (grout-to-ground bond) values associated with the Type B construction methods (pressure grouting thru casing during casing removal) shown in Table 5-3. The report notes 90% of contractors in the US use Type D construction methods, which may develop stronger bonds, but recommends using Type B values for design purposes. A factor of safety of 2 is recommended if there are no other concerns. We used a α_{bond} value of 19 psi corresponding with Type B construction methods for Silt & Clay (some sand, stiff, dense to very dense).

Assuming 15 micropiles, each ten inch diameter, a grouted Bond Length of 21 ft. 2 inches will achieve the geotechnical capacity required to support the east or west abutment. This length would put the bottom of the micropile at approximately 4 ft. to 5 ft. above the layer of Limestone rubble reported above the Porous Limestone (Dolomite). Because of the possible void space in the highly fractured limestone formation, ending the micropiles in the Limestone rubble or porous Limestone is a concern as it may be difficult for the contractor to control the grout quantities.

Note that the estimates given above are preliminary and that the contractor is responsible for designing the micropiles, load testing of pre-production micropiles, and proof testing of production micropiles to verify design assumptions and the adequacy of the installation methods.

Benchmarks: #1, Chiseled "□" in SW wingwall at Southwest corner of SN 046-0063. Elevation = 701.18, Sta. 147+56.70, 34.19' RT.
#5, Railroad spike in face of utility pole. Elevation = 675.27, Sta. 145+39.41, 148.57' RT.

Existing Structure: Structure No. 046-0063 was originally constructed in 1962 as Section 79R-VB and 79R-VF. In 2001, the bridge was rehabilitated with replacement of the abutment bearings, and reconstruction of the abutment back walls and approach slabs. In 2009, a Type 2399 steel railing was installed in front of the original barriers. The superstructure consists of three-span continuous, non-composite rolled steel beams with a 7" cast-in-place concrete deck. A 1¼" microsilica concrete overlay was added in 2001. The substructure consists of stub abutments supported by steel H-piles, multi-column piers with crash walls supported by spread footings bearing on bedrock. Wood piles are present at the original approach slab bents. The back-to-back of abutments length measures 178'-0" and the out-to-out of deck width measures 64'-0". The span lengths are 52'-9", 68'-9", and 52'-9". The structure is skewed 8°17'00" left forward. One lane of traffic in each direction will be maintained utilizing stage construction.

No salvage.

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, Customary U.S. Units, 8th Edition

DESIGN STRESSES

FIELD UNITS:

f'c = 3,500 psi
f'c = 4,000 psi (Superstructure Concrete)
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (AASHTO M270 Grade 50W)

HIGHWAY CLASSIFICATION

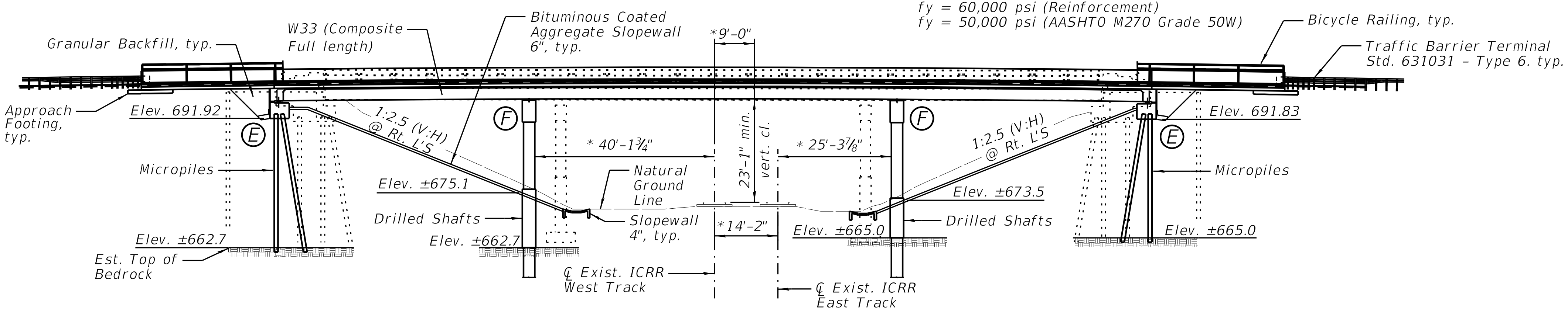
F.A.U. Route 6176 (Armour Road)
Functional Class: Minor Arterial
A.D.T.: 18,600 (2015), 23,436 (2041)
D.H.V.: 2,835 (2041)
A.D.T.T.: 1,674 (2015), 2,109 (2041)
Design Speed: 40 M.P.H.
Posted Speed: 40 M.P.H.
Two Way Traffic
Directional Distribution: 50/50

LOADING HL-93

Allow 50#/sq. ft. for future wearing surface.

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (SD1) = 0.072g
Design Spectral Acceleration at 0.2 sec. (SDs) = 0.125g
Soil Site Class = C

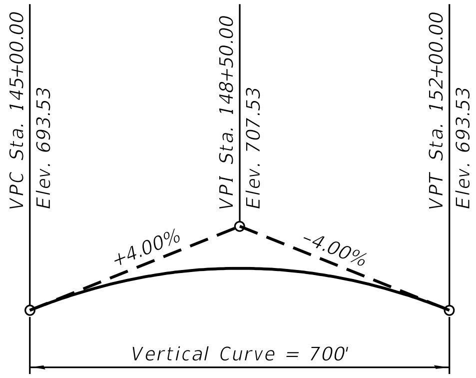


ELEVATION

**Dimension @ Rt. L's to Track*

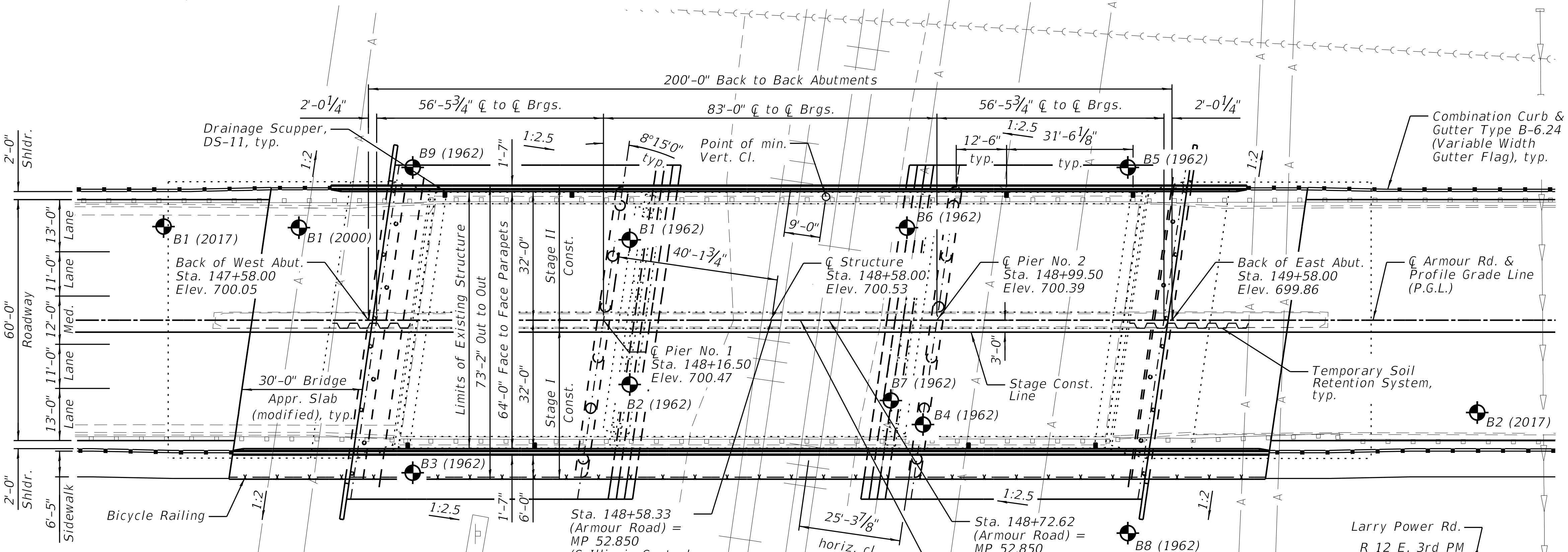
NOTE:

No freefall deck drains will be permitted in the span over the tracks or within 10 ft. of cross arms of a railroad pole line.

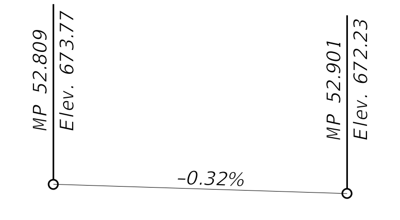


PROFILE GRADE

(Along ℄ Roadway)

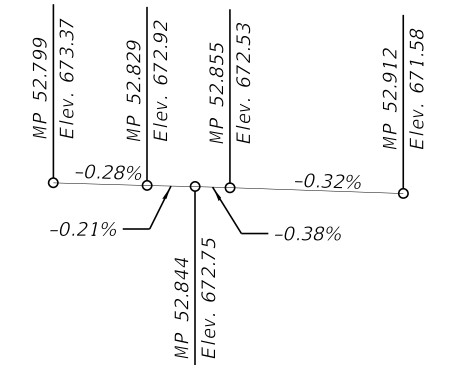


PLAN



ICRR WEST TRACK PROFILE GRADE

(Top of rail along East rail)

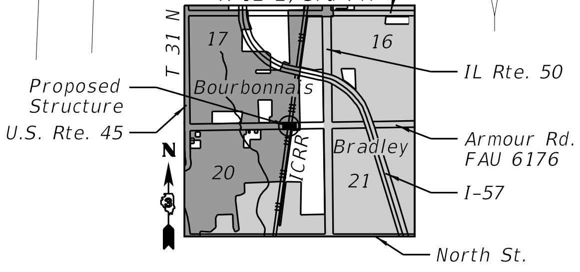


ICRR EAST TRACK PROFILE GRADE

(Top of rail along West rail)

MINIMUM VERTICAL CLEARANCE BELOW AERIAL POWER LINES

Station	Offset	Ex. Min. Vert. Cl.	Pr. Min. Vert. Cl.
147+44.00	2.06' RT	19.27'	19.14'
149+11.04	2.06' RT	61.60'	61.31'
149+84.39	28.15' RT	18.80'	18.88'



LOCATION SKETCH

ARMOUR ROAD OVER
ILLINOIS CENTRAL RAILROAD
F.A.U. 6176 - SECTION (79R-VB)R
KANKAKEE COUNTY
STATION 148+58.00
STRUCTURE NO. 046-0155

Farnsworth GROUP
2709 McGRAW DRIVE
BLOOMINGTON, ILLINOIS 61704
(309) 663-8435 / info@f-w.com

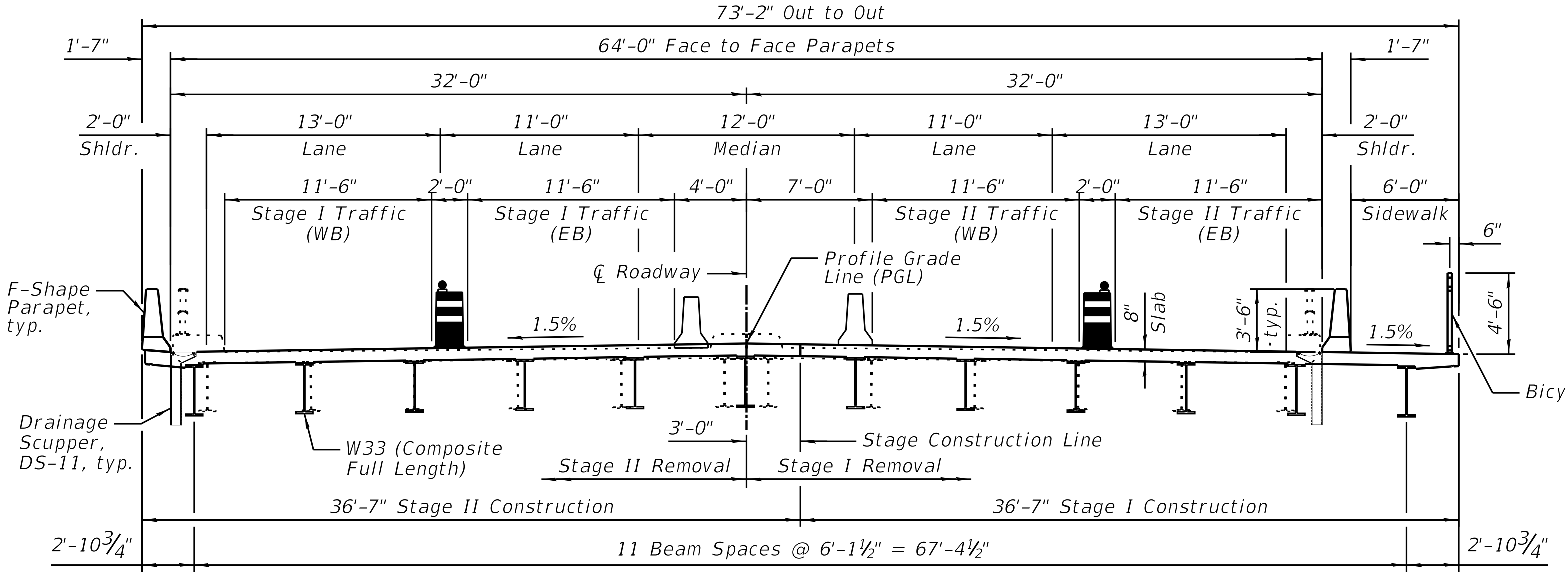
	DESIGNED - IIP	REVISED
	CHECKED - JCZ	REVISED
	DRAWN - DJM/IIP	REVISED
DATE - 04/06/18	CHECKED - JML	REVISED

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN
STRUCTURE NO. 046–0155
SHEET NO. 1 OF 2 SHEETS

