SHRP2 R23 SCOPING METHODOLOGY
Including Advanced Renewal Systems

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Introduction

The SHRP2 R23 project developed scoping guidelines for long life design and construction using existing pavements. The principal guidelines include decision matrices and associated rules supported by layer thickness tables. A web based interactive program was developed to simplify the use of this decision-making process. The program provides a set of approaches and estimates of pavement thicknesses for project scoping. This document includes renewal methods that include pavement systems developed for the SHRP2 R05 (precast pavements) and R21 (composite pavement) studies.

Scoping Methodology

A simplified view of layout and use of the R23 decision tables used in the scoping tool is shown in Figure 1 for existing flexible pavements. The first distress type considered, environment cracking, is illustrated. Similar layouts with different distress types apply to rigid and composite pavements. The scoping process uses a cascading decision order. In accordance with the figure: **One**, the order is based on the condition that requires the most aggressive renewal approach to that requiring the least. Each type of existing pavement distress is checked but once the first identified distress type is addressed the subsequent distress types are not further considered. **Two**, once a specific distress type is identified, either flexible or rigid options are selected for renewal. **Three**, an action is defined for each flexible or rigid option. This action describes treatments for the existing pavement and the appropriate thickness for the new pavement structure to be added to the existing. Tables 1 through 5 show the specific order of the scoping process with respect to pavement distress and existing pavement type. If one wishes to consider renewal options for multiple types of pavement distress for an existing pavement, each distress type can be quickly entered via the scoping tool and the results viewed.

There are limitations as to what this scoping tool can or should do. These include: (1) This is a scoping tool not a final design process. It is expected that all agency/owners will use their approved design processes for final design. (2) The interactive program does not provide guidance on short life overlay or maintenance projects. (3) It may be that local pavement practices which provide long-life solutions (30 to 50 years) are not considered by the scoping tool.

Supporting Features

The program also provides a platform for information that aid users in designing and building long life pavements using existing pavements. These include:

- Pavement Assessment Manual
- Best Practices
    - Rigid Pavements
    - Flexible Pavements
- Guide Specifications
- Life Cycle Cost Analysis
- Life Cycle Assessment (describes processes to assess environmental impact)
- Emerging Technologies or renewal strategies that may merit use in the future.

1

Start assessment at distress type and proceed downward. Once distress condition exists continue to the next column in the selected row to design criteria.

2

If one of the distress types applies to an existing pavement, select either a flexible or rigid option. Apply design criteria.

3

Distress type, design criteria, and renewal type define the action.

Distress Type and Description (Scoping Order Varies)	Renewal Pavement Type and Design Criteria		Action
Environmental Related Cracking • Transverse Cracking • Block Cracking	Flexible	Three renewal options are available. The design period (30 to 50 years), the subgrade M_R, and characterization of the existing pavement are required inputs.	Pulverize existing + thick HMA overlay
			Pulverize existing, stabilize + thick HMA overlay
			Remove and replace with HMA
	Rigid	Two options are available. The design period (30 to 50 years) and the subgrade M_R, and characterization of the existing pavement are required inputs.	Place unbonded PCC overlay
			Remove and replace with PCC
Subsequent distress types…	Flexible	…	…
	Rigid	…	…

Figure 1 Simplified View of Decision Table Layout for Existing Flexible Pavements

Decisions Tables

The decision tables and rules for the scoping tool follow as Tables 6 through 24.

Table 1 Scoping Methodology Decision Order—Existing HMA Pavements

Existing Pavement Type	Scoping Order	Distress	
		Type	Criteria
HMA	1	Transverse or Block Cracking	Present
HMA	2	Full Depth Fatigue Cracking in Wheelpath	≥ 10%
HMA	3	Stripping	Full Depth
HMA	4	Stripping	Partial Depth
HMA	5	Top Down Longitudinal and Alligator Cracking in Wheelpath	≥ 10%
HMA	6	Full Depth Fatigue Cracking in Wheelpath	< 10%
HMA	7	Top Down Longitudinal and Alligator Cracking in Wheelpath	< 10%

Table 2 Scoping Methodology Decision Order—Existing JPCP Pavements

Existing Pavement Type	Scoping Order	Distress	
		Type	Criteria
JPCP	1	D-Cracking	Moderate to High Severity
JPCP	2	D-Cracking	Light Severity
JPCP	3	Alkali-Silica Reactivity (ASR)	Present
JPCP	4	% Cracked Panels	Moderate to Severe ≥ 10%
JPCP	5	% Cracked Panels	Low to Moderate < 10%
JPCP	6	Joint Faulting	≥ 0.25 in. + D ≥ 0.04 in.
JPCP	7	Joint Faulting	≥ 0.25 in. + D < 0.04 in.
JPCP	8	Joint Faulting	< 0.25 in.
JPCP	9	Pumping	Present + D ≥ 0.04 in.
JPCP	10	Pumping	Present + D < 0.04 in.

Table 3 Scoping Methodology Decision Order—Existing JRCP Pavements

Existing Pavement Type	Scoping Order	Distress	
		Type	Criteria
JRCP	1	D-Cracking	Moderate to High Severity
JRCP	2	D-Cracking	Light Severity
JRCP	3	Alkali-Silica Reactivity (ASR)	Present
JRCP	4	Cracked Panels	Moderate to Severe ≥ 10%
JRCP	5	Cracked Panels	Low to Moderate < 10%
JRCP	6	Joint Faulting	≥ 0.25 in. + D ≥ 0.04 in.
JRCP	7	Joint Faulting	≥ 0.25 in. + D < 0.04 in.
JRCP	8	Joint Faulting	< 0.25 in.
JRCP	9	Pumping	Present + D ≥ 0.04 in.
JRCP	10	Pumping	Present + D < 0.04 in.

