Iowa State University
Dept. of Civil, Construction & Envr. Engineering

WISCONSIN
UNIVERSITY OF WISCONSIN–MADISON
Dept. of Civil & Envr. Engineering

Determining Pavement Design Criteria for Recycled Aggregate Base and Large Stone Subbase

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RESEARCH TEAM

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NRRA Members (Agency Partners)

- MnDOT
- Caltrans
- MDOT
- Illinois DOT
- LRRB
- MoDOT
- WiscDOT

NRRA Members (Industry Partners)

- Aggregate and Ready Mix
  (Association of MN)
- APA
- Braun Intertec
- CPAM
- Diamond Surface Inc
- Flint Hills Resources
- IGGA
- MIDSTATE
  (Reclamation and Trucking)
- MN Asphalt Pavement Association
- Minnesota State University
- NCP Tech Center
- Road Scanners
- University of Minnesota-Duluth
- University of New Hampshire
- MATHY
- 3M
- Paviasystems
- Michigan Tech
- University of Minnesota
- NCAT
- GSE Environmental
- HELIX
- Ingios
- WSB
- Cargill
- PITT Swanson Engineering
- INFRASENSE
- Collaborative Aggregates LLC
- American Engineering Testing, Inc.
- CTIS
- ARRA
- 1st
- O-BASF
- North Dakota State University
- All States Materials Group

OUTLINE

- Literature Review
  - Shear Strength
  - Stiffness
  - Permanent Deformation
  - Creep
  - F-T & W-D Durability
- Permeameter Data Analysis
- LWD Data Analysis
- DCP Data Analysis

LITERATURE REVIEW

- **Introduction**
  - Pavement Systems
  - Recycled Materials in Pavements
  - Large-Size Natural Materials in Pavements
  - Geosynthetic Applications
  - Research Motivation/General Purposes
- **Engineering Properties**
  - Gradation
  - Compaction
  - Hydraulic Conductivity
  - Strength (CBR & LBR)
  - Shear Strength
  - Stiffness (Mr)
  - Permanent Deformation
  - Creep Deformation
  - F-T & W-D Durability
  - Temperature Effects
  - Impurities
  - Geosynthetics
- **Environmental Properties**
  - pH Characteristics & Alkalinity
  - Leaching Characteristics
- **Design Methods**
- **Construction Specifications & Practices**
- **Conclusions**

Design Methods

- AASHTO 1993
- MEPDG Design

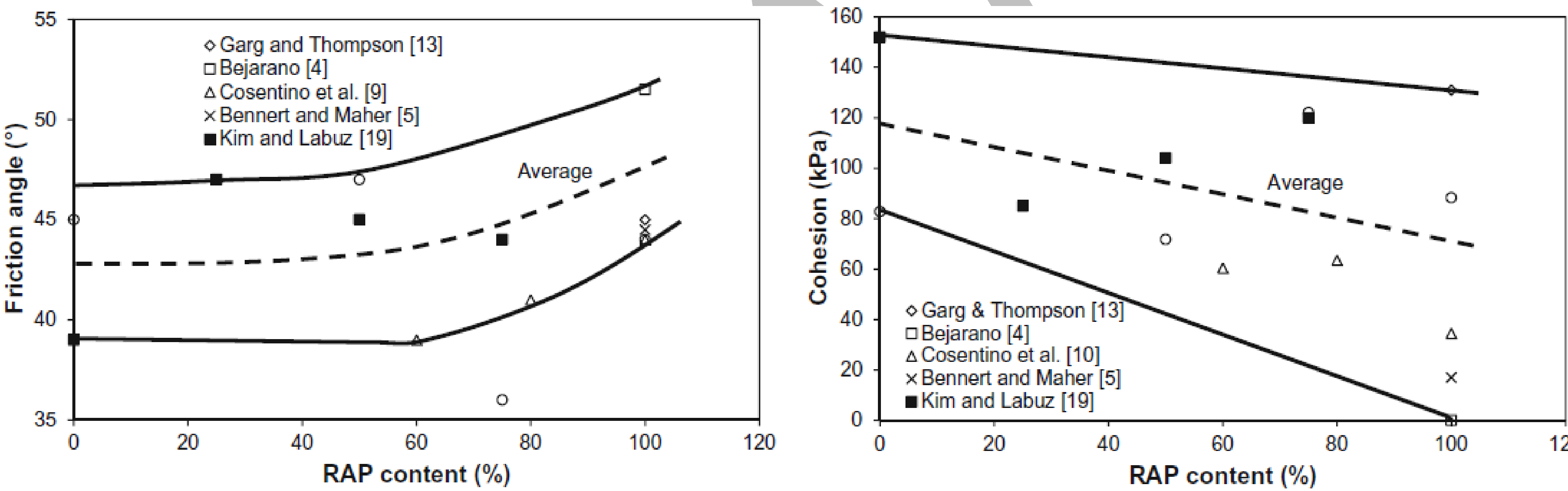
Construction Specifications & Practices

- MnDOT
- CalTrans
- MDOT
- MoDOT
- IDOT
- WisDOT

LITERATURE REVIEW

Shear Strength

- RAP & RCA ≤ Natural dense-graded aggregate *(LRRB 2016)*
- RAP content ↑, shear strength ↓ *(McGarrah 2007)*
- Shear strength of RCA ↑ with time *(Edil et al. 2012)*



(a) *Friction angle versus RAP content*　　(b) *Cohesion versus RAP content*

Fig. 6 Effect of RAP content on shear strength parameters of the RAP-aggregate blends

(Thakur and Han 2015)

LITERATURE REVIEW

Stiffness

- RAP & RCA content ↑, M_r ↑ *(LRRB 2016; Bennert et al. 2000)*
- RCA angularity ↑, M_r ↑ *(Edil et al. 2012; Stolle et al. 2009)*
- Rough RCA surface texture, M_r ↑ *(FHWA 2008)*
- Rehydration of cement

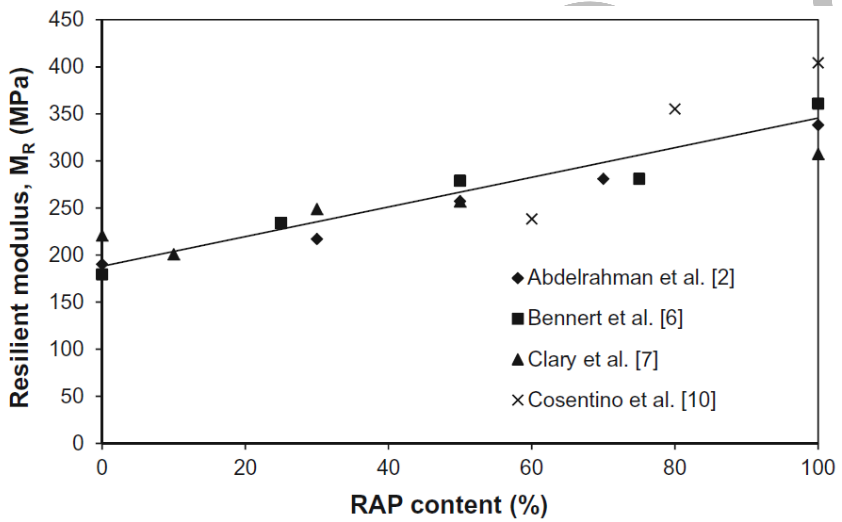


Fig. 2 Resilient modulus versus RAP content for the RAP-aggregate blends at bulk stress of 345 kPa

(Thakur and Han 2015)

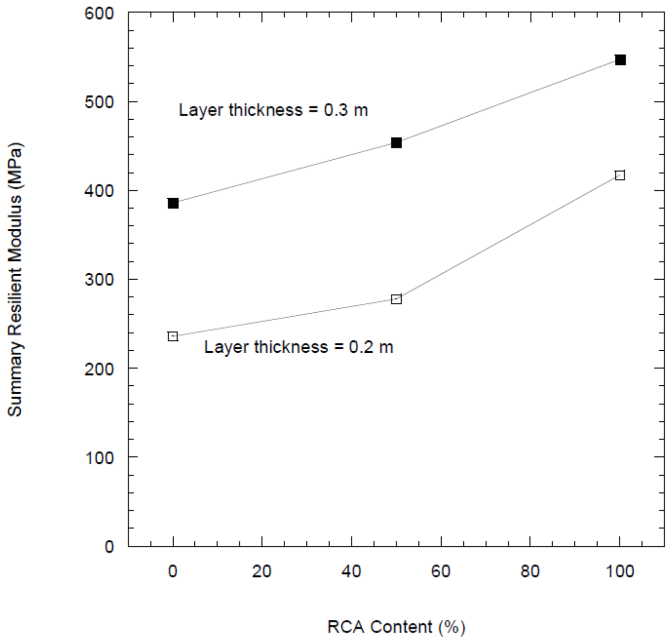


Figure 4.27 Summary Resilient Modulus versus RCA Content for RCA, Blended RCA/Class 5, and Class 5

(Edil et al. 2012)

LITERATURE REVIEW

Permanent Deformation

- Least deformation ➔ RCA *(LRRB 2016; Edil et al. 2012)*
- RAP content ↑, deformation ↑ *(Kim and Labuz 2007)*
- Progressive breakdown *(Bennert et al. 2000)*

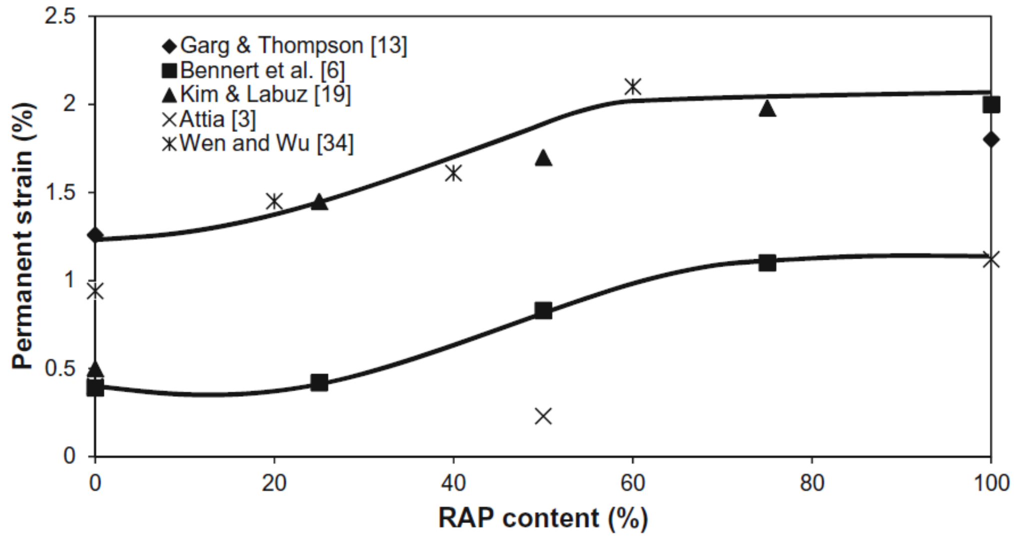


Fig. 10 Effect of RAP content on the permanent deformation of the RAP-aggregate blend

(Thakur and Han 2015)

