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Evaluation of Superpave Gyratory Compactor's Internal Angle in Alabama

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Research Objective

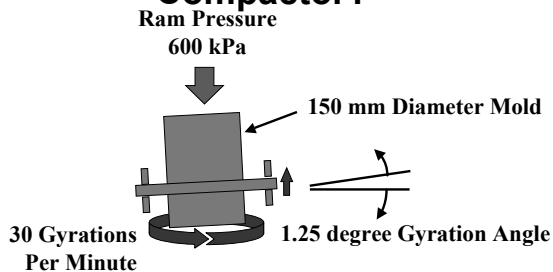
- Evaluate the potential of the Dynamic Angle Verification Kit (DAVK) to accurately measure the Internal Angle during compaction and to determine its effect on density

SGC Types in Alabama



Troxler	Pine	Brovold	Interlaken	Rainhart
4140	AFGC125X	HM-293	GYR-001	144
4141	AFG1A			

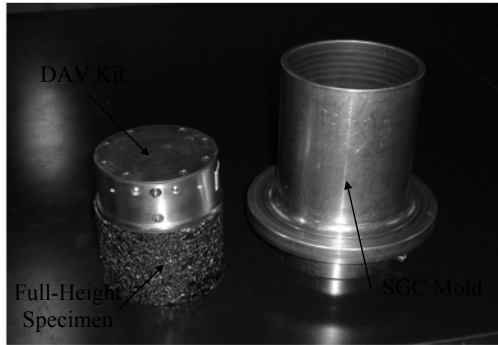
What Makes a Compactor a Superpave Gyratory Compactor?



What Seems to be the Problem?

Greater than expected variability in density between samples compacted in different gyratory compactors

Dynamic Angle Verification Kit



DAVK Calibration/Verification



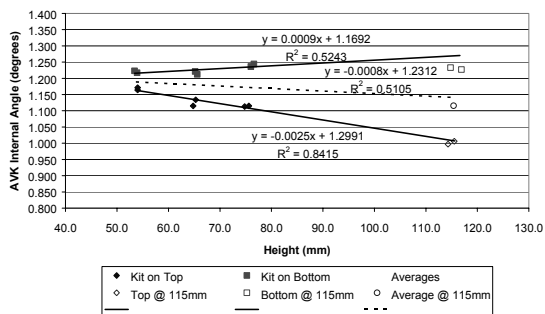
DAVK Internal Angle Measurement Considerations

- Internal angle measurements depend on position in the mold
- Internal angle measurements decrease as the sample size increases
- Problem; some SGC's will not allow for internal angle measurements with full-height samples

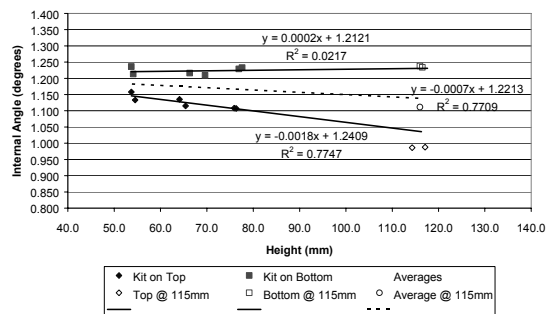
Preliminary Studies

- Comparison of two DAVK Kits
 - DAVK needs to cool to 40 °C prior to testing another sample
- Mix Gradation
- Extrapolation to Full Height Sample

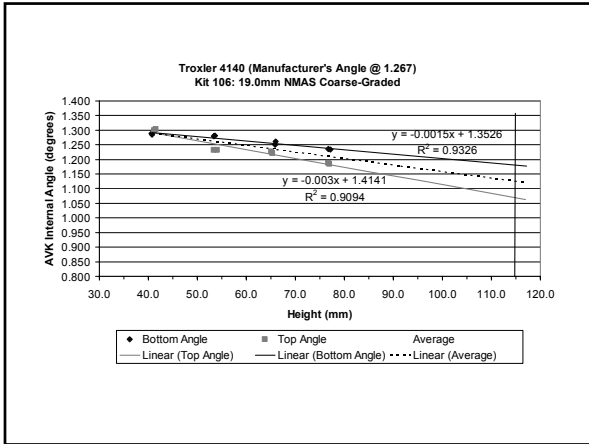
Pine AFG125X (Manufacturer's Angle @)
Kit 104: 19.0mm NMAS Coarse-Graded



