Pavement Rehabilitation Options in Indiana

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Decision to select treatment options

Rehabilitation Treatment Overview

Objectives

- Identify maintenance/rehabilitation treatments.
- Benefits of good timing.
- Preventive maintenance and its principles.

Introduction

- How do PCC pavements typically deteriorate?
- When is functional performance impaired?
- What about structural performance?
- What treatments are commonly used?

PCC Rehabilitation Treatments

- PCC Overlays
- HMA Overlays
- PCC Pavement Recycling
- Accelerated Rigid Paving Techniques
- Feasible Treatment Identification

Treatment Information

- Definitions
- Purpose and Applications
- Limitations and Effectiveness
- Design Considerations
- Pavement Surveys
- Cost Considerations
- Construction Considerations
- Equipment

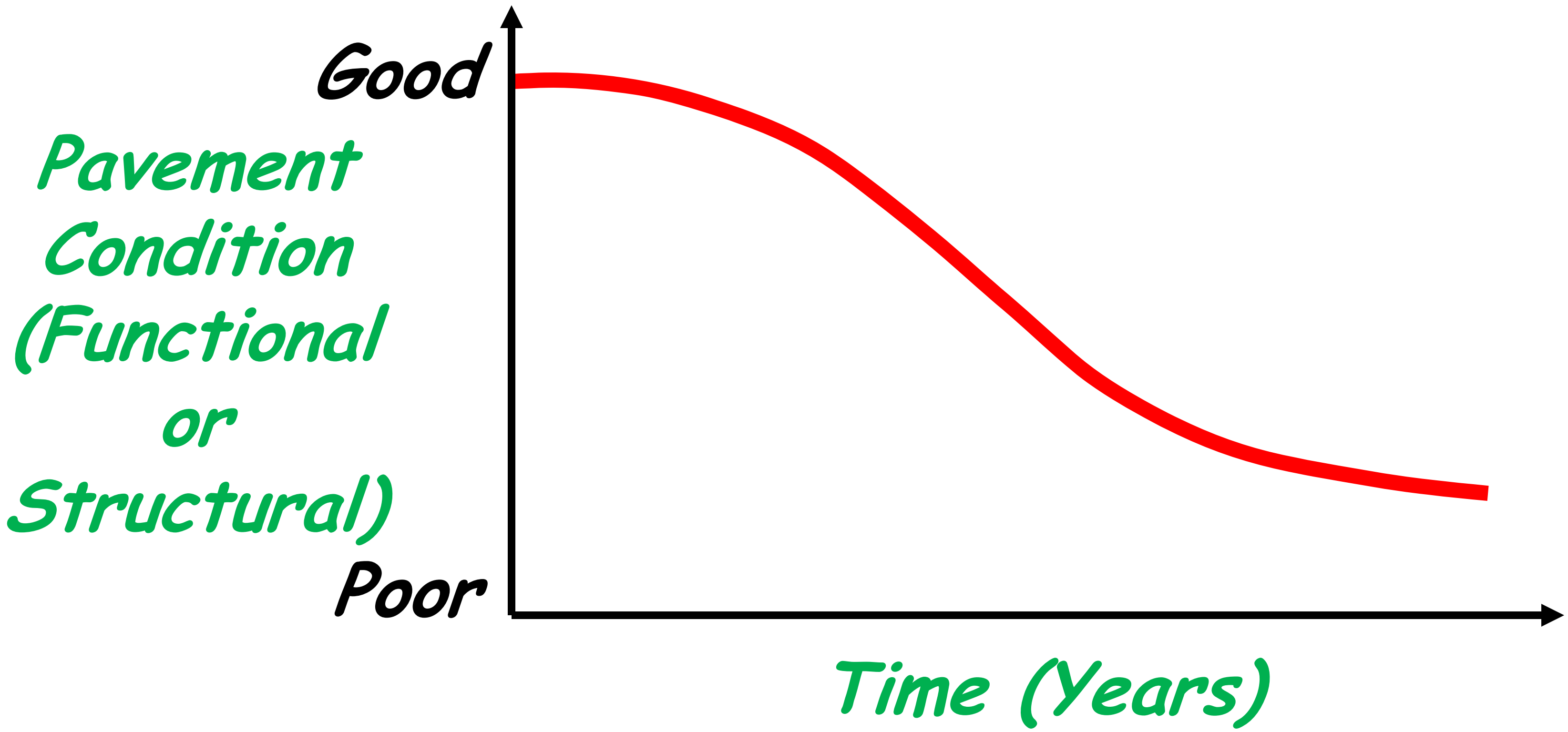
Identification of Candidate Treatments

- **Specific Distresses Present**
- **Condition**
  - Functional
  - Structural
- **Loadings and Environment**
- **Available Tools**
  - Decision trees
  - Decision matrices

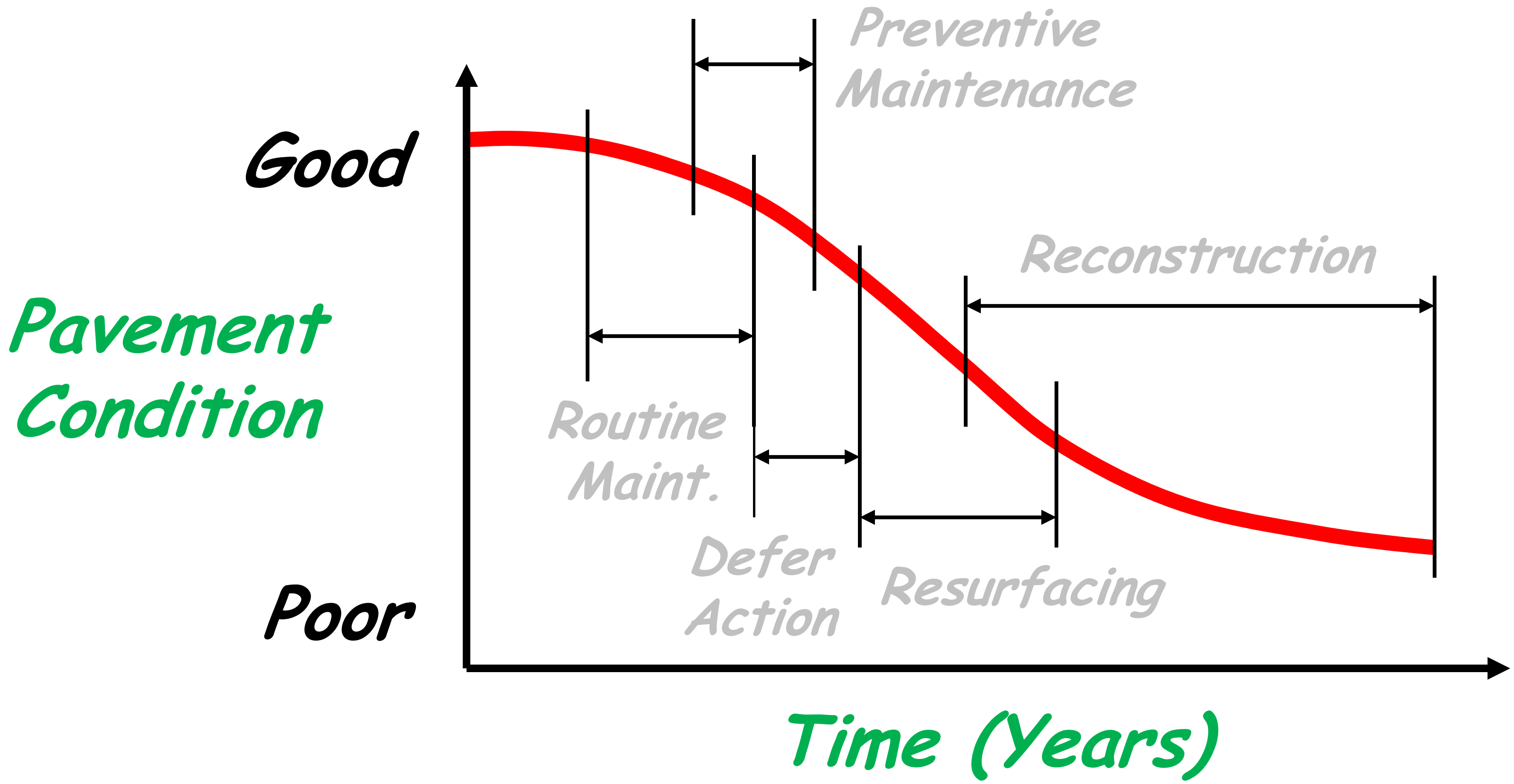
Treatment Timing Issues

- What factors affect treatment timing?
- When is too soon?
- Too late?