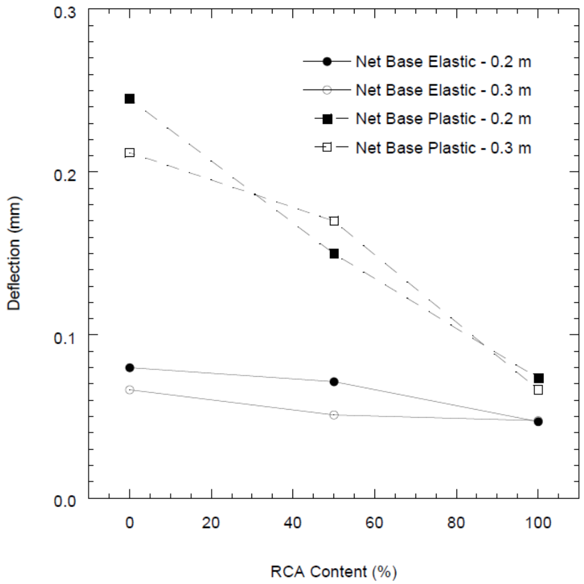


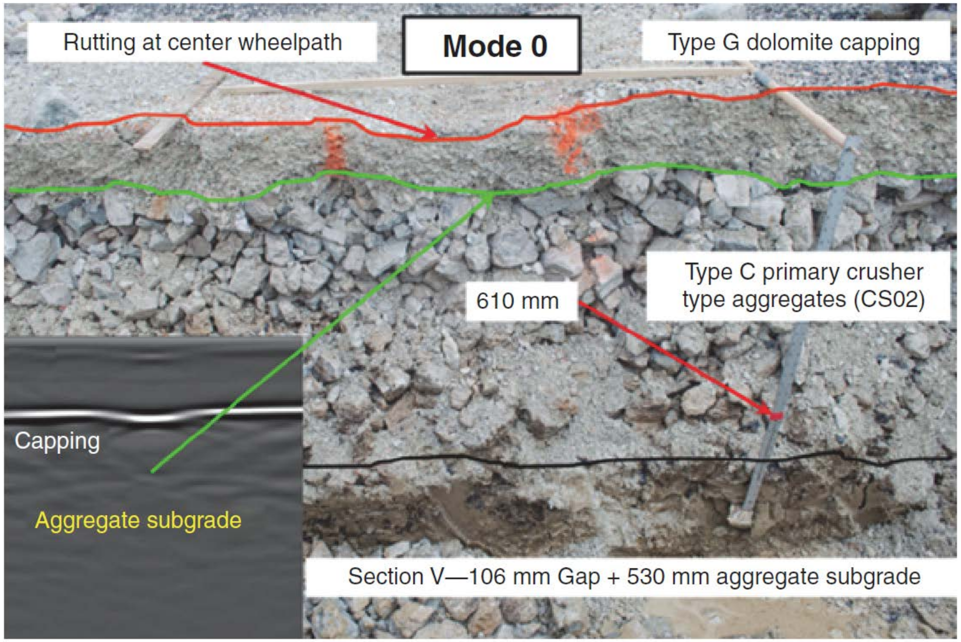
Figure 4.16 Comparison of Net Base Elastic and Net Base Plastic Deformations versus RCA Content for RCA, Blended RCA/Class 5, and Class 5

(Edil et al. 2012)

LITERATURE REVIEW

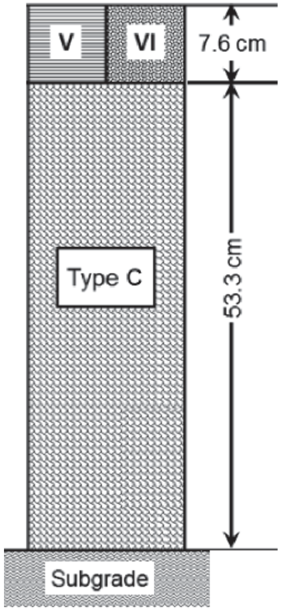
Permanent Deformation

- Type C ➔ 3-6” aggregates *(Kazmee et al. 2016)*
- Mobilization of large aggregates
- Open-graded large-size aggregates ➔ large voids
  particle movement
  reorientation



(Kazmee et al. 2016)

Red ➔ *Surface*
Green ➔ *Aggregate subgrade*
Black ➔ *Engineered subgrade*



LITERATURE REVIEW

Creep Deformation

- RAP ➔ high creep potential *(Thakur and Han 2015)*
- RAP content ↑, creep deformation ↑ *(Cosentino et al. 2003)*
- RAP + soil mixture ➔ creep control *(Cosentino et al. 2003)*

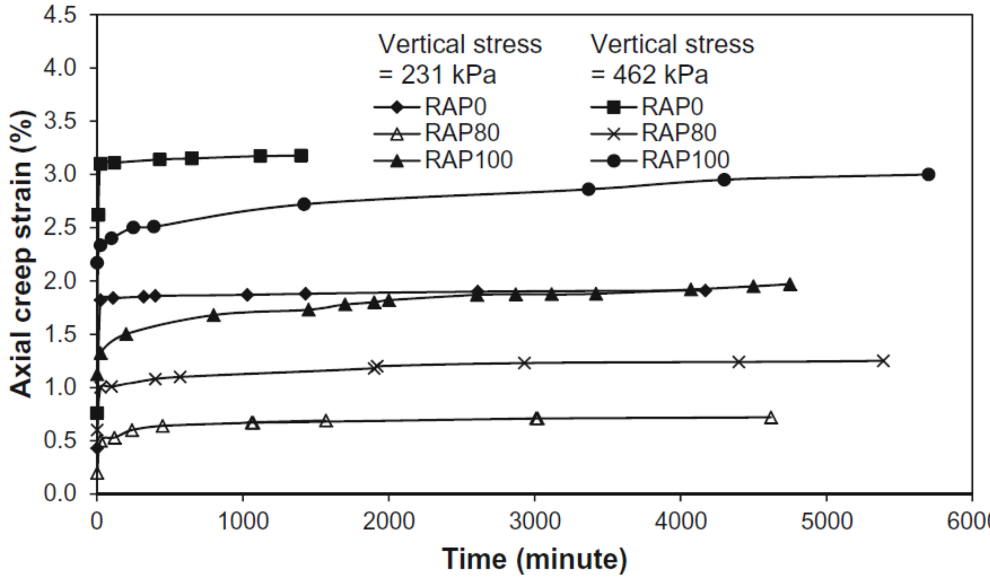


Fig. 14 Effect of RAP content and vertical stress on the creep behavior of the RAP-soil blends (redrawn and modified from Cosentino et al. [10])

(Thakur and Han 2015)

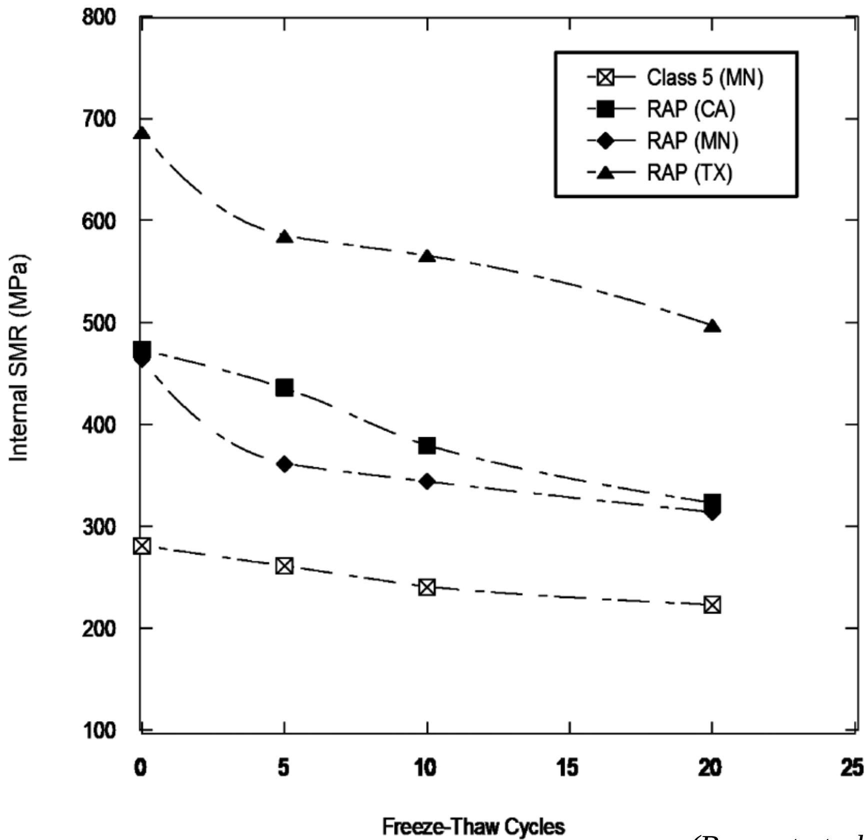
LITERATURE REVIEW

Freeze-Thaw Durability

- RAP ➔ more stable after 5 F-T cycles *(Bozyurt et al. 2013)*
- RAP SRM still > Class 5
- M_r may increase

  Water loss due to hydrophobicity

  (Attia and Abdelrahman 2010)

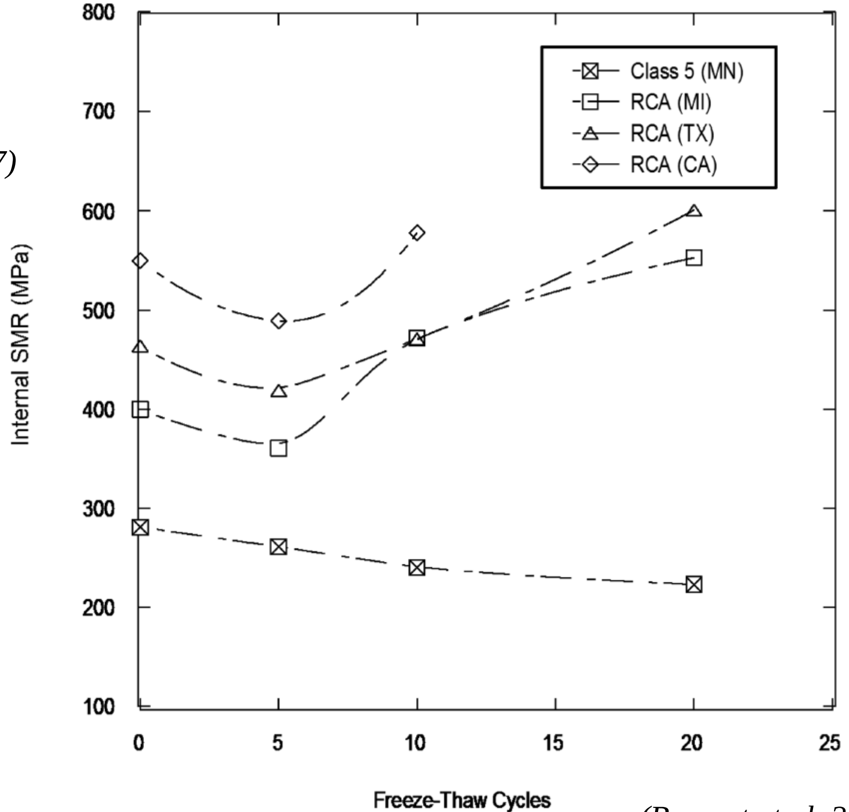


(Bozyurt et al. 2013)

LITERATURE REVIEW

Freeze-Thaw Durability

- RCA ➔ increase after 5 cycles *(Bozyurt et al. 2013)*
- Self-cementing *(Poon et al. 2006)*
- Fine generation over time
- Porosity ↑, F-T effect ↓ *(Rosa et al. 2017)*



(Bozyurt et al. 2013)

LITERATURE REVIEW

Wet-Dry Durability

- RAP & RCA ➔ Higher Micro-Deval losses than Class 5 *(Bozyurt 2011)*
- Loss of fines ➔ to the bottom
- W-D cycles ↑, fine content ↑

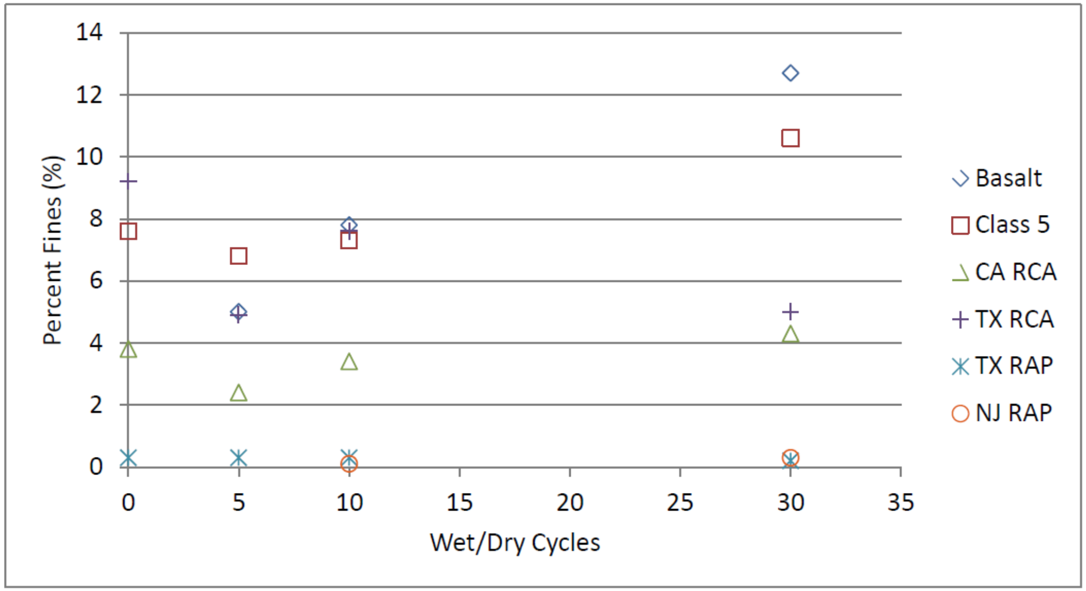


Figure 5.40 Percent Fines at Varying Wet/Dry Cycles

(Edil et al. 2012)