Pine AFG125X
Kit 106: 19.0mm NMAS Coarse-Graded



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DAVK Study in Alabama

- All SGC's in Alabama to be Evaluated for Internal Angle and Density
- 121 Gyrotories Evaluated
 - ALDOT SGC's
 - Contractor SGC's
- Data Collection Only (No Adjustments Made)

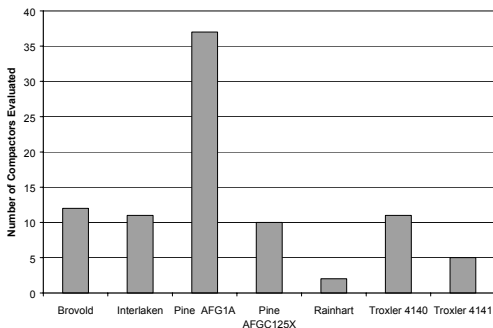
Testing Protocol

- Evaluate Manufacturer's Calibration
- Determine Internal Angle of Gyration
- Compact Three sample without Kit to 100 Gyrotations
- Determine density of compacted samples at NCAT
- Relate internal angle to changes in density

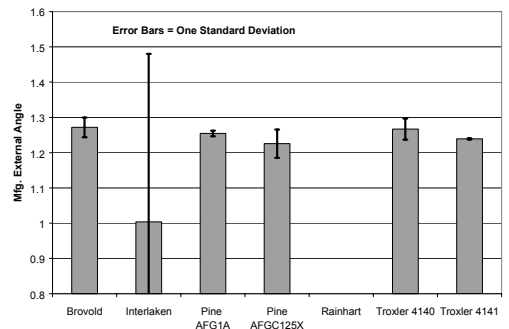
DAVK Testing Procedures Used for Each SGC

- Pine AFGC125X (Big Pine) and Rainhart 144
 - Full-Height: 2 Top, 2 Bottom
- Pine AFG1A (Baby Pine)
 - Full-Height: 4 Top, 2 Bottom
- Troxler (Big & Baby), Brovold, and Interlaken
 - Test Samples at Three Heights: 2 Top, 2 Bottom
 - Straight-Line Extrapolation to Full-Height

