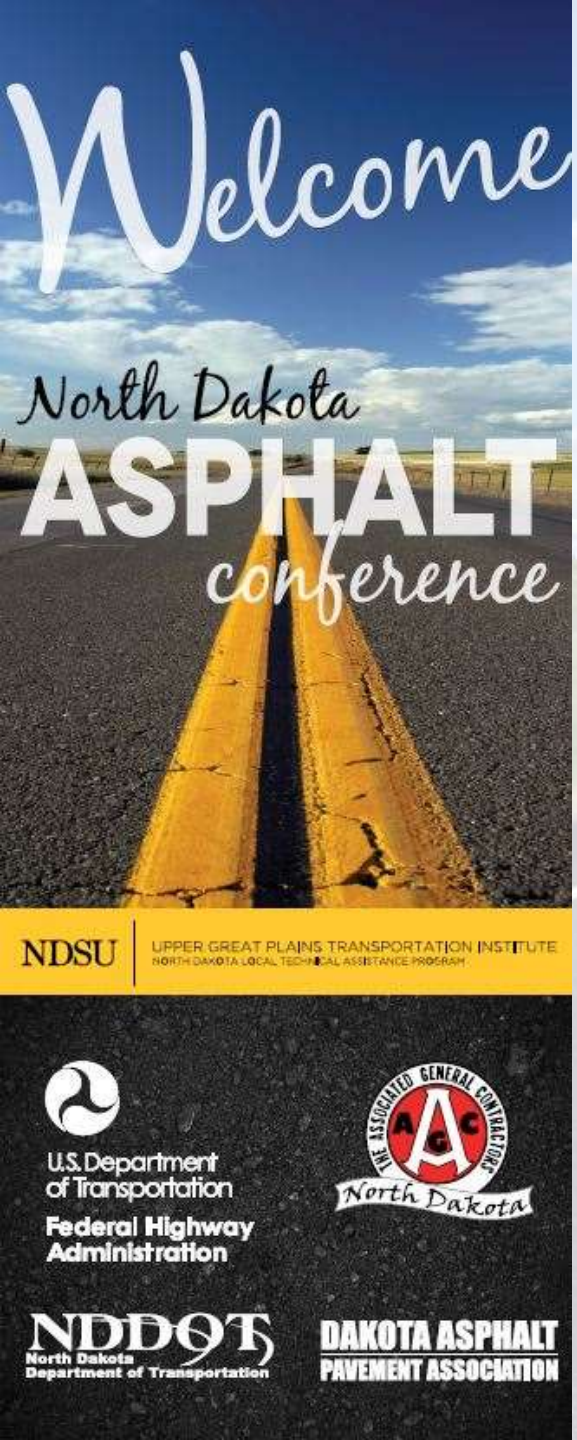


Effect of RAP on Cracking

Daba S. Gedafa, Ph.D., P.E., ENV SP
Associate Professor
UND Civil Engineering

North Dakota Asphalt Conference

Bismarck, ND - April 10-11-2018

Advantages and Disadvantages of RAP

- Advantages:
  - ensures proper utilization of limited natural resources (aggregate, binder)
  - reduces green house gas emission and energy consumption

- Usage of high RAP is limited due to:
  - the quality of blending between RAP and virgin materials
  - susceptibility to cracking due to aging

