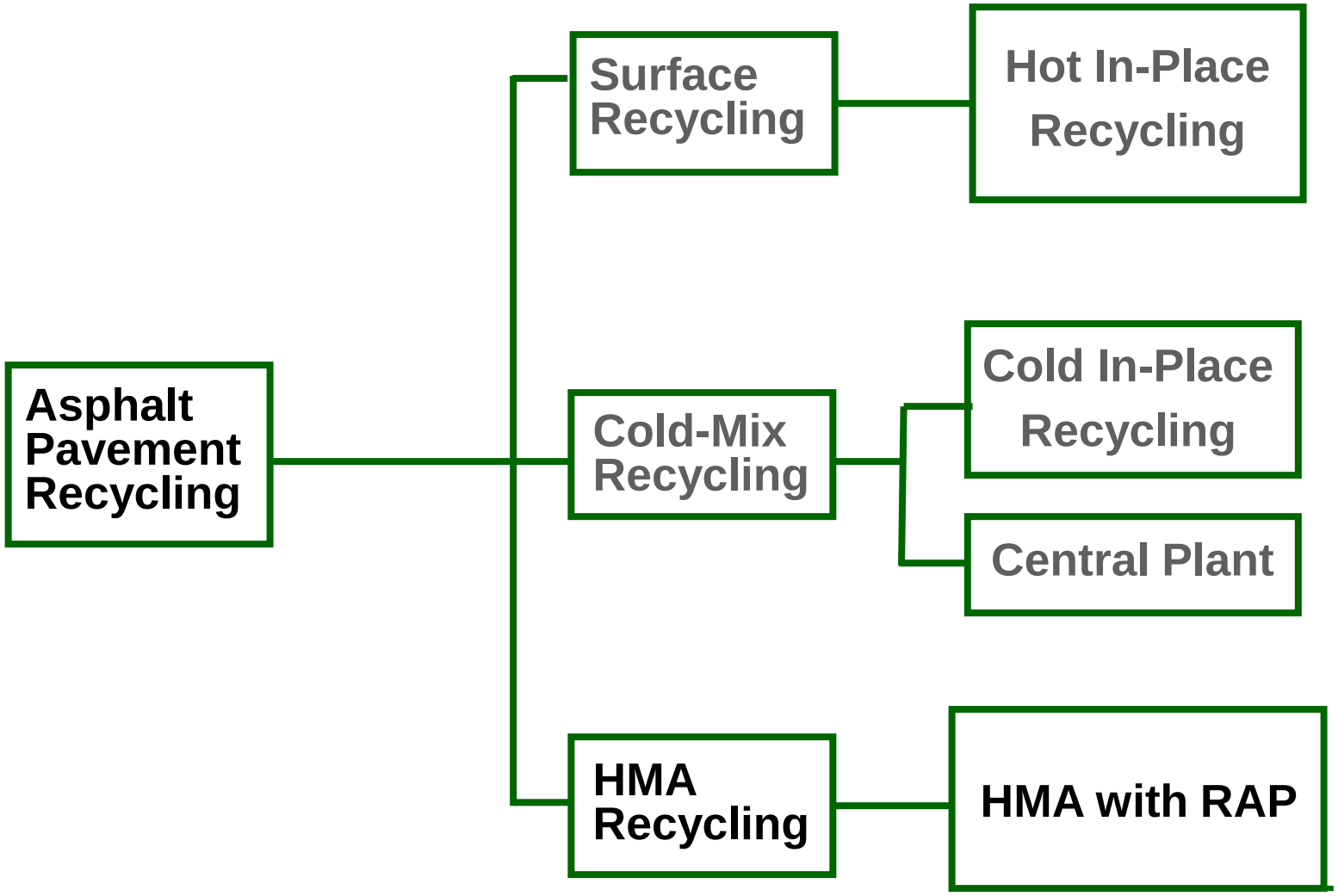
California Asphalt Pavement Association

High RAP Mixes in Asphalt Pavements

November 16, 2018
Building Better Roads Workgroup, San Diego, CA

CalAPA

Categories of Recycling



What is Reclaimed Asphalt Pavement?