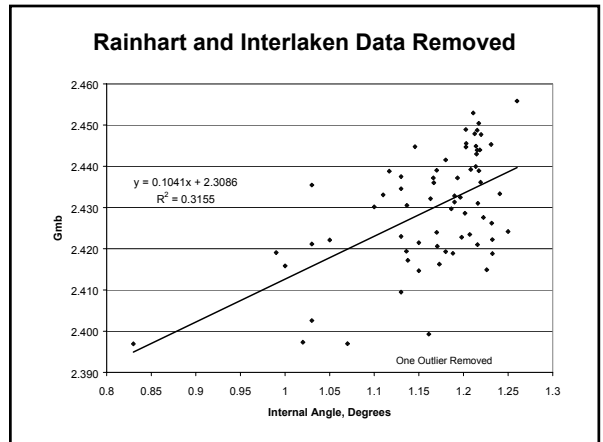
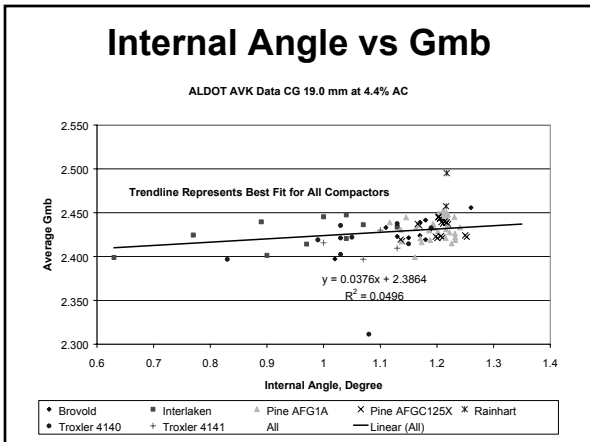
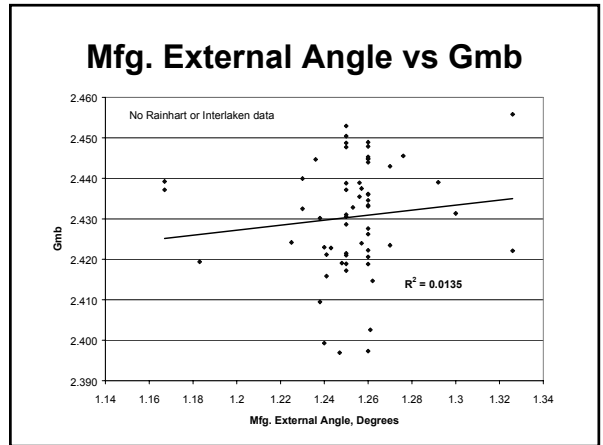
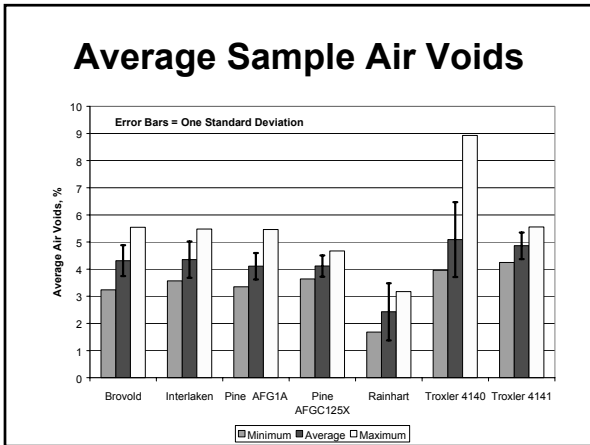
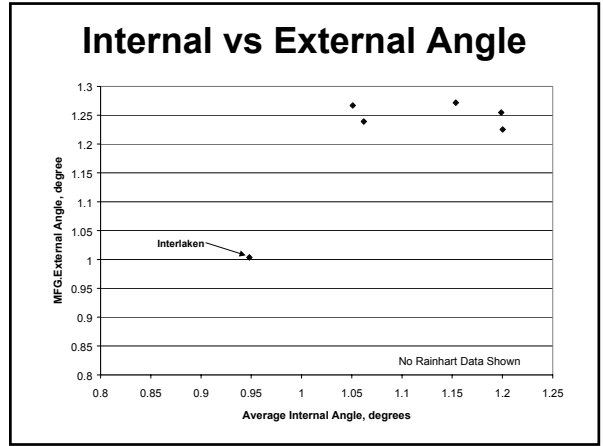
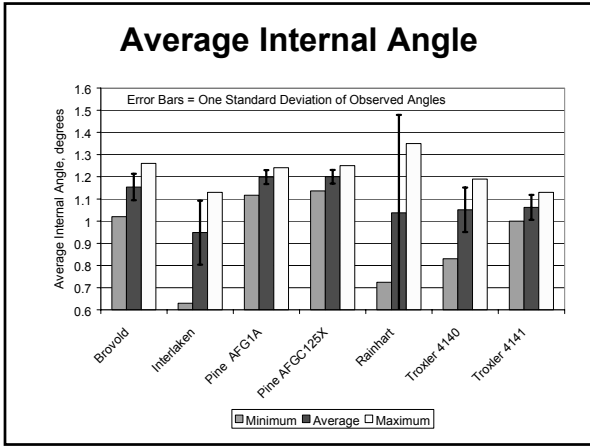
Number of Compactors Evaluated



Average Manufacturer's Angle

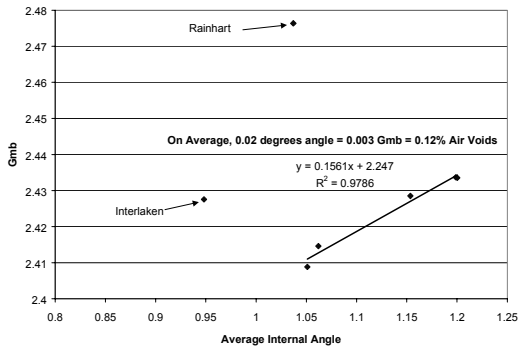


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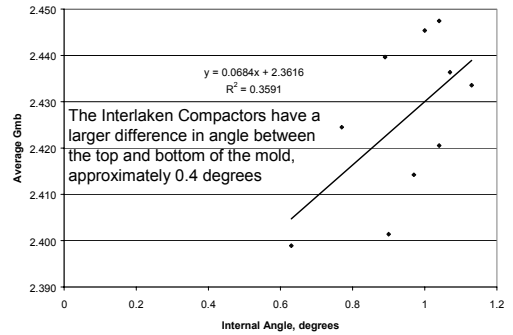


