

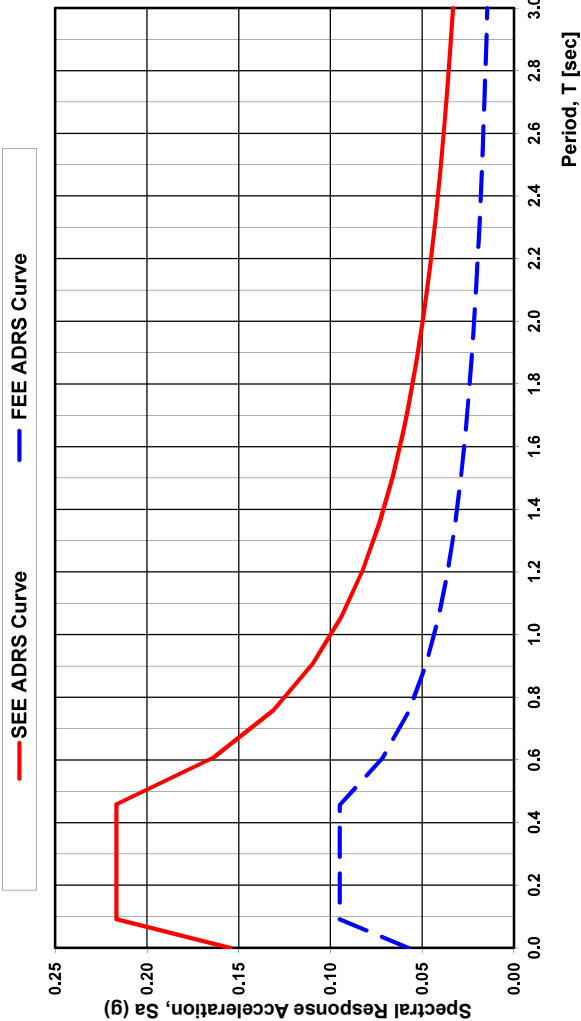
Appendix E

Seismic Data (From SCDOT)

SC Seismic Hazard Map Three-Point ADRS Curves				
PIN No: 38111	Project ID: 0038111	Latitude: 34.8377	Designer: M. Humphries - Upstate RPG	
Route: I-85/I-385	County: Greenville	Longitude: 82.2884	Date: 10/27/2014	
Project: I-85/I-385 Interchange Design Build				

Design EQ	PGA	S _{as}	S _{p1}	M _W	R (km)	Geologic Condition	Site Class	Damping
FEE	0.06	0.09	0.04	7.4	266	Geologically Realistic (Q = 100)	C	5%
SEE	0.15	0.22	0.10	7.4	266	Geologically Realistic (Q = 100)	C	

SC Seismic Hazard Map Three-Point ADRS Curve From Ground Surface



FEE ADRS Curve Three-Point Method			SEE ADRS Curve Three-Point Method		
T	S _a	T ₀	T	S _a	T ₀
0.00	0.06		0.00	0.22	
0.02	0.06		0.02	0.16	
0.03	0.07		0.03	0.18	
0.05	0.08		0.05	0.19	
0.06	0.08		0.06	0.20	
0.08	0.09		0.08	0.21	
0.09	0.09		0.09	0.22	
0.12	0.09		0.12	0.22	
0.15	0.09		0.15	0.22	
0.18	0.09		0.18	0.22	
0.21	0.09		0.21	0.22	
0.24	0.09		0.24	0.22	
0.27	0.09		0.28	0.22	
0.30	0.09		0.31	0.22	
0.33	0.09		0.34	0.22	
0.37	0.09		0.37	0.22	
0.40	0.09		0.40	0.22	
0.43	0.09		0.43	0.22	
0.46	0.09		0.46	0.22	
0.61	0.07		0.61	0.16	
0.76	0.06		0.76	0.13	
0.91	0.05		0.91	0.11	
1.06	0.04		1.06	0.09	
1.20	0.04		1.21	0.08	
1.35	0.03		1.36	0.07	
1.50	0.03		1.51	0.07	
1.65	0.03		1.65	0.06	
1.80	0.02		1.80	0.06	
1.95	0.02		1.95	0.05	
2.10	0.02		2.10	0.05	
2.25	0.02		2.25	0.04	
2.40	0.02		2.40	0.04	
2.55	0.02		2.55	0.04	
2.70	0.02		2.70	0.04	
2.85	0.02		2.85	0.03	
3.00	0.01		3.00	0.03	

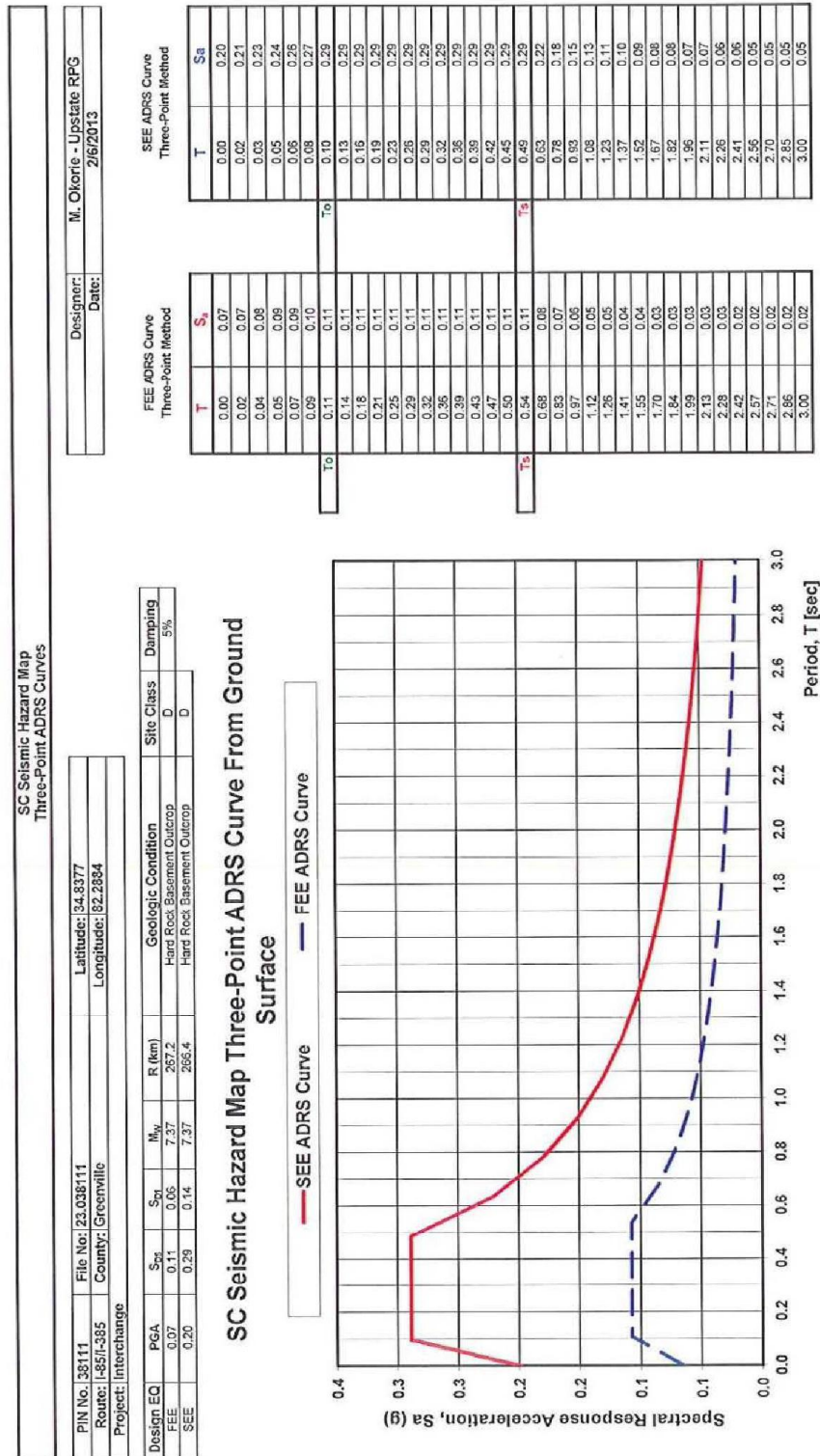


Figure 1: SC Seismic Hazard Map Three-Point ADRS Curves



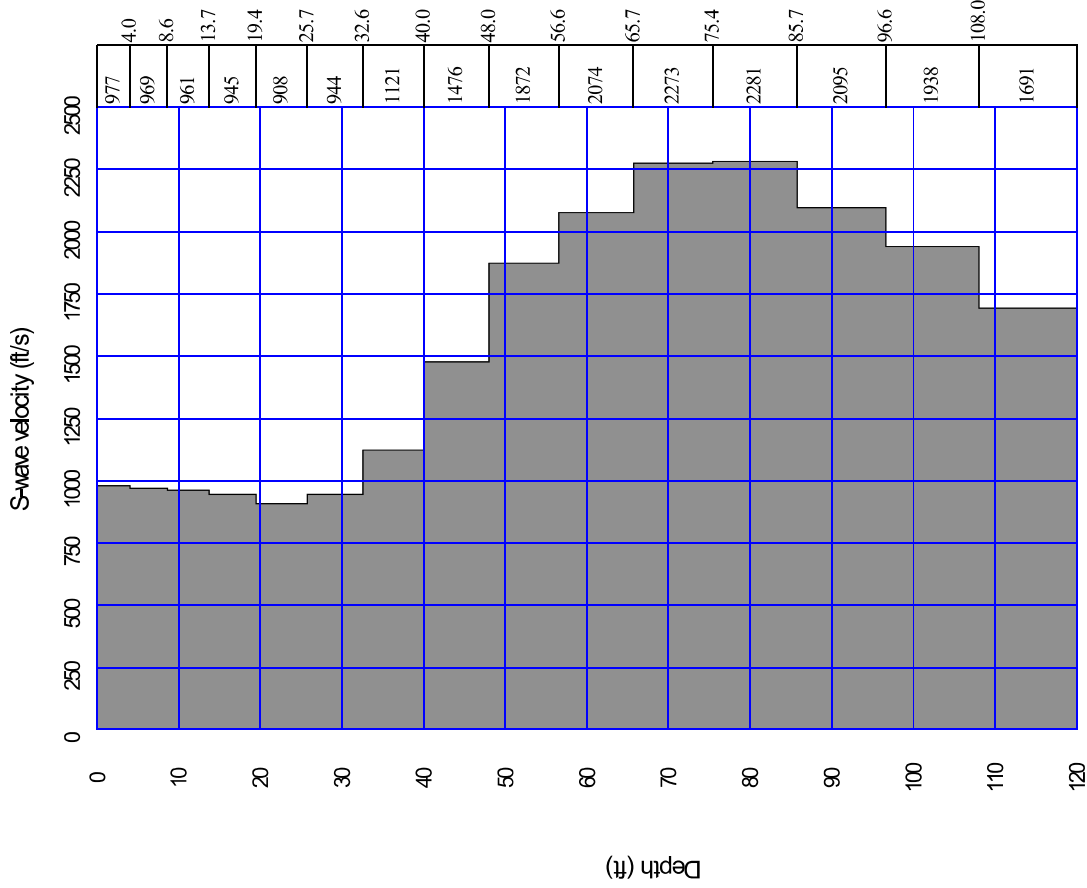
Florence & Hutcheson

An **ICA** Company

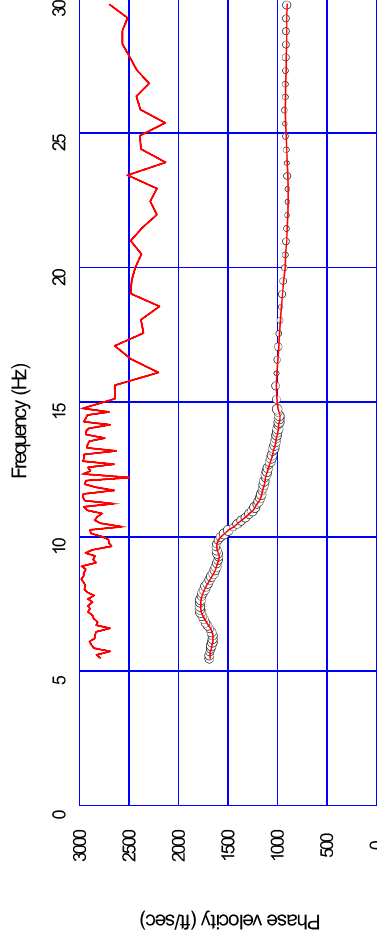
Project Name : I-85/I-385 Interchange
Location : Greenville County, South Carolina
Job Number : 08195-01
Project Job No. : 08195-01

MASW Summary

MASW Analysis No.	Alignment	Station	Offset (ft)	Average Shear Wave Velocity in Top 100 feet (ft/sec)
MASW-1	I-385 NB C/D	359+39	17' RT	1405.6
MASW-2	I-385	393+66	115' RT	1034.8
MASW-3	Ramp 4B	408+70	102' RT	1081.5
MASW-4	Roper Mt. Rd.	36+15	25' LT	1060.2



S-wave velocity model (inverted): I85-I385 MASW1 Active Passive Combined.rst
Average Vs 100ft = 1405.6 ft/sec

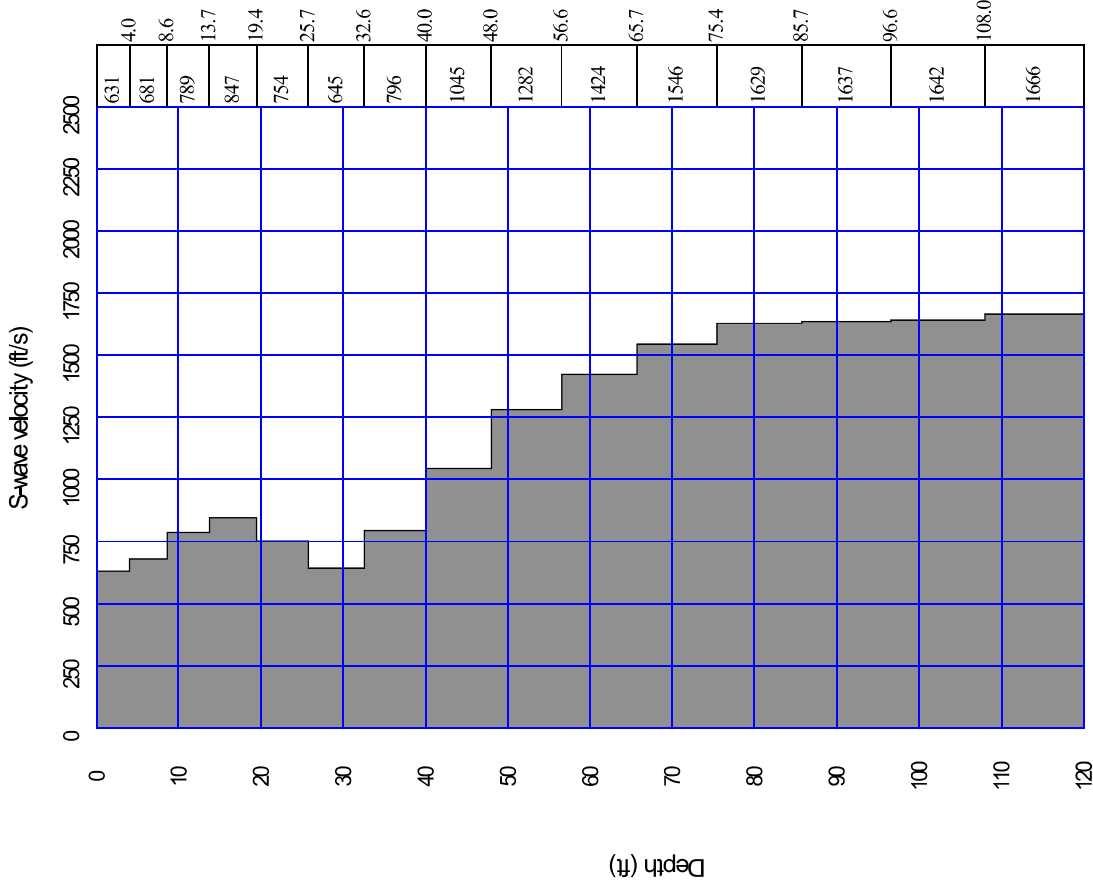


Dispersion curve: I85-I385 MASW1 Active Passive Combined.rst

Testing Results	
Depth(ft)	S-wave velocity(ft/s)
0.0	978.0
4.0	969.3
8.6	961.7
13.7	945.1
19.4	908.4
25.7	944.2
32.6	1121.6
40.0	1476.1
48.0	1872.5
56.6	2074.3
65.7	2281.4
75.4	2095.7
85.7	1938.6
96.6	1691.2
108.0	1691.2

Project Mgr:	WL	Project No.	EN105084
Prepared by:	BTS	Scale:	NA
Checked by:	WL	Date:	12/7/2011
Approved by:	GL		

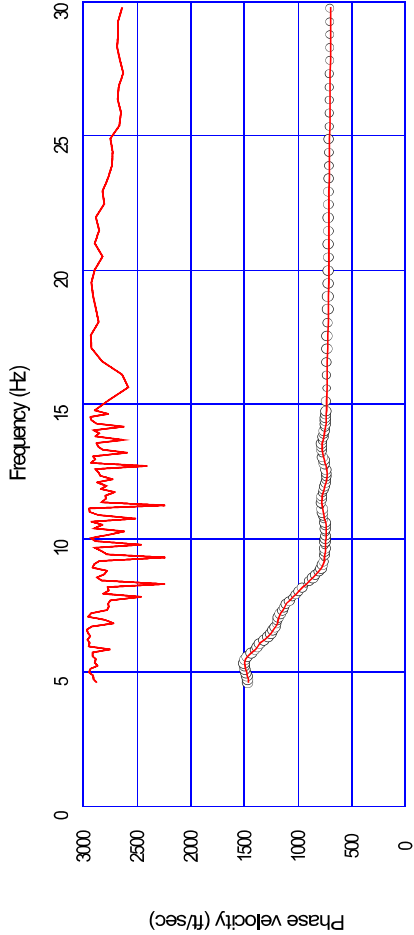
GEOPHYSICAL TESTING RESULTS MASW SHEAR WAVE VELOCITY I85 and I385 Interchange Greenville County, SC		TEST NO MASW1
--	--	--------------------------------



S-wave velocity model (inverted): 385 85 MASW2 Active Passive Combined.rst

Average Vs 100ft = 1034.8 ft/sec

Testing Results	
Depth(ft)	S-wave velocity(ft/s)
0.0	631.3
4.0	681.8
8.6	789.1
13.7	847.7
19.4	754.4
25.7	645.9
32.6	796.9
40.0	1045.9
48.0	1282.7
56.6	1424.0
65.7	1546.4
75.4	1629.8
85.7	1637.7
96.6	1642.6
108.0	1666.9



Project No. EN105084

Scale: NA

Date: 12/7/2011

Project Mgr: WL

Prepared by: BTS

Checked by: WL

Approved by: GL

TEST NO

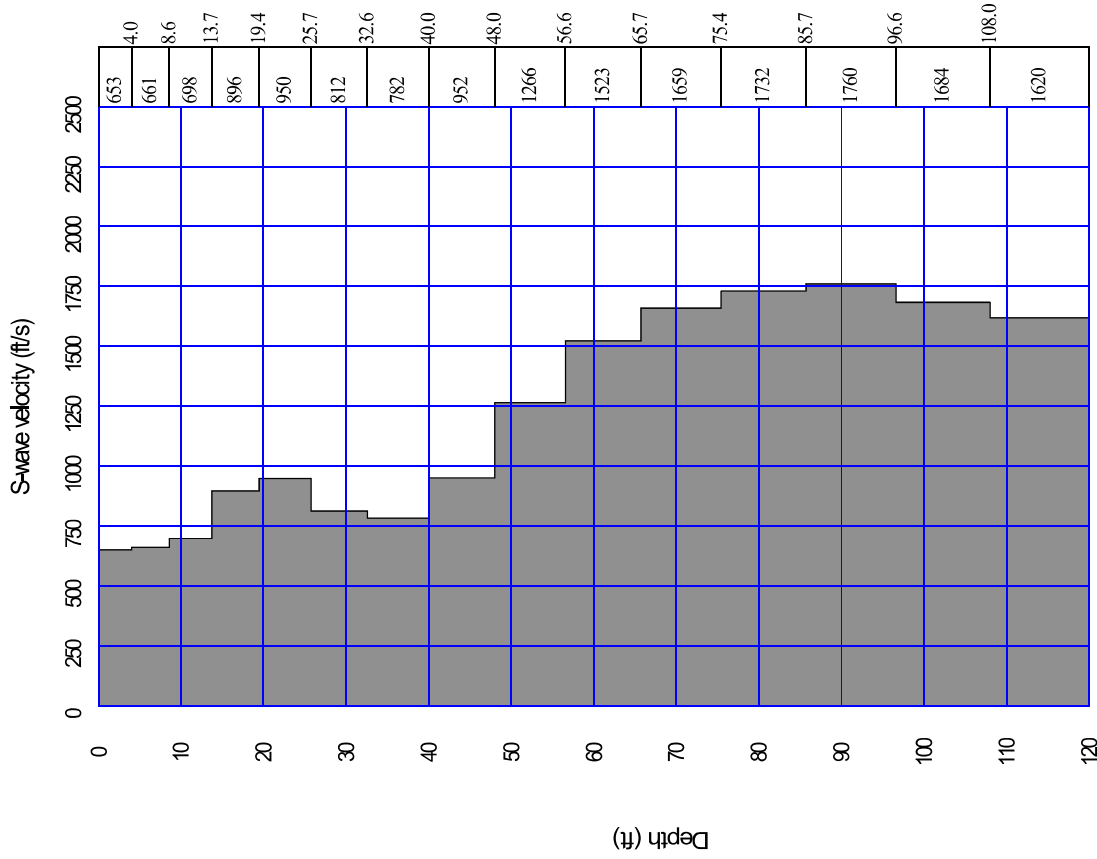
MASW2

GEOPHYSICAL TESTING RESULTS

MASW SHEAR WAVE VELOCITY

185 and I385 Interchange

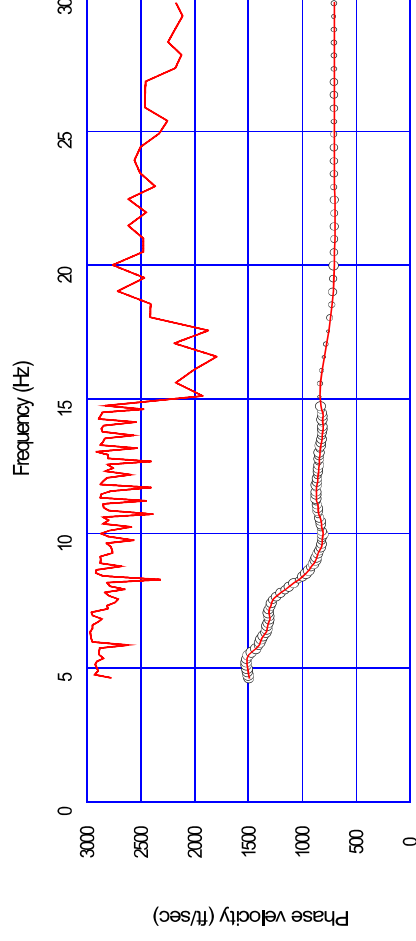
Greenville County, SC



S-wave velocity model (inverted): 385 85 MASW/3 Active Passive Combined.rst

Average Vs 100ft = 1081.5 ft/sec

Testing Results	
Depth(ft)	S-wave velocity(ft/s)
0.0	653.3
4.0	661.7
8.6	698.7
13.7	897.0
19.4	950.0
25.7	812.5
32.6	782.9
40.0	952.8
48.0	1266.2
56.6	1523.1
65.7	1659.9
75.4	1732.3
85.7	1760.4
96.6	1684.9
108.0	1620.0

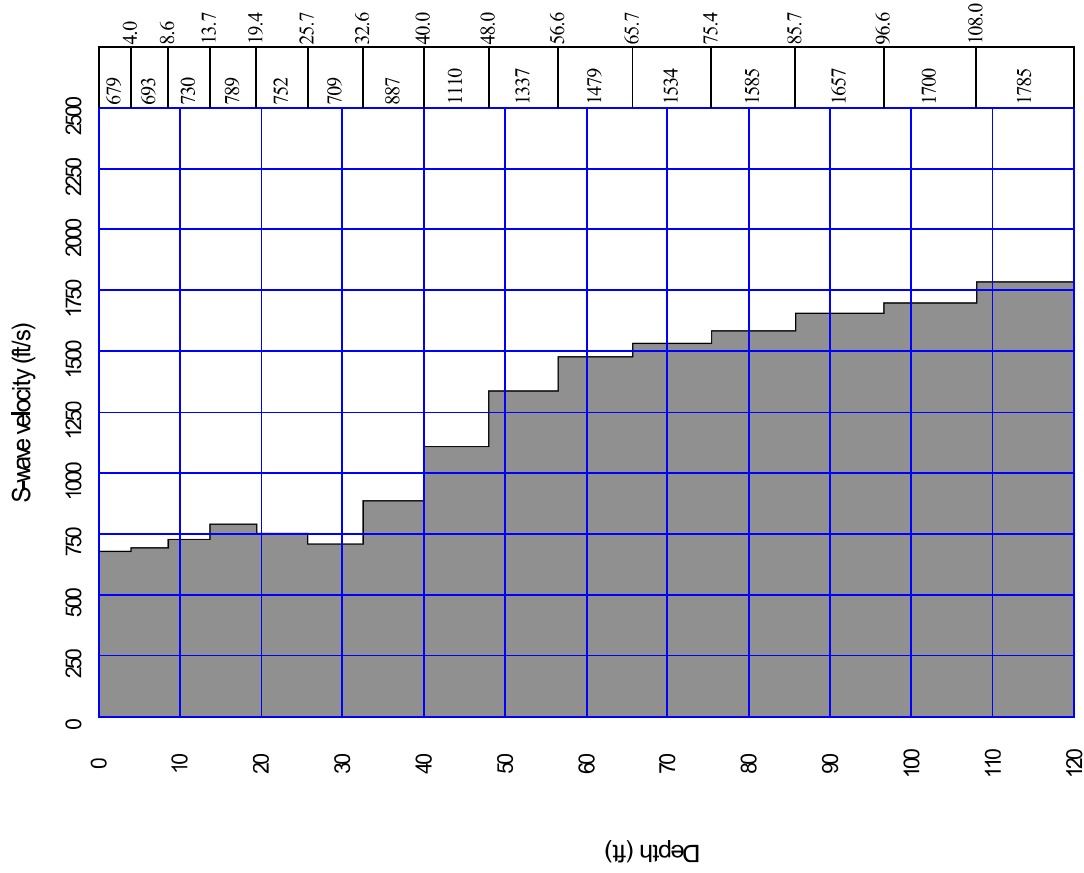


Dispersion curve : 385 85 MASW/3 Active Passive Combined.rst

Project Mgr:	WL	Project No.	EN105084
Prepared by:	BTS	Scale:	NA
Checked by:	WL	Date:	12/7/2011
Approved by:	GL		

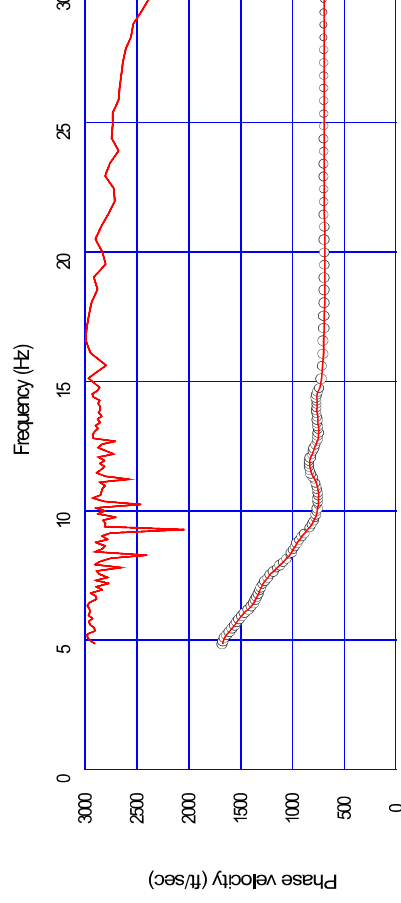
Terracon	
1450 FIFTH STREET WEST 3RD FLOOR NORTH CHARLESTON, SC 29405 PH: (843) 884-1234 FAX: (843) 884-0234	

GEOPHYSICAL TESTING RESULTS	
MASW SHEAR WAVE VELOCITY	
185 and I385 Interchange Greenville County, SC	
TEST NO	MASW3



S-wave velocity model (inverted): 385 85 MASW 4 Active Passive Combined.rst

Average Vs 100ft = 1060.2 ft/sec



Testing Results	
Depth(ft)	S-wave velocity(ft/s)
0.0	679.3
4.0	694.0
8.6	730.0
13.7	789.8
19.4	752.7
25.7	709.4
32.6	887.2
40.0	1110.1
48.0	1337.1
56.6	1479.8
65.7	1534.6
75.4	1585.6
85.7	1657.5
96.6	1700.0
108.0	1785.1

Project Mgr:	WL	Project No.	EN105084
Prepared by:	BTS	Scale:	NA
Checked by:	WL	Date:	12/7/2011
Approved by:	GL		

1450 FIFTH STREET WEST
 SUITE 604
 NORTH CHARLESTON, SC 29405
 TEL: (843) 884-2244
 FAX: (843) 884-2245

GEOPHYSICAL TESTING RESULTS MASW SHEAR WAVE VELOCITY 185 and I385 Interchange Greenville County, SC		TEST NO MASW4
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Appendix F

Liquefaction and Shear Strength Loss Triggering Evaluation

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: B01-SPT-01

GW Depth: 27.7 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SC	0.0	3.0	1.5	11	40	0.2	0.2	-0.003	0.001	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	18	5.5	24	0.13	1.10	1	0.267	6.111	0.29	0.43	0.15
2	SC	3.0	5.0	4.0	4	40	0.5	0.5	-0.037	0.005	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	7	5.5	12	0.08	1.10	1.2	0.134	0.833	0.18	0.71	0.25
3	SC	5.0	7.0	6.0	7	48	0.7	0.7	-0.068	0.008	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	12	5.5	17	0.10	1.10	1	0.176	0.972	0.19	0.64	0.22
4	SC	7.0	9.0	8.0	10	48	1.0	1.0	-0.101	0.012	0.99	0.13	0.04	1.04	0.12	0.04	1.49	0.75	15	5.5	20	0.11	1.08	1	0.208	1.042	0.22	0.55	0.19
5	SC	9.0	13.0	11.0	6	43	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.28	0.75	8	5.5	13	0.08	1.03	1.2	0.141	0.455	0.17	0.70	0.25
6	SC	13.0	15.0	14.0	15	43	1.7	1.7	-0.215	0.024	0.97	0.13	0.04	1.04	0.12	0.04	1.09	0.85	18	5.5	24	0.13	1.02	1	0.264	0.893	0.27	0.45	0.16
7	SM	15.0	18.0	16.5	9	43	2.0	2.0	-0.268	0.030	0.96	0.12	0.04	1.04	0.12	0.04	1.01	0.85	10	5.5	16	0.09	1.00	1	0.161	0.455	0.16	0.74	0.26
8	SC	18.0	23.0	20.5	8	47	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.89	0.95	9	5.5	14	0.09	0.98	1.2	0.151	0.325	0.18	0.66	0.23
9	SC	23.0	28.0	25.5	14	47	3.1	3.1	-0.485	0.054	0.92	0.12	0.04	1.04	0.12	0.04	0.81	0.95	14	5.5	20	0.11	0.95	1	0.202	0.458	0.19	0.60	0.21
10	PWR	28.0	33.0	30.5	100	47	3.7	3.5	-0.618	0.069	0.90	0.12	0.04	1.04	0.12	0.04	0.99	0.95	124	5.5	31	0.30	0.83	2	0.555	2.869	0.93	0.13	0.04
11	PWR	33.0	37.0	35.0	100	47	4.2	3.7	-0.744	0.083	0.88	0.13	0.04	1.04	0.12	0.04	0.99	1.00	130	5.5	31	0.30	0.81	2	0.555	2.671	0.90	0.14	0.05
12			-																										
13			-																										
14			-																										
15			-																										
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29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

B01-SPT-01

GW Depth:

27.7 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	3.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	3.0	5.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SC	5.0	7.0	0.64	0.22	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	7.0	9.0	0.55	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SC	9.0	13.0	0.70	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SC	13.0	15.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	18.0	0.74	0.26	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SC	18.0	23.0	0.66	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SC	23.0	28.0	0.60	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	PWR	28.0	33.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	33.0	37.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12		-													
13		-													
14		-													
15		-													
16		-													
17		-													
18		-													
19		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: B01-SPT-01

GW Depth: 27.7 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	3	11	14	18	46	21	30	2.77	19.24		1034.1
2	SC	3	5	4	5	7	46	21	30	1.01	6.99		376.0
3	SC	5	7	7	9	12	42	19	30	1.76	12.24		658.1
4	SC	7	9	10	13	15	42	19	30	2.20	15.30		822.7
5	SC	9	13	6	8	8	43	19	30	1.14	7.91		425.0
6	SC	13	15	15	20	18	43	19	30	2.74	19.04		1023.3
7	SM	15	18	9	12	10	68	34	32	1.52	10.55		982.5
8	SC	18	23	8	11	9	43	19	30	1.33	9.27		498.3
9	SC	23	28	14	18	14	43	19	30	2.13	14.77		793.9
10	PWR	28	33	100	132	124	0	0	40	9.30	64.57		12025.7
11	PWR	33	37	100	132	130	0	0	40	9.78	67.89		12644.2
12		-											
13		-											
14		-											
15		-											
16		-											
17		-											
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24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: B01-SPT-06