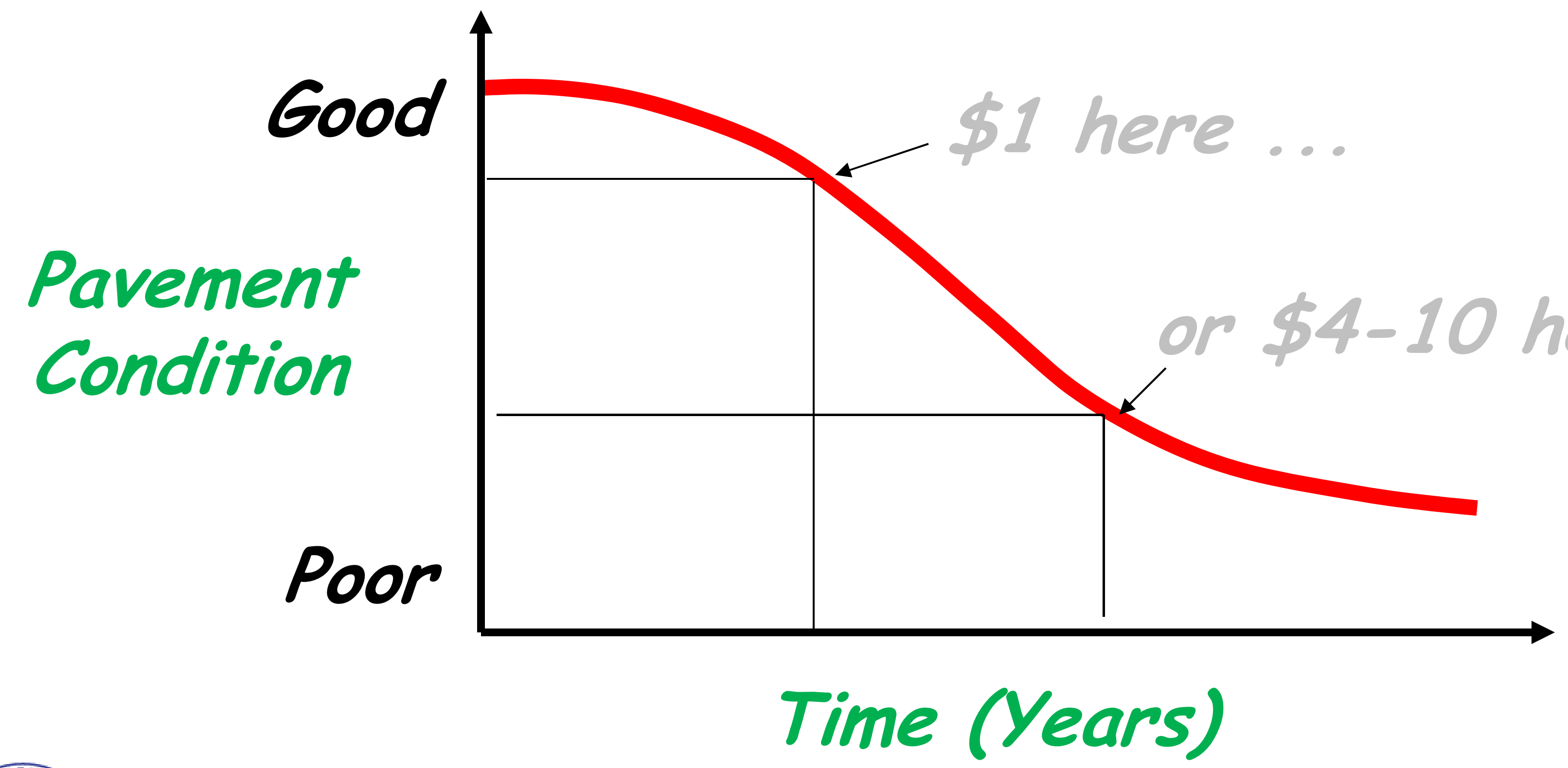
Typical Pavement Performance Curve



Typical Pavement Performance Curve



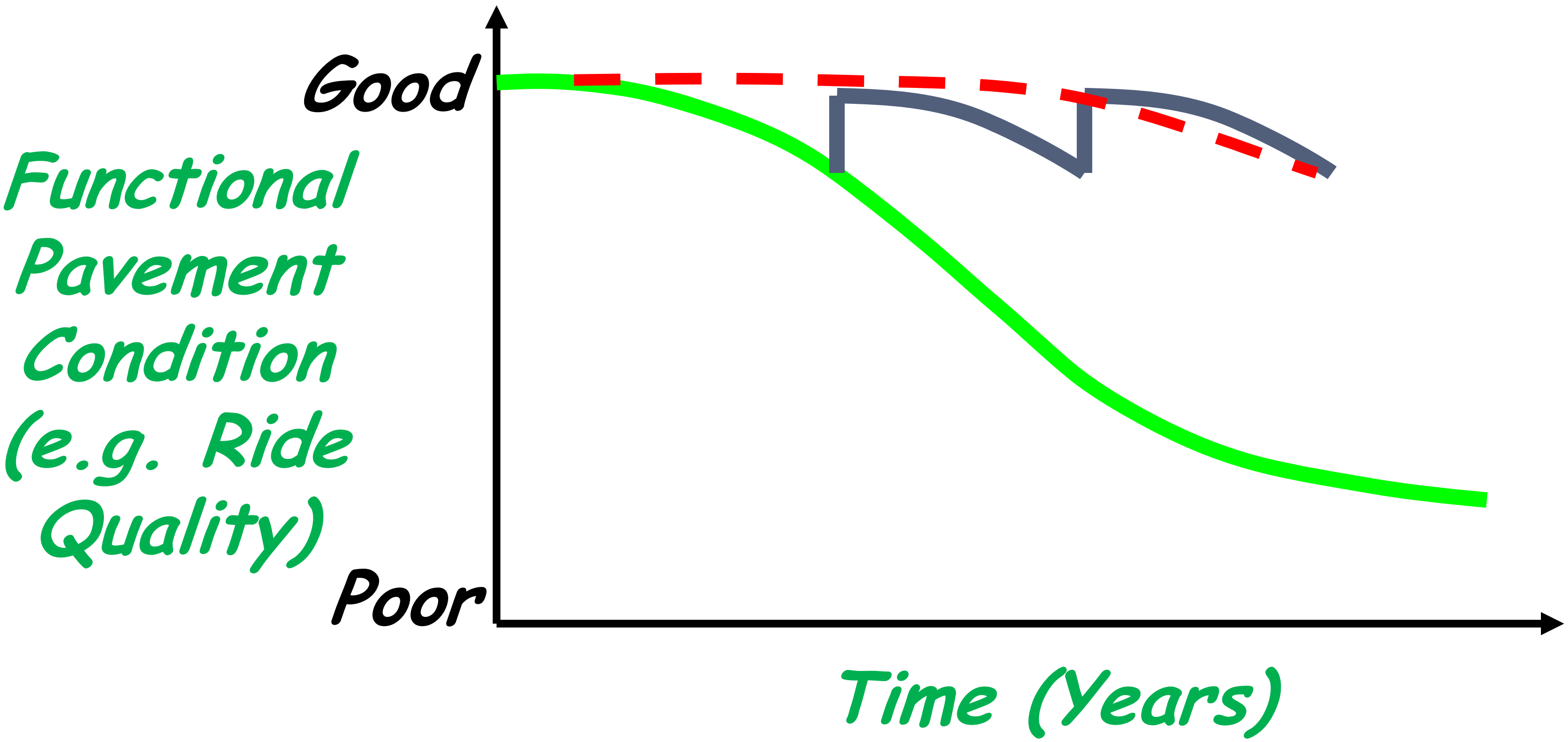
Cost Effects



Preventive Maintenance

- **Planned strategy**
- **Preserves the system**
- **Retards future deterioration**
- **Maintains or improves functional condition**

Anticipated PM Benefits



Anticipated PM Benefits

- **Functional Performance?**
- **Structural Performance?**
- **Costs:**
  - To the agency?
  - To the user?

Conventional Rehabilitation Treatment

HMA Pavement Overlay

Introduction

- **Most popular method**
- **Relatively fast and cost-effective means for:**
  - Correcting deficiencies
  - Restoring user satisfaction
  - Adding structural capacity
- **Poor performance is NOT uncommon**

Definitions

- Functional performance - Ability to provide a safe, smooth riding surface
- Structural performance - Ability to carry traffic without distress
- Empirical - Design based on past experience or observation
- Mechanistic - Design based upon engineering mechanics

Purpose and Applications

- **Improve functional and/or structural characteristics**
- **Wide range of applications**
  - Road surface categories
  - Climate and support conditions

Characteristics of Typical HMA Overlay

- Dense graded HMA
- Flexible or rigid surface
- 25 to 200 mm (1 to 8 in) thickness
- Mill and Fill

Limitations and Effectiveness

Why do we have premature failures?

- **Improper selection**
- **Wrong type**
- **Inadequate design**
- **Insufficient preoverlay repair**
- **Lack of consideration of reflection cracking**

Limitations and Effectiveness

What limits the effectiveness of HMA overlays?