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Gmb vs Internal Angle



Interlaken Gmb vs Angle



Summary of Findings

- Evident trend between internal angle and SGC type
- Evident trend between internal angle and density, strong relationship on average
- No trend between external angle and density
- Internal angle of gyration explains some of the differences between compactor brands

Other Observations

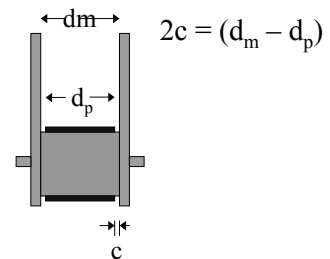
- Control samples in NCAT's Big Pine (NCAT's oldest compactor) indicated lower than expected density
- Internal angle approximately 1.15 degrees
- Samples from Pine 7.4% air voids vs 3.4% average for ALDOT study
- NCAT's mold approx. 151 mm in sample area

Mold Comparison

	NCAT	Pine Reference
Original Molds	2.344	2.384
Molds Swapped	2.371	2.356
New Molds	2.389*	2.389

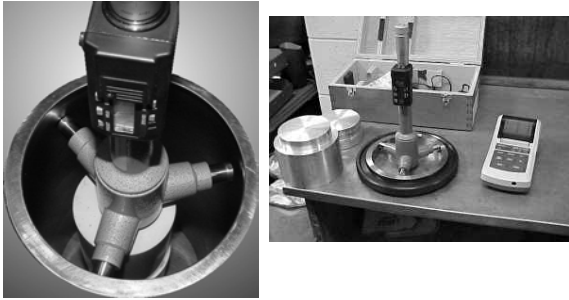
*NCAT Pine Serviced

End-Plate Clearance



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Ways To Measure I.D. Three-Point Gauge



Other Sources of Variability?

- Mix Handling
 - Oven
 - Loading Mold
 - Temperature
- Mix Variability
- Variance in Sample Height
- Variance in Pressure

DAV Activities

- Specifications
 - ASTM
 - DAV Std. Practice ballot expected 2003
 - AASHTO
 - DAV provisional standard tech section ballot 2002
 - T312 updates (to include DAV) tech section ballot 2002
- Precision/Bias
 - Extrapolation (Method "A")
 - ruggedness "substantially" complete
 - round-robin Spring 2003
 - Full-height (Method "B")
 - ruggedness Fall/Winter 2002
 - round robin Spring 2003
 - Target completion: June 2003
- Evaluation of "Method C": pre-compaction (FHWA)
- Comprehensive evaluation of affect on G_{mb} values
 - Individual agency efforts
 - National effort?

DAV Ruggedness Results (Extrapolation Procedure)

Summary of F Values for All Compactors, All Laboratories, and All Factors ($F_{crit} = 5.59$)

SGC Model	Lab	DAV Temp. (C)		N_{total}		"Short" Mix Ht. DAV on top (mm)		"Tall" Mix Ht. DAV on top (mm)		"Short" Mix Ht. DAV on bottom (mm)		"Tall" Mix Ht. DAV on bottom (mm)		Mix Nom. Max. Agg. Size (mm)	
Factor Levels:		30	45	50	100	25	35	60	70	25	35	60	70	9.5	12.5
AFGC125X	UAF	NS		NS		NS		NS		NS		NS		NS	
G1	PINE	NS		NS		NS		NS		11.31		NS		NS	
Brovold	FHWA	NS		NS		NS		NS		NS		NS		NS	
4140A	UAF2	NS		NS		NS		NS		NS		NS		NS	
4140B	FDOT	NS		13.34		NS		NS		NS		NS		NS	8.31
4141	NCAT														

Bottom Line: no consistent effect shown by any single factor across SGC models