- Material generated from the removal of an existing asphalt pavement or excess material generated from the production of an asphalt mix.
- Composed of aggregate and asphalt binder.

Why Use RAP?

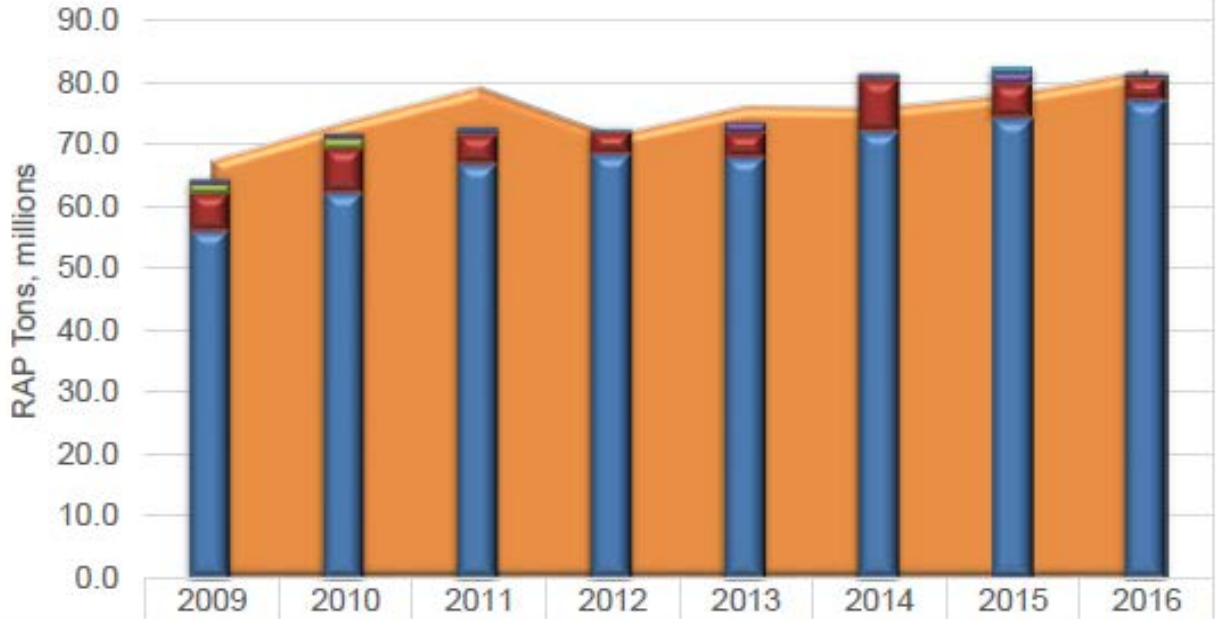
- Source of material for the production of asphalt mixes.
  - Aggregate
  - Binder
- Environmental
  - Reduce waste to landfills
  - Reduce need for material extraction, production and transportation
  - Reduce Emissions
- Mix Performance
  - Improved resistance to permanent Deformation

How much asphalt pavement is recycled?

- 77 million tons RAP used in HMA
- 99% of the asphalt pavement removed during widening and resurfacing projects reused in pavement construction

— 2016 NAPA Annual RAP/RAS/WMA Survey

Where does it go?



	2009	2010	2011	2012	2013	2014	2015	2016
Accepted	67.2	73.5	79.1	71.3	76.1	75.8	78.0	81.8
Landfilled	0.1	0.0	0.3	0.2	0.1	0.2	1.0	0.1
Used in Other	0.7	0.8	0.7	0.2	1.5	0.6	1.6	0.4
Used in Cold Mix	1.5	1.6	0.2	0.2	0.2	0.2	0.2	0.2
Used in Aggregate	6.2	7.3	4.9	3.6	4.0	8.5	5.5	3.7
Used in HMA/WMA	56.0	62.1	66.7	68.3	67.8	71.9	74.2	76.9

Engineering Mixes with RAP

Performance

RUTTING

CRACKING (FAT

Engineer the mixes to address rutting and cracking concerns! FIND THE BALANCE!!!

How old is this stuff?