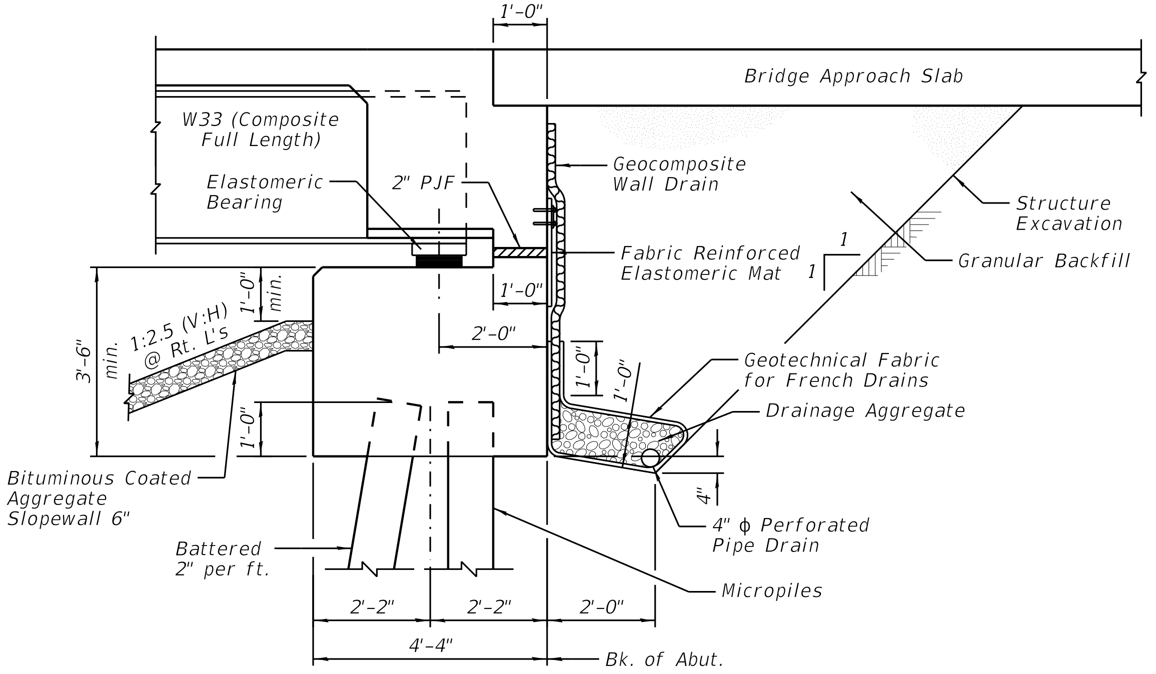
F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
6176	(79R-VB)R	KANKAKEE	2	1
		CONTRACT NO. 66F11		

ILLINOIS FED. AID PROJECT



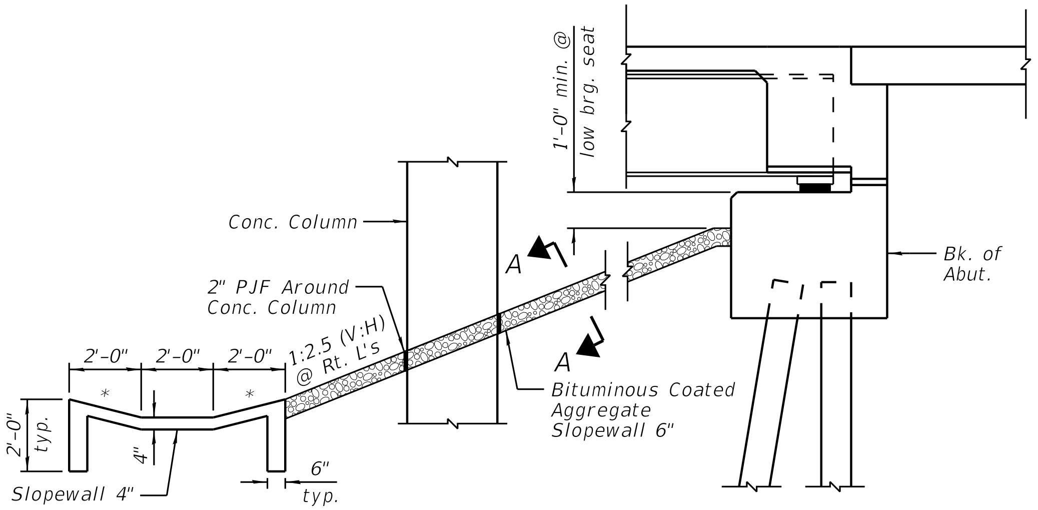
CROSS SECTION

(Looking East)



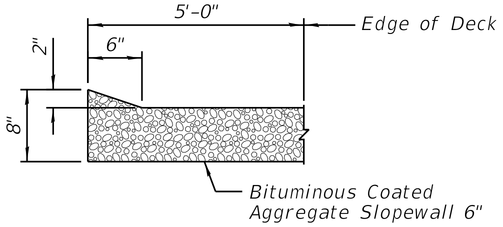
SECTION THRU ABUTMENT

(Horizontal dimensions @ Rt. L's)

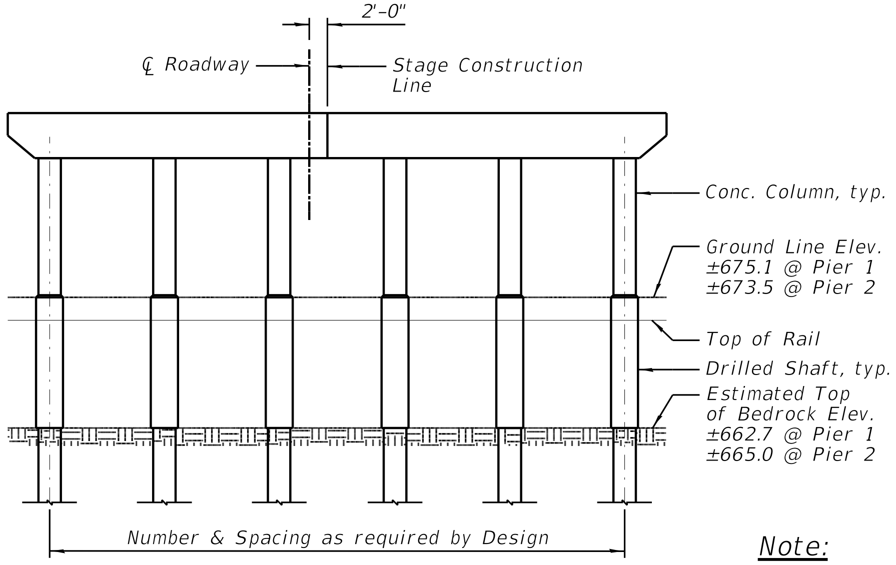


SECTION THRU SLOPEWALL

*1:4 (V:H)
(Horizontal dimensions @ Rt. L's)



SECTION A-A

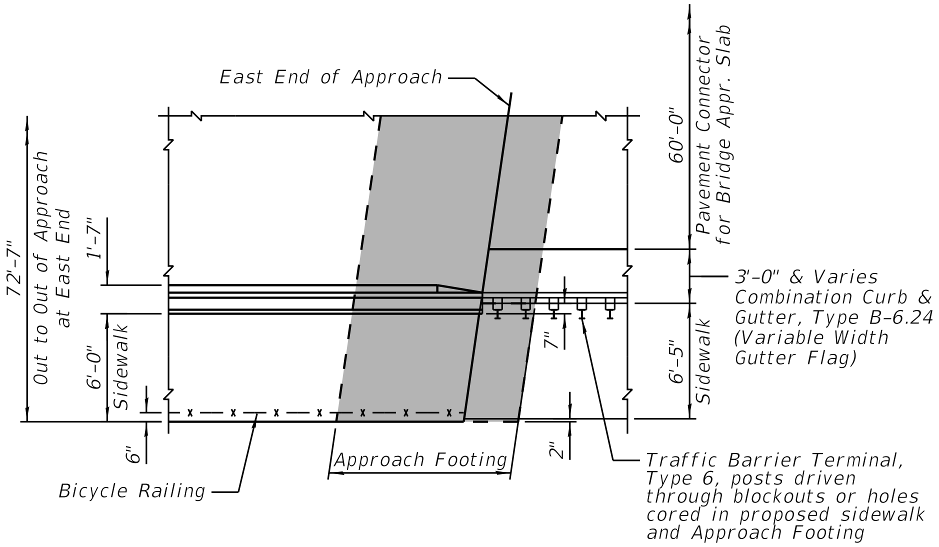


PIER SKETCH

(Looking East)

Note:

The existing Piers shall be removed during Stage II Construction.



PARTIAL PLAN
MODIFIED BRIDGE APPROACH SLAB

South edge of East Approach shown,
South edge of West Approach similar

N

ARMOUR ROAD OVER
ILLINOIS CENTRAL RAILROAD
F.A.U. 6176 - SECTION (79R-VB)R
KANKAKEE COUNTY
STATION 148+58.00
STRUCTURE NO. 046-0155

Farnsworth GROUP
2709 McGRAW DRIVE
BLOOMINGTON, ILLINOIS 61704
(309) 663-8435 / info@f-w.com

DATE - 04/06/18

DESIGNED - IIP
CHECKED - JCZ
DRAWN - DJM/IIP
CHECKED - JML

REVISED
REVISED
REVISED
REVISED

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

DETAILS
STRUCTURE NO. 046-0155

SHEET NO. 2 OF 2 SHEETS

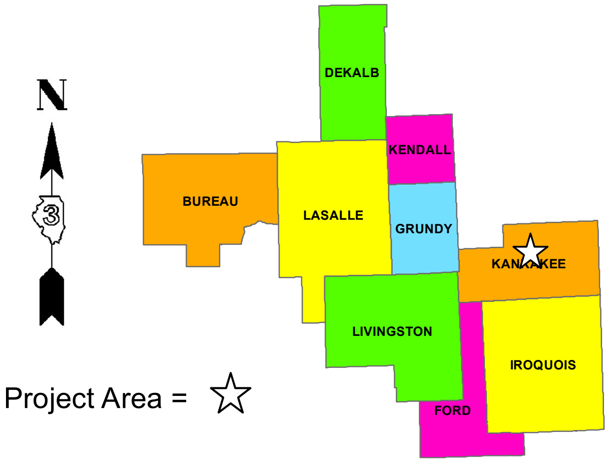
F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
6176	(79R-VB)R	KANKAKEE	2	2

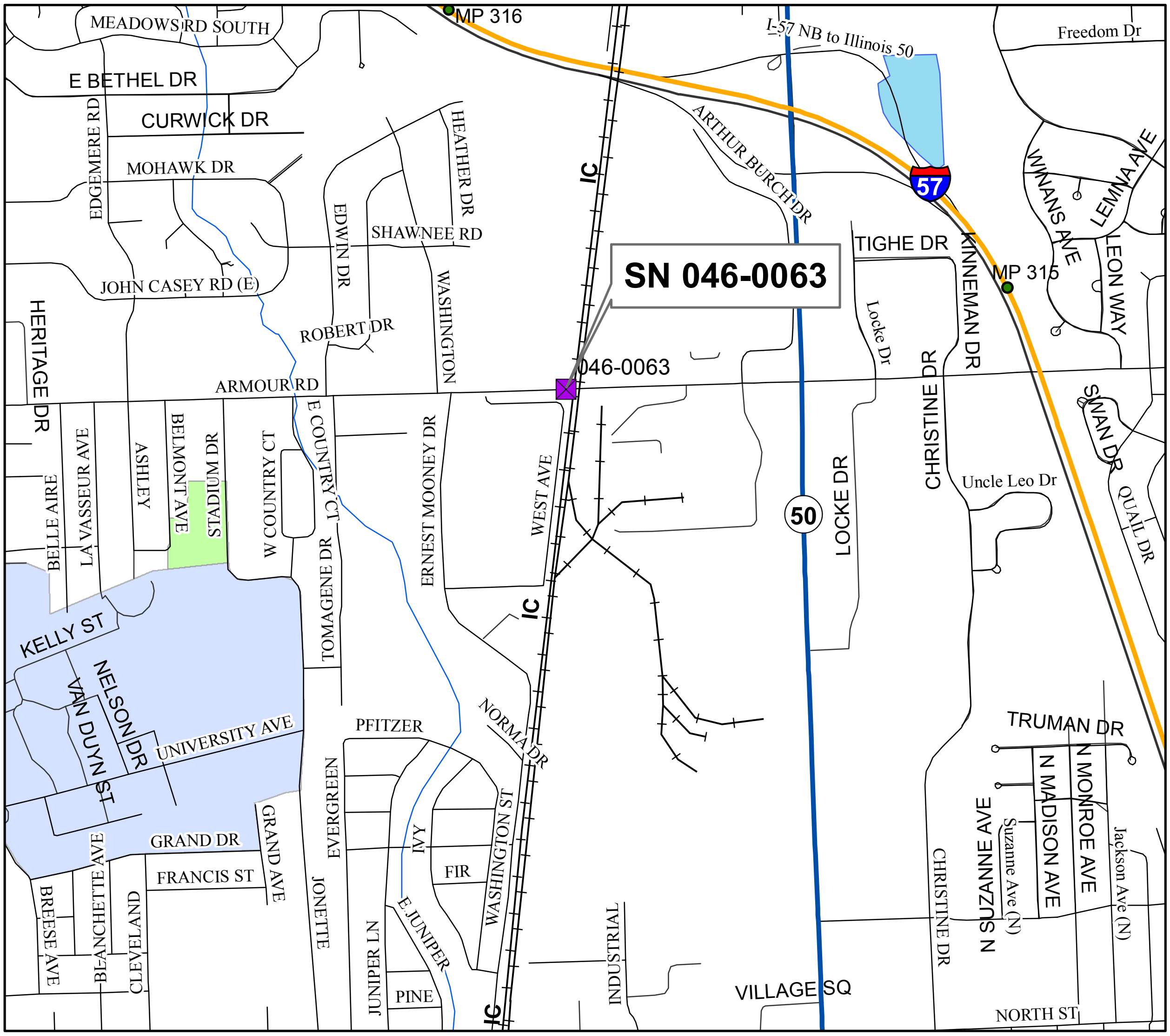
CONTRACT NO. 66F11

ILLINOIS FED. AID PROJECT

Project Location Map

Armour Road
Section (79R-VB)R
Kankakee County
Structure Replacement (046-0063)
0.3 miles west of IL 50
Phase I Job No: P-93-029-16
Contract No: 66F11





D3# 2277

By: IIP 11/15/17
Check: JCZ 11/16/17

SGR LOADS:

Project:	Armour Road over IC RR
Route:	FAU 6176
Section:	(79R-VB)R
County:	Kankakee
Structure:	SN 046-0063 (Existing) SN 046-0155 (Proposed)

TOTAL SUBSTRUCTURE REACTION				
LOCATION	LOAD	VERTICAL (K)	SHEAR (K)	MOMENT (FT-K)
ABUTMENT	SERVICE	1073	6	-
	STRENGTH	1447	13	-
PIER	SERVICE	1707	38	959
	STRENGTH	2241	44	1117

WORST CASE SHAFT REACTION				
LOCATION	LOAD	VERTICAL (K)	SHEAR (K)	MOMENT (FT-K)
ABUTMENT	SERVICE	442	1	-
	STRENGTH	636	3	-
PIER	SERVICE	399	7	164
	STRENGTH	572	7	184

Notes:

1. The proposed structure has a back-to-back of abutments length of 200’-0”, span lengths of 56’-4¼”, 83’-0”, and 56’-4¼” (center to center of bearings), and an out-to-out of deck width of 73’-2”. The superstructure has 12 beams.
2. Number of drilled shafts per abutment: 4
3. Number of drilled shafts per pier: 6
4. The abutments will have Type I Elastomeric Bearings, and the piers will have low-profile fixed bearings
5. Total substructure reactions are located at the center of the cap
6. Abutment shaft reactions are located at the bottom of the cap
7. Pier shafts reactions are located at the ground line
8. The shear and moment reactions presented in this document are the resultants of transverse and longitudinal actions.

