Project Title:
Statistical Model to Predict the Compressibility of Florida's Soils

(BDV24 TWO 977-24)

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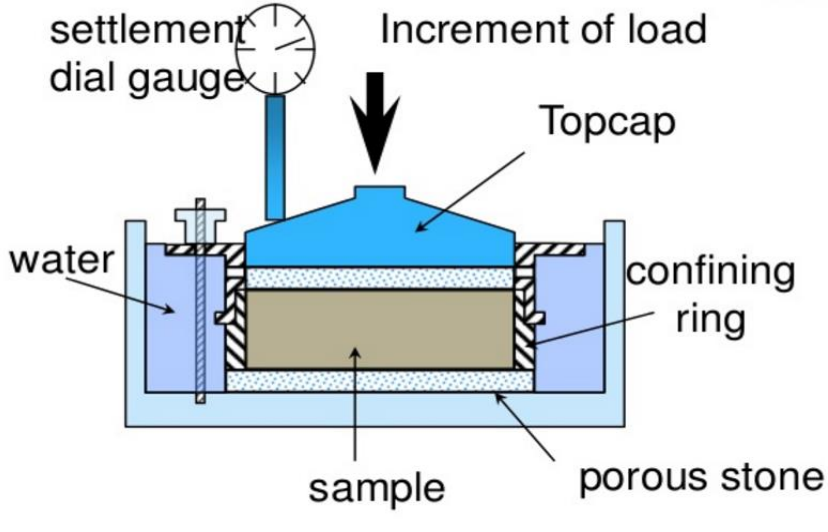
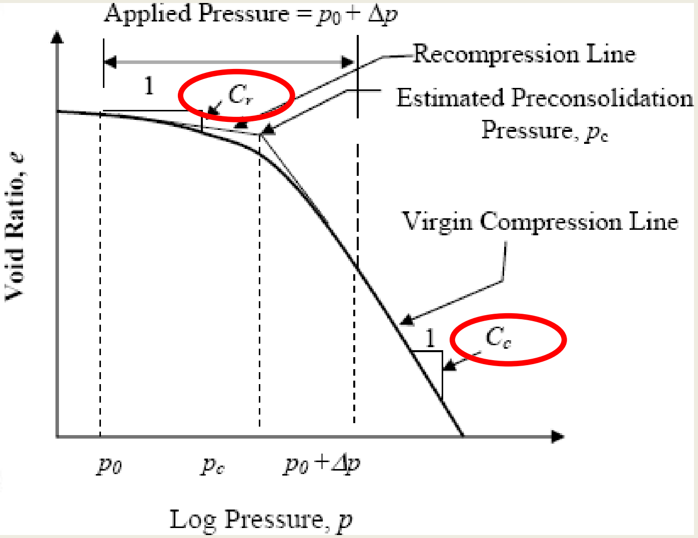
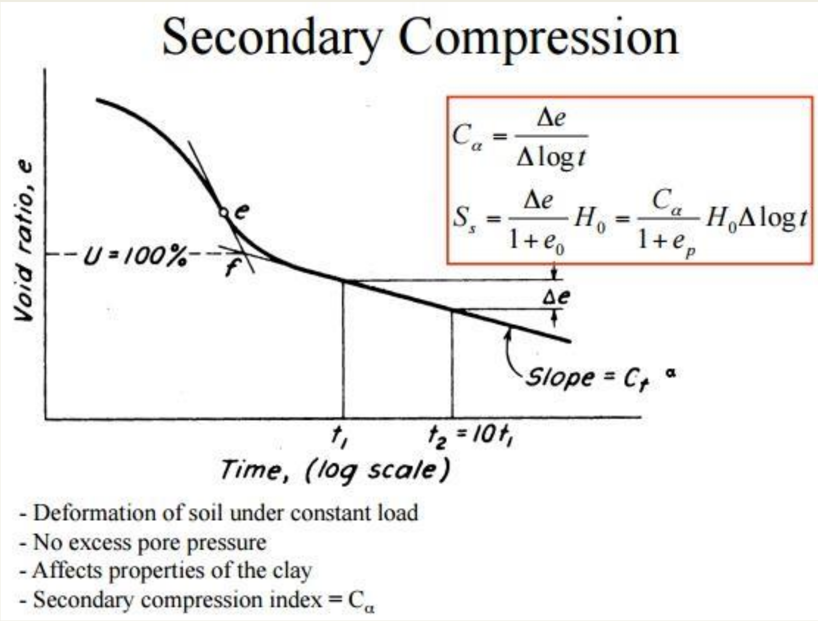
Presentation outline

- **Background**
- **Project Objectives**
- **Work Plan**
  - **Task 1:** Identify the existing soil compressibility models
  - **Task 2:** Compare the accuracy with the existing models
  - **Task 3:** Collect data throughout the state
  - **Task 4:** Evaluate the correlations of key affecting parameters and soil compressibility
  - **Task 5:** Develop a methodology to construct the statistical Cc, Cr, Cv, and Ca models
  - **Task 6:** Develop the soil compressibility prediction models for specific soil types
  - **Task 7:** Evaluate the relationship with field tests
- **Future Work Plan**

Background





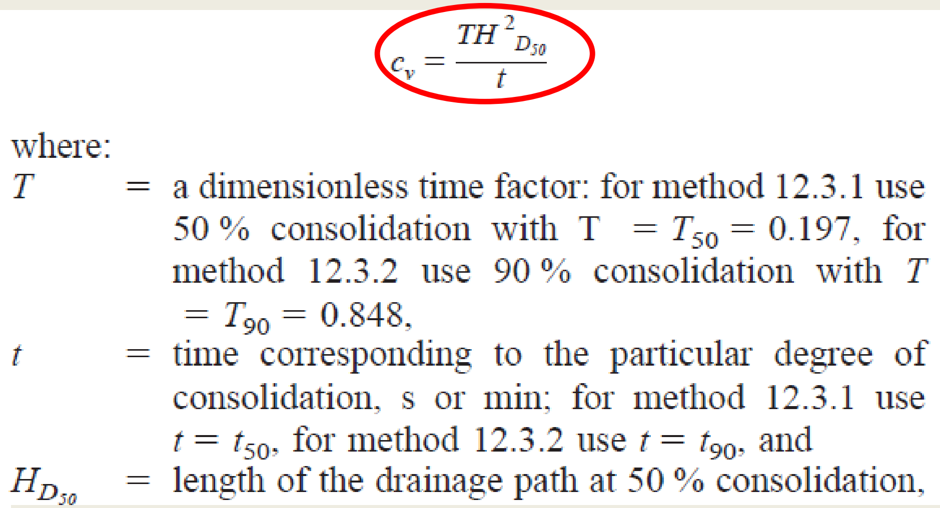


Secondary Compression

$$C_\alpha = \frac{\Delta e}{\Delta \log t}$$

$$S_s = \frac{\Delta e}{1+e_0} H_0 = \frac{C_\alpha}{1+e_p} H_0 \Delta \log t$$

- Deformation of soil under constant load
- No excess pore pressure
- Affects properties of the clay
- Secondary compression index = C_α



$$c_v = \frac{TH^2_{D_{50}}}{t}$$

where:

T = a dimensionless time factor: for method 12.3.1 use 50 % consolidation with T = T_{50} = 0.197, for method 12.3.2 use 90 % consolidation with $T = T_{90} = 0.848$,

t = time corresponding to the particular degree of consolidation, s or min; for method 12.3.1 use $t = t_{50}$, for method 12.3.2 use $t = t_{90}$, and

$H_{D_{50}}$ = length of the drainage path at 50 % consolidation,

Cv = coefficient of consolidation

C_α = secondary compression index

Background (cont.)

Problem Statement:

- Consolidation testing for the Cc, Cr, and Cv (coefficient of consolidation) is not simple and easy. Those indexes are difficult to quantify and have large uncertainty.
- Two ways to determine Cc, Cr, and Cv: (1) direct measurement via lab test and (2) correlation to other soil data determined from lab tests.
- Many previous studies on prediction models of soil compressibility such as Cc, Cr, and Cv. However, those models may not be accurate enough for Florida's soil conditions because the models are constructed based on local soils and most models are based on a simple linear regression model.

