



Appendix A
Preservation Treatment Options

*Tools and Tactics for Roadway Pavement Preservation: An
Implementation Guide to Preserving
High-Traffic-Volume Roadways*

Preservation Treatment Options

(An Appendix to the SHRP2 document, *Tools and Tactics for Roadway Pavement Preservation, An Implementation Guide to Preserving High-Traffic-Volume Roadways*)

Pavement preservation types and categories

Pavement preservation treatments are largely defined by their purpose, timing, and application characteristics. The effectiveness of a treatment is maximized when the pavement conditions are most suitable for being addressed by that treatment. Treatment application characteristics include the following:

- Re-working the existing pavement surface to restore profile or improve surface texture.
- Directly placing a new surface on the existing pavement surface.
- Partially removing the existing surface and placing a new surface.
- Global or blanket application versus localized or spot application.
- Type of treatment material(s) used.

Based on these application characteristics, as well as the purpose and timing, preservation treatments can be grouped into the following categories:

- **Retexturing/Reprofiling**—Revitalization of the surface texture to improve friction or other pavement-tire interactions. Removal of a small portion of the existing pavement surface to restore profile or improve surface drainage or ride quality.
- **Permanent Repairs**—Patching localized distressed areas or installing dowel bars across joints to restore the integrity or load transfer efficiency of PCC pavement slabs.
- **Crack/Joint Treatment**—Sealing or filling of cracks or joints to prevent the infiltration of water and incompressible materials, or to reinforce the pavement cracks or joints.
- **Asphalt Seals**—Global application of an asphaltic material to restore or rejuvenate the binder properties of an existing asphalt surface.
- **Asphalt-Aggregate Seals**—Global application of an asphalt-aggregate mixture to seal and protect the existing pavement surface, restore its profile, or improve its surface characteristics.
- **HMA Overlays**—Global application of a thin HMA layer to seal and protect the existing pavement surface, restore its profile, or improve its surface characteristics.

- **Mill-and-HMA Overlays**—Removal of a portion of the existing asphalt pavement surface followed by placement of a thin HMA overlay, in order to eliminate surface distress, seal and protect the existing pavement, restore profile, or improve surface characteristics.
- **Recycling**—Reuse of a portion of the existing asphalt pavement through in-place processing with material additives followed by placement as a new pavement layer, in order to eliminate surface distress, restore profile, or improve surface characteristics.
- **PCC Overlays**—Global application of a thin PCC layer to eliminate surface distress, restore profile, or improve surface characteristics.
- **Mill-and-PCC Overlays**—Removal of a portion of the existing pavement surface followed by placement of a thin PCC overlay, in order to eliminate surface distress, restore profile, or improve surface characteristics.

Because of the wide range of materials and procedures available and the numerous possibilities for pavement removal depths and material layer thicknesses, there are many conceivable preservation treatment options. Occasionally, two or more treatments may be combined, resulting in additional treatments. In addition, preservation treatments may be accompanied by a variety of preparatory activities, such as surface or base patching, leveling or shim course application (i.e., in wheelpaths, depressions, or other localized areas), bump grinding, and slab stabilization or jacking.

Table A-1 provides an expanded list of preservation treatment options for asphalt and concrete pavements. It shows the variations that are possible with each treatment type in terms of application features and materials used. It also lists other preservation treatments and preparatory activities that can be used in conjunction with the treatment.