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

ROCK CORE LOG

Page 1 **of** 1

Date 11/6/17

ROUTE FAS 1305 (Armour Rd.) **DESCRIPTION** Armour Road over I.C.G. Railroad, 0.3 miles West of IL 50 **LOGGED BY** Larry Myers

SECTION 79R-VB **LOCATION** SE 1/4, **SEC.** 17, **TWP.** 31N, **RNG.** 12E, 3rd **PM**, **Latitude** 41.162686, **Longitude** -87.858221

COUNTY Kankakee **CORING METHOD** Split Barrel Wire Line

STRUCT. NO. 046-0063
Station 148+43.23

CORING BARREL TYPE & SIZE N W/L 2

Core Diameter 1.9 **in**
Top of Rock Elev. 662.73 **ft**
Begin Core Elev. 662.73 **ft**

BORING NO. B1 (W. Abut.)
Station 147+07.00
Offset 23.3 ft Lt.
Ground Surface Elev. 698.73 **ft**

		DEPTH (ft)	**CORE (#)**	**RECOVERY (%)**	**R.Q.D. (%)**	**CORE TIME (min/ft)**	**STRENGTH (tsf)**
Buff Dolostone, Highly Porous & Vuggy, Highly Fractured, Some Rubblized Layers, Fossiliferous No Water Recovery while coring. Note: Due to low RQD, no strength specimens could be obtained.	662.73	-40	1	47	0	4.2	
		-45	2	40	0	3.4	
Note: Minor water at rock surface while drilling. No measurable water after coring.	647.73	-50	3	97	0	2.6	
End of Boring		-55					

Color pictures of the cores Yes
Cores will be stored for examination until Construction Complete
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

ROCK CORE LOG

Page 1 **of** 1

Date 11/7/17

ROUTE FAS 1305 (Armour Rd.) **DESCRIPTION** Armour Road over I.C.G. Railroad, 0.3 miles West of IL 50 **LOGGED BY** Larry Myers

SECTION 79R-VB **LOCATION** NE 1/4, **SEC.** 20, **TWP.** 31N, **RNG.** 12E, 3rd **PM**, **Latitude** 41.162565, **Longitude** -87.857039

COUNTY Kankakee **CORING METHOD** Split Barrel Wire Line

STRUCT. NO. 046-0063
Station 148+43.23

CORING BARREL TYPE & SIZE N W/L 2

Core Diameter 1.9 **in**
Top of Rock Elev. 665.04 **ft**
Begin Core Elev. 665.04 **ft**

BORING NO. B2 (E. Abut.)
Station 150+33.99
Offset 23.0 ft Rt.
Ground Surface Elev. 698.04 **ft**

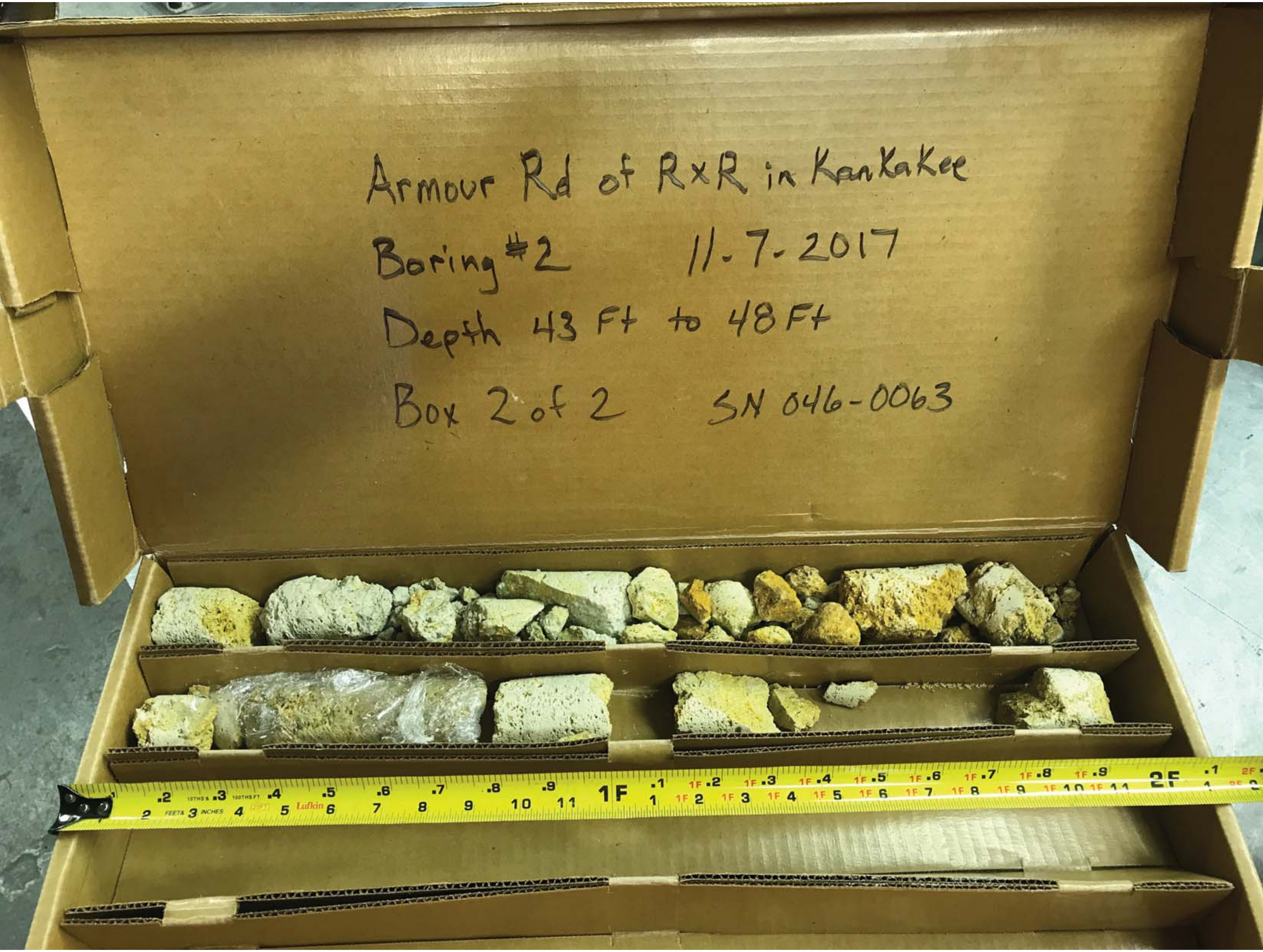
		DEPTH (ft)	CORE (#)	RECOVERY (%)	R.Q.D. (%)	CORE TIME (min/ft)	STRENGTH (tsf)
Buff Dolostone, Highly Porous & Vuggy, Highly Fractured, Some Rubblized Layers, Fossiliferous No Water Recovery while coring.	665.04	-35	1	83	0	3.6	
		-40	2	97	20	3.6	284.9 122.2
Note: Minor water at rock surface while drilling. No measurable water after coring.	650.04	-45	3	67	7	3.4	394.6
End of Boring		-50					

Color pictures of the cores Yes
Cores will be stored for examination until Construction Complete
The "Strength" column represents the uniaxial compressive strength of the core sample (ASTM D-2938)

BBS, form 138 (Rev. 8-99)


Armour Rd over RxR
Boring #1 SN. 046-0063
Box 1 of 1
Depth 36 Ft to 51 ft
11-6-17
Core Run #1
36
1F
2F


Armour Rd over R×R in Kankakee
Boring #2 11-7-2017
Depth 33 Ft to 43 Ft
Box 1 of 2 SN 046-0063
Start core run 1 33'
End 2 43


Armour Rd of RxR in Kankakee
Boring #2 11-7-2017
Depth 43 Ft to 48 Ft
Box 2 of 2 SN 046-0063
Lufkin

Illinois Department of Transportation

Memorandum

To: Bruce Hucker Attn: Royce Davis

From: Kenneth R. Lang By: Terry McCleary

Subject: Soil Borings*

Date: February 25, 2000

---

* FAS 1305 (Armor Road)
Section (79R-VB)I
Kankakee County
S.N. 046-0063

A boring was taken approximately 41' west of the west abutment. The location of this boring could not be any closer to the abutment because of overhead power lines. The attached boring shows the soil to be of a strength in excess of 1.0 ton/s.f. If you have any questions, please call Terry at Ext. 8458.

TLM:lw/ARMOR

Illinois Department of Transportation

Division of Highways
Illinois Department of Transportation

SOIL BORING LOG

Page 1 of 1

Date 2/23/00

ROUTE FAS 1305 **DESCRIPTION** SHEET PILE @ WEST ABUTMENT ON ARMOUR ROAD over AMTRACK **LOGGED BY** K.W.

SECTION (79R-VB)I **LOCATION** SE CORNER, SEC. 17, TWP. 31N, RNG. 2E, 3 PM

COUNTY KANKAKEE **DRILLING METHOD** HYDRAULIC PUSH TUBE **HAMMER TYPE** ____

STRUCT. NO. 046-0063
Station ____

BORING NO. 1
Station ____
Offset ____
Ground Surface Elev. ft ft

Surface Water Elev. ____ ft
Stream Bed Elev. ____ ft

Groundwater Elev.:
First Encounter ____ ft
Upon Completion NONE ft
After ____ Hrs. ____ ft

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Very Stiff to Hard Brown-Gray to Olive SILTY CLAY TILL & SILTY CLAY (FILL)				
			4.0P	19
	-5			
			2.7P	19
			2.0P	25
	-10			
			4.5P	21
	-15			
			2.5P	24
			3.6P	24
Stiff Black SILTY CLAY LOAM with Limestone Pieces & Organics	-20			

	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff Black SILTY CLAY LOAM with Limestone Pieces & Organics *(continued)*			1.7P	28
	-25			
	-30			
	-35			
	-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, from 137 (Rev. 8-99)

	District Engineer		
	Asst. Dist. Engr.		
	Local Rds. & Sts.		
	Research		
	Construction		
	Design		
	Right of Way		
	Materials		
	Maintenance		
	Adm. Service		
	Traffic		
	Landscape		
	Dist. Engr. Sec.		
	Claims		
	Gen. Office.		

April 5, 1962

SUBJECT: FOUNDATION BORING LOGS
F.A.S. Route 1305
Section 79 R-VB -24
Kankakee County
Station 148+43.23
Armour Road over Illinois Central Railroad

ATTENTION: Mr. W. E. Baumann
Engineer of Bridge & Traffic Structures

Mr. E. L. Sherertz
Engineer of Design
Illinois Division of Highways
State Highway Building
Springfield, Illinois

Dear Sir:

Herewith are the logs of borings made for the proposed structure, subject Route and Section.

The limestone encountered in these borings is dolomite in the Racine formation of Niagaran series.

The site of the proposed structure is in the N.E. 1/4 of the N.E. 1/4 of Section 20 in T.31N. in R.12E. of the 3 P.M.

Very truly yours,

Orville A. Evans
District Engineer

HWB:mlb
Enc.

Soils File

B.M: #5 S.E.W. In T.P. 55' Rt.
Sta. 147+50 Elev. 328.88

Existing Structure: 8 Timber Spans
To be removed by Bridge Contractor & 1 Steel Girder Span.

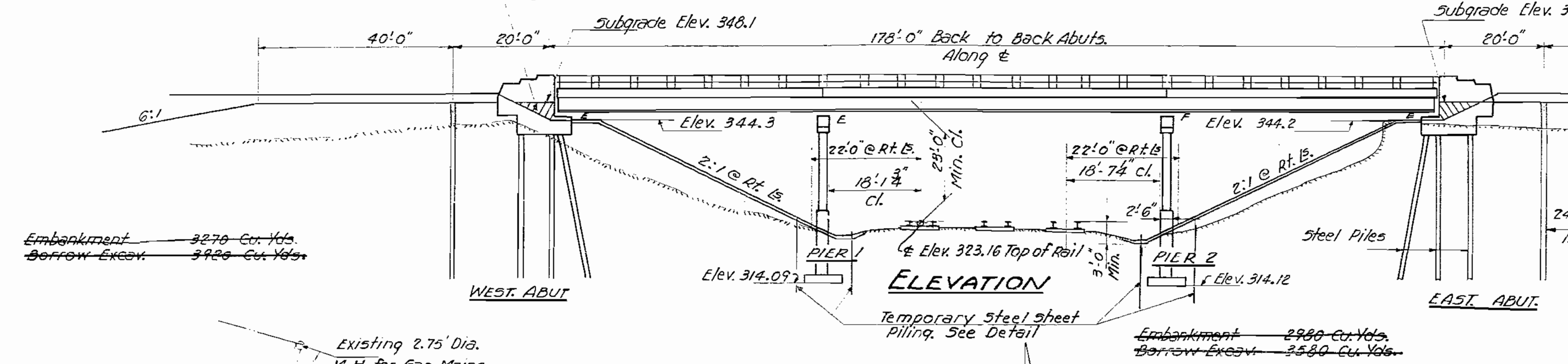
Salvage: None

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS & BUILDINGS
DIVISION OF HIGHWAYS