Fatigue/Alligator Cracking

Low-temperature/Thermal/Transverse Cracking

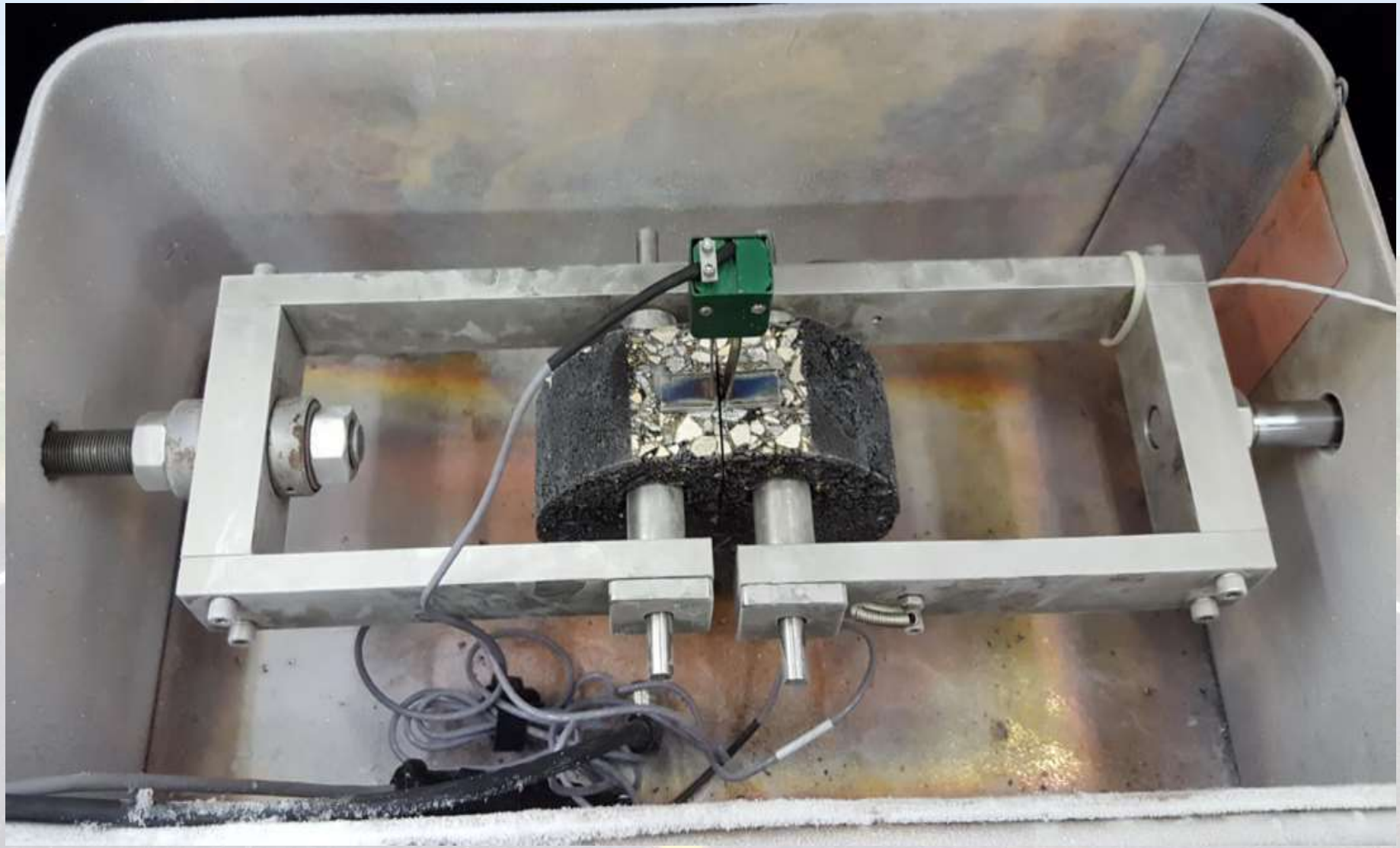
Objectives

- Determine the effect of RAP on cracking based on:
  - Field mixed/lab compacted specimens (DCT)
  - Field mixed/lab compacted and lab mixed/lab compacted specimens (DCT and SCB)