Table 4 Scoping Methodology Decision Order—Existing CRCP Pavements

Existing Pavement Type	Scoping Order	Distress	
		Type	Criteria
CRCP	1	Punchouts	> 5 per Mile
CRCP	2	D-Cracking	Moderate to High Severity
CRCP	3	D-Cracking	Light Severity
CRCP	4	Alkali-Silica Reactivity (ASR)	Present
CRCP	5	Punchouts	≤ 5 per mile

Table 5 Scoping Methodology Decision Order—Existing Composite Pavements

Existing Pavement Type	Scoping Order	Distress	
		Type	Criteria
JPCP Composite	1	General Pavement Condition	Poor: Indicating Damaged PCC with Severe D Cracking ASR etc
JPCP Composite	2	General Pavement Condition	Fair: Largely Reflection Cracking
CRCP Composite	1	General Pavement Condition	Poor: as indicated by > 5 punchouts per mile or other distress
CRCP Composite	2	General Pavement Condition	Fair: as indicated ≤ 5 punchouts per mile
JRCP Composite	1	General Pavement Condition	Poor: Indicating Damaged PCC with Severe D Cracking ASR etc
JRCP Composite	2	General Pavement Condition	Fair: Largely Reflection Cracking

Table 6 Scoping Process for Existing HMA Pavement and Environmental Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA	Transverse or Block Cracking	Present	Flexible	30 – 50	5, 10 or 20	1A	Pulverize Existing + Thick HMA
						1B	Pulverize Existing + Treat with Cement, Emulsion or Foamed Asphalt + Thick HMA
						1C	Remove and Replace Existing with HMA
			Rigid	30 – 50	5, 10, or 20	4A	Unbonded PCC OL**
						4B	Remove and Replace with PCCP
			Precast	30 - 39	5, 10, or 20	8A	Unbonded Precast PCC OL**
						8B	Unbonded Prestressed Precast PCC OL**
						8C	Remove and Replace with Precast PCCP
						8D	Remove and Replace with Prestressed Precast PCCP
			Composite	30 – 50	5, 10, or 20	10A	Unbonded HMA/PCC Composite OL**
						10B	Unbonded PCC/PCC Composite OL**
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
	See Table 1 for decision order						

When **Height Restrictions are present may remove HMA layers to help meet elevation limits.

Table 7 Scoping Process for Existing HMA Pavement and Full Depth Fatigue Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA	Full Depth Fatigue Cracking in Wheelpath	< 10%	Flexible	30 – 50	5, 10, or 20	1D	Full Depth Patch + HMA OL***
			Rigid	30 – 50	5, 10, or 20	4A	Unbonded PCC OL**
			Precast	30 – 39	5, 10 or 20	8A	Unbonded Precast PCC OL**
						8B	Unbonded Prestressed Precast PCC OL**
			Composite	30 – 50	5, 10 or 20	10A	Unbonded HMA/PCC Composite OL
						10B	Unbonded PCC/PCC Composite OL
		≥ 10%	Flexible	30 – 50	5, 10, or 20	1A	Pulverize Existing + Thick HMA
						1B	Pulverize Existing + Treat with Cement Emulsion or Foamed Asphalt + Thick HMA
						1C	Remove and Replace Existing with HMA
			Rigid	30 – 50	5, 10 or 20	4A	Unbonded PCC OL **
						4B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	8A	Unbonded Precast PCC OL**
						8B	Unbonded Prestressed Precast PCC OL**
						8C	Remove and Replace with Precast PCCP
						8D	Remove and Replace with Prestressed Precast PCCP
			Composite	30 – 50	5, 10 or 20	10A	Unbonded HMA/PCC Composite OL**
						10B	Unbonded PCC/PCC Composite OL**
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
	See Table 1 for decision order						

**When Height Restrictions are present may remove HMA layers to help meet elevation limits.

***Treat as remove and replace but subtract remaining HMA from the total HMA OL thickness.

Table 8 Scoping Process for Existing HMA Pavement and Materials Related Distress

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA	Stripping	Full Depth	Flexible	30 – 50	5, 10, or 20	1A	Pulverize Existing + Thick HMA
						1B	Pulverize Existing + Treat with Cement. Emulsion or Foamed Asphalt + Thick HMA
						1C	Remove and Replace Existing with HMA
			Rigid	30 – 50	5, 10, or 20	4A	Unbonded PCC OL***
						4B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	8A	Unbonded Precast PCC OL***
						8B	Unbonded Prestressed Precast PCC OL***
						8C	Remove and Replace with Precast PCCP
						8D	Remove and Replace with Prestressed Precast PCCP
			Composite	30 – 50	5, 10, or 20	10A	Unbonded HMA/PCC Composite OL***
						10B	Unbonded PCC/PCC Composite OL***
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
		Partial Depth	Flexible			1C	Remove Stripped Layers + Thick HMA OL**
			Rigid	30 – 50	5, 10, or 20	4A	Unbonded PCC OL ***
						4B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	8A	Unbonded Precast PCC OL***
						8B	Unbonded Prestressed Precast PCC OL***
						8C	Remove and Replace with Precast PCCP
						8D	Remove and Replace with Prestressed Precast PCCP
			Composite	30 – 50	5, 10, or 20	10A	Unbonded HMA/PCC Composite OL***
						10B	Unbonded PCC/PCC Composite OL***
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
	See Table 1 for decision order						

** Treat as remove and replace but subtract remaining HMA layers from total HMA OL thickness.

***When height restrictions are present may remove stripped HMA layers to help meet elevation limits.

Table 9 Scoping Process for Existing HMA Pavement and Top-Down Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA	Top Down Longitudinal and Alligator Cracking in Wheelpath	< 10%	Flexible	30 – 50	5, 10, or 20	1D	Patch Cracked Area + HMA OL**
			Rigid	30 – 50	5, 10, or 20	4A	Unbonded PCC OL***
			Precast	30 – 39	5, 10, or 20	8A	Unbonded Precast PCC OL***
						8B	Unbonded Prestressed Precast PCC OL***
			Composite	30 – 50	5, 10, or 20	10A	Unbonded HMA/PCC Composite OL
						10B	Unbonded PCC/PCC Composite OL
		≥ 10%	Flexible	30 – 50	5, 10, or 20	1C	Remove Cracked Layer + HMA OL**
			Rigid	30 – 50	5, 10 or 20	4A	Unbonded PCC OL ***
			Precast	30 – 39	5, 10, or 20	8A	Unbonded Precast PCC OL***
						8B	Unbonded Prestressed Precast PCC OL***
			Composite	30 – 50	5, 10, or 20	10A	Unbonded HMA/PCC Composite OL***
						10B	Unbonded PCC/PCC Composite OL***

** Treat as remove and replace but assume 2 inch removal of cracked wearing surface and subtract remaining HMA layers from replacement thickness for HMA OL thickness.

***When height restrictions are present may remove HMA thickness to help meet elevation limits.

Table 10 Scoping Process for Existing JPCP Pavement and D-Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JPCP	D-Cracking	Light Severity	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
					> 10	3A	Crack and Seat JPCP + HMA OL
						2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, or 20-	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	9A	Unbonded Precast PCC OL
						9B	Unbonded Prestressed Precast PCC OL
						9C	Remove and Replace with Precast PCCP
						9D	Remove and Replace with Prestressed Precast PCCP
			Composite	30 – 50	5, 10, or 20	11A	Unbonded HMA/PCC Composite OL
						11B	Unbonded PCC/PCC Composite OL
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
		Moderate to High Severity	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
						2A	Subgrade Guidelines Not Met: Remove and Replace JPCP with HMA
					> 10	2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, or 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	****	****
			Composite	30 – 50	5, 10, or 20	****	****
		See Table 2 for decision order					

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking.