GW Depth: 63.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	3.0	1.5	5	43	0.2	0.2	-0.003	0.001	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	8	5.5	14	0.09	1.10	1.2	0.147	2.778	0.19	0.65	0.23
2	SM	3.0	5.0	4.0	8	43	0.5	0.5	-0.037	0.005	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	13	5.5	19	0.10	1.10	1.2	0.194	1.667	0.26	0.49	0.17
3	SM	5.0	7.0	6.0	8	43	0.7	0.7	-0.068	0.008	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	13	5.5	19	0.10	1.10	1.2	0.194	1.111	0.26	0.49	0.17
4	SM	7.0	9.0	8.0	8	46	1.0	1.0	-0.101	0.012	0.99	0.13	0.04	1.04	0.12	0.04	1.52	0.75	12	5.5	17	0.10	1.07	1.2	0.178	0.833	0.23	0.54	0.19
5	SM	9.0	13.0	11.0	9	46	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	11	5.5	17	0.10	1.04	1.2	0.171	0.682	0.21	0.57	0.20
6	SM	13.0	18.0	15.5	10	46	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.04	0.85	12	5.5	17	0.10	1.01	1.2	0.175	0.538	0.21	0.57	0.20
7	SM	18.0	23.0	20.5	6	50	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.88	0.95	7	5.5	12	0.08	0.98	1.2	0.133	0.244	0.16	0.75	0.26
8	SM	23.0	28.0	25.5	12	50	3.1	3.1	-0.485	0.054	0.92	0.12	0.04	1.04	0.12	0.04	0.80	0.95	12	5.5	18	0.10	0.96	1.2	0.179	0.392	0.21	0.56	0.20
9	SM	28.0	32.0	30.0	16	50	3.6	3.6	-0.604	0.068	0.90	0.12	0.04	1.04	0.11	0.04	0.76	0.95	15	5.5	21	0.11	0.93	1.2	0.214	0.444	0.24	0.47	0.17
10	SC	32.0	35.0	33.5	19	44	4.0	4.0	-0.701	0.078	0.88	0.11	0.04	1.04	0.11	0.04	0.73	1.00	18	5.5	24	0.13	0.91	1.5	0.264	0.473	0.36	0.31	0.11
11	SM	35.0	37.0	36.0	12	38	4.3	4.3	-0.772	0.086	0.87	0.11	0.04	1.04	0.11	0.04	0.67	1.00	11	5.5	16	0.09	0.93	2	0.166	0.278	0.31	0.36	0.12
12	SM	37.0	39.0	38.0	11	38	4.6	4.6	-0.830	0.093	0.86	0.11	0.04	1.04	0.11	0.04	0.65	1.00	9	5.5	15	0.09	0.93	2	0.155	0.241	0.29	0.38	0.13
13	SM	39.0	41.0	40.0	13	38	4.8	4.8	-0.888	0.099	0.85	0.11	0.04	1.04	0.11	0.04	0.64	1.00	11	5.5	16	0.10	0.92	2	0.169	0.271	0.31	0.35	0.12
14	SM	41.0	43.0	42.0	18	24	5.0	5.0	-0.946	0.105	0.84	0.11	0.04	1.04	0.11	0.04	0.65	1.00	16	5.0	21	0.11	0.90	2	0.212	0.357	0.38	0.28	0.10
15	SM	43.0	45.0	44.0	17	24	5.3	5.3	-1.005	0.112	0.83	0.11	0.04	1.04	0.10	0.04	0.64	1.00	14	5.0	19	0.11	0.90	2	0.197	0.322	0.35	0.30	0.10
16	SM	45.0	47.0	46.0	12	48	5.5	5.5	-1.063	0.118	0.82	0.11	0.04	1.04	0.10	0.04	0.59	1.00	9	5.5	15	0.09	0.91	2	0.155	0.217	0.28	0.37	0.13
17	SM	47.0	53.0	50.0	8	43	6.0	6.0	-1.180	0.131	0.81	0.10	0.04	1.04	0.10	0.04	0.54	1.00	6	5.5	11	0.08	0.91	2	0.126	0.133	0.23	0.44	0.15
18	SM	53.0	58.0	55.5	11	43	6.7	6.7	-1.336	0.147	0.78	0.10	0.04	1.04	0.10	0.03	0.53	1.00	8	5.5	13	0.08	0.90	2	0.141	0.165	0.25	0.39	0.13
19	SM	58.0	63.0	60.5	24	20	7.3	7.3	-1.473	0.162	0.76	0.10	0.03	1.04	0.09	0.03	0.59	1.00	19	4.5	23	0.13	0.84	2	0.252	0.331	0.42	0.23	0.08
20	SM	63.0	67.0	65.0	29	20	7.8	7.7	-1.590	0.174	0.74	0.10	0.03	1.04	0.09	0.03	0.61	1.00	23	4.5	28	0.15	0.80	2	0.370	0.376	0.59	0.16	0.06
21	PWR	67.0	67.1	67.1	100	20	8.0	7.8	-1.641	0.179	0.73	0.10	0.03	1.04	0.09	0.03	0.98	1.00	129	4.5	31	0.30	0.59	2	0.555	1.278	0.66	0.14	0.05
22			-																										
23			-																										
24			-																										
25			-																										
26			-																										
27			-																										
28			-																										
29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

B01-SPT-06

GW Depth:

63.5 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	3.0	0.65	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	3.0	5.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	5.0	7.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
4	SM	7.0	9.0	0.54	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	9.0	13.0	0.57	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	13.0	18.0	0.57	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.07	0.00
7	SM	18.0	23.0	0.75	0.26	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.01	0.00
8	SM	23.0	28.0	0.56	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	28.0	32.0	0.47	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SC	32.0	35.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	35.0	37.0	0.36	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	37.0	39.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	39.0	41.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	41.0	43.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	43.0	45.0	0.30	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	SM	45.0	47.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	SM	47.0	53.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.03	0.00
18	SM	53.0	58.0	0.39	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
19	SM	58.0	63.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
20	SM	63.0	67.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
21	PWR	67.0	67.1	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.15	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: B01-SPT-06

GW Depth: 63.5 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	3	5	7	8	0	0	31	0.63	4.37		814.2
2	SM	3	5	8	11	13	0	0	34	1.01	6.99		1302.7
3	SM	5	7	8	11	13	0	0	34	1.01	6.99		1302.7
4	SM	7	9	8	11	12	52	20	34	1.80	12.47		1161.6
5	SM	9	13	9	12	11	52	20	33	1.68	11.65		1085.1
6	SM	13	18	10	13	12	52	20	33	1.75	12.12		1129.1
7	SM	18	23	6	8	7	52	22	30	1.00	6.91		643.5
8	SM	23	28	12	16	12	52	22	34	1.81	12.54		1168.1
9	SM	28	32	16	21	15	52	22	35	2.27	15.75		1466.8
10	SC	32	35	19	25	18	51	27	30	2.74	19.04		1023.8
11	SM	35	37	12	16	11	0	0	33	0.80	5.52		1028.5
12	SM	37	39	11	14	9	0	0	32	0.70	4.88		908.2
13	SM	39	41	13	17	11	0	0	33	0.82	5.72		1065.1
14	SM	41	43	18	24	16	0	0	35	1.16	8.08		1505.3
15	SM	43	45	17	22	14	0	0	35	1.07	7.41		1379.3
16	SM	45	47	12	16	9	0	0	32	0.70	4.86		905.9
17	SM	47	53	8	11	6	0	0	29	0.42	2.94		548.2
18	SM	53	58	11	14	8	0	0	31	0.57	3.99		743.2
19	SM	58	63	24	32	19	0	0	36	1.40	9.73		1812.0
20	SM	63	67	29	38	23	0	0	36	1.74	12.07		2247.2
21	PWR	67	67.1	100	132	129	0	0	40	9.66	67.10		12495.9
22			-										
23			-										
24			-										
25			-										
26			-										
27			-										
28			-										
29			-										
30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: B12-SPT-03

GW Depth: 50.3 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	ML	0.0	2.0	1.0	9	53	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	15	5.5	21	0.11	1.10	1.2	0.213	7.500	0.28	0.45	0.16
2	ML	2.0	4.0	3.0	8	53	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	13	5.5	19	0.10	1.10	1.2	0.194	2.222	0.26	0.49	0.17
3	ML	4.0	6.0	5.0	9	53	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	15	5.5	21	0.11	1.10	1.2	0.213	1.500	0.28	0.44	0.16
4	ML	6.0	8.0	7.0	10	53	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.60	0.75	16	5.5	21	0.11	1.10	1.2	0.223	1.190	0.29	0.42	0.15
5	SM	8.0	10.0	9.0	4	37	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.47	0.75	6	5.5	11	0.08	1.05	1.2	0.127	0.370	0.16	0.77	0.27
6	SM	10.0	12.0	11.0	13	37	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.23	0.75	16	5.5	21	0.11	1.05	2	0.223	0.985	0.47	0.26	0.09
7	SM	12.0	15.0	13.5	6	37	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.13	0.85	8	5.5	13	0.08	1.02	2	0.141	0.370	0.29	0.42	0.15
8	SM	15.0	20.0	17.5	6	44	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.97	0.85	7	5.5	12	0.08	1.00	2	0.133	0.286	0.26	0.45	0.16
9	SM	20.0	25.0	22.5	3	44	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.82	0.95	3	5.5	9	0.07	0.98	2	0.108	0.111	0.21	0.55	0.19
10	MH	25.0	30.0	27.5	8	54	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.75	0.95	8	5.5	13	0.08	0.96	2	0.140	0.242	0.27	0.43	0.15
11	SM	30.0	35.0	32.5	9	41	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.69	0.95	8	5.5	13	0.08	0.94	2	0.142	0.231	0.27	0.42	0.15
12	SM	35.0	40.0	37.5	6	41	4.5	4.5	-0.815	0.091	0.87	0.11	0.04	1.04	0.11	0.04	0.62	1.00	5	5.5	10	0.08	0.94	2	0.121	0.133	0.23	0.48	0.17
13	SM	40.0	45.0	42.5	8	41	5.1	5.1	-0.961	0.107	0.84	0.11	0.04	1.04	0.11	0.04	0.59	1.00	6	5.5	12	0.08	0.93	2	0.130	0.157	0.24	0.44	0.15
14	SM	45.0	50.0	47.5	30	41	5.7	5.7	-1.107	0.123	0.82	0.11	0.04	1.04	0.10	0.04	0.68	1.00	27	5.5	31	0.18	0.81	2	0.555	0.526	0.90	0.11	0.04
15	SM	50.0	55.0	52.5	18	35	6.3	6.2	-1.252	0.138	0.79	0.11	0.04	1.04	0.10	0.04	0.60	1.00	14	5.5	20	0.11	0.88	2	0.202	0.292	0.35	0.29	0.10
16	SM	55.0	60.0	57.5	21	35	6.9	6.5	-1.392	0.153	0.77	0.11	0.04	1.04	0.10	0.04	0.60	1.00	17	5.5	22	0.12	0.86	2	0.236	0.326	0.41	0.25	0.09
17	SM	60.0	65.0	62.5	67	35	7.5	6.7	-1.526	0.167	0.75	0.11	0.04	1.04	0.10	0.04	0.83	1.00	73	5.5	31	0.30	0.64	2	0.555	0.994	0.71	0.15	0.05
18	SM	65.0	70.0	67.5	29	35	8.1	7.0	-1.652	0.180	0.73	0.11	0.04	1.04	0.10	0.04	0.63	1.00	24	5.5	29	0.16	0.80	2	0.454	0.413	0.73	0.14	0.05
19	SM	70.0	75.0	72.5	23	35	8.7	7.3	-1.766	0.192	0.70	0.11	0.04	1.04	0.11	0.04	0.58	1.00	18	5.5	23	0.12	0.84	2	0.252	0.314	0.42	0.25	0.09
20	SM	75.0	80.0	77.5	35	35	9.3	7.6	-1.868	0.202	0.69	0.11	0.04	1.04	0.11	0.04	0.64	1.00	30	5.5	31	0.20	0.73	2	0.555	0.460	0.81	0.13	0.05
21	SM	80.0	85.0	82.5	51	35	9.9	7.9	-1.956	0.211	0.67	0.11	0.04	1.04	0.11	0.04	0.72	1.00	49	5.5	31	0.30	0.59	2	0.555	0.646	0.65	0.16	0.06
22	PWR	85.0	90.0	87.5	100	35	10.5	8.2	-2.027	0.217	0.65	0.11	0.04	1.04	0.11	0.04	0.98	1.00	129	5.5	31	0.30	0.58	2	0.555	1.223	0.64	0.16	0.06
23	PWR	90.0	95.0	92.5	100	35	11.1	8.5	-2.082	0.221	0.64	0.11	0.04	1.04	0.10	0.04	0.98	1.00	129	5.5	31	0.30	0.57	2	0.555	1.181	0.63	0.17	0.06
24	PWR	95.0	100.0	97.5	100	35	11.7	8.8	-2.118	0.224	0.62	0.11	0.04	1.04	0.10	0.04	0.98	1.00	129	5.5	31	0.30	0.56	2	0.555	1.142	0.62	0.17	0.06
25	PWR	100.0	105.0	102.5	100	35	12.3	9.0	-2.136	0.224	0.61	0.11	0.04	1.04	0.10	0.04	0.98	1.00	129	5.5	31	0.30	0.55	2	0.555	1.106	0.61	0.17	0.06
26	PWR	105.0	110.0	107.5	100	35	12.9	9.3	-2.135	0.222	0.61	0.11	0.04	1.04	0.11	0.04	0.98	1.00	128	5.5	31	0.30	0.54	2	0.555	1.072	0.60	0.18	0.06
27			-																										
28			-																										
29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

B12-SPT-03

GW Depth:

50.3 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.44	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
5	SM	8.0	10.0	0.77	0.27	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.05	0.00
6	SM	10.0	12.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	15.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.55	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	MH	25.0	30.0	0.43	0.15	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
11	SM	30.0	35.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
12	SM	35.0	40.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.03	0.00
13	SM	40.0	45.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
14	SM	45.0	50.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	50.0	55.0	0.29	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	SM	55.0	60.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	SM	60.0	65.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
18	SM	65.0	70.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
19	SM	70.0	75.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
20	SM	75.0	80.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
21	SM	80.0	85.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
22	PWR	85.0	90.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
23	PWR	90.0	95.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
24	PWR	95.0	100.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
25	PWR	100.0	105.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
26	PWR	105.0	110.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.11	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: B12-SPT-03

GW Depth: 50.3 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	9	12	15	46	17	30	2.27	15.74		846.1
2	ML	2	4	8	11	13	0	0	30	1.01	6.99		752.1
3	ML	4	6	9	12	15	0	0	30	1.13	7.87		846.1
4	ML	6	8	10	13	16	0	0	30	1.18	8.22		884.3
5	SM	8	10	4	5	6	0	0	29	0.44	3.03		565.0
6	SM	10	12	13	17	16	0	0	36	1.19	8.25		1537.3
7	SM	12	15	6	8	8	0	0	31	0.57	3.97		738.5
8	SM	15	20	6	8	7	49	12	30	0.98	6.79		632.7
9	SM	20	25	3	4	3	49	12	27	0.46	3.22		299.4
10	MH	25	30	8	11	8	55	15	30	1.13	7.85	0.41	421.9
11	SM	30	35	9	12	8	0	0	31	0.58	4.05		754.5
12	SM	35	40	6	8	5	0	0	29	0.37	2.54		472.7
13	SM	40	45	8	11	6	0	0	30	0.46	3.23		601.1
14	SM	45	50	30	40	27	0	0	36	2.02	14.06		2618.8
15	SM	50	55	18	24	14	0	0	35	1.06	7.37		1372.8
16	SM	55	60	21	28	17	0	0	36	1.25	8.68		1617.1
17	SM	60	65	67	88	73	0	0	36	5.48	38.04		7085.3
18	SM	65	70	29	38	24	0	0	36	1.80	12.49		2325.4
19	SM	70	75	23	30	18	0	0	36	1.32	9.20		1713.5
20	SM	75	80	35	46	30	0	0	36	2.23	15.45		2878.3
21	SM	80	85	51	67	49	0	0	36	3.65	25.31		4714.3
22	PWR	85	90	100	132	129	0	0	40	9.65	67.05		12487.1
23	PWR	90	95	100	132	129	0	0	40	9.65	67.01		12480.2
24	PWR	95	100	100	132	129	0	0	40	9.64	66.98		12473.5
25	PWR	100	105	100	132	129	0	0	40	9.64	66.94		12467.0
26	PWR	105	110	100	132	128	0	0	40	9.63	66.91		12460.8
27		-	-										
28		-	-										
29		-	-										
30		-	-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: B-32

GW Depth: 11.4 ft

B6-SPT-09

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	4.0	2.0	18	45.2	0.2	0.2	-0.009	0.002	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	30	5.5	31	0.20	1.10	2	0.555	7.500	1.22	0.10	0.04
2	SM	4.0	6.0	5.0	22	45.2	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.67	0.75	36	5.5	31	0.28	1.10	2	0.555	3.667	1.22	0.10	0.04
3	SM	6.0	8.0	7.0	18	45.2	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.49	0.75	26	5.5	31	0.17	1.10	2	0.555	2.143	1.22	0.10	0.04
4	SM	8.0	10.0	9.0	12	45.2	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.38	0.75	16	5.5	22	0.12	1.07	2	0.230	1.111	0.49	0.25	0.09
5	SM	10.0	12.0	11.0	14	45.2	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.23	0.75	17	5.5	22	0.12	1.05	2	0.241	1.061	0.51	0.24	0.08
6	SM	12.0	15.0	13.5	15	45.2	1.6	1.5	-0.205	0.023	0.97	0.14	0.05	1.04	0.13	0.05	1.15	0.85	19	5.5	25	0.13	1.04	2	0.287	1.007	0.60	0.22	0.08
7	SM	15.0	20.0	17.5	15	45.2	2.1	1.7	-0.291	0.033	0.95	0.15	0.05	1.04	0.15	0.05	1.08	0.85	18	5.5	24	0.12	1.02	2	0.260	0.872	0.53	0.28	0.10
8	SM	20.0	25.0	22.5	10	43	2.7	2.0	-0.409	0.046	0.93	0.16	0.06	1.04	0.16	0.06	1.00	0.95	12	5.5	18	0.10	1.00	2	0.184	0.498	0.37	0.43	0.15
9	SM	25.0	30.0	27.5	16	43	3.3	2.3	-0.537	0.060	0.91	0.17	0.06	1.04	0.16	0.06	0.94	0.95	19	5.5	24	0.13	0.98	2	0.273	0.697	0.54	0.31	0.11
10	SC	30.0	35.0	32.5	15	44.8	3.9	2.6	-0.673	0.075	0.89	0.17	0.06	1.04	0.17	0.06	0.88	0.95	17	5.5	22	0.12	0.97	2	0.234	0.581	0.45	0.37	0.13
11	SM	35.0	40.0	37.5	12	48.1	4.5	2.9	-0.815	0.091	0.87	0.18	0.06	1.04	0.17	0.06	0.83	1.00	13	5.5	19	0.10	0.96	2	0.190	0.418	0.37	0.47	0.16
12	SM	40.0	45.0	42.5	22	48.1	5.1	3.2	-0.961	0.107	0.84	0.18	0.06	1.04	0.17	0.06	0.82	1.00	24	5.5	29	0.16	0.93	2	0.448	0.696	0.83	0.20	0.07
13	SM	45.0	50.0	47.5	16	48.1	5.7	3.4	-1.107	0.123	0.82	0.18	0.06	1.04	0.17	0.06	0.77	1.00	16	5.5	22	0.12	0.94	2	0.229	0.464	0.43	0.39	0.14
14	SM	50.0	55.0	52.5	61	48.1	6.3	3.7	-1.252	0.138	0.79	0.17	0.06	1.04	0.17	0.06	0.89	1.00	72	5.5	31	0.30	0.81	2	0.555	1.633	0.90	0.19	0.07
15	PWR	55.0	60.0	57.5	100	48.1	6.9	4.0	-1.392	0.153	0.77	0.17	0.06	1.04	0.17	0.06	0.99	1.00	130	5.5	31	0.30	0.79	2	0.555	2.485	0.88	0.19	0.07
16	PWR	60.0	65.0	62.5	100	41.7	7.5	4.3	-1.526	0.167	0.75	0.17	0.06	1.04	0.16	0.06	0.99	1.00	130	5.5	31	0.30	0.77	2	0.555	2.319	0.85	0.19	0.07
17	PWR	65.0	70.0	67.5	100	41.7	8.1	4.6	-1.652	0.180	0.73	0.17	0.06	1.04	0.16	0.06	0.99	1.00	130	5.5	31	0.30	0.75	2	0.555	2.174	0.83	0.19	0.07
18	PWR	70.0	75.0	72.5	100	41.7	8.7	4.9	-1.766	0.192	0.70	0.16	0.06	1.04	0.16	0.06	0.99	1.00	130	5.5	31	0.30	0.73	2	0.555	2.046	0.81	0.19	0.07
19	PWR	75.0	80.0	77.5	100	45.2	9.3	5.2	-1.868	0.202	0.69	0.16	0.06	1.04	0.15	0.05	0.98	1.00	130	5.5	31	0.30	0.71	2	0.555	1.932	0.79	0.19	0.07
20																													
21																													
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26																													
27																													
28																													
29																													
30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

B-32

GW Depth:

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	8.0	10.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	10.0	12.0	0.24	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.22	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	25.0	30.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SC	30.0	35.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	35.0	40.0	0.47	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	40.0	45.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	45.0	50.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	50.0	55.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	PWR	55.0	60.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	PWR	60.0	65.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	PWR	65.0	70.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
18	PWR	70.0	75.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
19	PWR	75.0	80.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information														
Date: November 9, 2015														
Site: I-85/385														
Location: Greenville, SC														
Project ID: 0038111														
Boring: B-32														
GW Depth: ft														
Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	φ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)	
		top	bottom											
1	SM	0	4	18	24	30			36	2.27	15.74		2931.1	326454
2	SM	4	6	22	29	36			36	2.71	18.85		3510.1	
3	SM	6	8	18	24	26			36	1.98	13.78		2565.6	
4	SM	8	10	12	16	16			36	1.22	8.49		1581.6	
5	SM	10	12	14	18	17			36	1.27	8.85		1648.4	
6	SM	12	15	15	20	19			36	1.45	10.09		1879.8	
7	SM	15	20	15	20	18			36	1.36	9.41		1752.7	
8	SM	20	25	10	13	12			34	0.94	6.50		1210.9	218073
9	SM	25	30	16	21	19			36	1.41	9.76		1817.9	
10	SC	30	35	15	20	17			30	1.24	8.63		927.7	133585 435813
11	SM	35	40	12	16	13			34	0.98	6.82		1270.8	
12	SM	40	45	22	29	24			36	1.79	12.43		2314.8	
13	SM	45	50	16	21	16			36	1.22	8.46		1576.2	
14	SM	50	55	61	80	72			36	5.37	37.29		6944.0	
15	PWR	55	60	100	132	130			40	9.77	67.81		12629.6	
16	PWR	60	65	100	132	130			40	9.75	67.74		12615.7	
17	PWR	65	70	100	132	130			40	9.74	67.67		12602.6	
18	PWR	70	75	100	132	130			40	9.73	67.60		12590.4	
19	PWR	75	80	100	132	130			40	9.73	67.54		12578.9	
20			-											
21			-											
22			-											
23			-											
24			-											
25			-											
26			-											
27			-											
28			-											
29			-											
30			-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate φ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate φ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{r_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	φ´ (deg)	c´ (psf)	φ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	φ´ (deg)	c´ (psf)	φ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: B-50

GW Depth: 40.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						K _{DR}	SAND					CLAY	SEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	4.0	2.0	17	49	0.2	0.2	-0.009	0.002	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	2	0.555	7.083	1.22	0.10	0.04
2	SM	4.0	6.0	5.0	17	49	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	29	5.5	31	0.19	1.10	2	0.555	2.833	1.22	0.10	0.04
3	SM	6.0	8.0	7.0	22	49	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.44	0.75	31	5.5	31	0.22	1.10	2	0.555	2.619	1.22	0.10	0.04
4	ML	8.0	10.0	9.0	6	62	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.44	0.75	9	5.5	14	0.09	1.05	2	0.148	0.556	0.31	0.39	0.14
5	SM	10.0	12.0	11.0	9	33	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	11	5.5	17	0.10	1.04	2	0.171	0.682	0.35	0.35	0.12
6	SM	12.0	15.0	13.5	6	33	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.13	0.85	8	5.5	13	0.08	1.02	2	0.141	0.370	0.29	0.42	0.15
7	SM	15.0	20.0	17.5	14	33	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.98	0.85	15	5.5	21	0.11	0.99	2	0.215	0.667	0.43	0.28	0.10
8	SM	20.0	25.0	22.5	9	32	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.85	0.95	10	5.4	15	0.09	0.97	2	0.156	0.333	0.30	0.39	0.14
9	SM	25.0	30.0	27.5	7	32	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.75	0.95	7	5.4	12	0.08	0.96	2	0.132	0.212	0.25	0.45	0.16
10	SM	30.0	35.0	32.5	7	31	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.68	0.95	6	5.4	11	0.08	0.95	2	0.128	0.179	0.24	0.46	0.16
11																								2					
12																								2					
13																								2					
14																								2					
15																								2					
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

B-50

GW Depth:

40.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	8.0	10.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	10.0	12.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	25.0	30.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	30.0	35.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
11		-													
12		-													
13		-													
14		-													
15		-													
16		-													
17		-													
18		-													
19		-													
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: B-50
GW Depth: 40.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	4	17	22	29			36	2.14	14.86		2768.3
2	SM	4	6	17	22	29			36	2.14	14.86		2768.3
3	SM	6	8	22	29	31			36	2.35	16.34		3043.6
4	ML	8	10	6	8	9			30	0.64	4.46		479.0
5	SM	10	12	9	12	11			33	0.84	5.83		1085.1
6	SM	12	15	6	8	8			31	0.57	3.97		738.5
7	SM	15	20	14	18	15			35	1.15	7.97		1483.4
8	SM	20	25	9	12	10			32	0.72	4.97		924.8
9	SM	25	30	7	9	7			30	0.49	3.41		635.0
10	SM	30	35	7	9	6			30	0.45	3.09		576.3
11		-											
12		-											
13		-											
14		-											
15		-											
16		-											
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %

C_E: 1.47

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R1A-76

GW Depth: 16.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	6	35.9	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	11	5.5	17	0.10	1.10	1	0.171	5.000	0.19	0.67	0.23
2	SM	2.0	4.0	3.0	6	35.9	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	11	5.5	17	0.10	1.10	1	0.171	1.667	0.19	0.67	0.23
3	SM	4.0	6.0	5.0	5	35.9	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	9	5.5	15	0.09	1.10	1	0.155	0.833	0.17	0.73	0.26
4	SM	6.0	8.0	7.0	7	35.9	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.66	0.75	13	5.5	18	0.10	1.09	2	0.186	0.833	0.41	0.31	0.11
5	SM	8.0	10.0	9.0	30	45.6	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.25	0.75	41	5.5	31	0.30	1.10	2	0.555	2.778	1.22	0.10	0.04
6	SM	10.0	12.0	11.0	9	45.6	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	12	5.5	18	0.10	1.04	2	0.183	0.682	0.38	0.32	0.11
7	SM	12.0	15.0	13.5	6	45.6	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.13	0.85	8	5.5	14	0.09	1.02	2	0.148	0.370	0.30	0.40	0.14
8	SM	15.0	20.0	17.5	14	35.4	2.1	2.0	-0.291	0.033	0.95	0.13	0.05	1.04	0.13	0.04	1.00	0.85	17	5.5	23	0.12	1.00	2	0.248	0.698	0.50	0.25	0.09
9	SM	20.0	25.0	22.5	25	35.4	2.7	2.3	-0.409	0.046	0.93	0.14	0.05	1.04	0.14	0.05	0.95	0.95	33	5.5	31	0.23	0.97	2	0.555	1.090	1.07	0.13	0.04
10	SM	25.0	30.0	27.5	100	35.4	3.3	2.6	-0.537	0.060	0.91	0.15	0.05	1.04	0.15	0.05	1.00	0.95	139	5.5	31	0.30	0.92	2	0.555	3.872	1.03	0.14	0.05
11	SM	30.0	35.0	32.5	8	35.4	3.9	2.9	-0.673	0.075	0.89	0.16	0.05	1.04	0.15	0.05	0.81	0.95	9	5.5	15	0.09	0.97	2	0.153	0.279	0.30	0.51	0.18
12	SM	35.0	40.0	37.5	15	35.4	4.5	3.2	-0.815	0.091	0.87	0.16	0.06	1.04	0.15	0.05	0.80	1.00	18	5.5	23	0.12	0.94	2	0.251	0.475	0.47	0.33	0.11
13			-																										
14			-																										
15			-																										
16			-																										
17			-																										
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27			-																										
28			-																										
29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R8A-31

GW Depth:

38.5 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.67	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.67	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
3	SM	4.0	6.0	0.73	0.26	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.04	0.00
4	SM	6.0	8.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	15.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	25.0	30.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	30.0	35.0	0.51	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	35.0	40.0	0.33	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13		-													
14		-													
15		-													
16		-													
17		-													
18		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.05	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R8A-31

GW Depth: 38.5 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	6	9	11	0	0	33	0.84	5.84		1088.3
2	SM	2	4	6	9	11	0	0	33	0.84	5.84		1088.3
3	SM	4	6	5	7	9	0	0	32	0.70	4.87		907.0
4	SM	6	8	7	10	13	0	0	34	0.96	6.64		1236.2
5	SM	8	10	30	44	41	0	0	36	3.10	21.50		4004.2
6	SM	10	12	9	13	12	0	0	34	0.93	6.49		1208.7
7	SM	12	15	6	9	8	0	0	31	0.64	4.42		822.6
8	SM	15	20	14	21	17	0	0	36	1.31	9.08		1690.3
9	SM	20	25	25	37	33	0	0	36	2.47	17.17		3198.2
10	SM	25	30	100	147	139	0	0	36	10.41	72.27		13460.2
11	SM	30	35	8	12	9	0	0	32	0.68	4.73		881.0
12	SM	35	40	15	22	18	0	0	36	1.32	9.17		1708.6
13		-											
14		-											
15		-											
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30		-											

213024

880738

186453

For cohesionless soils, Equation 7-41 of the GDM was used to calculate φ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate φ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	φ' (deg)	c' (psf)	φ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	φ' (deg)	c' (psf)	φ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %

C_E: 1.47

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R2-39

GW Depth: 18.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	CH	0.0	2.0	1.0	9	51	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	7.500	7.50	0.02	0.01
2	SC	2.0	4.0	3.0	9	41	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	2.500	0.26	0.48	0.17
3	CH	4.0	6.0	5.0	5	41	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	9	5.5	15	0.09	1.10	1.5	0.155	0.833	0.83	0.15	0.05
4	CH	6.0	8.0	7.0	20	41	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.47	0.75	32	5.5	31	0.23	1.10	1.5	0.555	2.381	2.38	0.05	0.02
5	CH	8.0	10.0	9.0	15	41	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.01	0.13	0.04	1.35	0.75	22	5.5	28	0.15	1.09	1.5	0.374	1.389	1.39	0.09	0.03
6	CH	10.0	12.0	11.0	24	74	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.01	0.13	0.04	1.18	0.75	31	5.5	31	0.22	1.09	1.5	0.555	1.818	1.82	0.07	0.02
7	CH	12.0	15.0	13.5	8	74	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.01	0.13	0.04	1.13	0.85	11	5.5	17	0.10	1.02	1.5	0.171	0.494	0.49	0.25	0.09
8	SC	15.0	20.0	17.5	4	19	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.97	0.85	5	4.3	9	0.08	1.00	1.5	0.112	0.190	0.17	0.71	0.25
9	SM	20.0	23.5	21.8	5	38	2.6	2.4	-0.390	0.044	0.94	0.13	0.05	1.04	0.13	0.04	0.89	0.95	6	5.5	12	0.08	0.99	2	0.130	0.208	0.26	0.50	0.17
10	SM	23.5	25.0	24.3	9	38	2.9	2.6	-0.453	0.051	0.93	0.14	0.05	1.04	0.13	0.05	0.87	0.95	11	5.5	16	0.10	0.98	2	0.169	0.353	0.33	0.40	0.14
11	SM	25.0	30.0	27.5	12	38	3.3	2.7	-0.537	0.060	0.91	0.14	0.05	1.04	0.14	0.05	0.85	0.95	14	5.5	20	0.11	0.97	2	0.202	0.438	0.39	0.35	0.12
12	SM	30.0	35.0	32.5	11	38	3.9	3.0	-0.673	0.075	0.89	0.15	0.05	1.04	0.14	0.05	0.80	0.95	12	5.5	18	0.10	0.96	2	0.182	0.363	0.35	0.41	0.14
13	SM	35.0	40.0	37.5	17	38	4.5	3.3	-0.815	0.091	0.87	0.15	0.05	1.04	0.15	0.05	0.79	1.00	20	5.5	25	0.13	0.93	2	0.295	0.513	0.55	0.27	0.09
14		-																											
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30		-																											

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R2-39

GW Depth:

18.5

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CH	0.0	2.0	0.02	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	CH	4.0	6.0	0.15	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CH	6.0	8.0	0.05	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	CH	8.0	10.0	0.09	0.03	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	CH	10.0	12.0	0.07	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
7	CH	12.0	15.0	0.25	0.09	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
8	SC	15.0	20.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	23.5	0.50	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	23.5	25.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	25.0	30.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	30.0	35.0	0.41	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	35.0	40.0	0.27	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
16		-													
17		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R2-39
GW Depth: 18.5 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CH	0	2	9	13	17	52	31	26	2.52	17.53	0.38	942.5
2	SC	2	4	9	13	17	30	16	30	1.26	8.77		942.5
3	CH	4	6	5	7	9	30	16	26	0.70	4.87	0.18	523.6
4	CH	6	8	20	29	32	30	16	26	2.42	16.79	0.18	1805.4
5	CH	8	10	15	22	22	30	16	26	1.67	11.60	0.18	1247.0
6	CH	10	12	24	35	31	62	37	26	4.69	32.58	0.47	1751.4
7	CH	12	15	8	12	11	62	37	26	1.69	11.71	0.47	629.4
8	SC	15	20	4	6	5	33	17	29	0.36	2.52		270.8
9	SM	20	23.5	5	7	6			30	0.47	3.24		603.3
10	SM	23.5	25	9	13	11			33	0.82	5.71		1063.0
11	SM	25	30	12	18	14			35	1.07	7.40		1378.2
12	SM	30	35	11	16	12			34	0.92	6.41		1194.0
13	SM	35	40	17	25	20			36	1.48	10.26		1910.0
14		-											
15		-											
16		-											
17		-											
18													
19		-											
20		-											
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28		-											
29		-											
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38994.5

177077

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{r_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %

C_E: 1.47

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R2A-45

GW Depth: 6.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	CL	0.0	2.0	1.0	16	50	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	30	5.5	31	0.20	1.10	1	0.555	13.333	13.33	0.01	0.00
2	CL	2.0	4.0	3.0	19	50	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	36	5.5	31	0.27	1.10	1	0.555	5.278	5.28	0.02	0.01
3	SM	4.0	6.0	5.0	13	30	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	24	5.4	30	0.16	1.10	2	0.465	2.167	1.02	0.12	0.04
4	SM	6.0	8.0	7.0	7	30	0.8	0.8	-0.084	0.010	0.99	0.14	0.05	1.04	0.13	0.05	1.70	0.75	13	5.4	18	0.10	1.10	2	0.188	0.900	0.41	0.32	0.11
5	SM	8.0	10.0	9.0	7	30	1.1	0.9	-0.119	0.014	0.98	0.15	0.05	1.04	0.15	0.05	1.60	0.75	12	5.4	18	0.10	1.08	2	0.180	0.784	0.39	0.38	0.13
6	SM	10.0	12.0	11.0	9	30	1.3	1.0	-0.156	0.018	0.98	0.17	0.06	1.04	0.16	0.06	1.46	0.75	14	5.4	20	0.11	1.07	2	0.204	0.893	0.44	0.37	0.13
7	SM	12.0	15.0	13.5	7	30	1.6	1.2	-0.205	0.023	0.97	0.18	0.06	1.04	0.17	0.06	1.38	0.85	12	5.4	17	0.10	1.05	2	0.178	0.608	0.37	0.46	0.16
8	SM	15.0	20.0	17.5	10	30	2.1	1.4	-0.291	0.033	0.95	0.19	0.07	1.04	0.18	0.06	1.22	0.85	15	5.4	21	0.11	1.04	2	0.213	0.723	0.44	0.41	0.14
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R2A-45