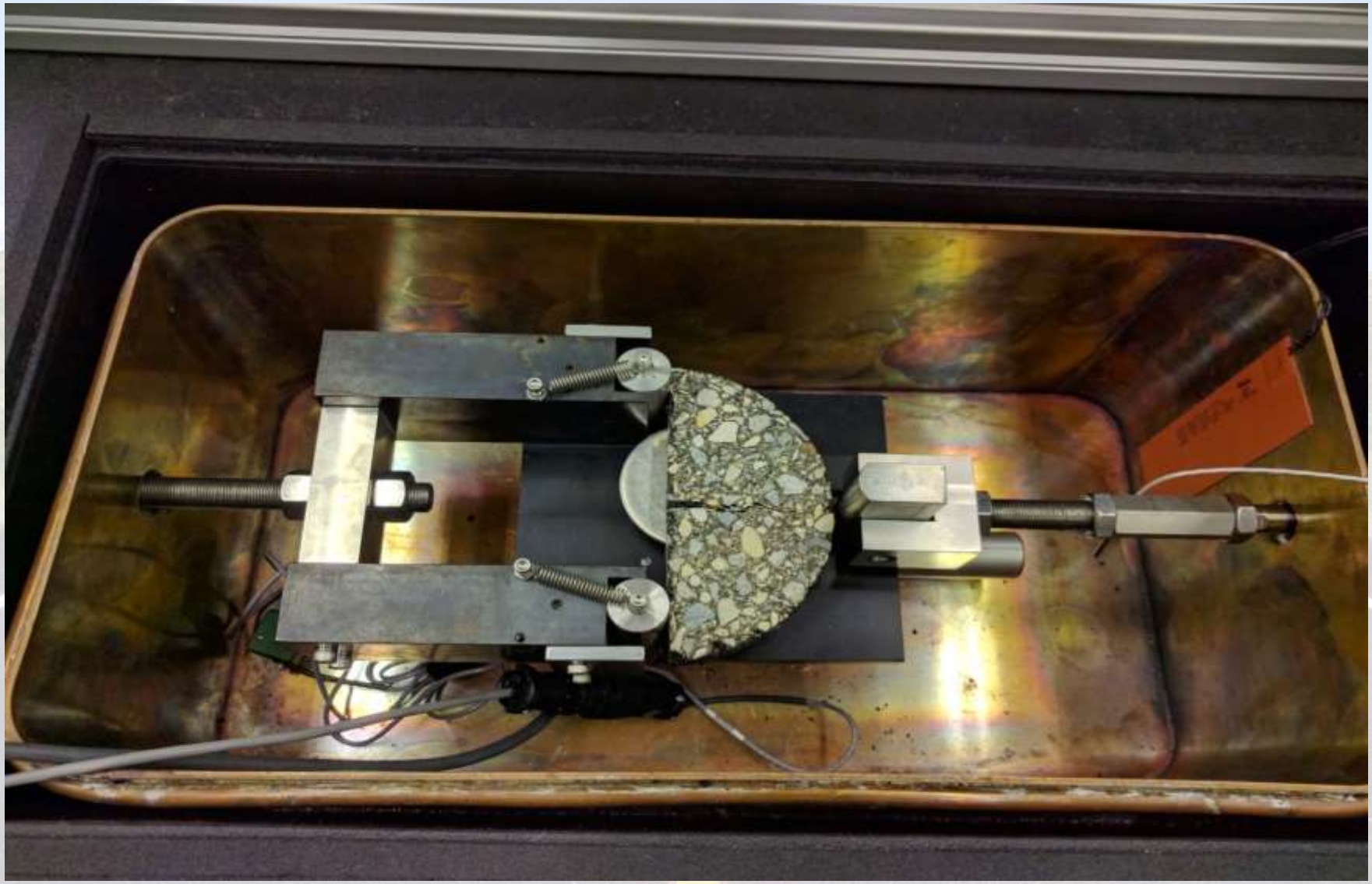
Methodology

- Specimens were compacted using Superpave Gyratory Compactor
- Specimens were prepared for performance tests
- DCT was used to determine low-temperature cracking performance
- SCB was used to determine fatigue cracking performance