Project Objectives

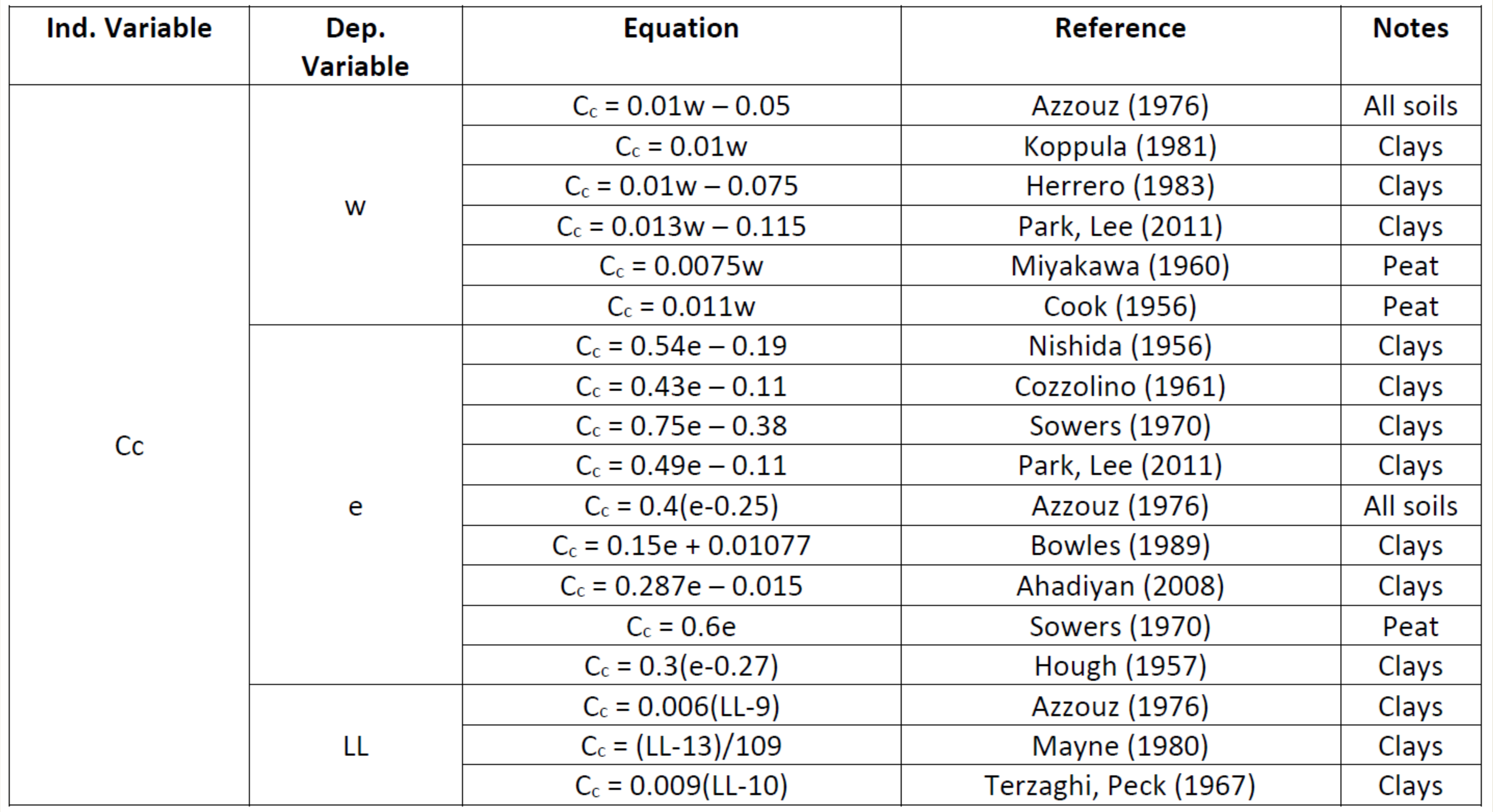
- To identify statistically significant affecting variables on Cc and Cr and to evaluate their correlations
- To identify the most accurate model of soil compressibility (from statistical perspective) for Florida's soils.
- To develop the best performing statistical models to predict Cc, Cr, Cv, and Ca for Florida's soils
  - State-of-the-art statistical techniques will be used
  - Models will be developed for specific soil types

Task 1: Identify the existing Cc, Cr, and Cv models

- Literature review to identify the existing “mathematical” models of soil compressibility.

- Review on previous studies of Florida
  - Informal survey to Districts and consultants (not many responses)

Existing prediction models



Ind. Variable	**Dep. Variable**	**Equation**	**Reference**	**Notes**
Cc	w	$C_c = 0.01w - 0.05$	Azzouz (1976)	All soils
		$C_c = 0.01w$	Koppula (1981)	Clays
		$C_c = 0.01w - 0.075$	Herrero (1983)	Clays
		$C_c = 0.013w - 0.115$	Park, Lee (2011)	Clays
		$C_c = 0.0075w$	Miyakawa (1960)	Peat
		$C_c = 0.011w$	Cook (1956)	Peat
	e	$C_c = 0.54e - 0.19$	Nishida (1956)	Clays
		$C_c = 0.43e - 0.11$	Cozzolino (1961)	Clays
		$C_c = 0.75e - 0.38$	Sowers (1970)	Clays
		$C_c = 0.49e - 0.11$	Park, Lee (2011)	Clays
		$C_c = 0.4(e-0.25)$	Azzouz (1976)	All soils
		$C_c = 0.15e + 0.01077$	Bowles (1989)	Clays
		$C_c = 0.287e - 0.015$	Ahadiyan (2008)	Clays
		$C_c = 0.6e$	Sowers (1970)	Peat
		$C_c = 0.3(e-0.27)$	Hough (1957)	Clays
	LL	$C_c = 0.006(LL-9)$	Azzouz (1976)	Clays
		$C_c = (LL-13)/109$	Mayne (1980)	Clays
		$C_c = 0.009(LL-10)$	Terzaghi, Peck (1967)	Clays

		$C_c = 0.014LL - 0.168$	Park, Lee (2011)	Clays
		$C_c = 0.0046(LL - 9)$	Bowles (1989)	Clays
		$C_c = 0.011(LL - 16)$	McClelland (1967)	Clays
	w, LL	$C_c = 0.009w + 0.005LL$	Koppula (1981)	Clays
		$C_c = 0.009w + 0.002LL - 0.01$	Azzouz (1976)	Clays
	e, w	$C_c = 0.4(e + 0.001w - 0.25)$	Azzouz (1976)	All soils
	e, LL	$C_c = -0.156 + 0.411e - 0.00058LL$	Al-Khafaji, Andersland (1992)	Clays
		$C_c = -0.023 + 0.271e + 0.001LL$	Ahadiyan (2008)	Clays
	e, w, LL	$C_c = 0.37(e + 0.003LL +).0004w - 0.34)$	Azzouz (1976)	Clays
		$C_c = -0.404 + 0.341e + 0.006w + 0.004LL$	Yoon, Kim (2008)	Clays
	w, LL, e, γ_{dry}	$C_c = 0.1597(w^{-0.0187})(1 + e)^{1.592}(LL^{-0.0638})(\gamma_{dry}^{-0.8276})$	Ozer (2008)	Clays
		$C_c = 0.151 + 0.001225w + 0.193e - 0.000258LL - 0.0699\gamma_{dry}$	Ozer (2008)	Clays
Cr	e	$C_r = 0.156e + 0.0107$	Elnaggar, Krizek (1971)	Clays
		$C_r = 0.208e + 0.0083$	Peck, Reed (1954)	Clays
		$C_r = 0.14(e+0.007)$	Azzouz (1976)	All soils
	w	$C_r = 0.003(w + 7)$	Azzouz (1976)	All soils
	LL	$C_r = 0.002(LL + 9)$	Azzouz (1976)	All soils
	e, w	$C_r = 0.142(e - 0.009w + 0.006)$	Azzouz (1976)	All soils
	w, LL	$C_r = 0.003w + 0.0006LL + 0.004$	Azzouz (1976)	All soils
	e, LL	$C_r = 0.126(e + 0.003LL - 0.06)$	Azzouz (1976)	All soils
	e, w, LL	$C_r = 0.135(e + 0.1LL - 0.002w - 0.06)$	Azzouz (1976)	All soils

Existing prediction models (cont.)

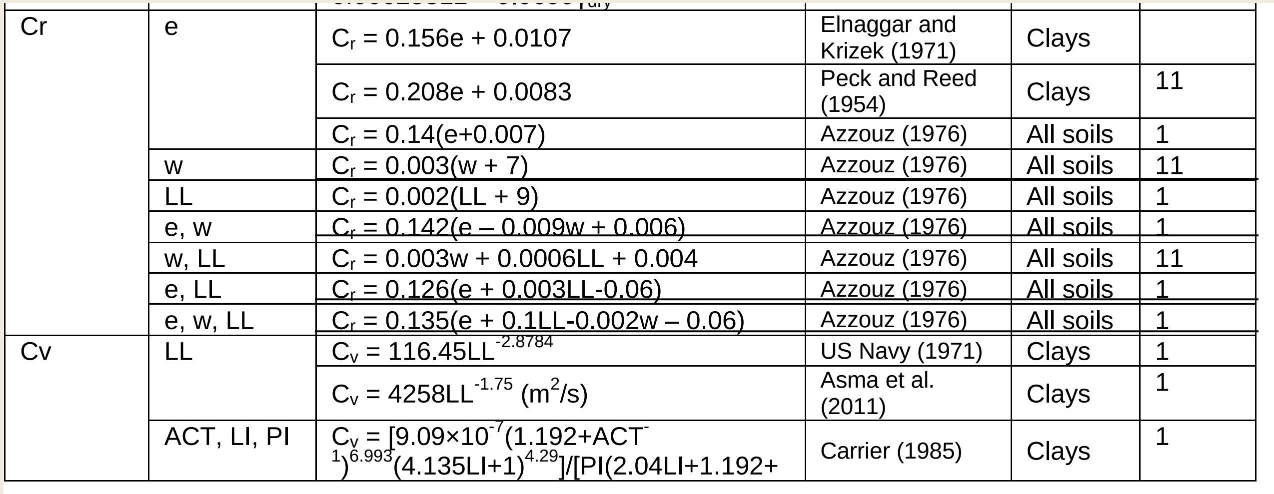
Cv	LL	$C_v = 116.45LL^{-2.8784}$	US Navy (1971)	Clays
		$C_v = 4258LL^{-1.75}$ (m²/s)	Asma et al. (2011)	Clays
	ACT, LI, PI	$C_v = [9.09\times10^{-7}(1.192+ACT^{-1})^{6.993}(4.135LI+1)^{4.29}]/[PI(2.04LI+1.192+ACT^{-1})^{7.993}]$ (m²/s)	Carrier (1985)	Clays
	e_{LL}, σ_v	$C_v = [1+ e_{LL}(1.23-0.276\log\sigma_v)]/ e_{LL} \times[1/\sigma_v^{0.353}]\times10^{-3}$ (cm²/s)	Raju et al. (1995)	Clays
	SI=LL-SL	$C_v = 3/[100(SI)^{3.54}]$ (m²/s)	Sridharan, Nagaraj (2004)	Clays
	PI	$C_v = 7.7525PI^{-3.1021}$ (cm²/s)	Solanki (2011)	Clays
Cα	PI	$C_\alpha = 0.00168 + 0.00033PI$	Nakase et al. (1988)	
	w	$C_\alpha = 0.0001w$	NAVFAC (1982)	
		$C_\alpha = 0.00018w$	Simons, Menzies (1999)	
	Cc	$C_\alpha = 0.032C_c$	Mesri and Godlewski (1977)	$0.025 < C_a < 0.1$
		$C_\alpha = 0.06$ to $0.07C_c$	Mesri (1986)	Peats and organic soil
		$C_\alpha = 0.015$ to $0.03C_c$	Mesri et al. (1990)	Sandy clays
	Cc, LL, PL, w	$C_\alpha = 0.001C_c\cdot LL\cdot PL^{-1.571}\cdot w$	Anagnostopoulos, Grammatikopoulos (2011)	Silts/Clay