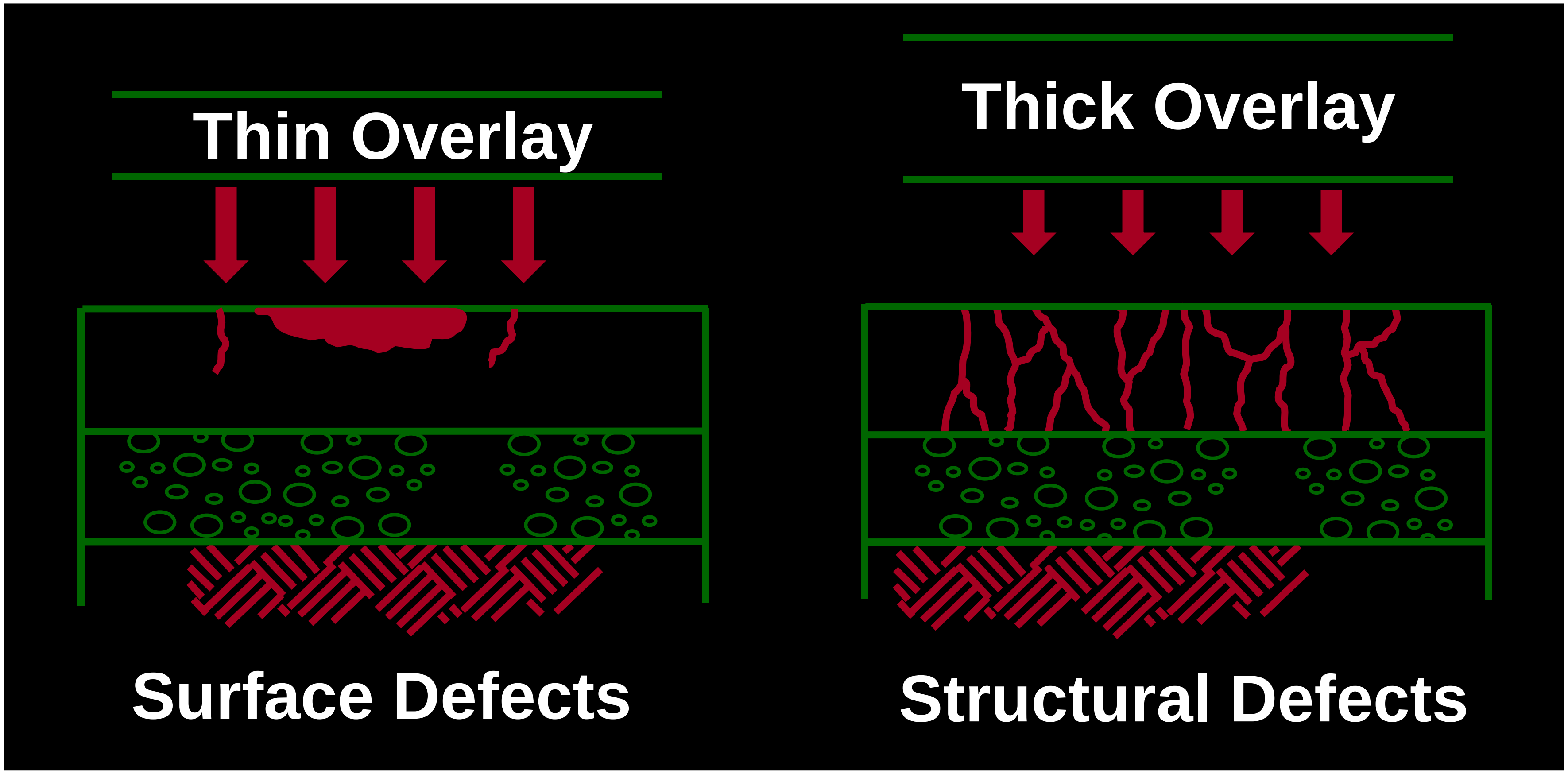
- **Distress exhibited in HMA**
- **Intended design life of the overlay**
- **Availability of quality materials**

Limitations and Effectiveness

How can we improve our overlays?

- Preoverlay treatments
- Better materials and practices
- Sound engineering judgment

Overlay Selection to Correct Deficiencies



What Are Considerations in Overlay Selection?

- **Construction feasibility**
  - Traffic control
  - Constructibility
  - Vertical clearances
  - Utilities
- **Performance period**
- **Funding**

Preoverlay Treatment and Repair

- **Dependent upon:**
  - Type of overlay
  - Structural adequacy of existing pavement
  - Existing types of distress
  - Future traffic
  - Physical constraints
  - Cost

To Repair or Not to Repair?

Types of Preoverlay Treatments

- Localized repair (patching)
- Surface leveling
- Controlling reflection cracking
- Drainage improvements

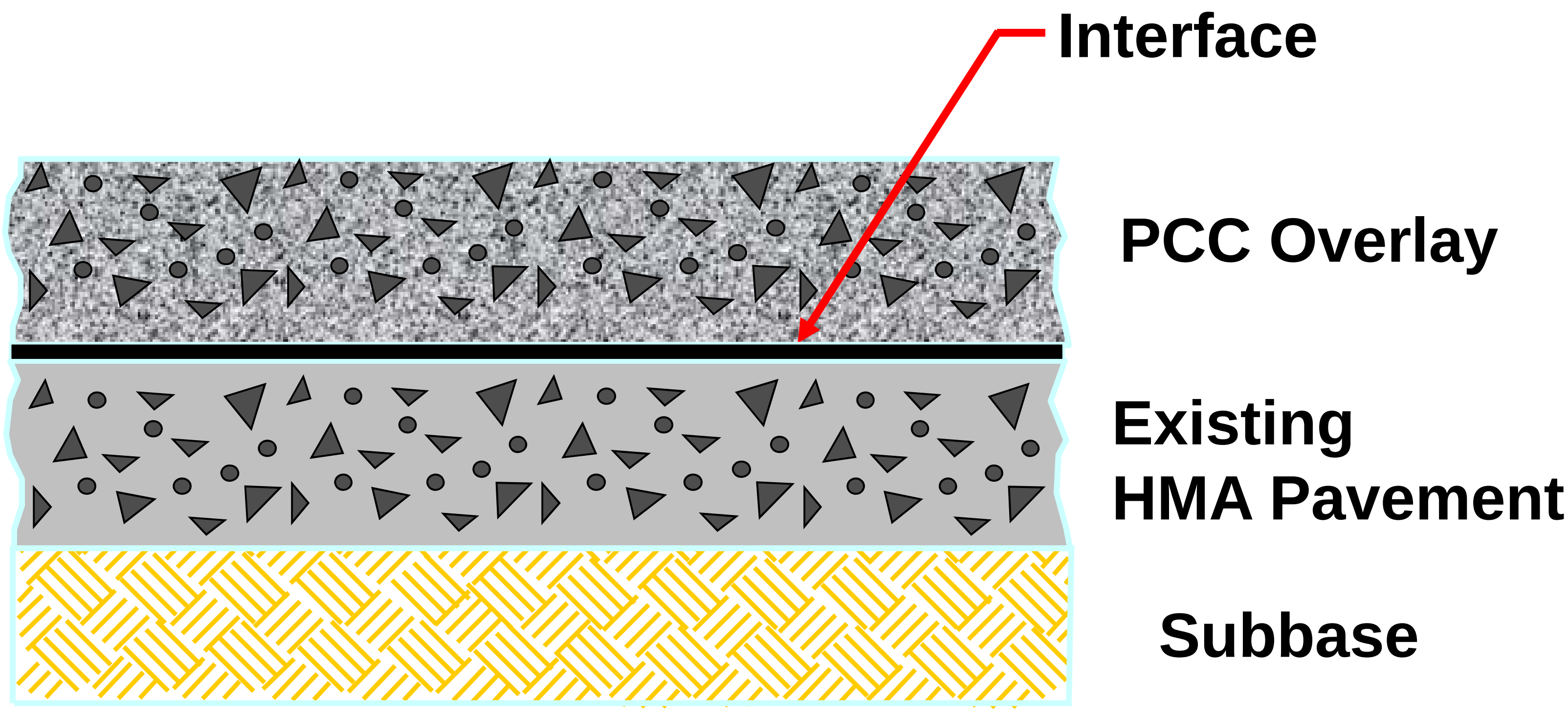
Conventional Rehabilitation Treatment

Concrete Pavement Overlay

Types of Whitetopping Overlays

- **Conventional Whitetopping**
  - Slabs greater than 100 mm thick
  - Placed directly on HMA pavement (little preoverlay repair)
- **Ultra-Thin Whitetopping**
  - Thin slabs (50 to 100 mm thick)
  - Short joint spacing (0.6 to 1.8 m)
  - Bonded to existing HMA to increase load-carrying capacity

Conventional Whitetopping



Applicability

- **Conventional Whitetopping**
  - Badly deteriorated HMA pavements
  - Most any traffic volume
- **Ultra-Thin Whitetopping**
  - Low volume roads exhibiting rutting, shoving, potholing
  - Urban intersections where recurrent rutting/washboarding has been a problem

Overlay Selection

- Detailed pavement evaluation (distress, FWD, coring)
- Construction feasibility
- Performance period
- Cost effectiveness

Whitetopping Feasibility—Constructibility

	Conventional
Vertical Clearance	Can be a problem
Traffic Control	May be difficult to construct under traffic
Construction	No special equipment

