


Testing of Specific Gravity and Absorption of Aggregates (NCHRP 4-35)

SEAUPG Annual Meeting
December 6-9, 2010




Project Objectives

- Develop test methods with balanced improvements in:
 - Accuracy, precision, ruggedness
 - Ease of use
 - Time of conditioning and testing
 - Costs of equipment and operation
 - Use for broad range of materials
- Impacts of changes to test methods on:
 - HMA mix design and PCC proportioning
 - Other aggregate characteristics
 - Technician training and qualification




Research Tasks

1. Identify test methods - Completed
2. Plan lab program - Completed
3. Prepare interim report - Completed
4. Conduct lab program – Completed
5. Plan ruggedness study - Completed
6. Conduct ruggedness study
7. Evaluate impacts of changes
8. Prepare final test procedures
9. Final report




Task 4 – Lab Testing Program

- Part 1 – Screening promising test methods
- Part 2 – Detailed evaluation
- Part 3 – Additional evaluation to reduce testing time and determine effect of P200



Part 1 Screening of Promising Test Methods







Part 1 - Screening

ID	Selected Test Method	Material Used for Evaluation
I. Test Methods for Coarse Aggregate		
I-1	AASHTO T 85 and ASTM C 127	Coarse aggregate (+ #4)
I-2	Rapid AASHTO T 85 with the CoreLok	Coarse aggregate (+ #4)
I-3	Volumetric Immersion (Phunque Flasks)	Coarse aggregate (+ #4)
II. Test Methods for Fine Aggregate		
II-1	AASHTO T 84 and ASTM C 128	Fine aggregate (- #4)
II-2	Modification to Materials Tested in AASHTO T 84/ASTM C 128	Fine aggregate (- #4 & + #200)
II-3	SSDetect System	Fine aggregate (- #4)
II-4	Modification to Materials Tested in SSDetect System	Fine aggregate (- #4 & + #200)
II-5	Volumetric Immersion (Phunque Flasks)	Fine aggregate (- #4)
II-6	AASHTO T 133	Fine material (- #200)
III. Test Methods for Combined Aggregate		
III-1	Volumetric Immersion (Phunque Flasks)	Complete gradation





Rapid AASHTO T 85

- Applicable material:
 - Coarse aggregate
- Use CoreLok to vacuum and rapidly saturate aggregate
- Use in conjunction with AASHTO T 85


Phunque Flask Methods

- Applicable materials:
 - Coarse, fine, combined aggregate
- Relatively simple operation
- Water level readings at 30 sec. and 25 hrs used in calculation
- Fragile in current design

SSDetect System





- Applicable material:
 - Fine aggregate
- Use infrared technology
- High initial cost
- Quick test compared to other methods






