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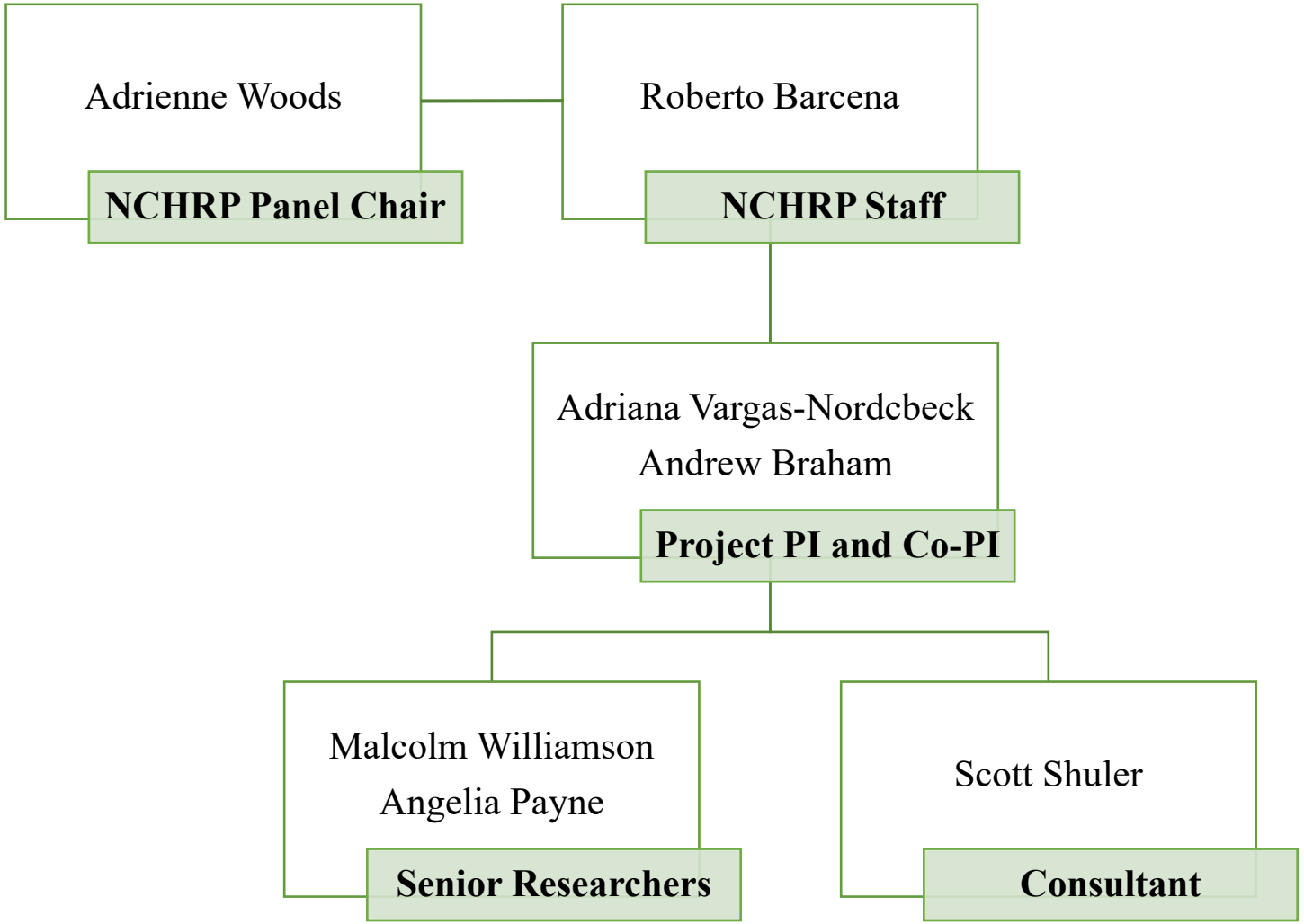
Development of a Field Test to Determine Chip Seal Aggregate Embedment