GW Depth:

6.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CL	0.0	2.0	0.01	0.00	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	CL	2.0	4.0	0.02	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	15.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.41	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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30															
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R2A-45

GW Depth: 6.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CL	0	2	16	23	30	0	0	26	2.24	15.58	-0.09	1675.5
2	CL	2	4	19	28	36	0	0	26	2.66	18.51	-0.09	1989.7
3	SM	4	6	13	19	24	0	0	36	1.82	12.66		2358.1
4	SM	6	8	7	10	13	0	0	34	0.98	6.82		1269.7
5	SM	8	10	7	10	12	0	0	34	0.92	6.41		1193.2
6	SM	10	12	9	13	14	0	0	35	1.09	7.53		1403.3
7	SM	12	15	7	10	12	0	0	34	0.90	6.26		1166.2
8	SM	15	20	10	15	15	0	0	35	1.14	7.93		1476.8
9		-											
10		-											
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29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %

C_E: 1.47

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R3-38

GW Depth: 35.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	6	39.3	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	11	5.5	17	0.10	1.10	1.2	0.171	5.000	0.23	0.56	0.20
2	SM	2.0	4.0	3.0	8	39.3	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	15	5.5	20	0.11	1.10	1.2	0.212	2.222	0.28	0.45	0.16
3	SM	4.0	6.0	5.0	4	35.4	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	7	5.5	13	0.08	1.10	1.2	0.140	0.667	0.18	0.68	0.24
4	SM	6.0	8.0	7.0	4	35.4	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.70	0.75	7	5.5	13	0.08	1.07	1.2	0.140	0.476	0.18	0.69	0.24
5	SM	8.0	10.0	9.0	8	35.4	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.42	0.75	12	5.5	18	0.10	1.06	1.2	0.183	0.741	0.23	0.53	0.18
6	SM	10.0	12.0	11.0	6	32.5	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.28	0.75	8	5.4	14	0.09	1.04	1.2	0.147	0.455	0.18	0.67	0.23
7	SM	12.0	15.0	13.5	4	32.5	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.14	0.85	6	5.4	11	0.08	1.02	1.2	0.126	0.247	0.15	0.79	0.28
8	SM	15.0	20.0	17.5	10	32.5	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.97	0.85	12	5.4	18	0.10	1.00	1.2	0.180	0.476	0.21	0.56	0.20
9	SM	20.0	25.0	22.5	14	34.9	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.86	0.95	17	5.5	22	0.12	0.96	1.2	0.238	0.519	0.28	0.43	0.15
10	SM	25.0	30.0	27.5	11	34.9	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.77	0.95	12	5.5	17	0.10	0.95	1.2	0.176	0.333	0.20	0.57	0.20
11	SM	30.0	35.0	32.5	19	45.5	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.74	0.95	20	5.5	25	0.13	0.91	1.2	0.293	0.487	0.32	0.35	0.12
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R8A-31

GW Depth:

38.5

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.56	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.68	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
4	SM	6.0	8.0	0.69	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.03	0.00
5	SM	8.0	10.0	0.53	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
6	SM	10.0	12.0	0.67	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.03	0.00
7	SM	12.0	15.0	0.79	0.28	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.12	0.00
8	SM	15.0	20.0	0.56	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.07	0.00
9	SM	20.0	25.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	25.0	30.0	0.57	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	30.0	35.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12		-													
13		-													
14		-													
15		-													
16		-													
17		-													
18		-													
19		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.27	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R8A-31
GW Depth: 38.5 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	6	9	11			33	0.84	5.84		1088.3
2	SM	2	4	8	12	15			35	1.12	7.79		1451.1
3	SM	4	6	4	6	7			31	0.56	3.90		725.6
4	SM	6	8	4	6	7			31	0.56	3.90		725.6
5	SM	8	10	8	12	12			34	0.94	6.50		1210.4
6	SM	10	12	6	9	8			31	0.63	4.40		820.1
7	SM	12	15	4	6	6			29	0.43	2.97		552.4
8	SM	15	20	10	15	12			34	0.91	6.32		1177.8
9	SM	20	25	14	21	17	36	9	36	1.26	8.75		1630.1
10	SM	25	30	11	16	12	36	9	33	0.88	6.12		1140.5
11	SM	30	35	19	28	20	55	21	36	2.94	20.43		1902.3
12			-										
13			-										
14			-										
15			-										
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Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %
C_E: 1.47
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: R8A-31
GW Depth: 38.5 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.				(ft)					(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	MH	0.0	2.0	1.0	24	52	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	45	5.5	31	0.30	1.10	1	0.555	20.000	0.61	0.21	0.07
2	MH	2.0	4.0	3.0	9	52	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	2.500	0.26	0.48	0.17
3	SM	4.0	6.0	5.0	8	35	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	15	5.5	20	0.11	1.10	2	0.212	1.333	0.47	0.27	0.09
4	SM	6.0	8.0	7.0	9	35	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.62	0.75	16	5.5	22	0.11	1.10	2	0.226	1.071	0.50	0.25	0.09
5	SM	8.0	13.0	10.5	22	35	1.3	1.3	-0.146	0.017	0.98	0.13	0.04	1.04	0.12	0.04	1.22	0.75	29	5.5	31	0.20	1.09	2	0.555	1.746	1.21	0.10	0.04
6	SM	13.0	18.0	15.5	8	35	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.04	0.85	10	5.5	16	0.09	1.01	2	0.164	0.430	0.33	0.37	0.13
7	SM	18.0	23.0	20.5	17	18	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.91	0.95	22	4.1	26	0.14	0.97	2	0.305	0.691	0.59	0.20	0.07
8	SM	23.0	28.0	25.5	11	18	3.1	3.1	-0.485	0.054	0.92	0.12	0.04	1.04	0.12	0.04	0.80	0.95	12	4.1	16	0.10	0.96	2	0.168	0.359	0.32	0.36	0.13
9	SM	28.0	33.0	30.5	18	18	3.7	3.7	-0.618	0.069	0.90	0.12	0.04	1.04	0.11	0.04	0.76	0.95	19	4.1	23	0.13	0.92	2	0.251	0.492	0.46	0.24	0.09
10	SM	33.0	38.0	35.5	13	17	4.3	4.3	-0.758	0.085	0.87	0.11	0.04	1.04	0.11	0.04	0.68	1.00	13	3.9	17	0.10	0.92	2	0.172	0.305	0.32	0.35	0.12
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R8A-31

GW Depth:

38.5 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.21	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.48	0.17	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.27	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	13.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	13.0	18.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	18.0	23.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	23.0	28.0	0.36	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	28.0	33.0	0.24	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	33.0	38.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11		-													
12		-													
13		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R8A-31

GW Depth: 38.5 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	24	35	45	55	20	30	6.73	46.75	0.41	2513.3
2	MH	2	4	9	13	17	55	20	30	2.52	17.53	0.41	942.5
3	SM	4	6	8	12	15	0	0	35	1.12	7.79		1451.1
4	SM	6	8	9	13	16	0	0	36	1.20	8.33		1552.3
5	SM	8	13	22	32	29	0	0	36	2.21	15.33		2855.1
6	SM	13	18	8	12	10	0	0	33	0.78	5.41		1008.0
7	SM	18	23	17	25	22	0	0	36	1.61	11.20		2085.7
8	SM	23	28	11	16	12	0	0	34	0.92	6.37		1187.0
9	SM	28	33	18	26	19	0	0	36	1.43	9.90		1844.4
10	SM	33	38	13	19	13	0	0	34	0.97	6.77		1260.5
11		-											
12		-											
13		-											
14		-											
15		-											
16		-											
17		-											
18													
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\sqrt{1.60} \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R85-15

GW Depth: 10.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	12	22	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	20	4.8	25	0.14	1.10	1	0.294	10.000	0.32	0.39	0.14
2	SM	2.0	4.0	3.0	14	22	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	24	4.8	29	0.15	1.10	1	0.408	3.889	0.45	0.28	0.10
3	SM	4.0	6.0	5.0	7	38	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	12	5.5	17	0.10	1.10	2	0.178	1.167	0.39	0.32	0.11
4	SM	6.0	8.0	7.0	39	38	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.30	0.75	51	5.5	31	0.30	1.10	2	0.555	4.643	1.22	0.10	0.04
5	PWR	8.0	10.0	9.0	100	38	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.01	0.75	101	5.5	31	0.30	1.10	2	0.555	9.259	1.22	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-15

GW Depth:

10.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	PWR	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6		-													
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29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-15

GW Depth:

10.0

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	12	16	20	46	12	36	3.06	21.25		1978.8
2	SM	2	4	14	19	24	46	12	36	3.57	24.79		2308.6
3	SM	4	6	7	9	12	45	17	34	1.79	12.40		1154.3
4	SM	6	8	39	52	51	45	17	36	7.62	52.90		4926.2
5	PWR	8	10	100	133	101	45	17	40	15.15	105.20		9796.1
6		-											
7		-											
8		-											
9		-											
10		-											
11		-											
12		-											
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Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\sqrt{1.60} \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 9, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %
C_E: 1.33
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: R85-18
GW Depth: 9.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	16	42	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	27	5.5	31	0.18	1.10	1	0.555	13.333	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	26	42	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	44	5.5	31	0.30	1.10	2	0.555	7.222	1.22	0.10	0.04
3	CH	4.0	6.0	5.0	8	51	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	14	5.5	19	0.11	1.10	2	0.195	1.333	1.33	0.10	0.03
4	CH	6.0	8.0	7.0	14	51	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.54	0.75	22	5.5	27	0.14	1.10	2	0.348	1.667	1.67	0.08	0.03
5	CL	8.0	10.0	9.0	5	53	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.01	0.13	0.04	1.46	0.75	7	5.5	13	0.08	1.05	2	0.138	0.463	0.46	0.27	0.10
6	SM	10.0	15.0	12.5	21	53	1.5	1.3	-0.185	0.021	0.97	0.15	0.05	1.04	0.14	0.05	1.21	0.75	25	5.5	31	0.17	1.07	2	0.551	1.639	1.18	0.12	0.04
7			-																										
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30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-18

GW Depth:

9.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	CH	4.0	6.0	0.10	0.03	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CH	6.0	8.0	0.08	0.03	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	CL	8.0	10.0	0.27	0.10	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7			-												
8			-												
9															
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25			-												
26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R85-18

GW Depth: 9.0 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	16	21	27			36	2.04	14.17		2638.4
2	SM	2	4	26	35	44			36	3.32	23.02		4287.4
3	CH	4	6	8	11	14	51	24	26	2.04	14.17	0.37	761.6
4	CH	6	8	14	19	22	51	24	26	3.23	22.44	0.37	1206.2
5	CL	8	10	5	7	7	43	22	26	1.09	7.60	0.30	408.3
6	SM	10	15	21	28	25			36	1.91	13.26		2468.9
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141683

58798.7

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498658

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58798.7

355517



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	φ' (deg)	c' (psf)	φ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	φ' (deg)	c' (psf)	φ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate φ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate φ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R85-20

GW Depth: 10.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSR _{eq} / CR _{Req}	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	7	26	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	12	5.1	17	0.10	1.10	1	0.174	5.833	0.19	0.66	0.23
2	SM	2.0	4.0	3.0	17	26	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.1	31	0.19	1.10	1	0.555	4.722	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	31	27	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.54	0.75	48	5.2	31	0.30	1.10	2	0.555	5.167	1.22	0.10	0.04
4	SM	6.0	8.0	7.0	18	27	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.49	0.75	27	5.2	31	0.18	1.10	2	0.555	2.143	1.22	0.10	0.04
5	SM	8.0	10.0	9.0	28	27	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	35	5.2	31	0.27	1.10	2	0.555	2.593	1.22	0.10	0.04
6																													
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30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-20

GW Depth:

10.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.66	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6		-													
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10		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R85-20
GW Depth: 10.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ′	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	7	9	12			34	0.89	6.20		1154.3
2	SM	2	4	17	23	29			36	2.17	15.05		2803.3
3	SM	4	6	31	41	48			36	3.57	24.80		4618.3
4	SM	6	8	18	24	27			36	2.01	13.95		2598.1
5	SM	8	10	28	37	35			36	2.65	18.40		3427.5
6		-											
7		-											
8		-											
9		-											
10		-											
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29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\sqrt{1.60} \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R85-52

GW Depth: 7.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	9	28	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	15	5.3	21	0.11	1.10	1	0.213	7.500	0.23	0.54	0.19
2	SM	2.0	4.0	3.0	13	28	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	22	5.3	27	0.14	1.10	2	0.359	3.611	0.79	0.16	0.06
3	SM	4.0	6.0	5.0	8	28	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	14	5.3	19	0.11	1.10	2	0.193	1.333	0.42	0.29	0.10
4	SM	6.0	8.0	7.0	12	19	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.57	0.75	19	4.3	23	0.13	1.10	2	0.251	1.429	0.55	0.22	0.08
5	SM	8.0	9.0	8.5	100	19	1.0	0.9	-0.110	0.013	0.98	0.14	0.05	1.04	0.14	0.05	1.01	0.75	101	4.3	31	0.30	1.10	2	0.555	10.794	1.22	0.11	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-15

GW Depth:

10.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.54	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.29	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.22	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	9.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6		-													
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28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-15

GW Depth:

10.0

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	9	12	15			35	1.15	7.97		1484.1
2	SM	2	4	13	17	22			36	1.66	11.51		2143.7
3	SM	4	6	8	11	14			34	1.02	7.08		1319.2
4	SM	6	8	12	16	19			36	1.41	9.80		1824.3
5	SM	8	9	100	133	101			36	7.59	52.73		9820.2
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R85-81

GW Depth: 10.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SC	0.0	2.0	1.0	29	43	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	49	5.5	31	0.30	1.10	2	0.555	24.167	1.22	0.10	0.04
2	SC	2.0	4.0	3.0	42	43	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.63	0.75	69	5.5	31	0.30	1.10	2	0.555	11.667	1.22	0.10	0.04
3	SC	4.0	6.0	5.0	67	43	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.21	0.75	81	5.5	31	0.30	1.10	2	0.555	11.167	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	43	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	101	5.5	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	SC	8.0	10.0	9.0	59	43	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.13	0.75	66	5.5	31	0.30	1.10	2	0.555	5.463	1.22	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R85-15

GW Depth:

10.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SC	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SC	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R85-15

GW Depth: 10.0 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	29	39	49			30	3.70	25.68		2760.8
2	SC	2	4	42	56	69	51	27	30	10.29	71.48		3842.7
3	SC	4	6	67	89	81			30	6.06	42.07		4523.8
4	PWR	6	8	100	133	101			40	7.60	52.81		9835.6
5	SC	8	10	59	79	66			30	4.99	34.63		3723.7
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Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	φ' (deg)	c' (psf)	φ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	φ' (deg)	c' (psf)	φ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate φ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate φ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %
C_E: 1.32
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: R385-24A
GW Depth: 10.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	21	24	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.0	31	0.27	1.10	1	0.555	17.500	0.61	0.21	0.07
2	CL	2.0	4.0	3.0	20	53	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	34	5.5	31	0.24	1.10	2	0.555	5.556	5.56	0.02	0.01
3	PWR	4.0	6.0	5.0	100	53	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	101	5.5	31	0.30	1.10	2	0.555	16.667	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	53	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	100	5.5	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	PWR	8.0	10.0	9.0	100	53	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.01	0.75	100	5.5	31	0.30	1.10	2	0.555	9.259	1.22	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	CL	2.0	4.0	0.02	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	PWR	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	PWR	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2R-04

GW Depth: 8.1 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	21	28	35	0	0	36	2.64	18.36		3419.6
2	CL	2	4	20	26	34	43	23	26	5.04	34.97	0.30	1880.2
3	PWR	4	6	100	132	101	0	0	40	7.55	52.43		9765.1
4	PWR	6	8	100	132	100	0	0	40	7.51	52.15		9712.6
5	PWR	8	10	100	132	100	0	0	40	7.48	51.94		9673.7
6		-											
7		-											
8		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R385-25A

GW Depth: 9.5 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	10	36	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	8.333	0.26	0.48	0.17
2	SC	2.0	4.0	3.0	22	36	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	37	5.5	31	0.29	1.10	1	0.555	6.111	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	66	36	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.21	0.75	79	5.5	31	0.30	1.10	2	0.555	11.000	1.22	0.10	0.04
4	SM	6.0	8.0	7.0	31	27	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.36	0.75	42	5.2	31	0.30	1.10	2	0.555	3.690	1.22	0.10	0.04
5	PWR	8.0	10.0	9.0	100	27	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.01	0.75	100	5.2	31	0.30	1.10	2	0.555	9.259	1.22	0.10	0.04
6	SM	10.0	12.0	11.0	50	27	1.3	1.2	-0.156	0.018	0.98	0.14	0.05	1.04	0.13	0.05	1.13	0.75	56	5.2	31	0.30	1.10	2	0.555	4.077	1.22	0.11	0.04
7	PWR	12.0	18.5	15.3	100	27	1.8	1.5	-0.241	0.027	0.96	0.16	0.05	1.04	0.15	0.05	1.00	0.85	112	5.2	31	0.30	1.09	2	0.555	6.797	1.21	0.12	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2R-04

GW Depth: 8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	PWR	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	12.0	18.5	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	10	13	17	0	0	36	1.26	8.74		1628.4
2	SC	2	4	22	29	37	0	0	30	2.77	19.24		2068.2
3	SM	4	6	66	87	79	0	0	36	5.93	41.16		7665.7
4	SM	6	8	31	41	42	0	0	36	3.13	21.72		4045.2
5	PWR	8	10	100	132	100	0	0	40	7.48	51.94		9673.7
6	SM	10	12	50	66	56	0	0	36	4.17	28.93		5388.3
7	PWR	12	18.5	100	132	112	0	0	40	8.44	58.58		10909.4
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29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R385-27A

GW Depth: 13.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	CH	0.0	2.0	1.0	11	53	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	18	5.5	24	0.13	1.10	1	0.267	9.167	9.17	0.01	0.00
2	CH	2.0	4.0	3.0	11	53	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	18	5.5	24	0.13	1.10	2	0.267	3.056	3.06	0.04	0.01
3	SC	4.0	6.0	5.0	4	48	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	7	5.5	12	0.08	1.10	2	0.134	0.667	0.29	0.42	0.15
4	SC	6.0	8.0	7.0	2	29	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.70	0.75	3	5.3	9	0.07	1.06	2	0.109	0.238	0.23	0.54	0.19
5	SM	8.0	10.0	9.0	2	29	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.52	0.75	3	5.3	8	0.07	1.04	2	0.107	0.185	0.22	0.55	0.19
6	SM	10.0	12.0	11.0	5	25	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.29	0.75	6	5.1	11	0.08	1.03	2	0.128	0.379	0.27	0.46	0.16
7	SM	12.0	15.0	13.5	31	25	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.09	0.85	38	5.1	31	0.30	1.07	2	0.555	1.951	1.19	0.10	0.04
8	SM	15.0	20.0	17.5	41	45	2.1	1.8	-0.291	0.033	0.95	0.14	0.05	1.04	0.14	0.05	1.03	0.85	47	5.5	31	0.30	1.03	2	0.555	2.254	1.14	0.12	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2R-04

GW Depth: 8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CH	0.0	2.0	0.01	0.00	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	CH	2.0	4.0	0.04	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	SC	4.0	6.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	6.0	8.0	0.54	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.55	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9															
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30															
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CH	0	2	11	14	18	61	32	26	2.77	19.24	0.46	1034.1
2	CH	2	4	11	14	18	61	32	26	2.77	19.24	0.46	1034.1
3	SC	4	6	4	5	7	54	28	30	1.01	6.99		376.0
4	SC	6	8	2	3	3	24	7	27	0.25	1.75		188.0
5	SM	8	10	2	3	3	30	7	27	0.22	1.56		290.5
6	SM	10	12	5	7	6	30	7	30	0.48	3.32		617.7
7	SM	12	15	31	41	38	0	0	36	2.82	19.61		3653.0
8	SM	15	20	41	54	47	0	0	36	3.54	24.57		4575.9
9		-											
10		-											
11		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\tau_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %
C_E: 1.32
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: R385-73
GW Depth: 20.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	3.0	1.5	26	23	0.2	0.2	-0.003	0.001	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	44	4.9	31	0.30	1.10	1	0.555	14.444	0.61	0.21	0.07
2	SM	3.0	5.0	4.0	9	23	0.5	0.5	-0.037	0.005	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	15	4.9	20	0.11	1.10	1	0.206	1.875	0.23	0.55	0.19
3	SM	5.0	7.0	6.0	25	38	0.7	0.7	-0.068	0.008	0.99	0.13	0.05	1.04	0.12	0.04	1.50	0.75	37	5.5	31	0.30	1.10	1	0.555	3.472	0.61	0.20	0.07
4	SM	7.0	9.0	8.0	23	38	1.0	1.0	-0.101	0.012	0.99	0.13	0.04	1.04	0.12	0.04	1.36	0.75	31	5.5	31	0.21	1.10	1	0.555	2.396	0.61	0.20	0.07
5	SM	9.0	11.0	10.0	25	25	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.23	0.75	30	5.1	31	0.21	1.10	1	0.555	2.083	0.61	0.20	0.07
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30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	3.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	3.0	5.0	0.55	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
3	SM	5.0	7.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	7.0	9.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
5	SM	9.0	11.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
6		-													
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27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.03	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	3	26	34	44			36	3.27	22.73		4233.8
2	SM	3	5	9	12	15			35	1.13	7.87		1465.5
3	SM	5	7	25	33	37	37	9	36	2.79	19.35		3603.5
4	SM	7	9	23	30	31			36	2.31	16.05		2989.1
5	SM	9	11	25	33	30			36	2.27	15.77		2937.6
6		-											
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Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
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ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
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SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W1A-1R-05

GW Depth: 20.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	5	32	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	8	5.4	14	0.09	1.10	1.2	0.147	4.167	0.19	0.65	0.23
2	SM	2.0	4.0	3.0	6	32	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	10	5.4	16	0.09	1.10	1	0.160	1.667	0.18	0.71	0.25
3	SM	4.0	6.0	5.0	5	32	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	8	5.4	14	0.09	1.10	2	0.147	0.833	0.32	0.39	0.14
4	SM	6.0	8.0	7.0	10	33	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.60	0.75	16	5.5	21	0.11	1.10	2	0.222	1.190	0.49	0.25	0.09
5	SM	8.0	10.0	9.0	9	33	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.41	0.75	13	5.5	18	0.10	1.06	2	0.183	0.833	0.39	0.32	0.11
6	SM	10.0	13.0	11.5	9	33	1.4	1.4	-0.165	0.019	0.97	0.13	0.04	1.04	0.12	0.04	1.23	0.75	11	5.5	16	0.10	1.04	2	0.168	0.652	0.35	0.35	0.12
7	SM	13.0	18.0	15.5	8	38	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.04	0.85	9	5.5	15	0.09	1.01	2	0.155	0.430	0.31	0.39	0.14
8	SM	18.0	20.0	19.0	20	38	2.3	2.3	-0.325	0.037	0.95	0.12	0.04	1.04	0.12	0.04	0.94	0.85	21	5.5	27	0.14	0.98	2	0.334	0.877	0.66	0.18	0.06
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W1A-1R-05

GW Depth:

20.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.65	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
3	SM	4.0	6.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	13.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	13.0	18.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	20.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W1A-1R-05

GW Depth: 20.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	5	7	8	0	0	31	0.63	4.37		814.2
2	SM	2	4	6	8	10	0	0	32	0.76	5.25		977.0
3	SM	4	6	5	7	8	0	0	31	0.63	4.37		814.2
4	SM	6	8	10	13	16	0	0	36	1.18	8.22		1531.7
5	SM	8	10	9	12	13	0	0	34	0.94	6.51		1212.5
6	SM	10	13	9	12	11	0	0	33	0.82	5.68		1058.7
7	SM	13	18	8	11	9	0	0	32	0.70	4.86		904.9
8	SM	18	20	20	26	21	0	0	36	1.58	11.00		2049.4
9		-											
10		-											
11		-											
12		-											
13		-											
14		-											
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28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

ϕ'_{Cohesionless} := (15.4 \cdot N'_{1.60})^{0.5} + 20

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

ϕ'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

c_{u,Low} := .075 \cdot N_{1.60}^{r_{1.60} .60}

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

c_{u,High} := .15 \cdot N_{1.60}

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W1A-1R-08

GW Depth: 15.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SC	0.0	2.0	1.0	6	49	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	10	5.5	16	0.09	1.10	1	0.162	5.000	0.18	0.71	0.25
2	MH	2.0	4.0	3.0	17	49	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	1	0.555	4.722	0.61	0.21	0.07
3	MH	4.0	6.0	5.0	18	56	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	31	5.5	31	0.21	1.10	1	0.555	3.000	0.61	0.20	0.07
4	SM	6.0	8.0	7.0	17	56	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.50	0.75	25	5.5	31	0.17	1.10	2	0.555	2.024	1.22	0.10	0.04
5	SM	8.0	10.0	9.0	17	36	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.33	0.75	23	5.5	28	0.15	1.09	2	0.391	1.574	0.85	0.14	0.05
6	PWR	10.0	15.0	12.5	100	36	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.00	0.75	100	5.5	31	0.30	1.09	2	0.555	6.667	1.21	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W1A-1R-08

GW Depth:

4.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.21	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	MH	4.0	6.0	0.20	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	PWR	10.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7			-												
8			-												
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26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W1A-1R-08

GW Depth: 4.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	6	8	10	41	21	30	1.53	10.63		571.2
2	MH	2	4	17	23	29	60	24	30	4.34	30.10	0.45	1618.4
3	MH	4	6	18	24	31	60	24	30	4.59	31.88	0.45	1713.6
4	SM	6	8	17	23	25	0	0	36	1.91	13.28		2473.4
5	SM	8	10	17	23	23	0	0	36	1.70	11.81		2199.3
6	PWR	10	15	100	133	100	0	0	40	7.53	52.32		9744.8
7		-											
8		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W1A-1R-10

GW Depth: 16.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	16	45	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	27	5.5	31	0.18	1.10	2	0.555	13.333	1.22	0.10	0.04
2	MH	2.0	4.0	3.0	18	45	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	31	5.5	31	0.21	1.10	2	0.555	5.000	1.22	0.10	0.04
3	MH	4.0	6.0	5.0	27	45	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.59	0.75	43	5.5	31	0.30	1.10	2	0.555	4.500	1.22	0.10	0.04
4	MH	6.0	8.0	7.0	25	69	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.41	0.75	35	5.5	31	0.27	1.10	2	0.555	2.976	1.22	0.10	0.04
5	SM	8.0	10.0	9.0	18	69	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.33	0.75	24	5.5	29	0.16	1.10	2	0.448	1.667	0.98	0.13	0.04
6	SM	10.0	15.0	12.5	12	69	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.16	0.75	14	5.5	19	0.11	1.03	2	0.199	0.800	0.41	0.30	0.10
7	SM	15.0	20.0	17.5	6	30	2.1	2.0	-0.291	0.033	0.95	0.13	0.05	1.04	0.13	0.04	1.00	0.85	7	5.4	12	0.08	1.00	2	0.134	0.299	0.27	0.47	0.16
8	SM	20.0	24.0	22.0	16	30	2.6	2.3	-0.396	0.045	0.93	0.14	0.05	1.04	0.14	0.05	0.94	0.95	19	5.4	24	0.13	0.98	2	0.278	0.706	0.55	0.25	0.09
9	SM	24.0	30.0	27.0	9	28	3.2	2.6	-0.524	0.059	0.91	0.15	0.05	1.04	0.15	0.05	0.87	0.95	10	5.3	15	0.09	0.98	2	0.158	0.352	0.31	0.47	0.16
10	SM	30.0	35.0	32.5	12	28	3.9	2.9	-0.673	0.075	0.89	0.16	0.05	1.04	0.15	0.05	0.83	0.95	13	5.3	18	0.10	0.96	2	0.182	0.418	0.35	0.43	0.15
11	PWR	35.0	40.0	37.5	100	28	4.5	3.2	-0.815	0.091	0.87	0.16	0.06	1.04	0.15	0.05	0.99	1.00	132	5.3	31	0.30	0.86	2	0.555	3.166	0.96	0.16	0.06
12	PWR	40.0	43.0	41.5	100	28	5.0	3.4	-0.932	0.104	0.85	0.16	0.06	1.04	0.16	0.05	0.99	1.00	132	5.3	31	0.30	0.84	2	0.555	2.951	0.93	0.17	0.06
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W1A-1R-10

GW Depth:

16.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	MH	4.0	6.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	MH	6.0	8.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.30	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.47	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	24.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	24.0	30.0	0.47	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	30.0	35.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	35.0	40.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	PWR	40.0	43.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13		-													
14		-													
15		-													
16		-													
17		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W1A-1R-10
GW Depth: 16.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	16	21	27	0	0	36	2.04	14.17		2638.4
2	MH	2	4	18	24	31	59	22	30	4.59	31.88	0.44	1713.6
3	MH	4	6	27	36	43	59	22	30	6.44	44.71	0.44	2403.4
4	MH	6	8	25	33	35	59	22	30	5.31	36.84	0.44	1980.7
5	SM	8	10	18	24	24	0	0	36	1.79	12.43		2315.5
6	SM	10	15	12	16	14	0	0	35	1.04	7.25		1351.0
7	SM	15	20	6	8	7	0	0	30	0.51	3.53		658.3
8	SM	20	24	16	21	19	0	0	36	1.43	9.95		1852.4
9	SM	24	30	9	12	10	0	0	32	0.75	5.19		965.9
10	SM	30	35	12	16	13	0	0	34	0.95	6.57		1222.8
11	PWR	35	40	100	133	132	0	0	40	9.93	68.94		12839.1
12	PWR	40	43	100	133	132	0	0	40	9.92	68.86		12824.7
13			-										
14			-										
15			-										
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25			-										
26			-										
27			-										
28			-										
29			-										
30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{r_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W1A-1R-09

GW Depth: 16.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CR _{Req}	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SC	0.0	2.0	1.0	10	40	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	23	0.12	1.10	1	0.241	8.333	0.27	0.48	0.17
2	SM	2.0	4.0	3.0	17	40	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	1	0.555	4.722	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	19	40	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	32	5.5	31	0.23	1.10	1	0.555	3.167	0.61	0.20	0.07
4	SM	6.0	8.0	7.0	17	32	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.50	0.75	25	5.4	31	0.17	1.10	2	0.550	2.024	1.21	0.10	0.04
5	SM	8.0	10.0	9.0	25	32	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.28	0.75	32	5.4	31	0.22	1.10	2	0.555	2.315	1.22	0.10	0.04
6	SM	10.0	15.0	12.5	10	32	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.17	0.75	12	5.4	17	0.10	1.03	2	0.175	0.667	0.36	0.34	0.12
7	SM	15.0	20.0	17.5	10	32	2.1	2.0	-0.291	0.033	0.95	0.13	0.05	1.04	0.13	0.04	1.00	0.85	11	5.4	17	0.10	1.00	2	0.172	0.498	0.34	0.37	0.13
8	PWR	20.0	25.0	22.5	100	32	2.7	2.3	-0.409	0.046	0.93	0.14	0.05	1.04	0.14	0.05	1.00	0.95	126	5.4	31	0.30	0.96	2	0.555	4.358	1.06	0.13	0.05
9	PWR	25.0	28.0	26.5	100	32	3.2	2.5	-0.511	0.057	0.92	0.15	0.05	1.04	0.14	0.05	1.00	0.95	126	5.4	31	0.30	0.93	2	0.555	3.961	1.03	0.14	0.05
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W1A-1R-09

GW Depth:

16.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	25.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	PWR	25.0	28.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10		-													
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27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W1A-1R-09

GW Depth: 16.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	10	13	17	0	0	30	1.28	8.85		952.0
2	SM	2	4	17	23	29	0	0	36	2.17	15.05		2803.3
3	SM	4	6	19	25	32	0	0	36	2.42	16.82		3133.1
4	SM	6	8	17	23	25	0	0	36	1.91	13.28		2473.4
5	SM	8	10	25	33	32	0	0	36	2.40	16.66		3102.8
6	SM	10	15	10	13	12	0	0	33	0.88	6.09		1133.4
7	SM	15	20	10	13	11	0	0	33	0.85	5.89		1097.4
8	PWR	20	25	100	133	126	0	0	40	9.48	65.83		12259.7
9	PWR	25	28	100	133	126	0	0	40	9.46	65.73		12240.9
10		-											
11		-											
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30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2B-1R-01

GW Depth: 7.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	26	30	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	44	5.4	31	0.30	1.10	1.2	0.555	21.667	0.73	0.17	0.06
2	SM	2.0	4.0	3.0	14	30	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	24	5.4	29	0.15	1.10	1.2	0.437	3.889	0.58	0.22	0.08
3	SM	4.0	6.0	5.0	11	30	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	19	5.4	24	0.13	1.10	1.2	0.269	1.833	0.36	0.35	0.12
4	SM	6.0	8.0	7.0	18	27	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.49	0.75	27	5.2	31	0.18	1.10	1.2	0.555	2.143	0.73	0.17	0.06
5	SM	8.0	10.0	9.0	4	27	1.1	1.0	-0.119	0.014	0.98	0.14	0.05	1.04	0.14	0.05	1.59	0.75	6	5.2	12	0.08	1.06	1.2	0.129	0.419	0.16	0.85	0.30
6	SM	10.0	12.0	11.0	17	27	1.3	1.1	-0.156	0.018	0.98	0.16	0.05	1.04	0.15	0.05	1.34	0.75	23	5.2	28	0.15	1.09	1.2	0.383	1.588	0.50	0.30	0.11
7	SM	12.0	18.0	15.0	7	44	1.8	1.3	-0.236	0.027	0.96	0.17	0.06	1.04	0.17	0.06	1.28	0.85	10	5.5	16	0.09	1.04	1.2	0.162	0.538	0.20	0.83	0.29
8	SM	18.0	23.0	20.5	20	44	2.5	1.6	-0.360	0.041	0.94	0.19	0.07	1.04	0.18	0.06	1.10	0.95	28	5.5	31	0.18	1.04	1.2	0.555	1.236	0.69	0.26	0.09
9	SM	23.0	28.0	25.5	14	30	3.1	1.9	-0.485	0.054	0.92	0.19	0.07	1.04	0.19	0.06	1.02	0.95	18	5.4	24	0.12	1.01	2	0.259	0.735	0.52	0.36	0.12
10	SM	28.0	33.0	30.5	6	30	3.7	2.2	-0.618	0.069	0.90	0.19	0.07	1.04	0.19	0.07	0.95	0.95	7	5.4	13	0.08	0.99	2	0.137	0.274	0.27	0.69	0.24
11	SM	33.0	38.0	35.5	18	30	4.3	2.5	-0.758	0.085	0.87	0.20	0.07	1.04	0.19	0.07	0.91	1.00	22	5.4	27	0.14	0.97	2	0.350	0.725	0.68	0.28	0.10
12	PWR	38.0	43.0	40.5	100	30	4.9	2.8	-0.902	0.101	0.85	0.19	0.07	1.04	0.19	0.07	0.99	1.00	133	5.4	31	0.30	0.90	2	0.555	3.611	1.00	0.19	0.07
13	PWR	43.0	44.0	43.5	100	30	5.2	2.9	-0.990	0.110	0.84	0.19	0.07	1.04	0.19	0.07	0.99	1.00	133	5.4	31	0.30	0.88	2	0.555	3.399	0.98	0.19	0.07
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2B-1R-01