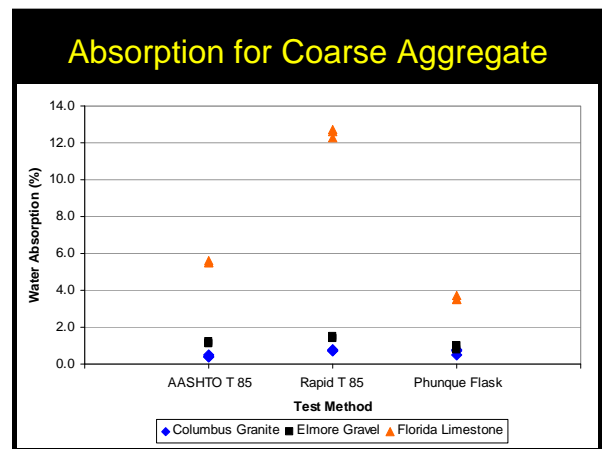
AASHTO T 133/ASTM C110

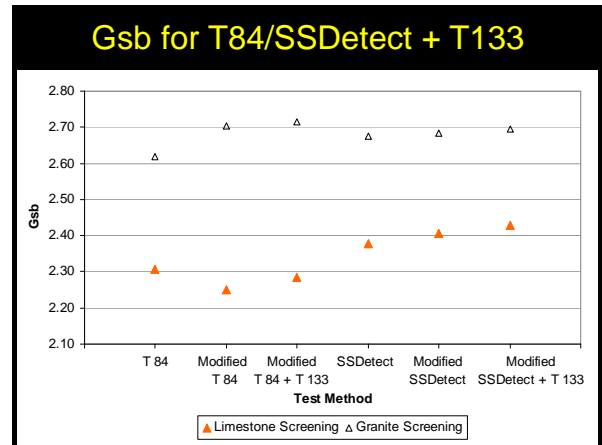
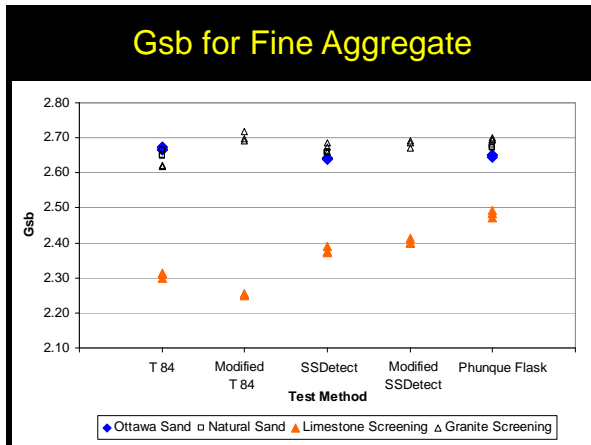
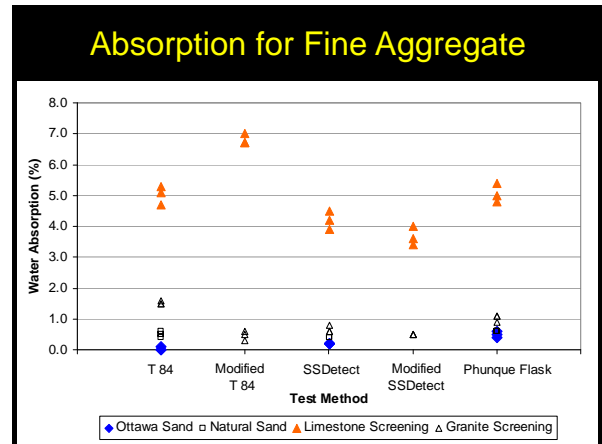
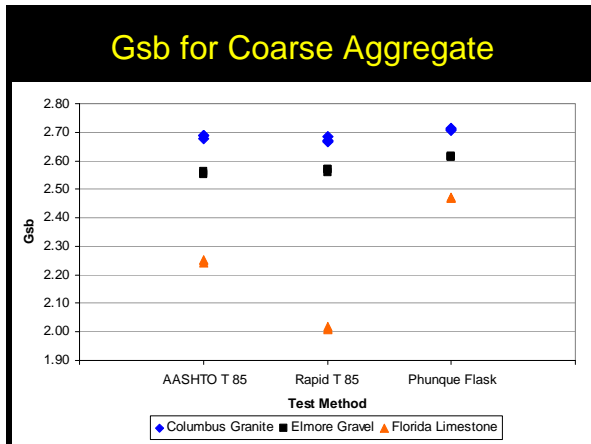
- Applicable material:
 - Passing #200
- Quick test compared to other methods
- Measure G_{sa} only

Part 1 of Task 4

ID	Materials	Source
I Coarse Aggregates		
I.1	Columbus granite (CG)	Barin Quarry, Vulcan Materials, Columbus, GA
I.2	Elmore gravel (EG)	Elmore Sand and Gravel, Elmore, AL
I.3	Florida limestone (FL)	CEMEX, Brooksville, FL
II Fine Aggregates		
II.1	Ottawa sand (OS)	Ottawa, IL
II.2	Natural sand (NS)	Foley Materials Company, Phenix City, AL
II.3	Limestone screenings (LS)	CEMEX, Brooksville, FL
II.4	Granite screenings (GS)	Barin Quarry, Vulcan Materials, Columbus, GA



Part 2

Detailed Evaluation of Selected Test Methods

Tests Evaluated in Part 2

- 2 methods for coarse aggregate:
 - AASHTO T 85
 - Rapid T 85 with CoreLok
 - AASHTO TP 77 (larger Phunque flask)
- 4 methods for fine aggregate:
 - AASHTO T 84
 - Modified AASHTO T 84 (removal of P₂₀₀)
 - AASHTO T 133/ASTM C 110 for P₂₀₀
 - ASTM D 7172 (SSDetect)
 - Modified SSDetect (removal of P₂₀₀)
 - AASHTO TP 77 (smaller Phunque flask)