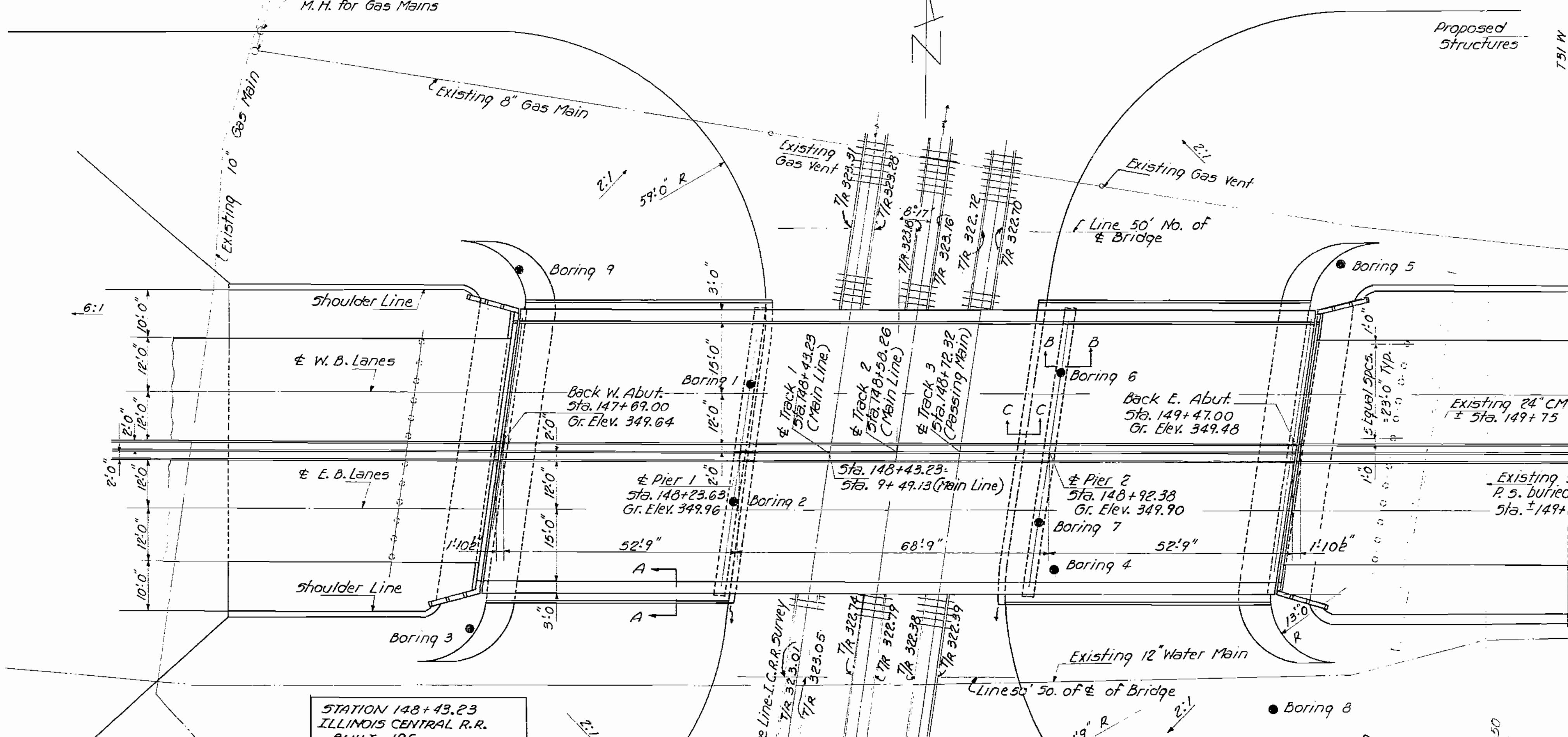
F.A.S. Route	Section	County	Total Sheets	Sheet No.
1305	79R-VB 79R-VF	Kankakee	22 12	6 5

Fed. Aid Project 4 5 G - [illegible]

Sheet No. 1
6 Sheets



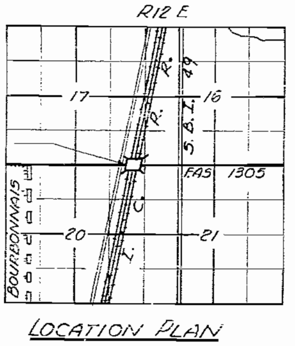
ELEVATION



STATION 148+43.23
ILLINOIS CENTRAL R.R.
BUILT 196
F.A.S. RT. 1305 · SEC. 79R-VB
PROJECT USG-1305-1(1)
LOADING H20-S16

NAME PLATE
See standard 2113

PLAN



LOCATION PLAN

GENERAL NOTES

Class-X-Concrete shall be used throughout.

Coarse aggregate which is to be used in parapet handrails and posts must be free of chert, flint, limonite, lignite and soft sandstone.

The concrete floor slab shall be finished in accordance with Art. 51.19 of the Standard Specifications.

Slope Wall shall be reinforced with welded wire fabric 6"×6" mesh, #4 wires, weighing 58 Lbs. per 100 sq. ft.

Rivets 3/4", Open Holes 13/16" unless noted.

All Structural Steel shall conform to the A.S.T.M. Specifications for Structural Steel A.S.T.M. Designation A 36

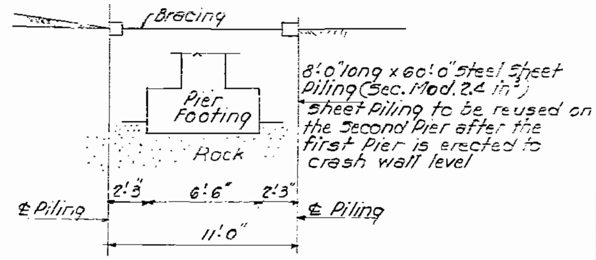
All rollers, rockers, bearing plates, lead plates, pintles and anchor bolts shall be fabricated and set in accordance with Art. 51.15 of the Standard Specifications and are included in quantity of Structural Steel. Estimated Wt. = 13000 Lbs.

Anchor Bolts shall be set before riveting diaphragms over supports.

Expansion Guards shall be fabricated and erected in accordance with Art. 51.13(d) of the Standard Specifications. Expansions Guards are included in quantity of Structural Steel. Estimated Wt. = 3070 Lbs.

Except as otherwise provided all Structural Steel shall receive one shop coat of red lead paint and two field coats of aluminum paint. See Arts. 56.1 to 56.5 inclusive of the Standard Specifications.

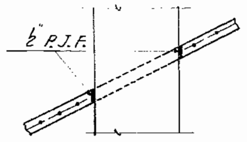
The Contractor shall drive one test pile at each Abutment in permanent locations as directed by the Engineer before ordering remainder of piles.



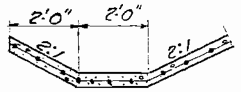
SHEET PILING DETAIL

TOTAL BILL OF MATERIAL · SEC. 79R-VB

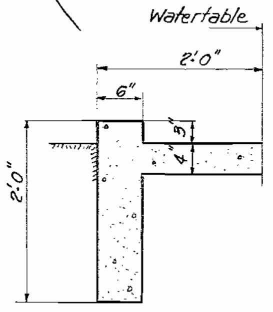
	ITEM	UNIT	SUPER.	SUBSTR.	TOTAL
	~~Borrow Excavation~~	~~Cu. Yds.~~		~~7500~~	~~7500~~
	Removal of Existing Structures	Each			1
	Class-A-Excavation for Structures	Cu. Yds.		330	330
	Rock Excavation for Structures	Cu. Yds.		20	20
	Erecting Structural Steel	Lbs.	304010		304010
	Class-X-Concrete	Cu. Yds.	312.1	365.2	677.3
	Aluminum Handrail	Lin. Ft.	352		352
	Reinforcement Bars	Lbs.	63980	31020	95000
	Creosoted Piles - Up to 20'	Lin. Ft.		360	360
	Steel Piles	Lin. Ft.		756	756
	Test Piles (Steel)	Each		2	2
	Name Plates	Each	1		1
	Slope Wall - 4"	Sq. Yds.		933	933
	Protective Coat	Sq. Yds.			1343
*	Temporary Steel Sheet Piling (Sec. Mod. 2.4 in³)	Sq. Ft.		960	960
	SECTION 79R-VF				
	Furnishing Structural Steel	Lbs.	304010		304010



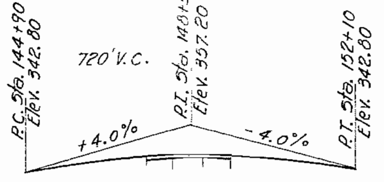
SECTION B-B



SECTION C-C



SECTION A-A



VERTICAL CURVE DATA

DESIGN STRESSES

fc - - - - 1400 #/□" Super. & Sub.
vc - - - - 75 #/□" Ftg.
fs - - - - 20000 #/□" Reinf.
fs - - - - 20000 #/□" Struct.
n - - - - 10

* Sheet Piling to be reused in erecting the Second Pier

DESIGNED	Walter Perry
CHECKED	Mario G. Pavillo
DRAWN	W.P. M. Miller
CHECKED	M.P.

MAY 24 1962

EXAMINED W.E. Baumann
ENGINEER OF BRIDGE AND TRAFFIC STRUCTURES

PASSED
ENGINEER OF DESIGN

APPROVED
CHIEF HIGHWAY ENGINEER

Loading H20-S16-44

GENERAL PLAN & ELEVATION
F.A.S. RT. 1305 OVER ILL. CENTRAL R.R.
SEC. 79R-V(B,F)
KANKAKEE COUNTY
STATION 148+43.23

ATTACHMENT J-1

FORM NO. B.D. 137 REV. 9-60

Sh. 1 of 1

BRIDGE FOUNDATION BORING LOG

PROJECT ____________

BRIDGE FAS Rt 1305 over IC RR

Date March 20, 1962

ROUTE FAS 1305

Bored By JES

SEC. 79 R-VB

STA. 148+43.23

Checked By HWB

COUNTY Kankakee

Pier #1

Boring No. 1

Station 148+23

Offset 20' Lt on Skew

Surface Water El. ---

Groundwater El. at Completion ---

After 7 ~~hours~~ days 316.88

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	320.78 0			
Loose Yellowish Brown SANDY LOAM (Fill)	319.28			
Soft Yellowish Brown CLAY LOAM (Fill)	318.28	3	--	
Hard Yellowish Brown CLAY (Till)	316.28	14	4.3 S	20
Very Stiff Gray CLAY (Till)	-5 314.78	21	3.1 B	17 18
Very Dense Yellowish Brown Fine Gravel & Limestone Fragments		61	--	--
Thin layers of porous LIMESTONE, soft layers of Rock Dust or Clay (Cored) 10% recovery	-10 309.28			
Light Buff Colored Porous LIMESTONE (Dolomite) thin to Medium Bedding (Cored) 25% recovery	-15 304.28			
	-20			

Elevation	N	Qu t/s.f.	w (%)
-25			
-30			
-35			
-40			
-45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30"

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B.D. 137 REV. 9-60

Sh. 1 of 1 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT ______

ROUTE FAS 1305

SEC. 79 R-VB

COUNTY Kankakee

Pier #1

Boring No. 2

Station 148+23

Offset 16' Rt ℄ on Skew

BRIDGE FAS Rt 1305

over IC RR

STA. 148+43.23

Date March 22, 1962

Bored By JES

Checked By HWB

Surface Water El. ---

Groundwater El. at Completion ---

After 6 ~~hours~~ days 316.88

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	320.88 0			
Clay Loam and CLAY (Till)	-5 314.88			
Light Buff Porous LIMESTONE (Dolomite) Thin Bedding (Cored) 30% recovery	311.38 -10			
Light Buff Porous LIMESTONE (Dolomite) Thin to Medium Bedding (Cored) 70% recovery	307.88			
	-15 -20			

Elevation	N	Qu t/s.f.	w (%)
-25 -30 -35 -40 -45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B.D. 137 REV. 9-60

Sh. 1 of 1 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT ______

ROUTE FAS 1305

SEC. 79 R-VB

COUNTY Kankakee

W. Abut.

Boring No. 3

Station 147+69

Offset 38' Rt ℄ on Skew

BRIDGE FAS Rt 1305

over IC RR

STA. 148+43.23

Date March 23, 1962

Bored By JES

Checked By HWB

Surface Water El. ______

Groundwater El. at Completion ______

After 5 days ~~Hours~~ 316.88

Elevation	N	Qu t/s.f.	w (%)

Ground Surface 329.88 0

Embankment and Overburden

-5

-10

315.38

Limestone Rubble 314.88 15

Light Buff Porous LIMESTONE (Dolomite) Thin Bedding, Soft Layers (Cored) 15% recovery

311.88

Light Buff Porous Limestone (Dolomite) Thin Bedding, some soft layers

-20

Elevation	N	Qu t/s.f.	w (%)

(Cored) 20% recovery

306.38

-25

-30

-35

-40

-45

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%

Type failure
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B.D. 137 REV. 9-60

Sh. 1 of 1 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT ______

BRIDGE FAS Rt 1305 over IC RR

Date March 27, 1962

ROUTE FAS 1305

Bored By JES

SEC. 79 R-VB

STA. 148+43.23

Checked By HWB

COUNTY Kankakee

Pier #2

Boring No. 4

Station 148+96

Offset 26' Rt ℄ on Skew

Surface Water El. ---

Groundwater El. at Completion ---

After ___ Hours ---

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	322.68 0			
	321.18			
Stiff Yellowish Brown and Black CLAY (Fill)		11	1.5 E	--
	319.18			
Very Stiff Yellowish Brown CLAY (Till)	-5	15	2.9 B	21
	317.18			
LIMESTONE Rubble	316.18	300 3/4"		
Light Gray and Buff Porous LIMESTONE (Dolomite) thin to Medium Bedding (Cored) 55% recovery	-10			
	311.18			
	-15			
	-20			

Elevation	N	Qu t/s.f.	w (%)
-25			
-30			
-35			
-40			
-45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B.D. 137 REV. 9-60 Sh. 1 of 1 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT ____
ROUTE FAS 1305
SEC. 79 R-VB
COUNTY Kankakee
E. Abut.
Boring No. 5
Station 149+47
Offset 38' Lt ℄ on Skew

BRIDGE FAS Rt 1305
over IC RR
STA. 148+43.23

Date March 28, 1962
Bored By JES
Checked By HWB

Surface Water El. ____
Groundwater El. at Completion ____
After ____ Hours ____

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	330.58 0			
Embankment				
	328.08			
Stiff Brownish Black CLAY LOAM		11	1.5 E	--
	325.58 -5			
Stiff Brown CLAY		9	1.8 S	25
	323.58			
Hard Yellowish Brown and Gray CLAY (Till)		25	5.4 S	19
	-10			
		18	4.1 S	21
	318.58			
Stiff Yellowish Brown and Gray CLAY (Till)				22
	316.58	15	1.4 B	27
	-15			
Limestone Layers, Rubble and CLAY (Cored) 10% recovery				
	312.88			
Gray and Light Buff Porous LIMESTONE (Dolomite) thin Bedding. (cored)	-20			

	Elevation	N	Qu t/s.f.	w (%)
Recovery 35%				
	305.88 -25			
	-30			
	-35			
	-40			
	-45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B D. 137 REV. 9-60

Sh. 1 of 1 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT ______

BRIDGE FAS Rt. 1305

over IC RR

Date March 29, 1962

ROUTE FAS 1305

Bored By JES

SEC. 79 R-VB

STA. 148+43.23

Checked By HWB

COUNTY Kankakee

Pier #2

Boring No. 6

Station 148+92

Offset 23' Lt ℄ on Skew

Surface Water El. --

Groundwater El. at Completion 316.78

After 48 Hours 317.0

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	322.28 0			
Fill	319.78			
Yellowish Brown and Gray CLAY (Till)	317.28 5			
Yellowish Brown CLAY LOAM (Gravelly)	314.78			
Limestone Rubble		300 3 1/2"		
LIMESTONE	313.28			
	-10			
	-15			
	-20			

Elevation	N	Qu t/s.f.	w (%)
-25			
-30			
-35			
-40			
-45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%

Type failure
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B.D. 137 REV. 9-60

Sh. 1 of 1 Sh

BRIDGE FOUNDATION BORING LOG

PROJECT ____

BRIDGE FAS Rt 1305

over IC RR

Date March 29, 1962

ROUTE FAS 1305

SEC. 79 R-VB

STA. 148+43.23

Bored By JES

Checked By HWB

COUNTY Kankakee

Pier #2

Boring No. 7

Station 148+88

Offset 20' Rt ℄ on Skew

Surface Water El. ---

Groundwater El. at Completion ---

After ____ Hours ---

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	320.0 0			
Overburden				
	315.0 -5			
LIMESTONE Rubble	314.3			
Auger Stopped on Hard Material.				
	-10			
	-15			
	-20			

Elevation	N	Qu t/s.f.	w (%)
-25			
-30			
-35			
-40			
-45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B D. 137 REV. 9-60

Sh. 1 of 1 Sh.

