

SEAUPG 2004 Conference - Baton Rouge

Presented By Dr. Athar Saeed, Sr. Pavement Engineer

EXPANDING THE REALM OF POSSIBILITY

Recycled Asphalt Pavement

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APPLIED RESEARCH ASSOCIATES, INC.
An Employee-Owned Company

SEAPUG
2004 Annual Meeting

My Purpose

- Benefits of Recycling
- Recycled Asphalt Pavement (Product) – RAP
 - Production
 - Evaluation
 - Utilization
- Information Resources
- Summary

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Benefits of Recycling

- Reduction in Construction Costs
 - Disposal
 - Transportation
 - Virgin aggregate
- Conservation of Aggregates and Binders
- Conservation of Energy
- Preservation of Environment
- Preservation of existing pavement geometrics
- Reduction in User Delay

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Production of RAP

- Existing HMA layer is removed
 - Cold milling
 - Hot Scarification/Planing
 - Ripping and crushing
- Partially or wholly coated part

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Properties of Processed RAP

Property Type	Property	Typical Value
Physical	Unit weight of original HMA	120 - 140 lbs/ft ³
	Moisture content	Normal: up to 5 percent Maximum: 7 - 8 percent
	Asphalt content	Normal: 4.5 - 8 percent Maximum Range: 3 - 7 percent
	Asphalt penetration	10 - 80 at 77 °F (25 °C)
	Absolute viscosity of recovered asphalt binder	4,000 - 25,000 poises at 140 °F (60 °C)
Mechanical	Unit weight of RAP	100 - 125 lbs/ft ³
	California bearing ratio	100 % RAP: 20 - 25 % 40 % RAP & 60 % aggregate: ≥150%

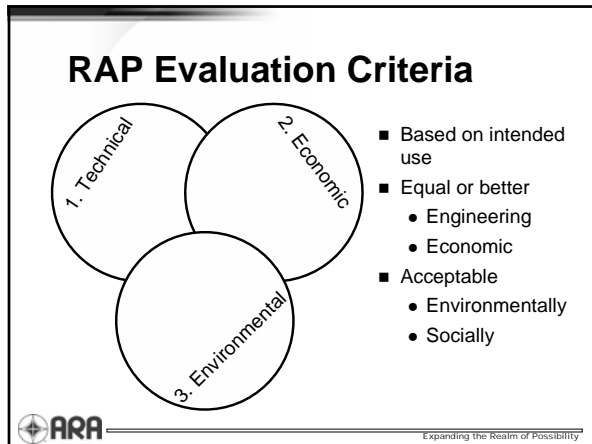
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RAP Gradation