DCT Test Setup



SCB Test Setup



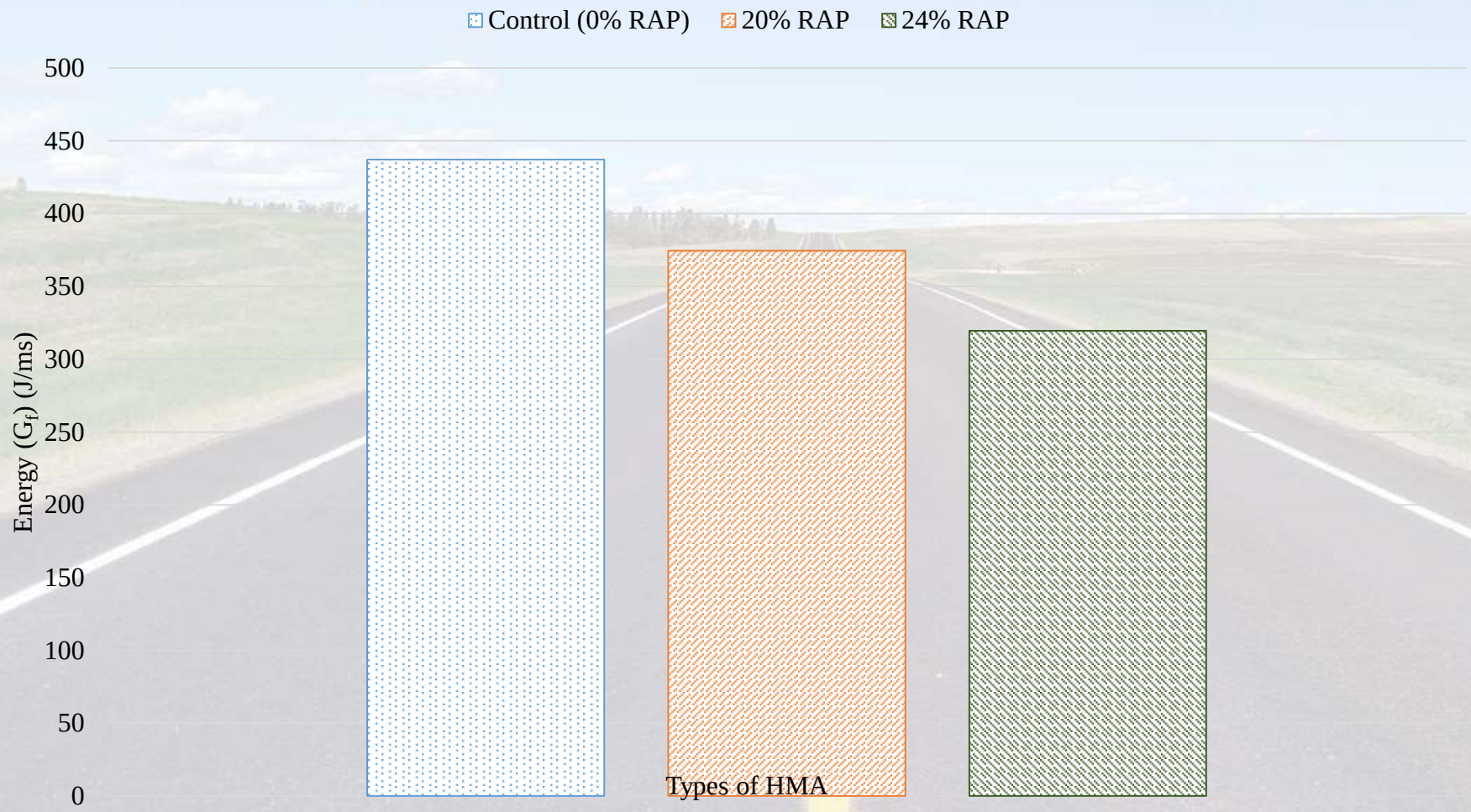
Mix Design

Control (0% RAP) Mix		20% RAP mix		24% RAP mix	
Materials	**Percent (%)**	**Materials**	**Percent (%)**	**Materials**	**Percent (%)**
Optimum AC	5.8	Optimum AC	5.7	Optimum AC	6.1
Virgin Binder	5.8	Virgin Binder	4.6	Virgin Binder	4.8
Crushed Rock	31	Crushed Rock	33	Crushed Rock	25
Natural Fines	26	Natural Fines	6	Natural Fines	8
Wash Frac Sand	16	Wash Frac Sand	29	Dirty Dust	18
Crusher Fines	27	Crusher Fines	12	Washed Dust	25
RAP	0	RAP	20	RAP	24