Table 11 Scoping Process for Existing JPCP Pavement and Alkali-Silica Reactivity

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JPCP	Alkali-Silica Reactivity (ASR)	Present	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
						3A	Crack and Seat JPCP + HMA OL
					> 10	2C	Rubblize JPCP + HMA OL
						3A	Crack and Seat JPCP + HMA OL
			Rigid	30 – 50	5, 10, or 20	7A	Repair JPCP then Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	9A	Unbonded Precast PCC OL
						9B	Unbonded Prestressed Precast PCC OL
						9C	Remove and Replace with Precast PCCP
						9D	Remove and Replace with Prestressed Precast PCCP
			Composite	30 – 50	5, 10, or 20	11A	Unbonded HMA/PCC Composite OL
						11B	Unbonded PCC/PCC Composite OL
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
	See Table 2 for decision order						

Table 12 Scoping Process for Existing JPCP Pavement and Slab Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JPCP	% Cracked Panels	Low to Moderate < 10%	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
					> 10	3A	Crack and Seat JPCP + HMA OL
						2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, or 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	****	****
			Composite	30 – 50	5, 10, or 20	****	****
		Moderate to Severe ≥ 10%	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
					> 10	3A	Crack and Seat JPCP + HMA OL
						2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, or 20	7A	Replace Shattered Slabs + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	****	****
			Composite	30 – 50	5, 10, or 20	****	****
	See Table 2 for decision order						

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown Table 10.

Table 13 Scoping Process for Existing JPCP Pavement and Joint Faulting

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JPCP	Joint Faulting	<0.25 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
					> 10	3A	Crack and Seat JPCP + HMA OL
						2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, or 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, or 20	****	****
			Composite	30 – 50	5, 10, or 20	****	****
		≥0.25 in. + D <0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
					> 10	3A	Crack and Seat JPCP + HMA OL
						2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		≥0.25 in. + D ≥ 0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblizing JPCP + HMA OL
					> 10	3A	Crack and Seat JPCP + HMA OL
						2C	Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Consider Crack and Seat JPCP + UBOL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 2 for decision order and repeat ****sequence for **precast** and **composite pavements** as shown in Table 10.						

Table 14 Scoping Process for Existing JPCP Pavement and Pumping

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JPCP	Pumping	Present + D < 0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Improve Drainage + Crack and Seat JPCP + HMA OL
					> 10	3A	Improve Drainage + Crack and Seat JPCP + HMA OL
						2C	Improve Drainage + Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Improve Drainage + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		Present + D ≥ 0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JPCP with HMA
					6 – 10	3A	Crack and Seat JPCP + HMA OL
					> 10	3A	Improve Drainage + Crack and Seat JPCP + HMA OL
						2C	Improve Drainage + Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Improve Drainage and consider Crack and Seat JPCP + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 15 Scoping Process for Existing JRCP Pavement and D-Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JRCP	D-Cracking	Light Severity	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		Moderate to High Severity	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						2A	Subgrade Guidelines Not Met: Remove and Replace JRCP with HMA
					> 10	2C	Rubblize JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 3 for decision order						

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 16 Scoping Process for Existing JRCP Pavement and Alkali-Silica Reactivity

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JRCP	Alkali-Silica Reactivity (ASR)	Present	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Repair JRCP then Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 3 for decision order						

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 17 Scoping Process for Existing JRCP Pavement and Slab Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JRCP	Cracked Panels	Low to Moderate < 10%	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		Moderate to Severe ≥ 10%	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Replace Shattered Slabs + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 394	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 3 for decision order						

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 18 Scoping Process for Existing JRCP Pavement and Joint Faulting

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JRCP	Joint Faulting	<0.25 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		≥0.25 in. + D <0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		≥0.25 in. + D ≥ 0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	2C	Rubblize JRCP + HMA OL
						3B	Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Consider Saw, Crack, and Seat JRCP + UBOL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 3 for decision order and repeat ****sequence for **precast** and **composite pavements** as shown in Table 10.						

Table 19 Scoping Process for Existing JRCP Pavement and Pumping

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
JRCP	Pumping	Present + D < 0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	3B	Saw, Crack and Seat JRCP + HMA OL
					> 10	3B	Improve Drainage + Saw, Crack and Seat JRCP + HMA OL
						2C	Improve Drainage + Rubblize JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL + Improve Drainage
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	9A	Unbonded **Precast** PCC OL + Improve Drainage
						9B	Unbonded **Prestressed Precast** PCC OL + Improve Drainage
						9C	Remove and Replace with **Precast** PCCP
						9D	Remove and Replace with **Prestressed Precast** PCCP
			Composite	30 – 50	5, 10, 20	11A	Unbonded HMA/PCC Composite OL + Improve Drainage
						11B	Unbonded PCC/PCC Composite OL + Improve Drainage
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite
		Present + D ≥ 0.04 in.	Flexible	30 – 50	< 6	2A	Remove and Replace JRCP with HMA
					6 – 10	3B	Saw, Crack, and Seat JRCP + HMA OL
					> 10	3B	Improve Drainage + Saw, Crack and Seat JRCP + HMA OL
						2C	Improve Drainage + Rubblize JRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Improve Drainage and consider Saw, Crack, and Seat or Rubblization JRCP + UBOL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	9A	Unbonded **Precast** PCC OL + Improve Drainage and consider Saw, Crack, and Seat or Rubblization of JRCP
						9B	Unbonded **Prestressed Precast** PCC OL + Improve Drainage and consider Saw, Crack, and Seat or Rubblization of JRCP
						9C	Remove and Replace with **Precast** PCCP
						9D	Remove and Replace with **Prestressed Precast** PCCP
			Composite	30 – 50	5, 10, 20	11A	Unbonded HMA/PCC Composite OL + Improve Drainage and consider Saw, Crack, and Seat or Rubblization of JRCP
						11B	Unbonded PCC/PCC Composite OL + Improve Drainage and consider Saw, Crack, and Seat or Rubblization of JRCP
						12A	Remove and Replace with HMA/PCC Composite
						12B	Remove and Replace with PCC/PCC Composite

Table 20 Scoping Process for Existing CRCP Pavement and Punchouts

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
CRCP	Punchouts	≤ 5 per mile	Flexible	30 – 50	5, 10 or 20	5	Repair Punchouts + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Repair punchouts + Unbonded PCC OL
						7B	Remove and Replace with PCCP
				30 – 39	5, 10 or 20	6	Repair all punchouts + Bonded PCC OL
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****
		> 5 per Mile	Flexible	30 – 50	< 6	2A	Remove and Replace CRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing CRCP + HMA OL
						2A	Subgrade Guidelines Not Met: Remove and Replace CRCP with HMA
					> 10	2C	Rubblize CRCP + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Replace Shattered Slabs + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 21 Scoping Process for Existing CRCP Pavement and D-Cracking