Whitetopping Feasibility—Performance Period

	Conventional
Existing Condition	Very deteriorated HMA pavements
Extent of Repair	Limited to very severe areas
Future Traffic	Any traffic level
Historical Reliability	Very good

Design Considerations

- Slab thickness
- Joint design
- Drainage design
- Reinforcement design
- PCC mix design
- Preoverlay repair and surface preparation

Preoverlay Repairs Whitetopping Overlays

- Localized repair of failed areas
- Filling of potholes
- Milling if rutting greater than 50 mm
- Repair of severe alligator cracking if poor support would otherwise result

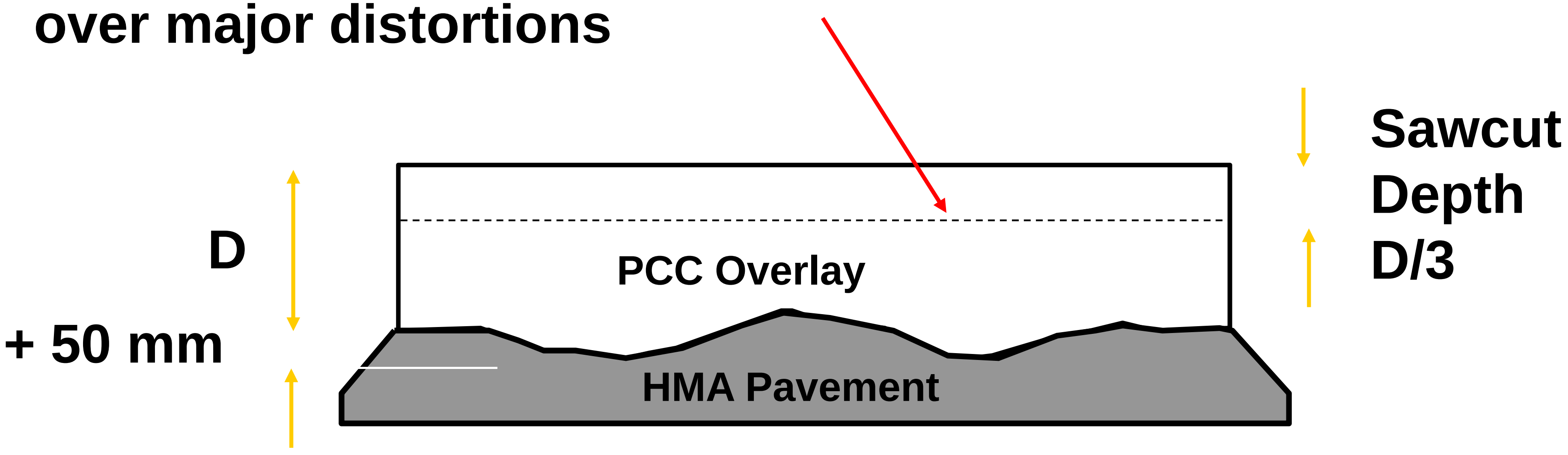
Goal: Uniform support

Construction —Whitetopping Overlays—

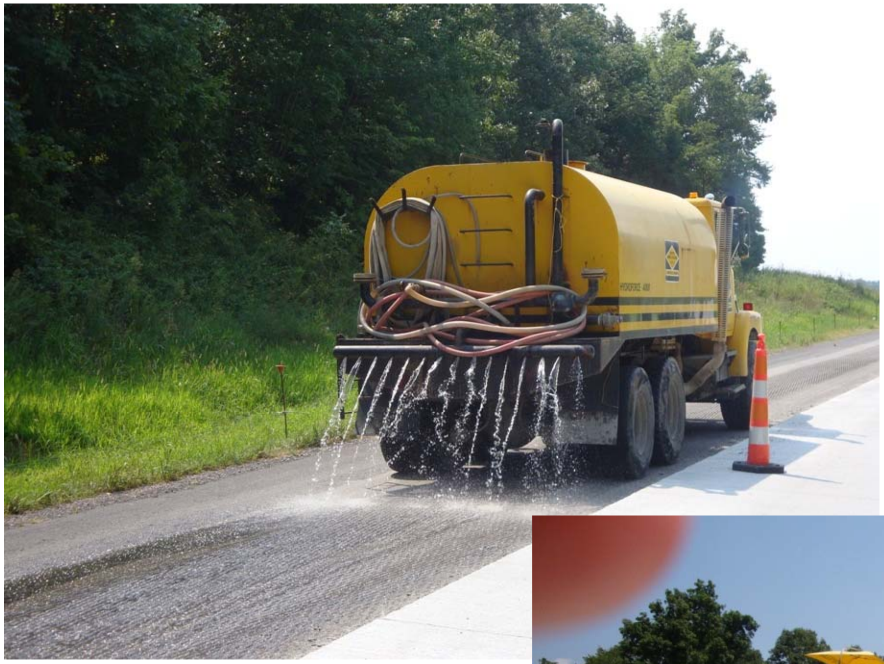
- **Conventional PCC paving equipment and construction practices are used**
- **PCC may be placed directly on HMA or on milled or leveled HMA surface**
- **Whitewashing of HMA surface may be required on hot days**

Whitetopping —Joint Sawing—

Consider increased saw depth over major distortions



SR-161 Whitetopping



SR-161 Whitetopping

Rehabilitation Option

Hot In-Place Recycling

Hot In-Place Recycling Description

- Three methods
  - Surface recycling
  - Remixing
  - Repaving
- Typical depth: 15 mm - 50 mm (0.6 in - 2.0 in)
- RAP mixed with additives and relaid
- Immediate opening to traffic
- Applicable for all traffic levels

Rehabilitation Option

Cold In-Place Recycling

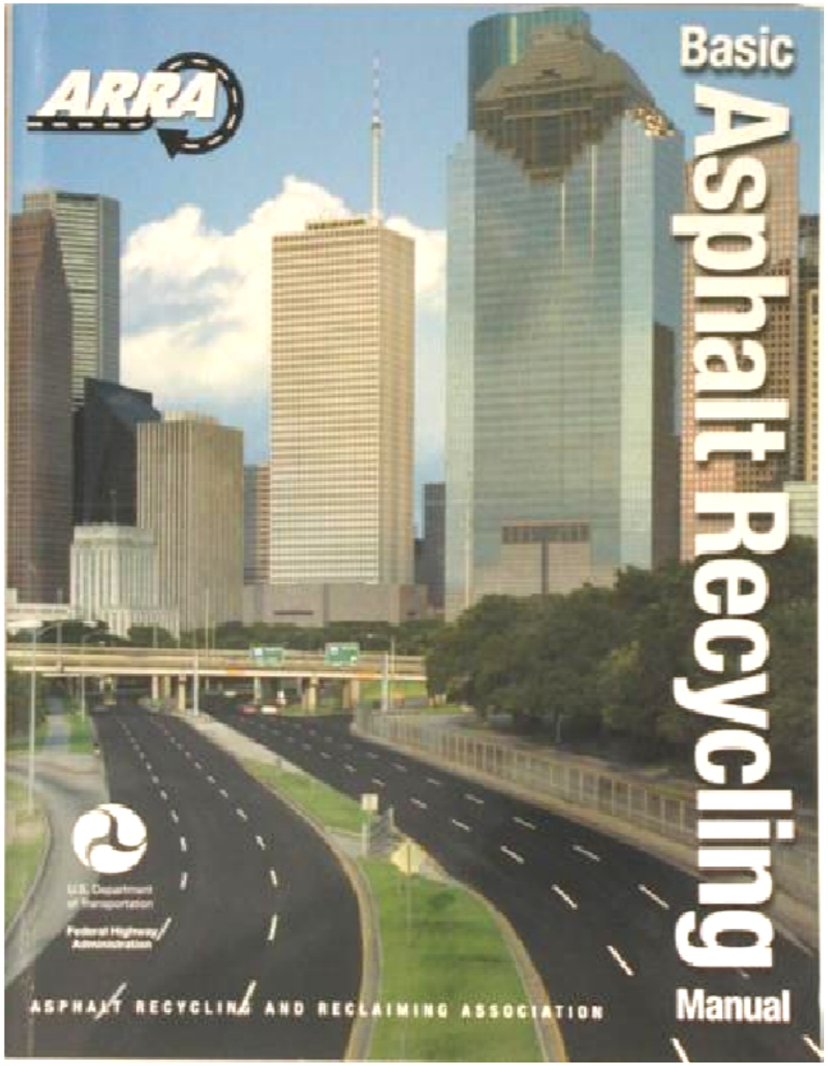
Cold In-Place Recycling Description

- Cold process
- Milling depth: 50 mm - 100 mm (2 in to 4 in)
- RAP mixed with additives and relaid
- Resurfacing is typically required
- Most commonly used on secondary and low-volume roads

Benefits

- Conserves energy and materials
- Preserves geometrics
- Many surface distresses eliminated
- Improves profile
- Modifies material characteristics
- Relatively inexpensive

Basic Asphalt Recycling Manual



In-Place Recycling

Measure of Effectiveness

Corrects	Slows/Reduces Severity
Poor friction Roughness Bleeding Raveling Rutting Poor cross slope	Cracking Moisture damage
Prevents/Delays	**Negatively Affects**
Cracking Raveling Roughness	None

Rehabilitation Option

Full Depth Reclamation (FDR)

Definition of Full-Depth Reclamation

- **Method of flexible pavement reconstruction that utilizes the existing asphalt, base, and subgrade material to produce a new stabilized base course for a chip seal, asphalt, or concrete wearing surface.**

Types of Reclamation Methods

- **Mechanical Stabilization**
- **Bituminous Stabilization**
  - emulsified asphalt
  - expanded (foamed) asphalt
- **Chemical Stabilization**
  - Portland cement, slag cement, lime, fly ash, other

Challenges Facing Our Roadways

- **Continuing growth**
- **Rising expectations from users**
- **A heavily used, aging system**
- **Environmental compatibility**
- **Changes in the workforce**
- **Funding limitations**

Combined with large increases in traffic volumes and/or allowable loads often leads to serious roadway base failures!