NCHRP Project No. 10-124

Research Team



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Project Panel

- Adrienne Woods (Chair), Idaho Transportation Department
- Roberto Barcena, NCHRP
- Anthony Avery, NCHRP
- Moses Akentuna, Louisiana Department of Transportation and Development
- Colin Franco, Rhode Island Department of Transportation
- Larry Galehouse
- Jaime Hernandez, Marquette University
- Nusrat Morshed, New Jersey Department of Transportation
- John Senger, Illinois Department of Transportation

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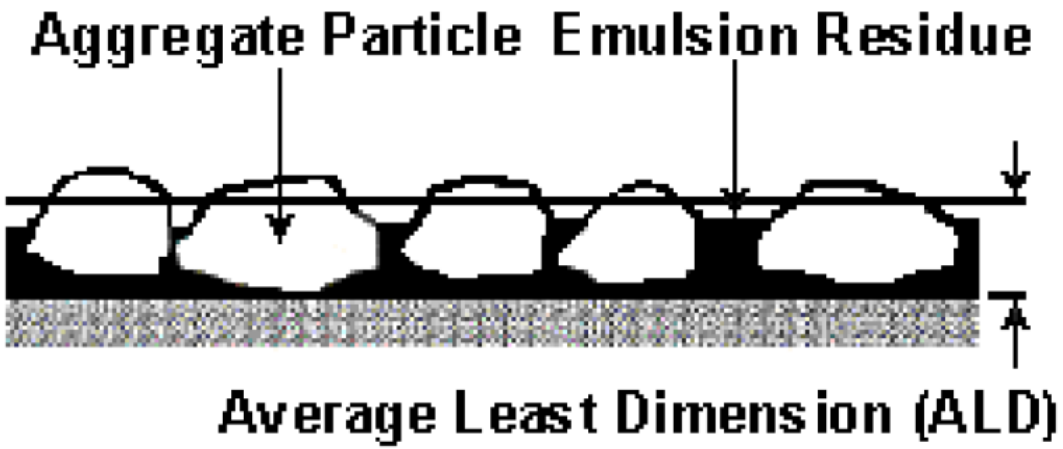
Background

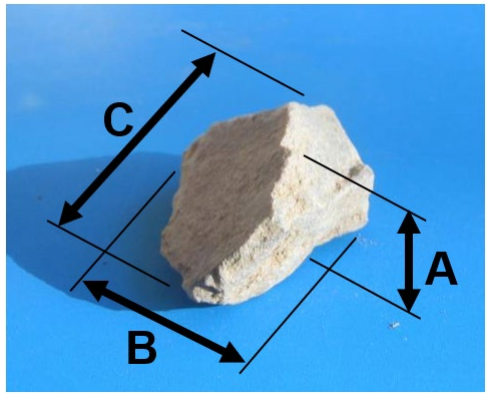
- Chip seals are popular pavement preservation treatments
- Design involves
  - Material selection – ensures materials are compatible and able to resist local conditions
  - Determination of application rates – resulting cover coat is one-stone thick and aggregate particles have proper embedment

Background

- Percent embedment (PE) is the percentage of the average least dimension (ALD) of the aggregate enveloped by the binder



ALD can be measured directly or computed based on particle size distribution and Flakiness Index



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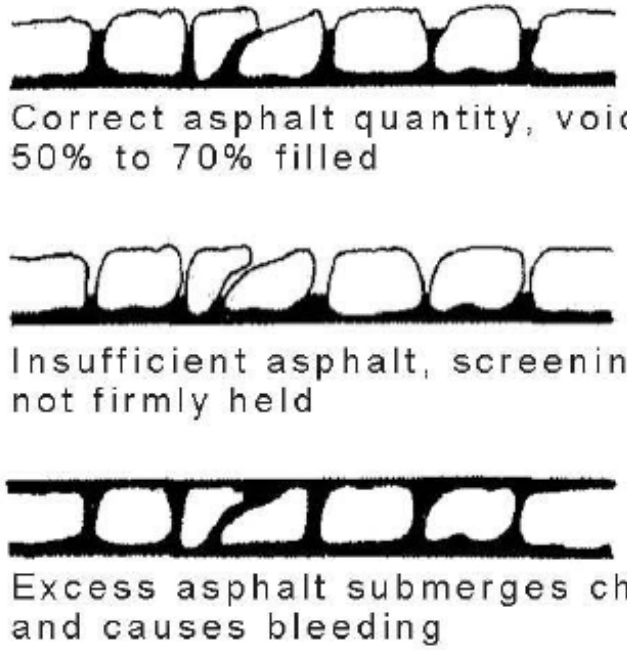
Background

- Design methods target embedment rate
  - Typically 50-70%



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Background

- Proper embedment is a key component but field verification is not standardized
  - Inspectors often rely on visual inspection

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Objective

- Identify, adapt, or develop a rapid field test method(s) to determine the percentage embedment depth of a uniformly placed chip seal of known aggregate gradation.