Survey Result
- Total 8 responses

Survey was re-sent out

Soil Compress. Model	Dependent variable	Equation	Reference	Notes	Check box*
Cc	w	$C_c = 0.01w - 0.05$	Azzouz (1976)	All soils	1
		$C_c = 0.0054(2.6w - 35)$	Nishida (1956)	Clays	1
		$C_c = 0.01w$	Koppula (1981)	Clays	11
		$C_c = 0.01w - 0.075$	Herrero (1983)	Clays	
		$C_c = 0.013w - 0.115$	Park and Lee (2011)	Clays	
		$C_c = 0.0075w$	Miyakawa (1960)	Peat	
		$C_c = 0.011w$	Cook (1956)	Peat	
		$C_c = 0.0102(w - 9.15)$	Hough (1957)	Clays	1
	e	$C_c = 0.54e - 0.19$	Nishida (1956)	Clays	1
		$C_c = 0.5217(e - 0.2)$	Nishida (1956)	Clays	1
		$C_c = 0.43e - 0.11$	Cozzolino (1961)	Clays	
		$C_c = 0.75e - 0.38$	Sowers (1970)	Clays	
		$C_c = 0.49e - 0.11$	Park, Lee (2011)	Clays	
		$C_c = 0.4(e-0.25)$	Azzouz (1976)	All soils	1
		$C_c = 0.15e + 0.01077$	Bowles (1989)	Clays	1
		$C_c = 0.287e - 0.015$	Ahadiyan (2008)	Clays	
		$C_c = 0.6e$	Sowers (1970)	Peat	1
		$C_c = 0.3(e-0.27)$ Rendon-Herrero (1980)	Hough (1957)??	Clays	1
		$C_c = 0.4049(e-0.3216)$	Hough (1957)	Clays	1
	LL	$C_c = 0.006(LL-9)$	Azzouz (1976)	Clays	11
		$C_c = (LL-13)/109$	Mayne (1980)	Clays	1
		$C_c = 0.009(LL-10)$	Terzaghi and Peck (1967)	Clays	1111111
		$C_c = 0.014LL-0.168$	Park and Lee (2011)	Clays	1
		$C_c = 0.0046(LL-9)$	Bowles (1989)	Clays	1
		$C_c = 0.011(LL-16)$	McClelland (1967)	Clays	
	w, LL	$C_c = 0.009w + 0.005LL$	Koppula (1981)	Clays	11
		$C_c = 0.009w + 0.002LL - 0.01$	Azzouz (1976)	Clays	11
	e, w	$C_c = 0.4(e + 0.001w - 0.25)$	Azzouz (1976)	All soils	1
	e, LL	$C_c = -0.156 + 0.411e - 0.00058LL$	Al-Khafaji, Andersland (1992)	Clays	1
		$C_c = -0.023 + 0.271e + 0.001LL$	Ahadiyan (2008)	Clays	
	e, w, LL	$C_c = 0.37(e + 0.003LL +).0004w - 0.34)$	Azzouz (1976)	Clays	1
		$C_c = -0.404 + 0.341e + 0.006w + 0.004LL$	Yoon and Kim (2008)	Clays	
	w, LL, e, γ_{dry}	$C_c = 0.1597(w^{-0.0187})(1 + e)^{1.592}(LL^{-0.0638})(\gamma_{dry}{}^{-0.8276})$	Ozer (2008)	Clays	
		$C_c = 0.151 + 0.001225w + 0.193e - 0.000258LL - 0.0699\gamma_{dry}$	Ozer (2008)	Clays	

Survey Result



Cr	e	$C_r = 0.156e + 0.0107$	Elnaggar and Krizek (1971)	Clays	
		$C_r = 0.208e + 0.0083$	Peck and Reed (1954)	Clays	11
		$C_r = 0.14(e+0.007)$	Azzouz (1976)	All soils	1
	w	$C_r = 0.003(w + 7)$	Azzouz (1976)	All soils	11
	LL	$C_r = 0.002(LL + 9)$	Azzouz (1976)	All soils	1
	e, w	$C_r = 0.142(e – 0.009w + 0.006)$	Azzouz (1976)	All soils	1
	w, LL	$C_r = 0.003w + 0.0006LL + 0.004$	Azzouz (1976)	All soils	11
	e, LL	$C_r = 0.126(e + 0.003LL-0.06)$	Azzouz (1976)	All soils	1
	e, w, LL	$C_r = 0.135(e + 0.1LL-0.002w – 0.06)$	Azzouz (1976)	All soils	1
Cv	LL	$C_v = 116.45LL^{-2.8784}$	US Navy (1971)	Clays	1
		$C_v = 4258LL^{-1.75}$ (m^2/s)	Asma et al. (2011)	Clays	1
	ACT, LI, PI	$C_v = [9.09\times10^{-7}(1.192+ACT^{-1})^{6.993}(4.135LI+1)^{4.29}]/[PI(2.04LI+1.192+$	Carrier (1985)	Clays	1

Task 2: Compare the accuracy with existing models

- Compare the accuracy of the prediction models identified in Task 1.
  - With respect to root mean square error (RMSE) and R2
- Identify good performing models for Florida’s soils
  - Use Florida’s data (644 data set)

Ranking Cc model

Consolidation parameter	Equation	Reference	Notes	RMSE	Rank
Cc	$C_c = -0.156 + 0.411e – 0.00058LL$	Al-Khafaji, Andersland (1992)	Clays	0.3881	1
	$C_c = 0.37(e + 0.003LL +).0004w – 0.34)$	Azzouz (1976)	Clays	0.3888	2
	$C_c = 0.49e – 0.11$	Park, Lee (2011)	Clays	0.3924	3
	$C_c = 0.54e – 0.19$	Nishida (1956)	Clays	0.3945	4
	$C_c = 0.013w-0.115$	Park, Lee (2011)	Clays	0.3953	5
	$C_c = 0.43e – 0.11$	Cozzolino (1961)	Clays	0.4046	6
	$C_c = 0.01w$	Koppula (1981)	Clays	0.4191	7
	$C_c = 0.01w – 0.075$	Herrero (1983)	Clays	0.4336	8
	$C_c = -0.023 + 0.271e + 0.001LL$	Ahadiyan (2008)	Clays	0.4597	9
	$C_c = 0.009w + 0.002LL – 0.01$	Azzouz (1976)	Clays	0.4875	10
	$C_c = -0.404 + 0.341e + 0.006w + 0.004LL$	Yoon, Kim (2006)	Clays	0.4991	11
	$C_c = 0.151 + 0.001225w + 0.193e – 0.000258LL – 0.0699\gamma_{dry}$	Ozer (2008)	Clays	0.5204	12
	$C_c = 0.3(e-0.27)$	Hough (1957)	Clays	0.5425	13
	$C_c = 0.009w + 0.005LL$	Koppula (1981)	Clays	0.5518	14
	$C_c = 0.75e – 0.38$	Sowers (1970)	Clays	0.5552	15
	$C_c = (LL-13)/109$	Mayne (1980)	Clays	0.5638	16
	$C_c = 0.009(LL -10)$	Terzaghi, Peck (1967)	Clays	0.5641	17
	$C_c = 0.1597(w^{-0.0187})(1 + e)^{1.592}(LL^{-0.0638})(\gamma_{dry}^{-0.8276})$	Ozer (2008)	Clays	0.5886	18
	$C_c = 0.011(LL-16)$	McClelland (1967)	Clays	0.5991	19
	$C_c = 0.006(LL – 9)$	Azzouz (1976)	Clays	0.6213	20
	$C_c = 0.0046(LL-9)$	Bowles (1989)	Clays	0.6989	21
	$C_c = 0.4(e + 0.001w – 0.25)$	Azzouz (1976)	All soils	0.7414	22
	$C_c = 0.4(e – 0.25)$	Azzouz (1976)	All soils	0.7501	23
	$C_c = 0.15e + 0.01077$	Bowles (1989)	Clays	0.7536	24
	$C_c = 0.287e – 0.015$	Ahadiyan (2008)	Clays	0.7692	25
	$C_c = 0.014LL – 0.168$	Park, Lee (2011)	Clays	0.7921	26
	$C_c = 0.01w – 0.05$	Azzouz (1976)	All soils	0.8359	27
	$C_c = 0.0075w$	Miyakawa (1960)	Peat	1.5194	28
	$C_c = 0.6e$	Sowers (1970)	Peat	1.7876	29
	$C_c = 0.011w$	Cook (1956)	Peat	1.9601	30