Table A-1. Specific Preservation Treatments

Treatment Category	Treatment Type	Work Done to Existing Pavement	Materials Application	Materials Selection	Other Treatments
Reprofiling/ Retexturing	Profile milling	Patching, as needed. Shallow pavement surface removal via standard cold milling to restore transverse profile (e.g., rut removal) and/or longitudinal profile (e.g., increase smoothness).			Can be used in conjunction with patching, asphalt-aggregate seals, HMA or PCC overlays, and recycling.
	Micro milling	Patching, as needed. Shallow pavement surface removal via micro milling to improve surface texture (for safety, smoothness, and/or noise) and/or restore profile.			Can be used in conjunction with patching, asphalt-aggregate seals, HMA or PCC overlays, and recycling.
	Diamond grinding	Patching and dowel bar retrofit, as needed. Shallow pavement surface removal via diamond grinding to restore profile and improve surface texture (for safety and/or noise).			Can be used in conjunction with joint resealing, partial-/full-depth repair, and dowel bar retrofit.
	Diamond grooving	Patching and load transfer restoration, as needed. Shallow pavement surface removal via diamond grooving to improve surface texture (for safety and/or noise).			Can be used in conjunction with joint resealing and partial-/full-depth repair.
Patches/Repairs	Partial-depth repair	Partial-depth PCC removal via jack hammer or milling, and repair area cleaning.	Patching to dimensions of repair area.	Various conventional and modified cementitious materials, polymeric materials, and bituminous materials.	Can be used in conjunction with joint resealing, diamond grinding, and full-depth repair.
	Full-depth repair/ slab replacement	Full-depth PCC removal near crack or joint, or full-depth PCC slab removal.	Patching to dimensions of repair area.	Various conventional and modified cementitious cast-in-place materials, or precast PCC slabs.	Can be used in conjunction with joint resealing, diamond grinding, and partial-depth repair.
	Dowel bar retrofit	Slot creation and cleaning across joints and/or cracks having poor load transfer.	Dowel bar placement. Patching material placement.	Epoxy-coated dowel bars of various diameters and lengths. Various conventional and modified cementitious materials, and epoxy resins.	Can be used in conjunction with joint resealing and diamond grinding.

SMA: Stone matrix asphalt.

RAP: Reclaimed asphalt pavement.

Sources: Caltrans 2008, NHI 2013, Peshkin et al. 2011a, Gransberg 2010, Gransberg and James 2005, Shuler et al. 2011, Newcomb 2009, Garcia and Hansen 2001, ARRA 2001, Smith et al. 2014, Hajek et al. 2011

Table A-1. Specific Preservation Treatments (continued)

Treatment Category	Treatment Type	Work Done to Existing Pavement	Materials Application	Materials Selection	Other Treatments
Crack/Joint Seals	Crack filling	Crack cleaning and drying.	Limited filler design configurations.	Various cold-applied or hot-applied asphalt fillers with/without polymer or rubber modifiers.	For asphalt-surfaced pavements, can be used prior to asphalt-aggregate seals and overlays.
	Crack sealing	Crack routing or sawing and crack cleaning and drying to provide good-quality sealant reservoir.	Various sealant design configurations.	Various hot-applied asphalt sealants with/without polymer or rubber modifiers.	For asphalt-surfaced pavements, can be used prior to asphalt-aggregate seals and overlays. For concrete pavements, can be used in conjunction with joint resealing, diamond grinding, and partial-/full-depth repair.
	Joint resealing	Joint seal removal, joint sawing, and joint cleaning and drying to provide good-quality sealant reservoir.	Various sealant design configurations.	Various sealant backer rod types. Various hot-applied asphalt sealants with/without polymer or rubber modifiers, cold-applied elastomeric sealants (1-part silicones or 2-part polysulfides or polyurethanes), and cold-applied preformed compression seals.	Can be used in conjunction with crack sealing, diamond grinding, and partial-/full-depth repair.
Asphalt Seals	Rejuvenator seals	Surface sweeping.	<u>Single Application</u> 0.06 to 0.1 gal/yd ² (0.011 to 0.02 in. thick)	Various diluted rejuvenating emulsions (typically engineered cationic emulsions) with/ without polymer-modifiers.	Can be used in a fog seal, sand seal, or scrub seal.
	Fog seals	Surface sweeping.	<u>Single Application</u> 0.05 to 0.1 gal/yd ² (0.009 to 0.02 in. thick)	Various diluted asphalt emulsions (typically slow-set).	
Asphalt-Aggregate Seals	Sand seals	Surface sweeping.	<u>Single Application</u> 0.125 to 0.35 in. thick	Various asphalt emulsions (typically rapid-set) topped with fine aggregate.	Can include rejuvenators.
	Scrub seals	Surface sweeping.	<u>Single Application</u> 0.125 to 0.35 in. thick. <u>Multiple Application</u> 0.375 to 1.5 in. thick.	Various asphalt emulsions (typically rapid set) with/without polymer-or rubber-modifiers, topped and scrubbed with fine aggregate.	Can include rejuvenators.
	Slurry seals	Patching and crack sealing, as needed. Surface sweeping.	<u>Single Application</u> 0.125 to 0.375 in. thick	Various asphalt emulsions (typically slow-set or quick-set) with/without polymer modifiers, mixed with different sized aggregate, as follows: <ul style="list-style-type: none"> • Type I—Fine gradation (0.125-in. max size), typically used on low traffic roads. • Type II—Moderate gradation (0.25-in. max size), typically used on moderate traffic roads. • Type III—Coarse gradation (0.375-in. max aggregate size), typically used for high traffic roads. 	Type I aggregate slurries are sometimes used as a preparatory treatment for HMA overlays or surface treatments. When used on top of chip seal, referred to as cape seal.