How do you know if you have a base problem and not just a surface deficiency?

Examples of Pavement Distress

- Alligator cracking
- Rutting
- Excessive patching
- Base failures
- Potholes
- Soil stains on surface

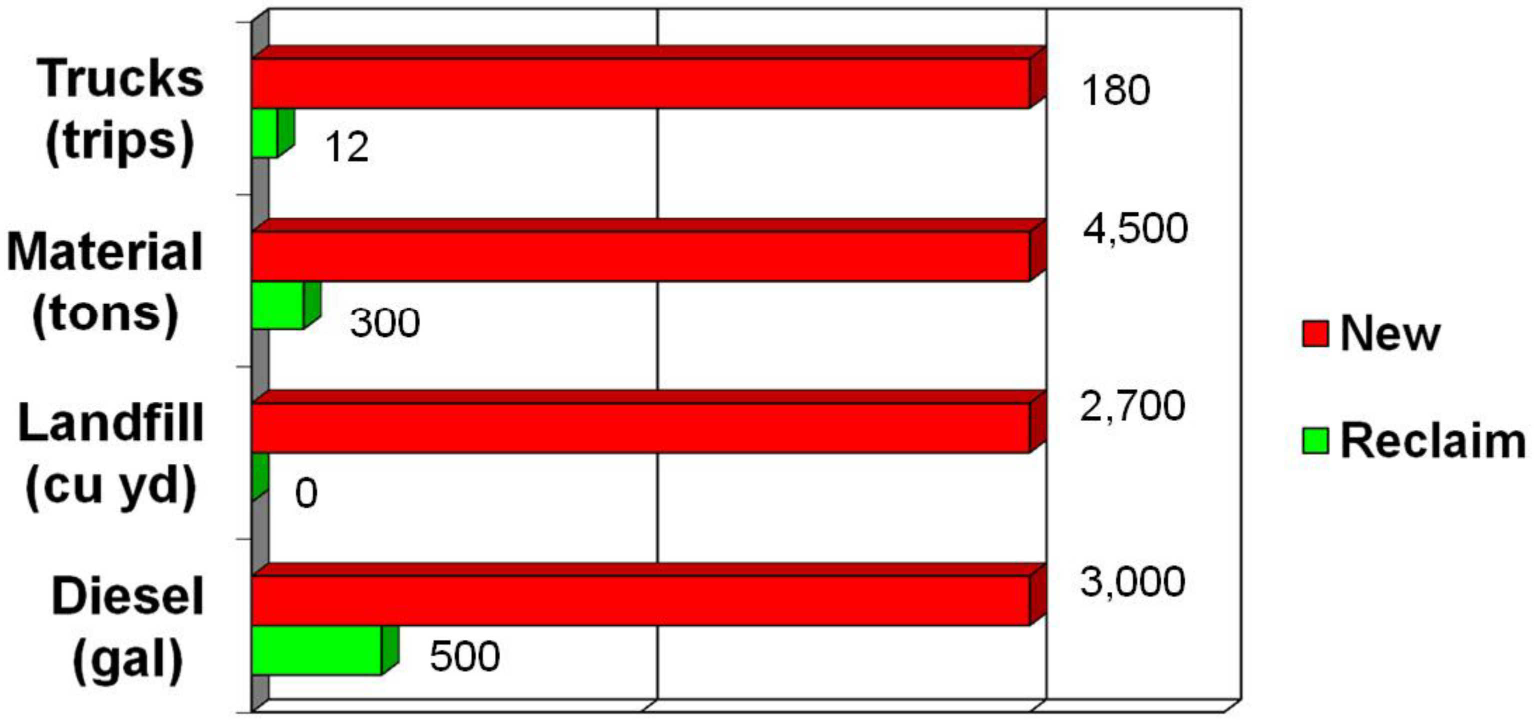
Advantages of the FDR Process

- Use of in-place materials
- Little or no material hauled off and dumped
- Maintains or improves existing grade
- Conserves virgin material
- Saves cost by using in-place "investment"
- Saves energy by reducing mining and hauls
- Very sustainable process

Rehabilitation Strategies

Attribute	Rehabilitation Strategy		
	FDR	Structural Overlay	Removal and Replacement
New pavement structure	√	√	√
Fast construction	√	√	X
Minimal traffic disruption	√	X	X
Minimal material in/out	√	X	X
Conserves resources	√	X	X
Maintains existing elevation	√	X	√
Low cost	√	X	X