- Rocks are REALLY old before we use them
- Binders are REALLY old before we use them

"So what's this? I asked for a *hammer!* A hammer! *This* is a crescent wrench! ... Well, maybe it's a hammer. ... Damn these stone tools."

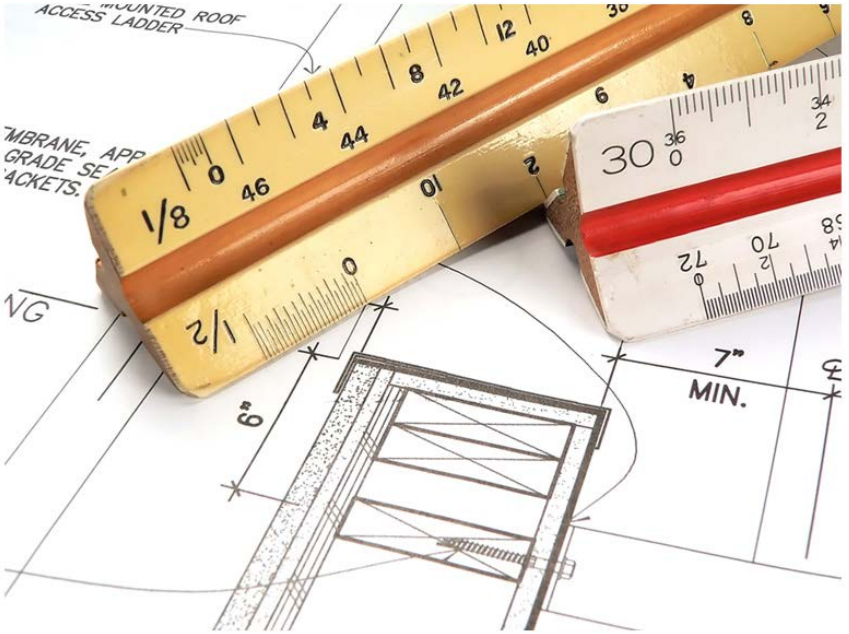
Material Characteristics

- Aggregate Characteristics
  - Aggregate Type
  - Typically same as local sources
- Aggregate Gradation
  - Fines (Mill & crush ½" or ¾" mixes)
- Binder Characteristics
  - "Stiffer"/Higher viscosity

Engineering a Solution

- Mix Design Keys:

- Aggregates
  - Adjust aggregate proportions
- Binder
  - Adjust virgin binder content
  - Adjust virgin binder grade
  - Consider additiives



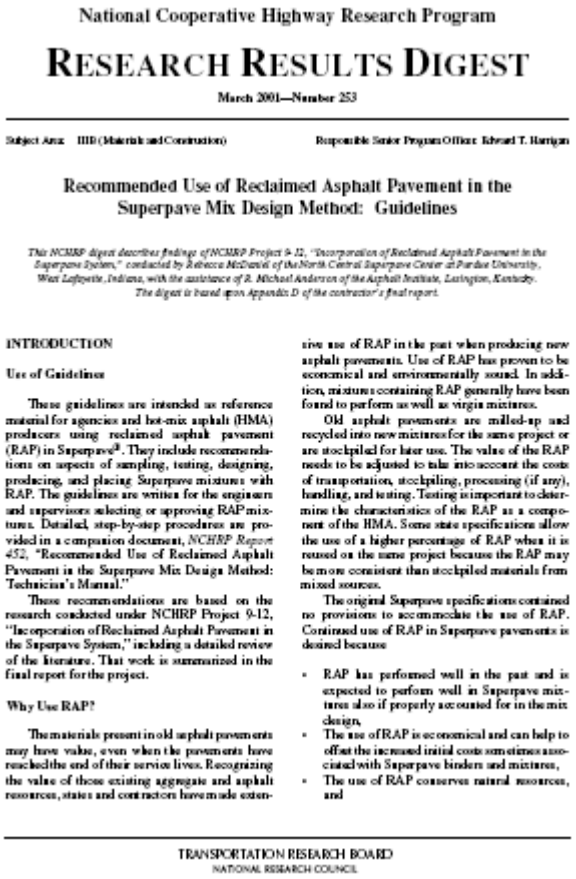
Using RAP - Research Findi

- Is extraction, rec
  and testi
  bin
  -
  -
  - E
    bin

"For low RAP contents, 10 to 20 percent, it is not necessary to do this testing because there is not enough of the old, hardened RAP binder present to change the total binder properties. At higher RAP contents, however, the RAP binder will have a noticeable effect, and it must be accounted for by using a softer grade of binder." - NCHRP Report 452