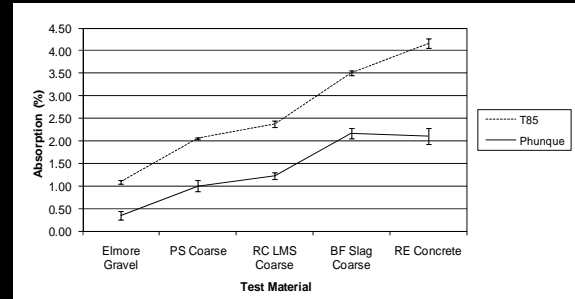
Testing Plan for Part 2

- 3 operators and 3 devices

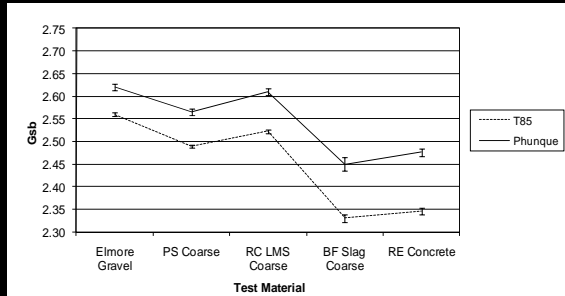
5 Coarse Aggregates	5 Fine Aggregates
Elmore gravel	Rounded natural sand
Preston sandstone	Preston sandstone
Blast furnace slag	Blast furnace slag
RC limestone	RC limestone
Recycled concrete	Texas limestone sand



Absorption for Coarse Aggregate



Gsb for Coarse Aggregate

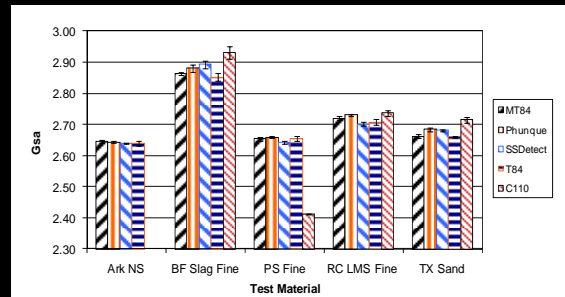


Methods for Coarse Aggregate

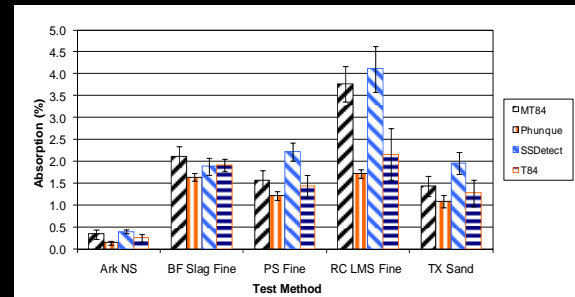
- Accuracy
 - AASHTO T 85 more rational
 - Questionable initial reading (at 30 sec.) used in Phunque method
- Precision
 - AASHTO T 85 more repeatable and reproducible

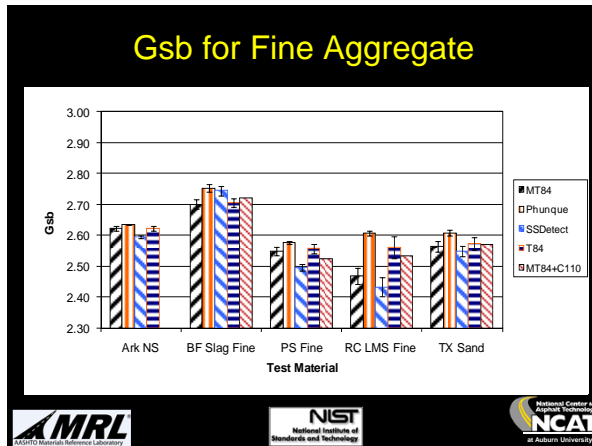


Gsa for Fine Aggregate



Absorption for Fine Aggregate





Methods for Fine Aggregate

- Accuracy
 - SSDetect is most rational, less subjective
 - Phunque method: initial reading (at 30 sec.) is questionable
 - AASHTO T 84 method: cone and tamp technique for determining SSD is subjective

Methods for Fine Aggregate (cont.)

- Precision
 - Phunque is most repeatable and reproducible
 - Modified T 84 and SSDetect yield similar r, R
 - Modified T 84's R is better than T 84's R
 - SSDetect and T 84 are affected by P200 content and absorption

Recommendations

- Coarse aggregate
 - AASHTO T 85
 - Modifications to reduce drying and soaking time





Recommendations

- Fine aggregate
 - Test + #200 and - #200 material separately
 - For - #200 material:
 - Use ASTM C 110 or AASHTO T 133 for determining Gsa
 - For + #200 material:
 - SSDetect
 - AASHTO T 84 (modifications to reduce drying and soaking time)

Part 3 Additional Evaluation to Reduce Testing Time




Testing Time

- Option 1
 - AASHTO T 85 – 3 days
 - SSDetect – 1 day
 - ASTM C110 – 1 day (optional)
- Option 2
 - AASHTO T 85 – 3 days
 - AASHTO T 84 – 3 days
 - ASTM C110 – 1 day (optional)