Ranking
Cr model

Cr	$C_r = 0.002(LL + 9)$	Azzouz (1976)	All soils	0.1682	1
	$C_r = 0.142(e - 0.009w + 0.006)$	Azzouz (1976)	All soils	0.1802	2
	$C_r = 0.126(e + 0.003LL - 0.06)$	Azzouz (1976)	All soils	0.2109	3
	$C_r = 0.003w + 0.0006LL + 0.004$	Azzouz (1976)	All soils	0.2344	4
	$C_r = 0.156e + 0.0107$	Elnaggar, Krizek (1971)	Clays	0.2536	5
	$C_r = 0.135(e + 0.1LL - 0.002w - 0.06)$	Azzouz (1976)	All soils	0.3131	6
	$C_r = 0.14(e+0.007)$	Azzouz (1976)	All soils	0.3369	7
	$C_r = 0.208e + 0.0083$	Peck, Reed (1954)	Clays	0.3643	8
	$C_r = 0.003(w + 7)$	Azzouz (1976)	All soils	0.4415	9

Task 3: Collect data and create comprehensive Florida’s geotechnical database

- Data collection has included:
  - Soil type and classification
  - Natural moisture
  - Dry and Wet density
  - Fines (passing No. 200)
  - Initial void ratio
  - Specific gravity
  - Atterberg limits (liquid limit (LL), Plasticity index (PI))
  - Organic content
  - Automatic hammer SPT N value
  - Effective overburden pressure
  - Soil compressibility index (Cc, Cr, Cv, Ca)

Data collection

A total of 644 consolidation test data so far. Each consolidation test has an accompanying SPT boring to provide a description of the soil's stiffness. The vast majority of the data collected is from the FDOT District 5 which includes the counties of Volusia, Seminole, Orange, Osceola, Brevard, Lake, Marion, Sumter, and Flagler.

Data Collection Detail

Soil type		**# of Data points**	
		Cc	Cr
Fine-grained	clays	396	380
	silts	31	21
Organic soils		124	89
Coarse-grained		93	93
Total		644	583

Stress Level	**Stress Range (psf)**	**# of Data points**	
		Cv	Ca
Low	< 2000	150	38
Intermediate	$2000 \le \sigma \le 4000$	147	38
High	> 4000	143	37
Total		440	113

Example data set of Cc and Cr

Project Description	FPID	County	FDOT District	Region	Soil Type	Classification (USCS)	Automatic Hammer Blow Count	Natural Moisture (%)	Dry Density (pcf)	Wet Density (pcf)	Specific Gravity	Fines (-200) (%)	Liquid Limit (LL)	Plasticity Index (PI)	Organic Content (%)	Initial Void Ratio (e)	Effective Overburden Pressure (ksf)	Compression Index (Cc)	Recompression Index (Cr)
US 441 over Beggs Rd.	239365-1	Orange	5	East Central	Coarse Grained	SC	5	62	62.0	100.4	2.63		101	85		1.65	4.38	1.00	0.05
SR 79 over Reedy Branch Creek	220773-5	Washington	3	Northwest	Coarse Grained	SC	13	31.4	90.2	118.52	2.75					0.90	0.26	0.25	0.02
SR 223 over CR 100A and CSX RR	208001-4	Bradford	2	Northeast	Fine Grained	CH	6	82	50.3	91.55	2.64	98	133	99		2.28	2.28	1.05	0.24
SW 42nd St. Flyover	424185-1	Marion	5	East Central	Fine Grained	CH	9.68	55	67.0	103.85	2.66	95	157	118		1.48	3.08	0.35	0.10
SR 10 at Little Pottsburg Creek	209531-2	Duval	2	Northeast	Organic Peat	PT	2	413.8	12.7	65.4	2.19	1			87	9.76	1.85	6.41	0.63

Example data set of Cv and Ca

Soil Type	**Classification (USCS)**	**Effective Overburden Pressure (ksf)**	**Wet Density (pcf)**	**Dry Density (pcf)**	**Natural Moisture (%)**	**Automatic Hammer Blow Count**	**Fines (-200) (%)**	**Liquid Limit (LL)**	**Plasticity Index (PI)**	**Initial Void Ratio (e)**	**Specific Gravity**	**Coefficient of Consolidation (Cv)**	**Coefficient of Secondary Compression (Calpha)**	**Stress Range**
Fine Grained	CH	1.12	104.61	71.6	46.1	2.42	58	61	44	1.35	2.7	0.01	0.009	High
Fine Grained	CH	1.12	104.61	71.6	46.1	2.42	58	61	44	1.35	2.7	0.05	0.003	Intermediate
Fine Grained	CH	1.49	95.25	52.8	80.4	12.9	88	108	75	2.24	2.74	0.11	0.001	Low

Task 4: Evaluate the correlations of key affecting parameters and soil compressibility

- Evaluate the correlation between key index parameters and soil compressibility (Cc and Cr)
  - Specific index parameters can have dominant influence in compressibility of specific soil types.
  - High plasticity clays (LL > 50)
  - Low plasticity clays (LL <= 50)
  - Silts
  - High organic soils (Natural Moisture >= 160)
  - Low organic soils (Natural Moisture < 160)

*Coefficient of Determination (R^2) and Root Mean Square Error (RMSE) values were calculated to quantify the performance level of the key index parameters and appear on the Excel file.

Top 3 Index Parameters - Positive Correlation with Cc

Silts	Pearson's Correlation Coefficient
Natural Moisture (%)	0.7388
Liquid Limit (LL)	0.7469
Plasticity Index (PI)	0.7347

Low plasticity clays	Pearson's Correlation Coefficient
Effective Overburden Pressure (ksf)	0.1803
Natural Moisture (%)	0.6168
Initial Void Ratio (e)	0.6454

Low organic Soils	Pearson's Correlation Coefficient
Natural Moisture (%)	0.3455
Automatic Hammer Blow Count	0.4187
Initial Void Ratio (e)	0.8130

High plasticity clays	Pearson's Correlation Coefficient
Natural Moisture (%)	0.8149
Liquid Limit (LL)	0.4601
Initial Void Ratio (e)	0.8286

High organic Soils	Pearson's Correlation Coefficient
Natural Moisture (%)	0.6420
Organic Content (%)	0.3701
Initial Void Ratio (e)	0.6480

Top 3 Index Parameters – Negative Correlation with Cc

Silts	Pearson's Correlation Coefficient
Dry Density (pcf)	-0.6111
Fines (-200) (%)	-0.6704
Specific Gravity	-0.7154

Low plasticity clays	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.4888
Dry Density (pcf)	-0.5513
Automatic Hammer Blow Count	-0.2066

Low organic Soils	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.5159
Dry Density (pcf)	-0.4111
Fines (-200) (%)	-0.2751

High plasticity clays	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.7025
Dry Density (pcf)	-0.7885
Fines (-200) (%)	-0.3365

High organic Soils	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.2536
Dry Density (pcf)	-0.6138
Effective Overburden Pressure (ksf)	-0.2496

Top 3 Index Parameters - Positive Correlation with Cr

Silts	Pearson's Correlation Coefficient
Natural Moisture (%)	0.7176
Liquid Limit (LL)	0.6159
Plasticity Index (PI)	0.6336

Low plasticity clays	Pearson's Correlation Coefficient
Liquid Limit (LL)	0.2207
Natural Moisture (%)	0.3812
Initial Void Ratio (e)	0.3743

Low organic Soils	Pearson's Correlation Coefficient
Effective Overburden Pressure (ksf)	0.1673
Natural Moisture (%)	0.3084
Initial Void Ratio (e)	0.7481

High plasticity clays	Pearson's Correlation Coefficient
Natural Moisture (%)	0.4541
Liquid Limit (LL)	0.4394
Initial Void Ratio (e)	0.4355

High organic Soils	Pearson's Correlation Coefficient
Natural Moisture (%)	0.4795
Organic Content (%)	0.1715
Initial Void Ratio (e)	0.8125

Top 3 Index Parameters – Negative Correlation with Cr

Silts	Pearson's Correlation Coefficient
Dry Density (pcf)	-0.5752
Fines (-200) (%)	-0.6351
Specific Gravity	-0.7426

Low plasticity clays	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.2332
Dry Density (pcf)	-0.3242
Automatic Hammer Blow Count	-0.0894

Low organic Soils	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.4484
Dry Density (pcf)	-0.3324
Fines (-200) (%)	-0.2098

High plasticity clays	Pearson's Correlation Coefficient
Wet Density (pcf)	-0.4228
Dry Density (pcf)	-0.4673
Automatic Hammer Blow Count	-0.1667

High organic Soils	Pearson's Correlation Coefficient
Effective Overburden Pressure (ksf)	-0.2307
Dry Density (pcf)	-0.4709
Fines (-200) (%)	-0.2100

Correlations with Cv and Ca

- Cv and Cα are a function of stress level => Three categories of stress levels
  - (1) low stress level in the range of 500-1000 psf
  - (2) mid-stress level in the range of 2000-3000 psf
  - (3) high stress level in the range of 5000-6000 psf

- Data set for different soil type:
  - Coarse-grained soil (low, mid, high stress levels)
  - Fine-grained soil (low, mid, high stress levels)
  - Organic soil (low, mid, high stress levels)

Cv Correlation for Fine-Grained Soil

High stress level

			Pearson's Correlation Coefficient	R-Squared	RMSE
Fine Grained High	CV	Effective Overburden Pressure (ksf)	-0.3230	0.1043	0.2944
Fine Grained High	CV	Wet Density (pcf)	0.0529	0.0028	0.3107
Fine Grained High	CV	Dry Density (pcf)	0.1063	0.0113	0.3094
Fine Grained High	CV	Natural Moisture (%)	-0.1591	0.0253	0.3072
Fine Grained High	CV	Automatic Hammer Blow Count	-0.0200	0.0004	0.3111
Fine Grained High	CV	Fines (-200) (%)	-0.1803	0.0325	0.306
Fine Grained High	CV	Liquid Limit (LL)	-0.0469	0.0022	0.3108
Fine Grained High	CV	Plasticity Index (PI)	-0.1072	0.0115	0.3093
Fine Grained High	CV	Initial Void Ratio (e)	-0.1404	0.0197	0.308
Fine Grained High	CV	Specific Gravity	-0.0469	0.0022	0.3108