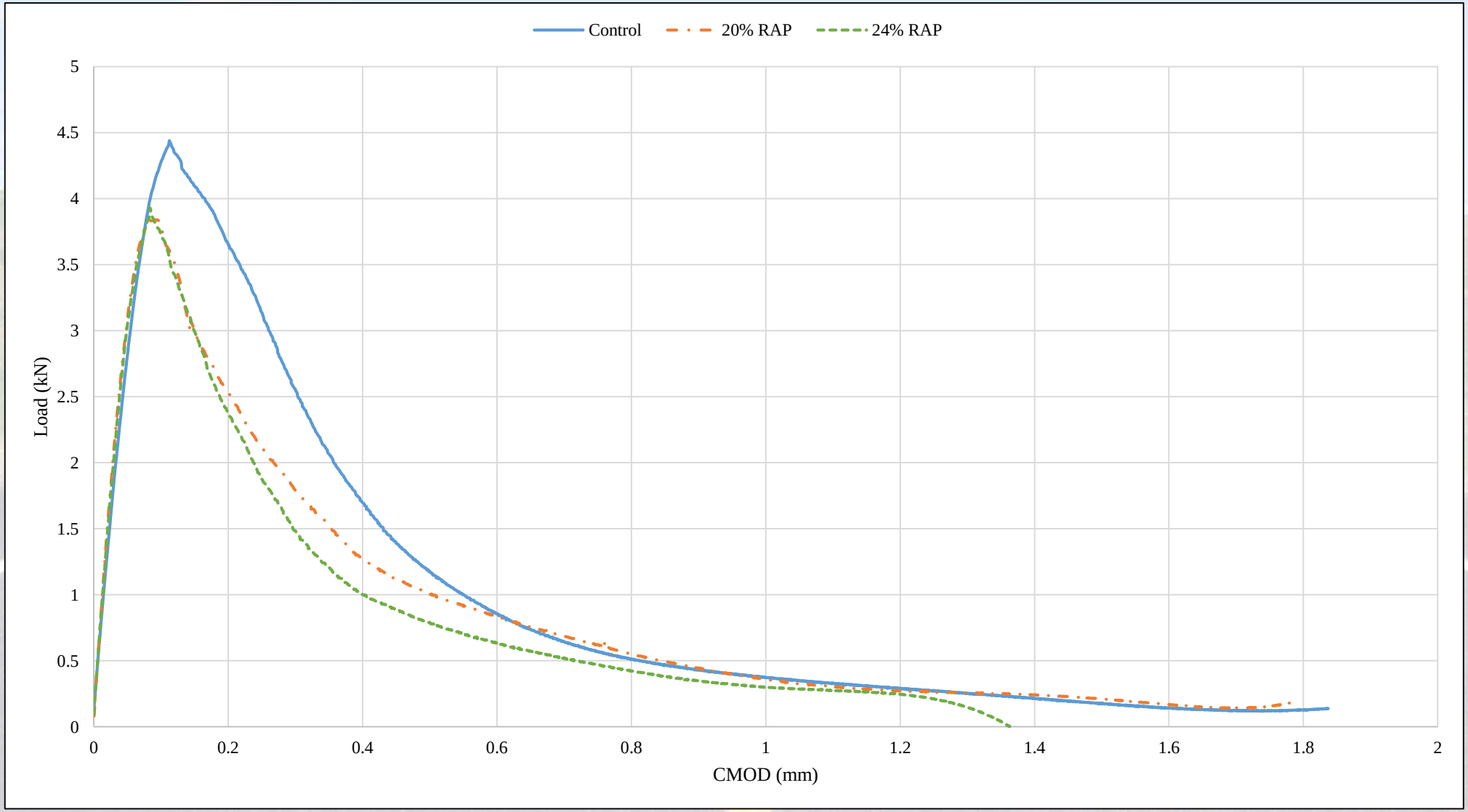
Specimen Details

Type of Mixture	# of specimen	Binder Grade	Dimension of Cylindrical Specimen	Air Void Content (%)	Nominal Max Agg. Size (mm)
Control (0% RAP)	8	PG 64-28	Height 75mm, Diameter 150mm	7±0.5	12.5
20 % RAP	8	PG 58-28			
24% RAP	8	PG 58-28			

Effect of RAP on Low-Temperature Cracking Resistance



Average Load Vs Crack Mouth Opening Displacement (CMOD)