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
CRCP	D-Cracking	Light Severity	Flexible	30 – 50	< 6	2A	Remove and Replace CRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing CRCP + HMA OL
					> 10	2C	Rubblize CRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
		Moderate to High Severity	Flexible	30 – 50	< 6	2A	Remove and Replace CRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing CRCP + HMA OL
						2A	Subgrade Guidelines Not Met: Remove and Replace CRCP with HMA
					> 10	2C	Rubblize CRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 4 for decision order						

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 22 Scoping Process for Existing CRCP Pavement and Alkali-Silica Reactivity

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
CRCP	Alkali-Silica Reactivity (ASR)	Present	Flexible	30 – 50	< 6	2A	Remove and Replace CRCP with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblizing CRCP + HMA OL
					> 10	2C	Rubblize CRCP + HMA OL
			Rigid	30 – 50	5, 10, 20	7A	Repair CRCP then Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10, 20	****	****
			Composite	30 – 50	5, 10, 20	****	****
	See Table 4 for decision order						

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 23 Scoping Process for Existing HMA/JPCP Composite Pavement and General Pavement Condition

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA/JPCP Composite Pavement	General Pavement Condition	Fair Largely Reflection Cracking	Flexible	30 – 50	<6	2A	Remove and Replace Composite with HMA
					6-10	3A	Remove HMA + Crack and Seat JPCP + HMA OL
						2B	Check Subgrade Guidelines for Rubblization if satisfied: Remove HMA + Rubblize JPCP + HMA OL
					>10	3A	Remove HMA + Crack and Seat JPCP + HMA OL
						2C	Remove HMA + Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****
		Poor Indicating Damaged PCC with Severe D Cracking ASR etc	Flexible	30 – 50	< 6	2A	Remove and Replace Composite with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblization if satisfied: Remove HMA + Rubblize JPCP + HMA OL
						2A	If Guidelines Not Met: Remove and Replace with HMA
					> 10	2C	Remove HMA + Rubblize JPCP + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Replace Shattered Slabs + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 24 Scoping Process for Existing HMA/JRCP Composite Pavement and General Pavement Condition

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA/JRCP Composite Pavement	General Pavement Condition	Fair Largely Reflection Cracking	Flexible	30 – 50	<6	2A	Remove and Replace Composite with HMA
					6-10	2B	Check Subgrade Guidelines for Rubblization if satisfied: Remove HMA + Rubblize JRCP + HMA OL
						3B	Remove HMA + Saw, Crack, and Seat JRCP + HMA OL
					>10	2C	Remove HMA + Rubblize JRCP + HMA OL
						3B	Remove HMA + Saw, Crack, and Seat JRCP + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****
		Poor Indicating Damaged PCC with Severe D Cracking ASR etc	Flexible	30 – 50	< 6	2A	Remove and Replace Composite with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblization if satisfied: Remove HMA + Rubblize JRCP + HMA OL
						2A	If Guidelines Not Met, Remove and Replace with HMA
					> 10	2C	Remove HMA + Rubblize JRCP + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Replace Shattered Slabs + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Table 25 Scoping Process for Existing HMA/CRCP Composite Pavement and General Pavement Condition

Existing Pavement Type	Distress Identification		Pavement Renewal Type	Design Criteria		Action	
	Type	Criteria		Period (years)	Subgrade M_R (1,000 psi)	Rule	Notes
HMA/CRCP Composite Pavement	General Pavement Condition	**Fair** Some reflection cracking	Flexible	30 – 50	5, 10 or 20	5	Repair Punchouts + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Repair Punchouts + Unbonded PCC OL
						7B	Remove and Replace with PCCP
				30 – 39	5, 10 or 20	6	Repair all Punchouts + Bonded PCC OL
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****
		Poor Indicating Damaged PCC with Severe D Cracking ASR etc	Flexible	30 – 50	< 6	2A	Remove and Replace Composite with HMA
					6 – 10	2B	Check Subgrade Guidelines for Rubblization if satisfied: Remove HMA + Rubblize CRCP + HMA OL
						2A	If Guidelines Not Met: Remove and Replace CRCP with HMA
					> 10	2C	Remove HMA + Rubblize CRCP + HMA OL
			Rigid	30 – 50	5, 10 or 20	7A	Replace Shattered Slabs + Unbonded PCC OL
						7B	Remove and Replace with PCCP
			Precast	30 – 39	5, 10 or 20	****	****
			Composite	30 – 50	5, 10 or 20	****	****

**** Repeat sequence as listed for **precast** and **composite pavements** with light severity D-cracking as shown in Table 10.

Decision Rules

1. Rule 1: HMA overlay over existing flexible pavement <u>or</u> remove and replace with HMA

This rule has four subgroups which define the action as well as the design table and the base value to be used in that table.

- **Rule 1A: HMA overlay over existing, pulverized full-depth flexible pavement—pulverized material used as untreated base**. Use Table 26 and 50 ksi base.
  <u>Action</u>: HMA overlay over pulverized existing flexible pavement
  <u>Description</u>: Pulverize existing flexible pavement to eliminate all cracking or materials related damage and overlay with HMA.
- **Rule 1B: HMA overlay over existing, pulverized full-depth flexible pavement—pulverized material used as treated base with cement, emulsion, or foamed asphalt binder**. Use Table 26 and 100 ksi base.
  <u>Action</u>: HMA overlay over pulverized existing flexible pavement.
  <u>Description</u>: Pulverize existing flexible pavement to eliminate all cracking or materials related damage and treat pulverized material to produce treated base and overlay with HMA.
- **Rule 1C**: **Remove and replace with HMA over untreated base**. Use Table 26 and 30 ksi base.
  <u>Action</u>: HMA overlay after removing and replacing existing HMA where needed.
  <u>Description</u>: Remove and replace existing HMA because of fatigue cracking, top down cracking, thermal cracking, stripping or other materials related distress then overlay with HMA. For stripping this may be limited to the striped layers and for top down cracking it will be limited to the top 2 inches of HMA.
- **Rule 1D**: **Patch and overlay with HMA**. Use Table 26 and 30 ksi base to determine new HMA depth but subtract existing HMA depth from new HMA depth to determine overlay depth.
  <u>Action</u>: HMA overlay after patching existing HMA where needed.
  <u>Description</u>: Patch existing HMA where fatigue cracking or top down cracking is < 10%, then overlay with HMA.