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Table A-1. Specific Preservation Treatments (continued)

Treatment Category	Treatment Type	Work Done to Existing Pavement	Materials Application	Materials Selection	Other Treatments
Asphalt-Aggregate Seals	Microsurfacing	Patching and crack sealing, as needed. Surface sweeping.	<u>Single Application</u> 0.25 to 0.375 in. thick. <u>Double Application</u> 0.375 to 0.75 in. thick. <u>Rut Fill Application</u> 0.25 to 1.5 in. thick.	Various polymer-modified asphalt emulsions (typically cationic slow-set or quick-set) mixed with different sized aggregate, as follows: <ul style="list-style-type: none"> • Type II—Moderate gradation (0.25-in. max size), typically used as surface course for low to moderate traffic roads and as scratch/leveling courses • Type III—Coarse gradation (0.375-in. max size), typically used as surface course for high traffic roads, or as rut-filling and scratch/leveling courses 	
	Chip seals (and variant designs)	Patching and crack sealing, as needed. Surface sweeping.	<u>Single Application</u> 0.375 to 0.5 in. thick. <u>Double Application</u> 0.75 to 1.0 in. thick. <u>Triple Application</u> 1.0 to 1.5 in. thick.	Various asphalt emulsions (standard or high-float rapid-set or medium-set) with/without polymer modifiers, or hot asphalt cements topped with one-sized aggregate (0.375- to 0.625-in. max size). Also, precoated aggregate chips (typically using hot asphalt cement, but emulsion also an option).	Can include fog seal placed on surface for holding chips in place or sand seal placed on surface for “locking” chips together. Other variant designs include: <ul style="list-style-type: none"> Cape seal—Slurry seal on chip seal Racked-in-seal—Choke stone on chip seal Sandwich seal—Chip seal sandwiched between a larger aggregate application (below) and smaller aggregate application (top) Inverted seal—Double application chip seal, with bottom seal using smaller aggregate and top seal using larger aggregate Cape seal—Slurry seal or microsurfacing on chip seal Geotextile-reinforced seal—Single-course chip seal on geotextile embedded in tack coat
HMA Overlays and Mill-and-HMA Overlays	Ultrathin HMA overlay, mill-and-thin HMA overlay	Patching and/or crack sealing, as needed. Milling to required depth, as needed. Surface sweeping and tack coat.	<u>Single-Lift Application</u> 0.5 to 0.75 in. thick.	Various binder grades (PG or other), with/without polymer or rubber modifiers. Various HMA mix types (dense-graded, open-graded) and sizes/gradations (typically 0.1875- to 0.25-in. max size for dense-graded and 0.375-in. max size for open-graded). Various aggregate types (polish resistant, RAP blend).	Can include cold milling up to 1.5 in. deep for distress removal, profile improvement, and/or enhanced bonding of overlay.