Sustainable Element of FDR Process



1 mile of 24-foot wide, 2-lane road, with a 6-inch base

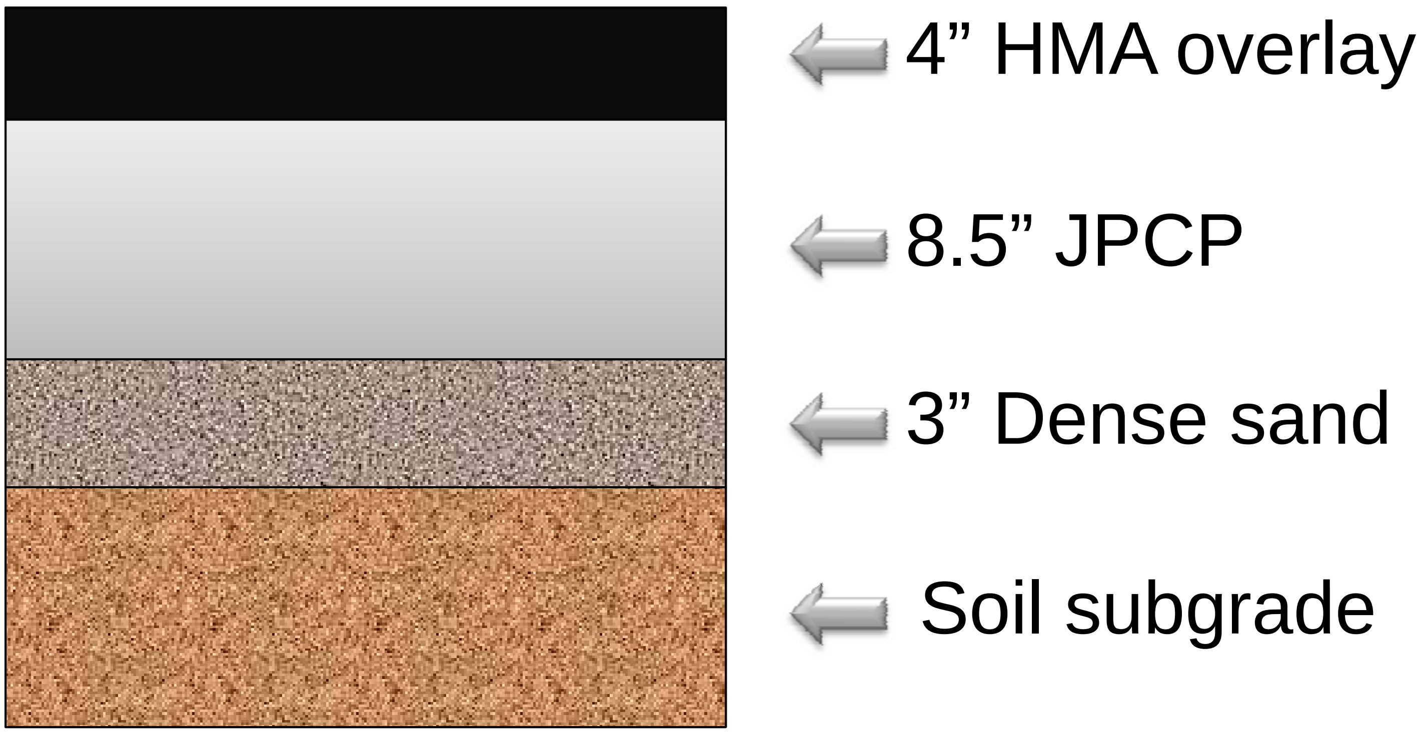
FDR in Indiana

Other Options for FDR

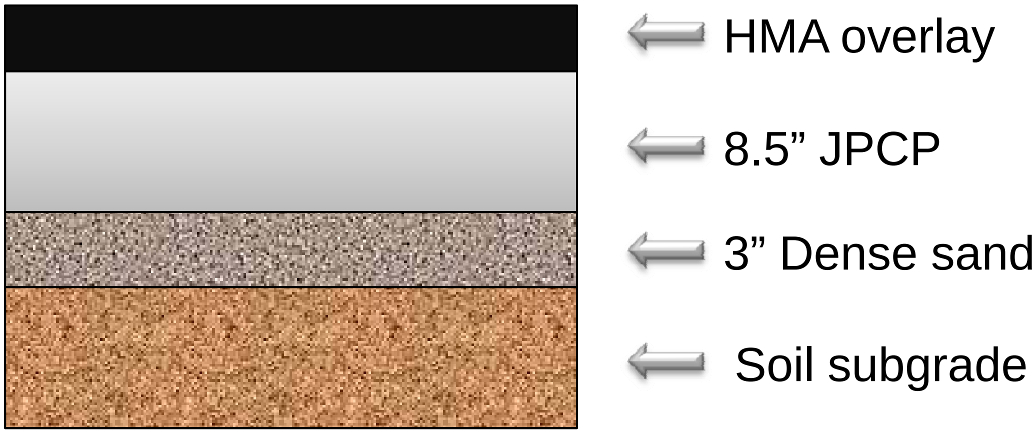
Design Issue

Pavement Rehabilitation Design

Existing pavement section

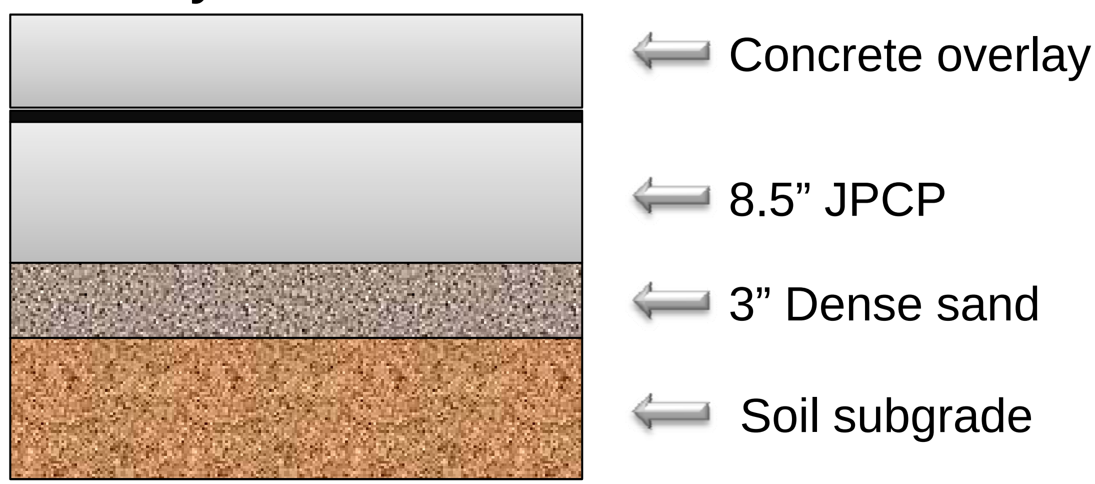


Proposed rehabilitation

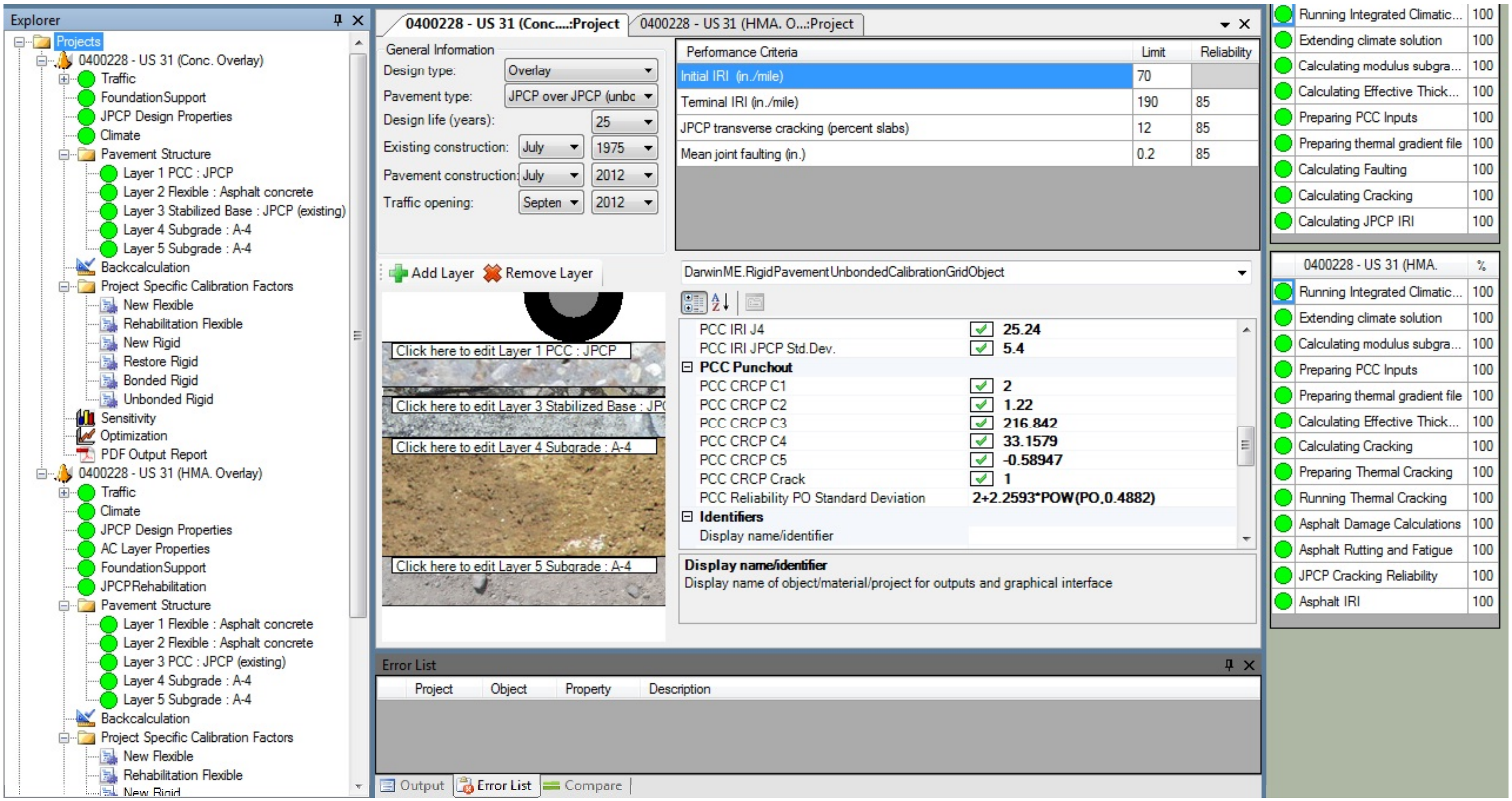


12 year LCCA

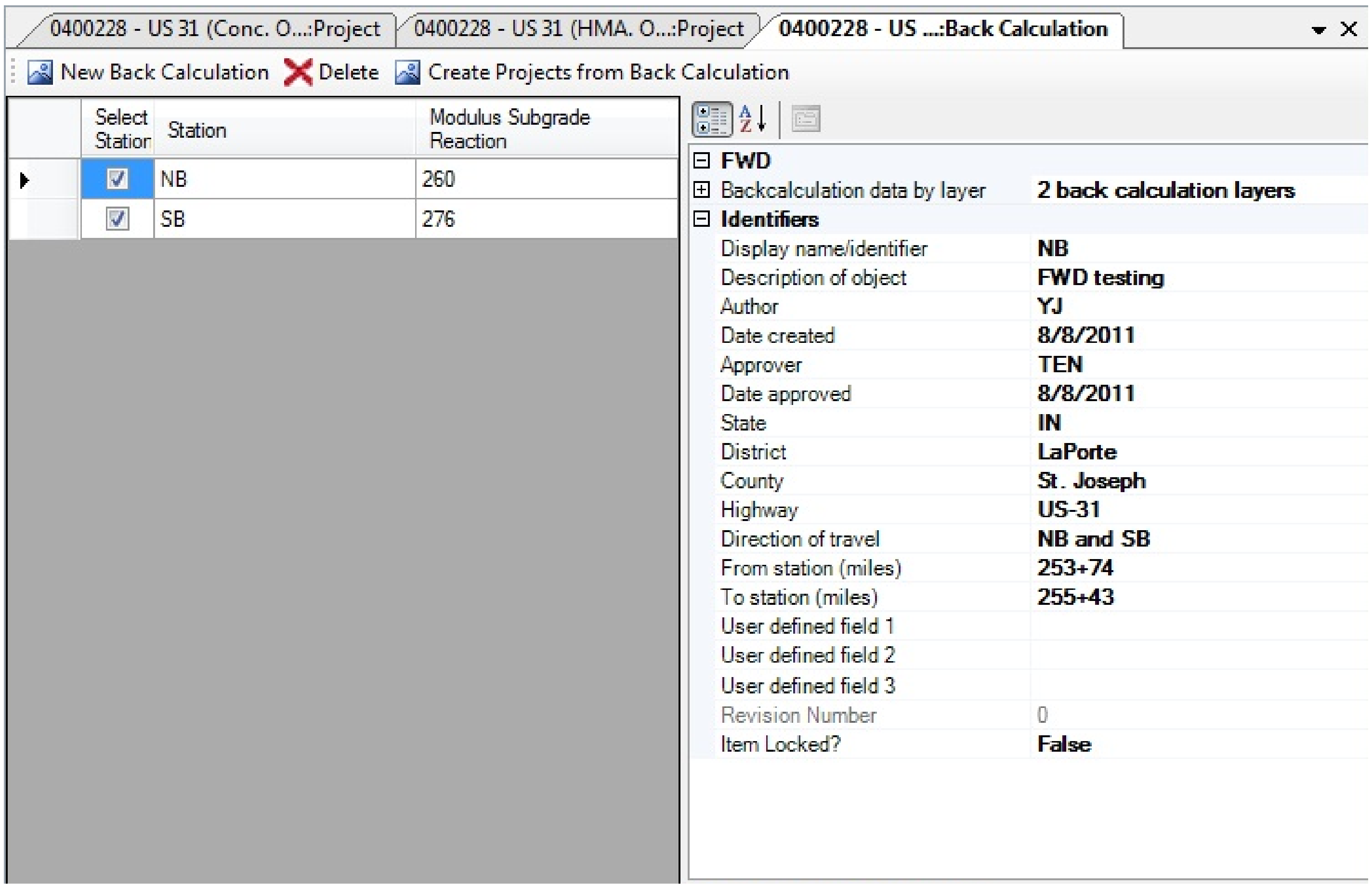
25 year LCCA



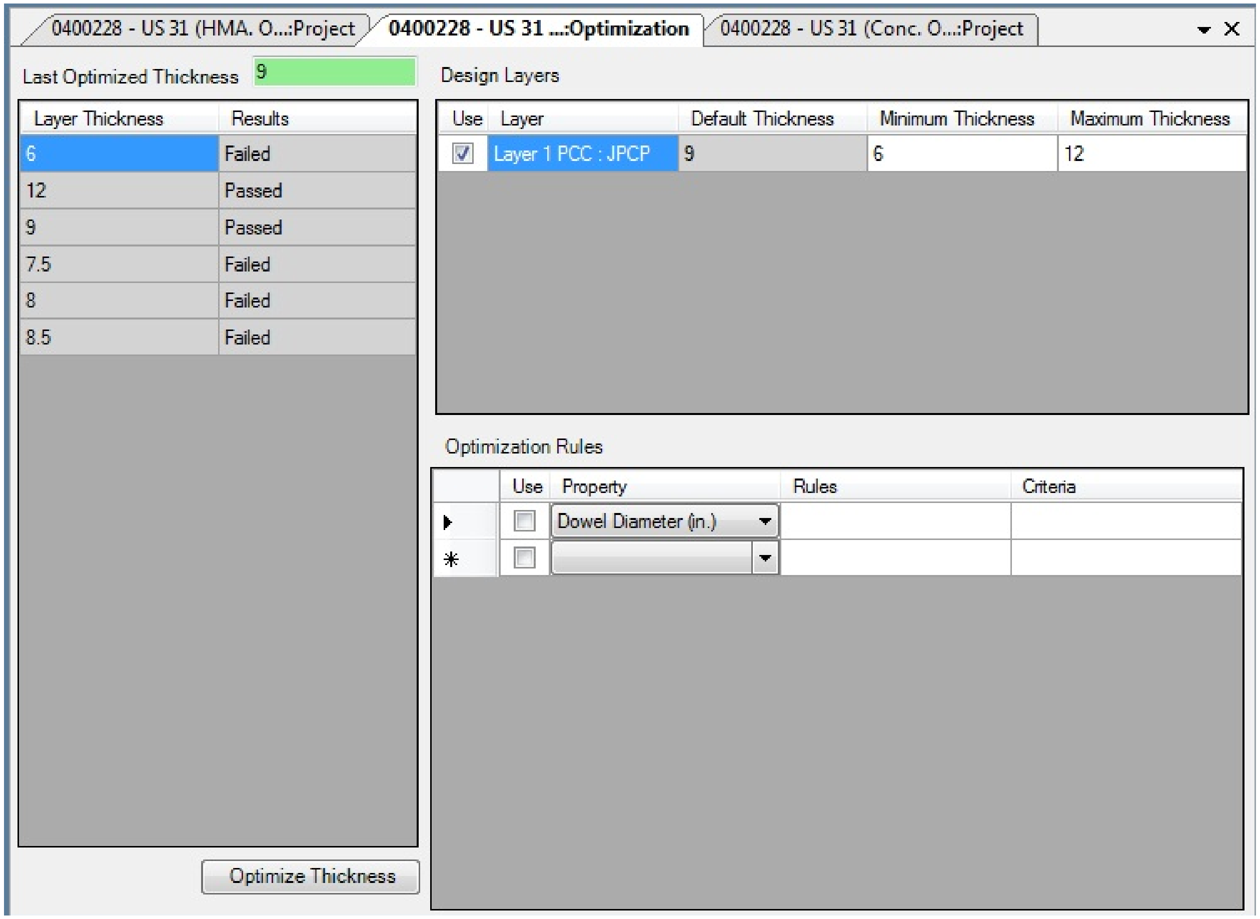
Design alternatives



