Module 4-12

Recycling Concrete Pavements

Objectives

- Identify conditions for recycling
- Identify potential benefits
- Describe the recycling process
- Describe properties of recycled aggregate and concrete
- Describe implications to mix design and structural design

Reasons to Reconstruct

- Little or no remaining life
- Substantial foundation movement
- Extensive joint deterioration
- Extensive durability problems
- Outdated geometric standards

Reasons to Reconstruct

Reasons to Reconstruct

Concrete Recycling

- Break up the existing pavement
- Haul to crushing plant
- Use as aggregate for new concrete
- Recycled coarse aggregate is more useful
- Pavements with durability problems can be recycled

Reasons for Recycling

- Dwindling landfill space
- Increasing disposal costs
- Conservation of materials
- Scarcity of high-quality aggregate
- Reduction in project cost

Uses of Recycled Concrete Aggregate

- HMA pavements
- PCC pavements
- Aggregate bases
- Stabilized bases
- Fill material
- Filter material
- Drainage layer

Limitations

- Harsher mix (less workability)
- Lower strengths
- Higher shrinkage
- Greater thermal expansion
- Less abrasion resistance

Demolition HMA Surface Removal

Demolition - Diesel Pile Hammer

Demolition - Drop Hammer

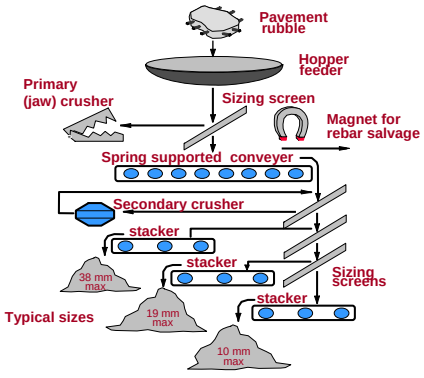
Demolition - “Headache” Ball

Demolition - Resonant Frequency Pavement Breaker

Steel Removed On Site

Steel Removal with Rhino Horn

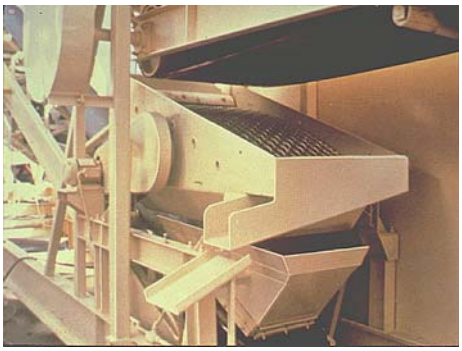
Plant Operations - Flow Chart



Plant Operations - Mobile Crushing Plant

Plant Operations - Main Hopper

Plant Operations - Sizing Screens



Plant Operations - Overview

End Product - RCA

Potential Contaminants

- Reinforcing steel
- Dowel bars and baskets
- Chemical admixtures
- Deicing salts
- Oil
- Joint sealant
- Material from underlying layers

Plant Operations - Steel Removal

Plant Operations - Steel Removal

Plant Operations - Steel Removal

Plant Operations - Steel Removal

Comparison of Aggregate Properties

Property	Virgin	RCA
Shape	Varies	Angular
Texture	Varies	Rough
Absorption, %	0.8-3.7	3.7-8.7
Specific Gravity	2.4-2.9	2.1-2.4
L.A. Abrasion, %	15-30	20-45
Sodium Sulfate, %	7-21	18-59
Magnesium Sulfate, %	4-7	1-9
Chloride Content, kg/m^3	0-1.2	0.6-7.1

PCC Mix Design

Follow conventional mix design

Adjust the amount of each component

Limit recycled fines to 30 %

Substitute portion of cement with flyash

Require higher air content

Concrete Properties

For same water-cement ratio

- **Up to 40% lower compressive strength**
- **20-40% lower elastic modulus**
- **8% lower flexural strength**

Greater resistance to freeze-thaw

Greater resistance to D-cracking

HMA Mix Design

Requires more asphalt cement

Less need for anti-stripping agent

Design Considerations

Properties affecting design

- Smaller aggregate top size
- Lower abrasion resistance

Design recommendations

- Use dowels at all transverse joints
- Use higher reinforcement contents
- Use stiffer foundation

Construction Consideration

Techniques and equipment are the same as those for normal construction

Cost Benefits

RCA production costs = $8-11/ton

Virgin aggregate costs = $13-15/ton

Eliminate disposal costs

Project savings up to 65% have been reported

Summary

Recycling is cost-effective alternative (scarcity of virgin aggregate)

Requires adjustment to mix design and pavement design

Good performance has been reported

No specialized techniques or equipment