BRIDGE FOUNDATION BORING LOG

PROJECT ____

BRIDGE FAS Rt 1305

over IC RR

Date April 2, 1962

ROUTE FAS 1305

SEC. 79 R-VB

STA. 148+43.23

Bored By JES

Checked By HWB

COUNTY Kankakee

E. Abut.

Boring No. 8

Station 149+47

Offset 53' Rt ℄ on Skew

Surface Water El. ____

Groundwater El. at Completion ____

After ____ Hours ____

	Elevation	N	Qu t/s.f.	w (%)
Ground Surface	320.98 0			
Clay and Clay (Till) Overburden				
	315.78 -5			
LIMESTONE Rubble				
	314.78			
Auger stopped on hand Material				
	-10			
	-15			
	-20			

Elevation	N	Qu t/s.f.	w (%)
-25			
-30			
-35			
-40			
-45			

N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage of oven dry weight-%

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

FORM NO. B.D. 137 REV. 9-60

Sh. 1 of 1

BRIDGE FOUNDATION BORING LOG

PROJECT ____

BRIDGE FAS Rt 1305 over IC RR

Date April 2, 1962

ROUTE FAS 1305

Bored By JES

SEC. 79 R-VB

STA. 148+43.23

Checked By HWB

COUNTY Kankakee

W. Abut.

Boring No. 9

Station 147+69

Offset 38' Lt ℄ on Skew

Surface Water El. ____

Groundwater El. at Completion 317.98

After ____ Hours ____

		Elevation	N	Qu t/s.f.	w (%)
Ground Surface	330.88	0			
CLAY and CLAY LOAM (Embankment					
		-5	12	---	--
	324.88				
Medium Yellowish Brown Gravelly LOAM			24	--	13
	322.38				
Hard Yellowish Brown and Gray CLAY (Till)		-10	28	6.2 S	18
			21	4.7 B	20
			200 9"		
	316.38	-15			
LIMESTONE Rubble	315.38				
Auger Stopped on Hard Material					
		-20			

Elevation	N	Qu t/s.f.	w (%)
-25			
-30			
-35			
-40			
-45			

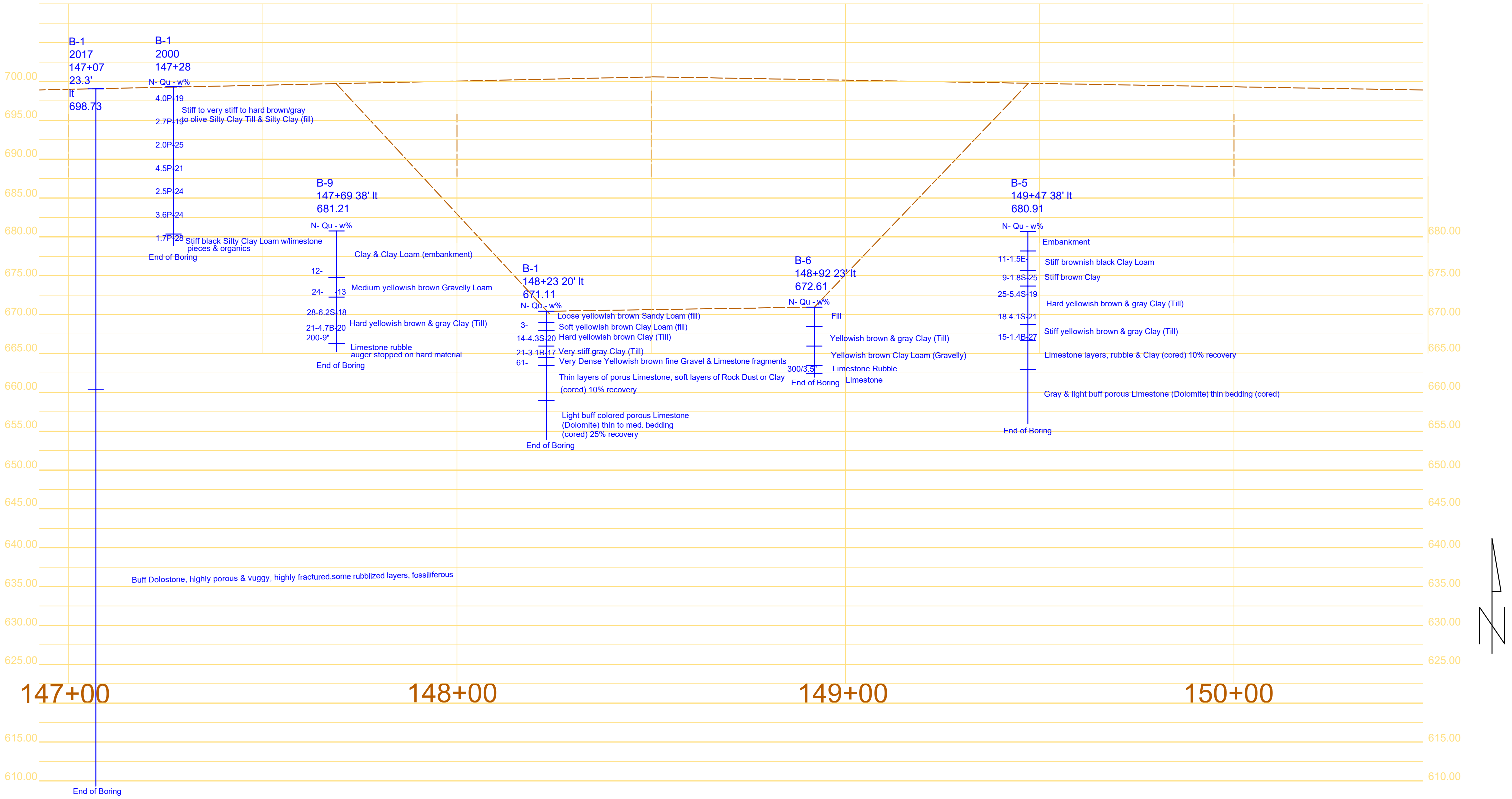
N - Standard Penetration Test - Blows per foot to drive 2" O.D. Split Spoon Sampler 12" with 140# hammer falling 30".

Qu - Unconfined Compressive Strength - t/sf

w - Water Content - percentage

Type failure:
B - Bulge Failure
S - Shear Failure
E - Estimated Value

North side



McCleary Engineering

Designed by:
Date:
Drawn by: MLL
Date: 1/5/18
Checked by:
Date:

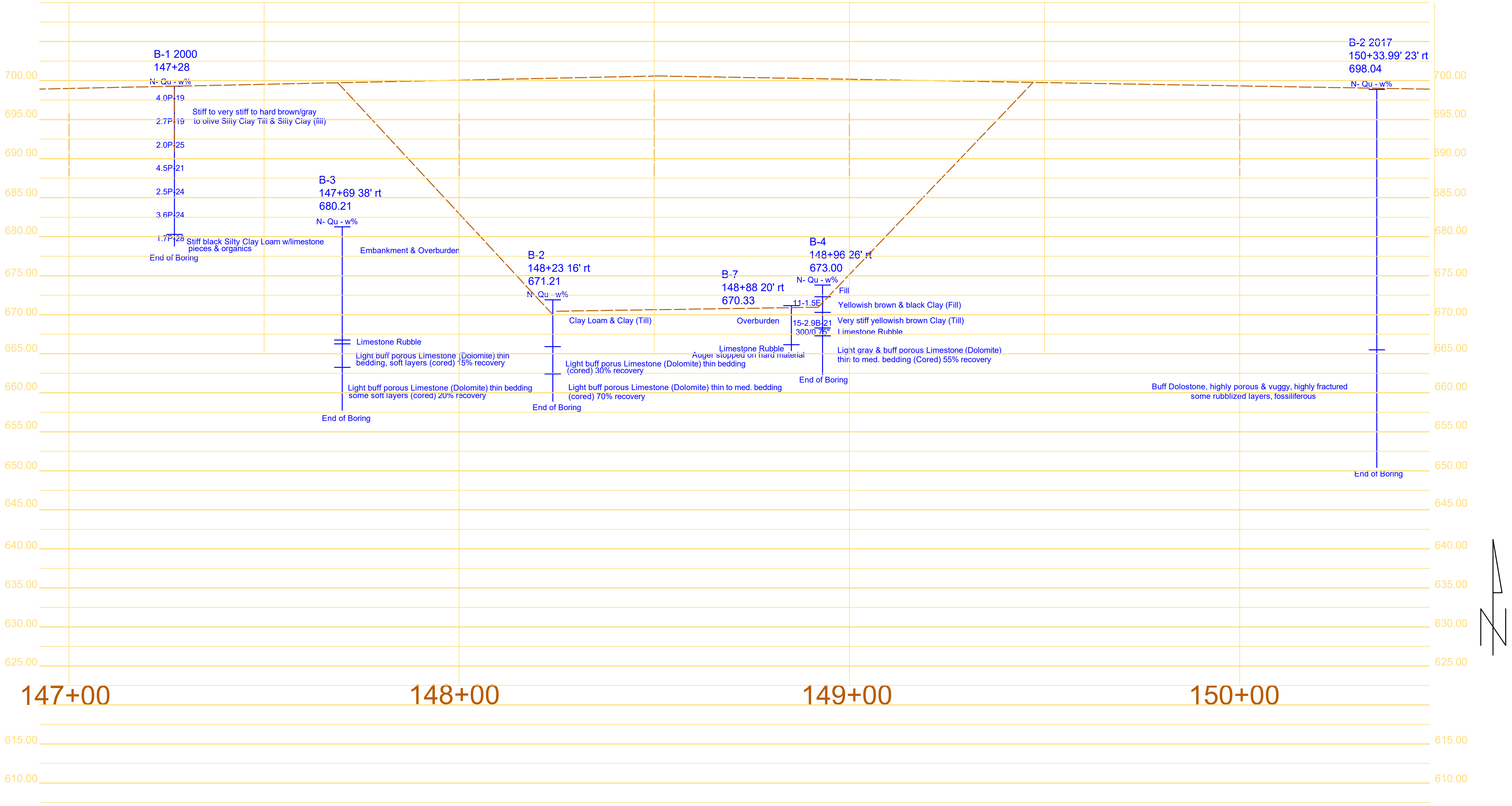
Armour Road over AMTRACK

Scale =
Sheet 2 of 2
Sta. to Sta.

Route	Section	County
FAS 1305		Kankakee

Bridge number:

South side



McCleary Engineering

Designed by:
Date:

Drawn by: MLL
Date: 1/5/18

Checked by:
Date:

Armour Road over AMTRACK

Scale = ______
Sheet 1 of 2
Sta. ____________ to Sta.________

Route	Section	County
FAS 1305		Kankakee

Bridge number: ___________________________

Illinois Department of Transportation

COHESIVE SOIL SETTLEMENT ESTIMATE

LOCATION AND BORING USED ==== Boring 4
TYPE OF SURCHARGE ================================ 1 (1=2:1 bridge cone, 2=continuous embank., 3=rectangular surch.)
DEPTH TO WATER TABLE (below top of existing embankment) == 100 FT

NEW EMBANKMENT:
NEW EMBANKMENT FILL UNIT WEIGHT =============== 120 PCF
NEW EMBANKMENT FILL HEIGHT ==================== 8.5 FT
PROPOSED WIDTH AT TOP ========================== 10 FT
PROPOSED WIDTH AT BOTTOM ====================== 18 FT (which is a 0.5:1 slope)

EXISTING EMBANKMENT (IF ANY):
EXISTING EMBANKMENT UNIT WEIGHT =========================== PCF
EXISTING EMBANKMENT HEIGHT ================================= FT
EXISTING WIDTH AT TOP ===================================== FT
EXISTING WIDTH AT BASE ==================================== FT (which is a 0.0:1 slope)

