VMS Boring

MEMORANDUM

MATERIALS AND GEOTECHNICAL BRANCH
GEOTECHNICAL PROGRAM
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DEPARTMENT OF TRANSPORTATION

1000 Ft W/ of prop. boring at 219+00 (Alt #2)

Variable Message Sign
I70, MM 243.45 Eastbound
Hidden Valley

TO: Alvin Stamp, CDOT - ITS

FROM: Laura A. Conroy, Geotechnical Program

DATE: July 29, 2010

SUBJECT: **FINAL GEOTECHNICAL RECOMMENDATIONS**
HIDDEN VALLEY SIGN, I70 MM 243.45 EASTBOUND

1.0 INTRODUCTION

This report presents geotechnical observations and recommendations for the proposed variable message sign structure on the eastbound shoulder of I70 at MM 243.45, Hidden Valley. The purpose of the geotechnical exploration is to characterize physical properties of foundation materials at the proposed sign location. We understand that a new variable message sign will replace the existing variable message sign at this location. Typically, the new cantilever sign is constructed on a 48 inch maximum diameter caisson drilled to a maximum depth of 29 feet below grade in accordance with CDOT Standard Plan No. S-614-50, sheet 14 of 14.

2.0 GEOTECHNICAL INVESTIGATION

The boring location was determined with Alvin Stamp of ITS on June 4, 2010. The boring was located on the eastbound shoulder approximately 40 feet east of the existing variable message sign. One boring was drilled on June 10, 2010 using a CME 75 drill rig using wireline core drilling methods. The boring was advanced to a depth of 32 feet. Standard penetration tests using split spoon samplers were performed in the boring at select intervals per ASTM D-1586.

2.1 SUBSURFACE CONDITIONS

The geology generally consists of gravel with sand, cobbles and boulders to a depth of approximately 24 feet below ground surface (bgs). A portion of the overburden soils may be fill material from prior roadway construction. Gneiss bedrock was encountered at a depth of approximately 24 feet bgs to the boring termination depth of approximately 32 feet bgs. The relative density of the overburden soils ranged from loose to very dense. The relative density was dependent on the amount of cobbles and boulders encountered at the sample depth. A piezometer was installed in the boring at the time of drilling to a depth of 32 feet bgs to allow for future measurement of groundwater. On June 23, 2010 the groundwater was measured at 11.9 feet bgs in the piezometer and on July 14, 2010 the groundwater was measured at 12.8 feet bgs. The boring log is included as Attachment 1.

2.2 LABORATORY TESTING

Laboratory testing was performed on selected samples to confirm the visual classifications. The gravel samples had AASHTO classifications of A-1-a with group index values of 0.

In addition one sample was analyzed for percent sulfate and pH. The sample was taken at a depth of approximately 12 to 13.5 feet bgs. The result of the water soluble sulfate test was 0. This test was performed in accordance with CP-L 2103. Based on the results of the water soluble sulfate test, the potential for sulfate attack on Portland cement concrete in direct contact with the foundation soils is classified as a Class 0 exposure per Table 601-4 of the CDOT Standard Special Revision Section 601. The pH test result was 5.6. This indicates a mild to no corrosion potential/non-aggressive condition for steel in contact with soil per Table C.1 of FHWA report FHWAO-IF-3-017, Geotechnical Engineering Circular No. 7 – Soil Nail Walls.

Our laboratory test results are presented in Attachment 2.

3.0 RECOMMENDATIONS – DRILLED SHAFTS

At the sign location, the encountered materials have strength characteristics greater than those used for drilled shaft design in the CDOT Standard Plan No. S-614-50, sheet 14 of 14. The depth of embedment for the shaft foundation is assumed to be controlled by lateral or torsional loading. Site specific recommendations are presented in Table 1 below. The capacities for the overburden soils presented below were determined using the equations from *Drilled Shafts: Construction Procedures and LRFD Design Methods*, May 2010, FHWA-NHI-10-016. The capacities for the gneiss bedrock were determined using the Denver Method.

TABLE 1. I70, MM 243.45 Sign Foundation
Recommended Ultimate Capacities, LRFD Method

Material	Depth Interval (ft)	Ultimate end bearing (ksf)	Ultimate side shear (ksf)
Overburden soils	5-24	24	0.9
Gneiss Bedrock	>24	150	15

The recommended side shear capacity can be used for torsional resistance and is applicable in both vertical directions without reduction. Because this is a non-redundant foundation, a resistance factor of 0.4 is recommended for end bearing. A resistance factor of 0.44 is recommended for side shear under compressive loading. A resistance factor of 0.34 is recommended for side shear in an uplift condition. The ultimate capacities of the gneiss bedrock assume a weighted load factor of 1.5.

The upper 5 feet of soil should be neglected for axial resistance. The lateral load analysis of the drilled shaft using LPILE should utilize the material properties presented in Table 2.