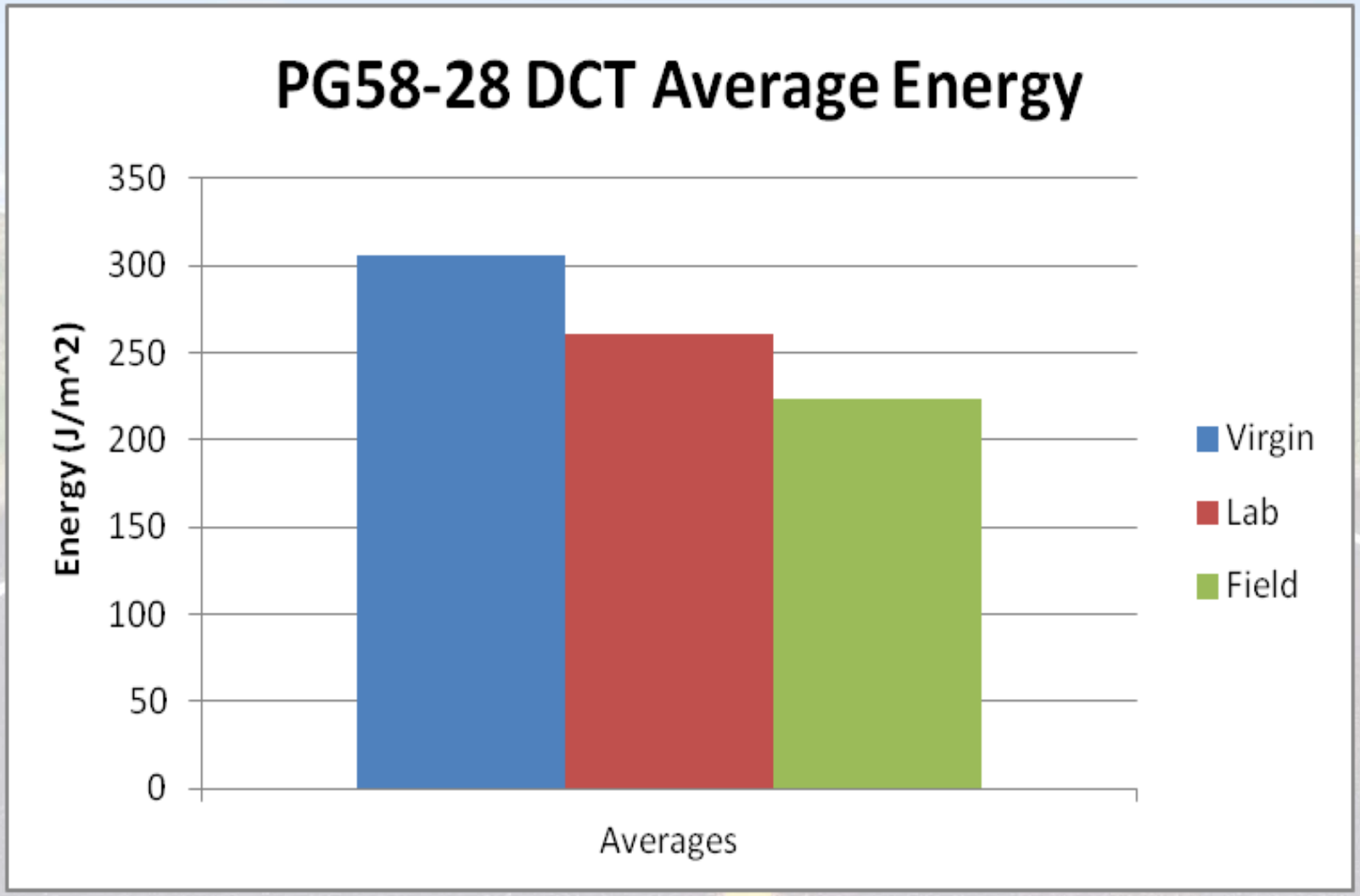
Mix Design

	PG 58-28		PG 64-28	
Material	Virgin Mix	Lab Mix	Virgin Mix	Lab Mix
Binder	6.1	4.4	5.4	4.1
RAP	0.0	24	0.0	22
Rock	38	28	24	18
Natural Fines	25	19	12	5
Dust	18	16	23	20
Washed Dust	19	13	41	35