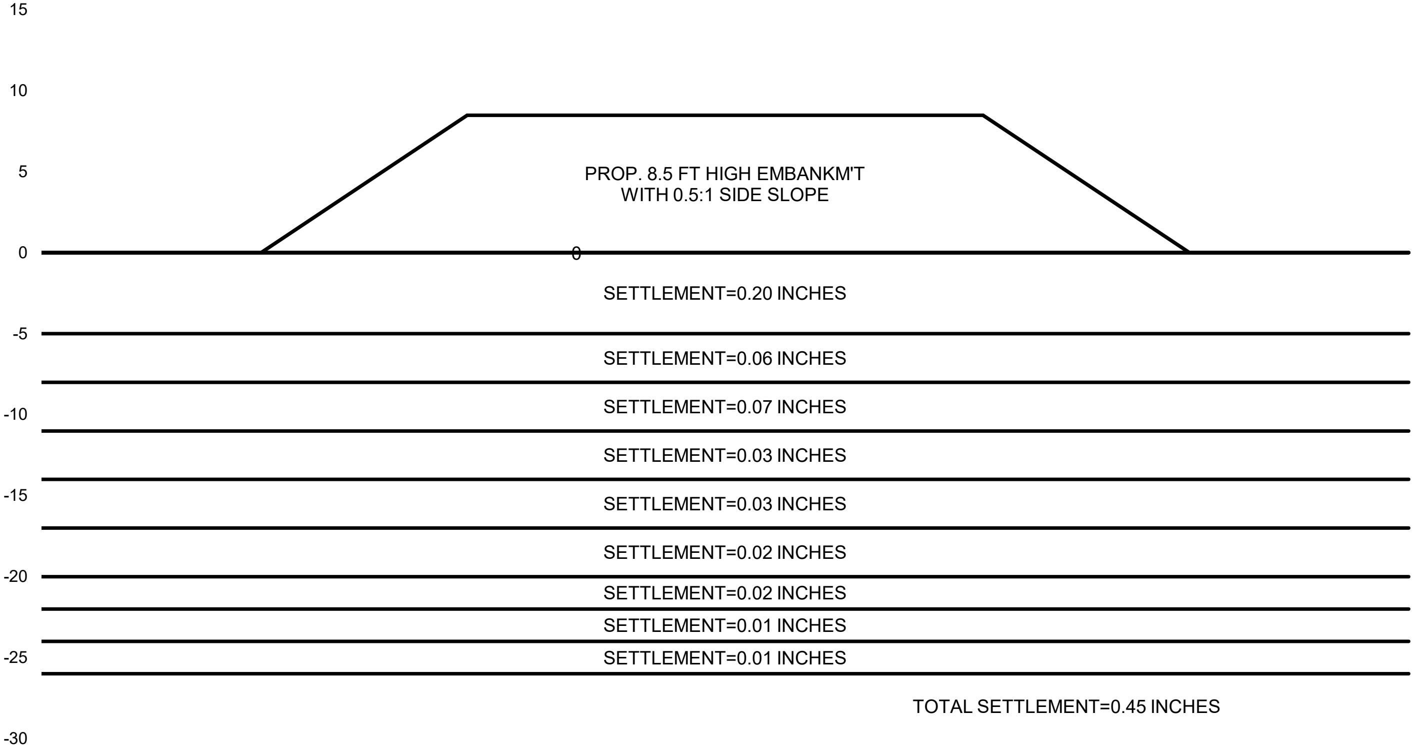
ASSUMPTIONS:

Soil Deposit is Normally Consolidated
Cohesive Layers are Saturated
Soils have a Low Sensitivity
Liquid Limit (LL)=Moist. Content (MC%)
Initial Void Ratio (Eo)=2.7*(MC%)/100
Comp. Index (Cc)=0.009*(LL-10)
Neglecting Granular & Secondary Settlem't

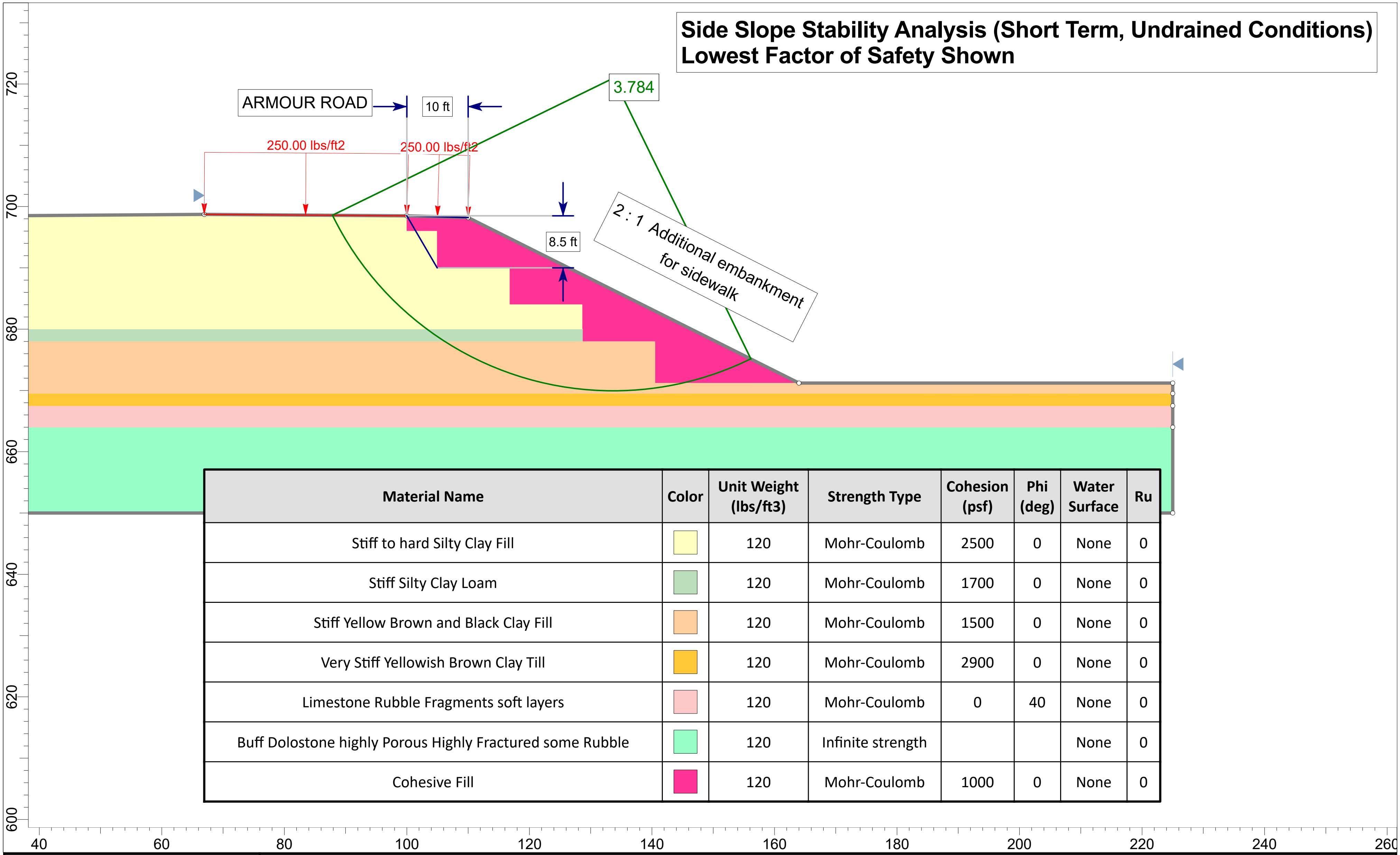
LAYER THICK (FT)	*TOTAL UNIT WT. (PCF)*	*UNCONF. COMP. STRENGTH (Qu) (TSF)*	*MOIST. CONTENT (%)*	*EXISTING PRESSURE (KSF)*	*PRESSURE INCREASE (KSF)*	*INITIAL VOID RATIO*	*COMPRESSION INDEX (Cc)*	*Qu CORRECTION FACTOR*	*LAYER SETTLEMENT (IN.)*
5.0	120	4.00	19	0.300	0.963	0.513	0.081	0.100	**0.20**
3.0	120	2.70	19	0.780	0.816	0.513	0.081	0.100	**0.06**
3.0	120	2.00	25	1.140	0.702	0.675	0.135	0.111	**0.07**
3.0	120	4.50	21	1.500	0.606	0.567	0.099	0.100	**0.03**
3.0	120	2.50	24	1.860	0.528	0.648	0.126	0.100	**0.03**
3.0	120	3.60	24	2.220	0.465	0.648	0.126	0.100	**0.02**
2.0	120	1.70	28	2.520	0.422	0.756	0.162	0.127	**0.02**
2.0	120	1.50	20	2.760	0.392	0.540	0.090	0.142	**0.01**
2.0	120	2.90	21	3.000	0.366	0.567	0.099	0.100	**0.01**

TOTAL SETTLEMENT UNDER CENTER OF BRIDGE CONE = 0.45 IN.

EMBANKMENT AND SOIL PROFILE



Side Slope Stability Analysis (Short Term, Undrained Conditions)
Lowest Factor of Safety Shown



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Stiff to hard Silty Clay Fill	🟨	120	Mohr-Coulomb	2500	0	None	0
Stiff Silty Clay Loam	🟩	120	Mohr-Coulomb	1700	0	None	0
Stiff Yellow Brown and Black Clay Fill	🟧	120	Mohr-Coulomb	1500	0	None	0
Very Stiff Yellowish Brown Clay Till	🟧	120	Mohr-Coulomb	2900	0	None	0
Limestone Rubble Fragments soft layers	🟥	120	Mohr-Coulomb	0	40	None	0
Buff Dolostone highly Porous Highly Fractured some Rubble	🟩	120	Infinite strength			None	0
Cohesive Fill	🟪	120	Mohr-Coulomb	1000	0	None	0

Mc Cleary Engineering

SLIDEINTERPRET 6.039

SLIDE - An Interactive Slope Stability Program	Armour Road - Kankakee Slope Stability Analysis		
Analysis Description	Armour Rd SLIDE Analysis Undrained.slim Slope Analysis		
Drawn By MJ	*Scale* 1:260	*Company*	McCleary Engineering
Date 12/28/2017, 3:31:47 PM		*File Name*	Armour Rd SLIDE Analysis Undrained.slim

USGS Design Maps Summary Report

User–Specified Input

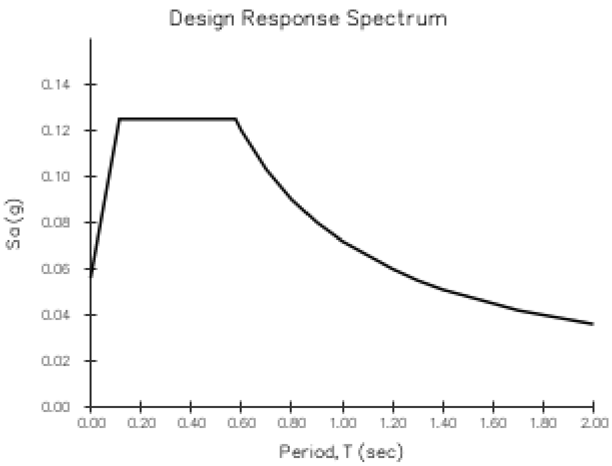
Report Title	Armour Road over ICG RR Wed September 20, 2017 20:50:29 UTC
Building Code Reference Document	2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (which utilizes USGS hazard data available in 2002)
Site Coordinates	41.16256°N, 87.85784°W
Site Soil Classification	Site Class C – “Very Dense Soil and Soft Rock”

USGS–Provided Output

PGA = 0.046 g **A_s =** 0.056 g

S_S = 0.104 g **S_{DS} =** 0.125 g

S_1 = 0.042 g **S_{D1} =** 0.072 g



Illinois Department of Transportation

SEISMIC SITE CLASS DETERMINATION

PROJECT TITLE=====Armour Rd over ICG RR in Kankaklee County SN 046-0063 Existing

Substructure 1

Base of Substruct. Elev. (or ground surf for bents)	341.45	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-1	
Top of Boring Elev.	342	ft.

Approximate Fixity Elev. 335.45 ft.

Individual Site Class Definition:

N (bar): 19 (Blows/ft.) Soil Site Class D
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 2.99 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	340.8	1.22	4	1.00	B
	338.3	2.50	4	1.00	
	335.8	2.50	4	1.00	
2.2	333.3	2.50	4	1.00	
4.7	330.8	2.50	4	1.00	
7.2	328.3	2.50	4	1.00	
9.7	325.8	2.50	4	1.00	
12.2	323.3	2.50	4	1.00	
14.7	320.8	2.50	4	1.00	
16.2	319.3	1.50	1		B
17.2	318.3	1.00	3		B
19.2	316.3	2.00	14	4.30	B
20.7	314.8	1.50	21	3.10	B
21.7	313.8	1.00	61		B
23.7	311.8	2.00		5.00	B
26.2	309.3	2.50		5.00	B
31.2	304.3	5.00		5.00	B
100.1	235.4	68.90	250	5.00	R

Substructure 2

Base of Substruct. Elev. (or ground surf for bents)	314.09	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-1	
Top of Boring Elev.	320.78	ft.

Approximate Fixity Elev. 308.09 ft.

Individual Site Class Definition:

N (bar): 104 (Blows/ft.) Soil Site Class C <----Controls
N_{ch} (bar): NA (Blows/ft.) NA
s_u (bar): 5 (ksf) Soil Site Class C

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	319.3	1.50	1		B
	318.3	1.00	3		B
	316.3	2.00	14	4.30	B
	314.8	1.50	21	3.10	B
	313.8	1.00	61		B
	311.8	2.00		5.00	B
	309.3	2.50		5.00	B
3.8	304.3	5.00		5.00	B
100.0	208.1	96.20	250	5.00	R

Substructure 3

Base of Substruct. Elev. (or ground surf for bents)	314.12	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-4	
Top of Boring Elev.	322.68	ft.

Approximate Fixity Elev. 308.12 ft.

Individual Site Class Definition:

N (bar): 100 (Blows/ft.) ####
N_{ch} (bar): #DIV/0! (Blows/ft.) ####
s_u (bar): #DIV/0! (ksf) ####

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	321.2	1.50	4	0.40	B
	319.2	2.00	11	1.50	B
	317.2	2.00	15	2.90	B
	316.2	1.00	300		B
	313.7	2.50	300		
	311.2	2.50	300		B
100.5	207.6	103.58	250	5.00	R

Substructure 4

Base of Substruct. Elev. (or ground surf for bents)	341.26	ft.
Pile or Shaft Dia.	12	inches
Boring Number	B-4	
Top of Boring Elev.	342	ft.

Approximate Fixity Elev. 335.26 ft.