Mid stress level

			Pearson's Correlation Coefficient	R-Squared	RMSE
Fine Grained Intermediate	CV	Effective Overburden Pressure (ksf)	0.2961	0.0877	0.4384
Fine Grained Intermediate	CV	Wet Density (pcf)	0.1000	0.01	0.4567
Fine Grained Intermediate	CV	Dry Density (pcf)	0.1539	0.0237	0.4535
Fine Grained Intermediate	CV	Natural Moisture (%)	-0.1817	0.033	0.4513
Fine Grained Intermediate	CV	Automatic Hammer Blow Count	0.0678	0.0046	0.4579
Fine Grained Intermediate	CV	Fines (-200) (%)	-0.1000	0.01	0.4567
Fine Grained Intermediate	CV	Liquid Limit (LL)	-0.0775	0.006	0.4576
Fine Grained Intermediate	CV	Plasticity Index (PI)	-0.0959	0.0092	0.4569
Fine Grained Intermediate	CV	Initial Void Ratio (e)	-0.1568	0.0246	0.4533
Fine Grained Intermediate	CV	Specific Gravity	-0.0141	0.0002	0.4589

Low stress level

			Pearson's Correlation Coefficient	R-Squared	RMSE
Fine Grained Low	CV	Effective Overburden Pressure (ksf)	0.3412	0.1164	0.4241
Fine Grained Low	CV	Wet Density (pcf)	0.0755	0.0057	0.4498
Fine Grained Low	CV	Dry Density (pcf)	0.1039	0.0108	0.4487
Fine Grained Low	CV	Natural Moisture (%)	-0.1058	0.0112	0.4486
Fine Grained Low	CV	Automatic Hammer Blow Count	0.0265	0.0007	0.451
Fine Grained Low	CV	Fines (-200) (%)	-0.0954	0.0091	0.4491
Fine Grained Low	CV	Liquid Limit (LL)	-0.0200	0.0004	0.451
Fine Grained Low	CV	Plasticity Index (PI)	-0.0436	0.0019	0.4507
Fine Grained Low	CV	Initial Void Ratio (e)	-0.0900	0.0081	0.4493
Fine Grained Low	CV	Specific Gravity	-0.0095	0.00009	0.4511

Ca Correlation for Fine-Grained Soil

High stress level

			Pearson’s Correlation Coefficient	R-Squared	RMSE
Fine Grained High	Ca	Effective Overburden Pressure (ksf)	-0.2020	0.0408	0.0156
Fine Grained High	Ca	Wet Density (pcf)	-0.5922	0.3507	0.0129
Fine Grained High	Ca	Dry Density (pcf)	-0.6701	0.449	0.0118
Fine Grained High	Ca	Natural Moisture (%)	0.7865	0.6186	0.0098
Fine Grained High	Ca	Automatic Hammer Blow Count	-0.2696	0.0727	0.0154
Fine Grained High	Ca	Fines (-200) (%)	-0.2542	0.0646	0.0154
Fine Grained High	Ca	Liquid Limit (LL)	0.7402	0.5479	0.01
Fine Grained High	Ca	Plasticity Index (PI)	0.7262	0.5274	0.011
Fine Grained High	Ca	Initial Void Ratio (e)	0.6754	0.4561	0.0118
Fine Grained High	Ca	Specific Gravity	-0.6716	0.451	0.0118

Mid stress level

			Pearson’s Correlation Coefficient	R-Squared	RMSE
Fine Grained Intermediate	Ca	Effective Overburden Pressure (ksf)	-0.2988	0.0893	0.0042
Fine Grained Intermediate	Ca	Wet Density (pcf)	-0.6251	0.3907	0.0034
Fine Grained Intermediate	Ca	Dry Density (pcf)	-0.6777	0.4593	0.0032
Fine Grained Intermediate	Ca	Natural Moisture (%)	0.7084	0.5018	0.0031
Fine Grained Intermediate	Ca	Automatic Hammer Blow Count	-0.2012	0.0405	0.0043
Fine Grained Intermediate	Ca	Fines (-200) (%)	0.0100	0.0001	0.0044
Fine Grained Intermediate	Ca	Liquid Limit (LL)	0.5594	0.3129	0.0036
Fine Grained Intermediate	Ca	Plasticity Index (PI)	0.5325	0.2836	0.0037
Fine Grained Intermediate	Ca	Initial Void Ratio (e)	0.6680	0.4462	0.0032
Fine Grained Intermediate	Ca	Specific Gravity	-0.5163	0.2666	0.0037

Low stress level

			Pearson’s Correlation Coefficient	R-Squared	RMSE
Fine Grained Low	Ca	Effective Overburden Pressure (ksf)	-0.1905	0.0363	0.0028
Fine Grained Low	Ca	Wet Density (pcf)	-0.3033	0.092	0.0027
Fine Grained Low	Ca	Dry Density (pcf)	-0.3881	0.1506	0.0026
Fine Grained Low	Ca	Natural Moisture (%)	0.4501	0.2026	0.0025
Fine Grained Low	Ca	Automatic Hammer Blow Count	-0.2983	0.089	0.0027
Fine Grained Low	Ca	Fines (-200) (%)	0.0975	0.0095	0.0028
Fine Grained Low	Ca	Liquid Limit (LL)	0.0707	0.005	0.0028
Fine Grained Low	Ca	Plasticity Index (PI)	0.0889	0.0079	0.0028
Fine Grained Low	Ca	Initial Void Ratio (e)	0.3321	0.1103	0.0026
Fine Grained Low	Ca	Specific Gravity	-0.4351	0.1893	0.0025

Cv Correlation for Organic Soil

High stress level

			Pearson’s Correlation Coefficient	R-Squared	RMSE
Organic Peat High	CV	Effective Overburden Pressure (ksf)	-0.1517	0.023	0.7072
Organic Peat High	CV	Wet Density (pcf)	0.0071	0.00005	0.7154
Organic Peat High	CV	Dry Density (pcf)	-0.0283	0.0008	0.7151
Organic Peat High	CV	Natural Moisture (%)	0.0424	0.0018	0.7148
Organic Peat High	CV	Automatic Hammer Blow Count	-0.2030	0.0412	0.7005
Organic Peat High	CV	Fines (-200) (%)	-0.2696	0.0727	0.6889
Organic Peat High	CV	Organic Content (%)	0.4107	0.1687	0.6523
Organic Peat High	CV	Initial Void Ratio (e)	0.2508	0.0629	0.6925
Organic Peat High	CV	Specific Gravity	0.2502	0.0626	0.6927

Mid stress level

			Pearson’s Correlation Coefficient	R-Squared	RMSE
Organic Peat Intermediate	CV	Effective Overburden Pressure (ksf)	0.0400	0.0016	1.1404
Organic Peat Intermediate	CV	Wet Density (pcf)	-0.0922	0.0085	1.1365
Organic Peat Intermediate	CV	Dry Density (pcf)	-0.1245	0.0155	1.1324
Organic Peat Intermediate	CV	Natural Moisture (%)	0.0894	0.008	1.1367
Organic Peat Intermediate	CV	Automatic Hammer Blow Count	-0.0200	0.0004	1.1411
Organic Peat Intermediate	CV	Fines (-200) (%)	-0.3736	0.1396	1.0587
Organic Peat Intermediate	CV	Organic Content (%)	0.4156	0.1727	1.0381
Organic Peat Intermediate	CV	Initial Void Ratio (e)	0.2352	0.0553	1.1093
Organic Peat Intermediate	CV	Specific Gravity	0.1020	0.0104	1.1354

Low stress level

			Pearson’s Correlation Coefficient	R-Squared	RMSE
Organic Peat Low	CV	Effective Overburden Pressure (ksf)	-0.1411	0.0199	2.5222
Organic Peat Low	CV	Wet Density (pcf)	-0.0911	0.0083	2.537
Organic Peat Low	CV	Dry Density (pcf)	-0.1425	0.0203	2.5216
Organic Peat Low	CV	Natural Moisture (%)	0.0781	0.0061	2.5398
Organic Peat Low	CV	Automatic Hammer Blow Count	-0.0954	0.0091	2.536
Organic Peat Low	CV	Fines (-200) (%)	-0.4111	0.169	2.3224
Organic Peat Low	CV	Organic Content (%)	0.3800	0.1444	2.3565
Organic Peat Low	CV	Initial Void Ratio (e)	0.2040	0.0416	2.4941
Organic Peat Low	CV	Specific Gravity	0.2054	0.0422	2.4933

Ca Correlation for Organic Soil

High stress level

			Pearson's Correlation Coefficient	R-Squared	RMSE
Organic Peat High	Ca	Effective Overburden Pressure (ksf)	-0.8529	0.7275	0.0055
Organic Peat High	Ca	Wet Density (pcf)	-0.3162	0.1	0.0101
Organic Peat High	Ca	Dry Density (pcf)	-0.5165	0.2668	0.0091
Organic Peat High	Ca	Natural Moisture (%)	0.2064	0.0426	0.0104
Organic Peat High	Ca	Automatic Hammer Blow Count	-0.9229	0.8518	0.0041
Organic Peat High	Ca	Fines (-200) (%)	-0.9270	0.8594	0.004
Organic Peat High	Ca	Organic Content (%)	-0.3076	0.0946	0.0101
Organic Peat High	Ca	Initial Void Ratio (e)	0.4085	0.1669	0.0097
Organic Peat High	Ca	Specific Gravity	0.5550	0.308	0.0088