GW Depth:

7.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.22	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.85	0.30	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	CHECK	0.00
6	SM	10.0	12.0	0.30	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	18.0	0.83	0.29	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	CHECK	0.00
8	SM	18.0	23.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	23.0	28.0	0.36	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	28.0	33.0	0.69	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	33.0	38.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	PWR	38.0	43.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	PWR	43.0	44.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
16		-													
17		-													
18		-													
19		-													
20		-													
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23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2B-1R-01

GW Depth:

7.0

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	26	35	44	0	0	36	3.32	23.02		4287.4
2	SM	2	4	14	19	24	0	0	36	1.79	12.40		2308.6
3	SM	4	6	11	15	19	0	0	36	1.40	9.74		1813.9
4	SM	6	8	18	24	27	0	0	36	2.01	13.95		2598.1
5	SM	8	10	4	5	6	0	0	30	0.48	3.32		618.2
6	SM	10	12	17	23	23	0	0	36	1.71	11.86		2208.5
7	SM	12	18	7	9	10	0	0	33	0.76	5.30		987.9
8	SM	18	23	20	27	28	0	0	36	2.09	14.49		2698.1
9	SM	23	28	14	19	18	0	0	36	1.36	9.46		1761.9
10	SM	28	33	6	8	7	0	0	31	0.54	3.75		697.7
11	SM	33	38	18	24	22	0	0	36	1.63	11.32		2108.9
12	PWR	38	43	100	133	133	0	0	40	9.95	69.08		12866.1
13	PWR	43	44	100	133	133	0	0	40	9.94	69.02		12853.7
14		-											
15		-											
16		-											
17		-											
18													
19		-											
20		-											
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24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u,Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u,High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-1R-02

GW Depth: 17.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SC	0.0	2.0	1.0	3	39	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	5	5.5	11	0.08	1.10	1.2	0.122	2.500	0.16	0.78	0.27
2	SC	2.0	4.0	3.0	8	39	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	13	5.5	19	0.10	1.10	1	0.194	2.222	0.21	0.59	0.21
3	SC	4.0	6.0	5.0	16	39	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	27	5.5	31	0.18	1.10	1	0.555	2.667	0.61	0.20	0.07
4	SC	6.0	8.0	7.0	11	39	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.58	0.75	17	5.5	23	0.12	1.10	1	0.244	1.310	0.27	0.46	0.16
5	SM	8.0	10.0	9.0	11	49	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.39	0.75	15	5.5	21	0.11	1.07	2	0.213	1.019	0.45	0.27	0.10
6	SM	10.0	13.0	11.5	10	49	1.4	1.4	-0.165	0.019	0.97	0.13	0.04	1.04	0.12	0.04	1.22	0.75	12	5.5	18	0.10	1.04	2	0.179	0.725	0.37	0.33	0.12
7	SM	13.0	18.0	15.5	17	49	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.03	0.85	20	5.5	25	0.13	1.01	2	0.294	0.914	0.59	0.20	0.07
8	SM	18.0	23.0	20.5	12	39	2.5	2.2	-0.360	0.041	0.94	0.13	0.05	1.04	0.13	0.05	0.94	0.95	14	5.5	20	0.11	0.99	2	0.202	0.535	0.40	0.33	0.11
9	SM	23.0	28.0	25.5	10	39	3.1	2.5	-0.485	0.054	0.92	0.14	0.05	1.04	0.14	0.05	0.88	0.95	11	5.5	17	0.10	0.98	2	0.169	0.395	0.33	0.42	0.15
10	SM	28.0	33.0	30.5	10	39	3.7	2.8	-0.618	0.069	0.90	0.15	0.05	1.04	0.15	0.05	0.83	0.95	10	5.5	16	0.09	0.97	2	0.164	0.355	0.32	0.46	0.16
11	SM	33.0	38.0	35.5	20	35	4.3	3.1	-0.758	0.085	0.87	0.16	0.05	1.04	0.15	0.05	0.82	1.00	22	5.5	27	0.14	0.94	2	0.353	0.644	0.66	0.23	0.08
12	SM	38.0	43.0	40.5	35	35	4.9	3.4	-0.902	0.101	0.85	0.16	0.06	1.04	0.15	0.05	0.84	1.00	39	5.5	31	0.30	0.84	2	0.555	1.031	0.93	0.16	0.06
13	SM	43.0	45.0	44.0	25	35	5.3	3.6	-1.005	0.112	0.83	0.16	0.06	1.04	0.15	0.05	0.79	1.00	26	5.5	31	0.17	0.90	2	0.555	0.695	1.00	0.15	0.05
14		-																											
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29		-																											
30		-																											

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-1R-02

GW Depth:

17.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.78	0.27	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.00	0.00
2	SC	2.0	4.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SC	4.0	6.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	6.0	8.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.27	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	13.0	0.33	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	13.0	18.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	23.0	0.33	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	23.0	28.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	28.0	33.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	33.0	38.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	38.0	43.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	43.0	45.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
16		-													
17		-													
18		-													
19		-													
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2A-1R-02

GW Depth: 17.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	3	4	5	31	17	29	0.38	2.62		282.0
2	SC	2	4	8	11	13	31	17	30	1.01	6.99		752.1
3	SC	4	6	16	21	27	31	17	30	2.01	13.99		1504.2
4	SC	6	8	11	14	17	31	17	30	1.29	8.95		962.8
5	SM	8	10	11	14	15	0	0	35	1.13	7.84		1460.0
6	SM	10	13	10	13	12	0	0	34	0.91	6.29		1170.9
7	SM	13	18	17	22	20	0	0	36	1.48	10.25		1909.2
8	SM	18	23	12	16	14	0	0	35	1.06	7.37		1372.5
9	SM	23	28	10	13	11	0	0	33	0.83	5.74		1068.5
10	SM	28	33	10	13	10	0	0	33	0.78	5.41		1007.9
11	SM	33	38	20	26	22	0	0	36	1.63	11.30		2104.2
12	SM	38	43	35	46	39	0	0	36	2.90	20.16		3755.1
13	SM	43	45	25	33	26	0	0	36	1.95	13.56		2525.3
14		-											
15		-											
16		-											
17		-											
18													
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26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-1R-03

GW Depth: 21.7 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	CH	0.0	2.0	1.0	3	69	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	5	5.5	11	0.08	1.10	1	0.122	2.500	2.50	0.05	0.02
2	CH	2.0	4.0	3.0	8	69	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	13	5.5	19	0.10	1.10	1	0.194	2.222	2.22	0.06	0.02
3	CH	4.0	6.0	5.0	9	69	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	15	5.5	21	0.11	1.10	1	0.213	1.500	1.50	0.09	0.03
4	CH	6.0	8.0	7.0	7	69	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.66	0.75	11	5.5	17	0.10	1.08	1	0.173	0.833	0.83	0.15	0.05
5	SM	8.0	10.0	9.0	11	34	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.39	0.75	15	5.5	21	0.11	1.07	2	0.213	1.019	0.45	0.27	0.10
6	SM	10.0	12.0	11.0	11	34	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.25	0.75	14	5.5	19	0.11	1.04	2	0.194	0.833	0.41	0.30	0.11
7	SM	12.0	15.0	13.5	13	34	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.11	0.85	16	5.5	22	0.12	1.02	2	0.228	0.802	0.47	0.26	0.09
8	SM	15.0	20.0	17.5	12	40	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.98	0.85	13	5.5	19	0.10	0.99	2	0.190	0.571	0.38	0.32	0.11
9	SM	20.0	25.0	22.5	11	40	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.86	0.95	12	5.5	17	0.10	0.97	2	0.177	0.415	0.34	0.35	0.12
10	SM	25.0	30.0	27.5	21	40	3.3	2.9	-0.537	0.060	0.91	0.13	0.05	1.04	0.13	0.04	0.85	0.95	22	5.5	28	0.15	0.94	2	0.373	0.715	0.71	0.18	0.06
11	SM	30.0	35.0	32.5	15	40	3.9	3.2	-0.673	0.075	0.89	0.14	0.05	1.04	0.13	0.05	0.79	0.95	15	5.5	20	0.11	0.95	2	0.210	0.465	0.40	0.34	0.12
12	SM	35.0	40.0	37.5	21	40	4.5	3.5	-0.815	0.091	0.87	0.14	0.05	1.04	0.14	0.05	0.78	1.00	22	5.5	27	0.14	0.92	2	0.352	0.598	0.65	0.21	0.08
13	SM	40.0	45.0	42.5	14	32	5.1	3.8	-0.961	0.107	0.84	0.15	0.05	1.04	0.14	0.05	0.73	1.00	13	5.4	19	0.10	0.93	2	0.192	0.368	0.36	0.39	0.14
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-1R-03

GW Depth:

21.7 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CH	0.0	2.0	0.05	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	CH	2.0	4.0	0.06	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	CH	4.0	6.0	0.09	0.03	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CH	6.0	8.0	0.15	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.27	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.30	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	15.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	25.0	30.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	30.0	35.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	35.0	40.0	0.21	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	40.0	45.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
16		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2A-1R-03
GW Depth: 21.7 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CH	0	2	3	4	5	67	36	26	0.76	5.25	0.51	282.0
2	CH	2	4	8	11	13	67	36	26	2.01	13.99	0.51	752.1
3	CH	4	6	9	12	15	67	36	26	2.27	15.74	0.51	846.1
4	CH	6	8	7	9	11	67	36	26	1.72	11.92	0.51	640.7
5	SM	8	10	11	14	15	0	0	35	1.13	7.84		1460.0
6	SM	10	12	11	14	14	0	0	34	1.02	7.05		1312.8
7	SM	12	15	13	17	16	0	0	36	1.21	8.43		1570.4
8	SM	15	20	12	16	13	0	0	34	0.98	6.82		1270.2
9	SM	20	25	11	14	12	0	0	34	0.89	6.17		1149.9
10	SM	25	30	21	28	22	0	0	36	1.67	11.59		2157.9
11	SM	30	35	15	20	15	0	0	35	1.12	7.74		1442.2
12	SM	35	40	21	28	22	0	0	36	1.63	11.29		2102.4
13	SM	40	45	14	18	13	0	0	34	1.00	6.98		1299.6
14		-											
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28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-1R-04

GW Depth: 27.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSR _{eq} / CR _{Req}	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	MH	0.0	2.0	1.0	5	68	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	8	5.5	14	0.09	1.10	1	0.147	4.167	0.16	0.78	0.27
2	MH	2.0	4.0	3.0	12	68	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	20	5.5	26	0.13	1.10	1	0.306	3.333	0.34	0.37	0.13
3	ML	4.0	6.0	5.0	10	55	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	1.667	0.26	0.48	0.17
4	ML	6.0	8.0	7.0	10	55	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.60	0.75	16	5.5	21	0.11	1.10	2	0.223	1.190	0.49	0.25	0.09
5	ML	8.0	10.0	9.0	7	55	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.43	0.75	10	5.5	15	0.09	1.06	2	0.159	0.648	0.34	0.37	0.13
6	ML	10.0	13.0	11.5	7	55	1.4	1.4	-0.165	0.019	0.97	0.13	0.04	1.04	0.12	0.04	1.24	0.75	9	5.5	14	0.09	1.03	2	0.149	0.507	0.31	0.40	0.14
7	SM	13.0	18.0	15.5	7	55	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.04	0.85	8	5.5	14	0.09	1.01	2	0.145	0.376	0.29	0.41	0.14
8	SM	18.0	23.0	20.5	9	42	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.89	0.95	10	5.5	16	0.09	0.98	2	0.161	0.366	0.32	0.37	0.13
9	SM	23.0	28.0	25.5	4	42	3.1	3.1	-0.485	0.054	0.92	0.12	0.04	1.04	0.12	0.04	0.76	0.95	4	5.5	9	0.07	0.97	2	0.113	0.131	0.22	0.53	0.18
10	SM	28.0	33.0	30.5	3	42	3.7	3.4	-0.618	0.069	0.90	0.12	0.04	1.04	0.12	0.04	0.70	0.95	3	5.5	8	0.07	0.96	2	0.105	0.087	0.20	0.59	0.21
11	SM	33.0	38.0	35.5	5	42	4.3	3.7	-0.758	0.085	0.87	0.13	0.05	1.04	0.13	0.04	0.68	1.00	4	5.5	10	0.07	0.95	2	0.118	0.134	0.23	0.56	0.20
12	SM	38.0	43.0	40.5	7	32	4.9	4.0	-0.902	0.101	0.85	0.13	0.05	1.04	0.13	0.05	0.67	1.00	6	5.4	12	0.08	0.94	2	0.129	0.174	0.24	0.53	0.19
13	SM	43.0	45.0	44.0	17	32	5.3	4.2	-1.005	0.112	0.83	0.14	0.05	1.04	0.13	0.05	0.71	1.00	16	5.4	21	0.11	0.91	2	0.222	0.403	0.41	0.32	0.11
14			-																										
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29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-1R-04

GW Depth:

27.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.78	0.27	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.37	0.13	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
4	ML	6.0	8.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	10.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	ML	10.0	13.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	13.0	18.0	0.41	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	23.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	23.0	28.0	0.53	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.03	0.00
10	SM	28.0	33.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	33.0	38.0	0.56	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	38.0	43.0	0.53	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	43.0	45.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
16		-													
17		-													
18		-													
19		-													
20		-													
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23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.04	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2A-1R-04

GW Depth: 27.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	5	7	8	67	21	30	1.26	8.74	0.51	470.1
2	MH	2	4	12	16	20	67	21	30	3.02	20.98	0.51	1128.1
3	ML	4	6	10	13	17	0	0	30	1.26	8.74		940.1
4	ML	6	8	10	13	16	0	0	30	1.18	8.22		884.3
5	ML	8	10	7	9	10	0	0	30	0.74	5.15		553.7
6	ML	10	13	7	9	9	0	0	30	0.64	4.47		480.2
7	SM	13	18	7	9	8	0	0	31	0.61	4.26		792.6
8	SM	18	23	9	12	10	0	0	32	0.75	5.23		973.7
9	SM	23	28	4	5	4	0	0	28	0.29	1.99		371.2
10	SM	28	33	3	4	3	0	0	26	0.20	1.37		255.6
11	SM	33	38	5	7	4	0	0	28	0.34	2.34		436.0
12	SM	38	43	7	9	6	0	0	30	0.46	3.20		596.2
13	SM	43	45	17	22	16	0	0	36	1.18	8.22		1531.7
14		-											
15		-											
16		-											
17		-											
18													
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25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-1R-05

GW Depth: 26.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						K _{DR}	SAND					CLAY	SEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	CH	0.0	2.0	1.0	3	57	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	5	5.5	11	0.08	1.10	1	0.122	2.500	2.50	0.05	0.02
2	CH	2.0	4.0	3.0	11	57	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	18	5.5	24	0.13	1.10	1	0.267	3.056	3.06	0.04	0.01
3	CH	4.0	6.0	5.0	7	57	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	12	5.5	17	0.10	1.10	1	0.176	1.167	1.17	0.11	0.04
4	SM	6.0	8.0	7.0	9	43	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.62	0.75	14	5.5	20	0.11	1.09	2	0.204	1.071	0.45	0.28	0.10
5	SM	8.0	10.0	9.0	9	43	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.41	0.75	13	5.5	18	0.10	1.06	2	0.184	0.833	0.39	0.32	0.11
6	SM	10.0	13.0	11.5	8	43	1.4	1.4	-0.165	0.019	0.97	0.13	0.04	1.04	0.12	0.04	1.23	0.75	10	5.5	15	0.09	1.03	2	0.158	0.580	0.33	0.37	0.13
7	SM	13.0	18.0	15.5	13	43	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.04	0.85	15	5.5	21	0.11	1.01	2	0.213	0.699	0.43	0.28	0.10
8	SM	18.0	23.0	20.5	7	42	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.89	0.95	8	5.5	13	0.08	0.98	2	0.142	0.285	0.28	0.42	0.15
9	SM	23.0	28.0	25.5	10	42	3.1	3.1	-0.485	0.054	0.92	0.12	0.04	1.04	0.12	0.04	0.79	0.95	10	5.5	15	0.09	0.96	2	0.160	0.327	0.31	0.38	0.13
10	SM	28.0	33.0	30.5	6	42	3.7	3.4	-0.618	0.069	0.90	0.13	0.04	1.04	0.12	0.04	0.73	0.95	5	5.5	11	0.08	0.96	2	0.125	0.178	0.24	0.51	0.18
11	SM	33.0	38.0	35.5	8	23	4.3	3.7	-0.758	0.085	0.87	0.13	0.05	1.04	0.13	0.04	0.71	1.00	7	4.9	12	0.08	0.95	2	0.135	0.218	0.26	0.50	0.17
12	SM	38.0	43.0	40.5	8	23	4.9	4.0	-0.902	0.101	0.85	0.14	0.05	1.04	0.13	0.05	0.68	1.00	7	4.9	12	0.08	0.94	2	0.133	0.202	0.25	0.52	0.18
13	SM	43.0	45.0	44.0	12	23	5.3	4.2	-1.005	0.112	0.83	0.14	0.05	1.04	0.13	0.05	0.68	1.00	11	4.9	16	0.10	0.93	2	0.162	0.289	0.30	0.44	0.15
14			-																										
15			-																										
16			-																										
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30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-1R-05

GW Depth:

26.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CH	0.0	2.0	0.05	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	CH	2.0	4.0	0.04	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	CH	4.0	6.0	0.11	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	13.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	13.0	18.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	23.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	23.0	28.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	28.0	33.0	0.51	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	33.0	38.0	0.50	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	38.0	43.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	43.0	45.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
16		-													
17		-													
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20		-													
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22		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2A-1R-05

GW Depth: 26.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CH	0	2	3	4	5	61	32	26	0.76	5.25	0.46	282.0
2	CH	2	4	11	14	18	61	32	26	2.77	19.24	0.46	1034.1
3	CH	4	6	7	9	12	61	32	26	1.76	12.24	0.46	658.1
4	SM	6	8	9	12	14	0	0	35	1.08	7.48		1393.5
5	SM	8	10	9	12	13	0	0	34	0.94	6.51		1212.5
6	SM	10	13	8	11	10	0	0	32	0.73	5.08		945.7
7	SM	13	18	13	17	15	0	0	35	1.13	7.86		1464.2
8	SM	18	23	7	9	8	0	0	31	0.58	4.04		753.1
9	SM	23	28	10	13	10	0	0	32	0.75	5.18		963.9
10	SM	28	33	6	8	5	0	0	29	0.41	2.86		532.6
11	SM	33	38	8	11	7	0	0	31	0.56	3.89		724.6
12	SM	38	43	8	11	7	0	0	30	0.54	3.73		694.2
13	SM	43	45	12	16	11	0	0	33	0.81	5.63		1049.2
14		-											
15		-											
16		-											
17		-											
18													
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24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{r_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-MB1-01

GW Depth: 40.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	4	49	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	7	5.5	12	0.08	1.10	1.2	0.134	3.333	0.18	0.71	0.25
2	SM	2.0	4.0	3.0	10	49	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1.2	0.238	2.778	0.31	0.40	0.14
3	SM	4.0	6.0	5.0	2	42	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	3	5.5	9	0.07	1.08	1.2	0.110	0.333	0.14	0.87	0.30
4	MH	6.0	8.0	7.0	17	63	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.50	0.75	25	5.5	31	0.16	1.10	2	0.531	2.024	1.17	0.11	0.04
5	MH	8.0	10.0	9.0	10	63	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.40	0.75	14	5.5	19	0.11	1.07	2	0.197	0.926	0.42	0.29	0.10
6	ML	10.0	14.0	12.0	5	56	1.4	1.4	-0.175	0.020	0.97	0.13	0.04	1.04	0.12	0.04	1.22	0.75	6	5.5	12	0.08	1.03	2	0.129	0.347	0.26	0.46	0.16
7	SM	14.0	18.0	16.0	4	38	1.9	1.9	-0.257	0.029	0.96	0.12	0.04	1.04	0.12	0.04	1.03	0.85	5	5.5	10	0.07	1.00	2	0.119	0.208	0.24	0.51	0.18
8	SM	18.0	23.0	20.5	8	39	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.89	0.95	9	5.5	14	0.09	0.98	2	0.151	0.325	0.30	0.40	0.14
9	SM	23.0	25.0	24.0	6	42	2.9	2.9	-0.446	0.050	0.93	0.12	0.04	1.04	0.12	0.04	0.80	0.95	6	5.5	12	0.08	0.97	2	0.129	0.208	0.25	0.46	0.16
10	SM	25.0	28.0	26.5	14	43	3.2	3.2	-0.511	0.057	0.92	0.12	0.04	1.04	0.12	0.04	0.79	0.95	14	5.5	19	0.11	0.95	2	0.199	0.440	0.38	0.30	0.11
11	SM	28.0	30.0	29.0	8	38	3.5	3.5	-0.577	0.065	0.90	0.12	0.04	1.04	0.11	0.04	0.73	0.95	7	5.5	13	0.08	0.95	2	0.139	0.230	0.26	0.43	0.15
12	SM	30.0	33.0	31.5	14	46	3.8	3.8	-0.646	0.072	0.89	0.12	0.04	1.04	0.11	0.04	0.73	0.95	13	5.5	18	0.10	0.93	2	0.186	0.370	0.35	0.32	0.11
13	SM	33.0	35.0	34.0	10	46	4.1	4.1	-0.715	0.080	0.88	0.11	0.04	1.04	0.11	0.04	0.68	1.00	9	5.5	14	0.09	0.94	2	0.152	0.245	0.28	0.39	0.14
14	SM	35.0	40.0	37.5	13	46	4.5	4.5	-0.815	0.091	0.87	0.11	0.04	1.04	0.11	0.04	0.66	1.00	11	5.5	17	0.10	0.92	2	0.172	0.289	0.32	0.34	0.12
15			-																										
16			-																										
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-MB1-01

GW Depth:

40.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.87	0.30	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.06	0.00
4	MH	6.0	8.0	0.11	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	MH	8.0	10.0	0.29	0.10	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	ML	10.0	14.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	14.0	18.0	0.51	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	23.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	23.0	25.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	25.0	28.0	0.30	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	28.0	30.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	30.0	33.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	33.0	35.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	35.0	40.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15		-													
16		-													
17		-													
18		-													
19		-													
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.08	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2A-MB1-01

GW Depth: 40.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	4	5	7	62	31	30	1.01	6.99		651.4
2	SM	2	4	10	13	17	0	0	36	1.26	8.74		1628.4
3	SM	4	6	2	3	3	0	0	27	0.25	1.75		325.7
4	MH	6	8	17	22	25	0	0	30	1.89	13.11	-0.09	1410.1
5	MH	8	10	10	13	14	0	0	30	1.03	7.18	-0.09	771.9
6	ML	10	14	5	7	6	0	0	30	0.45	3.14		338.1
7	SM	14	18	4	5	5	0	0	28	0.34	2.39		445.6
8	SM	18	23	8	11	9	0	0	32	0.67	4.63		863.2
9	SM	23	25	6	8	6	0	0	30	0.45	3.15		585.8
10	SM	25	28	14	18	14	0	0	35	1.04	7.24		1349.2
11	SM	28	30	8	11	7	0	0	31	0.55	3.81		709.1
12	SM	30	33	14	18	13	0	0	34	0.96	6.65		1238.2
13	SM	33	35	10	13	9	0	0	32	0.67	4.66		868.4
14	SM	35	40	13	17	11			33	0.85	5.91		1100.5
15		-											
16		-											
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-MB1-02

GW Depth: 28.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	CL	0.0	2.0	1.0	6	57	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	10	5.5	16	0.09	1.10	1.5	0.161	5.000	5.00	0.03	0.01
2	CL	2.0	4.0	3.0	11	57	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	18	5.5	24	0.13	1.10	1.5	0.267	3.056	3.06	0.04	0.01
3	CL	4.0	6.0	5.0	17	57	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	1.5	0.555	2.833	2.83	0.05	0.02
4	CL	6.0	8.0	7.0	16	57	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.51	0.75	24	5.5	29	0.16	1.10	1.5	0.450	1.905	1.90	0.07	0.02
5	CL	8.0	10.0	9.0	11	57	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.01	0.13	0.04	1.39	0.75	15	5.5	21	0.11	1.07	2	0.213	1.019	1.02	0.12	0.04
6	ML	10.0	12.0	11.0	6	51	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.28	0.75	8	5.5	13	0.08	1.03	2	0.141	0.455	0.29	0.42	0.15
7	ML	12.0	16.0	14.0	4	51	1.7	1.7	-0.215	0.024	0.97	0.13	0.04	1.04	0.12	0.04	1.12	0.85	5	5.5	10	0.08	1.01	2	0.122	0.238	0.25	0.49	0.17
8	SM	16.0	20.0	18.0	4	49	2.2	2.2	-0.302	0.034	0.95	0.12	0.04	1.04	0.12	0.04	0.95	0.85	4	5.5	10	0.07	0.99	2	0.116	0.185	0.23	0.52	0.18
9	SM	20.0	23.0	21.5	11	45	2.6	2.6	-0.384	0.043	0.94	0.12	0.04	1.04	0.12	0.04	0.87	0.95	12	5.5	18	0.10	0.97	2	0.179	0.426	0.35	0.34	0.12
10	SM	23.0	25.0	24.0	13	45	2.9	2.9	-0.446	0.050	0.93	0.12	0.04	1.04	0.12	0.04	0.83	0.95	14	5.5	19	0.10	0.96	2	0.194	0.451	0.37	0.31	0.11
11	SM	25.0	30.0	27.5	8	44	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.75	0.95	8	5.5	13	0.08	0.96	2	0.140	0.242	0.27	0.43	0.15
12	ML	30.0	33.0	31.5	9	51	3.8	3.6	-0.646	0.072	0.89	0.12	0.04	1.04	0.12	0.04	0.72	0.95	8	5.5	14	0.09	0.95	2	0.145	0.251	0.28	0.43	0.15
13	ML	33.0	35.0	34.0	3	51	4.1	3.7	-0.715	0.080	0.88	0.13	0.04	1.04	0.12	0.04	0.67	1.00	3	5.5	8	0.07	0.96	2	0.105	0.080	0.20	0.60	0.21
14	ML	35.0	38.0	36.5	8	51	4.4	3.9	-0.787	0.088	0.87	0.13	0.04	1.04	0.12	0.04	0.69	1.00	7	5.5	13	0.08	0.94	2	0.138	0.206	0.26	0.47	0.17
15	SM	38.0	40.0	39.0	10	51	4.7	4.0	-0.859	0.096	0.86	0.13	0.05	1.04	0.13	0.04	0.68	1.00	9	5.5	15	0.09	0.94	2	0.152	0.248	0.29	0.44	0.15
16	PWR	40.0	44.0	42.0	100	51	5.0	4.2	-0.946	0.105	0.84	0.13	0.05	1.04	0.13	0.04	0.99	1.00	130	5.5	31	0.30	0.78	2	0.555	2.382	0.86	0.15	0.05
17																													
18																													
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29																													
30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-MB1-02

GW Depth:

28.5 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CL	0.0	2.0	0.03	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	CL	2.0	4.0	0.04	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	CL	4.0	6.0	0.05	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CL	6.0	8.0	0.07	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	CL	8.0	10.0	0.12	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	ML	10.0	12.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	ML	12.0	16.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	16.0	20.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
9	SM	20.0	23.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	23.0	25.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	25.0	30.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
12	ML	30.0	33.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	ML	33.0	35.0	0.60	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	ML	35.0	38.0	0.47	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	38.0	40.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	PWR	40.0	44.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17		-													
18		-													
19		-													
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.02	0.00

L-Pile Input Parameters

Project Information													
Date: September 16, 2015													
Site: I-85/385													
Location: Greenville, SC													
Project ID: 0038111													
Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	φ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CL	0	2	6	8	10	62	31	26	1.51	10.49	0.47	564.1
2	CL	2	4	11	14	18	0	0	26	1.38	9.62	-0.09	1034.1
3	CL	4	6	17	22	29	0	0	26	2.14	14.86	-0.09	1598.2
4	CL	6	8	16	21	24	0	0	26	1.79	12.44	-0.09	1338.1
5	CL	8	10	11	14	15	0	0	26	1.13	7.84	-0.09	842.9
6	ML	10	12	6	8	8	0	0	30	0.57	3.95		425.0
7	ML	12	16	4	5	5	0	0	30	0.37	2.60		279.8
8	SM	16	20	4	5	4	0	0	28	0.32	2.22		413.7
9	SM	20	23	11	14	12	0	0	34	0.90	6.26		1166.4
10	SM	23	25	13	17	14	0	0	34	1.01	7.04		1311.0
11	SM	25	30	8	11	8	0	0	31	0.57	3.92		730.8
12	ML	30	33	9	12	8	0	0	30	0.61	4.24		455.8
13	ML	33	35	3	4	3	0	0	30	0.20	1.37		147.3
14	ML	35	38	8	11	7			30	0.54	3.77		405.1
15	SM	38	40	10	13	9			32	0.68	4.70		874.8
16	PWR	40	44	100	132	130			40	9.76	67.77		12621.1
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate φ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate φ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	φ´ (deg)	c´ (psf)	φ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	φ´ (deg)	c´ (psf)	φ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2A-MB2-01

GW Depth: 30.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	37	33	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	62	5.5	31	0.30	1.10	1	0.555	30.833	0.61	0.21	0.07
2	SC	2.0	4.0	3.0	10	32	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.4	22	0.12	1.10	1	0.236	2.778	0.26	0.48	0.17
3	SC	4.0	6.0	5.0	13	32	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	22	5.4	27	0.14	1.10	1	0.355	2.167	0.39	0.32	0.11
4	SC	6.0	8.0	7.0	14	32	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.54	0.75	21	5.4	27	0.14	1.10	1	0.337	1.667	0.37	0.34	0.12
5	SC	8.0	10.0	9.0	14	32	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.36	0.75	19	5.4	24	0.13	1.08	1	0.272	1.296	0.29	0.42	0.15
6	CH	10.0	13.0	11.5	15	61	1.4	1.4	-0.165	0.019	0.97	0.13	0.04	1.01	0.13	0.04	1.20	0.75	18	5.5	23	0.12	1.05	1.5	0.254	1.087	1.09	0.12	0.04
7	CH	13.0	16.0	14.5	15	61	1.7	1.7	-0.225	0.026	0.96	0.13	0.04	1.01	0.12	0.04	1.07	0.85	18	5.5	23	0.12	1.02	1.5	0.258	0.862	0.86	0.14	0.05
8	CH	16.0	18.0	17.0	12	61	2.0	2.0	-0.279	0.032	0.95	0.12	0.04	1.01	0.12	0.04	0.99	0.85	13	5.5	19	0.10	1.00	1.5	0.192	0.588	0.59	0.21	0.07
9	SM	18.0	20.0	19.0	6	43	2.3	2.3	-0.325	0.037	0.95	0.12	0.04	1.04	0.12	0.04	0.92	0.85	6	5.5	12	0.08	0.99	1.5	0.130	0.263	0.19	0.61	0.22
10	SC	20.0	22.0	21.0	7	48	2.5	2.5	-0.372	0.042	0.94	0.12	0.04	1.04	0.12	0.04	0.87	0.95	8	5.5	13	0.08	0.98	1.5	0.141	0.278	0.21	0.57	0.20
11	SM	22.0	25.0	23.5	5	39	2.8	2.8	-0.434	0.049	0.93	0.12	0.04	1.04	0.12	0.04	0.81	0.95	5	5.5	11	0.08	0.97	2	0.122	0.177	0.24	0.49	0.17
12	SM	25.0	28.0	26.5	9	45	3.2	3.2	-0.511	0.057	0.92	0.12	0.04	1.04	0.12	0.04	0.77	0.95	9	5.5	14	0.09	0.96	2	0.150	0.283	0.29	0.40	0.14
13	SM	28.0	30.0	29.0	8	45	3.5	3.5	-0.577	0.065	0.90	0.12	0.04	1.04	0.11	0.04	0.73	0.95	7	5.5	13	0.08	0.95	2	0.139	0.230	0.26	0.43	0.15
14	SM	30.0	32.0	31.0	2	45	3.7	3.7	-0.632	0.071	0.90	0.12	0.04	1.04	0.11	0.04	0.67	0.95	2	5.5	7	0.06	0.96	2	0.099	0.055	0.19	0.60	0.21
15	SM	32.0	33.0	32.5	5	45	3.9	3.7	-0.673	0.075	0.89	0.12	0.04	1.04	0.12	0.04	0.68	0.95	4	5.5	10	0.07	0.95	2	0.116	0.134	0.22	0.52	0.18
16	SM	33.0	35.0	34.0	9	41	4.1	3.8	-0.715	0.080	0.88	0.12	0.04	1.04	0.12	0.04	0.70	1.00	8	5.5	14	0.09	0.94	2	0.146	0.235	0.28	0.43	0.15
17	SM	35.0	40.0	37.5	13	41	4.5	4.0	-0.815	0.091	0.87	0.13	0.04	1.04	0.12	0.04	0.70	1.00	12	5.5	17	0.10	0.93	2	0.179	0.322	0.33	0.36	0.13
18	SM	40.0	45.0	42.5	17	41	5.1	4.3	-0.961	0.107	0.84	0.13	0.05	1.04	0.12	0.04	0.70	1.00	16	5.5	21	0.11	0.91	2	0.220	0.394	0.40	0.31	0.11
19		-																											
20		-																											
21		-																											
22		-																											
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26		-																											
27		-																											
28		-																											
29		-																											
30		-																											

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-MB2-01

GW Depth:

30.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SC	4.0	6.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	6.0	8.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SC	8.0	10.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	CH	10.0	13.0	0.12	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
7	CH	13.0	16.0	0.14	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
8	CH	16.0	18.0	0.21	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
9	SM	18.0	20.0	0.61	0.22	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
10	SC	20.0	22.0	0.57	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	22.0	25.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
12	SM	25.0	28.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	28.0	30.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	30.0	32.0	0.60	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	32.0	33.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	SM	33.0	35.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	SM	35.0	40.0	0.36	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
18	SM	40.0	45.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
19			-												
20			-												
21			-												
22			-												
23			-												
24			-												
25			-												
26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.03	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2A-MB2-01

GW Depth:

30.0

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	37	49	62			36	4.66	32.35		6025.0
2	SC	2	4	10	13	17			30	1.26	8.74		940.1
3	SC	4	6	13	17	22			30	1.64	11.37		1222.1
4	SC	6	8	14	18	21			30	1.60	11.08		1191.1
5	SC	8	10	14	18	19			30	1.41	9.78		1051.4
6	CH	10	13	15	20	18	59	33	26	2.66	18.48	0.44	993.6
7	CH	13	16	15	20	18	59	33	26	2.69	18.71	0.44	1006.0
8	CH	16	18	12	16	13	59	33	26	1.99	13.85	0.44	744.4
9	SM	18	20	6	8	6			30	0.47	3.23		602.4
10	SC	20	22	7	9	8	41	19	30	1.15	7.97		428.7
11	SM	22	25	5	7	5			29	0.38	2.64		491.6
12	SM	25	28	9	12	9			32	0.65	4.54		844.7
13	SM	28	30	8	11	7			31	0.55	3.81		709.1
14	SM	30	32	2	3	2			25	0.12	0.87		161.4
15	SM	32	33	5	7	4			28	0.32	2.22		413.3
16	SM	33	35	9	12	8			31	0.62	4.31		802.2
17	SM	35	40	13	17	12			34	0.90	6.25		1163.6
18	SM	40	45	17	22	16			36	1.17	8.13		1514.9
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2B-1R-02

GW Depth: 8.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	16	19	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	27	4.3	31	0.18	1.10	1	0.555	13.333	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	28	19	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	48	4.3	31	0.30	1.10	1	0.555	7.778	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	24	19	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.63	0.75	39	4.3	31	0.30	1.10	1	0.555	4.000	0.61	0.20	0.07
4	SC	6.0	8.0	7.0	7	28	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.66	0.75	12	5.3	17	0.10	1.08	1.5	0.173	0.833	0.28	0.44	0.15
5	SM	8.0	10.0	9.0	12	28	1.1	1.0	-0.119	0.014	0.98	0.14	0.05	1.04	0.13	0.05	1.42	0.75	17	5.3	22	0.12	1.08	1.5	0.238	1.179	0.39	0.34	0.12
6	SM	10.0	15.0	12.5	11	38	1.5	1.2	-0.185	0.021	0.97	0.16	0.05	1.04	0.15	0.05	1.30	0.75	14	5.5	20	0.11	1.05	1.5	0.203	0.902	0.32	0.47	0.16
7	SM	15.0	20.0	17.5	51	38	2.1	1.5	-0.291	0.033	0.95	0.17	0.06	1.04	0.17	0.06	1.07	0.85	62	5.5	31	0.30	1.08	2	0.555	3.384	1.20	0.14	0.05
8	PWR	20.0	21.0	20.5	100	38	2.5	1.7	-0.360	0.041	0.94	0.18	0.06	1.04	0.17	0.06	1.00	0.95	127	5.5	31	0.30	1.05	2	0.555	5.952	1.17	0.15	0.05
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29																													
30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2B-1R-02

GW Depth:

7.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	6.0	8.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.47	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	21.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9															
10															
11															
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25															
26															
27															
28															
29															
30															
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2B-1R-02

GW Depth: 7.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	16	21	27	0	0	36	2.04	14.17		2638.4
2	SM	2	4	28	37	48	0	0	36	3.57	24.79		4617.2
3	SM	4	6	24	32	39	0	0	36	2.94	20.42		3803.6
4	SC	6	8	7	9	12	34	15	30	0.87	6.03		648.8
5	SM	8	10	12	16	17	0	0	36	1.28	8.87		1651.8
6	SM	10	15	11	15	14	0	0	35	1.07	7.44		1386.6
7	SM	15	20	51	68	62	0	0	36	4.63	32.18		5992.9
8	PWR	20	21	100	133	127	0	0	40	9.53	66.16		12321.0
9		-											
10		-											
11		-											
12		-											
13		-											
14		-											
15		-											
16		-											
17		-											
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23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2B-1R-03

GW Depth: 23.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	4	37	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	7	5.5	12	0.08	1.10	1.2	0.135	3.333	0.18	0.71	0.25
2	SM	2.0	4.0	3.0	15	37	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	26	5.5	31	0.17	1.10	1	0.555	4.167	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	15	37	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	26	5.5	31	0.17	1.10	1	0.555	2.500	0.61	0.20	0.07
4	SC	6.0	8.0	7.0	20	36	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.47	0.75	29	5.5	31	0.20	1.10	1.5	0.555	2.381	0.92	0.14	0.05
5	SC	8.0	10.0	9.0	15	36	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.35	0.75	20	5.5	26	0.13	1.08	1.5	0.309	1.389	0.50	0.25	0.09
6	SM	10.0	15.0	12.5	3	39	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.21	0.75	4	5.5	9	0.07	1.02	1.5	0.112	0.200	0.17	0.71	0.25
7	SM	15.0	20.0	17.5	13	39	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.98	0.85	14	5.5	20	0.11	0.99	2	0.204	0.619	0.41	0.29	0.10
8	SM	20.0	25.0	22.5	18	39	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.87	0.95	20	5.5	25	0.13	0.96	2	0.299	0.667	0.57	0.20	0.07
9	SM	25.0	30.0	27.5	24	31	3.3	3.1	-0.537	0.060	0.91	0.13	0.04	1.04	0.12	0.04	0.84	0.95	26	5.4	31	0.17	0.93	2	0.555	0.787	1.03	0.12	0.04
10	SM	30.0	35.0	32.5	27	31	3.9	3.3	-0.673	0.075	0.89	0.13	0.05	1.04	0.13	0.05	0.82	0.95	28	5.4	31	0.19	0.90	2	0.555	0.809	1.00	0.13	0.05
11	PWR	35.0	40.0	37.5	100	31	4.5	3.6	-0.815	0.091	0.87	0.14	0.05	1.04	0.13	0.05	0.99	1.00	132	5.4	31	0.30	0.82	2	0.555	2.758	0.91	0.15	0.05
12	PWR	40.0	41.0	40.5	100	31	4.9	3.8	-0.902	0.101	0.85	0.14	0.05	1.04	0.14	0.05	0.99	1.00	132	5.4	31	0.30	0.81	2	0.555	2.632	0.90	0.15	0.05
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2B-1R-03

GW Depth:

23.5 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	6.0	8.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SC	8.0	10.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.07	0.00
7	SM	15.0	20.0	0.29	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	25.0	30.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	30.0	35.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	35.0	40.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	PWR	40.0	41.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13		-													
14		-													
15		-													
16		-													
17		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.07	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2B-1R-03

GW Depth: 23.5 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	4	5	7			30	0.51	3.54		659.6
2	SM	2	4	15	20	26			36	1.91	13.28		2473.5
3	SM	4	6	15	20	26			36	1.91	13.28		2473.5
4	SC	6	8	20	27	29	39	19	30	2.20	15.27		1641.3
5	SC	8	10	15	20	20	39	19	30	1.52	10.54		1133.7
6	SM	10	15	3	4	4			27	0.27	1.88		350.9
7	SM	15	20	13	17	14			35	1.08	7.49		1394.2
8	SM	20	25	18	24	20			36	1.49	10.35		1927.5
9	SM	25	30	24	32	26			36	1.92	13.33		2482.5
10	SM	30	35	27	36	28			36	2.11	14.62		2723.6
11	PWR	35	40	100	133	132			40	9.91	68.79		12810.8
12	PWR	40	41	100	133	132			40	9.90	68.74		12801.2
13			-										
14			-										
15			-										
16			-										
17			-										
18													
19			-										
20			-										
21			-										
22			-										
23			-										
24			-										
25			-										
26			-										
27			-										
28			-										
29			-										
30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 80 %

C_E: 1.33

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W2B-1R-04

GW Depth: 4.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	12	42	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	20	5.5	26	0.14	1.10	1.5	0.313	10.000	0.52	0.24	0.09
2	SM	2.0	4.0	3.0	22	42	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	37	5.5	31	0.30	1.10	1.5	0.555	6.111	0.92	0.14	0.05
3	SM	4.0	6.0	5.0	20	42	0.6	0.5	-0.052	0.006	0.99	0.14	0.05	1.04	0.14	0.05	1.70	0.75	34	5.5	31	0.25	1.10	1.5	0.555	3.720	0.92	0.15	0.05
4	SM	6.0	8.0	7.0	30	42	0.8	0.7	-0.084	0.010	0.99	0.17	0.06	1.04	0.16	0.06	1.50	0.75	45	5.5	31	0.30	1.10	2	0.555	4.596	1.22	0.13	0.05
5	SM	8.0	10.0	9.0	5	48	1.1	0.8	-0.119	0.014	0.98	0.18	0.06	1.04	0.17	0.06	1.70	0.75	9	5.5	14	0.09	1.08	2	0.148	0.651	0.32	0.54	0.19
6	SM	10.0	15.0	12.5	14	48	1.5	1.0	-0.185	0.021	0.97	0.20	0.07	1.04	0.19	0.07	1.43	0.75	20	5.5	26	0.13	1.10	2	0.304	1.444	0.67	0.28	0.10
7	SM	15.0	20.0	17.5	17	35	2.1	1.3	-0.291	0.033	0.95	0.21	0.07	1.04	0.20	0.07	1.24	0.85	24	5.5	29	0.16	1.07	2	0.452	1.352	0.97	0.21	0.07
8	SM	20.0	25.0	22.5	23	35	2.7	1.5	-0.409	0.046	0.93	0.21	0.07	1.04	0.20	0.07	1.11	0.95	32	5.5	31	0.23	1.06	2	0.555	1.488	1.18	0.17	0.06
9	SM	25.0	30.0	27.5	53	35	3.3	1.8	-0.537	0.060	0.91	0.21	0.07	1.04	0.21	0.07	1.02	0.95	68	5.5	31	0.30	1.03	2	0.555	2.890	1.14	0.18	0.06
10	SM	30.0	35.0	32.5	40	31	3.9	2.1	-0.673	0.075	0.89	0.21	0.07	1.04	0.21	0.07	0.98	0.95	50	5.4	31	0.30	0.98	2	0.555	1.885	1.09	0.19	0.07
11	PWR	35.0	40.0	37.5	100	31	4.5	2.4	-0.815	0.091	0.87	0.21	0.07	1.04	0.20	0.07	1.00	1.00	133	5.4	31	0.30	0.94	2	0.555	4.150	1.05	0.19	0.07
12	PWR	40.0	41.0	40.5	100	31	4.9	2.6	-0.902	0.101	0.85	0.21	0.07	1.04	0.20	0.07	1.00	1.00	133	5.4	31	0.30	0.92	2	0.555	3.872	1.03	0.20	0.07
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W2B-1R-04

GW Depth:

4.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.24	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.54	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	25.0	30.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	30.0	35.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	35.0	40.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	PWR	40.0	41.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13		-													
14		-													
15		-													
16		-													
17		-													
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23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W2B-1R-04

GW Depth: 4.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	12	16	20			36	1.53	10.63		1978.8
2	SM	2	4	22	29	37			36	2.81	19.48		3627.8
3	SM	4	6	20	27	34			36	2.55	17.71		3298.0
4	SM	6	8	30	40	45			36	3.38	23.47		4370.9
5	SM	8	10	5	7	9			31	0.64	4.43		824.5
6	SM	10	15	14	19	20			36	1.50	10.45		1945.6
7	SM	15	20	17	23	24			36	1.79	12.46		2321.4
8	SM	20	25	23	31	32			36	2.43	16.89		3145.5
9	SM	25	30	53	71	68			36	5.13	35.66		6640.4
10	SM	30	35	40	53	50			36	3.73	25.93		4828.9
11	PWR	35	40	100	133	133			40	9.97	69.24		12894.8
12	PWR	40	41	100	133	133			40	9.96	69.16		12880.6
13			-										
14			-										
15			-										
16			-										
17			-										
18													
19			-										
20			-										
21			-										
22			-										
23			-										
24			-										
25			-										
26			-										
27			-										
28			-										
29			-										
30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-04

GW Depth: 28.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SC	0.0	2.0	1.0	10	48	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	8.333	0.26	0.48	0.17
2	SC	2.0	4.0	3.0	19	48	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	32	5.5	31	0.22	1.10	1	0.555	5.278	0.61	0.21	0.07
3	SC	4.0	6.0	5.0	20	48	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	34	5.5	31	0.24	1.10	1	0.555	3.333	0.61	0.20	0.07
4	CL	6.0	8.0	7.0	7	50	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.66	0.75	11	5.5	17	0.10	1.08	1	0.173	0.833	0.83	0.15	0.05
5	CL	8.0	10.0	9.0	11	50	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.01	0.13	0.04	1.39	0.75	15	5.5	21	0.11	1.07	1	0.213	1.019	1.02	0.12	0.04
6	CL	10.0	12.0	11.0	11	50	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.01	0.13	0.04	1.25	0.75	14	5.5	19	0.11	1.04	1	0.195	0.833	0.83	0.15	0.05
7	MH	12.0	15.0	13.5	5	54	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.14	0.85	6	5.5	12	0.08	1.02	2	0.131	0.309	0.27	0.45	0.16
8	MH	15.0	20.0	17.5	5	54	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.97	0.85	5	5.5	11	0.08	1.00	2	0.125	0.238	0.25	0.48	0.17
9	SM	20.0	25.0	22.5	5	54	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.83	0.95	5	5.5	11	0.08	0.98	2	0.123	0.185	0.24	0.49	0.17
10	SM	25.0	30.0	27.5	17	37	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.79	0.95	17	5.5	22	0.12	0.94	2	0.238	0.515	0.45	0.26	0.09
11	ML	30.0	35.0	32.5	8	53	3.9	3.7	-0.673	0.075	0.89	0.12	0.04	1.04	0.12	0.04	0.71	0.95	7	5.5	13	0.08	0.95	2	0.137	0.219	0.26	0.46	0.16
12	ML	35.0	40.0	37.5	11	53	4.5	3.9	-0.815	0.091	0.87	0.13	0.04	1.04	0.12	0.04	0.70	1.00	10	5.5	16	0.09	0.94	2	0.161	0.279	0.30	0.41	0.14
13	SM	40.0	45.0	42.5	10	32	5.1	4.2	-0.961	0.107	0.84	0.13	0.05	1.04	0.13	0.04	0.67	1.00	9	5.4	14	0.09	0.93	2	0.150	0.237	0.28	0.46	0.16
14	SM	45.0	50.0	47.5	20	32	5.7	4.5	-1.107	0.123	0.82	0.13	0.05	1.04	0.13	0.05	0.70	1.00	18	5.4	24	0.13	0.90	2	0.265	0.443	0.48	0.27	0.10
15	SM	50.0	55.0	52.5	16	33	6.3	4.8	-1.252	0.138	0.79	0.14	0.05	1.04	0.13	0.05	0.66	1.00	14	5.5	19	0.11	0.91	2	0.198	0.333	0.36	0.36	0.13
16	SM	55.0	60.0	57.5	21	33	6.9	5.1	-1.392	0.153	0.77	0.14	0.05	1.04	0.13	0.05	0.67	1.00	18	5.5	24	0.13	0.88	2	0.267	0.413	0.47	0.28	0.10
17	SM	60.0	65.0	62.5	43	33	7.5	5.4	-1.526	0.167	0.75	0.14	0.05	1.04	0.13	0.05	0.76	1.00	43	5.5	31	0.30	0.70	2	0.555	0.799	0.78	0.17	0.06
18	SM	65.0	70.0	67.5	51	33	8.1	5.7	-1.652	0.180	0.73	0.13	0.05	1.04	0.13	0.05	0.78	1.00	53	5.5	31	0.30	0.69	2	0.555	0.900	0.76	0.17	0.06
19	SM	70.0	75.0	72.5	21	33	8.7	6.0	-1.766	0.192	0.70	0.13	0.05	1.04	0.13	0.05	0.62	1.00	17	5.5	23	0.12	0.87	2	0.245	0.353	0.42	0.30	0.11
20	SM	75.0	80.0	77.5	49	29	9.3	6.2	-1.868	0.202	0.69	0.13	0.05	1.04	0.13	0.04	0.76	1.00	49	5.3	31	0.30	0.66	2	0.555	0.785	0.73	0.18	0.06
21	SM	80.0	85.0	82.5	43	29	9.9	6.5	-1.956	0.211	0.67	0.13	0.05	1.04	0.13	0.04	0.72	1.00	41	5.3	31	0.30	0.65	2	0.555	0.658	0.72	0.18	0.06
22	SM	85.0	90.0	87.5	33	29	10.5	6.8	-2.027	0.217	0.65	0.13	0.05	1.04	0.13	0.04	0.66	1.00	29	5.3	31	0.19	0.77	2	0.555	0.484	0.85	0.15	0.05
23																													
24																													
25																													
26																													
27																													
28																													
29																													
30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SC	4.0	6.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	CL	6.0	8.0	0.15	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	CL	8.0	10.0	0.12	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	CL	10.0	12.0	0.15	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
7	MH	12.0	15.0	0.45	0.16	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
8	MH	15.0	20.0	0.48	0.17	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
10	SM	25.0	30.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	ML	30.0	35.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	ML	35.0	40.0	0.41	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	40.0	45.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	45.0	50.0	0.27	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	50.0	55.0	0.36	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	SM	55.0	60.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	SM	60.0	65.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
18	SM	65.0	70.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
19	SM	70.0	75.0	0.30	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
20	SM	75.0	80.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
21	SM	80.0	85.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
22	SM	85.0	90.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W4-1R-09
GW Depth: 6.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	10	13	17	32	10	30	1.26	8.74		940.1
2	SC	2	4	19	25	32	32	10	30	2.39	16.61		1786.2
3	SC	4	6	20	26	34	32	10	30	2.52	17.48		1879.8
4	CL	6	8	7	9	11	49	26	26	1.72	11.92	0.35	640.7
5	CL	8	10	11	14	15	49	26	26	2.26	15.68	0.35	842.9
6	CL	10	12	11	14	14	49	26	26	2.03	14.10	0.35	757.9
7	MH	12	15	5	7	6	53	18	30	0.95	6.63	0.39	356.5
8	MH	15	20	5	7	5	53	18	30	0.81	5.66	0.39	304.1
9	SM	20	25	5	7	5			29	0.39	2.71		504.8
10	SM	25	30	17	22	17			36	1.26	8.76		1632.2
11	ML	30	35	8	11	7			30	0.53	3.71		398.4
12	ML	35	40	11	14	10			30	0.76	5.27		566.6
13	SM	40	45	10	13	9			32	0.66	4.57		851.9
14	SM	45	50	20	26	18			36	1.38	9.58		1784.5
15	SM	50	55	16	21	14			35	1.04	7.23		1345.8
16	SM	55	60	21	28	18			36	1.39	9.62		1791.3
17	SM	60	65	43	57	43			36	3.22	22.35		4161.5
18	SM	65	70	51	67	53			36	3.94	27.37		5096.7
19	SM	70	75	21	28	17			36	1.29	8.99		1674.0
20	SM	75	80	49	65	49			36	3.66	25.38		4727.6
21	SM	80	85	43	57	41			36	3.05	21.16		3941.1
22	SM	85	90	33	43	29			36	2.14	14.86		2768.0
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-05

GW Depth: 33.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom	(ft)					(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	17	49	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	1	0.555	14.167	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	17	48	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	1	0.555	4.722	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	12	48	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	20	5.5	26	0.13	1.10	1	0.306	2.000	0.34	0.37	0.13
4	SM	6.0	8.0	7.0	13	48	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.55	0.75	20	5.5	25	0.13	1.10	1	0.301	1.548	0.33	0.38	0.13
5	SM	8.0	10.0	9.0	28	48	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	35	5.5	31	0.26	1.10	1	0.555	2.593	0.61	0.20	0.07
6	CH	10.0	12.0	11.0	11	48	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.01	0.13	0.04	1.25	0.75	14	5.5	19	0.11	1.04	2	0.195	0.833	0.83	0.15	0.05
7	CH	12.0	15.0	13.5	21	48	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.01	0.13	0.04	1.10	0.85	26	5.5	31	0.17	1.04	2	0.555	1.296	1.30	0.10	0.03
8	CH	15.0	20.0	17.5	7	63	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.01	0.12	0.04	0.97	0.85	8	5.5	13	0.08	1.00	2	0.141	0.333	0.33	0.37	0.13
9	SM	20.0	25.0	22.5	5	63	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.83	0.95	5	5.5	11	0.08	0.98	2	0.123	0.185	0.24	0.49	0.17
10	SM	25.0	30.0	27.5	2	47	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.71	0.95	2	5.5	7	0.06	0.97	2	0.100	0.061	0.19	0.59	0.21
11	ML	30.0	35.0	32.5	7	38	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.68	0.95	6	5.5	11	0.08	0.95	2	0.128	0.179	0.24	0.46	0.16
12	ML	35.0	40.0	37.5	9	59	4.5	4.3	-0.815	0.091	0.87	0.12	0.04	1.04	0.12	0.04	0.66	1.00	8	5.5	13	0.08	0.94	2	0.142	0.212	0.27	0.43	0.15
13	SM	40.0	45.0	42.5	6	59	5.1	4.5	-0.961	0.107	0.84	0.12	0.04	1.04	0.12	0.04	0.61	1.00	5	5.5	10	0.08	0.94	2	0.121	0.132	0.23	0.52	0.18
14	SM	45.0	50.0	47.5	8	59	5.7	4.8	-1.107	0.123	0.82	0.13	0.04	1.04	0.12	0.04	0.61	1.00	6	5.5	12	0.08	0.93	2	0.132	0.166	0.24	0.50	0.17
15	SM	50.0	55.0	52.5	10	59	6.3	5.1	-1.252	0.138	0.79	0.13	0.04	1.04	0.12	0.04	0.60	1.00	8	5.5	13	0.09	0.92	2	0.143	0.196	0.26	0.47	0.16
16	SM	55.0	60.0	57.5	14	59	6.9	5.4	-1.392	0.153	0.77	0.13	0.04	1.04	0.12	0.04	0.61	1.00	11	5.5	17	0.10	0.90	2	0.172	0.259	0.31	0.40	0.14
17	SM	60.0	65.0	62.5	24	33	7.5	5.7	-1.526	0.167	0.75	0.13	0.04	1.04	0.12	0.04	0.65	1.00	21	5.5	26	0.14	0.86	2	0.318	0.422	0.55	0.23	0.08
18	SM	65.0	70.0	67.5	18	33	8.1	6.0	-1.652	0.180	0.73	0.13	0.04	1.04	0.12	0.04	0.61	1.00	14	5.5	20	0.11	0.88	2	0.204	0.301	0.36	0.34	0.12
19	SM	70.0	75.0	72.5	19	33	8.7	6.3	-1.766	0.192	0.70	0.13	0.04	1.04	0.12	0.04	0.60	1.00	15	5.5	20	0.11	0.87	2	0.211	0.303	0.37	0.33	0.12
20	SM	75.0	80.0	77.5	40	33	9.3	6.6	-1.868	0.202	0.69	0.13	0.04	1.04	0.12	0.04	0.70	1.00	37	5.5	31	0.29	0.65	2	0.555	0.610	0.72	0.17	0.06
21	PWR	80.0	85.0	82.5	78	33	9.9	6.8	-1.956	0.211	0.67	0.13	0.04	1.04	0.12	0.04	0.88	1.00	90	5.5	31	0.30	0.63	2	0.555	1.140	0.70	0.17	0.06
22	SM	85.0	90.0	87.5	52	33	10.5	7.1	-2.027	0.217	0.65	0.12	0.04	1.04	0.12	0.04	0.75	1.00	51	5.5	31	0.30	0.62	2	0.555	0.729	0.69	0.18	0.06
23																													
24																													
25																													
26																													
27																													
28																													
29																													
30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
4	SM	6.0	8.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
5	SM	8.0	10.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
6	CH	10.0	12.0	0.15	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
7	CH	12.0	15.0	0.10	0.03	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
8	CH	15.0	20.0	0.37	0.13	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.49	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
10	SM	25.0	30.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.08	0.00
11	ML	30.0	35.0	0.46	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
12	ML	35.0	40.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	40.0	45.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	45.0	50.0	0.50	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	50.0	55.0	0.47	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	SM	55.0	60.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	SM	60.0	65.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
18	SM	65.0	70.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
19	SM	70.0	75.0	0.33	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
20	SM	75.0	80.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
21	PWR	80.0	85.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
22	SM	85.0	90.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.14	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	17	22	29			36	2.14	14.86		2768.3
2	SM	2	4	17	22	29			36	2.14	14.86		2768.3
3	SM	4	6	12	16	20			36	1.51	10.49		1954.1
4	SM	6	8	13	17	20			36	1.49	10.38		1933.3
5	SM	8	10	28	37	35			36	2.62	18.17		3384.7
6	CH	10	12	11	14	14	69	38	26	2.03	14.10	0.53	757.9
7	CH	12	15	21	28	26	69	38	26	3.86	26.82	0.53	1441.6
8	CH	15	20	7	9	8	69	38	26	1.14	7.93	0.53	426.5
9	SM	20	25	5	7	5			29	0.39	2.71		504.8
10	SM	25	30	2	3	2			25	0.13	0.93		173.0
11	ML	30	35	7	9	6			30	0.45	3.09		332.7
12	ML	35	40	9	12	8			30	0.59	4.07		437.2
13	SM	40	45	6	8	5			29	0.36	2.53		470.3
14	SM	45	50	8	11	6			30	0.48	3.33		620.1
15	SM	50	55	10	13	8			31	0.59	4.13		768.4
16	SM	55	60	14	18	11			33	0.84	5.86		1091.6
17	SM	60	65	24	32	21			36	1.55	10.75		2001.2
18	SM	65	70	18	24	14			35	1.08	7.47		1392.0
19	SM	70	75	19	25	15			35	1.12	7.80		1452.7
20	SM	75	80	40	53	37			36	2.77	19.25		3585.5
21	PWR	80	85	78	103	90			40	6.76	46.97		8747.2
22	SM	85	90	52	68	51			36	3.83	26.61		4956.4
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-06

GW Depth: 38.5 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CR _{Req}	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	21	42	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.5	31	0.27	1.10	1	0.555	17.500	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	19	42	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	32	5.5	31	0.22	1.10	1	0.555	5.278	0.61	0.21	0.07
3	ML	4.0	6.0	5.0	8	51	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	13	5.5	19	0.10	1.10	1	0.194	1.333	0.21	0.59	0.21
4	ML	6.0	8.0	7.0	12	51	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.57	0.75	19	5.5	24	0.13	1.10	1	0.270	1.429	0.30	0.42	0.15
5	ML	8.0	9.0	8.5	6	51	1.0	1.0	-0.110	0.013	0.98	0.13	0.04	1.04	0.12	0.04	1.49	0.75	9	5.5	14	0.09	1.06	1.2	0.151	0.588	0.19	0.64	0.23
6	SM	9.0	15.0	12.0	11	51	1.4	1.4	-0.175	0.020	0.97	0.13	0.04	1.04	0.12	0.04	1.19	0.75	13	5.5	18	0.10	1.03	2	0.188	0.764	0.39	0.31	0.11
7	SM	15.0	17.0	16.0	33	51	1.9	1.9	-0.257	0.029	0.96	0.12	0.04	1.04	0.12	0.04	1.01	0.85	37	5.5	31	0.30	1.01	2	0.555	1.719	1.12	0.11	0.04
8	SM	17.0	19.0	18.0	19	39	2.2	2.2	-0.302	0.034	0.95	0.12	0.04	1.04	0.12	0.04	0.97	0.85	21	5.5	26	0.14	0.99	2	0.317	0.880	0.63	0.19	0.07
9	SM	19.0	21.0	20.0	26	39	2.4	2.4	-0.348	0.039	0.94	0.12	0.04	1.04	0.12	0.04	0.93	0.85	27	5.5	31	0.18	0.97	2	0.555	1.083	1.07	0.11	0.04
10	SM	21.0	23.0	22.0	9	46	2.6	2.6	-0.396	0.045	0.93	0.12	0.04	1.04	0.12	0.04	0.86	0.95	10	5.5	15	0.09	0.97	2	0.157	0.341	0.31	0.38	0.13
11	SC	23.0	25.0	24.0	2	46	2.9	2.9	-0.446	0.050	0.93	0.12	0.04	1.04	0.12	0.04	0.78	0.95	2	5.5	7	0.07	0.98	2	0.101	0.069	0.20	0.59	0.21
12	CH	25.0	28.0	26.5	19	64	3.2	3.2	-0.511	0.057	0.92	0.12	0.04	1.01	0.12	0.04	0.81	0.95	19	5.5	25	0.13	0.94	2	0.285	0.597	0.60	0.20	0.07
13	CH	28.0	30.0	29.0	15	64	3.5	3.5	-0.577	0.065	0.90	0.12	0.04	1.01	0.12	0.04	0.76	0.95	14	5.5	20	0.11	0.94	2	0.204	0.431	0.43	0.27	0.09
14	SM	30.0	35.0	32.5	8	43	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.68	0.95	7	5.5	12	0.08	0.95	2	0.135	0.205	0.26	0.44	0.15
15	SM	35.0	40.0	37.5	4	43	4.5	4.5	-0.815	0.091	0.87	0.11	0.04	1.04	0.11	0.04	0.60	1.00	3	5.5	9	0.07	0.94	2	0.109	0.089	0.21	0.53	0.19
16	SM	40.0	45.0	42.5	8	43	5.1	4.9	-0.961	0.107	0.84	0.11	0.04	1.04	0.11	0.04	0.61	1.00	6	5.5	12	0.08	0.93	2	0.132	0.165	0.24	0.45	0.16
17	SM	45.0	50.0	47.5	9	43	5.7	5.1	-1.107	0.123	0.82	0.12	0.04	1.04	0.11	0.04	0.59	1.00	7	5.5	13	0.08	0.92	2	0.136	0.175	0.25	0.45	0.16
18	SM	50.0	55.0	52.5	13	43	6.3	5.4	-1.252	0.138	0.79	0.12	0.04	1.04	0.12	0.04	0.60	1.00	10	5.5	16	0.09	0.91	2	0.163	0.240	0.30	0.39	0.14
19	SM	55.0	60.0	57.5	18	34	6.9	5.7	-1.392	0.153	0.77	0.12	0.04	1.04	0.12	0.04	0.62	1.00	15	5.5	20	0.11	0.89	2	0.208	0.315	0.37	0.32	0.11
20	SM	60.0	65.0	62.5	18	34	7.5	6.0	-1.526	0.167	0.75	0.12	0.04	1.04	0.12	0.04	0.60	1.00	14	5.5	20	0.11	0.88	2	0.204	0.300	0.36	0.33	0.11
21	SM	65.0	70.0	67.5	27	34	8.1	6.3	-1.652	0.180	0.73	0.12	0.04	1.04	0.12	0.04	0.64	1.00	23	5.5	28	0.15	0.83	2	0.399	0.429	0.66	0.18	0.06
22	SM	70.0	75.0	72.5	26	34	8.7	6.6	-1.766	0.192	0.70	0.12	0.04	1.04	0.12	0.04	0.63	1.00	21	5.5	27	0.14	0.83	2	0.345	0.395	0.57	0.20	0.07
23	SM	75.0	80.0	77.5	53	34	9.3	6.9	-1.868	0.202	0.69	0.12	0.04	1.04	0.12	0.04	0.76	1.00	53	5.5	31	0.30	0.63	2	0.555	0.772	0.70	0.17	0.06
24	SM	80.0	85.0	82.5	60	34	9.9	7.2	-1.956	0.211	0.67	0.12	0.04	1.04	0.12	0.04	0.79	1.00	62	5.5	31	0.30	0.62	2	0.555	0.839	0.69	0.17	0.06
25	SM	85.0	90.0	87.5	33	42	10.5	7.4	-2.027	0.217	0.65	0.12	0.04	1.04	0.12	0.04	0.64	1.00	28	5.5	31	0.18	0.76	2	0.555	0.443	0.84	0.14	0.05
26	SM	90.0	95.0	92.5	27	42	11.1	7.7	-2.082	0.221	0.64	0.12	0.04	1.04	0.11	0.04	0.59	1.00	21	5.5	27	0.14	0.81	2	0.334	0.349	0.54	0.21	0.07
27	SM	95.0	100.0	97.5	38	42	11.7	8.0	-2.118	0.224	0.62	0.12	0.04	1.04	0.11	0.04	0.65	1.00	33	5.5	31	0.23	0.68	2	0.555	0.474	0.76	0.15	0.05
28																													
29																													
30																													

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

Page 1 of 3

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
4	ML	6.0	8.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
5	ML	8.0	9.0	0.64	0.23	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
6	SM	9.0	15.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	17.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	17.0	19.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	19.0	21.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	21.0	23.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SC	23.0	25.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	CH	25.0	28.0	0.20	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
13	CH	28.0	30.0	0.27	0.09	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
14	SM	30.0	35.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
15	SM	35.0	40.0	0.53	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.05	0.00
16	SM	40.0	45.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17	SM	45.0	50.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
18	SM	50.0	55.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
19	SM	55.0	60.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
20	SM	60.0	65.0	0.33	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
21	SM	65.0	70.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
22	SM	70.0	75.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
23	SM	75.0	80.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
24	SM	80.0	85.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
25	SM	85.0	90.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
26	SM	90.0	95.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
27	SM	95.0	100.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.12	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W4-1R-09
GW Depth: 6.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	21	28	35			36	2.64	18.36		3419.6
2	SM	2	4	19	25	32			36	2.39	16.61		3093.9
3	ML	4	6	8	11	13			30	1.01	6.99		752.1
4	ML	6	8	12	16	19			30	1.39	9.67		1040.0
5	ML	8	9	6	8	9			30	0.66	4.61		495.6
6	SM	9	15	11	14	13			34	0.97	6.73		1253.8
7	SM	15	17	33	43	37			36	2.81	19.51		3632.9
8	SM	17	19	19	25	21			36	1.54	10.70		1992.5
9	SM	19	21	26	34	27			36	2.03	14.11		2627.7
10	SM	21	23	9	12	10			32	0.72	5.03		936.4
11	SC	23	25	2	3	2	28	13	25	0.15	1.02		109.5
12	CH	25	28	19	25	19	57	32	26	2.89	20.10	0.42	1080.6
13	CH	28	30	15	20	14	57	32	26	2.15	14.93	0.42	802.5
14	SM	30	35	8	11	7			30	0.51	3.57		664.8
15	SM	35	40	4	5	3			27	0.24	1.65		306.4
16	SM	40	45	8	11	6			30	0.48	3.32		618.4
17	SM	45	50	9	12	7			30	0.53	3.66		681.8
18	SM	50	55	13	17	10			33	0.77	5.37		1000.9
19	SM	55	60	18	24	15			35	1.10	7.63		1421.1
20	SM	60	65	18	24	14			35	1.07	7.46		1389.4
21	SM	65	70	27	36	23			36	1.72	11.91		2218.4
22	SM	70	75	26	34	21			36	1.61	11.17		2081.2
23	SM	75	80	53	70	53			36	3.97	27.54		5129.2
24	SM	80	85	60	79	62			36	4.66	32.33		6021.7
25	SM	85	90	33	43	28			36	2.08	14.42		2686.1
26	SM	90	95	27	36	21			36	1.58	11.00		2049.2
27	SM	95	100	38	50	33			36	2.44	16.93		3153.1
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-07

