

## Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

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Cecil L. Jones  
Diversified Engineering Services, Inc.

### Recycled Concrete Aggregate



- What is RCA and Why Use it?
- How is it Made?
- Survey of State Practices
- Areas of Concern
- Availability and Economics
- Pathway to Expanding Use
- Challenge

### What is RCA and Why use it?



- Concrete that is no longer needed
  - Crushed to size
  - Contaminates removed
  - Meets normal aggregate specifications
  - Aggregate properties do not change
    - Good aggregates remain good aggregates
- Meets Engineering, Economic and Environmental Parameters

### What is RCA and Why use it?



- Engineering Perspective
  - Equal or better performance than virgin
  - Angularity and unhydrated cement contribute to strength increase
  - AASHTO Specification Since 2002
    - M 319 – Reclaimed Concrete Aggregate for Unbound Soil-Aggregate Base Course

## Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

### What is RCA and Why use it?



- **Economic Perspective**
  - Cost savings possible
    - \$ 2.00 to \$ 4.00 per ton savings reported
    - Contingent upon normal market forces
  - More readily available than virgin in some markets

### What is RCA and Why use it?



- **Environmental Perspective**
  - Reduces waste
    - Landfill
    - Waste pits
    - Bury on site
  - Potential energy savings
  - Reduced transportation costs
    - Can be crushed on site

### How is RCA Made



- **Concrete obtained from demolition of:**
  - **Known Sources**
    - Structures and pavements “on site”
    - Concrete elements from other projects
  - **Unknown Sources**
    - Commercial sources – actual origin may not be known

### How is RCA Made



- **Stockpiled on site**
  - Mobile crusher brought to project
- **Central crushing facility**
  - Demolition debris carried to central site
- **Main difference from virgin aggregate**
  - Removal of contaminants
    - Wood & Brick
    - Ferrous materials (reinforcing)
    - Soil

# Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

## How is RCA Made

- Manual or Mechanical pre-separation
- Primary Screening to remove soil
- Primary Crushing
- Magnetic Separation to remove steel
- Additional Crushing, Screening
- Additional Manual or Mechanical Contaminant Removal
- Washing (if required) and Final Sizing

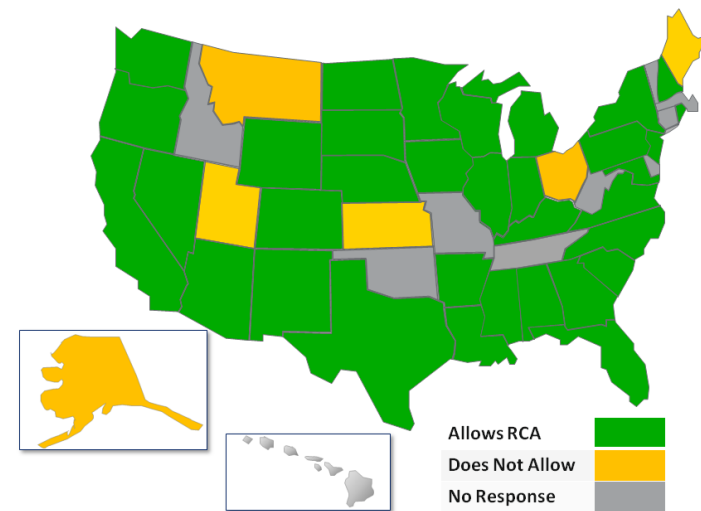
## State Practices

- Survey to State Materials Engineers
  - September 2012
- 39 States and DC Responded
- Simple Survey
  - Do you allow RCA?
  - Limitations?
  - Estimated Tonnage
  - Environmental Issues?
  - Link to Specifications

## State Practices

- 33 States Allow RCA as Base
- 7 Do Not Allow
  - Two of those considering allowing
  - One other would allow “if requested”
  - One other allowing on one project

Recycled Concrete Aggregate Base Use



## Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

### State Practices

- **Considerable Variation across States**
  - Same as Virgin Aggregates
  - 50% Blend
  - Known Source Only
  - Not with Fabric Wrapped Subdrains
  - Prequalification Requirements
  - Some Testing Variations