2. Rule 2: HMA overlay over existing, rubblized PCC pavement <u>or</u> remove and replace with HMA

This rule has three subgroups based on suitability of the subgrade soil to support <u>rubblization</u> of the existing PCC pavement.

- **Rule 2A: Remove and replace with HMA. If subgrade MR < 6,000 psi** or CBR < 4%, do not rubblize or crack and seat. Do remove and replace the existing JPCP or JRCP with HMA over flexible base. Use Table 26 with 5 ksi subgrade and 30 ksi base.
  <u>Action</u>: Remove and Replace existing PCC pavement.

Description: Remove and replace existing PCC pavement because the subgrade is too weak to consider cracking and seating or rubblize the existing PCC pavement.

- **Rule 2B: Rubblize + HMA overlay**. **If subgrade MR ≥ 6,000 psi but < 10,000 psi**, consult the TTI rubblization guidelines as to whether rubblization is viable. If viable, use Table 26 with 10 ksi subgrade and 50 ksi base.
  Action: Rubblize existing PCC pavement and overlay with HMA.
  Description: The existing PCC pavement may be rubblized to stop reflection cracking provided the subgrade meets the TTI guidelines for rubblization, then place thick HMA overlay. See the description of the TTI guidelines in the Pavement Assessment Manual.
- **Rule 2C: Rubblize + HMA overlay. If subgrade MR ≥ 10,000 psi**, then rubblization is a viable option. Apply Table 26 with 20 ksi subgrade and 50 ksi base.
  Action: Rubblize existing PCC pavement and overlay with HMA.
  Description: Rubblize the existing rigid pavement to minimize or eliminate reflection cracking then place thick HMA overlay. Refer to section on rubblization in the Rigid Best Practices for rubblization details.

Notes

Rubblization guidelines include the following:

1. If the subgrade MR < 6,000 psi or CBR < 4%, do not rubblize. Perform remove and replace with HMA.
2. If the subgrade MR ≥ 6,000 psi but < 10,000 psi, consult the TTI rubblization guidelines as to whether rubblization is viable.
3. If the subgrade MR ≥ 10,000 psi, then rubblization is a viable option.
4. The selection of the HMA thickness is based on a drop-down menu of subgrade moduli = 5,000 psi, 10,000 psi, or 20,000 psi. The existing pavement shall be characterized by one of four possible moduli: 30,000 psi, 50,000 psi, 75,000 psi, or 100,000 psi. It is recommended that an existing pavement modulus = 50,000 psi be used to reflect rubblized PCC.

3. Rule 3: HMA overlay over crack and seat of existing JPCP or saw, crack, and seat of existing JRCP

This Rule has two subgroups, one for cracking and seating plane Jointed concrete (JPCP) and a second which requires cutting the steel in reinforced concrete pavements (JRCP) before cracking and seating to minimize reflection cracking

- **Rule 3A: HMA overlay after cracking and seating the existing JPCP pavement.** Use Table26 with 75 ksi base.
  Action: Crack and Seat existing rigid pavement and overlay with thick HMA
  Description: Crack and Seat existing rigid pavement to minimize reflection cracking. Refer to section on cracking and seating in the Rigid Best Practices for details.
- **Rule 3B: HMA overlay after saw crack and seating the existing JRCP pavement**. Use Table 26 with a 75 ksi base.
  Action: Saw, crack and seat existing JRCP pavement and overlay with thick HMA

Description: Saw, crack and seat existing JPCP pavement to cut reinforcing steel and minimize reflection cracking. Refer to section on saw, crack and seating in the Rigid Best Practices for details.

The thicknesses for the of HMA overlay are shown as Table 26. The selection of the HMA thickness is based on a drop-down menu of subgrade moduli = 5,000 psi, 10,000 psi, or 20,000 psi. The existing pavement shall be characterized by one of four possible moduli: 30,000 psi, 50,000 psi, 75,000 psi, or 100,000 psi. It is recommended that an existing pavement modulus = 75,000 psi be used to reflect crack and seated PCC.

4. **Rule 4: Unbonded PCC overlay over existing HMA pavement or remove and replace**
   This Rule has two subgroups, one for placing an unbonded PCC overlay over existing HMA, and the other for replacing an existing pavement with PCCP placed on a flexible base.
   - **Rule 4A: Unbonded PCC overlay w**here base type is shown as flexible and thickness comes from existing pavement description rounded to the closest thickness in Table 27.
     Action: Place unbonded PCC overlay over existing HMA.
     Description: Place unbonded JPCP or CRCP overlay on existing HMA pavement. HMA thickness will be based on existing pavement thickness unless height restrictions require milling existing pavement to meet those restrictions.
   - **Rule 4B: Remove and Replace with PCCP** where base type is shown as flexible and thickness comes from Table 27 with minimum 4 inch HMA base.
     Action: Replace existing pavement.
     Description: Replace existing pavement with JPCP or CRCP over a 4 inch HMA base.

5. **Rule 5: HMA overlay over existing CRCP pavement**
   Thickness determination of an HMA overlay where base type is shown as CRCP, use Table 28 shown below.
   Action: HMA overlay of existing CRCP pavement.
   Description: HMA overlay over existing CRCP pavement which has experienced no more than 5 punchouts per mile which have been repaired before placing overlay. Note sufficient surfacing is also provided for periodic replacement of the wearing surface

6. **Rule 6: Bonded CRCP overlay over existing CRCP pavement**
   This rule applies to **bonded PCC overlays over CRCP.** Presumably, this type of PCC overlay would be CRCP (welded wire fabric for BCO thicknesses less than 8 in.; regular rebar for ≥ 8 in.). A statement by R23 on surface texture of the existing pavement prior to overlay will be required (such as cold milling, shot blasting, etc). Apply Table 29 below with the base type shown as CRCP and the thicknesses rounded to the closest thickness shown on the table.
   Action: Bonded CRCP overlay over existing CRCP pavement
   Description: Place a bonded CRCP overlay over existing CRCP pavement which has experienced no more than 5 punchouts per mile which have been repaired prior to placing overlay. Refer to Rigid Best Practices for details.

7. **Rule 7: Unbonded PCC overlay over existing PCC pavement, composite pavement or remove and replace**
   - **Rule 7A: Unbonded PCC overlay.** Thickness determination of an **unbonded PCC overlay** where base type is shown as rigid and PCC overlay thickness from Table 30. This rule applies to existing composite (HMA/PCC) as well.

Action: Place unbonded PCC overlay over existing rigid or composite pavement.
Description: Place an unbonded PCC overlay over the existing PCC or composite pavement. A 2 inch HMA layer is recommended as a bond breaker between the existing PCC and the PCC overlay. For a composite pavement, no bond breaker is required as the existing HMA will serve as the bond breaker. Refer to the section on unbonded overlays in the Rigid Best Practices for details.