GW Depth: 28.5 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	6	45	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	10	5.5	16	0.09	1.10	1.2	0.161	5.000	0.21	0.59	0.21
2	SM	2.0	4.0	3.0	20	45	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	34	5.5	31	0.24	1.10	1.2	0.555	5.556	0.73	0.17	0.06
3	SM	4.0	6.0	5.0	24	45	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.63	0.75	39	5.5	31	0.30	1.10	1.2	0.555	4.000	0.73	0.17	0.06
4	SM	6.0	8.0	7.0	13	45	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.55	0.75	20	5.5	25	0.13	1.10	1.2	0.301	1.548	0.40	0.31	0.11
5	SM	8.0	10.0	9.0	14	21	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.36	0.75	19	4.6	23	0.13	1.08	1.2	0.257	1.296	0.33	0.37	0.13
6	SM	10.0	15.0	12.5	11	21	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.16	0.75	13	4.6	17	0.10	1.03	1.2	0.177	0.733	0.22	0.56	0.20
7	SM	15.0	20.0	17.5	30	21	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.98	0.85	33	4.6	31	0.24	0.99	1.2	0.555	1.429	0.66	0.18	0.06
8	SM	20.0	25.0	22.5	20	36	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.88	0.95	22	5.5	27	0.14	0.96	1.2	0.361	0.741	0.41	0.28	0.10
9	SM	25.0	30.0	27.5	9	36	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.76	0.95	9	5.5	14	0.09	0.96	1.2	0.148	0.273	0.17	0.67	0.24
10	SM	30.0	35.0	32.5	16	36	3.9	3.7	-0.673	0.075	0.89	0.12	0.04	1.04	0.12	0.04	0.75	0.95	15	5.5	21	0.11	0.93	1.2	0.212	0.438	0.24	0.50	0.18
11	ML	35.0	40.0	37.5	7	52	4.5	3.9	-0.815	0.091	0.87	0.13	0.04	1.04	0.12	0.04	0.67	1.00	6	5.5	12	0.08	0.95	2	0.130	0.178	0.25	0.50	0.18
12	ML	40.0	43.0	41.5	7	52	5.0	4.2	-0.932	0.104	0.85	0.13	0.05	1.04	0.13	0.04	0.65	1.00	6	5.5	12	0.08	0.94	2	0.129	0.168	0.24	0.52	0.18
13	ML	43.0	45.0	44.0	5	52	5.3	4.3	-1.005	0.112	0.83	0.13	0.05	1.04	0.13	0.04	0.62	1.00	4	5.5	10	0.07	0.94	2	0.115	0.116	0.22	0.59	0.21
14	SM	45.0	50.0	47.5	7	52	5.7	4.5	-1.107	0.123	0.82	0.13	0.05	1.04	0.13	0.05	0.62	1.00	6	5.5	11	0.08	0.94	2	0.127	0.155	0.24	0.55	0.19
15	SM	50.0	55.0	52.5	13	42	6.3	4.8	-1.252	0.138	0.79	0.14	0.05	1.04	0.13	0.05	0.64	1.00	11	5.5	16	0.10	0.92	2	0.169	0.271	0.31	0.42	0.15
16	SM	55.0	60.0	57.5	16	42	6.9	5.1	-1.392	0.153	0.77	0.14	0.05	1.04	0.13	0.05	0.64	1.00	13	5.5	19	0.10	0.90	2	0.194	0.314	0.35	0.37	0.13
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

Page 1 of 3

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ_N}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ_N}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.56	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.04	0.00
7	SM	15.0	20.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
8	SM	20.0	25.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.04	0.00
9	SM	25.0	30.0	0.67	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.17	0.00
10	SM	30.0	35.0	0.50	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	ML	35.0	40.0	0.50	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	ML	40.0	43.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	ML	43.0	45.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	45.0	50.0	0.55	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	50.0	55.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	SM	55.0	60.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17		-													
18		-													
19		-													
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.28	0.00

L-Pile Input Parameters

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W4-1R-09

GW Depth: 6.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	6	8	10			32	0.76	5.25		977.0
2	SM	2	4	20	26	34			36	2.52	17.49		3256.8
3	SM	4	6	24	32	39			36	2.90	20.17		3756.0
4	SM	6	8	13	17	20			36	1.49	10.38		1933.3
5	SM	8	10	14	18	19			36	1.41	9.78		1821.1
6	SM	10	15	11	14	13			34	0.95	6.59		1227.0
7	SM	15	20	30	40	33			36	2.47	17.18		3199.5
8	SM	20	25	20	26	22			36	1.64	11.42		2126.1
9	SM	25	30	9	12	9			31	0.64	4.44		827.6
10	SM	30	35	16	21	15			35	1.13	7.82		1457.1
11	ML	35	40	7	9	6	45	16	30	0.93	6.48		348.2
12	ML	40	43	7	9	6			30	0.45	3.13		336.9
13	ML	43	45	5	7	4			30	0.31	2.14		230.3
14	SM	45	50	7	9	6			29	0.43	2.99		557.2
15	SM	50	55	13	17	11			33	0.82	5.72		1064.8
16	SM	55	60	16	21	13			34	1.01	7.03		1308.9
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

ϕ'_{Cohesionless} := (15.4 \cdot N'_{1.60})^{0.5} + 20

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

ϕ'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

c_{u,Low} := .075 \cdot N_{1.60}^{r_{1.60} .60}

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

c_{u,High} := .15 \cdot N_{1.60}

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-08

GW Depth: 28.5 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	5	29	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	8	5.3	14	0.09	1.10	1.5	0.146	4.167	0.24	0.52	0.18
2	CH	2.0	4.0	3.0	5	29	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	8	5.3	14	0.09	1.10	2	0.146	1.389	1.39	0.09	0.03
3	CH	4.0	6.0	5.0	12	75	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	20	5.5	26	0.13	1.10	2	0.306	2.000	2.00	0.06	0.02
4	CH	6.0	8.0	7.0	10	75	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.60	0.75	16	5.5	21	0.11	1.10	2	0.223	1.190	1.19	0.11	0.04
5	CH	8.0	10.0	9.0	9	75	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.01	0.13	0.04	1.41	0.75	13	5.5	18	0.10	1.06	2	0.184	0.833	0.83	0.15	0.05
6	ML	10.0	15.0	12.5	3	57	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.21	0.75	4	5.5	9	0.07	1.02	2	0.112	0.200	0.23	0.53	0.19
7	SM	15.0	18.0	16.5	5	44	2.0	2.0	-0.268	0.030	0.96	0.12	0.04	1.04	0.12	0.04	1.01	0.85	6	5.5	11	0.08	1.00	2	0.126	0.253	0.25	0.48	0.17
8	SM	18.0	20.0	19.0	8	44	2.3	2.3	-0.325	0.037	0.95	0.12	0.04	1.04	0.12	0.04	0.93	0.85	8	5.5	14	0.09	0.99	2	0.146	0.351	0.29	0.41	0.14
9	SM	20.0	25.0	22.5	14	44	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.86	0.95	15	5.5	21	0.11	0.97	2	0.213	0.519	0.41	0.28	0.10
10	SM	25.0	30.0	27.5	10	33	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.76	0.95	10	5.5	15	0.09	0.95	2	0.156	0.303	0.30	0.38	0.13
11	SM	30.0	35.0	32.5	21	33	3.9	3.7	-0.673	0.075	0.89	0.12	0.04	1.04	0.12	0.04	0.77	0.95	20	5.5	26	0.13	0.92	2	0.308	0.575	0.57	0.21	0.07
12	SM	35.0	40.0	37.5	31	33	4.5	3.9	-0.815	0.091	0.87	0.13	0.04	1.04	0.12	0.04	0.79	1.00	32	5.5	31	0.22	0.85	2	0.555	0.787	0.94	0.13	0.05
13	SM	40.0	45.0	42.5	40	33	5.1	4.2	-0.961	0.107	0.84	0.13	0.05	1.04	0.13	0.04	0.80	1.00	42	5.5	31	0.30	0.78	2	0.555	0.946	0.86	0.15	0.05
14	SM	45.0	50.0	47.5	30	33	5.7	4.5	-1.107	0.123	0.82	0.13	0.05	1.04	0.13	0.05	0.74	1.00	29	5.5	31	0.20	0.84	2	0.555	0.665	0.93	0.14	0.05
15	PWR	50.0	54.0	52.0	100	33	6.2	4.8	-1.237	0.137	0.80	0.14	0.05	1.04	0.13	0.05	0.99	1.00	130	5.5	31	0.30	0.74	2	0.555	2.095	0.82	0.16	0.06
16																													
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	CH	2.0	4.0	0.09	0.03	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	CH	4.0	6.0	0.06	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CH	6.0	8.0	0.11	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	CH	8.0	10.0	0.15	0.05	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	ML	10.0	15.0	0.53	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
7	SM	15.0	18.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	20.0	0.41	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	25.0	30.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	30.0	35.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	35.0	40.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	40.0	45.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	45.0	50.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	PWR	50.0	54.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16			-												
17			-												
18			-												
19			-												
20			-												
21			-												
22			-												
23			-												
24			-												
25			-												
26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W4-1R-09
GW Depth: 6.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	5	7	8	32	17	31	0.63	4.37		814.2
2	CH	2	4	5	7	8	71	38	26	1.26	8.74	0.55	470.1
3	CH	4	6	12	16	20	71	38	26	3.02	20.98	0.55	1128.1
4	CH	6	8	10	13	16	71	38	26	2.37	16.45	0.55	884.3
5	CH	8	10	9	12	13	71	38	26	1.88	13.02	0.55	700.0
6	ML	10	15	3	4	4			30	0.27	1.86		200.1
7	SM	15	18	5	7	6			29	0.42	2.93		546.1
8	SM	18	20	8	11	8			31	0.62	4.33		806.3
9	SM	20	25	14	18	15			35	1.13	7.86		1463.4
10	SM	25	30	10	13	10			32	0.72	4.97		925.3
11	SM	30	35	21	28	20			36	1.52	10.55		1964.7
12	SM	35	40	31	41	32			36	2.40	16.70		3109.8
13	SM	40	45	40	53	42			36	3.16	21.94		4086.8
14	SM	45	50	30	40	29			36	2.20	15.30		2850.4
15	PWR	50	54	100	132	130			40	9.74	67.63		12595.1
16		-											
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-09

GW Depth: 6.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	18	34	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	30	5.5	31	0.20	1.10	1	0.555	15.000	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	18	24	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	30	5.0	31	0.20	1.10	1	0.555	5.000	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	13	47	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	22	5.5	27	0.14	1.10	2	0.358	2.167	0.79	0.16	0.06
4	SM	6.0	8.0	7.0	8	47	0.8	0.8	-0.084	0.010	0.99	0.14	0.05	1.04	0.13	0.05	1.70	0.75	13	5.5	19	0.10	1.10	2	0.194	1.029	0.43	0.32	0.11
5	SM	8.0	12.0	10.0	8	47	1.2	1.0	-0.137	0.016	0.98	0.16	0.06	1.04	0.16	0.05	1.52	0.75	12	5.5	18	0.10	1.07	2	0.179	0.842	0.38	0.40	0.14
6	SM	12.0	14.0	13.0	12	20	1.6	1.1	-0.195	0.022	0.97	0.18	0.06	1.04	0.17	0.06	1.35	0.85	18	4.5	23	0.12	1.07	2	0.242	1.068	0.52	0.33	0.11
7	PWR	14.0	16.0	15.0	100	20	1.8	1.2	-0.236	0.027	0.96	0.18	0.06	1.04	0.18	0.06	1.01	0.85	113	4.5	31	0.30	1.10	2	0.555	8.075	1.22	0.14	0.05
8	SM	16.0	18.0	17.0	37	20	2.0	1.4	-0.279	0.032	0.95	0.19	0.07	1.04	0.18	0.06	1.13	0.85	47	4.5	31	0.30	1.10	2	0.555	2.733	1.22	0.15	0.05
9	SM	18.0	23.0	20.5	24	20	2.5	1.6	-0.360	0.041	0.94	0.19	0.07	1.04	0.19	0.07	1.11	0.95	33	4.5	31	0.24	1.06	2	0.555	1.543	1.18	0.16	0.06
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-09

GW Depth:

6.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	12.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	14.0	0.33	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	14.0	16.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	16.0	18.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	18.0	23.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10		-													
11		-													
12		-													
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14		-													
15		-													
16		-													
17		-													
18		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information													
Date: September 16, 2015				Boring: W4-1R-09									
Site: I-85/385				GW Depth: 6.0 ft									
Location: Greenville, SC													
Project ID: 0038111													
Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	18	24	30			36	2.27	15.74		2931.1
2	SM	2	4	18	24	30			36	2.27	15.74		2931.1
3	SM	4	6	13	17	22	44	17	36	3.27	22.73		2116.9
4	SM	6	8	8	11	13	44	17	34	2.01	13.99		1302.7
5	SM	8	12	8	11	12	44	17	34	1.81	12.55		1168.3
6	SM	12	14	12	16	18			36	1.36	9.43		1756.4
7	PWR	14	16	100	132	113			40	8.46	58.74		10939.5
8	SM	16	18	37	49	47			36	3.51	24.41		4545.5
9	SM	18	23	24	32	33			36	2.49	17.32		3226.5
10			-										
11			-										
12			-										
13			-										
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292956

1575287

559585

For cohesionless soils, Equation 7-41 of the GDM was used to calculate φ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate φ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	φ´ (deg)	c´ (psf)	φ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	φ´ (deg)	c´ (psf)	φ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W4-1R-11

GW Depth: 7.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SC	0.0	2.0	1.0	10	39	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.238	8.333	0.26	0.48	0.17
2	SM	2.0	4.0	3.0	13	41	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	22	5.5	27	0.14	1.10	2	0.358	3.611	0.79	0.16	0.06
3	SM	4.0	6.0	5.0	3	34	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	5	5.5	11	0.08	1.09	2	0.122	0.500	0.27	0.47	0.16
4	SM	6.0	8.0	7.0	24	34	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.42	0.75	34	5.5	31	0.24	1.10	2	0.555	2.857	1.22	0.10	0.04
5	SM	8.0	10.0	9.0	19	34	1.1	1.0	-0.119	0.014	0.98	0.14	0.05	1.04	0.14	0.05	1.39	0.75	26	5.5	31	0.17	1.10	2	0.555	1.989	1.22	0.11	0.04
6	SM	10.0	12.0	11.0	29	36	1.3	1.1	-0.156	0.018	0.98	0.16	0.05	1.04	0.15	0.05	1.26	0.75	36	5.5	31	0.28	1.10	2	0.555	2.709	1.22	0.12	0.04
7	SM	12.0	14.0	13.0	8	36	1.6	1.2	-0.195	0.022	0.97	0.17	0.06	1.04	0.16	0.06	1.34	0.85	12	5.5	18	0.10	1.05	2	0.179	0.675	0.38	0.43	0.15
8	SM	14.0	20.0	17.0	26	36	2.0	1.4	-0.279	0.032	0.95	0.18	0.06	1.04	0.17	0.06	1.15	0.85	33	5.5	31	0.24	1.08	2	0.555	1.836	1.20	0.14	0.05
9	SM	20.0	25.0	22.5	20	36	2.7	1.7	-0.409	0.046	0.93	0.19	0.07	1.04	0.18	0.06	1.07	0.95	27	5.5	31	0.17	1.02	2	0.555	1.154	1.14	0.16	0.06
10	SM	25.0	30.0	27.5	19	48	3.3	2.0	-0.537	0.060	0.91	0.19	0.07	1.04	0.19	0.07	1.00	0.95	24	5.5	29	0.15	1.00	2	0.437	0.940	0.87	0.21	0.07
11	SM	30.0	35.0	32.5	16	48	3.9	2.3	-0.673	0.075	0.89	0.20	0.07	1.04	0.19	0.07	0.93	0.95	19	5.5	24	0.13	0.98	2	0.272	0.693	0.53	0.35	0.12
12	SM	35.0	40.0	37.5	22	32	4.5	2.6	-0.815	0.091	0.87	0.19	0.07	1.04	0.19	0.07	0.90	1.00	26	5.4	31	0.17	0.96	2	0.555	0.847	1.06	0.18	0.06
13	SM	40.0	45.0	42.5	15	32	5.1	2.9	-0.961	0.107	0.84	0.19	0.07	1.04	0.19	0.07	0.84	1.00	17	5.4	22	0.12	0.96	2	0.232	0.520	0.44	0.42	0.15
14	SC	45.0	50.0	47.5	6	44	5.7	3.2	-1.107	0.123	0.82	0.19	0.07	1.04	0.18	0.06	0.76	1.00	6	5.5	12	0.08	0.96	2	0.129	0.189	0.25	0.74	0.26
15	PWR	50.0	55.0	52.5	100	44	6.3	3.5	-1.252	0.138	0.79	0.19	0.07	1.04	0.18	0.06	0.99	1.00	131	5.5	31	0.30	0.84	2	0.555	2.890	0.93	0.20	0.07
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

Page 1 of 3

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W4-1R-10

GW Depth:

25.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.47	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	14.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	14.0	20.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	25.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	25.0	30.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	30.0	35.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	35.0	40.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	40.0	45.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SC	45.0	50.0	0.74	0.26	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	PWR	50.0	55.0	0.20	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16			-												
17			-												
18			-												
19			-												
20			-												
21			-												
22			-												
23			-												
24			-												
25			-												
26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W4-1R-10

GW Depth: 25.0 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	10	13	17	38	19	30	1.26	8.74		940.1
2	SM	2	4	13	17	22			36	1.64	11.37		2116.9
3	SM	4	6	3	4	5			29	0.38	2.62		488.5
4	SM	6	8	24	32	34			36	2.53	17.58		3274.5
5	SM	8	10	19	25	26			36	1.96	13.62		2536.5
6	SM	10	12	29	38	36			36	2.71	18.80		3501.6
7	SM	12	14	8	11	12			34	0.90	6.27		1168.1
8	SM	14	20	26	34	33			36	2.50	17.35		3232.1
9	SM	20	25	20	26	27			36	2.00	13.88		2584.9
10	SM	25	30	19	25	24	34	7	36	1.77	12.32		2294.6
11	SM	30	35	16	21	19			36	1.40	9.73		1812.8
12	SM	35	40	22	29	26			36	1.94	13.51		2515.4
13	SM	40	45	15	20	17			36	1.24	8.61		1603.0
14	SC	45	50	6	8	6	53	25	30	0.90	6.25		336.0
15	PWR	50	55	100	132	131			40	9.79	67.98		12660.1
16		-											
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

135374

325548

48390



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %

C_E: 1.47

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W85-1L-02

GW Depth: 4.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	8	37	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	15	5.5	20	0.11	1.10	1	0.212	6.667	0.23	0.54	0.19
2	GP	2.0	4.0	3.0	47	8	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.56	0.75	80	0.4	31	0.30	1.10	2	0.555	13.056	1.22	0.10	0.04
3			-																										
4			-																										
5			-																										
6			-																										
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29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W85-1L-02

GW Depth: 4.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.54	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	GP	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3		-													
4		-													
5		-													
6		-													
7		-													
8		-													
9		-													
10		-													
11		-													
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17		-													
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20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W85-1L-02

GW Depth: 4.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ′	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	8	12	15	0	0	35	1.12	7.79		1451.1
2	GP	2	4	47	69	80	0	0	40	6.03	41.87		13426.5
3		-											
4		-											
5		-											
6		-											
7		-											
8		-											
9		-											
10		-											
11		-											
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16		-											
17		-											
18													
19		-											
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21		-											
22		-											
23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 88 %
C_E: 1.47
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: W85-1L-03
GW Depth: 6.1 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	22	38	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	41	5.5	31	0.30	1.10	1	0.555	18.333	0.61	0.21	0.07
2	SP	2.0	4.0	3.0	76	10	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.22	0.75	102	1.1	31	0.30	1.10	2	0.555	21.111	1.22	0.10	0.04
3	PWR	4.0	6.0	5.0	100	10	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	112	1.1	31	0.30	1.10	2	0.555	16.667	1.22	0.10	0.04
4			-																										
5			-																										
6			-																										
7			-																										
8			-																										
9																													
10			-																										
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30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W85-1L-03

GW Depth:

6.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SP	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	PWR	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4		-													
5		-													
6		-													
7		-													
8		-													
9		-													
10		-													
11		-													
12		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W85-1L-03

GW Depth:

6.1 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ′	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	22	32	41	0	0	36	3.09	21.43		3990.6
2	SP	2	4	76	111	102	0	0	32	7.63	52.99		9868.0
3	PWR	4	6	100	147	112	0	0	40	8.41	58.41		10877.5
4		-											
5		-											
6		-											
7		-											
8		-											
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24		-											
25		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-2L-02

GW Depth: 5.4 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	11	46	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	18	5.5	24	0.13	1.10	1	0.267	9.167	0.29	0.43	0.15
2	SM	2.0	4.0	3.0	8	46	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	13	5.5	19	0.10	1.10	1	0.194	2.222	0.21	0.59	0.21
3	ML	4.0	6.0	5.0	23	57	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.65	0.75	37	5.5	31	0.30	1.10	2	0.555	3.833	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	46	0.8	0.7	-0.084	0.010	0.99	0.15	0.05	1.04	0.14	0.05	1.02	0.75	100	5.5	31	0.30	1.10	2	0.555	13.511	1.22	0.12	0.04
5		-																											
6		-																											
7		-																											
8		-																											
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10		-																											
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30		-																											

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2L-02

GW Depth:

5.4

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.59	0.21	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
3	ML	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5		-													
6		-													
7		-													
8		-													
9		-													
10		-													
11		-													
12		-													
13		-													
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23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2L-02

GW Depth:

5.4

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ′	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	11	14	18	0	0	36	1.38	9.62		1791.2
2	SM	2	4	8	11	13	0	0	34	1.01	6.99		1302.7
3	ML	4	6	23	30	37	0	0	30	2.81	19.51		2098.0
4	PWR	6	8	100	132	100	0	0	40	7.52	52.26		9732.3
5		-											
6		-											
7		-											
8		-											
9		-											
10		-											
11		-											
12		-											
13		-											
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24		-											
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26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\lceil 1.60 .60 \rceil}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %
C_E: 1.32
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: W385-2L-03
GW Depth: 11.2 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	ML	0.0	2.0	1.0	17	52	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	29	5.5	31	0.19	1.10	1	0.555	14.167	0.61	0.21	0.07
2	ML	2.0	4.0	3.0	21	52	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.5	31	0.27	1.10	1	0.555	5.833	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	16	17	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	27	3.9	31	0.18	1.10	2	0.533	2.667	1.17	0.11	0.04
4	PWR	6.0	8.0	7.0	100	17	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	100	3.9	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	SM	8.0	13.0	10.5	36	17	1.3	1.3	-0.146	0.017	0.98	0.13	0.04	1.04	0.12	0.04	1.16	0.75	41	3.9	31	0.30	1.10	2	0.555	2.857	1.22	0.10	0.04
6	PWR	13.0	18.0	15.5	100	17	1.9	1.6	-0.247	0.028	0.96	0.15	0.05	1.04	0.14	0.05	1.00	0.85	112	3.9	31	0.30	1.07	2	0.555	6.283	1.19	0.12	0.04
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30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2L-03

GW Depth:

11.2 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	13.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	PWR	13.0	18.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7			-												
8			-												
9															
10			-												
11			-												
12			-												
13			-												
14			-												
15			-												
16			-												
17			-												
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22			-												
23			-												
24			-												
25			-												
26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2L-03

GW Depth: 11.2 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	17	22	29	0	0	30	2.14	14.86		1598.2
2	ML	2	4	21	28	35	0	0	30	2.64	18.36		1974.2
3	SM	4	6	16	21	27	0	0	36	2.01	13.99		2605.4
4	PWR	6	8	100	132	100	0	0	40	7.51	52.15		9712.6
5	SM	8	13	36	47	41	0	0	36	3.10	21.50		4003.7
6	PWR	13	18	100	132	112	0	0	40	8.42	58.50		10895.7
7		-											
8		-											
9		-											
10		-											
11		-											
12		-											
13		-											
14		-											
15		-											
16		-											
17		-											
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23		-											
24		-											
25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-2R-01

GW Depth: 23.1 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5}		CRR* _{EQ}	CSReq / CRReq	
		top	bottom				(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ		SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	MH	0.0	2.0	1.0	12	62	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	20	5.5	26	0.13	1.10	1	0.306	10.000	0.34	0.37	0.13
2	MH	2.0	4.0	3.0	21	62	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.5	31	0.27	1.10	1	0.555	5.833	0.61	0.21	0.07
3	MH	4.0	6.0	5.0	11	62	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	18	5.5	24	0.13	1.10	2	0.267	1.833	0.59	0.21	0.07
4	SM	6.0	8.0	7.0	7	49	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.66	0.75	11	5.5	17	0.10	1.08	2	0.173	0.833	0.38	0.33	0.12
5	SM	8.0	10.0	9.0	5	49	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.46	0.75	7	5.5	13	0.08	1.05	2	0.138	0.463	0.29	0.43	0.15
6	SM	10.0	13.0	11.5	7	49	1.4	1.4	-0.165	0.019	0.97	0.13	0.04	1.04	0.12	0.04	1.24	0.75	9	5.5	14	0.09	1.03	2	0.149	0.507	0.31	0.40	0.14
7	SM	13.0	18.0	15.5	6	49	1.9	1.9	-0.247	0.028	0.96	0.12	0.04	1.04	0.12	0.04	1.04	0.85	7	5.5	13	0.08	1.01	2	0.136	0.323	0.27	0.44	0.15
8	SM	18.0	23.0	20.5	6	49	2.5	2.5	-0.360	0.041	0.94	0.12	0.04	1.04	0.12	0.04	0.88	0.95	7	5.5	12	0.08	0.98	2	0.133	0.244	0.26	0.45	0.16
9	SM	23.0	28.0	25.5	8	49	3.1	2.9	-0.485	0.054	0.92	0.13	0.04	1.04	0.12	0.04	0.81	0.95	8	5.5	14	0.09	0.97	2	0.145	0.275	0.28	0.43	0.15
10	SM	28.0	33.0	30.5	10	49	3.7	3.2	-0.618	0.069	0.90	0.13	0.05	1.04	0.13	0.05	0.78	0.95	10	5.5	15	0.09	0.96	2	0.158	0.313	0.30	0.43	0.15
11	SM	33.0	38.0	35.5	11	36	4.3	3.5	-0.758	0.085	0.87	0.14	0.05	1.04	0.13	0.05	0.75	1.00	11	5.5	16	0.10	0.95	2	0.167	0.316	0.32	0.42	0.15
12	SM	38.0	43.0	40.5	28	36	4.9	3.8	-0.902	0.101	0.85	0.14	0.05	1.04	0.14	0.05	0.79	1.00	29	5.5	31	0.19	0.88	2	0.555	0.742	0.97	0.14	0.05
13	PWR	43.0	43.5	43.3	100	36	5.2	3.9	-0.983	0.109	0.84	0.14	0.05	1.04	0.14	0.05	0.99	1.00	130	5.5	31	0.30	0.80	2	0.555	2.543	0.89	0.16	0.05
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-01

GW Depth:

23.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.37	0.13	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.21	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	MH	4.0	6.0	0.21	0.07	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.33	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	13.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	13.0	18.0	0.44	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	18.0	23.0	0.45	0.16	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	23.0	28.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	28.0	33.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	33.0	38.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	38.0	43.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	PWR	43.0	43.5	0.16	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
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27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2R-01

GW Depth: 23.1 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	12	16	20	69	36	27	3.02	20.98	0.53	1128.1
2	MH	2	4	21	28	35	69	36	27	5.29	36.72	0.53	1974.2
3	MH	4	6	11	14	18	69	36	27	2.77	19.24	0.53	1034.1
4	SM	6	8	7	9	11	0	0	33	0.86	5.96		1109.8
5	SM	8	10	5	7	7	0	0	31	0.54	3.75		698.4
6	SM	10	13	7	9	9	0	0	31	0.64	4.47		831.8
7	SM	13	18	6	8	7	0	0	30	0.53	3.65		680.1
8	SM	18	23	6	8	7	0	0	30	0.50	3.46		643.5
9	SM	23	28	8	11	8	0	0	31	0.61	4.21		784.8
10	SM	28	33	10	13	10	0	0	32	0.73	5.05		941.1
11	SM	33	38	11	14	11	0	0	33	0.81	5.62		1046.9
12	SM	38	43	28	37	29	0	0	36	2.18	15.11		2813.6
13	PWR	43	43.5	100	132	130	0	0	40	9.77	67.84		12634.2
14		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

ϕ'_{Cohesionless} := (15.4 \cdot N'_{1.60})^{0.5} + 20

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

ϕ'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

c_{u,Low} := .075 \cdot N_{1.60}^{r_{1.60} .60}

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

c_{u,High} := .15 \cdot N_{1.60}

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-2R-02

GW Depth: 8.6 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	6	41	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	10	5.5	16	0.09	1.10	1	0.161	5.000	0.18	0.71	0.25
2	SM	2.0	4.0	3.0	12	41	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	20	5.5	26	0.13	1.10	1	0.306	3.333	0.34	0.37	0.13
3	SM	4.0	6.0	5.0	6	41	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	10	5.5	16	0.09	1.10	1	0.161	1.000	0.18	0.71	0.25
4	SM	6.0	8.0	7.0	13	47	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.55	0.75	20	5.5	25	0.13	1.10	1	0.301	1.548	0.33	0.38	0.13
5	SM	8.0	10.0	9.0	31	47	1.1	1.1	-0.119	0.014	0.98	0.13	0.05	1.04	0.13	0.04	1.26	0.75	38	5.5	31	0.30	1.10	2	0.555	2.938	1.22	0.10	0.04
6	SM	10.0	12.0	11.0	51	32	1.3	1.2	-0.156	0.018	0.98	0.14	0.05	1.04	0.14	0.05	1.13	0.75	57	5.4	31	0.30	1.10	2	0.555	4.358	1.22	0.11	0.04
7	PWR	12.0	14.0	13.0	100	32	1.6	1.3	-0.195	0.022	0.97	0.15	0.05	1.04	0.15	0.05	1.01	0.85	113	5.4	31	0.30	1.10	2	0.555	7.779	1.22	0.12	0.04
8	PWR	14.0	15.0	14.5	100	32	1.7	1.4	-0.225	0.026	0.96	0.16	0.06	1.04	0.15	0.05	1.01	0.85	113	5.4	31	0.30	1.10	2	0.555	7.289	1.22	0.13	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-02

GW Depth:

8.6

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.37	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.04	0.00
4	SM	6.0	8.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	12.0	14.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	14.0	15.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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26															
27															
28															
29															
30															
												Total Seismic Settlement		0.04	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-02

GW Depth:

8.6

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	6	8	10	0	0	32	0.76	5.25		977.0
2	SM	2	4	12	16	20	0	0	36	1.51	10.49		1954.1
3	SM	4	6	6	8	10	0	0	32	0.76	5.25		977.0
4	SM	6	8	13	17	20	48	19	36	2.99	20.76		1933.3
5	SM	8	10	31	41	38	48	19	36	5.77	40.05		3729.6
6	SM	10	12	51	67	57	0	0	36	4.29	29.76		5542.4
7	PWR	12	14	100	132	113	0	0	40	8.45	58.70		10933.0
8	PWR	14	15	100	132	113	0	0	40	8.44	58.64		10921.6
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24		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %
C_E: 1.32
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: W385-2R-04
GW Depth: 8.1 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SC	0.0	2.0	1.0	8	23	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	13	4.9	18	0.10	1.10	2	0.187	6.667	0.41	0.31	0.11
2	SC	2.0	4.0	3.0	11	23	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	18	4.9	23	0.13	1.10	2	0.256	3.056	0.56	0.22	0.08
3	SM	4.0	6.0	5.0	13	31	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	22	5.4	27	0.14	1.10	2	0.354	2.167	0.78	0.16	0.06
4	PWR	6.0	8.0	7.0	100	31	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	100	5.4	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5		-																											
6		-																											
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.22	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5		-													
6		-													
7		-													
8		-													
9		-													
10		-													
11		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2R-04

GW Depth: 8.1 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	8	11	13	48	25	30	2.01	13.99		752.1
2	SC	2	4	11	14	18	48	25	30	2.77	19.24		1034.1
3	SM	4	6	13	17	22	38	6	36	1.64	11.37		2116.9
4	PWR	6	8	100	132	100	38	6	40	7.51	52.15		9712.6
5		-											
6		-											
7		-											
8		-											
9		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-4R-02

GW Depth: 20.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SC	0.0	2.0	1.0	34	42	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	57	5.5	31	0.30	1.10	1	0.555	28.333	0.61	0.21	0.07
2	SC	2.0	4.0	3.0	53	42	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.47	0.75	77	5.5	31	0.30	1.10	1	0.555	14.722	0.61	0.21	0.07
3	SM	4.0	6.0	5.0	13	42	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	22	5.5	27	0.14	1.10	1	0.358	2.167	0.39	0.32	0.11
4	SM	6.0	8.0	7.0	9	42	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.62	0.75	14	5.5	20	0.11	1.09	1	0.204	1.071	0.22	0.56	0.19
5	SM	8.0	10.0	9.0	69	42	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.09	0.75	75	5.5	31	0.30	1.10	2	0.555	6.389	1.22	0.10	0.04
6	SM	10.0	15.0	12.5	12	26	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.16	0.75	14	5.1	19	0.11	1.03	2	0.193	0.800	0.40	0.31	0.11
7	SM	15.0	20.0	17.5	14	26	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.98	0.85	15	5.1	20	0.11	0.99	2	0.211	0.667	0.42	0.28	0.10
8	PWR	20.0	25.0	22.5	100	26	2.7	2.5	-0.409	0.046	0.93	0.13	0.05	1.04	0.12	0.04	1.00	0.95	125	5.1	31	0.30	0.93	2	0.555	3.931	1.03	0.12	0.04
9	PWR	25.0	30.0	27.5	100	26	3.3	2.8	-0.537	0.060	0.91	0.14	0.05	1.04	0.13	0.05	0.99	0.95	124	5.1	31	0.30	0.90	2	0.555	3.531	0.99	0.13	0.05
10	SM	30.0	35.0	32.5	57	28	3.9	3.1	-0.673	0.075	0.89	0.14	0.05	1.04	0.14	0.05	0.91	0.95	65	5.3	31	0.30	0.87	2	0.555	1.827	0.96	0.15	0.05
11	PWR	35.0	39.0	37.0	100	28	4.4	3.4	-0.801	0.089	0.87	0.15	0.05	1.04	0.14	0.05	0.99	1.00	131	5.3	31	0.30	0.84	2	0.555	2.959	0.94	0.15	0.05
12			-																										
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29			-																										
30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
4	SM	6.0	8.0	0.56	0.19	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.04	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	25.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	PWR	25.0	30.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	30.0	35.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	35.0	39.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12		-													
13		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.05	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-2R-04

GW Depth: 8.1 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	34	45	57	40	17	30	8.56	59.46		3196.3
2	SM	2	4	53	70	77			30	5.77	40.09		7465.6
3	SM	4	6	13	17	22			36	1.64	11.37		2116.9
4	SM	6	8	9	12	14			35	1.08	7.48		1393.5
5	SM	8	10	69	91	75			36	5.59	38.83		7231.7
6	SM	10	15	12	16	14			35	1.03	7.16		1334.1
7	SM	15	20	14	18	15			35	1.15	7.97		1483.4
8	PWR	20	25	100	132	125			40	9.35	64.90		12086.5
9	PWR	25	30	100	132	124			40	9.33	64.79		12065.7
10	SM	30	35	57	75	65			36	4.88	33.91		6315.6
11	PWR	35	39	100	132	131			40	9.79	68.00		12664.9
12		-											
13		-											
14		-											
15		-											
16		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-RN-05