TABLE 2. I-70 MM 243.45 Eastbound Sign Foundation Recommended Material Properties for Lateral Load Analysis of Drilled Shaft using LPILE

Material	Depth Interval (ft)	Internal Friction Angle, ϕ (degrees)	Cohesion, c (lb/ft^2)	Modulus of Horizontal Subgrade Reaction, k_h (lb/in^3)	Strain at ½ the maximum principal stress difference, ε_{50}	Total Unit Weight, γ_T (lb/ft^3)
Overburden soils above the water table	0 to 12	33	–	90	–	115
Overburden soils below the water table	12-24	33		60		120
Gneiss bedrock	>24	–	8,000	2,000	0.004	140

Difficult caisson construction drilling should be expected due to the presence of cobbles and boulders in the overburden soils and the nature of very hard gneiss bedrock. Groundwater is anticipated to be encountered during shaft construction. Caving soils should be expected, especially below the groundwater table. Casing or drilling mud may be required during the excavation of the caisson holes. Dewatering of the bottom of the caisson holes may also be required during construction prior to the placement of concrete. Alternatively, the concrete may be placed by tremie or other methods to avoid segregation of the aggregate or voids in the finished shaft. If rock coring techniques are utilized for caisson construction, the bedrock socket should be roughened.

Please contact the Geotechnical Program at 303-398-6603 with questions.

REVIEW: Liu

COPY: DeVito – R1 RTD
Schiebel – R1 Materials Engineer
Wang – Staff Bridge
Zufall/Kotzer – Branch Materials and Geotech
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ATTACHMENT 1

BORING LOG

GEOLOGICAL BORING LOG

1

DEPARTMENT OF TRANSPORTATION

PROJECT ID	SA	PROJECT NAME	DATE DRILLED
		Hidden Valley Sign	6/10/10

ROUTE	COUNTY	STRUCTURE/BENT	LOCATION
I 70	Clear Creek	Sign/	MM 243.45

TOP HOLE ELEV	TOTAL DEPTH	SURVEY INFO	GEOLOGIST/FOREMAN
	32.0ft		L. Conroy/R. Brown

ELEV (ft)	DEPTH (ft)	LOG	DESCRIPTION	SAMPLE TYPE	DEPTH (ft)	SAMPLE ID	N-VALUE REC%/RQD%
			Gravel and Cobbles with Gneiss Boulders and Sand (possible fill)		0.0		
	2.5						
	3.0		*lost water* / *water back*				
	5.5		Gravel with Sand and Silt, gray, dense (possible fill)		5.5	1A 12-13-35	48
	7.0		Gravel and Cobbles with Sand and Boulders (possible fill)		7.0		
	12.0		Gravel with Sand and Clay, brown, loose, occasional boulders and Cobbles (possible fill)		12.0 12.0	1B 4-7-2	9
	17.0		dense		17.0 17.0	1C 9-15-16	31
	22.0		gray, very dense		22.0 22.0	1D 17-50/5"	50/5" 67% 56%
	24.0		Gneiss Bedrock, gray, very hard, jointed with iron stains (joints near horizontal or near vertical)				
					27.0 27.0	1E bounced	4/0" 100% 78%
	28.0		SPT refusal, no recovery				
	32.0 32.0		SPT refusal, no recovery Total Boring Depth 32.0ft		32.0	1F bounced	10/0"

SPT DATA: 5 10 20 40 70

WELL DIAGRAM: piezometer installed

SPT | CON'T | GRAB | SHELBY | CORE | CALIFORNIA

H_2O DEPTH	▽ 11.9	▼ 12.8
DATE	6/23/10	7/14/10

NOTES: CME 75, Wireline

LOGIC BORING LOG I70 MM234 HIDDEN VALLEY SIGN.GPJ CO_DOT.GDT 7/29/10

ATTACHMENT 2
I70, MM 243.45 Eastbound, Hidden Valley
LABORATORY TEST SUMMARY

Boring No.	Depth (ft)	Sample No.	Visual Description	USCS	AASHTO	AASHTO Gradation				Liquid Limit	Plastic Limit	Plasticity Index	Water Content (%)	Dry Density (lb/ft^3)	Uniaxial Compressive Strength/Strain (psf/%)	Swell (%)	Water Soluble Sulfates (%)	Soil pH ($H_2O/CaCl_2$)	Resistivity ohm/cm Saturated
						Gravel (%)	Coarse Sand (%)	Fine Sand (%)	Silt & Clay (%)										
TH1	5.5-7	1A	Gravel w/sand	GP-GM	A-1-a (0)	59.5	14.6	17.9	8.1	NV	–	NP	5.0	–	–	–	–	–	–
TH1	12-13.5	1B	Gravel w/sand	–	–	–	–	–	–	–	–	–	–	–	–	–	0.0	5.6	–
TH1	17.18.5	1C	Gravel w/sand	GP-GC	A-1-a (0)	79.2	5.3	6.9	8.6	27	21	6	11.8	–	–	–	–	–	–