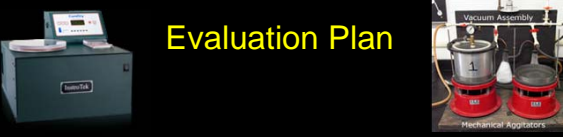





Possible Modifications

Currently Specified	Alternative	Time Savings
Dry sample using conventional oven. Cool sample in air.	Dry using vacuum drier or test in natural moisture condition	Approx. 4 hrs
Immerse sample in water for 15 to 19 hrs	Vacuum immerse sample (AASHTO T 209)	Approx. 14 hrs
Dry back sample using conventional oven. Cool sample in air.	Dry back sample using vacuum drier	Approx. 4 hrs




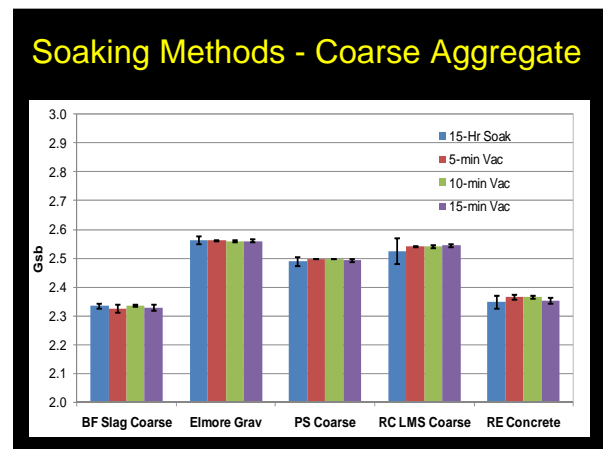
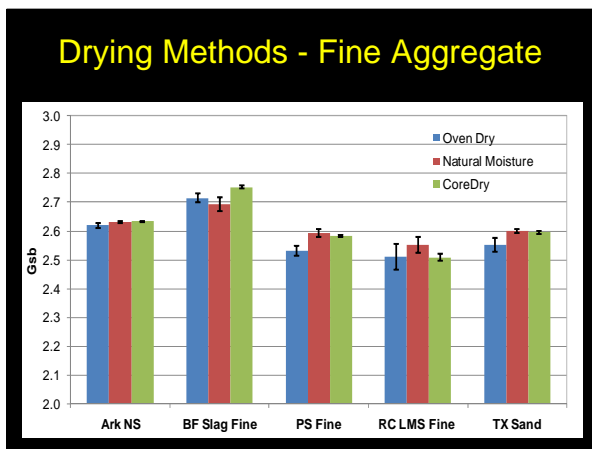
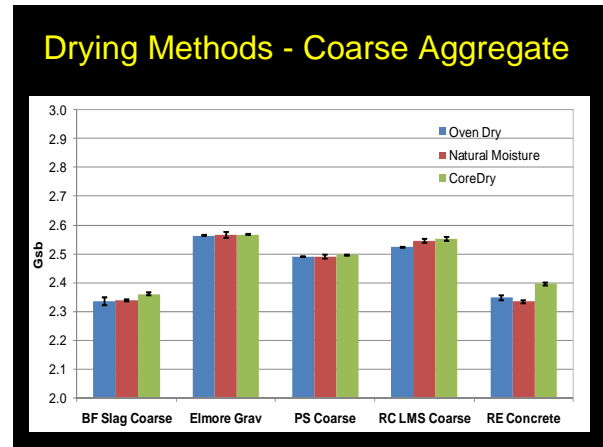




Evaluation Plan

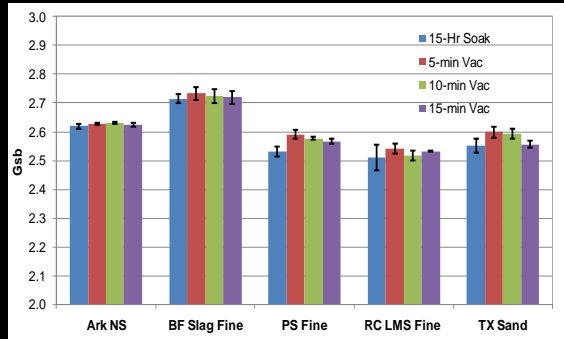


Evaluate drying methods:
oven vs. vacuum drier or natural condition

Evaluate soaking methods:
Non-vacuum immersion vs. vacuum immersion (5, 10, 15 min.)

Soaking Methods - Fine Aggregate



Summary

- Option 1
 - AASHTO T 85 – 3 days
 - SSDetect – 1 day
 - ASTM C110 – 1 day (optional)
- Option 2
 - AASHTO T 85 – 3 days
 - AASHTO T 84 – 3 days
 - ASTM C110 – 1 day (optional)



Thank You