GW Depth: 12.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SC	0.0	2.0	1.0	16	40	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	27	5.5	31	0.18	1.10	1	0.555	13.333	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	23	40	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	39	5.5	31	0.30	1.10	2	0.555	6.389	1.22	0.10	0.04
3	SM	4.0	6.0	5.0	11	31	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	18	5.4	24	0.13	1.10	2	0.265	1.833	0.58	0.21	0.07
4	SM	6.0	8.0	7.0	79	31	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.09	0.75	85	5.4	31	0.30	1.10	2	0.555	9.405	1.22	0.10	0.04
5	SM	8.0	10.0	9.0	32	31	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.24	0.75	39	5.4	31	0.30	1.10	2	0.555	2.963	1.22	0.10	0.04
6	SM	10.0	15.0	12.5	26	31	1.5	1.5	-0.185	0.021	0.97	0.13	0.05	1.04	0.12	0.04	1.13	0.75	29	5.4	31	0.19	1.06	2	0.555	1.770	1.18	0.11	0.04
7	SM	15.0	20.0	17.5	30	33	2.1	1.8	-0.291	0.033	0.95	0.15	0.05	1.04	0.14	0.05	1.05	0.85	35	5.5	31	0.27	1.03	2	0.555	1.708	1.15	0.12	0.04
8	SM	20.0	25.0	22.5	23	33	2.7	2.0	-0.409	0.046	0.93	0.16	0.06	1.04	0.15	0.05	0.99	0.95	29	5.5	31	0.19	1.00	2	0.555	1.125	1.11	0.14	0.05
9	SM	25.0	30.0	27.5	18	26	3.3	2.3	-0.537	0.060	0.91	0.17	0.06	1.04	0.16	0.06	0.93	0.95	21	5.1	26	0.14	0.98	2	0.319	0.772	0.63	0.26	0.09
10	SM	30.0	35.0	32.5	15	26	3.9	2.6	-0.673	0.075	0.89	0.17	0.06	1.04	0.17	0.06	0.88	0.95	16	5.1	22	0.12	0.97	2	0.227	0.572	0.44	0.38	0.13
11	SM	35.0	40.0	37.5	17	26	4.5	2.9	-0.815	0.091	0.87	0.17	0.06	1.04	0.17	0.06	0.84	1.00	19	5.1	24	0.13	0.95	2	0.267	0.584	0.51	0.33	0.12
12	PWR	40.0	44.0	42.0	100	26	5.0	3.2	-0.946	0.105	0.84	0.17	0.06	1.04	0.17	0.06	0.99	1.00	131	5.1	31	0.30	0.86	2	0.555	3.157	0.96	0.18	0.06
13			-																										
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-RN-05

GW Depth:

12.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	15.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	25.0	30.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	30.0	35.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	SM	35.0	40.0	0.33	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	PWR	40.0	44.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13		-													
14		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-RN-05
GW Depth: 12.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	16	21	27	42	20	30	4.03	27.98		1504.2
2	SM	2	4	23	30	39			36	2.90	20.11		3745.3
3	SM	4	6	11	14	18			36	1.38	9.62		1791.2
4	SM	6	8	79	104	85			36	6.39	44.37		8262.9
5	SM	8	10	32	42	39			36	2.94	20.41		3801.9
6	SM	10	15	26	34	29			36	2.17	15.09		2811.2
7	SM	15	20	30	40	35			36	2.64	18.33		3413.9
8	SM	20	25	23	30	29			36	2.14	14.85		2765.0
9	SM	25	30	18	24	21			36	1.57	10.93		2035.2
10	SM	30	35	15	20	16			36	1.23	8.57		1595.7
11	SM	35	40	17	22	19			36	1.41	9.79		1822.5
12	PWR	40	44	100	132	131			40	9.80	68.07		12678.0
13			-										
14			-										
15			-										
16			-										
17			-										
18													
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30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-RN-06

GW Depth: 13.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSR _{eq} / CR _{Req}	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SC	0.0	2.0	1.0	6	34	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	10	5.5	16	0.09	1.10	1	0.161	5.000	0.18	0.71	0.25
2	SC	2.0	4.0	3.0	10	34	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	17	5.5	22	0.12	1.10	1	0.237	2.778	0.26	0.48	0.17
3	CH	4.0	6.0	5.0	14	62	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	24	5.5	29	0.15	1.10	1	0.429	2.333	2.33	0.06	0.02
4	SM	6.0	8.0	7.0	10	49	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.60	0.75	16	5.5	21	0.11	1.10	1	0.223	1.190	0.24	0.51	0.18
5	SM	8.0	10.0	9.0	7	49	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.43	0.75	10	5.5	15	0.09	1.06	1	0.159	0.648	0.17	0.73	0.26
6	SM	10.0	12.0	11.0	9	42	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	11	5.5	17	0.10	1.04	1	0.171	0.682	0.18	0.69	0.24
7	SM	12.0	15.0	13.5	9	42	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.14	0.85	11	5.5	17	0.10	1.02	1	0.173	0.566	0.18	0.70	0.24
8	SM	15.0	20.0	17.5	23	42	2.1	1.8	-0.291	0.033	0.95	0.14	0.05	1.04	0.14	0.05	1.04	0.85	27	5.5	31	0.18	1.02	2	0.555	1.264	1.13	0.12	0.04
9	SM	20.0	22.0	21.0	33	49	2.5	2.0	-0.372	0.042	0.94	0.15	0.05	1.04	0.15	0.05	1.00	0.95	41	5.5	31	0.30	1.00	2	0.555	1.633	1.11	0.13	0.05
10	SM	22.0	24.0	23.0	45	49	2.8	2.1	-0.421	0.047	0.93	0.16	0.05	1.04	0.15	0.05	0.98	0.95	55	5.5	31	0.30	0.98	2	0.555	2.107	1.09	0.14	0.05
11	PWR	24.0	26.0	25.0	100	49	3.0	2.3	-0.472	0.053	0.92	0.16	0.06	1.04	0.15	0.05	1.00	0.95	125	5.5	31	0.30	0.96	2	0.555	4.442	1.07	0.14	0.05
12	SM	26.0	28.0	27.0	44	38	3.2	2.4	-0.524	0.059	0.91	0.16	0.06	1.04	0.16	0.05	0.95	0.95	53	5.5	31	0.30	0.95	2	0.555	1.859	1.05	0.15	0.05
13	SM	28.0	30.0	29.0	22	38	3.5	2.5	-0.577	0.065	0.90	0.16	0.06	1.04	0.16	0.06	0.91	0.95	25	5.5	31	0.16	0.96	2	0.526	0.887	1.02	0.16	0.05
14	SM	30.0	35.0	32.5	51	38	3.9	2.7	-0.673	0.075	0.89	0.17	0.06	1.04	0.16	0.06	0.93	0.95	60	5.5	31	0.30	0.91	2	0.555	1.901	1.01	0.16	0.06
15	SM	35.0	40.0	37.5	47	38	4.5	3.0	-0.815	0.091	0.87	0.17	0.06	1.04	0.16	0.06	0.90	1.00	56	5.5	31	0.30	0.88	2	0.555	1.582	0.98	0.17	0.06
16	PWR	40.0	44.0	42.0	100	38	5.0	3.2	-0.946	0.105	0.84	0.17	0.06	1.04	0.17	0.06	0.99	1.00	131	5.5	31	0.30	0.86	2	0.555	3.096	0.95	0.17	0.06
17		-																											
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

Page 1 of 3

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-RN-06

GW Depth:

13.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ_N}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ_N}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SC	0.0	2.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SC	2.0	4.0	0.48	0.17	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	CH	4.0	6.0	0.06	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.51	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.73	0.26	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.04	0.00
6	SM	10.0	12.0	0.69	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.08	0.00
7	SM	12.0	15.0	0.70	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	22.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	SM	22.0	24.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	24.0	26.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	SM	26.0	28.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	SM	28.0	30.0	0.16	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14	SM	30.0	35.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
15	SM	35.0	40.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
16	PWR	40.0	44.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
17		-													
18		-													
19		-													
20		-													
21		-													
22		-													
23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.12	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: W385-RN-06

GW Depth: 13.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SC	0	2	6	8	10	38	15	30	0.76	5.25		564.1
2	SC	2	4	10	13	17	38	15	30	1.26	8.74		940.1
3	CH	4	6	14	18	24	64	35	26	3.53	24.48	0.49	1316.1
4	SM	6	8	10	13	16	54	15	36	2.37	16.45		1531.7
5	SM	8	10	7	9	10	54	15	32	1.48	10.30		959.0
6	SM	10	12	9	12	11			33	0.84	5.83		1085.1
7	SM	12	15	9	12	11			33	0.86	5.96		1109.8
8	SM	15	20	23	30	27			36	2.01	13.95		2597.2
9	SM	20	22	33	43	41			36	3.08	21.42		3989.7
10	SM	22	24	45	59	55			36	4.15	28.80		5364.2
11	PWR	24	26	100	132	125			40	9.36	65.02		12110.1
12	SM	26	28	44	58	53			36	3.94	27.37		5097.6
13	SM	28	30	22	29	25			36	1.88	13.08		2436.0
14	SM	30	35	51	67	60			36	4.46	31.00		5774.1
15	SM	35	40	47	62	56			36	4.19	29.11		5421.0
16	PWR	40	44	100	132	131			40	9.80	68.05		12674.1
17		-											
18													
19		-											
20		-											
21		-											
22		-											
23		-											
24		-											
25		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 79 %

C_E: 1.32

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: W385-RS-06

GW Depth: 13.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.				(ft)					(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	39	37	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	65	5.5	31	0.30	1.10	1	0.555	32.500	0.61	0.21	0.07
2	SM	2.0	4.0	3.0	5	37	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	8	5.5	14	0.09	1.10	2	0.147	1.389	0.32	0.39	0.14
3	SM	4.0	6.0	5.0	28	24	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.58	0.75	44	5.0	31	0.30	1.10	2	0.555	4.667	1.22	0.10	0.04
4	SM	6.0	8.0	7.0	29	24	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.38	0.75	39	5.0	31	0.30	1.10	2	0.555	3.452	1.22	0.10	0.04
5	SM	8.0	10.0	9.0	28	24	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	35	5.0	31	0.26	1.10	2	0.555	2.593	1.22	0.10	0.04
6	SM	10.0	12.0	11.0	16	26	1.3	1.3	-0.156	0.018	0.98	0.13	0.04	1.04	0.12	0.04	1.22	0.75	19	5.1	24	0.13	1.05	2	0.277	1.212	0.58	0.21	0.07
7	SM	12.0	15.0	13.5	32	26	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.08	0.85	39	5.1	31	0.30	1.07	2	0.555	2.014	1.19	0.10	0.04
8	SM	15.0	20.0	17.5	16	26	2.1	1.8	-0.291	0.033	0.95	0.14	0.05	1.04	0.14	0.05	1.05	0.85	19	5.1	24	0.13	1.01	2	0.266	0.880	0.54	0.26	0.09
9	SM	20.0	24.0	22.0	72	26	2.6	2.1	-0.396	0.045	0.93	0.15	0.05	1.04	0.15	0.05	0.99	0.95	90	5.1	31	0.30	0.99	2	0.555	3.464	1.10	0.14	0.05
10	PWR	24.0	26.0	25.0	100	26	3.0	2.3	-0.472	0.053	0.92	0.16	0.06	1.04	0.15	0.05	1.00	0.95	125	5.1	31	0.30	0.96	2	0.555	4.442	1.07	0.14	0.05
11			-																										
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30			-																										

Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	10.0	12.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	15.0	20.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	20.0	24.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	PWR	24.0	26.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11		-													
12		-													
13		-													
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23		-													
24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: September 16, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

W385-2R-04

GW Depth:

8.1

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	39	51	65			36	4.91	34.10		6350.7
2	SM	2	4	5	7	8			31	0.63	4.37		814.2
3	SM	4	6	28	37	44			36	3.27	22.69		4225.8
4	SM	6	8	29	38	39			36	2.96	20.57		3830.6
5	SM	8	10	28	37	35			36	2.62	18.17		3384.7
6	SM	10	12	16	21	19			36	1.44	10.03		1868.4
7	SM	12	15	32	42	39			36	2.91	20.22		3764.9
8	SM	15	20	16	21	19			36	1.41	9.76		1817.2
9	SM	20	24	72	95	90			36	6.72	46.67		8691.5
10	PWR	24	26	100	132	125			40	9.36	65.02		12110.1
11		-											
12		-											
13		-											
14		-											
15		-											
16		-											
17		-											
18													
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23		-											
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25		-											
26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-1-01

GW Depth: 15.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	ML	0.0	2.0	1.0	15	48	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	26	5.5	31	0.17	1.10	2	0.555	12.500	1.22	0.10	0.04
2	ML	2.0	4.0	3.0	17	48	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	30	5.5	31	0.20	1.10	2	0.555	4.722	1.22	0.10	0.04
3	ML	4.0	6.0	5.0	18	48	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	32	5.5	31	0.22	1.10	2	0.555	3.000	1.22	0.10	0.04
4	ML	6.0	8.0	7.0	13	48	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.55	0.75	21	5.5	26	0.14	1.10	2	0.329	1.548	0.72	0.17	0.06
5	ML	8.0	12.0	10.0	20	48	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.25	0.75	26	5.5	31	0.17	1.09	2	0.555	1.667	1.21	0.10	0.04
6	SM	12.0	15.0	13.5	8	48	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.13	0.85	11	5.5	16	0.09	1.02	2	0.166	0.494	0.34	0.36	0.13
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-1-01

GW Depth:

15.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.36	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7			-												
8			-												
9			-												
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23			-												
24			-												
25			-												
26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-1-01

GW Depth: 15.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	15	21	26			30	1.98	13.78		1481.6
2	ML	2	4	17	24	30			30	2.25	15.62		1679.1
3	ML	4	6	18	25	32			30	2.38	16.54		1777.9
4	ML	6	8	13	18	21			30	1.57	10.91		1172.6
5	ML	8	12	20	28	26			30	1.95	13.53		1455.3
6	SM	12	15	8	11	11			33	0.79	5.52		1028.2
7													
8													
9													
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-1-02

GW Depth: 4.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						K _{DR}	SAND					CLAY	SEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	ML	0.0	2.0	1.0	4	26	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	7	5.1	12	0.08	1.10	1.2	0.134	3.333	0.18	0.71	0.25
2	ML	2.0	4.0	3.0	3	26	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	5	5.1	10	0.08	1.10	1.2	0.121	0.833	0.16	0.78	0.27
3	ML	4.0	6.0	5.0	2	26	0.6	0.5	-0.052	0.006	0.99	0.14	0.05	1.04	0.14	0.05	1.70	0.75	4	5.1	9	0.07	1.09	1.2	0.109	0.372	0.14	0.97	0.34
4	ML	6.0	8.0	7.0	1	26	0.8	0.7	-0.084	0.010	0.99	0.17	0.06	1.04	0.16	0.06	1.70	0.75	2	5.1	7	0.06	1.07	1.2	0.098	0.153	0.13	1.27	0.45
5	ML	8.0	12.0	10.0	5	26	1.2	0.8	-0.137	0.016	0.98	0.19	0.06	1.04	0.18	0.06	1.70	0.75	9	5.1	14	0.09	1.08	2	0.148	0.606	0.32	0.56	0.20
6	SM	12.0	15.0	13.5	4	26	1.6	1.0	-0.205	0.023	0.97	0.20	0.07	1.04	0.19	0.07	1.52	0.85	7	5.1	12	0.08	1.06	2	0.135	0.389	0.28	0.67	0.24
7	SM	15.0	20.0	17.5	12	26	2.1	1.3	-0.291	0.033	0.95	0.21	0.07	1.04	0.20	0.07	1.27	0.85	18	5.1	23	0.12	1.06	2	0.251	0.954	0.53	0.38	0.13
8	ML	20.0	25.0	22.5	17	26	2.7	1.5	-0.409	0.046	0.93	0.21	0.07	1.04	0.20	0.07	1.13	0.95	25	5.1	30	0.16	1.04	2	0.508	1.100	1.06	0.19	0.07
9	ML	25.0	30.0	27.5	10	26	3.3	1.8	-0.537	0.060	0.91	0.21	0.07	1.04	0.21	0.07	1.05	0.95	14	5.1	19	0.11	1.01	2	0.193	0.545	0.39	0.53	0.18
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-1-02

GW Depth:

4.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.78	0.27	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.01	0.00
3	ML	4.0	6.0	0.97	0.34	0.75	0.9	0.95	0.7	0.85	0.90	F,S,EQ	no	CHECK	0.00
4	ML	6.0	8.0	1.27	0.45	0.75	0.9	0.95	0.7	0.85	0.90	F,S,EQ	no	CHECK	0.00
5	ML	8.0	12.0	0.56	0.20	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.67	0.24	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	ML	20.0	25.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	ML	25.0	30.0	0.53	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: November 9, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-1-02

GW Depth: 4.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	4	6	7			30	0.53	3.67		395.1
2	ML	2	4	3	4	5			30	0.40	2.76		296.3
3	ML	4	6	2	3	4			30	0.26	1.84		197.5
4	ML	6	8	1	1	2			30	0.13	0.92		98.8
5	ML	8	12	5	7	9			30	0.66	4.59		493.9
6	SM	12	15	4	6	7			30	0.54	3.73		694.4
7	SM	15	20	12	17	18			36	1.35	9.35		1740.4
8	ML	20	25	17	24	25			30	1.89	13.13		1411.2
9	ML	25	30	10	14	14			30	1.03	7.17		771.4
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-1B-01

GW Depth: 15.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	MH	0.0	2.0	1.0	14	26	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	25	5.1	30	0.16	1.10	1	0.475	11.667	0.52	0.24	0.08
2	ML	2.0	4.0	3.0	20	26	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.1	31	0.27	1.10	2	0.555	5.556	1.22	0.10	0.04
3	ML	4.0	6.0	5.0	9	26	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	16	5.1	21	0.11	1.10	2	0.219	1.500	0.48	0.26	0.09
4	ML	6.0	8.0	7.0	8	26	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.64	0.75	14	5.1	19	0.11	1.09	2	0.191	0.952	0.42	0.30	0.10
5	ML	8.0	12.0	10.0	3	26	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.39	0.75	4	5.1	9	0.07	1.04	2	0.115	0.250	0.24	0.52	0.18
6	ML	12.0	15.0	13.5	14	26	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.11	0.85	18	5.1	23	0.13	1.03	2	0.257	0.864	0.53	0.23	0.08
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-1B-01

GW Depth:

15.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.24	0.08	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.30	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.52	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	ML	12.0	15.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-1B-01

GW Depth: 15.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	14	19	25			30	1.85	12.86	-0.09	1382.8
2	ML	2	4	20	28	35			30	2.65	18.37		1975.4
3	ML	4	6	9	12	16			30	1.19	8.27		888.9
4	ML	6	8	8	11	14			30	1.02	7.07		760.0
5	ML	8	12	3	4	4			30	0.33	2.26		243.1
6	ML	12	15	14	19	18			30	1.37	9.52		1023.6
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-2B-01

GW Depth: 14.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						K _{DR}	SAND					CLAY	SEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	ML	0.0	2.0	1.0	15	31	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	26	5.4	31	0.17	1.10	2	0.555	12.500	1.22	0.10	0.04
2	ML	2.0	4.0	3.0	20	31	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.4	31	0.27	1.10	2	0.555	5.556	1.22	0.10	0.04
3	SC	4.0	6.0	5.0	7	31	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	12	5.4	18	0.10	1.10	2	0.181	1.167	0.40	0.31	0.11
4	SC	6.0	8.0	7.0	8	31	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.64	0.75	14	5.4	19	0.11	1.09	2	0.194	0.952	0.42	0.29	0.10
5	SC	8.0	12.0	10.0	5	31	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.37	0.75	7	5.4	12	0.08	1.04	2	0.136	0.417	0.28	0.43	0.15
6	SM	12.0	15.0	13.5	17	31	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.10	0.85	22	5.4	27	0.14	1.03	2	0.363	1.049	0.75	0.16	0.06
7	SM	15.0	20.0	17.5	12	31	2.1	1.9	-0.291	0.033	0.95	0.14	0.05	1.04	0.13	0.05	1.03	0.85	15	5.4	20	0.11	1.01	2	0.205	0.638	0.41	0.32	0.11
8	SM	20.0	25.0	22.5	6	31	2.7	2.2	-0.409	0.046	0.93	0.15	0.05	1.04	0.15	0.05	0.95	0.95	8	5.4	13	0.08	0.99	2	0.139	0.277	0.28	0.53	0.18
9	PWR	25.0	30.0	27.5	100	31	3.3	2.5	-0.537	0.060	0.91	0.16	0.06	1.04	0.15	0.05	1.00	0.95	131	5.4	31	0.30	0.94	2	0.555	4.069	1.04	0.15	0.05
10	PWR	30.0	34.0	32.0	100	31	3.8	2.7	-0.659	0.074	0.89	0.16	0.06	1.04	0.16	0.06	1.00	0.95	131	5.4	31	0.30	0.91	2	0.555	3.681	1.01	0.16	0.05
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-2B-01

GW Depth:

14.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ} N	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ} N	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SC	4.0	6.0	0.31	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SC	6.0	8.0	0.29	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SC	8.0	12.0	0.43	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.16	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.53	0.18	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	PWR	25.0	30.0	0.15	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	PWR	30.0	34.0	0.16	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11		-													
12		-													
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27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-2B-01

GW Depth: 14.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	15	21	26			30	1.98	13.78		1481.6
2	ML	2	4	20	28	35			30	2.65	18.37		1975.4
3	SC	4	6	7	10	12			30	0.93	6.43		691.4
4	SC	6	8	8	11	14			30	1.02	7.07		760.0
5	SC	8	12	5	7	7			30	0.53	3.69		397.2
6	SM	12	15	17	24	22			36	1.65	11.49		2139.6
7	SM	15	20	12	17	15			35	1.09	7.58		1412.6
8	SM	20	25	6	8	8			31	0.56	3.91		728.6
9	PWR	25	30	100	138	131			40	9.82	68.22		12705.5
10	PWR	30	34	100	138	131			40	9.81	68.11		12685.1
11		-											
12		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-3-01

GW Depth: 7.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	- 2.0	1.0	12	47	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	21	5.5	27	0.14	1.10	1.2	0.336	10.000	0.44	0.28	0.10
2	SM	2.0	- 4.0	3.0	20	47	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.5	31	0.27	1.10	1.2	0.555	5.556	0.73	0.17	0.06
3	SM	4.0	- 6.0	5.0	14	47	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	25	5.5	30	0.16	1.10	1.2	0.497	2.333	0.66	0.19	0.07
4	PWR	6.0	- 7.0	6.5	100	47	0.8	0.8	-0.076	0.009	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	105	5.5	31	0.30	1.10	2	0.555	12.821	1.22	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-3-01

GW Depth:

7.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.19	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	7.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5		-													
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29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-3-01

GW Depth: 7.0 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	12	17	21			36	1.59	11.02		2053.0
2	SM	2	4	20	28	35			36	2.65	18.37		3421.7
3	SM	4	6	14	19	25			36	1.85	12.86		2395.2
4	PWR	6	7	100	138	105			40	7.90	54.86		10216.5
5		-											
6		-											
7		-											
8		-											
9		-											
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29		-											
30		-											



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{r_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %
C_E: 1.38
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: BX-4-01
GW Depth: 15.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	CL	0.0	- 2.0	1.0	30	65	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	53	5.5	31	0.30	1.10	2	0.555	25.000	25.00	0.01	0.00
2	MH	2.0	- 4.0	3.0	37	65	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	65	5.5	31	0.30	1.10	2	0.555	10.278	1.22	0.10	0.04
3	MH	4.0	- 6.0	5.0	17	65	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	30	5.5	31	0.20	1.10	2	0.555	2.833	1.22	0.10	0.04
4	MH	6.0	- 8.0	7.0	23	65	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.43	0.75	34	5.5	31	0.25	1.10	2	0.555	2.738	1.22	0.10	0.04
5	ML	8.0	- 12.0	10.0	8	65	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.34	0.75	11	5.5	17	0.10	1.05	2	0.170	0.667	0.36	0.34	0.12
6	PWR	12.0	- 15.0	13.5	100	65	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.00	0.85	118	5.5	31	0.30	1.06	2	0.555	6.173	1.18	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-4-01

GW Depth:

15.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CL	0.0	2.0	0.01	0.00	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	MH	4.0	6.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	MH	6.0	8.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	PWR	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-4-01

GW Depth: 15.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CL	0	2	30	42	53			26	3.97	27.56	-0.09	2963.1
2	MH	2	4	37	51	65			30	4.89	33.99	-0.09	3654.5
3	MH	4	6	17	24	30			30	2.25	15.62	-0.09	1679.1
4	MH	6	8	23	32	34			30	2.57	17.82	-0.09	1916.5
5	ML	8	12	8	11	11			30	0.83	5.77		620.9
6	PWR	12	15	100	138	118			40	8.85	61.45		11444.1
7		-											
8		-											
9		-											
10		-											
11		-											
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26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %
C_E: 1.38
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: BX-8-01
GW Depth: 15.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	CL	0.0	- 2.0	1.0	17	17	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	30	3.9	31	0.20	1.10	2	0.555	14.167	14.17	0.01	0.00
2	SM	2.0	- 4.0	3.0	22	17	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	39	3.9	31	0.30	1.10	2	0.555	6.111	1.22	0.10	0.04
3	SM	4.0	- 6.0	5.0	26	17	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.60	0.75	43	3.9	31	0.30	1.10	2	0.555	4.333	1.22	0.10	0.04
4	SM	6.0	- 8.0	7.0	37	17	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.32	0.75	51	3.9	31	0.30	1.10	2	0.555	4.405	1.22	0.10	0.04
5	SM	8.0	- 12.0	10.0	25	17	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.23	0.75	32	3.9	31	0.22	1.10	2	0.555	2.083	1.22	0.10	0.04
6	SM	12.0	- 15.0	13.5	15	17	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.11	0.85	20	3.9	23	0.13	1.03	2	0.256	0.926	0.53	0.23	0.08
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-8-01

GW Depth:

15.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CL	0.0	2.0	0.01	0.00	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	12.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-8-01

GW Depth: 15.0 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CL	0	2	17	24	30			26	2.25	15.62	-0.09	1679.1
2	SM	2	4	22	30	39			36	2.91	20.21		3763.8
3	SM	4	6	26	36	43			36	3.24	22.53		4196.7
4	SM	6	8	37	51	51			36	3.79	26.32		4901.5
5	SM	8	12	25	35	32			36	2.39	16.57		3086.3
6	SM	12	15	15	21	20			36	1.47	10.18		1895.6
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Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %
C_E: 1.38
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: BX-10-01
GW Depth: 3.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRR _{eq}	
		top	bottom				(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	PWR	0.0	3.0	1.5	100	11	0.2	0.2	-0.003	0.001	1.00	0.13	0.05	1.04	0.13	0.04	1.04	0.75	108	1.6	31	0.30	1.10	2	0.555	55.556	1.22	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-10-01

GW Depth:

3.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	PWR	0.0	3.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2		-													
3		-													
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30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-10-01

GW Depth: 3.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ′	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	PWR	0	3	100	138	108			40	8.09	56.16		10459.0
2		-											
3		-											
4		-											
5		-											
6		-											
7		-											
8		-											
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30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: **Greenville, SC**

Project ID: 0038111

Quake Parameters

M_w: 7.37MSF¹: 1.04 sand
$$\text{MSF}^2: \frac{1.01}{\text{clay}}$$

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER 83 %

C_E: 1.38

C _B :	1
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C _S :	1.0
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General Parameters

 $\gamma_{\text{soil}}: 120 \text{ lb/ft}^3$ $\gamma_{\text{water}}: 62.4 \text{ lb/ft}^3$ [illegible]

Notes:

Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-385-01

GW Depth:

18.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.63	0.22	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	CL	2.0	4.0	0.06	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	CL	4.0	6.0	0.39	0.13	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CL	6.0	8.0	0.27	0.09	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.92	0.32	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.46	0.00
6	ML	12.0	15.0	0.80	0.28	0.75	0.9	0.95	0.7	0.85	0.90	SSL	no	0.16	0.00
7	ML	15.0	20.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	25.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	ML	25.0	30.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.62	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

BX-385-01

GW Depth:

18.0

ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	7	10	12			30	0.93	6.43		691.4
2	CL	2	4	8	11	14			26	1.06	7.35	-0.09	790.2
3	CL	4	6	2	3	4			26	0.26	1.84	-0.09	197.5
4	CL	6	8	4	6	7			26	0.53	3.67	-0.09	395.1
5	ML	8	12	2	3	3			30	0.22	1.53		164.1
6	ML	12	15	4	6	5			30	0.40	2.80		300.8
7	ML	15	20	19	26	22			30	1.64	11.38		1224.0
8	PWR	20	25	100	138	131			40	9.83	68.24		12708.7
9	ML	25	30	14	19	16			30	1.19	8.24		886.5
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\sqrt{1.60} \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %
C_E: 1.38
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: BX-385NBCD-01

GW Depth: 25.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	ML	0.0	2.0	1.0	16	34	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	28	5.5	31	0.19	1.10	2	0.555	13.333	1.22	0.10	0.04
2	ML	2.0	4.0	3.0	21	34	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	37	5.5	31	0.30	1.10	2	0.555	5.833	1.22	0.10	0.04
3	ML	4.0	6.0	5.0	29	34	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.56	0.75	47	5.5	31	0.30	1.10	2	0.555	4.833	1.22	0.10	0.04
4	ML	6.0	8.0	7.0	31	34	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.36	0.75	44	5.5	31	0.30	1.10	2	0.555	3.690	1.22	0.10	0.04
5	ML	8.0	12.0	10.0	39	34	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.17	0.75	47	5.5	31	0.30	1.10	2	0.555	3.250	1.22	0.10	0.04
6	ML	12.0	15.0	13.5	27	34	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.08	0.85	34	5.5	31	0.25	1.05	2	0.555	1.667	1.17	0.10	0.04
7	SM	15.0	20.0	17.5	65	34	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.99	0.85	76	5.5	31	0.30	0.99	2	0.555	3.095	1.09	0.11	0.04
8	PWR	20.0	25.0	22.5	100	34	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	1.00	0.95	131	5.5	31	0.30	0.91	2	0.555	3.704	1.01	0.12	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385NBCD-01

GW Depth: 25.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	ML	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	SM	15.0	20.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	25.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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28															
29															
30															
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385NBCD-01

GW Depth: 25.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	16	22	28			30	2.12	14.70		1580.3
2	ML	2	4	21	29	37			30	2.78	19.29		2074.2
3	ML	4	6	29	40	47			30	3.52	24.48		2631.8
4	ML	6	8	31	43	44			30	3.29	22.82		2453.6
5	ML	8	12	39	54	47			30	3.55	24.62		2647.1
6	ML	12	15	27	37	34			30	2.58	17.93		1928.1
7	SM	15	20	65	90	76			36	5.69	39.49		7354.3
8	PWR	20	25	100	138	131			40	9.81	68.12		12686.4
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %
C_E: 1.38
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: BX-385NBCD-02
GW Depth: 15.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	MH	0.0	- 2.0	1.0	4	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	7	5.5	13	0.08	1.10	1	0.137	3.333	0.15	0.84	0.29
2	CL	2.0	- 4.0	3.0	10	54	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	18	5.5	23	0.12	1.10	2	0.252	2.778	2.78	0.05	0.02
3	CL	4.0	- 6.0	5.0	20	54	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.01	0.13	0.04	1.70	0.75	35	5.5	31	0.27	1.10	2	0.555	3.333	3.33	0.04	0.01
4	CL	6.0	- 8.0	7.0	26	54	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.01	0.13	0.04	1.41	0.75	38	5.5	31	0.30	1.10	2	0.555	3.095	3.10	0.04	0.01
5	ML	8.0	- 12.0	10.0	10	54	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.32	0.75	14	5.5	19	0.11	1.05	2	0.196	0.833	0.41	0.30	0.10
6	SM	12.0	- 15.0	13.5	20	10	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.10	0.85	26	1.1	27	0.17	1.04	2	0.345	1.235	0.71	0.17	0.06
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385NBCD-02

GW Depth: 15.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.84	0.29	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	CL	2.0	4.0	0.05	0.02	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	CL	4.0	6.0	0.04	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	CL	6.0	8.0	0.04	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.30	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SM	12.0	15.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385NBCD-02

GW Depth: 15.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	4	6	7			30	0.53	3.67	-0.09	395.1
2	CL	2	4	10	14	18			26	1.32	9.19	-0.09	987.7
3	CL	4	6	20	28	35			26	2.65	18.37	-0.09	1974.9
4	CL	6	8	26	36	38			26	2.84	19.75	-0.09	2123.2
5	ML	8	12	10	14	14			30	1.03	7.12		766.0
6	SM	12	15	20	28	26			36	1.94	13.44		2503.0
7		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-385SB CD-01

GW Depth: 12.5 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	26	35	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	46	5.5	31	0.30	1.10	2	0.555	21.667	1.22	0.10	0.04
2	SM	2.0	4.0	3.0	28	35	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	49	5.5	31	0.30	1.10	2	0.555	7.778	1.22	0.10	0.04
3	SM	4.0	6.0	5.0	57	35	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.28	0.75	76	5.5	31	0.30	1.10	2	0.555	9.500	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	35	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	5.5	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	ML	8.0	12.0	10.0	19	35	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	25	5.5	30	0.16	1.08	2	0.504	1.583	1.09	0.11	0.04
6	ML	12.0	15.0	13.5	14	35	1.6	1.6	-0.205	0.023	0.97	0.13	0.05	1.04	0.13	0.04	1.13	0.85	19	5.5	24	0.13	1.03	2	0.271	0.899	0.56	0.23	0.08
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385SB CD-01

GW Depth: 12.5 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	ML	12.0	15.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385SBCD-01

GW Depth: 12.5 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	26	36	46			36	3.44	23.88		4448.2
2	SM	2	4	28	39	49			36	3.70	25.72		4790.3
3	SM	4	6	57	79	76			36	5.67	39.38		7334.9
4	PWR	6	8	100	138	105			40	7.89	54.79		10204.4
5	ML	8	12	19	26	25			30	1.86	12.92		1388.6
6	ML	12	15	14	19	19			30	1.40	9.71		1043.7
7		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60}.60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: BX-385SB CD-02