Binder Grade Adjustments

- 0-15% RAP
  - Select Normally Used Binder Grade
- 16-25% RAP
  - Reduce the specified PG grade (high and low requirements) by 6°C
    - Ex. If PG 64-10 Normal, then PG 58-16
- >25% RAP
  - Use Blending Charts



National Cooperative Highway Research Program

RESEARCH RESULTS DIGEST

March 2001—Number 253

Subject Area: IIIB (Materials and Construction) Responsible Senior Program Officer: Edward T. Harrigan

Recommended Use of Reclaimed Asphalt Pavement in the Superpave Mix Design Method: Guidelines

This NCHRP digest describes findings of NCHRP Project 9-12, "Incorporation of Reclaimed Asphalt Pavement in the Superpave System," conducted by Rebecca McDaniel of the North Central Superpave Center at Purdue University, West Lafayette, Indiana, with the assistance of R. Michael Anderson of the Asphalt Institute, Lexington, Kentucky. The digest is based upon Appendix D of the contractor's final report.

INTRODUCTION

Use of Guidelines

These guidelines are intended as reference material for agencies and hot-mix asphalt (HMA) producers using reclaimed asphalt pavement (RAP) in Superpave®. They include recommendations on aspects of sampling, testing, designing, producing, and placing Superpave mixtures with RAP. The guidelines are written for the engineers and supervisors selecting or approving RAP mixtures. Detailed, step-by-step procedures are provided in a companion document, *NCHRP Report 452*, "Recommended Use of Reclaimed Asphalt Pavement in the Superpave Mix Design Method: Technician's Manual."

These recommendations are based on the research conducted under NCHRP Project 9-12, "Incorporation of Reclaimed Asphalt Pavement in the Superpave System," including a detailed review of the literature. That work is summarized in the final report for the project.

Why Use RAP?

The materials present in old asphalt pavements may have value, even when the pavements have reached the end of their service lives. Recognizing the value of these existing aggregate and asphalt resources, states and contractors have made extensive use of RAP in the past when producing new asphalt pavements. Use of RAP has proven to be economical and environmentally sound. In addition, mixtures containing RAP generally have been found to perform as well as virgin mixtures.

Old asphalt pavements are milled-up and recycled into new mixtures for the same project or are stockpiled for later use. The value of the RAP needs to be adjusted to take into account the costs of transportation, stockpiling, processing (if any), handling, and testing. Testing is important to determine the characteristics of the RAP as a component of the HMA. Some state specifications allow the use of a higher percentage of RAP when it is reused on the same project because the RAP may be more consistent than stockpiled materials from mixed sources.

The original Superpave specifications contained no provisions to accommodate the use of RAP. Continued use of RAP in Superpave pavements is desired because

- RAP has performed well in the past and is expected to perform well in Superpave mixtures also if properly accounted for in the mix design,
- The use of RAP is economical and can help to offset the increased initial costs sometimes associated with Superpave binders and mixtures,
- The use of RAP conserves natural resources, and

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RAP Usage - Specifications

- Caltrans: allows up to 25% in HMA-A
  - 0-15% - no change in virgin Binder Grade
  - 15-25% - reduce binder grade 6C for high and low temperature. No recycling agents.
- Greenbook: allows high RAP mixes
  - 0-25% - no change in virgin binder grade
  - >25% - evaluate with blending charts to meet specified grades. Recycling agents allowed.
- City of Los Angeles: requires minimum 50% RAP in dense graded mixes with recycling agents.

Conclusions

RAP Makes Sense

- Sustainable
  - Reducing virgin resource needs
    - Petroleum
    - Aggregate
  - Reducing waste from construction projects
- Proven Performance
  - Research Projects
  - State DOTs
  - Local Agencies
- Specification tools are in-place!!!

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