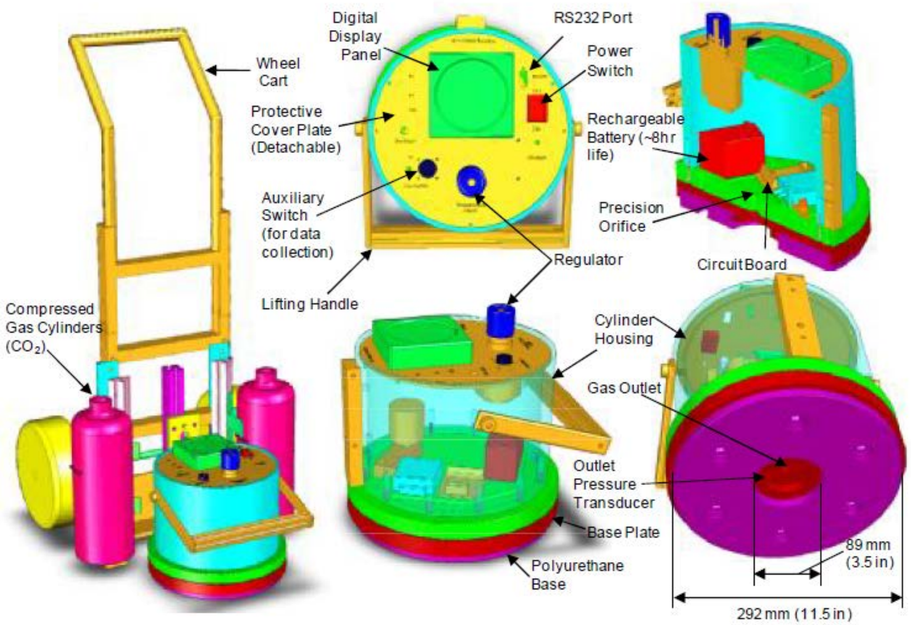
- RAPs were more intact
  - Cohesion
  - Asphalt at 50°C

(Edil et al. 2012)

PERMEAMETER DATA ANALYSIS

Concept *(White et al. 2010)*

- Variability of in-situ permeability – up to 400%
- Gas permeameter test (GPT)
- Rapid (< 30 sec) and portable (16 kg)
  - Self-contained pressurized gas system
  - Self sealing base plate



PERMEAMETER DATA ANALYSIS

Concept *(White et al. 2010)*

$$K_{gas} = \left[\frac{2\mu_{gas} Q P_1}{r\, G_o \left(P_1^{\,2} - P_2^{\,2}\right)}\right]$$

$$K_{rg} = (1 - S_e)^2 \left(1 - S_e^{((2+\lambda)/\lambda)}\right)$$

$$K_{sat} = K_{gas} \times \frac{\rho\, g}{\mu_{water} K_{rg}}$$

$$\Rightarrow K_{sat} = \left[\frac{2\mu_{gas} Q P_1}{r\, G_o \left(P_1^{\,2} - P_2^{\,2}\right)}\right] \times \frac{\rho\, g}{\mu_{water} (1 - S_e)^2 \left(1 - S_e^{((2+\lambda)/\lambda)}\right)}$$

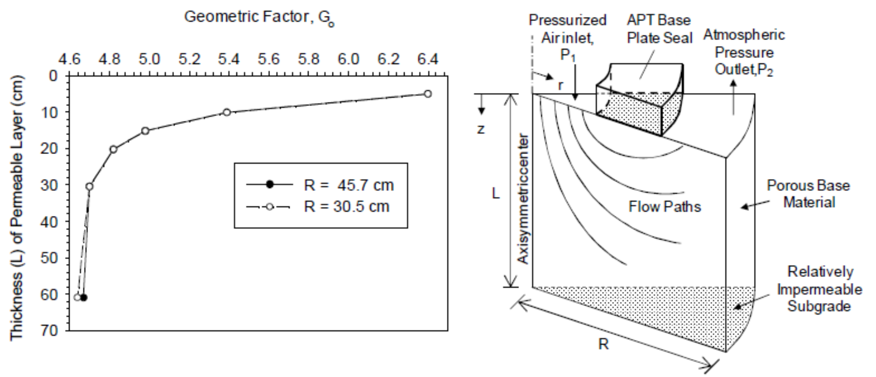


FIGURE 7 Graph to determine the geometric factor G_o for K_{sat} calculation

Where;

K_{sat} = saturated hydraulic conductivity (cm/s)
K_{gas} = gas permeability
K_{rg} = relative permeability to gas
μ_{gas} = kinematic viscosity of the gas (PaS)
Q = volumetric flow rate (cm^3/s)
P_1 = absolute gas pressure on the soil surface;
$[P_1 (Pa) = P_{o(g)}$ (mm of H_2O) x 250 + 101325]
$P_{o(g)}$ = gauge pressure at the orifice outlet (mm of H_2O)
P_2 = atmospheric pressure (Pa)
r = radius at the outlet (4.45 cm)
G_o= Geometric factor (dimensionless factor see Figure 7)
S_e = effective water saturation [$S_e = (S – S_r)/(1-S_r)$]
λ = Brooks-Corey pore size distribution index
S_r = residual water saturation
S = water saturation
ρ = density of water (g/sm^3)
g = acceleration due to gravity (cm/s^2)
μ_{water} = absolute viscosity of water (gm/cm-s)

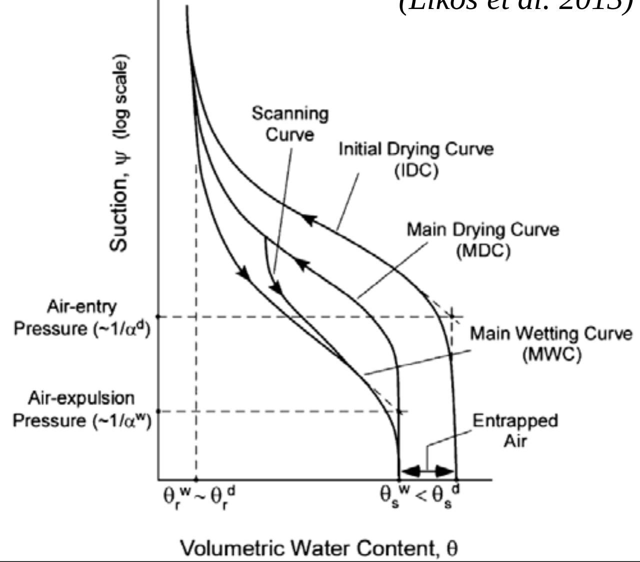
PERMEAMETER DATA ANALYSIS

Concept *(White et al. 2010)*

- S ➔ from in-situ dry unit weight and moisture content
- S_r and λ ➔ from soil water characteristic curves (SWCC)
- SWCC ➔ need to know gradation

$$\theta_w = C(h) \times \left[\frac{\theta_{sat}}{\left[\ln\left[2.7183 + \left(\frac{\psi}{a_f} \right)^{b_f} \right] \right]^{c_f}} \right] \quad \text{with } C(h) = \left[1 - \frac{\ln\left(1 + \frac{\psi}{\psi_r} \right)}{\ln\left(1 + \frac{1.45 \times 10^5}{\psi_r} \right)} \right]$$

(Likos et al. 2013)



- a_f, b_f, c_f, and ψ_r ➔ SWCC curve fitting parameters correlated with material gradation properties

- SWCC parameters were derived and then S_r and λ values were calculated using the Brooks and Corey *(*35*)* approach.

PERMEAMETER DATA ANALYSIS

Concept *(White et al. 2010)*

- Typical S_r and λ values (alternative)

TABLE 2 Summary of residual saturation and pore size distribution index values reported in the literature and typical values calculated using equations 6 to 18 for granular materials

Material Type or USCS Classification	Residual Saturation (S_r)	Pore Size Distribution Index, λ	Reference
Touchet Silt Loam	18 to 22	1.02 to 1.70	
Columbia Sandy Loam	18 to 22	1.27 to 1.70	*(43)*
Unconsolidated Sand	8 to 9	4.02 to 4.75	
Volcanic sand	16	2.29	
Fine sand	17	3.7	*(35)*
Glass beads	9	7.3	
Natural Sand Deposits	—	4	*(44)*
Crushed Granite	—	0.33 to 0.36	
Crushed Shale	—	0.23 to 0.27	*(36)*
Crushed Limestone	—	0.22 to 0.31	
Range of values for typical filter materials and open graded bases *(45)*			Calculated using equations 6 to 18
SW (Filter Materials)	10 to 11	0.65 to 2.15	
SP (Filter Materials)	10	11.15	
GP (Open Graded Bases)	1 to 2	17.26 to 18.20	
Range of values determined for granular materials used in this study			Calculated using equations 6 to 18
SP	10	2.20 to 4.08	
SW-SM	11	0.54	
GP	2 to 5	3.65 to 4.62	
GP-GM	11 to 15	0.59 to 0.98	

PERMEAMETER DATA ANALYSIS

Data Analysis

SAMPLE DATA SHEET

Date:	08.01.2017		
Location:	185-0		
Test Number:	A		
Orifice:	GPT(B)		
Material:	5QC		

GPT(A) – orifice diameter = 2982.00 μm
GPT(B) – orifice diameter = 870.95 μm
GPT(C) – orifice diameter = 293.66 μm
GPT(D) – orifice diameter = 149.41 μm

Initial Values:

Initial P1:	0.00	PSIG	(1)
Initial P2:	0.00	inches of H_2O	(2)
Initial Q:	0.00	CFH	(3)

GPT Readings:

Gas Used:	Air		
GPT orrifice dia:	870.95	μm	

1st Reading				Corrected 1st Reading			
P1:	80	PSIG	(4)	P1:	80	PSIG	(7) =(4)-(1)
P2:	3.89	inches of H_2O	(5)	P2:	3.89	inches of H_2O	(8) =(5)-(2)
Q:	1083	CFH	(6)	Q:	1083	CFH	(9) =(6)-(3)
2nd Reading				Corrected 2nd Reading			
P1:	40	PSIG	(10)	P1:	40	PSIG	(13) =(10)-(1)
P2:	3.89	inches of H_2O	(11)	P2:	3.89	inches of H_2O	(14) =(11)-(2)
Q:	622	CFH	(12)	Q:	622	CFH	(15) =(12)-(3)
3rd Reading				Corrected 3rd Reading			
P1:	20	PSIG	(16)	P1:	20	PSIG	(19) =(16)-(1)
P2:	2.81	inches of H_2O	(17)	P2:	2.81	inches of H_2O	(20)=(17)-(2)
Q:	390	CFH	(18)	Q:	390	CFH	(21) =(18)-(3)
4th Reading				Corrected 4th Reading			
P1:	10	PSIG	(22)	P1:	10	PSIG	(25) =(22)-(1)
P2:	1.83	inches of H_2O	(23)	P2:	1.83	inches of H_2O	(26) =(23)-(2)
Q:	264	CFH	(24)	Q:	264	CFH	(27) =(24)-(3)

Develop P2 vs. Q relationship and determine Q at a desired P2 value.
[For example, P2 = 1 in of H_2O]

P2:	1.00	inches of H_2O	(28)
Q:	-44.07	CFH	(29)

Density and Layer Thickness Measurements:

Dry Density, γ_d:	105.51	pcf	(30)
Moisture, w:	0.089	in decimals	(31)
Sp.Gr., G_s:	2.7		(32) Assume 2.70 if unknown
Saturation, S:	0.40		(33) =[(32)*(31)]/{[(32)*62.4/(30)]-1}
Thickness, L:	30.48	cm	(34)

K_{sat} Calculation Parameters:

μ_{gas}:	1.83E-05	Pas	(35) (CO_2: 1.48E-05, Air: 1.83E-05, Nitrogen: 1.78E-05)
P_1:	101575	Pa	(36) = (28)*250+101325
P_2:	101325	Pa	(37)
Q:	-346.6	cm^3/s	(38) =(29)*7.86579
r:	4.45	cm	(39)
G_0:	4.7		(40) Determine using Figure 2 based on (34)
ρ:	1	g/cc	(41)
μ_{water}:	0.01	g/cm-s	(42)
g:	981	cm/s^2	(43)
S_r:	0.035		(44) Determine based on soil type from Table 2
S_e:	0.38		(45) =[(33)-(44)]/[1-(44)]
λ:	4.135		(46) Determine based on soil type from Table 2