Mid stress level

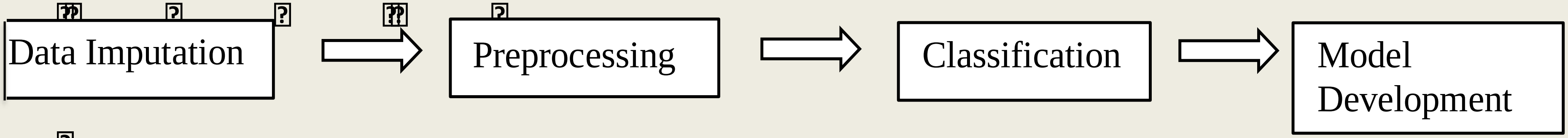
			Pearson's Correlation Coefficient	R-Squared	RMSE
Organic Peat Intermediate	Ca	Effective Overburden Pressure (ksf)	-0.3208	0.1029	0.0449
Organic Peat Intermediate	Ca	Wet Density (pcf)	-0.1939	0.0376	0.0465
Organic Peat Intermediate	Ca	Dry Density (pcf)	-0.4161	0.1731	0.0431
Organic Peat Intermediate	Ca	Natural Moisture (%)	-0.2646	0.07	0.0457
Organic Peat Intermediate	Ca	Automatic Hammer Blow Count	-0.3222	0.1038	0.0449
Organic Peat Intermediate	Ca	Fines (-200) (%)	-0.1900	0.0361	0.0466
Organic Peat Intermediate	Ca	Organic Content (%)	0.7305	0.5337	0.0324
Organic Peat Intermediate	Ca	Initial Void Ratio (e)	0.5738	0.3293	0.0388
Organic Peat Intermediate	Ca	Specific Gravity	0.6782	0.4599	0.0348

Low stress level

			Pearson's Correlation Coefficient	R-Squared	RMSE
Organic Peat Low	Ca	Effective Overburden Pressure (ksf)	-0.9487	0.9	0.0026
Organic Peat Low	Ca	Wet Density (pcf)	-0.5920	0.3505	0.0067
Organic Peat Low	Ca	Dry Density (pcf)	-0.7849	0.616	0.0051
Organic Peat Low	Ca	Natural Moisture (%)	0.5344	0.2856	0.007
Organic Peat Low	Ca	Automatic Hammer Blow Count	-0.9692	0.9394	0.002
Organic Peat Low	Ca	Fines (-200) (%)	-0.7222	0.5216	0.0058
Organic Peat Low	Ca	Organic Content (%)	-0.0224	0.0005	0.0083
Organic Peat Low	Ca	Initial Void Ratio (e)	0.7319	0.5357	0.0057
Organic Peat Low	Ca	Specific Gravity	0.4551	0.2071	0.0074

Task 5: Develop a methodology to construct the statistical Cc, Cr, Cv, and Ca models

Procedure of data analysis

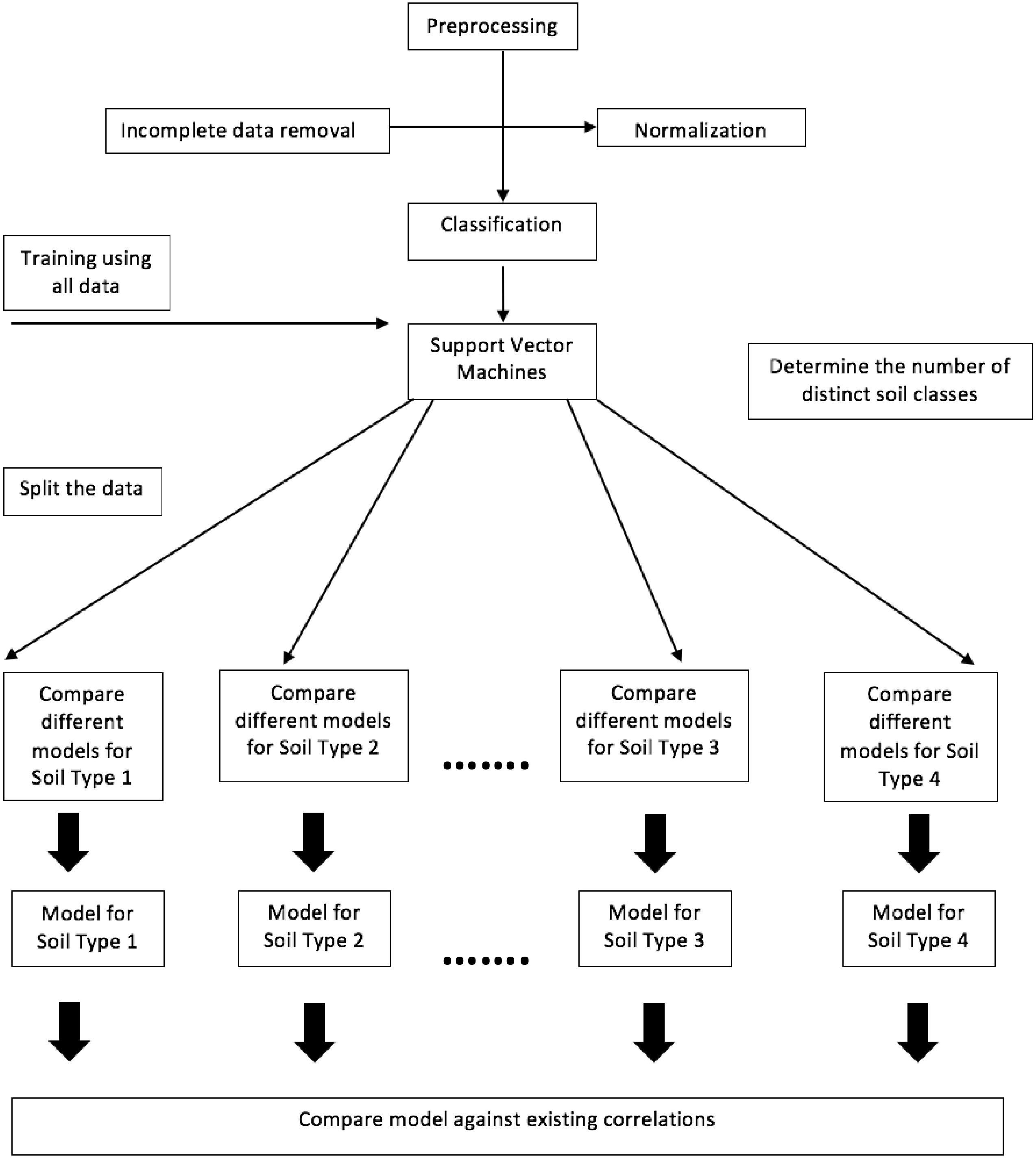


Data Imputation

Preprocessing

Classification

Model Development



Preprocessing

Incomplete data removal

Normalization

Classification

Training using all data

Support Vector Machines

Determine the number of distinct soil classes

Split the data

Compare different models for Soil Type 1

Compare different models for Soil Type 2

....

Compare different models for Soil Type 3

Compare different models for Soil Type 4

Model for Soil Type 1

Model for Soil Type 2

....

Model for Soil Type 3

Model for Soil Type 4

Compare model against existing correlations

Detailed Procedure

- Step 1: Data imputation
- Step 2: Data Preprocessing (consisting of normalization and outlier detection).
- Step 3: Identification of distinct soil types through supervised learning (Support Vector Machines).
- Step 4: Cc, Cr, Cv, and Ca model development for each soil type identified from Step 3. Development of appropriate regression models and investigation of potential interaction effects.
- Step 5: Models validation. Investigation of the ability of models to predict on data that have not been used for model development.
- Step 6: Quantification of uncertainties and estimation of confidence intervals that will quantify the predictive accuracy of the proposed models.