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Research Approach

Phase I

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Phase I

- Gather information about relevant research, methodologies, tools, and technologies that have been used or could be used in determining the actual percent embedment of chip seal aggregate
  - Published and unpublished documents
  - Agency specifications
  - Interviews with key stakeholders

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Phase I

- Several methods identified from preliminary review
  - Volumetric (sand patch)
  - Laser-based (CTM, profiler)
  - Digital image analysis
  - Light-based (LiDAR, photogrammetry, structured light scanning)

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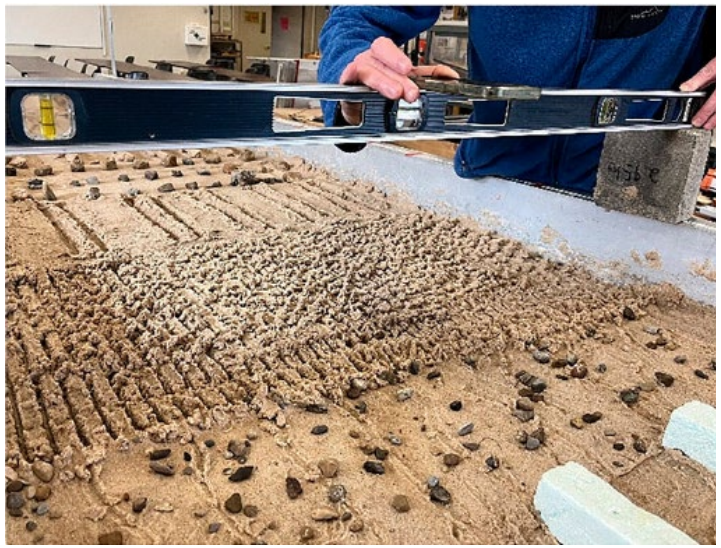