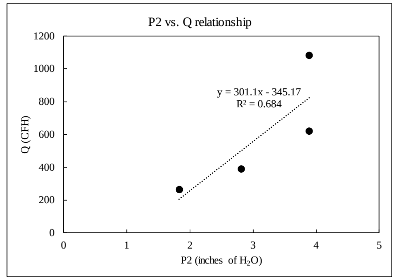
K_{sat} Calculation:

K_{sat}:	-0.41	cm/s	(47)
K_{sat}:	-1158.1	ft/day	(48) =(47)*2834.6

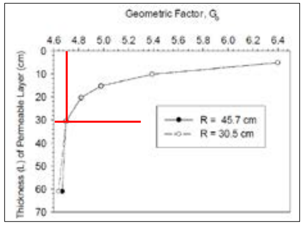
$$K_{sat} = \left[\frac{2\mu_{gas} Q P_1}{r G_o \left(P_1^2 - P_2^2\right)}\right] \times \frac{\rho g}{\mu_{water}\left(1-S_e\right)^2\left(1-S_e^{(2+\lambda)/\lambda}\right)}$$

185-0 (A)	Wet Density, γ_m (pcf)	Moisture, w (%)	Dry Density, γ_d (pcf)
Base	114.9	8.9	105.51
		0.089	

	P2 (inches of H_2O)	Q (CFH)
1st Reading	3.89	1083
2nd Reading	3.89	622
3rd Reading	2.81	390
4th Reading	1.83	264



	in	cm
Thickness	12	30.48



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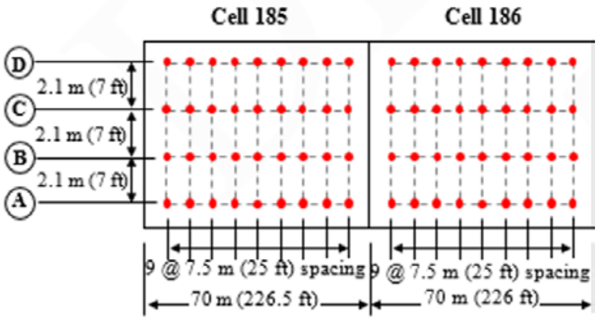
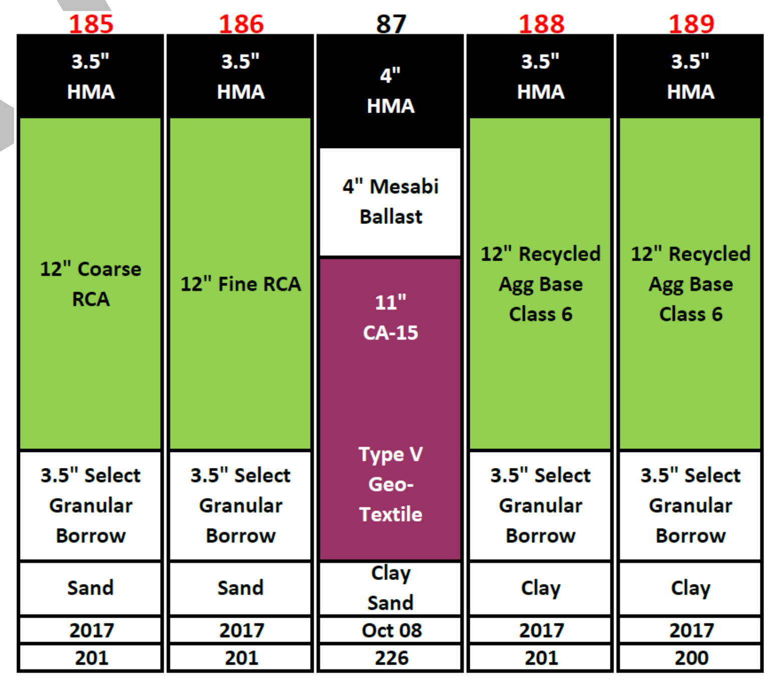


PERMEAMETER DATA ANALYSIS

Data Analysis

Cell		Saturated Hydraulic Conductivity (cm/s) - 08.01.2017							
		-0	-25	-50	-75	-100	-125	-150	-175
185	A	-0.41	1.27	-	6.76	2.89	-	3.91	3.57
	B	2.72	4.88	13.36	14.07	62.54	24.28	4.86	4.58
	C	4.36	1.51	11.16	4.36	18.38	5.17	0.68	-1.87
	D	3.97	1.29	2.83	11.86	11.64	5.44	-85.3	-1.5

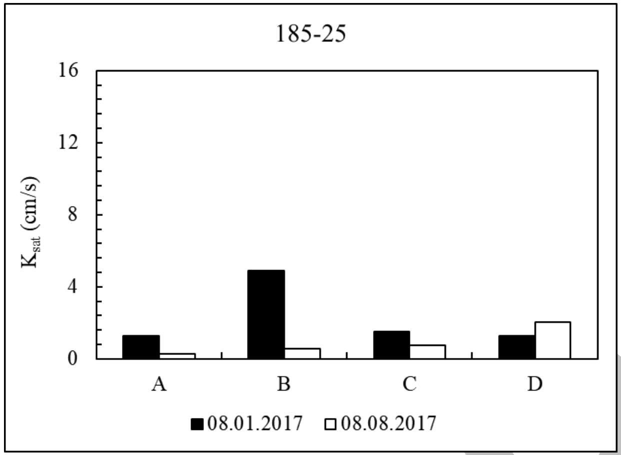
Cell		Saturated Hydraulic Conductivity (cm/s) - 08.08.2017		
		+25	+50	+75
185	A	0.25	0.42	0.42
	B	0.57	1.05	0.97
	C	0.74	3.25	0.77
	D	2.04	2.26	3.2
186	A	0.68	0.57	0.46
	B	0.58	0.38	0.25
	C	0.36	0.25	0.83
	D	0.71	0.28	0.46
188	A	0.46	0.17	0.26
	B	0.36	0.28	0.75
	C	0.17	0.1	0.75
	D	0.41	0.31	0.51
189	A	0.57	2.33	2.52
	B	0.32	0.91	5.92
	C	0.6	1.22	1.53
	D	0.29	0.29	0.48

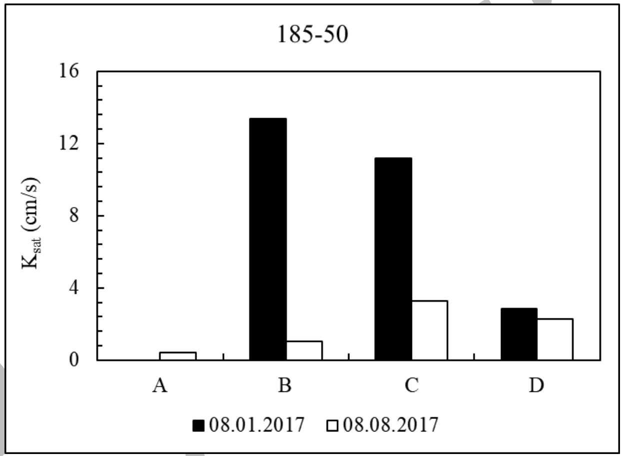


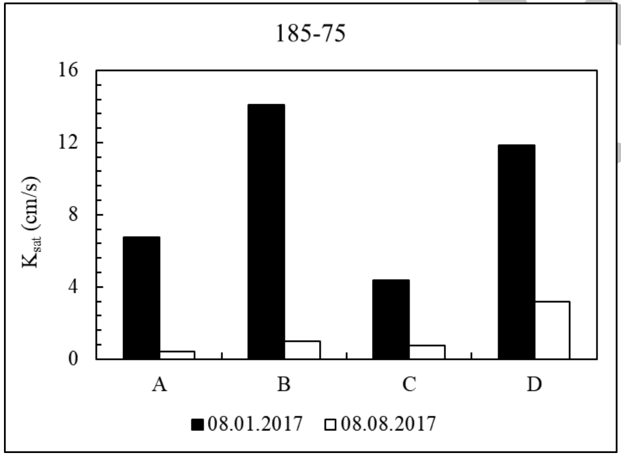
PERMEAMETER DATA ANALYSIS

Data Analysis

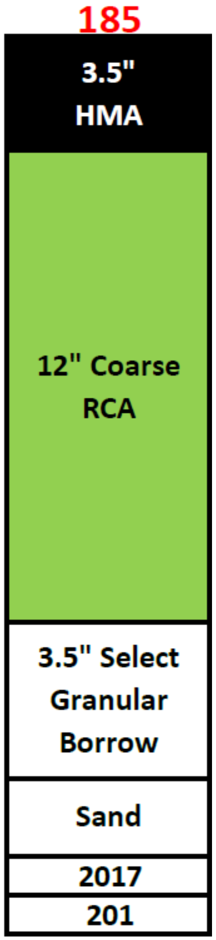
Effect of Compaction







- Same dry density and moisture content values were used for before-after compaction condition.
- More info is needed.



LWD DATA ANALYSIS

Concept *(Vennapusa and White 2009)*

$$E = \frac{(1-\nu^2)\sigma_0 a}{d_0} f$$

where:

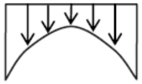
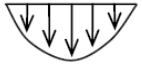
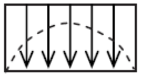
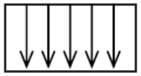
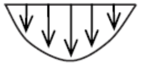
- E = elastic modulus (MPa),
- d_0 = measured settlement (mm),
- ν = Poisson's ratio,
- σ_0 = applied stress (MPa),
- a = radius of the plate (mm), and
- f = shape factor depending on stress distribution (see Table 1).

$$F = \sqrt{2mghC}$$

where:

- F = Applied force (N),
- m = mass of falling weight (kg),
- g = acceleration due to gravity, 9.81 (m/s^2),
- h = drop height (m), and
- C = material stiffness constant (N/m).

TABLE 1—*Summary of shape factors in E_{LWD} estimation (Terzaghi and Peck 1967; Fang 1991).*

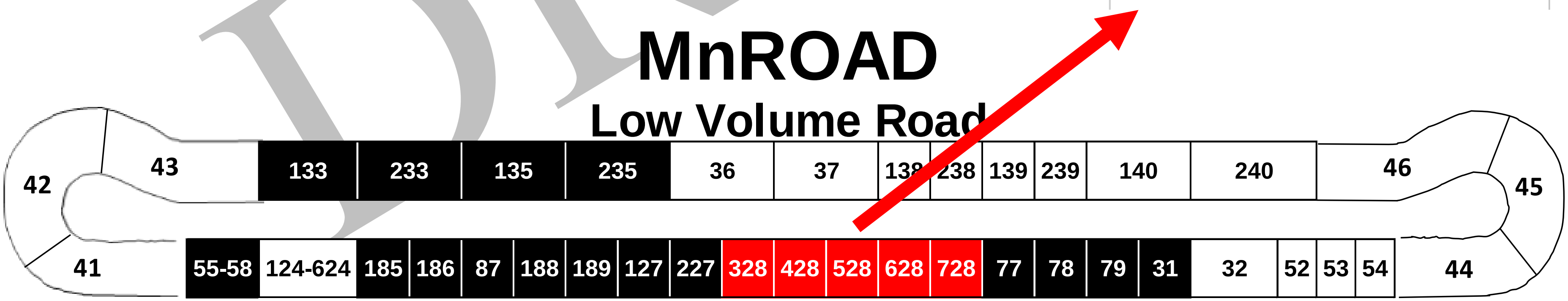
Plate type	Soil type	Stress distribution (shape)		Shape factor (f)
Rigid	Clay (elastic material)	Inverse Parabolic		π/2
Rigid	Cohesionless sand	Parabolic		8/3
Rigid	Material with intermediate characteristics	Inverse Parabolic to Uniform		π/2 to 2
Flexible	Clay (elastic material)	Uniform		2
Flexible	Cohesionless Sand	Parabolic		8/3

LWD DATA ANALYSIS

Data Analysis

328 - Outside			
S_1 (µm)	825	S_1 (mm)	0.825
S_2 (µm)	846	S_2 (mm)	0.846
S_3 (µm)	819	S_3 (mm)	0.819
S_{ave} (µm)	830.0	S_{ave} (mm)	0.83
E_{vd} (MPa)	-		
Plate diameter (mm)	200		
Poisson's ratio, v	0.4		
Shape factor, f	2		
Falling weight, m (kg)	10		
Drop height, h (m)	0.5		
C (N/m)	362396		
Contact area, A (m^2)	0.031		
Applied force, F (Pa)	5962.47		
Applied stress, σ_0 (Pa)	189791		
Applied stress, σ_0 (MPa)	0.18979		
Elastic modulus, E (MPa)	38.42		