- **Rule 7B: Remove and replace with PCC** where base type is shown as rigid and thickness comes from Table 27 with 4 inch HMA base.
  Action: Replace existing PCCP pavement.
  Description: Replace existing pavement with JPCP or CRCP over a 4 inch HMA base.

8. **Rule 8: Unbonded precast overlay over existing HMA pavement or remove and replace**
   This rule has four subgroups, one using a precast pavement with a standard design and the other using a precast pavement with a prestressed design.
   - **Rule 8A: Unbonded precast overlay** where the base type is shown as flexible and thickness comes from Table 27.
     Action: Place unbonded Precast Pavement overlay over existing HMA
     Description: Place unbonded Precast Pavement overlay on existing HMA pavement. HMA thickness will be based on existing pavement thickness unless height restrictions require milling existing pavement to meet those restrictions. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.
   - **Rule 8B: Unbonded prestressed precast overlay** where the base type is shown as flexible and thickness comes from Table 31 for prestressed pavement design.
     Action: Place unbonded Prestressed Precast Pavement overlay over existing HMA.
     Description: Place unbonded Prestressed Precast Pavement overlay on existing HMA pavement. HMA thickness will be based on existing pavement thickness unless height restrictions require milling existing pavement to meet those restrictions. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.
   - **Rule 8C: Remove and replace with precast pavement** where base type is shown as flexible and thickness comes from Table 27 with minimum 4 inch HMA base.
     Action: Replace existing pavement with precast pavement.
     Description: Replace existing pavement with precast over a 4 inch HMA base. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.
   - **Rule 8D: Remove and replace with prestressed precast pavement** where base type is shown as flexible and thickness comes from Table 31 with minimum 4 inch HMA base.
     Action: Replace existing pavement with prestressed precast pavement.
     Description: Replace existing pavement with prestressed precast over a 4 inch HMA base. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.

9. **Rule 9: Unbonded precast overlay over existing PCC pavement, composite pavement, or remove and replace**
   This rule has four subgroups, one using a precast pavement with a standard design and the other using a precast pavement with a prestressed design.

- **Rule 9A: Unbonded precast overlay** where the base type is shown as rigid with 2 inch HMA bond breaker and thickness comes from Table 30. This rule applies to existing composite (HMA/PCC) as well.
  Action: Place unbonded Precast Pavement overlay over existing PCC or composite pavement.
  Description: Place unbonded Precast Pavement overlay on existing PCC or composite pavement. A 2 inch HMA layer is recommended as a bond breaker between the existing PCC and the precast pavement overlay. For a composite pavement, no bond breaker is required as the existing HMA will serve as the bond breaker. Refer to the section on unbonded overlays in the Rigid Best Practices for details. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.
- **Rule 9B: Unbonded prestressed precast overlay** where the base type is shown as rigid with 2 inch HMA bond breaker and thickness comes from Table 32 for pre-stressed pavement design. This rule applies to existing composite (HMA/PCC) as well.
  Action: Place unbonded Prestressed Precast Pavement overlay over existing PCC or composite pavement.
  Description: Place unbonded Prestressed Precast Pavement overlay on existing PCC pavement. A 2 inch HMA layer is recommended as a bond breaker between the existing PCC and the precast pavement overlay. For a composite pavement, no bond breaker is required as the existing HMA will serve as the bond breaker. Refer to the section on unbonded overlays in the Rigid Best Practices for details. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.
- **Rule 9C: Remove and replace with precast pavement** where original pavement type is shown as rigid and thickness comes from Table 27 with minimum 4 inch HMA base.
  Action: Replace existing pavement with precast pavement.
  Description: Replace existing pavement with precast over a 4 inch HMA base. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.
- **Rule 9D: Remove and replace with prestressed precast pavement** where the original pavement type is shown as rigid and thickness comes from Table 31 with minimum 4 inch HMA base.
  Action: Replace existing pavement with prestressed precast pavement.
  Description: Replace existing pavement with prestressed precast over a 4 inch HMA base. Refer to Report S2-R05-RR-1 "Precast Concrete Pavement Technology" at: www.trb.org/Main/Blurbs/167788.aspx.for more information.

10. Rule 10: Unbonded composite overlay over existing HMA pavement

This rule has two subgroups, one using a composite pavement with HMA/PCC design and the other using a composite pavement with PCC/PCC "wet on wet" design.

- **Rule 10A: Unbonded composite HMA/PCC overlay** where the base type is shown as flexible pavement and apply thicknesses from Table 33.
  Action: Place unbonded composite HMA/PCC overlay over existing HMA.
  Description: Place unbonded composite HMA/PCC overlay on existing HMA pavement. Refer to Report S2 R21-RR-2 "Composite Pavement Systems-- Volume 1 HMA/PCC Composite Pavements" at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RR-2.pdf

- **Rule10B: Unbonded composite PCC/PCC overlay** where the base type is shown as flexible pavement and apply thicknesses from Table 34 for PCC/PCC pavement design.
  Action: Place unbonded composite PCC/PCC overlay over existing HMA.
  Description: Place unbonded composite PCC/PCC overlay on existing HMA pavement. The two layers represent a composite pavement with a thin high-quality PCC surfacing over a thicker structural PCC layer. Refer to Report S2 R21-RR-3 "Composite Pavement Systems--Volume 2 PCC/PCC Composite Pavements" at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RR-3.pdf.

11. Rule 11: Unbonded composite overlay over existing PCC pavement or composite pavement

This rule has two subgroups, one using a composite pavement with a HMA/PCC design and the other using a composite pavement with a PCC/PCC "wet on wet" design.

- **Rule 11A: Unbonded composite HMA/PCC overlay** where the base type is shown as rigid with 2 inch HMA bond breaker and apply thicknesses from Table 35. This rule applies to existing composite (HMA/PCC) as well.
  Action: Place unbonded composite HMA/PCC overlay over existing PCC or composite pavement.
  Description: Place unbonded composite HMA/PCC overlay over existing PCC or composite pavement. A 2 inch HMA layer is recommended as a bond breaker between the existing PCC and the composite pavement overlay. For an existing composite pavement, no bond breaker is required as the existing HMA will serve as the bond breaker. Refer to the section on unbonded overlays in the Rigid Best Practices for details, as well as the SHRP2 R21 Report S2 R21-RR-2 "Composite Pavement Systems--Volume 1 HMA/PCC Composite Pavements" at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RR-2.pdf.
- **Rule 11B: Unbonded composite PCC/PCC overlay** where the base type is shown as rigid with a 2 inch bond breaker and apply thicknesses from Table 36. This rule applies to existing composite (HMA/PCC) as well.
  Action: Place unbonded composite PCC/PCC overlay over existing PCC or composite pavement.
  Description: Place unbonded composite PCC/PCC overlay over existing PCC or composite pavement. A 2 inch HMA layer is recommended as a bond breaker between the existing PCC and the composite pavement overlay. For an existing composite pavement, no bond breaker is required as the existing HMA will serve as the bond breaker. The two layers represent a composite pavement with a thin high-quality PCC surfacing over a thicker structural PCC layer. Refer to the section on unbonded overlays in the Rigid Best Practices and the SHRP 2 R21 Report for details S2 R21-RR-3 "Composite Pavement Systems--Volume 2 PCC/PCC Composite Pavements" at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RR-3.pdf.