### State Practices

- **Estimated Tonnage Varied Considerably**
  - 1.8 Million Tons in Texas
  - One other in excess of one Million Tons
  - Several states in the 100 to 200 Thousand Tons Range
  - Several States with only Token Tonnage

### State Practices

- **Most States Had No Environmental Issues**
- **Environmental Issues Listed**
  - Leachates
  - Freeze-thaw
  - Corrosion of zinc coated and aluminum pipe (pH)
  - Precipitates
  - Asbestos & lead

### Areas of Concern

- **Leachates**
  - Corrosion of metal pipe & vegetation damage
  - Addressed in AASHTO M 319
    - Not use in low, wet areas
  - **Precipitates clogging filter fabrics**
    - RMRC developed recommendations to limit and testing protocol
    - One state blends with virgin to address

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### Areas of Concern



- **Hazardous Materials**
  - Asbestos & lead from commercial sources
  - Require Supplier certification
  - State DEPs have range of requirements
    - One legislature exempted RCA from permitting
    - One state developed a compliance agreement for RCA
    - One state exempted from solid waste regulation for on site use

### Areas of Concern



- **Gradation and Allowable Contaminants**
  - Gradation varies by state
  - Most allow 5% brick & 5% asphalt pavement
  - AASHTO M 319 gives Performance Criteria
    - CBR testing
    - Resilient Modulus testing
    - Field validation (test strips) or historical data

### Areas of Concern



- **ASR**
  - Not an issue
- **Sulfate Attack**
  - Could be an issue with some aggregates
  - Local experience valuable
  - If an issue, test soils and surface water that may contact RCA in place

### Availability and Economics



- Estimated 140 Million Tons produced annually in USA
- Market forces could increase this amount
- New Aggregate Sources costly and time consuming to open
- Some areas do not have quality virgin aggregates available



## Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

### Availability and Economics

- Cost savings of \$ 2.00 to \$ 4.00 per ton estimated from several states.
- Savings of up to \$ 6.00 per ton experienced in areas with limited supply of virgin aggregates
  - Most states do not differentiate in bids, so actual cost savings difficult to document

### Pathway to Expanding Use of RCA

- Uniform Application of Specifications
  - Varies between states
  - AASHTO M 319 only referenced by one state
- Uniform Environmental Requirements
  - Uniformity would help industry that does business across state lines – and help reduce cost

### Pathway to Expanding Use of RCA

- Technology Transfer Between States
  - Significant research completed by states
  - Similar research producing similar results by states increases costs and delays acceptance
- Advance and Improve Existing Specifications
  - Means to address remaining concerns
  - Establish ETG?

### Pathway to Expanding Use of RCA

- Identify “Champions” to Communicate Facts about RCA
- Provide Brochure or Fact Sheet for Specifiers

## Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

### Summary



- Significant Research in last 10 Years
- RCA shown to meet engineering requirements as a base material
- Most states conclude that RCA is an environmentally acceptable choice
- Many states realize economic benefits by using RCA
- National Standard in place since 2002

### Summary



RCA has exhibited that the engineering, economic and environmental benefits of using RCA warrants consideration for use in the transportation system, and is the aggregate of choice in some states.

(Summary from 2004 FHWA State of the Practice National Review)

### Challenge



- Review & Support Research
- Communicate!!
  - Understand and Address Barriers
- Build on Existing Experience
- Encourage Use of AASHTO M 319

### Challenge



- If RCA is Not Allowed in Your Area – Why Not?
  - Revisit based upon recent research
- Take actions to unify specifications across state lines
- Communicate with Stakeholders to Advance the Technology

## Examination of Engineering and Environmental Characteristics of Recycled Aggregates as Road Base and Embankments

### Resources

- Construction & Demolition Recycling Association
- TRB
- Industrial Resources Council
- FHWA
- Recycled Materials Resource Center
- State DOT Research

# Thank You