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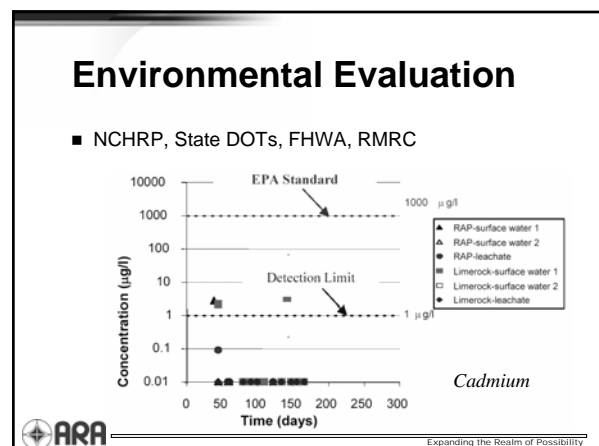
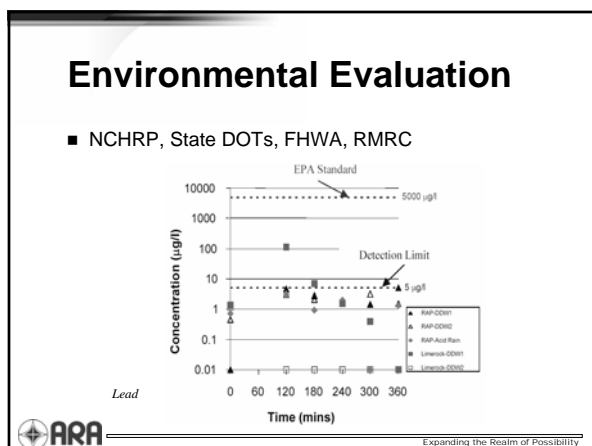
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- ### Technical Evaluation
- Initial Screening Tests
 - Sieve analysis, density,
 - Strength/Stiffness Tests
 - Static and repeated load triaxial, M_R , strain,
 - Other Tests
 - Toughness, durability,
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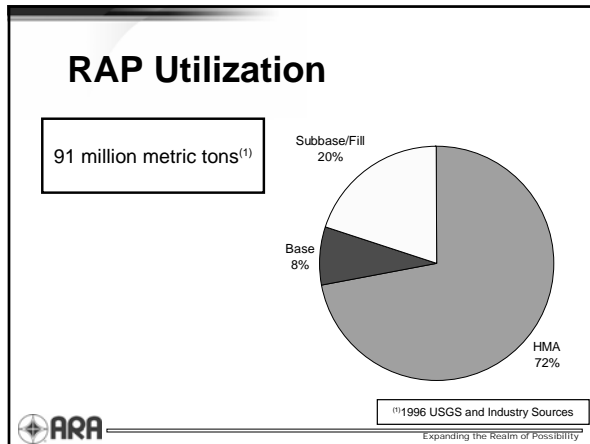
- ### Economic Evaluation
- Quantity
 - Disposal Saving
 - Transportation Saving
 - Processing Cost
 - Additional Material Cost
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- ### Societal Evaluation
- Storage Site Aesthetics
 - Safety/Health Hazard
 - Government/Special Interest Group
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- ### RAP Uses
- Hot Mix Asphalt Recycling
 - Hot In-Place Recycling
 - Cold In-Place Recycling
 - Full Depth Reclamation
 - Unbound Base/Subbase
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- ### RAP in HMA
- Typically 10 – 30 percent RAP in recycled HMA mixes
 - RAP obtained by milling or ripping and crushing
 - RAP combined with aggregate, binder, . . .
 - Production, placement, compaction
 - No difference
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- ### Hot In-Place Recycling
- Existing pavement heated and softened
 - Scarified/milled to a specified depth (up to 2 inch)
 - Single pass operation
 - Multiple pass operation
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- ### Cold In-Place Recycling
- Reuse of existing pavement material without heat
 - Virgin aggregate and/or asphalt emulsion can be added if needed
 - Placement and compaction
 - Use of a recycling train common
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- ### Full Depth Reclamation
- All asphalt pavement section and some base
 - Similar to CIR but produces a stabilized base
 - Asphalt emulsions, aggregate (if needed) added
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Unbound Base/Subbase


- RAP obtained by milling or ripping and crushing
- RAP combined with virgin aggregate if needed
- Production, placement, compaction
 - No difference



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Available Resources

- FHWA
 - <http://www.fhwa.dot.gov/pavement/recycle.htm>
 - The User Guidelines for Waste and Byproduct
- National Cooperative Highway Research Program
 - NCHRP 4-21
 - NCHRP 4-23
 -
- Recycled Materials Resource Center
 - Several research projects
- State DOTs



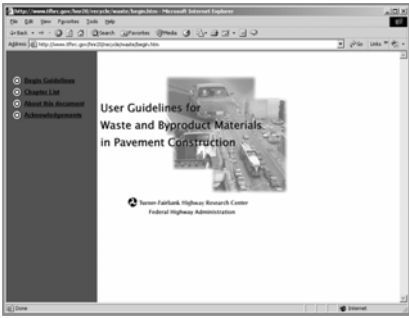

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NCHRP



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FHWA



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RMRC

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NAPA

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Summary

- Proven successful technology
- Environmentally sound
- Economical
- Conservation of natural resources



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