12. Rule 12: Remove and replace existing pavement with composite pavement

This rule has two subgroups, one using a composite pavement with a HMA/PCC design and the other using a composite pavement with a PCC/PCC "wet on wet" design with a flexible base.

- **Rule 12A: Remove and Replace with composite HMA/PCC pavement** and apply thicknesses from Table37 with a minimum of 4 inch HMA over a 6 inch thick granular base.
  Action: Replace existing pavement with composite HMA/PCC pavement.
  Description: Replace existing pavement with composite HMA/PCC pavement. Refer to S2 R21-RR-2 "Composite Pavement Systems--Volume 1 HMA/PCC Composite Pavements" at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RR-2.pdf for more information.

- **Rule 12B: Remove and Replace with composite PCC/PCC pavement** and apply thicknesses from Table 38 with a minimum of 4 inch HMA over a 6 inch thick granular base.
  Action: Replace existing pavement with composite PCC/PCC pavement.
  Description: Replace existing pavement with a composite PCC/PCC pavement. The two layers represent a composite pavement with a thin high-quality PCC surfacing over a thicker structural PCC layer. Refer to SHRP 2 R21 Report for details S2 R21-RR-3 "Composite Pavement Systems--Volume 2 PCC/PCC Composite Pavements" at: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-R21-RR-3.pdf.

Table 26 HMA Thicknesses for Remove and Replace and Overlays

HMA Overlay for Subgrade M_R = 5,000 psi.

ESALs (millions)	Existing Pavement or Base Modulus			
	30,000 psi	50,000 psi	75,000 psi	100,000 psi
≤10	10.0	9.0	8.0	6.0
10-25	11.0	10.0	8.5	6.5
25-50	12.0	11.0	9.0	7.0
50-100	13.0	11.5	9.5	7.5
100-200	14.0	12.0	10.0	7.5

HMA Overlay for Subgrade M_R = 10,000 psi.

ESALs (millions)	Existing Pavement or Base Modulus			
	30,000 psi	50,000 psi	75,000 psi	100,000 psi
≤10	10.0	8.0	7.0	6.0
10-25	11.0	9.0	8.0	6.5
25-50	12.0	9.5	8.5	7.0
50-100	12.0	10.0	8.5	7.0
100-200	13.0	11.0	9.0	7.0

HMA Overlay for Subgrade M_R = 20,000 psi.

ESALs (millions)	Existing Pavement or Base Modulus			
	30,000 psi	50,000 psi	75,000 psi	100,000 psi
≤10	9.5	7.5	6.5	5.5
10-25	10.0	8.5	7.0	6.0
25-50	11.0	9.0	7.5	6.5
50-100	11.5	9.5	8.0	6.5
100-200	12.0	10.0	8.5	7.0

Table 27 Unbonded PCC and Precast Pavement Thicknesses for Remove and Replace and Overlays over Existing HMA

Unbonded JCP or PCP over Existing HMA: Subgrade M_R = 5,000 psi

ESALs (millions)	Existing HMA Thickness							
	4 in.		6 in.		8 in.		10 in.	
	JCP	PCP	JCP	PCP	JCP	PCP	JCP	PCP
≤10	9	8.5	8.5	8.0	8.5	8.0	8.5	8.0
10-25	9.5	9.0	9.0	8.5	9.0	8.5	9.0	8.5
25-50	9.5	9.0	9.5	9.0	9.5	9.0	9.5	9.0
50-100	10.0	9.5	10.0	9.5	10.0	9.5	10.0	9.5
100-200	13.0	12.5	12.5	12.0	12.0	11.5	11.5	11.0

Unbonded JCP or PCP over Existing HMA: Subgrade M_R = 10,000 psi

ESALs (millions)	Existing HMA Thickness							
	4 in.		6 in.		8 in.		10 in.	
	JCP	PCP	JCP	PCP	JCP	PCP	JCP	PCP
≤10	8.5	8.0	8.5	8.0	8.0	8.0	8 .0	8.0
10-25	9.0	8.5	9.0	8.5	9.0	8.5	9.0	8.5
25-50	9.5	9.0	9.5	9.0	9.5	9.0	9.5	9.0
50-100	10.5	10.0	10.0	9.5	10.0	9.5	10.0	9.5
100-200	12.0	11.5	12.0	11.5	11.5	11.0	11.5	11.0

Unbonded JCP or PCP over Existing HMA: Subgrade M_R = 20,000 psi

ESALs (millions)	Existing HMA Thickness							
	4 in.		6 in.		8 in.		10 in.	
	JCP	PCP	JCP	PCP	JCP	PCP	JCP	PCP
≤10	8.5	8.0	8.0	8.0	8.0	8.0	7.5	7.5
10-25	9.0	8.5	9.0	8.5	8.5	8.0	8.5	8.0
25-50	10.0	9.5	9.5	9.0	9.5	9.0	9.5	9.0
50-100	10.5	10.0	10.0	9.5	10.0	9.5	10.0	9.5
100-200	11.5	11.0	11.5	11.0	11.5	11.0	11.0	10.5

Note: Unbonded precast PCC thicknesses after Table 8.3 "Precast Concrete Pavement Technology," Final Report, March 2012 at: http://www.trb.org/Main/Blurbs/167788.aspx A project specific design is required.