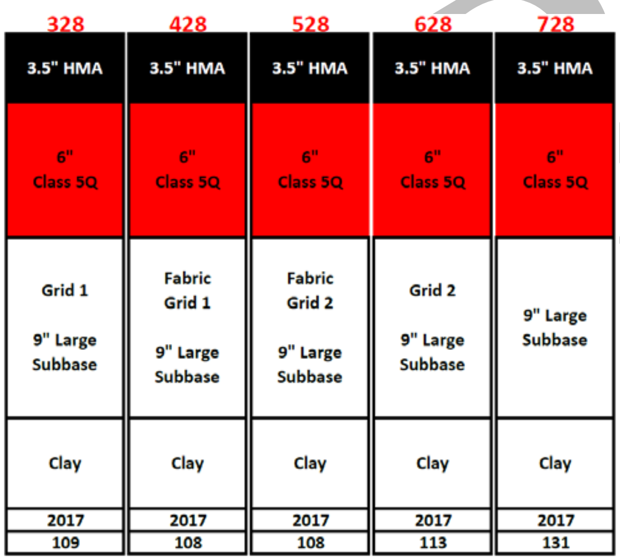
328 - Inside			
S_1 (µm)	606	S_1 (mm)	0.606
S_2 (µm)	592	S_2 (mm)	0.592
S_3 (µm)	589	S_3 (mm)	0.589
S_{ave} (µm)	595.7	S_{ave} (mm)	0.59567
E_{vd} (MPa)	-		
Plate diameter (mm)	200		
Poisson's ratio, v	0.4		
Shape factor, f	2		
Falling weight, m (kg)	10		
Drop height, h (m)	0.5		
C (N/m)	362396		
Contact area, A (m^2)	0.031		
Applied force, F (Pa)	5962.47		
Applied stress, σ_0 (Pa)	189791		
Applied stress, σ_0 (MPa)	0.18979		
Elastic modulus, E (MPa)	53.53		

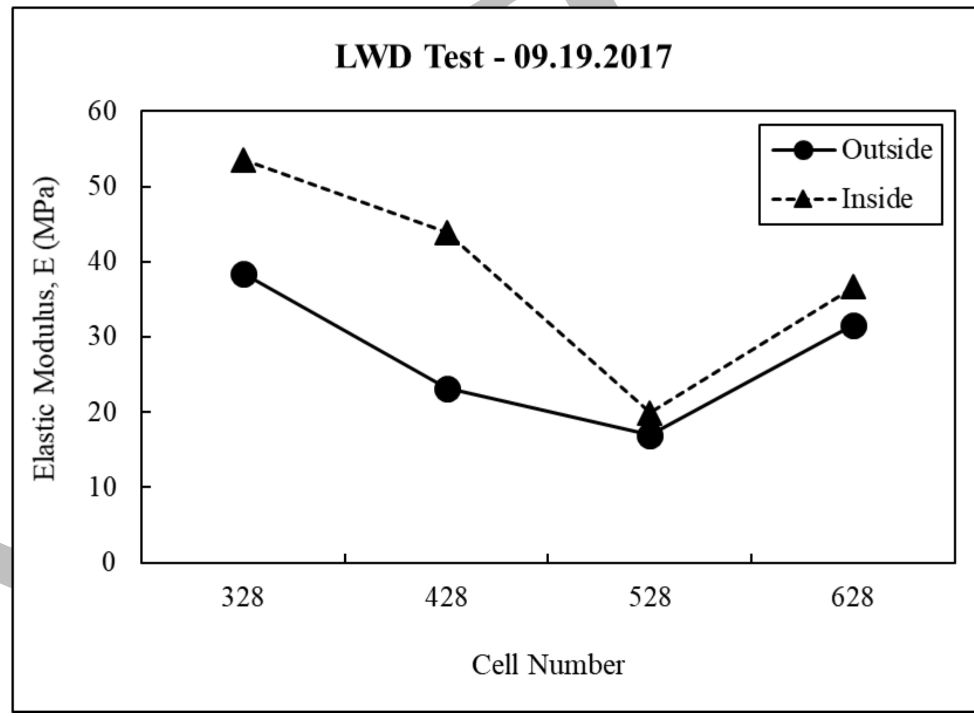


LWD DATA ANALYSIS

LWD Test – 328-628 - 09.19.2017

LWD Test - 09.19.2017		
Cell Number	**Elastic modulus, E (MPa)**	
	Outside	**Inside**
328	38.42	53.53
428	23.18	43.88
528	16.96	19.91
628	31.57	36.62





LWD DATA ANALYSIS

LWD Test – 08.21.2017

LWD Test - 08.21.2017				
Station	Elastic modulus, E (MPa)	E_{vd} (MPa)	Elastic modulus, E (MPa)	E_{vd} (MPa)
	-10	-10	+10	+10
18300	40.46	38.07	24.77	23.3
18400	-	-	26.48	24.9
18500	31.32	29.5	15.06	14.2
18550	46.14	43.4	39.84	37.5

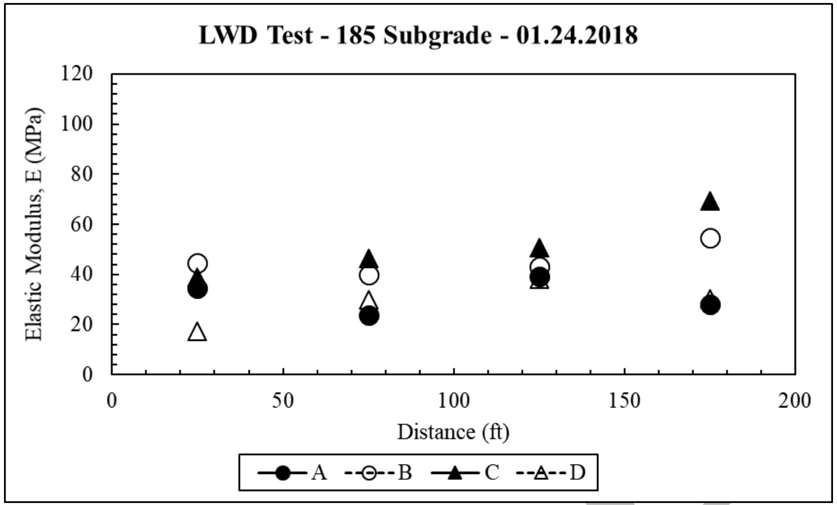
LWD Test - 08.21.2017				
Station	Elastic modulus, E (MPa)	E_{vd} (MPa)	Elastic modulus, E (MPa)	E_{vd} (MPa)
	-10	-10	+10	+10
17930	61.4	57.8	44.68	42.02
17980	57.48	54.1	55.97	52.6
18150	48.26	45.3	50.56	47.5
18250	38.85	36.5	27.35	25.7

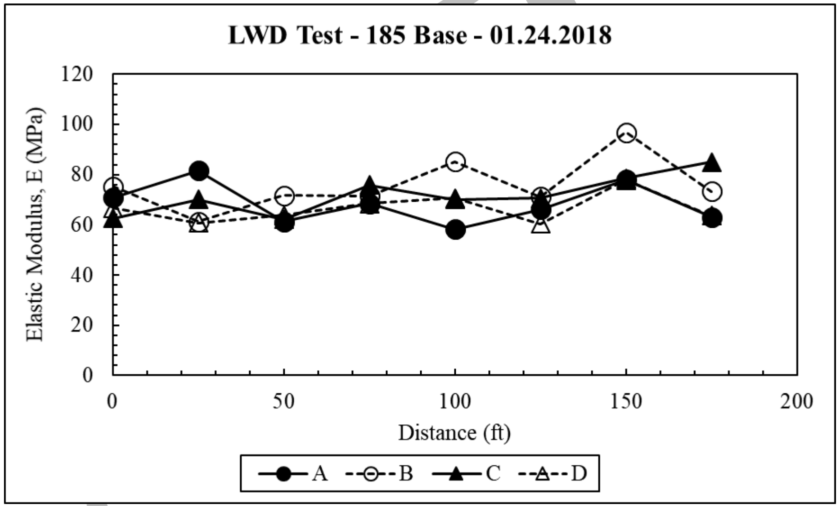
LWD Test - 08.21.2017				
Station	Elastic modulus, E (MPa)	E_{vd} (MPa)	Elastic modulus, E (MPa)	E_{vd} (MPa)
	-10	-10	+10	+10
17630	58.79	55.35	62.68	58.9
17680	55.39	52.1	53.47	50.3
17730	53.89	50.7	71.07	66.8
17880	62.56	58.8	65.07	61.2

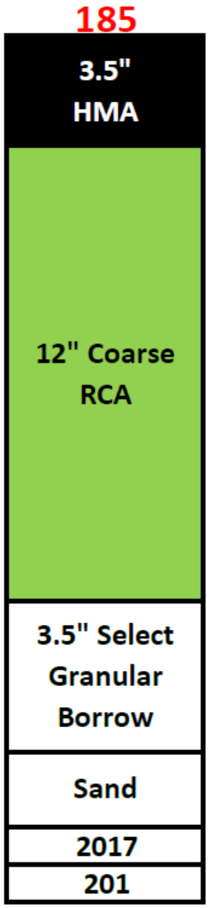
- Cell numbers are required.
- Roadway Lane and Offset: Given as -10 or +10. Which one is outside/inside?

LWD DATA ANALYSIS

LWD Test – 01.24.2018 - UTEP



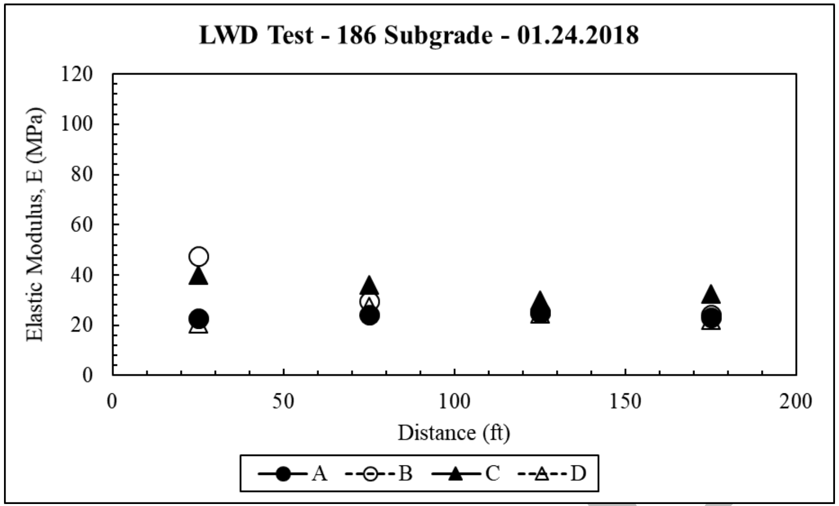


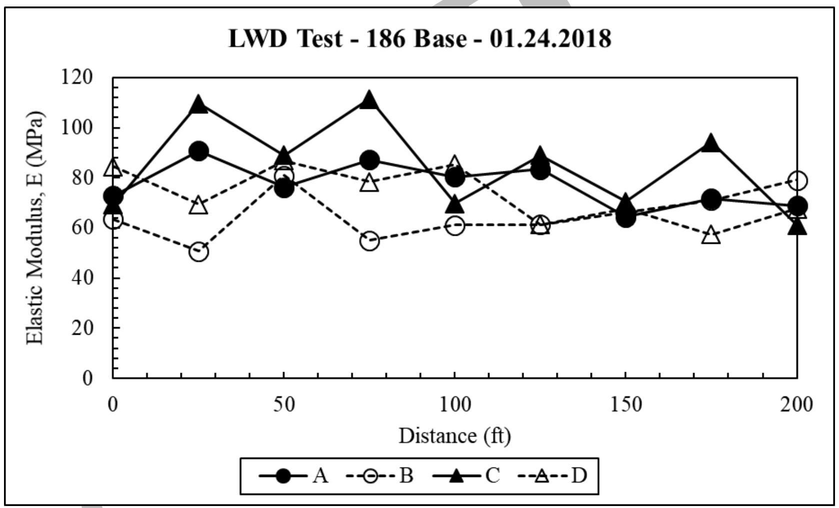


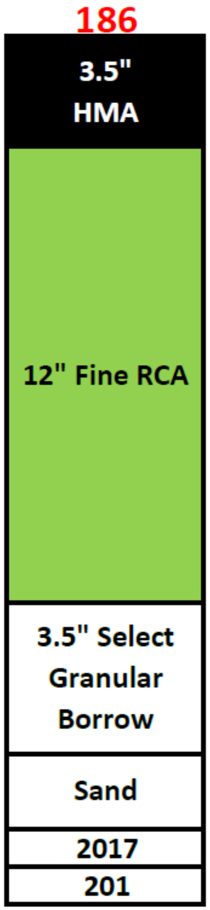
- Information about the LWD is needed, i.e., plate diameter, drop height, mass.