Backcalculation inputs



JPCP optimization



JPCP optimization result

Design Structure

Layer type	Material Type	Thickness (in.):
PCC	JPCP	9.0 (Optimized)
Flexible	Asphalt concrete	2.0
Stabilized	JPCP (existing)	8.5
Subgrade	A-4	24.0
Subgrade	A-4	Semi-infinite

Joint Design:

Joint spacing (ft)	15.0
Dowel diameter (in.)	1.25
Slab width (ft)	12.0

Traffic

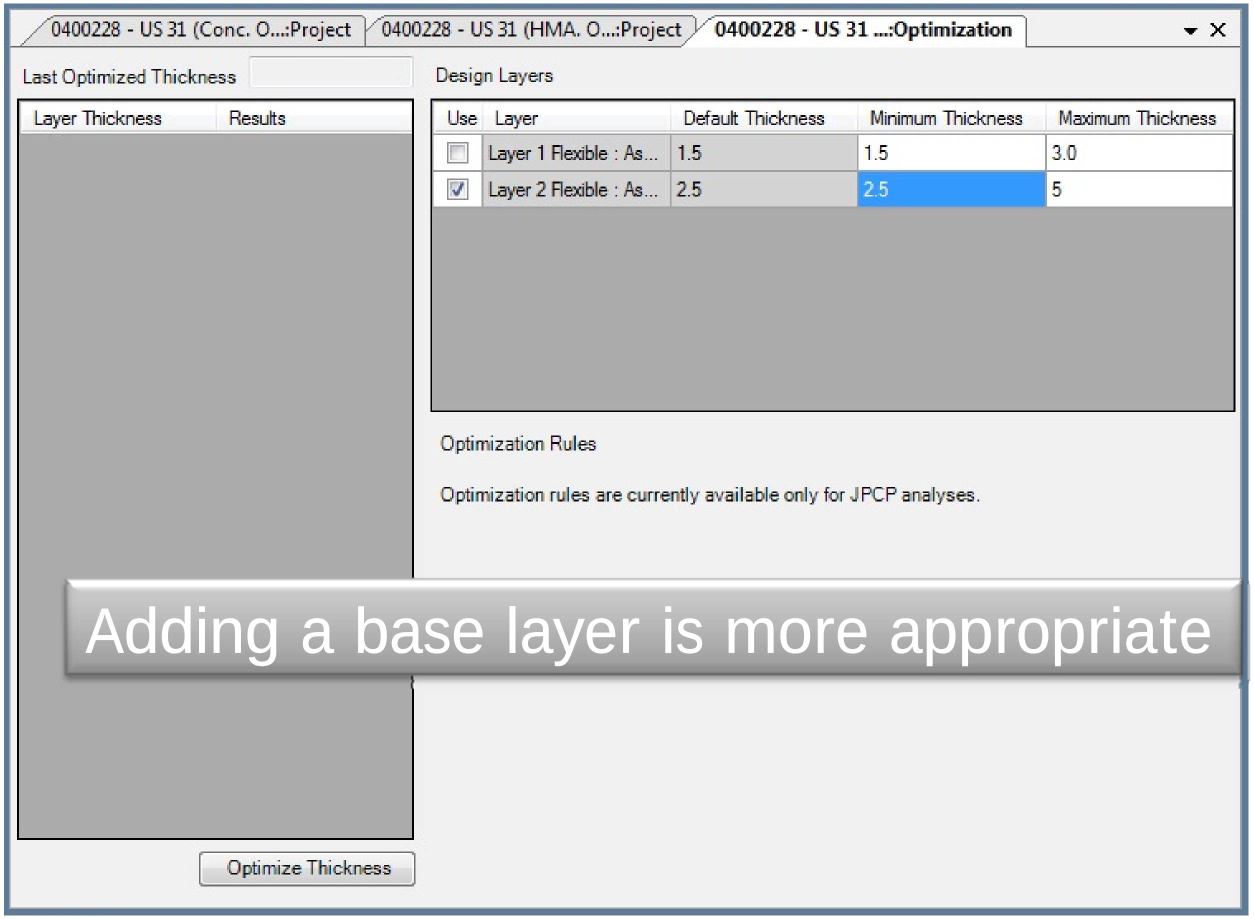
Age (year)	Heavy Trucks (cumulative)
2012 (initial)	6,000
2024 (12 years)	14,273,700
2037 (25 years)	31,794,300

