Module 3-7

Hot In-Place Recycling

Objectives

- Types of hot in-place recycling
- Equipment and operational sequence
- Mixture design methods
- Structural layer coefficients
- Economics
- Specifications
- Quality control / Quality Assurance

Introduction - History

1930s - 1940s	Heater planer
1950s - 1960s	Heater scarification Heater repaving
1980s	Heater remixing
Late 1980s and 1990s	Increased depths Improved uniformity and air quality

General Attributes

- Soften existing asphalt pavement with heat
- Mechanically removing the pavement
- Mixing with asphalt binder and/or new mixture
- Replacing recycled pavement on surface

Methods and Equipment

- Heater scarification
- Repaving
- Remixing

Early Pavement Heater

Early Propane Heater and Scarifier

Early Propane Heater and Scarifier

Small Heater for Patching

Early Multi-Stage Heater

Typical Heater Scarifying Operation

Equipment Development and Typical Use

Early concerns

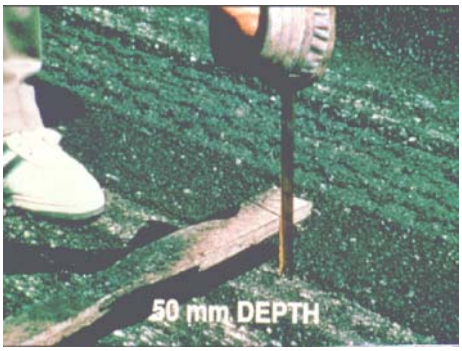
- **In-place air voids**
- **Overheating**
- **Air quality**
- **Safety**
- **Depth**
- **Production / cost**
- **Vegetation**

Equipment Development and Typical Use

Problems with Heater

Multiple Stage Heater with Milling Head

Multiple Stage Milling Removal



What Potential Problems Here?

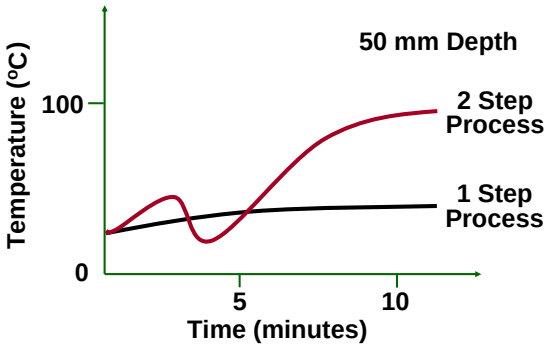
Equipment Development and Typical Use

Developments in the late 1980s, early 1990s

- **Greater depths**
- **Uniformity and control**
- **Air quality**
- **Production**

Two-Step Process

Two-Step Process



Two-Step Process Example Project

First Stage Hot Milling Head

First Stage Millings

Introduction of New Mix

Added HMA

Pavement After Second Milling

RAM and New Mix Passed to Paver

RAM and New Mix Behind Paver

Needs (1994)

- Higher mixture temperatures
- Greater depths
- Improved air quality
- Variable widths
- Reduced noise
- Larger amounts of new material
- Climb steep grades
- Better uniformity
- QC/QA guidelines

Operating Characteristics

Hot air and low level infrared for heating

Diesel and other fuels

Recirculating hot-air system air quality

Heating, stirring, drying of RAP on road surface

Five-Step Process

Preheating (units 1 and 2)

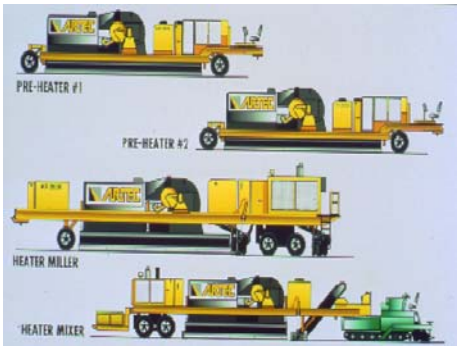
Heater / Miller (unit 3)

Heater / Mixer (unit 4)

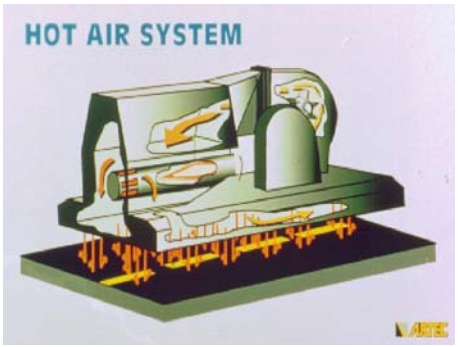
Addition of new material and mixing

Laydown and compaction

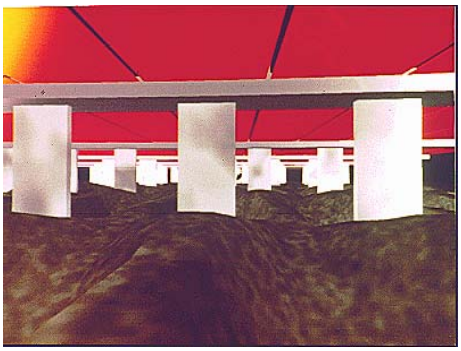
Five-Step Process



Five-Step Process



Mixing Paddles and Hot Air



Five-Step Equipment

Use of Hot In-Place Recycling

Experimental basis - 28 states

Somewhat regular basis - 10 states

Heater scarification - 13 states

Repaving - 15 states

Remixing - 16 states

Economics

Hot-In Place Recycling Operation	Approximate Cost (Dollars / sq.m.)
Heater-scarification (25 mm + recycling agent)	1.20
Heater-scarification (+ 25 mm overlay)	3.17
Repaving (recycle 25 mm + 25 mm hot-mix asphalt mixed together)	3.50
Remixing (recycle 25 mm + 10-20 percent new hot-mix asphalt)	2.75
Remixing (recycle 50 mm + 10-20 percent new hot-mix asphalt)	3.25

Guidelines For Use

- Uniformity of old pavement
- Depth of old HMA
- Presence of chip seal
- Asphalt content
- Aggregate gradation
- Asphalt properties
- Traffic
- Types of distress

Specifications

- Description
- Materials
- Mixture design
- Equipment
- Construction operation
- Acceptance
- Measurement
- Payment

Quality Control / Quality Assurance

- Adjustments for condition of old pavement
- Asphalt binder content
- In-place density
- Laboratory molded density
- Smoothness
- Depth of recycling

Summary

- HIPR types
- Equipment
- Mix design
- Economics
- Specifications
- QC /QA