LWD DATA ANALYSIS

LWD Test – 01.24.2018 - UTEP



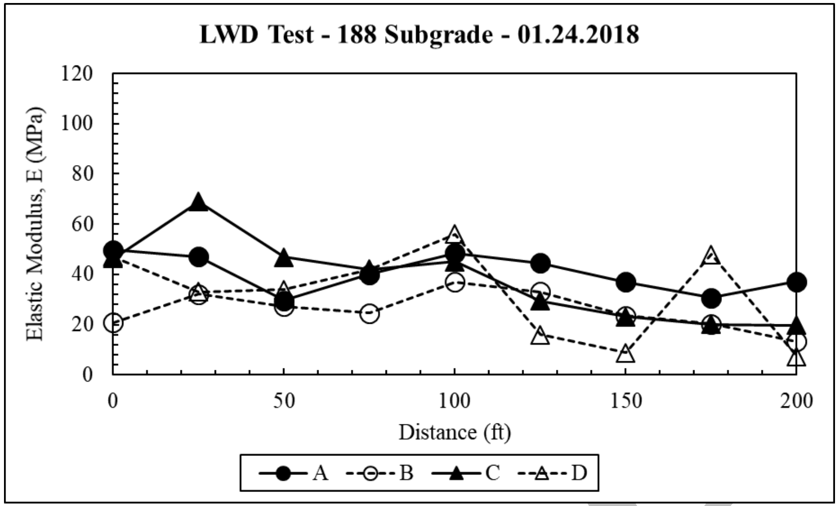


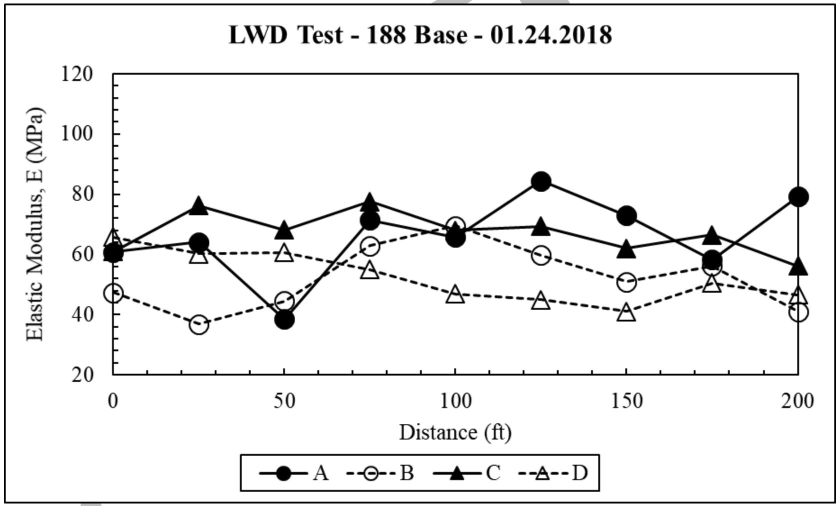


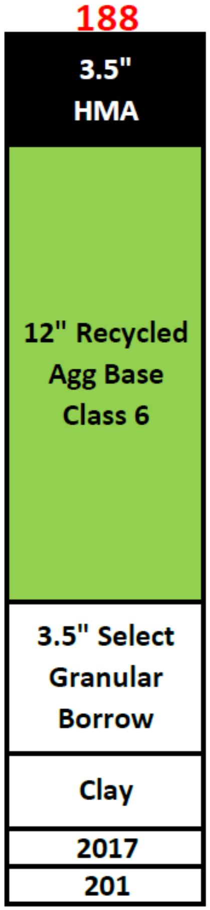
- Information about the LWD is needed, i.e., plate diameter, drop height, mass.

LWD DATA ANALYSIS

LWD Test – 01.24.2018 - UTEP



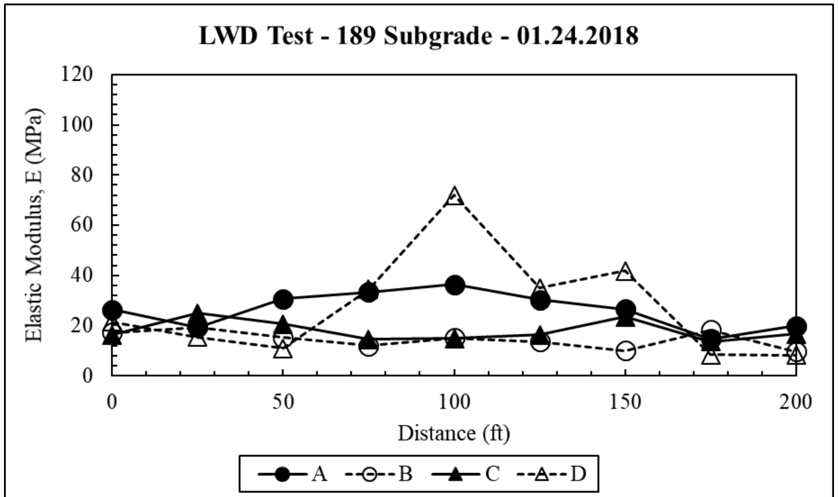


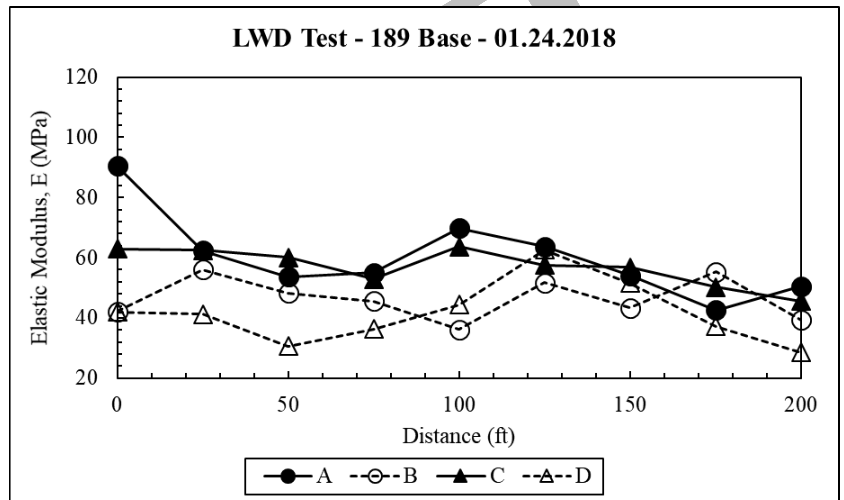


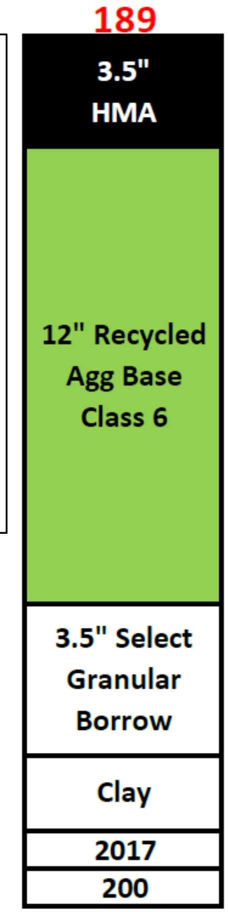
- Information about the LWD is needed, i.e., plate diameter, drop height, mass.

LWD DATA ANALYSIS

LWD Test – 01.24.2018 - UTEP



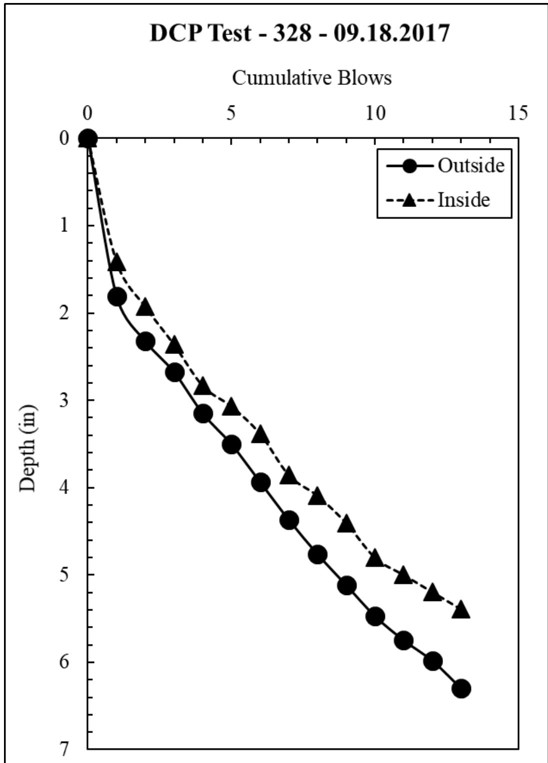


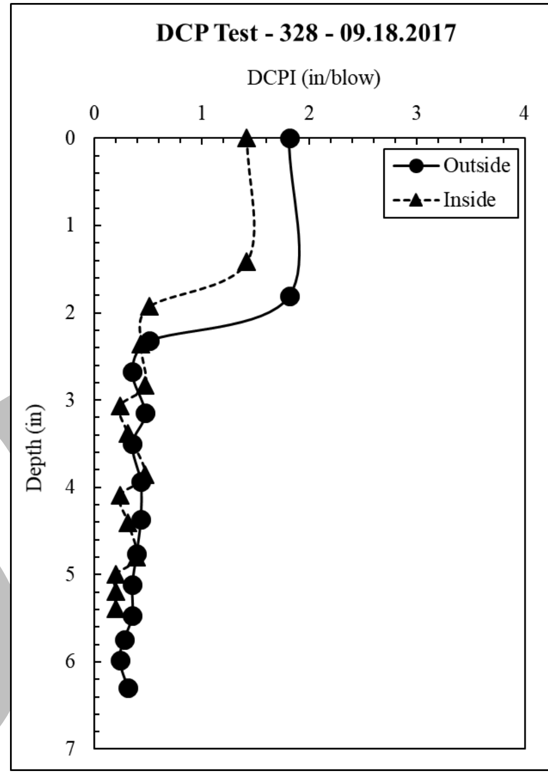


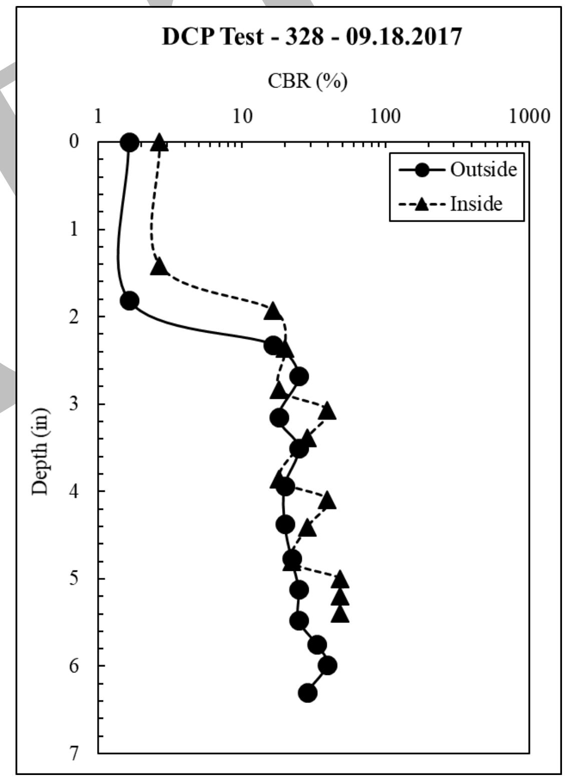
- Information about the LWD is needed, i.e., plate diameter, drop height, mass.