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Table A-1. Specific Preservation Treatments (continued)

Treatment Category	Treatment Type	Work Done to Existing Pavement	Materials Application	Materials Selection	Other Treatments
HMA Overlays and Mill-and-HMA Overlays	Thin HMA Overlay, mill-and-thin HMA overlay	Patching and/or crack sealing, as needed. Milling to required depth, as needed. Surface sweeping and tack coat.	<u>Single-Lift Application</u> 0.875 to 1.5 in. thick. <u>Double-Lift Application</u> 1.0 to 1.5 in. thick.	Various binder grades (PG or other), with/without polymer or rubber modifiers. Various HMA mix types (dense-graded, open-graded, gap-graded/SMA) and sizes/gradations (typically 0.25- to 0.5-in. max size for dense-graded and 0.375- to 0.5-in. max size for open-graded and gap-graded). Various aggregate types (polish resistant, RAP blend).	Can include cold milling up to 1.5 in. deep for distress removal, profile improvement, and/or enhanced bonding of overlay.
	Ultrathin bonded wearing course, mill-and-ultrathin bonded wearing course	Patching and/or crack sealing, as needed. Milling to required depth, as needed. Surface sweeping and tack coat.	<u>Single-Lift Application</u> 0.375 to 0.75 in. thick.	Polymer-modified emulsion membrane. Various binder grades (PG or other) with polymer modifier. Various gap-graded HMA sizes/gradations, as follows: <ul style="list-style-type: none"> • Type A—Fine (0.25-in max size) • Type B—Moderate (0.375-in max size) • Type C—Coarse (0.5-in max size) 	Can include cold milling up to 1.5 in. deep for distress removal, profile improvement, and/or enhanced bonding of overlay
Recycling	Hot in-place recycling—surface recycling		<u>Single Application</u> 0.5 to 1.5 in. deep/thick	Various asphalt emulsion rejuvenators to improve scarified RAP-mix layer.	Can be surfaced with a thin HMA overlay or asphalt-aggregate seal (i.e., the second pass in double-pass surface recycling).
	Hot in-place recycling—remixing		<u>Single-Stage Application</u> 1 to 2 in. deep/thick. <u>Multi-Stage Application</u> 1.5 to 3 in. deep/thick (0.5 to 1.5 in. per layer).	Various asphalt emulsion rejuvenators, virgin aggregate, and/or HMA, as needed, to improve recycled RAP-mix layer.	Can be surfaced with a thin HMA overlay or asphalt-aggregate seal.
	Hot in-place recycling—repaving		<u>Single-Pass Application</u> 0.5 to 1.5 in. deep/thick recycled layer and 0.5 to 1.5 in thick integral overlay. <u>Multi-Pass Application</u> 1 to 2 in. deep/thick recycled layer (0.5 to 1 in. per layer) and 1 to 2 in. thick integral overlay.	Various asphalt emulsion rejuvenators, virgin aggregate, and/or HMA, as needed, to improve recycled RAP-mix layer. Various binder grades (PG or other) with/without polymer or rubber modifiers for integral overlay. Various HMA mix types (dense-graded, open-graded, gap-graded/SMA) and sizes/gradations (typically 0.25- to 0.5-in. max size for dense-graded and 0.375- to 0.5-in. max size for open-graded and gap-graded) for integral overlay.	

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Table A-1. Specific Preservation Treatments (continued)

Treatment Category	Treatment Type	Work Done to Existing Pavement	Materials Application	Materials Selection	Other Treatments
Recycling	Cold in-place recycling		<u>Single Application</u> 2 to 4 in. deep/thick.	Various asphalt emulsions (typically standard and high-float slow- or medium-set) with/ without polymer modifiers. Virgin aggregate, as needed, to improve RAP mix.	Can be surfaced with a thin HMA overlay or asphalt-aggregate seal.
PCC Overlays and Mill-and-PCC Overlays	Ultrathin PCC overlay, mill-and-ultrathin PCC overlay	Patching, as needed. Milling to required depth, as needed. Surface sweeping.	<u>Single Application</u> 2 to 4 in. thick.	Type I or II Portland cement mixes, with or without polyolefin or polypropylene fibers (fibrous mixes typically required for thinner application [2 to 3 in]).	For asphalt-surfaced pavements, can include cold milling up to 1.5 in. deep for distress removal, profile improvement, and/or enhanced bonding of overlay.

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