Data imputation

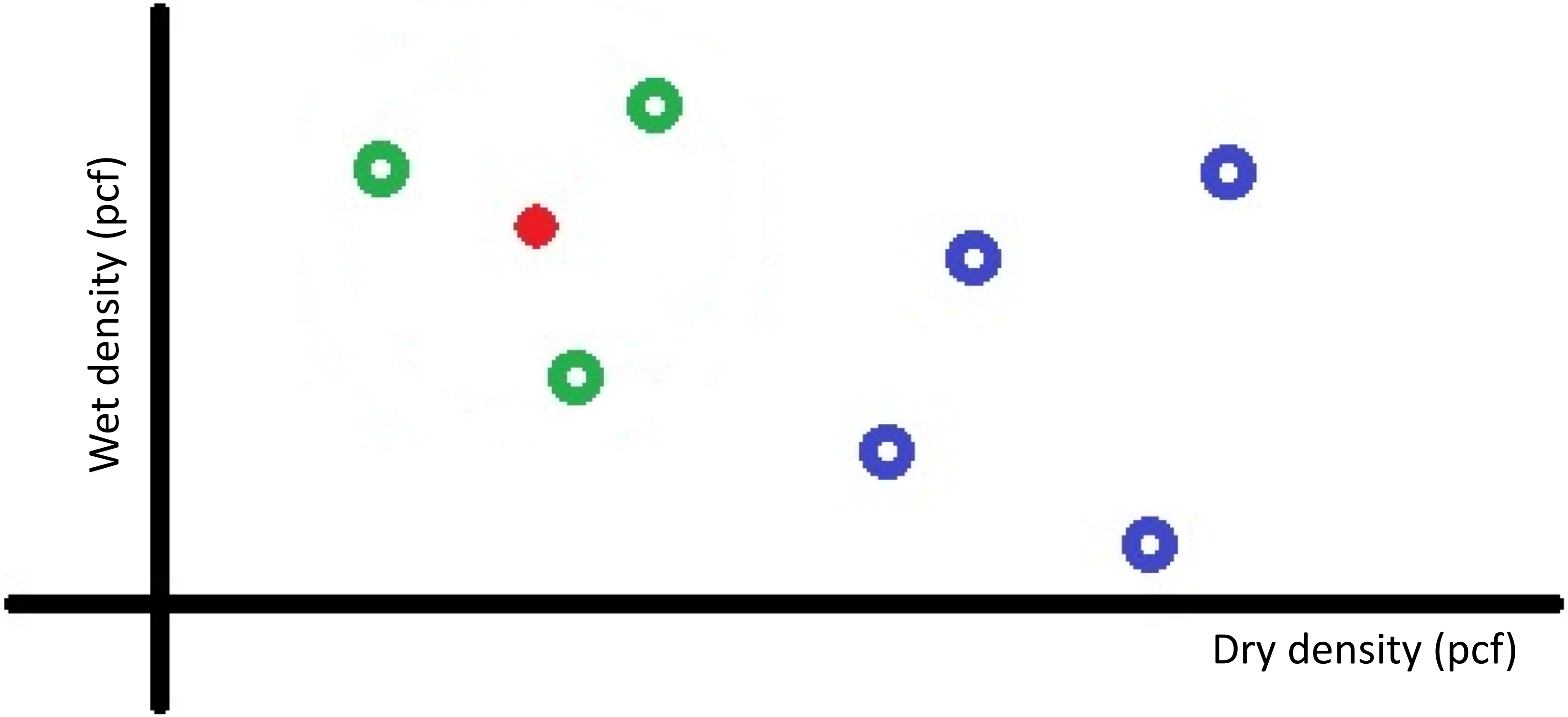


Figure 2: Illustrative example with samples that have three attributes, Wet Density, Dry Density, and Specific Gravity. Sample that appears in red is assumed to have a missing value on Specific Gravity.

Data imputation (cont.)

Table 1: Values of all samples as well as their distances to the red sample of Figure 2. The Euclidean distance formula that was used also appears in the Table.

	Specific Gravity	Wet Density (pcf)	Dry Density (pcf)	$\sqrt{(WD1-WD2)^2+(DD1-DD2)^2}$ =Euclidean Distance
Green Sample	2.71	97.0	61.0	$\sqrt{(97.0-91.2)^2+(61.0-53.0)^2}$ = 9.88
Green Sample	2.69	85.94	59.9	8.67
Green Sample	2.55	96.84	47.0	8.23
Blue Sample	1.90	88.03	95.0	42.11
Blue Sample	2.89	90.5	93.0	40.00
Blue Sample	2.20	93.9	85.0	32.11
Blue Sample	1.95	79.9	89.9	38.59
Blue Sample	2.35	78.0	91.0	40.22
Red Sample	?	91.2	53.0	

Data imputation (cont.)

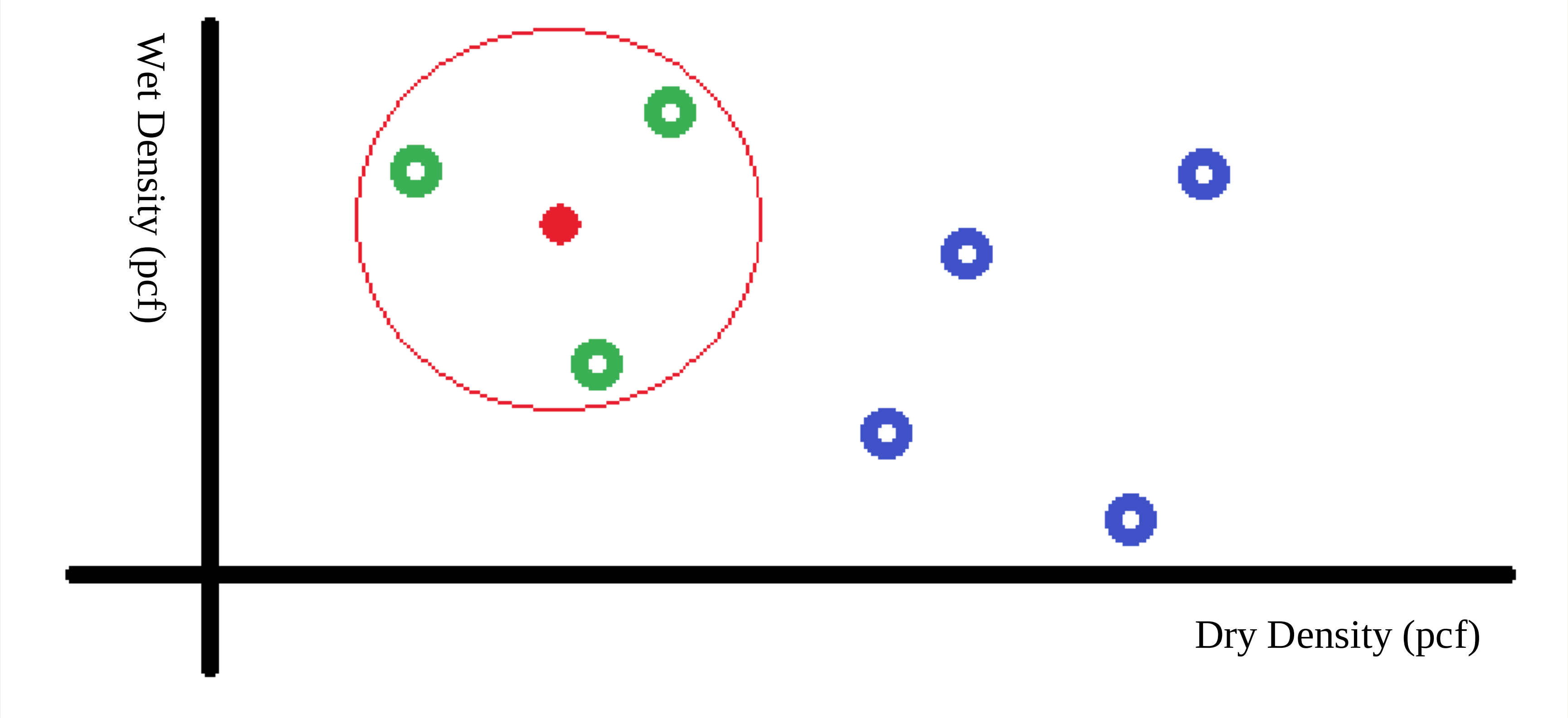


Figure 3: Illustrative example with samples that have three attributes, Wet Density, Dry Density, and Specific Gravity. Sample that appears in red is assumed to have a missing value on Specific Gravity. The missing value for Specific Gravity of the incomplete sample (red) is calculated as the result of averaging

Data imputation (cont.)

Table 2: Values of all samples as well as their distances to the red sample of Figure 3. The missing value for Specific Gravity of the incomplete sample (red) is calculated as the result of averaging the values of Specific Gravity from the three nearest neighbors that appear in bold.

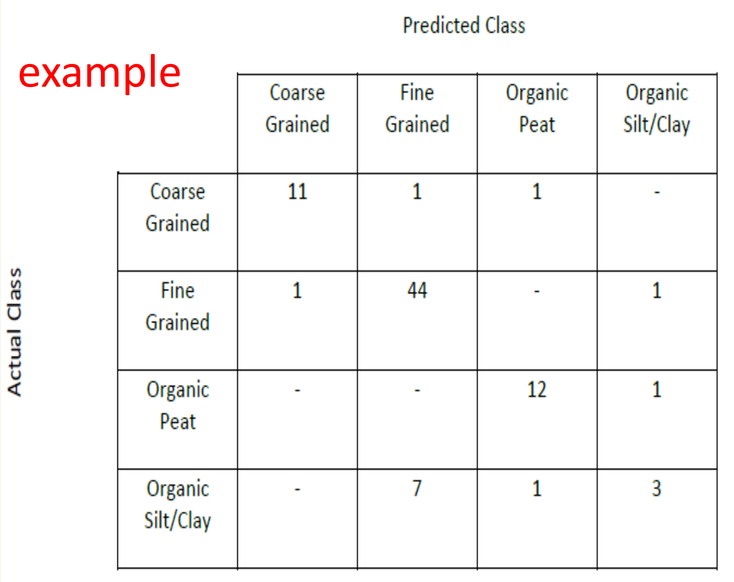
	Specific Gravity	Wet Density (pcf)	Dry Density (pcf)	Euclidean Distance
Green Sample	**2.71**	97.0	61.0	*9.88
Green Sample	**2.69**	85.94	59.9	*8.67
Green Sample	**2.55**	96.84	47.0	*8.23
Blue Sample	1.90	88.03	95.0	42.11
Blue Sample	2.89	90.5	93.0	40.00
Blue Sample	2.20	93.9	85.0	32.11
Blue Sample	1.95	79.9	89.9	38.59
Blue Sample	2.35	78.0	91.0	40.22
Red Sample	**= 2.71+2.69+2.55)/3** **= 2.65**	91.2	53.0	

Preprocessing

- Full data sets were segregated from non-full data sets. Full data sets include the following parameters: moisture content, initial void ratio, dry unit weight, wet unit weight, fines content, Atterberg limits, specific gravity, automatic hammer blow count, and overburden stress.
- Data is normalized through z-score normalization, which offers a way to compare observations that are measured on different scale. Each soil classification has a unique dimensionality due to a varying number of full data sets.