GW Depth: 7.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq		
		(ksf)	(ksf)				α	β	r _d	SEE	FEE		SEE		FEE								C _σ					K _σ	K _{DR}	SAND
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	MH	0.0	-	1.5	0.8	26	30	0.1	0.1	0.007	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	46	5.4	31	0.30	1.10	2	0.555	28.889	1.22	0.10	0.04
2	MH	1.5	-	3.0	2.3	29	30	0.3	0.3	-0.013	0.002	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	51	5.4	31	0.30	1.10	2	0.555	10.741	1.22	0.10	0.04
3	PWR	3.0	-	5.0	4.0	100	30	0.5	0.5	-0.037	0.005	1.00	0.13	0.05	1.04	0.13	0.04	1.02	0.75	106	5.4	31	0.30	1.10	2	0.555	20.833	1.22	0.10	0.04
4	PWR	5.0	-	7.0	6.0	100	30	0.7	0.7	-0.068	0.008	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	105	5.4	31	0.30	1.10	2	0.555	13.889	1.22	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385SB CD-02

GW Depth: 7.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	1.5	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	1.5	3.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	PWR	3.0	5.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	5.0	7.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5		-													
6		-													
7		-													
8		-													
9		-													
10		-													
11		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: BX-385SBCD-02

GW Depth: 7.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ′	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	1.5	26	36	46			30	3.44	23.88	-0.09	2568.0
2	MH	1.5	3	29	40	51			30	3.84	26.64	-0.09	2864.3
3	PWR	3	5	100	138	106			40	7.96	55.28		10296.2
4	PWR	5	7	100	138	105			40	7.91	54.93		10229.6
5		-											
6		-											
7		-											
8		-											
9		-											
10		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c′ (psf)	ϕ′ (deg)	c′ (psf)	ϕ′ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: I85-100

GW Depth: 34.6 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	SM	0.0	2.0	1.0	44	21	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	78	4.6	31	0.30	1.10	2	0.555	36.667	1.22	0.10	0.04
2	PWR	2.0	4.0	3.0	100	21	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.03	0.75	107	4.6	31	0.30	1.10	2	0.555	27.778	1.22	0.10	0.04
3	PWR	4.0	6.0	5.0	100	21	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	106	4.6	31	0.30	1.10	2	0.555	16.667	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	21	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	4.6	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	PWR	8.0	10.0	9.0	100	21	1.1	1.1	-0.119	0.014	0.98	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	4.6	31	0.30	1.10	2	0.555	9.259	1.22	0.10	0.04
6	PWR	10.0	15.0	12.5	100	21	1.5	1.5	-0.185	0.021	0.97	0.13	0.04	1.04	0.12	0.04	1.00	0.75	104	4.6	31	0.30	1.09	2	0.555	6.667	1.21	0.10	0.04
7	PWR	15.0	20.0	17.5	100	21	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	1.00	0.85	117	4.6	31	0.30	0.99	2	0.555	4.762	1.09	0.11	0.04
8	PWR	20.0	25.0	22.5	100	21	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	1.00	0.95	131	4.6	31	0.30	0.91	2	0.555	3.704	1.01	0.12	0.04
9	PWR	25.0	30.0	27.5	100	21	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.99	0.95	130	4.6	31	0.30	0.85	2	0.555	3.030	0.94	0.12	0.04
10	PWR	30.0	35.0	32.5	100	21	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.99	0.95	130	4.6	31	0.30	0.80	2	0.555	2.564	0.89	0.13	0.04
11	PWR	35.0	42.0	38.5	100	21	4.6	4.4	-0.844	0.094	0.86	0.12	0.04	1.04	0.11	0.04	0.99	1.00	137	4.6	31	0.30	0.77	2	0.555	2.285	0.85	0.13	0.05
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

I85-100

GW Depth:

34.6

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	PWR	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	PWR	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	PWR	8.0	10.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	PWR	10.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	15.0	20.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	25.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	PWR	25.0	30.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	PWR	30.0	35.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	35.0	42.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12		-													
13		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: I85-100
GW Depth: 34.6 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	44	61	78			36	5.82	40.42		7527.7
2	PWR	2	4	100	138	107			40	8.00	55.54		10343.7
3	PWR	4	6	100	138	106			40	7.93	55.09		10259.5
4	PWR	6	8	100	138	105			40	7.89	54.79		10204.4
5	PWR	8	10	100	138	105			40	7.86	54.57		10163.5
6	PWR	10	15	100	138	104			40	7.82	54.29		10110.2
7	PWR	15	20	100	138	117			40	8.81	61.19		11396.7
8	PWR	20	25	100	138	131			40	9.81	68.12		12686.4
9	PWR	25	30	100	138	130			40	9.78	67.90		12645.7
10	PWR	30	35	100	138	130			40	9.75	67.72		12611.9
11	PWR	35	42	100	138	137			40	10.25	71.15		13251.2
12		-											
13		-											
14		-											
15		-											
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26		-											
27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: I85-101

GW Depth: 33.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						K _{DR}	SEE					FEE	
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	ML	0.0	2.0	1.0	10	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	18	5.5	23	0.12	1.10	2	0.252	8.333	0.55	0.23	0.08
2	ML	2.0	4.0	3.0	12	54	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	21	5.5	27	0.14	1.10	2	0.336	3.333	0.74	0.17	0.06
3	ML	4.0	6.0	5.0	6	54	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	11	5.5	16	0.09	1.10	2	0.165	1.000	0.36	0.34	0.12
4	ML	6.0	8.0	7.0	7	54	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.66	0.75	12	5.5	18	0.10	1.09	2	0.179	0.833	0.39	0.32	0.11
5	ML	8.0	12.0	10.0	6	54	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.36	0.75	8	5.5	14	0.09	1.04	2	0.147	0.500	0.31	0.40	0.14
6	SC	12.0	17.0	14.5	9	41	1.7	1.7	-0.225	0.026	0.96	0.13	0.04	1.04	0.12	0.04	1.08	0.85	11	5.5	17	0.10	1.01	2	0.173	0.517	0.35	0.34	0.12
7	PWR	17.0	20.0	18.5	100	41	2.2	2.2	-0.313	0.035	0.95	0.12	0.04	1.04	0.12	0.04	1.00	0.85	117	5.5	31	0.30	0.97	2	0.555	4.505	1.08	0.11	0.04
8	PWR	20.0	25.0	22.5	100	41	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	1.00	0.95	131	5.5	31	0.30	0.91	2	0.555	3.704	1.01	0.12	0.04
9	PWR	25.0	30.0	27.5	100	41	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.99	0.95	130	5.5	31	0.30	0.85	2	0.555	3.030	0.94	0.12	0.04
10	PWR	30.0	37.0	33.5	100	41	4.0	4.0	-0.701	0.078	0.88	0.12	0.04	1.04	0.11	0.04	0.99	1.00	137	5.5	31	0.30	0.79	2	0.555	2.507	0.88	0.13	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

I85-101

GW Depth:

33.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.32	0.11	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.40	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SC	12.0	17.0	0.34	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	17.0	20.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	PWR	20.0	25.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	PWR	25.0	30.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	PWR	30.0	37.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: I85-101
GW Depth: 33.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	10	14	18			30	1.32	9.19		987.7
2	ML	2	4	12	17	21			30	1.59	11.02		1185.2
3	ML	4	6	6	8	11			30	0.79	5.51		592.6
4	ML	6	8	7	10	12			30	0.90	6.26		673.1
5	ML	8	12	6	8	8			30	0.63	4.40		472.6
6	SC	12	17	9	12	11			30	0.86	5.95		640.1
7	PWR	17	20	100	138	117			40	8.80	61.14		11386.6
8	PWR	20	25	100	138	131			40	9.81	68.12		12686.4
9	PWR	25	30	100	138	130			40	9.78	67.90		12645.7
10	PWR	30	37	100	138	137			40	10.26	71.26		13270.9
11		-											
12		-											
13		-											
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30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: 185-102

GW Depth: 47.3 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom				(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	MH	0.0	2.0	1.0	6	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	11	5.5	16	0.09	1.10	1	0.165	5.000	0.18	0.69	0.24
2	MH	2.0	4.0	3.0	11	54	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	19	5.5	25	0.13	1.10	1	0.288	3.056	0.32	0.40	0.14
3	MH	4.0	6.0	5.0	14	54	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	25	5.5	30	0.16	1.10	1	0.497	2.333	0.55	0.23	0.08
4	MH	6.0	8.0	7.0	8	54	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.64	0.75	14	5.5	19	0.11	1.09	1	0.195	0.952	0.21	0.58	0.20
5	MH	8.0	12.0	10.0	12	54	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.30	0.75	16	5.5	22	0.12	1.06	1	0.229	1.000	0.24	0.51	0.18
6	SC	12.0	17.0	14.5	28	41	1.7	1.7	-0.225	0.026	0.96	0.13	0.04	1.04	0.12	0.04	1.05	0.85	35	5.5	31	0.26	1.04	2	0.555	1.609	1.15	0.11	0.04
7	ML	17.0	20.0	18.5	9	54	2.2	2.2	-0.313	0.035	0.95	0.12	0.04	1.04	0.12	0.04	0.94	0.85	10	5.5	15	0.09	0.99	2	0.160	0.405	0.32	0.38	0.13
8	ML	20.0	25.0	22.5	7	54	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.84	0.95	8	5.5	13	0.08	0.97	2	0.142	0.259	0.28	0.42	0.15
9	ML	25.0	30.0	27.5	8	54	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.75	0.95	8	5.5	13	0.09	0.96	2	0.143	0.242	0.27	0.42	0.15
10	ML	30.0	35.0	32.5	10	54	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.70	0.95	9	5.5	15	0.09	0.94	2	0.153	0.256	0.29	0.39	0.14
11	ML	35.0	40.0	37.5	16	54	4.5	4.5	-0.815	0.091	0.87	0.11	0.04	1.04	0.11	0.04	0.68	1.00	15	5.5	21	0.11	0.91	2	0.213	0.356	0.39	0.28	0.10
12	ML	40.0	45.0	42.5	18	54	5.1	5.1	-0.961	0.107	0.84	0.11	0.04	1.04	0.11	0.04	0.65	1.00	16	5.5	22	0.12	0.89	2	0.229	0.353	0.41	0.26	0.09
13	ML	45.0	50.0	47.5	12	54	5.7	5.7	-1.107	0.123	0.82	0.11	0.04	1.04	0.10	0.04	0.58	1.00	10	5.5	15	0.09	0.90	2	0.157	0.211	0.28	0.36	0.13
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

I85-102

GW Depth:

47.3 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Φ _{SSL}	Φ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.69	0.24	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.40	0.14	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	MH	4.0	6.0	0.23	0.08	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	MH	6.0	8.0	0.58	0.20	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
5	MH	8.0	12.0	0.51	0.18	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
6	SC	12.0	17.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	ML	17.0	20.0	0.38	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	ML	20.0	25.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	ML	25.0	30.0	0.42	0.15	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.01	0.00
10	ML	30.0	35.0	0.39	0.14	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	ML	35.0	40.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12	ML	40.0	45.0	0.26	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
13	ML	45.0	50.0	0.36	0.13	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
14		-													
15		-													
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24		-													
25		-													
26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.01	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: I85-102
GW Depth: 47.3 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	6	8	11			30	0.79	5.51	-0.09	592.6
2	MH	2	4	11	15	19			30	1.46	10.10	-0.09	1086.5
3	MH	4	6	14	19	25			30	1.85	12.86	-0.09	1382.8
4	MH	6	8	8	11	14			30	1.02	7.07	-0.09	760.0
5	MH	8	12	12	17	16			30	1.22	8.45	-0.09	908.4
6	SC	12	17	28	39	35			30	2.60	18.07		1943.3
7	ML	17	20	9	12	10			30	0.75	5.20		559.4
8	ML	20	25	7	10	8			30	0.58	4.02		432.8
9	ML	25	30	8	11	8			30	0.59	4.12		443.3
10	ML	30	35	10	14	9			30	0.69	4.77		512.7
11	ML	35	40	16	22	15			30	1.13	7.83		842.0
12	ML	40	45	18	25	16			30	1.22	8.45		908.1
13	ML	45	50	12	17	10			30	0.72	5.03		541.0
14		-											
15		-											
16		-											
17		-											
18													
19		-											
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27		-											
28		-											
29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{1.60 \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: I85-103

GW Depth: 35.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						K _{DR}	SAND					CLAY	SEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	CL	0.0	2.0	1.0	5	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.01	0.13	0.05	1.70	0.75	9	5.5	14	0.09	1.10	2	0.150	4.167	4.17	0.03	0.01
2	MH	2.0	4.0	3.0	15	54	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	26	5.5	31	0.17	1.10	2	0.555	4.167	1.22	0.10	0.04
3	MH	4.0	6.0	5.0	21	54	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.68	0.75	37	5.5	31	0.29	1.10	2	0.555	3.500	1.22	0.10	0.04
4	ML	6.0	8.0	7.0	10	54	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.60	0.75	17	5.5	22	0.12	1.10	2	0.234	1.190	0.52	0.24	0.08
5	ML	8.0	12.0	10.0	11	54	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.31	0.75	15	5.5	20	0.11	1.06	2	0.212	0.917	0.45	0.28	0.10
6	ML	12.0	17.0	14.5	14	54	1.7	1.7	-0.225	0.026	0.96	0.13	0.04	1.04	0.12	0.04	1.07	0.85	18	5.5	23	0.12	1.02	2	0.252	0.805	0.51	0.24	0.08
7	ML	17.0	20.0	18.5	26	54	2.2	2.2	-0.313	0.035	0.95	0.12	0.04	1.04	0.12	0.04	0.96	0.85	29	5.5	31	0.20	0.98	2	0.555	1.171	1.09	0.11	0.04
8	ML	20.0	25.0	22.5	15	54	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.86	0.95	17	5.5	23	0.12	0.96	2	0.242	0.556	0.47	0.25	0.09
9	ML	25.0	30.0	27.5	12	54	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.77	0.95	12	5.5	18	0.10	0.95	2	0.180	0.364	0.34	0.33	0.12
10	ML	30.0	35.0	32.5	15	54	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.72	0.95	14	5.5	20	0.11	0.93	2	0.203	0.385	0.38	0.30	0.10
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

I85-103

GW Depth:

35.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ_{SSL}	$\phi_{SSLQ,N}$	$\phi_{F,S,EQ}$	ϕ_{SSL}	$\phi_{SSLQ,N}$	$\phi_{F,S,EQ}$	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	CL	0.0	2.0	0.03	0.01	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	MH	4.0	6.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.24	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	ML	8.0	12.0	0.28	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	ML	12.0	17.0	0.24	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	ML	17.0	20.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	ML	20.0	25.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	ML	25.0	30.0	0.33	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	ML	30.0	35.0	0.30	0.10	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11		-													
12		-													
13		-													
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25		-													
26		-													
27		-													
28		-													
29		-													
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												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: I85-103
GW Depth: 35.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	CL	0	2	5	7	9			26	0.66	4.59	-0.09	493.9
2	MH	2	4	15	21	26			30	1.98	13.78	-0.09	1481.6
3	MH	4	6	21	29	37			30	2.75	19.09	-0.09	2052.6
4	ML	6	8	10	14	17			30	1.24	8.64		929.1
5	ML	8	12	11	15	15			30	1.12	7.79		837.5
6	ML	12	17	14	19	18			30	1.32	9.19		987.9
7	ML	17	20	26	36	29			30	2.20	15.28		1643.3
8	ML	20	25	15	21	17			30	1.28	8.87		953.9
9	ML	25	30	12	17	12			30	0.91	6.34		681.4
10	ML	30	35	15	21	14			30	1.07	7.42		797.6
11		-											
12		-											
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For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: I85-105

GW Depth: 15.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	PWR	0.0	2.0	1.0	100	11	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.05	0.75	109	1.6	31	0.30	1.10	2	0.555	83.333	1.22	0.10	0.04
2	PWR	2.0	4.0	3.0	100	11	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.03	0.75	107	1.6	31	0.30	1.10	2	0.555	27.778	1.22	0.10	0.04
3	PWR	4.0	6.0	5.0	100	11	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	106	1.6	31	0.30	1.10	2	0.555	16.667	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	11	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	1.6	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	PWR	8.0	12.0	10.0	100	11	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	1.6	31	0.30	1.10	2	0.555	8.333	1.22	0.10	0.04
6	PWR	12.0	15.0	13.5	100	11	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.00	0.85	118	1.6	31	0.30	1.06	2	0.555	6.173	1.18	0.10	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

I85-105

GW Depth:

15.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ_N}	Φ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	PWR	0.0	2.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	PWR	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	PWR	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	PWR	8.0	12.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	PWR	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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26			-												
27			-												
28			-												
29			-												
30			-												
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: I85-105

GW Depth: 15.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	PWR	0	2	100	138	109			40	8.14	56.52		10527.1
2	PWR	2	4	100	138	107			40	8.00	55.54		10343.7
3	PWR	4	6	100	138	106			40	7.93	55.09		10259.5
4	PWR	6	8	100	138	105			40	7.89	54.79		10204.4
5	PWR	8	12	100	138	105			40	7.85	54.48		10146.3
6	PWR	12	15	100	138	118			40	8.85	61.45		11444.1
7		-											
8		-											
9		-											
10		-											
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27		-											
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29		-											
30		-											

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\sqrt{1.60} \cdot .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: I85-106

GW Depth: 40.0 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSR _{eq} / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SAND	CLAY					SEE	FEE
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	ML	0.0	2.0	1.0	10	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	18	5.5	23	0.12	1.10	2	0.252	8.333	0.55	0.23	0.08
2	ML	2.0	4.0	3.0	12	54	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	21	5.5	27	0.14	1.10	2	0.336	3.333	0.74	0.17	0.06
3	ML	4.0	6.0	5.0	10	54	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	18	5.5	23	0.12	1.10	2	0.252	1.667	0.55	0.23	0.08
4	ML	6.0	8.0	7.0	16	54	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.51	0.75	25	5.5	31	0.16	1.10	2	0.525	1.905	1.16	0.11	0.04
5	SM	8.0	12.0	10.0	18	35	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.26	0.75	24	5.5	29	0.15	1.08	2	0.434	1.500	0.94	0.13	0.05
6	ML	12.0	15.0	13.5	16	54	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.11	0.85	21	5.5	26	0.14	1.03	2	0.324	0.988	0.67	0.18	0.06
7	ML	15.0	20.0	17.5	22	54	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	0.98	0.85	25	5.5	31	0.16	0.99	2	0.543	1.048	1.08	0.11	0.04
8	SM	20.0	25.0	22.5	33	35	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.90	0.95	39	5.5	31	0.30	0.91	2	0.555	1.222	1.01	0.12	0.04
9	SM	25.0	30.0	27.5	37	35	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.85	0.95	41	5.5	31	0.30	0.85	2	0.555	1.121	0.94	0.12	0.04
10	ML	30.0	35.0	32.5	19	54	3.9	3.9	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.74	0.95	18	5.5	24	0.13	0.92	2	0.268	0.487	0.49	0.23	0.08
11	ML	35.0	40.0	37.5	13	54	4.5	4.5	-0.815	0.091	0.87	0.11	0.04	1.04	0.11	0.04	0.66	1.00	12	5.5	17	0.10	0.92	2	0.178	0.289	0.33	0.33	0.12
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

I85-106

GW Depth:

40.0

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	ML	0.0	2.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	ML	2.0	4.0	0.17	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	ML	4.0	6.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	ML	6.0	8.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SM	8.0	12.0	0.13	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	ML	12.0	15.0	0.18	0.06	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	ML	15.0	20.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	SM	25.0	30.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	ML	30.0	35.0	0.23	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	ML	35.0	40.0	0.33	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
12		-													
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28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: I85-106
GW Depth: 40.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	ML	0	2	10	14	18			30	1.32	9.19		987.7
2	ML	2	4	12	17	21			30	1.59	11.02		1185.2
3	ML	4	6	10	14	18			30	1.32	9.19		987.7
4	ML	6	8	16	22	25			30	1.88	13.07		1405.8
5	SM	8	12	18	25	24			36	1.77	12.29		2289.2
6	ML	12	15	16	22	21			30	1.56	10.83		1164.9
7	ML	15	20	22	30	25			30	1.90	13.20		1419.0
8	SM	20	25	33	46	39			36	2.93	20.38		3795.4
9	SM	25	30	37	51	41			36	3.11	21.61		4024.5
10	ML	30	35	19	26	18			30	1.39	9.63		1035.9
11	ML	35	40	13	18	12			30	0.89	6.21		667.5
12			-										
13			-										
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30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015
Site: I-85/385
Location: Greenville, SC
Project ID: 0038111

Quake Parameters

M_w: 7.37
MSF¹: 1.04 sand
MSF²: 1.01 clay
a_{SEE}: 0.2 % g
a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %
C_E: 1.38
C_B: 1
C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³
γ_{water}: 62.4 lb/ft³

Boring: R2A-104
GW Depth: 21.0 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	MH	0.0	2.0	1.0	14	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	25	5.5	30	0.16	1.10	1	0.497	11.667	0.55	0.23	0.08
2	SM	2.0	4.0	3.0	5	35	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	9	5.5	14	0.09	1.10	1.2	0.150	1.389	0.20	0.63	0.22
3	SM	4.0	6.0	5.0	1	35	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.70	0.75	2	5.5	7	0.06	1.08	1.2	0.100	0.167	0.13	0.97	0.34
4	ML	6.0	8.0	7.0	4	54	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.70	0.75	7	5.5	13	0.08	1.07	1.2	0.137	0.476	0.18	0.71	0.25
5	ML	8.0	12.0	10.0	14	54	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.29	0.75	19	5.5	24	0.13	1.06	1.2	0.273	1.167	0.35	0.35	0.12
6	PWR	12.0	15.0	13.5	100	30	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.00	0.85	118	5.4	31	0.30	1.06	2	0.555	6.173	1.18	0.10	0.04
7	PWR	15.0	21.0	18.0	100	30	2.2	2.2	-0.302	0.034	0.95	0.12	0.04	1.04	0.12	0.04	1.00	0.85	117	5.4	31	0.30	0.98	2	0.555	4.630	1.08	0.11	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R2A-104

GW Depth:

21.0 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.23	0.08	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.63	0.22	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.97	0.34	0.75	0.9	0.95	0.7	0.85	0.90	F,S,EQ	no	0.23	0.00
4	ML	6.0	8.0	0.71	0.25	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.03	0.00
5	ML	8.0	12.0	0.35	0.12	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.02	0.00
6	PWR	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	15.0	21.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.28	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R2A-104

GW Depth: 21.0 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	14	19	25			30	1.85	12.86	-0.09	1382.8
2	SM	2	4	5	7	9			32	0.66	4.59		855.4
3	SM	4	6	1	1	2			25	0.13	0.92		171.1
4	ML	6	8	4	6	7			30	0.53	3.67		395.1
5	ML	8	12	14	19	19			30	1.40	9.75		1048.3
6	PWR	12	15	100	138	118			40	8.85	61.45		11444.1
7	PWR	15	21	100	138	117			40	8.81	61.17		11391.5
8			-										
9			-										
10			-										
11			-										
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29			-										
30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c´ (psf)	ϕ´ (deg)	c´ (psf)	ϕ´ (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R385-107

GW Depth: 11.1 ft

Sample	USCS	Layer		z	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor	CRR _{7.5}	CRR _{7.5}	CRR* _{EQ}	CSReq / CRReq	
		top	bottom	(ft)			(ksf)	(ksf)	α	β	r _d	SEE	FEE		SEE	FEE						C _σ	K _σ	K _{DR}	SAND	CLAY		SEE	FEE
Equation No.									(1)	(2)	(3)	(4) (5)		(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)		
1	SM	0.0	2.0	1.0	10	21	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	18	4.6	22	0.12	1.10	2	0.237	8.333	0.52	0.24	0.08
2	SM	2.0	4.0	3.0	50	21	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.51	0.75	78	4.6	31	0.30	1.10	2	0.555	13.889	1.22	0.10	0.04
3	PWR	4.0	6.0	5.0	100	21	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.02	0.75	106	4.6	31	0.30	1.10	2	0.555	16.667	1.22	0.10	0.04
4	PWR	6.0	8.0	7.0	100	21	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	4.6	31	0.30	1.10	2	0.555	11.905	1.22	0.10	0.04
5	PWR	8.0	12.0	10.0	100	21	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.01	0.75	105	4.6	31	0.30	1.10	2	0.555	8.333	1.22	0.10	0.04
6	PWR	12.0	15.0	13.5	100	21	1.6	1.5	-0.205	0.023	0.97	0.14	0.05	1.04	0.13	0.05	1.00	0.85	118	4.6	31	0.30	1.09	2	0.555	6.802	1.21	0.11	0.04
7	PWR	15.0	17.5	16.3	100	21	2.0	1.6	-0.263	0.030	0.96	0.15	0.05	1.04	0.14	0.05	1.00	0.85	118	4.6	31	0.30	1.06	2	0.555	6.140	1.18	0.12	0.04
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R385-107

GW Depth:

11.1 ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ}	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	SM	0.0	2.0	0.24	0.08	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
2	SM	2.0	4.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
3	PWR	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	PWR	6.0	8.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	PWR	8.0	12.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	PWR	12.0	15.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	15.0	17.5	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8		-													
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26		-													
27		-													
28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R385-107

GW Depth: 11.1 ft

Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ´	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	SM	0	2	10	14	18			36	1.32	9.19		1710.8
2	SM	2	4	50	69	78			36	5.88	40.84		7606.2
3	PWR	4	6	100	138	106			40	7.93	55.09		10259.5
4	PWR	6	8	100	138	105			40	7.89	54.79		10204.4
5	PWR	8	12	100	138	105			40	7.85	54.48		10146.3
6	PWR	12	15	100	138	118			40	8.86	61.54		11461.9
7	PWR	15	17.5	100	138	118			40	8.85	61.44		11443.1
8			-										
9			-										
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30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - \left(0.28 \cdot PI\right) + 0.00145 \cdot \left(PI\right)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$



Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}

SPT LIQUEFACTION POTENTIAL CALCULATION SHEET

* Areas of user input are shaded in green



Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Quake Parameters

M_w: 7.37

MSF¹: 1.04 sand

MSF²: 1.01 clay

a_{SEE}: 0.2 % g

a_{FEE}: 0.07 % g

Hammer Parameters

ER: 83 %

C_E: 1.38

C_B: 1

C_S: 1.0

General Parameters

γ_{soil}: 120 lb/ft³

γ_{water}: 62.4 lb/ft³

Boring: R385-108

GW Depth: 31.4 ft

Sample	USCS	Layer		z (ft)	N _m	(FC)	σ _{vo}	σ' _{vo}	Shear Stress Reduction Coefficient			CSR _{eq}		MSF	CSR* _{eq}		C _N	C _R	(N ₁) ₆₀	ΔN* _{1,60}	(N ₁) _{60cs}	High Overburden Correction		Age Factor K _{DR}	CRR _{7.5} SAND	CRR _{7.5} CLAY	CRR* _{EQ}	CSReq / CRReq	
		(ksf)	(ksf)				α	β	r _d	SEE	FEE	SEE	FEE		C _σ	K _σ						SEE	FEE						
Equation No.		top	bottom						(1)	(2)	(3)	(4) (5)	(6) (7)	(8)		(9)	(10)	(11)	(12)	(13)	(14)	(15)		(16)	(17)	(18)			
1	MH	0.0	2.0	1.0	20	54	0.1	0.1	0.004	0.000	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	35	5.5	31	0.27	1.10	2	0.555	16.667	1.22	0.10	0.04
2	MH	2.0	4.0	3.0	32	54	0.4	0.4	-0.023	0.003	1.00	0.13	0.05	1.04	0.13	0.04	1.70	0.75	56	5.5	31	0.30	1.10	2	0.555	8.889	1.22	0.10	0.04
3	SM	4.0	6.0	5.0	23	21	0.6	0.6	-0.052	0.006	0.99	0.13	0.05	1.04	0.12	0.04	1.65	0.75	39	4.6	31	0.30	1.10	2	0.555	3.833	1.22	0.10	0.04
4	SM	6.0	8.0	7.0	10	21	0.8	0.8	-0.084	0.010	0.99	0.13	0.04	1.04	0.12	0.04	1.60	0.75	17	4.6	21	0.12	1.10	2	0.222	1.190	0.49	0.25	0.09
5	SP	8.0	12.0	10.0	15	21	1.2	1.2	-0.137	0.016	0.98	0.13	0.04	1.04	0.12	0.04	1.28	0.75	20	4.6	25	0.13	1.07	2	0.281	1.250	0.60	0.21	0.07
6	SP	12.0	15.0	13.5	32	21	1.6	1.6	-0.205	0.023	0.97	0.13	0.04	1.04	0.12	0.04	1.08	0.85	41	4.6	31	0.30	1.06	2	0.555	1.975	1.18	0.10	0.04
7	PWR	15.0	20.0	17.5	100	21	2.1	2.1	-0.291	0.033	0.95	0.12	0.04	1.04	0.12	0.04	1.00	0.85	117	4.6	31	0.30	0.99	2	0.555	4.762	1.09	0.11	0.04
8	SM	20.0	25.0	22.5	15	21	2.7	2.7	-0.409	0.046	0.93	0.12	0.04	1.04	0.12	0.04	0.86	0.95	17	4.6	22	0.12	0.96	2	0.228	0.556	0.44	0.27	0.09
9	PWR	25.0	30.0	27.5	100	21	3.3	3.3	-0.537	0.060	0.91	0.12	0.04	1.04	0.11	0.04	0.99	0.95	130	4.6	31	0.30	0.85	2	0.555	3.030	0.94	0.12	0.04
10	PWR	30.0	35.0	32.5	100	21	3.9	3.8	-0.673	0.075	0.89	0.12	0.04	1.04	0.11	0.04	0.99	0.95	130	4.6	31	0.30	0.80	2	0.555	2.610	0.89	0.13	0.04
11	PWR	35.0	40.0	37.5	100	21	4.5	4.1	-0.815	0.091	0.87	0.12	0.04	1.04	0.12	0.04	0.99	1.00	137	4.6	31	0.30	0.78	2	0.555	2.428	0.87	0.14	0.05
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Notes:
Triggering analysis and seismic settlement analysis based on Chapter 13 of South Carolina Department of Transportation (SCDOT) Geotechnical Design Manual (GDM).

SPT LIQUEFACTION POTENTIAL SUMMARY

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring:

R385-108

GW Depth:

31.4

ft



Sample	USCS	Layer		CSR _{eq} / CRR _{eq}		ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	ϕ _{SSL}	ϕ _{SSLQ} N	ϕ _{F,S,EQ}	Triggering		Settlement	
		top	bottom	SEE	FEE	SEE			FEE			SEE	FEE	SEE	FEE
1	MH	0.0	2.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
2	MH	2.0	4.0	0.10	0.04	0.9	N/A	0.95	0.85	N/A	0.90	no	no	0.00	0.00
3	SM	4.0	6.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
4	SM	6.0	8.0	0.25	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
5	SP	8.0	12.0	0.21	0.07	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
6	SP	12.0	15.0	0.10	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
7	PWR	15.0	20.0	0.11	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
8	SM	20.0	25.0	0.27	0.09	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
9	PWR	25.0	30.0	0.12	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
10	PWR	30.0	35.0	0.13	0.04	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
11	PWR	35.0	40.0	0.14	0.05	0.75	0.9	0.95	0.7	0.85	0.90	no	no	0.00	0.00
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28		-													
29		-													
30		-													
												Total Seismic Settlement		0.00	0.00

L-Pile Input Parameters

Project Information

Date: November 5, 2015

Site: I-85/385

Location: Greenville, SC

Project ID: 0038111

Boring: R385-108

GW Depth: 31.4 ft



Sample	USCS	Layer		N	N ₆₀	N _{1.60}	LL	PI	ϕ'	c _u (ksf)	c _u (psi)	c _c	E _s (psi)
		top	bottom										
1	MH	0	2	20	28	35			30	2.65	18.37	-0.09	1975.4
2	MH	2	4	32	44	56			30	4.23	29.40	-0.09	3160.6
3	SM	4	6	23	32	39			36	2.95	20.50		3818.0
4	SM	6	8	10	14	17			36	1.24	8.64		1609.3
5	SP	8	12	15	21	20			32	1.50	10.39		1935.5
6	SP	12	15	32	44	41			32	3.04	21.10		3928.8
7	PWR	15	20	100	138	117			40	8.81	61.19		11396.7
8	SM	20	25	15	21	17			36	1.28	8.87		1652.3
9	PWR	25	30	100	138	130			40	9.78	67.90		12645.7
10	PWR	30	35	100	138	130			40	9.75	67.74		12615.5
11	PWR	35	40	100	138	137			40	10.26	71.22		13264.1
12			-										
13			-										
14			-										
15			-										
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30			-										

For cohesionless soils, Equation 7-41 of the GDM was used to calculate ϕ.

$$\phi'_{Cohesionless} := \left(15.4 \cdot N'_{1.60}\right)^{0.5} + 20$$

For cohesive soils, Equation 7-45 of the GDM was used to calculate ϕ.

Please note that the +/- 8° was omitted from the end of the equation.

$$\phi'_{Cohesive} := 35.7 - (0.28 \cdot PI) + 0.00145 \cdot (PI)^2$$

For Low Plasticity Soils, Equation 7-30 of the GDM was used to calculate c
LL<40

$$c_{u.Low} := .075 \cdot N_{1.60}^{\Gamma_{1.60} .60}$$

For High Plasticity Soils, Equation 7-31 of the GDM was used to calculate c
LL>/=40

$$c_{u.High} := .15 \cdot N_{1.60}$$

Table 7-15, Maximum Allowable Total Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	34	0	18
SW	Coarse Grained Sand	0	17	0	7
SM, SP	Fine Grained Sand	0	17	0	7
SP	Uniform Rounded Sand	0	15	0	6
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	1500	15	1200	6
SM-ML	Residual Soils	900	14	700	6
CL-ML	NC Clay (Low Plasticity)	1500	0	900	0
CL, CH	NC Clay (Med-High Plasticity)	2500	0	1250	0
CL-ML	OC Clay (Low Plasticity)	2500	0	1400	0
CL, CH	OC Clay (Med-High Plasticity)	4000	0	2000	0

Table 7-16, Maximum Allowable Effective Soil Shear Strengths

Soil Description		Peak		Residual	
		c' (psf)	ϕ' (deg)	c' (psf)	ϕ' (deg)
USCS	Description				
GW, GP, GM, GC	Stone and Gravel	0	40	0	34
SW	Coarse Grained Sand	0	38	0	32
SM, SP	Fine Grained Sand	0	36	0	30
SP	Uniform Rounded Sand	0	32	0	32
ML, MH, SC	Silt, Clayey Sand, Clayey Silt	0	30	0	27
SM-ML	Residual Soils	0	27	0	22
CL-ML	NC Clay (Low Plasticity)	0	35	0	31
CL, CH	NC Clay (Med-High Plasticity)	0	26	0	16
CL-ML	OC Clay (Low Plasticity)	0	34	0	31
CL, CH	OC Clay (Med-High Plasticity)	0	28	0	16

Table 7-18, Elastic Modulus Correlations For Soil

Soil Description		Elastic Modulus, E _s (psi)
USCS	Description	
GW, GP, GM, GC	Sandy gravels and gravels	167*N _{1.60}
SW	Coarse grained sands	139*N _{1.60}
SM, SP, PWR	Clean fine to medium grained sands and slightly silty sands, Partially Weathered Rock	97*N _{1.60}
ML, MH, SC, SM-ML, CL-ML, CL, CH	Silts, sandy silts, slightly cohesive mixtures	56*N _{1.60}