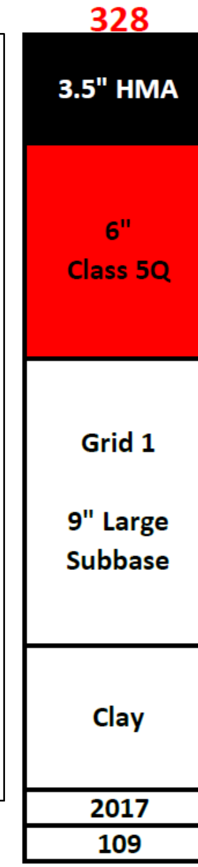
DCP DATA ANALYSIS

DCP Test – 328 - 09.18.2017



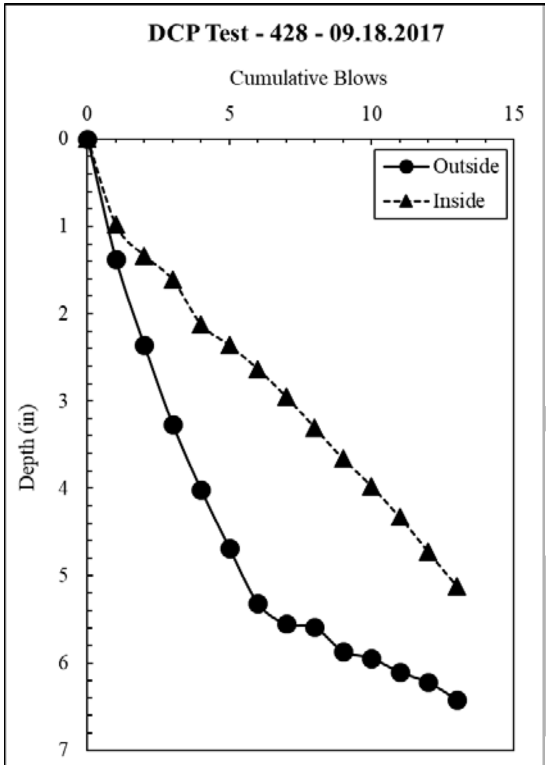


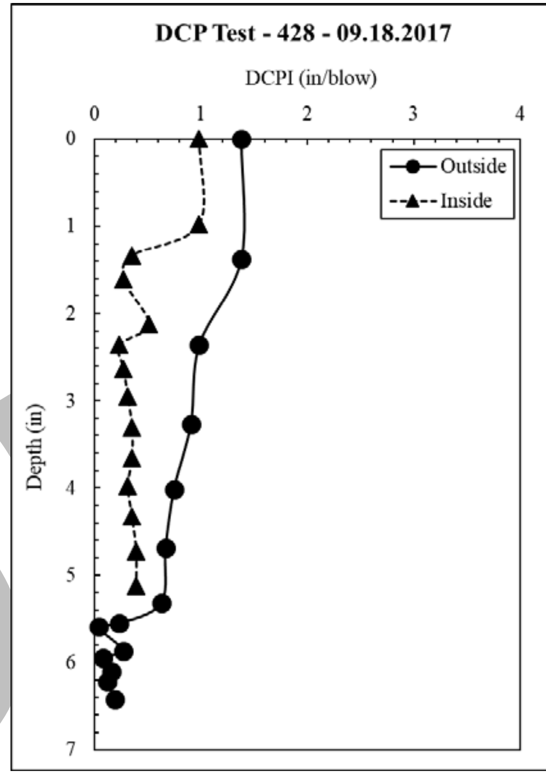


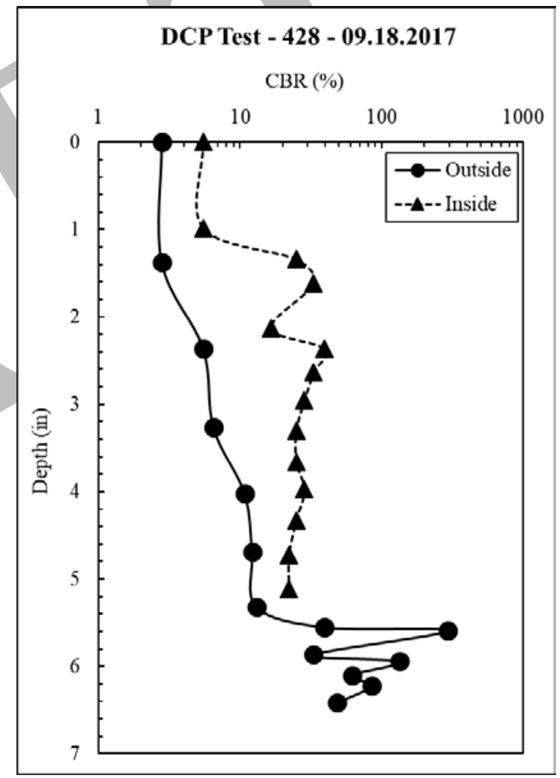


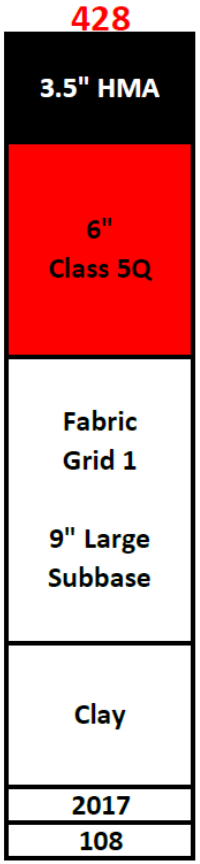
DCP DATA ANALYSIS

DCP Test – 428 - 09.18.2017



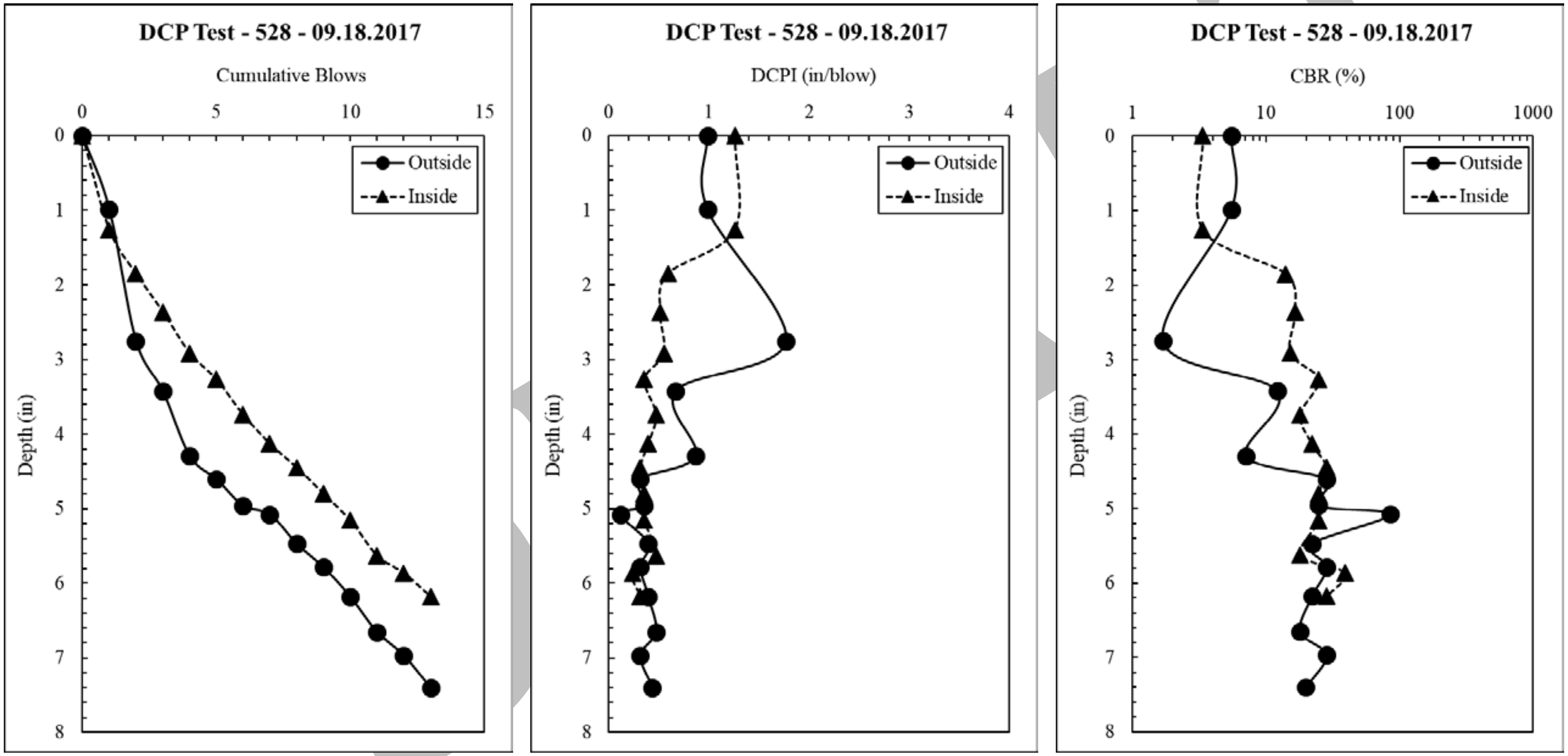


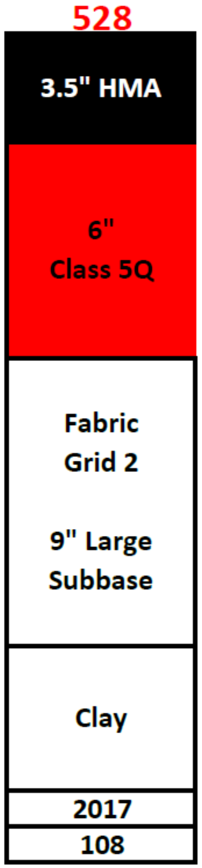




DCP DATA ANALYSIS

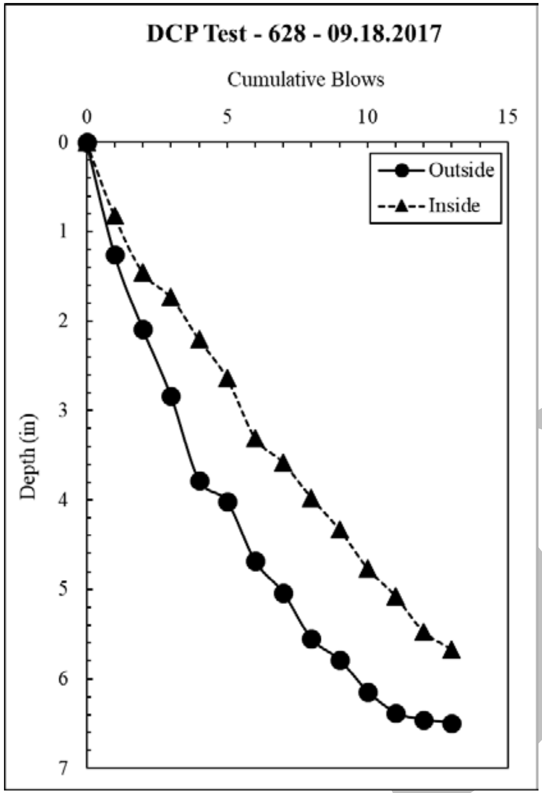
DCP Test – 528 - 09.18.2017

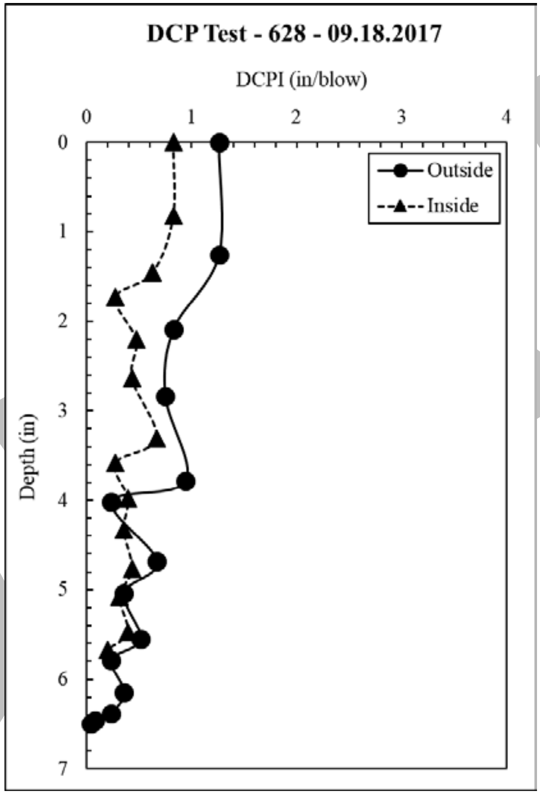


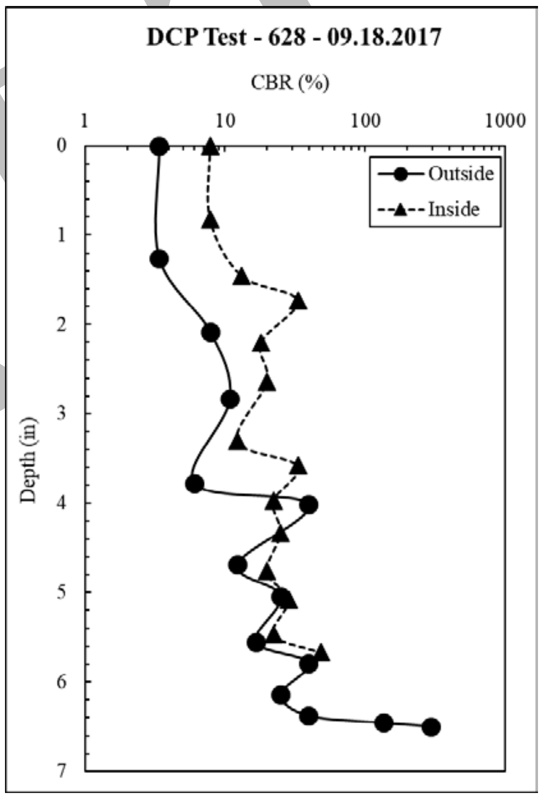


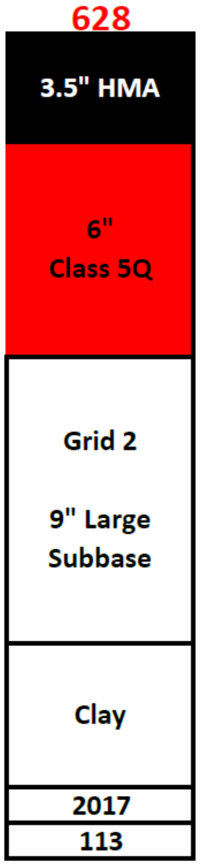
DCP DATA ANALYSIS

DCP Test – 628 - 09.18.2017



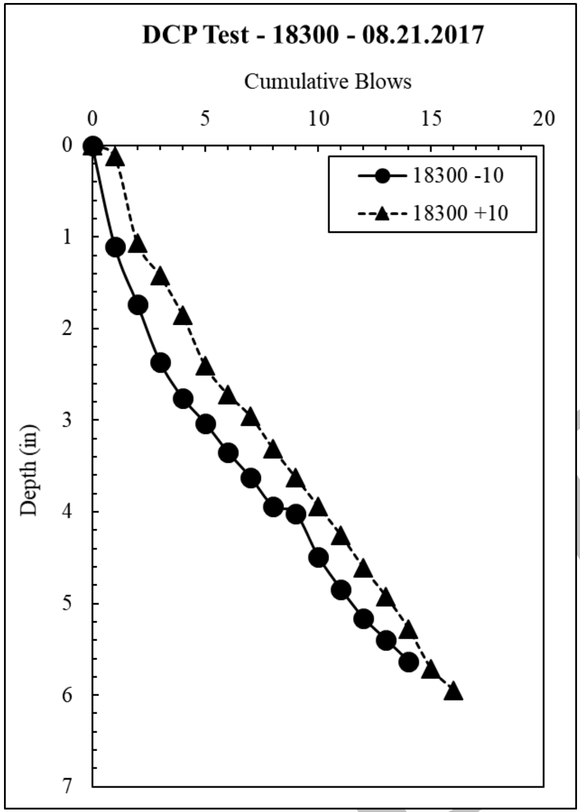


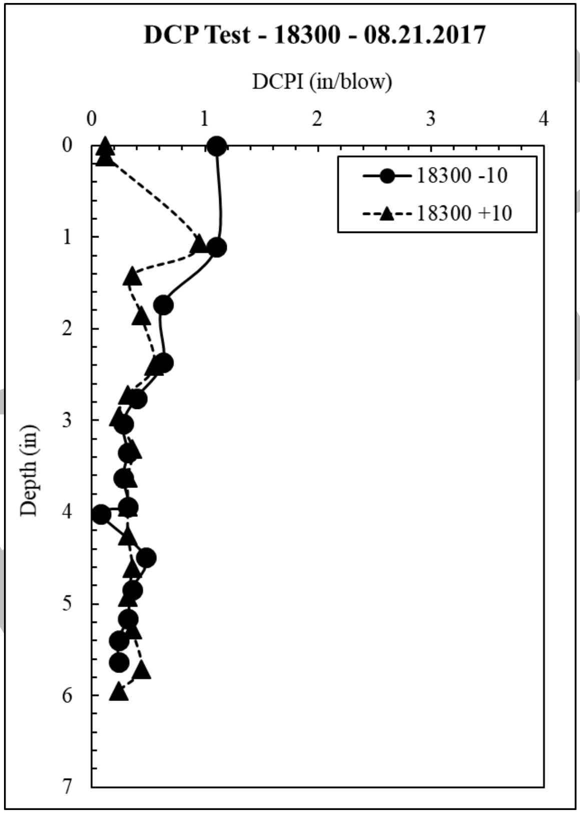


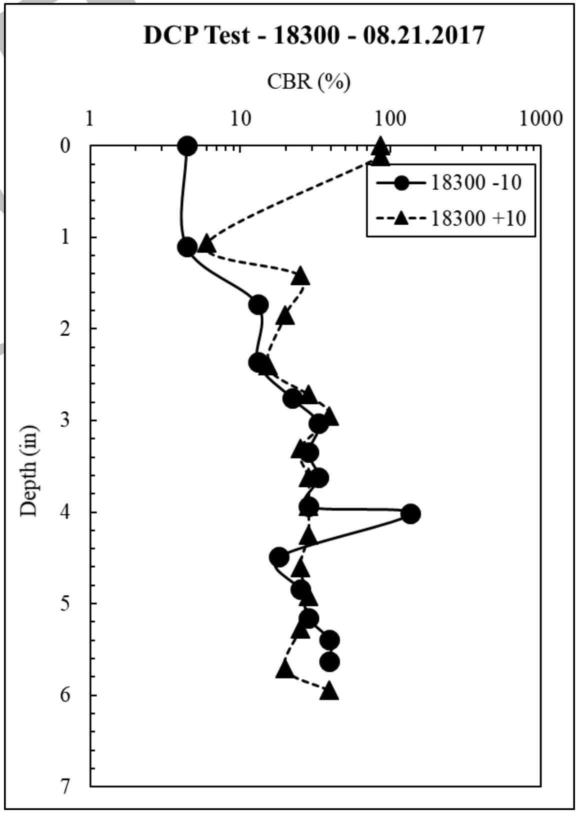


DCP DATA ANALYSIS

DCP Test – 18300 – 08.21.2017 *(Example)*



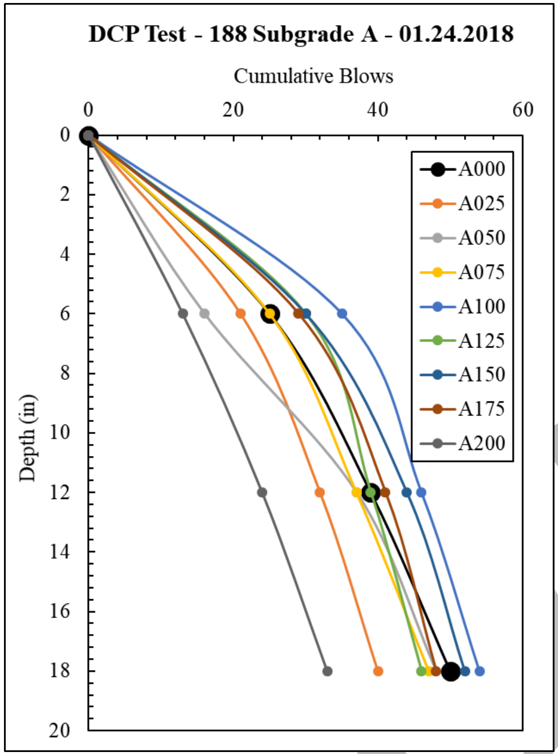


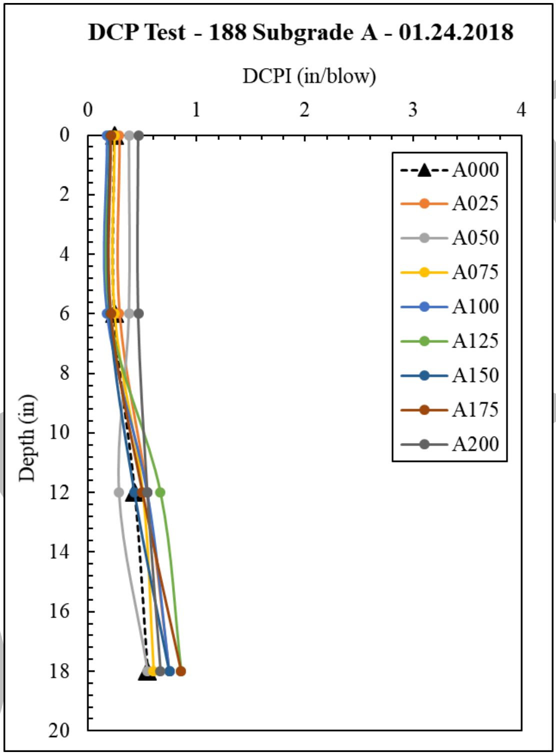


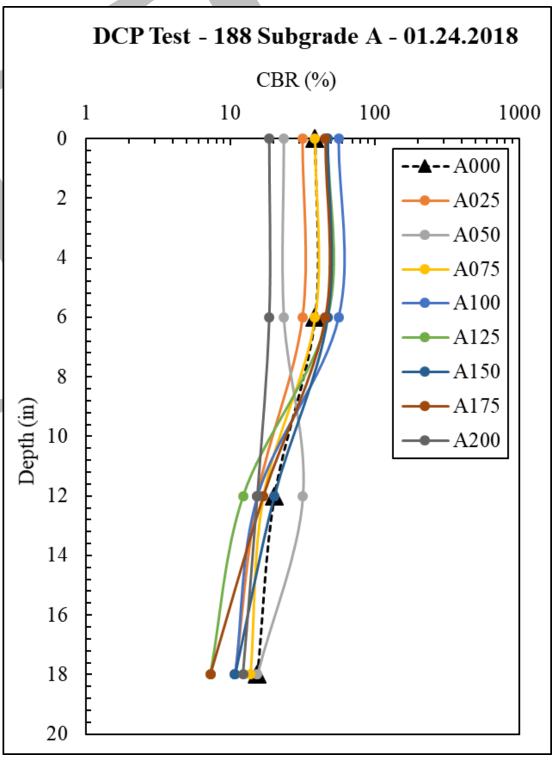
- Cell numbers are needed.

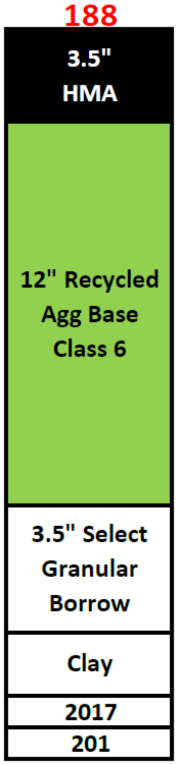
DCP DATA ANALYSIS

DCP Test – 01.24.2018 – UTEP *(Example 188 A)*









SUMMARY

Permeameter

- Compaction effort reduced the K_{sat}.
- Some negative K_{sat} values were calculated due to some errors related to obtained P2 values.
- Gradation – compaction (before/after compaction) data are required for more accurate analyses.

LWD & DCP

- Inside lane has higher elastic modulus.
- Cell numbers are required for the LWD & DCP data taken on 08.21.2017.
- Meaning of -10 & +10 should be provided (inside or outside).
- LWD specs (plate diameter, drop height, mass) are required for the data taken by UTEP (01.24.2018).

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SCHEDULE

TASKS	MONTHS																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Task 1	■	■	■	■	■																												
Task 2						■	■	■	■																								
Task 3		■	■	■	■	■	■	■	■																								
Task 4		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■													
Task 5		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
Task 6		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
Task 7																								■	■	■	■	■					
Task 8																											■	■	■	■	■		
Task 9																															■	■	■

Thank You!

QUESTIONS??