Individual Site Class Definition:

N (bar): 33 (Blows/ft.) Soil Site Class D
N_{ch} (bar): 91 (Blows/ft.) Soil Site Class C
s_u (bar): 2.83 (ksf) Soil Site Class C <----Controls

Seismic Soil Column Depth (ft)	Bot. Of Sample Elevation	Sample Thick. (ft.)	N	Qu (tsf)	Layer Description Boundary
	340.9	1.12	4	1.00	
	338.4	2.50	4	1.00	
	335.9	2.50	4	1.00	
1.9	333.4	2.50	4	1.00	
4.4	330.9	2.50	4	1.00	B
6.9	328.4	2.50	4	1.00	
8.9	326.4	2.00	4	1.00	
10.4	324.9	1.50	12		B
12.9	322.4	2.50	24		B
15.4	319.9	2.50	28	6.20	
17.9	317.4	2.50	21	4.70	
19.9	315.4	2.00	267		B
100.0	235.2	80.14	267	5.00	R

Global Site Class Definition: Substructures 1 through 4

N (bar): 64 (Blows/ft.) Soil Site Class C
N_{ch} (bar): (Blows/ft.) NA, H < 0.1*H (Total)
s_u (bar): 3.97 (ksf) Soil Site Class C <----Controls

Illinois Department of Transportation

DRILLED SHAFT AXIAL CAPACITY IN ROCK - DOLOMITE, LIMESTONE, SANDSTONE, AND HARD SHALE

STRUCTURE ================================ SN 046-0155
SUBSTRUCTURE & REFERENCE BORING ======= E Pier - Boring #2
GROUND SURFACE ELEVATION =============== 672.70 FT
GROUND WATER ELEVATION ================= FT
ESTIMATED TOP OF ROCK ELEVATION ========= 665.04 FT
DRILLED SHAFT DIAMETER IN ROCK =========== 48 IN.
FACTORED AXIAL LOAD ====================== 373 KIPS
DRILLED SHAFT CONCRETE STRENGTH, f'c ====== 3.5 KSI

FOUNDATION REDUNDANCY ==== REDUNDANT

Drilled Shaft Dia.'s for Design Table

24 IN.
30 IN.
36 IN.
42 IN.
48 IN.
60 IN.

SOCKET DEPTH (FT)	TIP ELEV. (FT)	LAYER THICK. (FT)	UNCONFINED COMPRESSIVE STRENGTH (q_u) (KSF)	ROCK TYPE	GSI	ROCK CONDITION	RQD (%)	JOINT TYPE	ROCK INTACT OR TIGHTLY JOINTED?	SIDE RESISTANCE						AVG. q_u W/IN 2 - SHAFT DIA. (KSF)	TIP RESISTANCE			COMBINED SIDE & TIP RESISTANCE					
										NOM. RESIST. (KIPS)	Σ NOM. RESIST. (KIPS)	Σ FACT. RESIST. (KIPS)	SETTLEMENT				NOM. RESIST. (KIPS)	FACT. RESIST. (KIPS)	SETTL. w_{Rn} (IN.)	R_p/R_n	NOM. RESIST. (KIPS)	FACT. RESIST. (KIPS)	SETTLEMENT		
													Q_{C1} (KIPS)	w_{C1} (IN.)	w_{Rn} (IN.)								Q_{C1} (KIPS)	w_{C1} (IN.)	w_{Rn} (IN.)
1.00	664.04	1.00	122.2	Dolomite	15	Fractured	0	Open	No	0						162.9	294	147	0.294	1.00	294	147	0	0.000	#####
2.00	663.04	1.00	122.2	Dolomite	15	Fractured	0	Open	No	0						162.9	314	157	0.300	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
3.00	662.04	1.00	122.2	Dolomite	15	Fractured	0	Open	No	0						196.9	370	185	0.343	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
4.00	661.04	1.00	122.2	Dolomite	15	Fractured	0	Open	No	0						231.0	426	213	0.383	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
5.00	660.04	1.00	122.2	Dolomite	15	Fractured	0	Open	No	0						265.0	482	241	0.419	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
6.00	659.04	1.00	284.9	Dolomite	25	Fractured	20	Open	No	90	90	50	269	0.142	-1.520	278.7	809	405	0.725	0.00	90	50	269	0.142	-1.520
7.00	658.04	1.00	284.9	Dolomite	25	Fractured	20	Open	No	90	181	99	340	0.157	-0.955	292.5	861	430	0.794	0.00	181	99	340	0.157	-0.955
8.00	657.04	1.00	122.2	Dolomite	23	Fractured	20	Open	No	59	240	132	380	0.160	-0.693										
9.00	656.04	1.00	122.2	Dolomite	23	Fractured	20	Open	No	59	299	164	420	0.163	-0.491										
10.00	655.04	1.00	122.2	Dolomite	23	Fractured	20	Open	No	59	358	197	460	0.166	-0.330										
11.00	654.04	1.00	394.6	Dolomite	20	Fractured	7	Open	No	37	395	217	548	0.188	-0.441										
12.00	653.04	1.00	394.6	Dolomite	20	Fractured	7	Open	No	37	433	238	636	0.208	-0.520										
13.00	652.04	1.00	394.6	Dolomite	20	Fractured	7	Open	No	37	470	258	724	0.226	-0.580										
14.00	651.04	1.00	394.6	Dolomite	20	Fractured	7	Open	No	37	507	279	812	0.243	-0.625										
15.00	650.04	1.00	394.6	Dolomite	20	Fractured	7	Open	No	37	544	299	901	0.259	-0.662										

no results

negative results

See hand calculations using AASHTO formulas

Illinois Department of Transportation

DRILLED SHAFT AXIAL CAPACITY IN ROCK - DOLOMITE, LIMESTONE, SANDSTONE, AND HARD SHALE

STRUCTURE ================================ SN 046-0155

SUBSTRUCTURE & REFERENCE BORING ======= W. Pier - Boring #1

GROUND SURFACE ELEVATION =============== 674.70 FT

GROUND WATER ELEVATION ================= FT

ESTIMATED TOP OF ROCK ELEVATION ========= 662.73 FT

DRILLED SHAFT DIAMETER IN ROCK =========== 48 IN.

FACTORED AXIAL LOAD ====================== 374 KIPS

DRILLED SHAFT CONCRETE STRENGTH, f'c ====== 3.5 KSI

FOUNDATION REDUNDANCY ==== REDUNDANT

Drilled Shaft Dia.'s for Design Table

24	IN.
30	IN,
36	IN.
42	IN.
48	IN.
60	IN.

										SIDE RESISTANCE						*AVG. q_u W/IN 2 - SHAFT DIA. (KSF)*	*TIP RESISTANCE*			*COMBINED SIDE & TIP RESISTANCE*					
													SETTLEMENT										*SETTLEMENT*		
SOCKET DEPTH (FT)	*TIP ELEV. (FT)*	*LAYER THICK. (FT)*	*UNCONFINED COMPRESSIVE STRENGTH (q_u) (KSF)*	*ROCK TYPE*	*GSI*	*ROCK CONDITION*	*RQD (%)*	*JOINT TYPE*	*ROCK INTACT OR TIGHTLY JOINTED?*	*NOM. RESIST. (KIPS)*	*Σ NOM. RESIST. (KIPS)*	*Σ FACT. RESIST. (KIPS)*	*Q_{C1} (KIPS)*	*w_{C1} (IN.)*	*w_{Rn} (IN.)*		*NOM. RESIST. (KIPS)*	*FACT. RESIST. (KIPS)*	*SETTL. w_{Rn} (IN.)*	*R_P/R_n*	*NOM. RESIST. (KIPS)*	*FACT. RESIST. (KIPS)*	*Q_{C1} (KIPS)*	*w_{C1} (IN.)*	*w_{Rn} (IN.)*
1.00	661.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	368	184	0.352	1.00	368	184	0	0.000	#####
2.00	660.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	384	192	0.368	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
3.00	659.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	400	200	0.374	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
4.00	658.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	415	207	0.379	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
5.00	657.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	429	214	0.382	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
6.00	656.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	443	221	0.384	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
7.00	655.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	456	228	0.386	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
8.00	654.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	469	235	0.425	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
9.00	653.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	482	241	0.409	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
10.00	652.73	1.00	122.2	Dolomite	20	Fractured	0	Open	No	0						122.2	494	247	0.437	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
11.00	651.73	1.00	122.2	Dolomite	25	Fractured	0	Open	No	0						122.2	600	300	0.543	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
12.00	650.73	1.00	122.2	Dolomite	25	Fractured	0	Open	No	0						122.2	613	307	0.579	#####	#DIV/0!	#DIV/0!	#DIV/0!	#####	#####
13.00	649.73	1.00	122.2	Dolomite	25	Fractured	0	Open	No	0															
14.00	648.73	1.00	122.2	Dolomite	25	Fractured	0	Open	No	0															
15.00	647.73	1.00	122.2	Dolomite	25	Fractured	0	Open	No	0															
16.00	646.73	1.00	122.2	Dolomite	18	Fractured	0	Open	No	0															
17.00	645.73	1.00	122.2	Dolomite	18	Fractured	0	Open	No	0															
18.00	644.73	1.00	122.2	Dolomite	18	Fractured	0	Open	No	0															
19.00	643.73	1.00	122.2	Dolomite	18	Fractured	0	Open	No	0															
20.00	642.73	1.00	122.2	Dolomite	18	Fractured	0	Open	No	0															

Illinois Department of Transportation

DRILLED SHAFT AXIAL CAPACITY IN ROCK -
DOLOMITE, LIMESTONE, SANDSTONE, AND HARD SHALE

STRUCTURE ================================ SN 046-0155
SUBSTRUCTURE & REFERENCE BORING ====== E. Abutment - Boring #2
GROUND SURFACE ELEVATION =============== 691.83 FT
GROUND WATER ELEVATION ================= FT
ESTIMATED TOP OF ROCK ELEVATION ========= 665.04 FT
DRILLED SHAFT DIAMETER IN ROCK =========== 48 IN.
FACTORED AXIAL LOAD ===================== 362 KIPS
DRILLED SHAFT CONCRETE STRENGTH, f'c ====== 3.5 KSI

FOUNDATION REDUNDANCY ==== REDUNDANT

Drilled Shaft Dia.'s for Design Table
24 IN.
30 IN,
36 IN.
42 IN.
48 IN.
60 IN.

SOCKET DEPTH (FT)	TIP ELEV. (FT)	LAYER THICK. (FT)	UNCONFINED COMPRESSIVE STRENGTH (q_u) (KSF)	ROCK TYPE	GSI	ROCK CONDITION	RQD (%)	JOINT TYPE	ROCK INTACT OR TIGHTLY JOINTED?	SIDE RESISTANCE						AVG. q_u W/IN 2 - SHAFT DIA. (KSF)	TIP RESISTANCE			COMBINED SIDE & TIP RESISTANCE					
										NOM. RESIST. (KIPS)	Σ NOM. RESIST. (KIPS)	Σ FACT. RESIST. (KIPS)	SETTLEMENT				NOM. RESIST. (KIPS)	FACT. RESIST. (KIPS)	SETTL. w_{Rn} (IN.)	R_p/R_n	NOM. RESIST. (KIPS)	FACT. RESIST. (KIPS)	SETTLEMENT		
													Q_{C1} (KIPS)	w_{C1} (IN.)	w_{Rn} (IN.)								Q_{C1} (KIPS)	w_{C1} (IN.)	w_{Rn} (IN.)
1.00	664.04	1.00	122.2	Dolomite	15	Fractured	11	Open	No	33	33	18	0	0.000	-0.471	162.9	483	241	0.483	1.00	483	241	0	0.000	0.076
2.00	663.04	1.00	122.2	Dolomite	15	Fractured	11	Open	No	33	65	36	80	0.053	-0.428	162.9	494	247	0.472	0.55	145	76	135	0.053	0.062
3.00	662.04	1.00	122.2	Dolomite	15	Fractured	11	Open	No	33	98	54	119	0.084	-0.403	196.9	560	280	0.519	0.45	177	93	210	0.084	0.055
4.00	661.04	1.00	122.2	Dolomite	15	Fractured	11	Open	No	33	130	72	159	0.106	-0.386	231.0	624	312	0.560	0.37	208	111	278	0.107	0.048
5.00	660.04	1.00	122.2	Dolomite	15	Fractured	11	Open	No	33	163	89	199	0.124	-0.372	265.0	686	343	0.597	0.32	239	128	342	0.125	0.041
6.00	659.04	1.00	284.9	Dolomite	25	Fractured	20	Open	No	90	253	139	269	0.142	-0.010	278.7	1077	538	0.964	0.50	501	263	428	0.143	0.203
7.00	658.04	1.00	284.9	Dolomite	25	Fractured	20	Open	No	90	343	189	340	0.157	0.183	292.5	1127	563	1.039	0.50	687	361	511	0.159	0.302
8.00	657.04	1.00	122.2	Dolomite	23	Fractured	20	Open	No	59	403	221	380	0.160	0.299										
9.00	656.04	1.00	122.2	Dolomite	23	Fractured	20	Open	No	59	462	254	420	0.163	0.389										
10.00	655.04	1.00	122.2	Dolomite	23	Fractured	20	Open	No	59	521	286	460	0.166	0.462										
11.00	654.04	1.00	394.6	Dolomite	20	Fractured	11	Open	No	58	579	319	548	0.188	0.317										
12.00	653.04	1.00	394.6	Dolomite	20	Fractured	11	Open	No	58	638	351	636	0.208	0.215										
13.00	652.04	1.00	394.6	Dolomite	20	Fractured	11	Open	No	58	696	383	724	0.226	0.138										
14.00	651.04	1.00	394.6	Dolomite	20	Fractured	11	Open	No	58	755	415	812	0.243	0.079										
15.00	650.04	1.00	394.6	Dolomite	20	Fractured	11	Open	No	58	813	447	901	0.259	0.033										

Used as the estimated Settlement in the SGR

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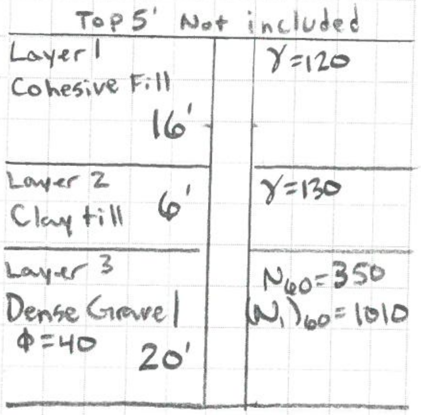
$\Sigma_i R = \Sigma_i \varphi_S R_{SN} + \varphi_B R_{BN}$

Granular: $\varphi_S = 0.55$, $\varphi_B = 0.50$

Cohesive: $\varphi_s = 0.45$, $\varphi_B = 0.40$



Granular soils

$R_{SN} = \pi B D_Z f_{SN}$ $\qquad R_{BN} = \frac{\pi B^2}{4} q_{BN}$

$f_{SN} = \sigma_v' K \tan\delta \Rightarrow \beta = K \tan\delta$

$f_{SN} = \sigma_v' \beta$

$\delta = \phi' = 27.5 + 9.5 \log(N_1)_{60}$

$K_o = (1 - \sin\phi')\, OCR^{\sin\phi'} \leq K_p = \tan^2(45 + \frac{\phi'}{2})$