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	190.00	120.37	85.00	99.96	Pass
Mean joint faulting (in.)	0.20	0.07	85.00	100.00	Pass
JPCP transverse cracking (percent slabs)	12.00	9.49	85.00	92.70	Pass

HMA optimization



Adding a base layer is more appropriate

HMA sensitivity

0400228 - US 31 (H...:Sensitivity | 0400228 - US 31 (Conc. O...:Project | 0400228 - US 31 (HMA. O...:Project

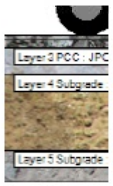
Run Factorial

Create Sensitivity | Run Sensitivity | View Summary

Use	Property	Layer	Default	Minimum	Maximum	# of Increments
	Two-way AADTT		6000			
	Thickness (in.):	Layer 1 Flexible : Asp...	1.5			
	Binder Content (%)	Layer 1 Flexible : Asp...	11.61			
	Air voids (%)	Layer 1 Flexible : Asp...	8			
✓	Thickness (in.):	Layer 2 Flexible : Asp...	2.5	2.5	5	5
	Binder Content (%)	Layer 2 Flexible : Asp...	10.66			
	Air voids (%)	Layer 2 Flexible : Asp...	8			
	Thickness (in.):	Layer 3 PCC : JPCP (...	8.5			
	Thickness (in.):	Layer 4 Subgrade : A-4	24			
	Unbound Modulus	Layer 4 Subgrade : A-4	6000			
	Dowel diameter (in.)		1.25			
	PCC joint spacing (ft)		15			
	Slab width (ft)		12			
	PCC coefficient of th...	Layer 3 PCC : JPCP (...	5.4			
	28-Day modulus of ru...	Layer 3 PCC : JPCP (...	350			

HMA Sensitivity result

Design Structure



Layer type	Material Type	Thickness (in.):
Flexible	Asphalt concrete	1.5
Flexible	Asphalt concrete	2.5
PCC	JPCP (existing)	8.5
Subgrade	A-4	24.0
Subgrade	A-4	Semi-infinite

Volumetric at Construction:

Effective binder content (%)	11.6
Air voids (%)	8.0

Traffic

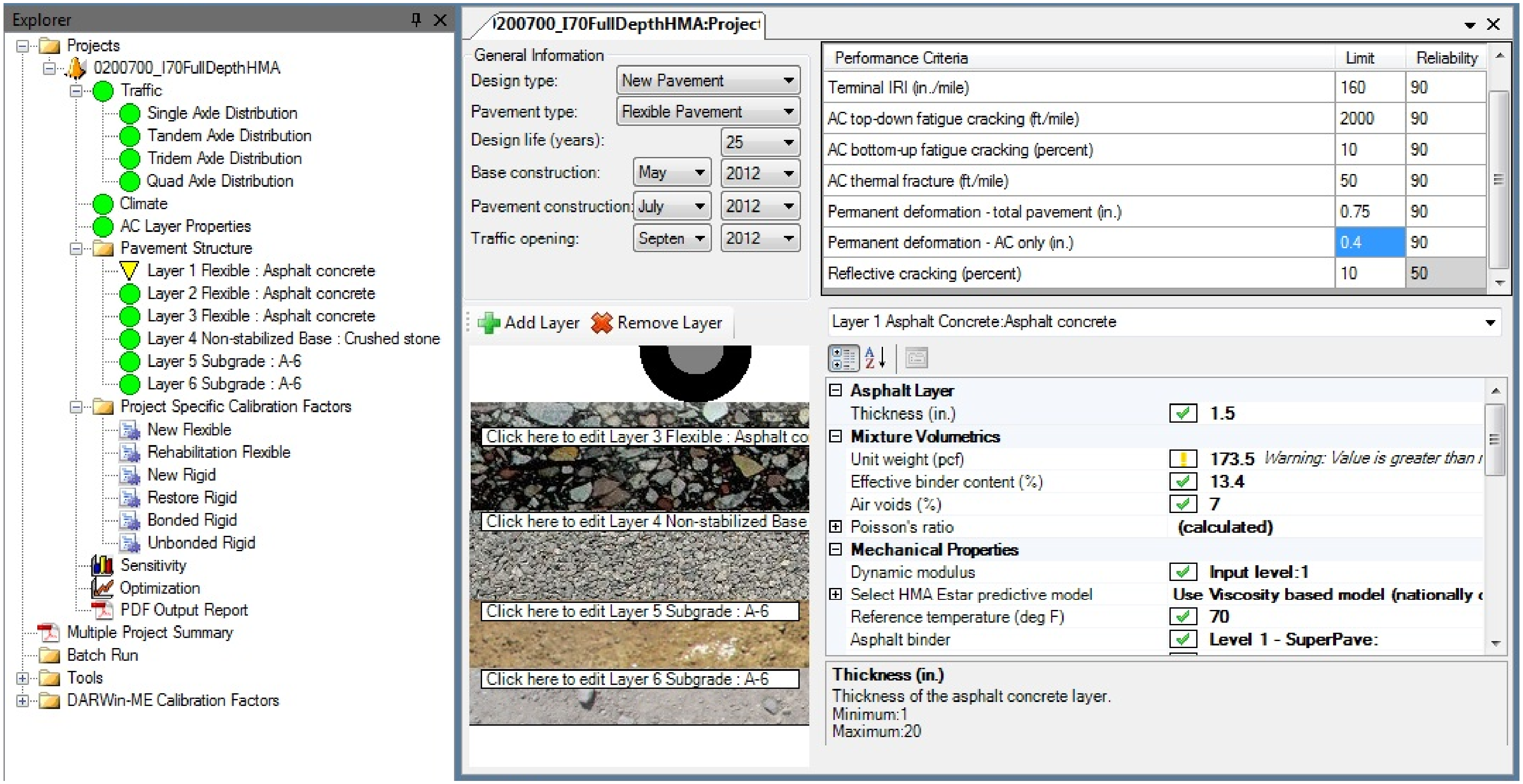
Age (year)	Heavy Trucks (cumulative)
2012 (initial)	6,000
2018 (6 years)	6,461,420
2024 (12 years)	13,661,300

Design Outputs

Distress Prediction Summary

Distress Type	Distress @ Specified Reliability		Reliability (%)		Criterion Satisfied?
	Target	Predicted	Target	Achieved	
Terminal IRI (in./mile)	172.00	105.11	90.00	100.00	Pass
Permanent deformation - total pavement (in.)	0.75	0.20	90.00	100.00	Pass
Total Cracking (Reflective + Alligator) (percent)	100.00	7.33	-	-	-
AC thermal fracture (ft/mile)	250.00	217.40	90.00	95.93	Pass
JPCP transverse cracking (percent slabs)	15.00	19.72	90.00	74.75	Fail
AC bottom-up fatigue cracking (percent)	25.00	1.45	90.00	100.00	Pass
AC top-down fatigue cracking (ft/mile)	2000.00	257.71	90.00	100.00	Pass
Permanent deformation - AC only (in.)	0.25	0.20	90.00	98.85	Pass

FDR and New HMA design inputs



Decision making process

Treatment Selection

Treatment Selection Factors

- Available Funds
- Staged Construction
- Traffic Control
- Lane Closure
- Minimum Desired Life
- Future Maintenance
- Geometric Issues

Treatment Selection Factors (continued)

- Present and Future Utilities
- Right-of-Way Restrictions
- Regulatory Restrictions
- Available Materials and Equipment
- Contractor Expertise and Manpower
- Agency Policies

Selection Process

- Develop feasible alternatives for evaluation
- Identify key decision factors important to agency (e.g., cost, service life, traffic control, duration of construction, etc.)
- Assign weighting values for each decision factor
- Assign scoring values for each alternative
- Add scores and rank alternatives

Selection Worksheet

	Decision Factor 1	Decision Factor 2	Decision Factor 3	Decision Factor 4	TOTAL SCORE
Weight	Weight 1	Weight 2	Weight 3	Weight 4	
Alt 1					
Alt 2					
Alt 3					
Alt 4					

Questions???