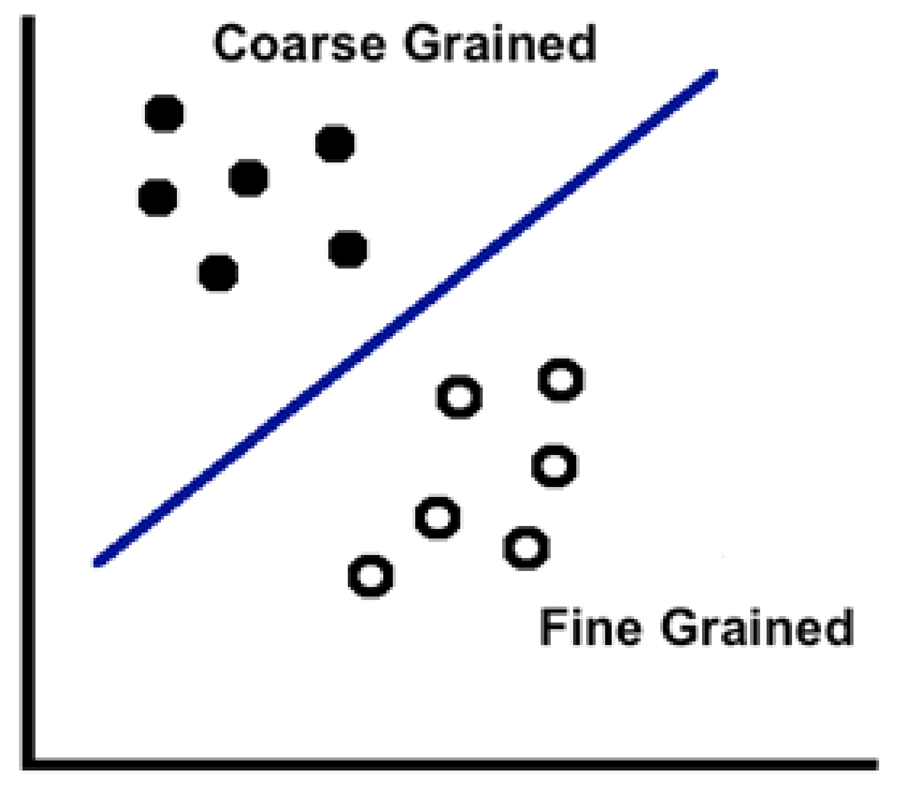
Classification

- In this stage, a classification model is developed that assists in determining the number of distinct soil groups that exists.
- The goal is to confirm or reject the hypothesis that each soil type requires a different statistical model.
- The data is comprised of two sets – training and testing. Training data is used to teach the algorithm, testing data is used to evaluate the accuracy and predictability of the model.
- The confusion matrix illustrates how well the testing data was filtered to the class that the training data predicted it would fall into.



example

		Predicted Class			
		Coarse Grained	Fine Grained	Organic Peat	Organic Silt/Clay
Actual Class	Coarse Grained	11	1	1	-
	Fine Grained	1	44	-	1
	Organic Peat	-	-	12	1
	Organic Silt/Clay	-	7	1	3



Example of data classification (e.g. classified soils group as coarse and fine grained)

Preliminary Analyses

Notes:

- Data were filtered because many reports use the soil classification based on visual check in the field.
- The assumed classes are CH, CL, MH, OH, OL, Pt.
- The SVM confirms that the assumed classes are valid.
- A regression model was developed with interactions for each distinct group/class.

Preliminary Results for the Regression Analyses

Cc models

Equation	Soil type	R^2	R^2_{adj}	RMSE
C_c = -0.0935 -0.0097 * Automatic Hammer Blow Count + 0.0013 * Liquid Limit (LL) + 0.5438 * eo -0.0884 * Gs -0.0002 * [(Automatic Hammer Blow Count-5.5505)*(Liquid Limit (LL)-105.48)] -0.3081 * [(eo-1.87194) * (Gs-2.63074)]	CH	0.7856	0.7808	0.3352
C_c = -0.0380 + 0.0096 * Effective Overburden Pressure (ksf) + 0.0006 * Natural Moisture (%) -0.00007 * [(Natural Moisture (%) - 41.0916)*(Natural Moisture (%)-41.0916)]-0.0001 * Fines (-200) (%) + 0.00008 * [(Fines (-200) (%)-65.8702)*(Fines (-200) (%)-65.8702)] -0.0008 * Liquid Limit (LL) + 0.0001 * [(Liquid Limit (LL)-39.0571)*(Liquid Limit (LL)-39.0571)] + 0.0354 * eo	CL	0.9299	0.9046	0.0169
C_C = 2.6079 -0.1255 * Effective Overburden Pressure (ksf) -0.0409 * Dry Density (pcf) -0.0255 * Natural Moisture (%) + 0.0104 * Fines (-200) (%) + 0.0134 * Liquid Limit (LL) + 0.0467 * OC (%)	MH	0.9674	0.9396	0.1161
C_C = 2.0373 -0.0062 * Fines (-200) (%) - 0.0101 * OC (%) + 0.0045 * PI + 0.4757 * eo - 0.7941 *Gs - 0.00006 * [(Fines (-200) (%) - 73.8544)*(OC (%)-22.5399)] - 0.0011 * [(PI-81.8785)*(eo-2.9381)] - 0.1205 * [(eo-2.9381)*(Gs-2.3313)]	OH	0.8513	0.8343	0.3807
C_C = -0.4802 + 0.1076 * Automatic Hammer Blow Count + 0.0106 * OC (%) + 0.2488 * eo + 0.0033 * [(OC (%)-15.15)*(OC (%)-15.15)]	OL	0.9278	0.9086	0.2254
Cc = 6.1799 -0.0936 * Wet Density (pcf) -0.0011 * Natural Moisture (%) + 0.5869 * eo -0.0004 * [(Wet Density (pcf)-64.3413)*(Natural Moisture (%) -481.673)] + 0.026 * [(Wet Density (pcf)-64.3413)*(eo-7.69917)]	PT	0.8206	0.7992	1.1861

Preliminary Results for the Regression Analyses (cont.)

Cr models

Equation	Soil type	R^2	R^2_{adj}	RMSE
C_r = -1.5942 -0.029 * Effective Overburden Pressure (ksf) -0.0092 * Automatic Hammer Blow Count + 0.0015 * Fines (-200) (%) + 0.0025 * Liquid Limit (LL) - 0.001 * OC (%) + 0.5119 * Gs	MH	MH	0.9992	0.9977
C_r = 0.3100 * + 0.0459 * Effective Overburden Pressure (ksf) -0.0081 * Automatic Hammer Blow Count -0.0006 * Fines (-200) (%) - 0.00006 * Liquid Limit (LL) -0.0033 * OC (%) + 0.0008 * PI + 0.0812 * eo - 0.1472 * Gs - 0.01175 * [(Effective Overburden Pressure (ksf)-1.48643)*(Automatic Hammer Blow Count-3.05006)] + 0.0029 * [(Effective Overburden Pressure (ksf)-1.48643)*(OC (%)-21.6517)] - 0.00002 * [(Fines (-200) (%)-72.7234)*(PI-83.18)] - 0.00003* [(Liquid Limit (LL)-150.138)*(OC (%)-21.6517)] -0.0036 * [(OC (%)-21.6517)*(Gs-2.34662)] + 0.00007 * [(PI-83.18)*(eo-2.96471)]	OH	0.7731	0.7153	0.0751
Cr = 0.0654 + 0.0294 * Effective Overburden Pressure (ksf) + 0.0036 * Dry Density (pcf) - 0.0001 * Fines (-200) (%) + 0.0502 * eo - 0.1353 * Gs - 0.0856 * [(Effective Overburden Pressure (ksf)-1.015)*(Gs-2.343)] + 0.00005 * [(Dry Density (pcf)-50.45)*(Fines (-200) (%)-63.4)]	OL	0.9990	0.9956	0.0026
Cr = 0.0654 + 0.0294 * Effective Overburden Pressure (ksf) + 0.0036 * Dry Density (pcf) - 0.0001 * Fines (-200) (%) + 0.0502 * eo - 0.1353 * Gs - 0.0856 * [(Effective Overburden Pressure (ksf)-1.015)*(Gs-2.343)] + 0.00005 * [(Dry Density (pcf)-50.45)*(Fines (-200) (%)-63.4)]	OL	0.9990	0.9956	0.0026

Task 6: Develop the soil compressibility prediction models for specific soil types (under development)

- With the framework developed in Task 5, the models to be developed include:
  - Cc, Cr, Cv, and Cα models
- Soil types to be considered:
  - Cc and Cr models:
    - Soil types: CH, CL, MH, OH, OL, Pt
  - Cv and Ca models:

Task 7: Evaluate the relationship with field tests (under development)

- Evaluate the relationship between field tests (CPT if any) and the soil compressibility, especially with highly compressible soils.
  - correlation of the compressibility (Cc and Cr) and CPT tip resistance will be then investigated.
  - A lack of data => Additional CPT tests at selected sites (***under work***)

Preliminary Plan

1. Review consolidation reports for locations which may be accessible for additional CPTus with minimal GSE change from date of original Shelby tube removal.
2. Identify target layer and penetration depth.
3. Perform <u>3 CPTs</u> per consolidation test. Each with a dissipation test at same elevation as consolidation test.
4. Develop correlations between CPT data and soil compressibility.

Proposed Locations for Additional CPT testing

1. FCX outer beltway –Greencove springs (D2)
2. 301 Bypass –Stark FL (D2)
3. FCX North Cecil –NewWorld Ave (D2)
4. SR415 –Volusia Co. (D5)

Challenges

- Very rare to find consolidation test reports performed at locations where there is no current-day structure..
- CPT Truck accessibility major limitation to determine locations
- Any additional locations with Consolidation Data would be greatly appreciated ☺

Thank you!

Question?