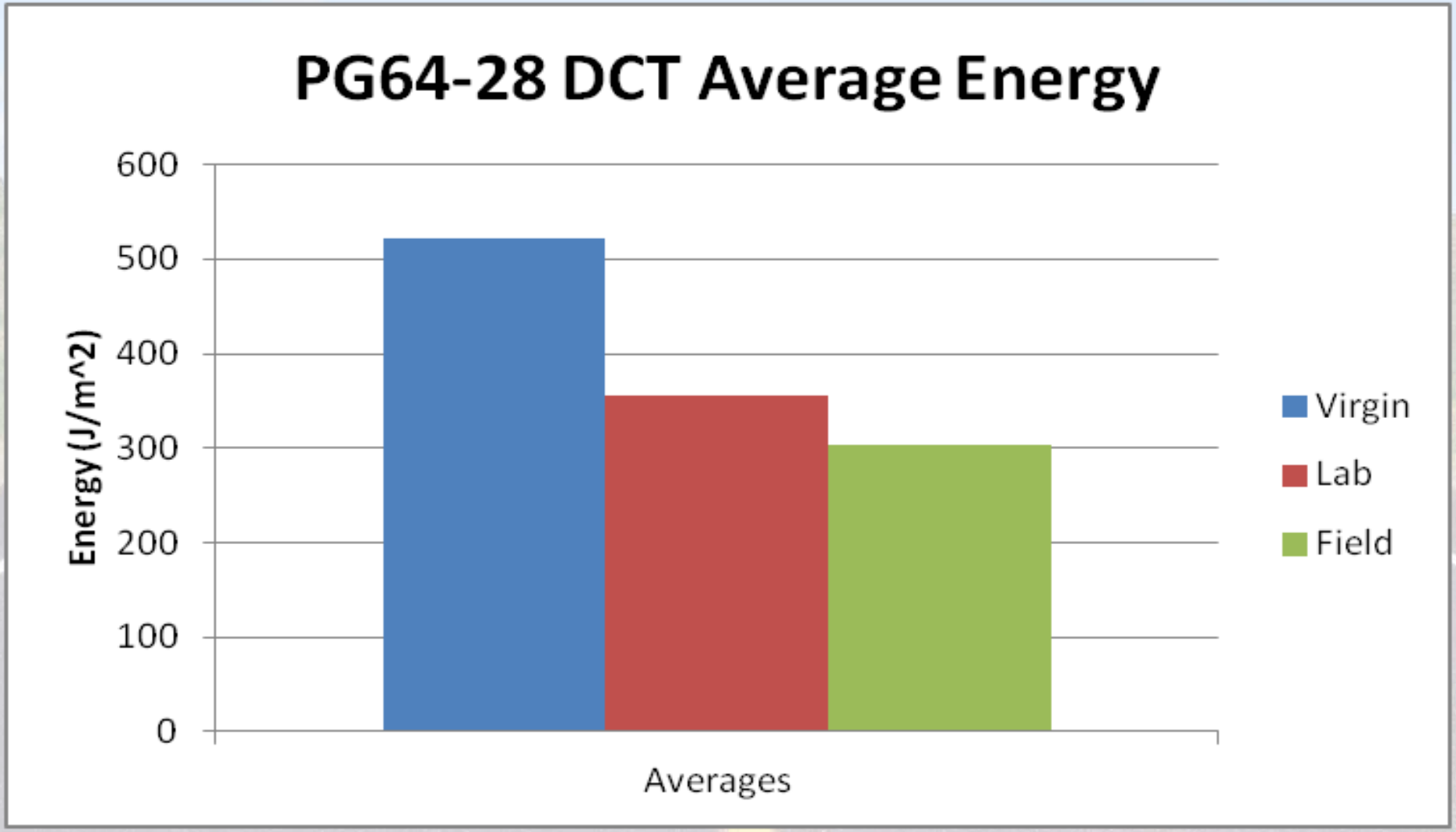
DCT Results

Binder Grade	Mix	DCT		
		Average Energy (J/m^2)	Std Dev	COV (%)
PG58-28	Virgin	305.67	86.00	28.14
	Lab	260.33	22.81	8.76
	Field	224.00	19.80	8.84
PG64-28	Virgin	521.50	7.77	1.49
	Lab	355.25	42.89	12.07
	Field	304.25	23.19	7.62