Table 28 HMA Overlay Thicknesses over Existing CRCP with Existing Pavement or Base Modulus = 100,000 psi

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	6.0	6.0	5.5
10-25	6.5	6.5	6.0
25-50	7.0	7.0	6.5
50-100	7.5	7.0	6.5
100-200	7.5	7.0	7.0

Table 29 Bonded CRCP Overlay Thicknesses over Existing CRCP

Bonded CRCP Overlay over CRCP: Subgrade M_R = 5,000 psi

ESALs (millions)	Existing PCC Thickness (CRCP)		
	8 in.	10 in.	12 in.
≤10	6.0	6.0	6.0
10-25	7.0	6.5	6.5
25-50	8.0	7.0	7.0
50-100	10.0	8.0	8.0

Bonded CRCP Overlay over CRCP: Subgrade M_R = 10,000 psi

ESALs (millions)	Existing PCC Thickness (CRCP)		
	8 in.	10 in.	12 in.
≤10	6.0	6.0	6.0
10-25	7.0	6.5	6.5
25-50	8.0	7.0	7.0
50-100	10.0	8.0	8.0

Bonded CRCP Overlay over CRCP: Subgrade M_R = 20,000 psi

ESALs (millions)	Existing PCC Thickness (CRCP)		
	8 in.	10 in.	12 in.
≤10	6.0	6.0	6.0
10-25	7.0	6.5	6.5
25-50	8.0	7.0	7.0
50-100	10.0	8.0	8.0

Table 30 Unbonded PCC and Precast Pavement Overlay over Existing PCC
Unbonded PCC or PCP over PCC with 2 inch HMA bond breaker

ESALs (millions)	Subgrade Modulus					
	5,000 psi		10,000 psi		20,000 psi	
	JCP	PCP	JCP	PCP	JCP	PCP
≤10	8.5	8.0	8.0	8.0	8.0	8.0
10-25	9.0	8.5	9.0	8.5	8.5	8.0
25-50	9.5	9.0	9.5	9.0	9.5	9.0
50-100	10.0	9.5	10.0	9.5	10.0	9.5
100-200	12.0	11.5	11.5	11.0	11.5	11.0

Notes: (1) Unbonded precast PCC thicknesses after Table 8.3 "Precast Concrete Pavement Technology," Final Report, March 2012 at: http://www.trb.org/Main/Blurbs/167788.aspx A project specific design is required. (2) This table also applies to existing composite pavement (HMA/PCC) without the 2 inch HMA bond breaker

Table 31 Unbonded Prestressed Precast Pavement Overlay Thicknesses over Existing HMA

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	8.0	8.0	8.0
10-25	8.0	8.0	8.0
25-50	8.0	8.0	8.0
50-100	8.0	8.0	8.0
100-200	8.0	8.0	8.0

Note: Thickness estimates from Table 8.4 "Precast Concrete Pavement Technology" at http://www.trb.org/Main/Blurbs/167788.aspx a project specific design is required.

Table 32 Unbonded Prestressed Precast PCC Pavement Overlay over Existing PCC
Unbonded Prestressed Precast PCC over PCC with 2 inch bond breaker*

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	8.0	8.0	8.0
10-25	8.0	8.0	8.0
25-50	8.0	8.0	8.0
50-100	8.0	8.0	8.0
100-200	8.0	8.0	8.0

Notes: (1) Thickness estimates from Table 8.4 "Precast Concrete Pavement Technology" at: http://www.trb.org/Main/Blurbs/167788.aspx a project specific design is required. (2) This table also applies to existing composite pavement (HMA/PCC) without the 2 inch HMA bond breaker.

Table 33 Unbonded Composite HMA/ PCC Pavement Overlay over Existing HMA

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	2/7	2/7	2/7
10-25	2/7.5	2/7.5	2/7
25-50	2/8	2/8	2/8
50-100	2/9	2/9	2/9
100-200	2/10	2/10	2/10

Notes: (1) The two values shown represent HMA thickness over PCC thickness in inches, (2) 1.25 inch dowels for total PCC thickness < 9 inches and 1.5 inch dowels for thickness ≥ 9 inches

Table 34 Unbonded Composite PCC/ PCC Pavement Overlay over Existing HMA

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	2/7	2/7	2/7
10-25	2/7.5	2/7.5	2/7
25-50	2/8	2/8	2/8
50-100	2/9	2/8.5	2/8.5
100-200	2/13.5	2/12.5	2/12

Notes: (1) The two values shown represent PCC thickness over PCC thickness in inches with the first thickness representing higher quality PCC than the second, (2) 1.25 inch dowels for total PCC thickness < 9 inches and 1.5 inch dowels for thickness ≥ 9 inches

Table 35 Unbonded Composite HMA/ PCC Pavement Overlay over Existing PCC Existing PCC with 2 inch thick bond breaker

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	2/7	2/7	2/7
10-25	2/7	2/7	2/7
25-50	2/7.5	2/7.5	2/7.5
50-100	2/8.5	2/8.5	2/8.5
100-200	2/9	2/9	2/9

Notes: (1) The two values shown represent HMA thickness over PCC thickness in inches, (2) 1.25 inch dowels for total PCC thickness < 9 inches and 1.5 inch dowels for thickness ≥ 9 inches. (3) This table also applies to existing composite pavement (HMA/PCC) without the 2 inch HMA bond breaker..

Table36 Unbonded Composite PCC/ PCC Pavement Overlay over Existing PCC Existing PCC with 2 inch thick bond breaker

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	2/6.5	2/6	2/6
10-25	2/7	2/7	2/6.5
25-50	2/7.5	2/7.5	2/7.5
50-100	2/8.5	2/8	2/8
100-200	2/11.5	2/10.5	2/10

Notes: (1) The two values shown represent PCC thickness over PCC thickness in inches with the first thickness representing higher quality PCC than the second, (2) 1.25 inch dowels for total PCC thickness < 9 inches and 1.5 inch dowels for thickness ≥ 9 inches, (3) Existing PCC pavement is assumed to be 9 inches of PCC over a 6 inch granular base. (4) This table also applies to existing composite pavement (HMA/PCC) without the 2 inch bond breaker.

Table 37 Remove and Replace with Composite HMA/ PCC Pavement Composite HMA/PCC over 4 inch of HMA and 6 inch Granular Base

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	2/7	2/7	2/7
10-25	2/7.5	2/7.5	2/7
25-50	2/8	2/8	2/8
50-100	2/9	2/9	2/9
100-200	2/10	2/10	2/10

Notes: (1) The two values shown represent HMA thickness over PCC thickness in inches, (2) 1.25 inch dowels for total PCC thickness < 9 inches and 1.5 inch dowels for thickness ≥ 9 inches

Table 38 Remove and Replace with Composite PCC/ PCC Pavement Composite PCC/PCC over 4 inch HMA and 6 inch Granular Base

ESALs (millions)	Subgrade Moduli		
	5,000 psi	10,000 psi	20,000 psi
≤10	2/7	2/7	2/7
10-25	2/7.5	2/7.5	2/7
25-50	2/8	2/8	2/8
50-100	2/9	2/8.5	2/8.5
100-200	2/13.5	2/12.5	2/12

Note: (1) The two values shown represent PCC thickness over PCC thickness in inches with the first thickness representing higher quality PCC than the second, (2) 1.25 inch dowels for total PCC thickness < 9 inches and 1.5 inch dowels for thickness ≥ 9 inches