$OCR = \frac{\sigma_p'}{\sigma_v'}$, $\sigma_p' = P_a (0.47)(N_{60})^m$

$m = 0.6$ For clean quartz sand

$m = 0.8$ For silty sands

$P_a = 2116$ psf

$q_{BN} = 0.6 N_{60} \leq 30$ tsf

Cohesive soils

$R_{SN} = \pi B D_Z f_{SN}$ $\qquad R_{BN} = \frac{\pi B^2}{4} q_{BN}$

$f_{SN} = \alpha S_u$ where

$\alpha = 0$, $D \leq 5$

$\alpha = 0.55$, $\frac{S_u}{P_a} \leq 1.5$

$\alpha = 0.55 - 1.0(\frac{S_u}{P_a} - 1.5)$, $1.5 \leq \frac{S_u}{P_a} \leq 2.25$

$q_{BN} = N_c^* S_u$

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Layer 1 - Cohesive

$$\text{Average } S_u = \frac{4000+2700+2000+4500+2500+3600}{6} = 3200\,\text{psf}$$ ✓

$$\frac{S_u}{P_a} = \frac{3200}{2116} = 1.51$$ ✓

$$\alpha = 0.55 - 1.0(1.51-1.5) = 0.54$$ ✓

Unit side resistance: $f_{SN} = 0.54(3200) = 1728\text{ psf}$ ✓

Factored Side Resistance = 0.94 ksf
TLM 1-5-18

Layer 2 - Cohesive

$$\text{Average } S_u = \frac{1500+2900}{2} = 2200\,\text{psf}$$ ✓

$$\frac{S_u}{P_a} = \frac{2200}{2116} = 1.03$$ ✓

$1.03 < 1.5$ so, $\alpha = 0.55$ ✓

Unit side resistance: $f_{SN} = 0.55(2200) = 1210\text{ psf}$ ✓

Factored Side Resistance = 0.67 ksf
TLM 1-5-18

Layer 3 - Granular/Gravely

for the case that the rock socket is treated as angular gravel TLM 1-5-18

$$\sigma'_v = (16 \times 120\,\text{pcf}) + (6 \times 125\,\text{pcf}) + (10 \times 135\,\text{pcf}) = 4020\,\text{psf}$$ ✓

$\delta = 46^\circ$, as directed ✓

$$\sigma'_p = 2116(0.15)(350) = 111090\,\text{psf}$$ ✓

$$OCR = \frac{111090}{4020} = 27.63$$ ✓

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Layer 3 - Granular cont.

$K_o = (1-\sin 46)\, 27.63^{\sin 46} = 3.05$ $K_o \leq K_p$ ✓

$K_p = \tan^2(45 + \frac{46}{2}) = 6.12$

$\beta = 3.05 \tan 46 = 3.17$

Unitside Resistance : $f_{SN} = 4020\,psf \times 3.17 = 12743\, psf$ Factored Side Resistance = 6.99 ksf

Base Resistance for the case if the rock socket is treated as angular gravel
TCM 1-5-18

$q_{BN} = 0.6\, N_{60}$

$q_{BN} = 0.6(350) = 210\, tsf$ Factored Base Resistance = 105 tsf

$\overset{105\,tsf}{\cancel{210}} \; \overset{\geq}{\cancel{\leq}} \; 30\, tsf$ X

Use 30tsf AASHTO 10.8.3.5.2C, Tip Resistance

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Unit Tip Resistance

$$q_p = A + q_u\left[m_b\left(\frac{A}{q_u}\right) + s\right]^a$$ 10.3.3.5.4c-2

$$A = \sigma_{vb}' + q_u\left[m_b\frac{(\sigma_{vb}')}{q_u} + s\right]^a$$ 10.8.3.5.4c-3

Assume a 7ft Rock socket

$\sigma_{vb}' = 120pcf(6') + 135pcf(7') = 1665psf = 1.7ksf$

$q_u = 120\ tsf = 240\ ksf$

$s = e^{\left(\frac{GSI - 100}{9-3D}\right)}$ 10.4.6.4-2

$e = 2.718$

$GSI = 20$

$D = 0.5$

$s = 2.718^{\left(\frac{20-100}{9-3(0.5)}\right)} = 0.00002$

$a = \frac{1}{2} + \frac{1}{6}\left(e^{\left(-\frac{GSI}{15}\right)} - e^{-20/3}\right)$ 10.4.6.4-3

$a = \frac{1}{2} + \frac{1}{6}\left(2.718^{\left(-\frac{20}{15}\right)} - 2.718^{-20/3}\right)$

$a = \frac{1}{2} + \frac{1}{6}(0.26 - 0.001)$

$a = 0.54$

$m_b = m_i e^{\left(\frac{GSI - 100}{28-14D}\right)}$

$m_i = 9$ from Table 10.4.6.4-1 AASHTO Bridge Manual

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$m_i = 9$

$m_b = 9 \cdot 2.718^{\left(\frac{20-100}{28-7}\right)}$ 10.4.6.4-4

$m_b = 0.1995 \simeq 0.20$

$A = \sigma_{vb}' + q_u\left[m_b \frac{(\sigma_{vb}')}{q_u} + s\right]^a$ 10.8.3.5.4c-3

$A = 1.7\text{ksf} + 240\text{ ksf}\left[0.20\ \frac{(1.7\text{ksf})}{240\text{ ksf}} + 0.00002\right]^{0.54}$

$A = 8.7$ ksf

$q_p = A + q_u\left[m_b\left(\frac{A}{q_u}\right) + s\right]^a$ 10.8.3.5.4c-2

$q_p = \overset{8.7}{\cancel{11.48}}\text{ksf} + 240\text{ksf}\left[0.20\left(\frac{\overset{8.7}{\cancel{11.48}}\text{ksf}}{240\text{ ksf}}\right) + 0.00002\right]^{0.54}$

$q_p = 25.5$ksf

$\phi_p = 0.5$

Factored Unit Tip Resistance = 12.75 ksf

Project Armour Road – Drilled Shafts – Rock

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Unit Side Resistance in Fractured Rock

$$q_s = Pa \cdot 0.65 \alpha_E \sqrt{\frac{q_u}{Pa}}$$ 10.8.3.5.4b-2

$Pa = 2.12$ ksf

$\alpha_E \approx 0.45$

$q_u = 240$ ksf

$$q_s = 2.12\text{ ksf} \cdot 0.65 \cdot 0.45 \cdot \sqrt{\frac{240\text{ ksf}}{2.12\text{ ksf}}}$$

$q_s = 6.6$ ksf ✓

$\phi_s = 0.55$

Factored Unit Side Resistance = 3.63 ksf ✓

Table 10.5.5.2.4-1—Resistance Factors for Geotechnical Resistance of Drilled Shafts

Method/Soil/Condition			Resistance Factor
Nominal Axial Compressive Resistance of Single-Drilled Shafts, φ_{stat}	Side resistance in clay	α-method (Brown et al., 2010)	0.45
	Tip resistance in clay	Total Stress (Brown et al., 2010)	0.40
	Side resistance in sand	β-method (Brown et al., 2010)	0.55
	Tip resistance in sand	Brown et al. (2010)	0.50
	Side resistance in cohesive IGMs	Brown et al. (2010)	0.60
	Tip resistance in cohesive IGMs	Brown et al. (2010)	0.55
	Side resistance in rock	Kulhawy et al. (2005) Brown et al. (2010)	0.55
	Side resistance in rock	Carter and Kulhawy (1988)	0.50
	Tip resistance in rock	Canadian Geotechnical Society (1985) Pressuremeter Method (Canadian Geotechnical Society, 1985) Brown et al. (2010)	0.50
Block Failure, φ_{b1}	Clay		0.55
Uplift Resistance of Single-Drilled Shafts, φ_{up}	Clay	α-method (Brown et al., 2010)	0.35
	Sand	β-method (Brown et al., 2010)	0.45
	Rock	Kulhawy et al. (2005) Brown et al. (2010)	0.40
Group Uplift Resistance, φ_{ug}	Sand and clay		0.45
Horizontal Geotechnical Resistance of Single Shaft or Shaft Group	All materials		1.0
Static Load Test (compression), φ_{load}	All Materials		0.70
Static Load Test (uplift), φ_{upload}	All Materials		0.60

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Micropile Geotechnical Capacity

use 10" micropiles

O.D. = 10.75"

assume drill hole dia = O.D. + 2"

= 12.75" = 1.0625'

$\therefore$ use - bond α = 19 psi × $\frac{144 \text{ in}^2}{\text{ft}^2}$ = 2736 psf

- 15 piles

1447 kip ÷ 15 = 96.5 kip/pile

from Farnsworth Group

$$L_b = \frac{P \times FS}{\alpha_{Bond} \times \pi \times D} = \text{bond length}$$

$$L_b = \frac{96500 \times 2}{2736 \frac{\text{lb}}{\text{ft}^2} \times \pi \times 1.0625 \text{ ft}}$$

as recommended in FHWA manual

L_b = 21.13 ft

= 26.41 ft @ 12 piles

Table 5-3. Summary of Typical α_{bond} (Grout-to-Ground Bond) Values for Micropile Design.

Soil / Rock Description	Grout-to-Ground Bond Ultimate Strengths, kPa (psi)			
	Type A	Type B	Type C	Type D
Silt & Clay (some sand) (soft, medium plastic)	35-70 (5-10)	35-95 (5-14)	50-120 (5-17.5)	50-145 (5-21)
Silt & Clay (some sand) (stiff, dense to very dense)	50-120 (5-17.5)	70-190 (10-27.5)	95-190 (14-27.5)	95-190 (14-27.5)
Sand (some silt) (fine, loose-medium dense)	70-145 (10-21)	70-190 (10-27.5)	95-190 (14-27.5)	95- 240 (14-35)
Sand (some silt, gravel) (fine-coarse, med.-very dense)	95-215 (14-31)	120-360 (17.5-52)	145-360 (21-52)	145-385 (21-56)
Gravel (some sand) (medium-very dense)	95-265 (14-38.5)	120-360 (17.5-52)	145-360 (21-52)	145-385 (21-56)
Glacial Till (silt, sand, gravel) (medium-very dense, cemented)	95-190 (14-27.5)	95-310 (14-45)	120-310 (17.5-45)	120-335 (17.5-48.5)
Soft Shales (fresh-moderate fracturing, little to no weathering)	205-550 (30-80)	N/A	N/A	N/A
Slates and Hard Shales (fresh-moderate fracturing, little to no weathering)	515-1,380 (75-200)	N/A	N/A	N/A
Limestone (fresh-moderate fracturing, little to no weathering)	1,035-2,070 (150-300)	N/A	N/A	N/A
Sandstone (fresh-moderate fracturing, little to no weathering)	520-1,725 (75.5-250)	N/A	N/A	N/A
Granite and Basalt (fresh-moderate fracturing, little to no weathering)	1,380-4,200 (200-609)	N/A	N/A	N/A

Type A: Gravity grout only
Type B: Pressure grouted through the casing during casing withdrawal
Type C: Primary grout placed under gravity head, then one phase of secondary “global” pressure grouting
Type D: Primary grout placed under gravity head, then one or more phases of secondary “global” pressure grouting

Table 4-5. Dimensions and Yield Strength of Common Micropile Pipe Types and Sizes.

API N-80 Pipe – Common Sizes					
Casing OD Wall(1), mm (in.)	139.7 (5.500)	139.7 (5.500)	177.8 (7.000)	177.8 (7)	244.5 (9.625)
Wall Thickness(1), mm (in.)	9.17 (0.361)	10.5 (0.415)	12.6 (0.498)	18.5 (0.73)	12.0 (0.472)
Area(2), mm^2 ($in.^2$)	3760 (5.83)	4280 (6.63)	6560 (10.2)	9280 (14.4)	8760 (13.6)
Yield Strength(3), kN (kip)	2,070 (466)	2,360 (530)	3,620 (814)	5,120 (1,151)	4,830 (1,086)
ASTM A519, A106 Pipe – Common Sizes(5)					
Casing OD Wall(1), mm (in.)	139.7 (5.50)	168.3 (6.625)	203.2 (8.00)	273.1 (10.75)	-
Wall Thickness(1), mm (in.)	12.7 (0.50)	12.7 (0.50)	12.7 (0.50)	16 (0.625)	-
Area(2), mm^2 ($in.^2$)	5,067 (7.85)	6,208 (9.62)	7,600 (11.8)	12,850 (19.9)	-
Yield Strength(3), kN (kip)	1,270 (286)	1,540 (346)	1,890 (425)	3,190 (717)	-

Notes: (1)Casing outside diameter (OD) and wall thickness (t) are nominal dimensions.
(2)Steel area is calculated as $A_s = (\pi/4) \times (OD^2 - ID^2)$.
(3)Nominal yield stress for API N-80 steel is F_y = 552 MPa (80 ksi).
(4)Nominal yield stress for ASTM A519 & A106 steel is F_y = 241 MPa (36 ksi).
(5)Other pipe sizes are manufactured but may not be readily available. Check for availability through suppliers.

Boring #	Soil Type	RQD %	Angle of Internal Friction (degrees)	Average Undrained Cohesion (ksf)	Static Soil Modulus, k (pci)	Soil Strain Parameter E50	Effective Unit Wt. (pcf)	k
W. Abut. IDOT borings 3 (1962), 1 (2000) & B1 (2017)	Cohesive Fill	-	-	3.2	-	0.005	120	-
	Stiff Clay	-	-	1.7	-	0.007	120	-
	Fractured Dolostone (treat as Dense Granular)	0	46	-	-	-	72.0	160
Piers 1 IDOT boring 1 (1962) B1 (2017)	Loose Sandy Loam	-	28	-	-	0.004	120.0	
	Soft Clay Loam	-	-	0.5	-	0.02	115.0	
	V. Stiff to Hard Clay Till	-	-	3.7	-	0.005	125.0	-
	Fractured Dolostone (treat as Dense Granular)	0	46	-	-	-	72.0	160
Pier 2 IDOT boring 4 (1962) B2 (2017)	Cohesive Fill	-	-	1.5	-	0.007	120.0	-
	Very Stiff Clay Till	-	-	2.9	-	0.005	125.0	
	Fractured Dolostone (treat as Dense Granular)	11	46	-	-	-	72.0	160
E. Abut. IDOT borings 5 (1962) 1 (2000) & B2 (2017)	Cohesive Fill	-	-	3.2	-	0.005	120.0	
	Stiff Clay Loam	-	-	1.5	-	0.007	120.0	
	Stiff Clay	-	-	1.8		0.007	120.0	
	Hard Clay Till	-	-	4.8	-	0.004	130.0	
	Stiff Clay Till	-	-	1.4	-	0.007	120.0	
	Fractured Dolostone (treat as Dense Granular)	11	46	-	-	-	72.0	160