DCT Results for PG 58-28



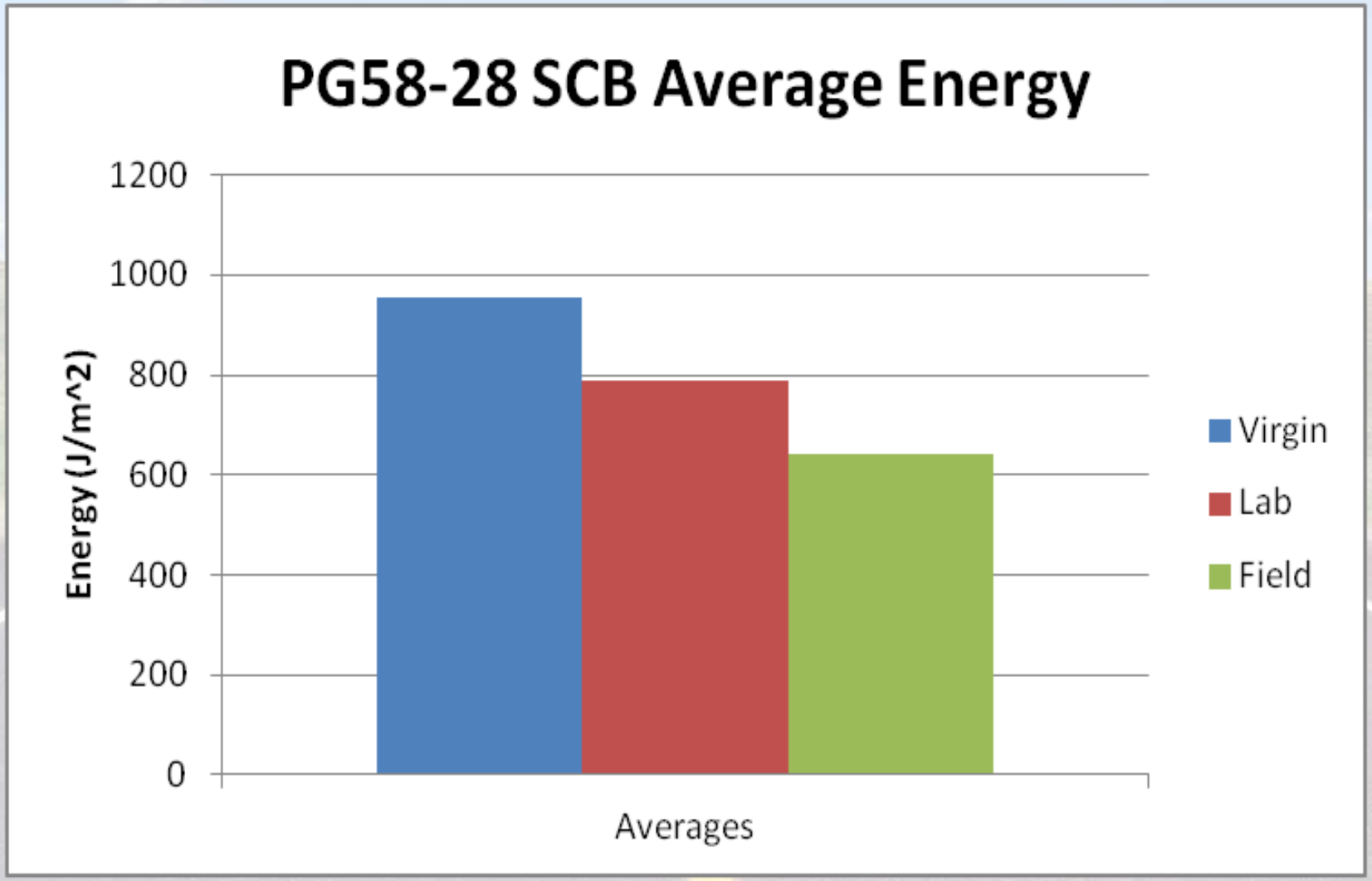
DCT Results for PG 64-28



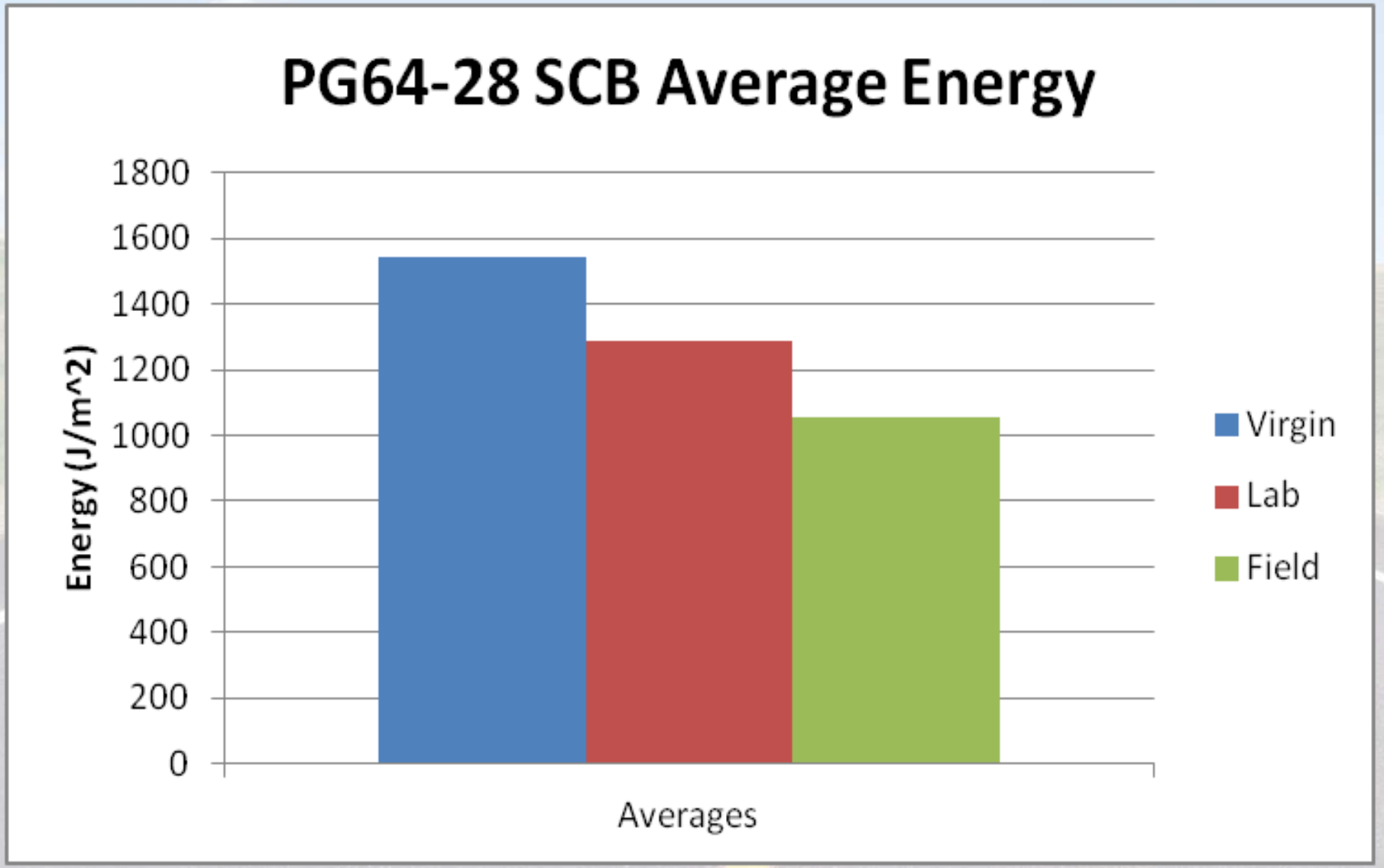
SCB Test Results

Binder Grade	Mix	SCB		
		Average Energy (J/m^2)	Std Dev	COV (%)
PG58-28	Virgin	955.32	221.29	23.16
	Lab	790.17	133.82	16.94
	Field	640.45	202.14	31.56
PG64-28	Virgin	1540.56	242.71	15.75
	Lab	1290.17	115.78	8.97
	Field	1053.48	202.58	19.23

SCB Results for PG 58-28



SCB Results for PG 64-28



Conclusions

- As RAP content increases, fracture energy decreases

- Field mixed/lab compacted specimens had less fracture energy than lab mixed/lab compacted specimens for the same mix design

Thank you

Email: daba.Gedafa@engr.und.edu

Phone: 701-777-3976

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