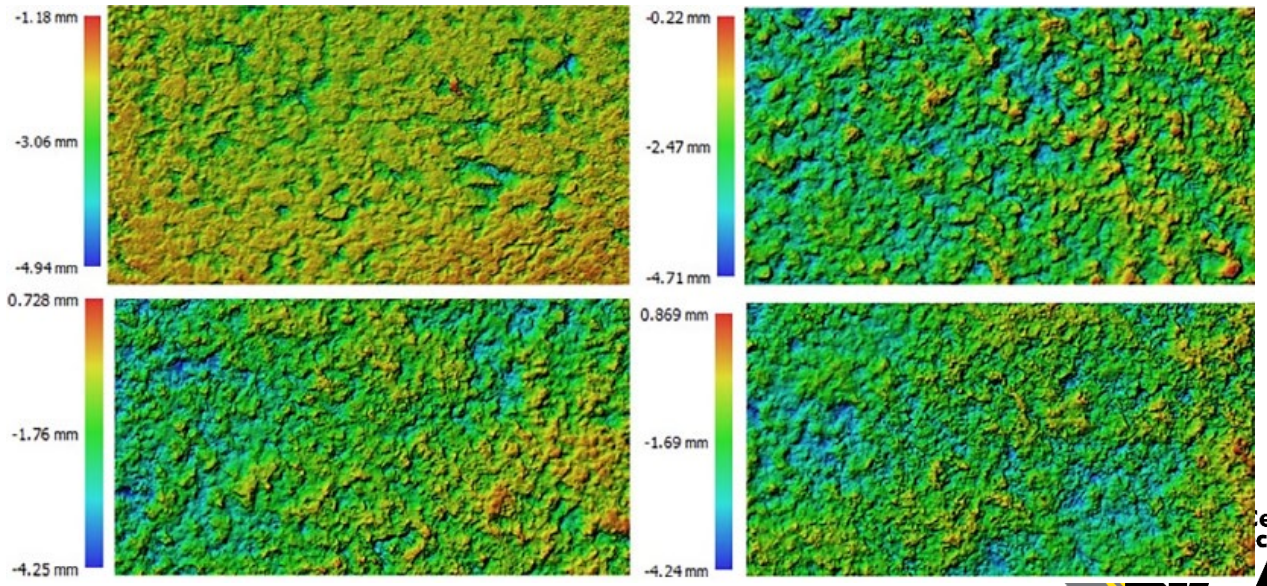

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Phase I

- Preliminary evaluation
- Stage 1 – rate tests based on equipment requirements, availability, simplicity, cost, accuracy, testing time, and analysis.
  - Identify “desirable” tests
- Stage 2 – conduct laboratory testing
  - One “standard” material (known, constant dimensions)
  - One chip seal aggregate
  - Evaluate accuracy and precision of each test
  - Identify ~ 4 tests to move forward

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Phase II

- Select tests for further analysis
  - Volumetric (sand patch)
  - Laser-based (circular texture meter)
  - Light-based (structured light scanner)
  - Light-based (Smartphone)

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Phase II

- Develop experimental matrix
  - Binder type
  - Aggregate size/binder application rate
  - Aggregate color

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Phase III

- Laboratory and field testing
  - Lab – determine applicability, accuracy, and variability under controlled conditions
  - Field – validate results during construction of chip seal projects.
    - May introduce additional factors

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Phase III

- Field testing – target a wide range of regional and climatic conditions

Region	Possible State	Notable characteristics
Southeast	Texas	Wet-no freeze climate, extensive use of hot-applied binder
	Alabama or South Carolina	Wet-no freeze climate, use of lightweight aggregate
Midwest	North Dakota or South Dakota	Dry-freeze climate, typically low traffic applications
Rocky Mountain West	New Mexico	Dry-no freeze climate, use of RAP aggregate
	Arizona	Dry-no freeze climate, high traffic applications
Northeast	Massachusetts or New Hampshire	Wet-freeze climate, use of rubber chip seals

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Phase III

- Develop and incorporate approach to assess chip seal performance based on percent embedment
  - Conduct wheel loaded test (HWTD, TWPD)

Materials	Binder application rate	Performance Evaluation	
		Aggregate loss	Bleeding
• Two aggregate sources (different sizes) • One binder source (hot-applied or emulsified asphalt)	• Low • Medium • High (based on recommended ranges by aggregate size)	• % loss by weight of aggregate	• Macrotexture and visual assessment

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Deliverables

Deliverable	Contents
Interim Report 1	• Synthesis of critical literature review. • Results of preliminary evaluation of tests. • Recommendation of tests to be considered for further evaluation.
Interim Report 2	• Detailed work plan describing the experimental matrix, including specific test methods selected for laboratory and field evaluation, and variables considered.
Interim Report 3	• Results from evaluation described in the work plan. • Recommended test(s) to determine aggregate embedment in chip seals. • Framework based on field aggregate embedment as measured by the selected tests for developing an incentive and disincentive program to maximize the performance of chip seals. • Appendix with draft test procedure(s) with supporting construction recommendation for review and consideration by the AASHTO Committee on Materials and Pavements (COMP).
Technical Memorandum	• Recommendations for implementation. • List of organizations with the expertise and resources to lead the implementation effort. • Obstacles or challenges and strategies to overcome them. • Recommended methods to evaluate the effectiveness of the implementation.

Schedule

Phase	Task	Month																																		
		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	34	35	36
I	1-Literature and Practice Review																																				
	2-Preliminary Evaluation																																				
	3-Interim Report 1								X																												
	Panel Review																																				
	Interim Meeting																																				
II	4-Develop Detailed Work Plan																																				
	5-Interim Report 2													X																							
	Panel Review																																				
	Interim Meeting																																				
III	6-Execute Work Pland																																				
	7-Interim Report 3																																			X	
	8-Technical Memorandum																																			X	
	Panel Review																																				
	Final Meeting																																				
Amplified Work Plan (AWP)		X																																		
Monthly Progress Report (MPR)			X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Quarterly Progress Report (QPR)				X			X			X			X			X			X			X			X			X			X			X			X

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Questions?

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