COMPOSITE PAVEMENT OVERLAY

PROJECT: US 130 MAIN STREET TO US ROUTE 1

2018 NJ Asphalt Paving Conference

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PAVEMENT DESIGN

Acknowledgement

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  Associate Professor, Rutgers University

Outline

- Basic Information of Composite Pavement
- Challenges of Composite Pavement
- Composite Pavement Rehabilitation Strategies
- Case Study-Route 130

Basic Information of Composite Pavement

COMPOSITE PAVEMENT

Composite Pavement Rehabilitation Goals

Improve Pavement Condition

Improve Ride Quality

Improve Safety

Extend Life

Typically Functional Overlay – Minor Rehab

Sometimes A Structural Overlay – Major Rehab

Reduce Life Cycle Costs

Increase Customer Satisfaction
- Noise Reducing Surface(s)

Challenges of Composite Pavement

Risk of Removing HMA Overlay

Challenges of Removing HMA Overlay:

Pavement Recommendation:

Mill 3” and Pave with 3” SMA 12.5 MM Surface Course

Challenges of Removing HMA Overlay:

Core Information:

Lane 1 Core information was 5.25” to 7.75” HMA over PCC.

Lane 2 Core information was not available during design.

Lane 3 Core information was 3.5” to 19.5” HMA over PCC.

Challenges: Pavement ME Analysis for Composite Pavement

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3” AC Over JPCP

8” AC Over JPCP

Challenges: Composite Pavement

- NJDOT's concrete/composite pavement infrastructure continuing to age and deteriorate
- PCC reconstruction costly
- Rubblization is option, but require minimum of 6 inches Overlay
- PCC rehabilitation generally not successful
- Most simple rehabilitation technique – Hot Mix Asphalt (HMA) Overlay
  - Unfortunately, high deflections at PCC joints/cracks creates excessive straining in HMA overlay
  - Most cases, cracking initiated in HMA above crack/joint in PCC (called Reflective Cracking)

Challenges: Composite Pavement

- When reflective crack reaches pavement surface
  - Affects overall integrity of pavement
    - Smoothness – intermittent cracking also affects safety
    - Pathway for water intrusion
    - Area for immediate raveling
- Little guidance on how to design HMA overlays for PCC pavements
  - HMA material/mixture selection

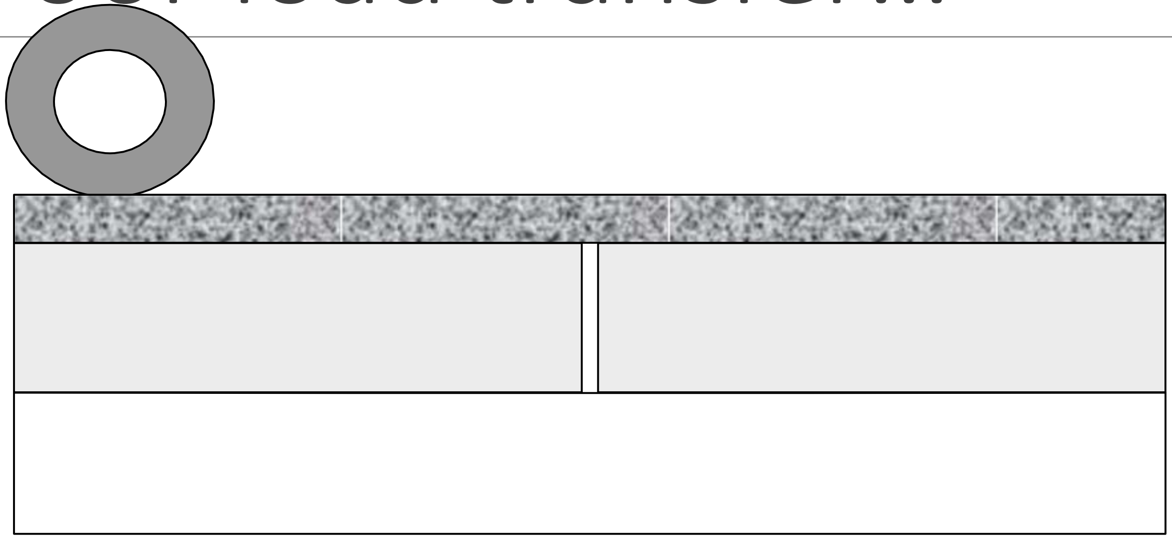
Modes of Reflective Cracking

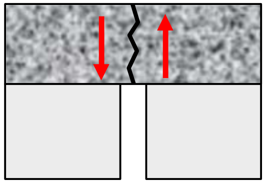
- Mode 1 – Poor Load Transfer at joint/crack results in independent movement of PCC slabs
- Mode 2 – Excessive Vertical Bending at PCC joint/crack (Pure Tensile Straining)
- Mode 3 – Horizontal Deflections (PCC slab expansion and contraction) due to environmental cycling

Reflective Cracking: Mode 1

- Mode 1 – Poor Load Transfer at joint/crack results in independent movement of PCC slabs

“Poor load transfer…”





Mode 1: Vertical Shear Stress

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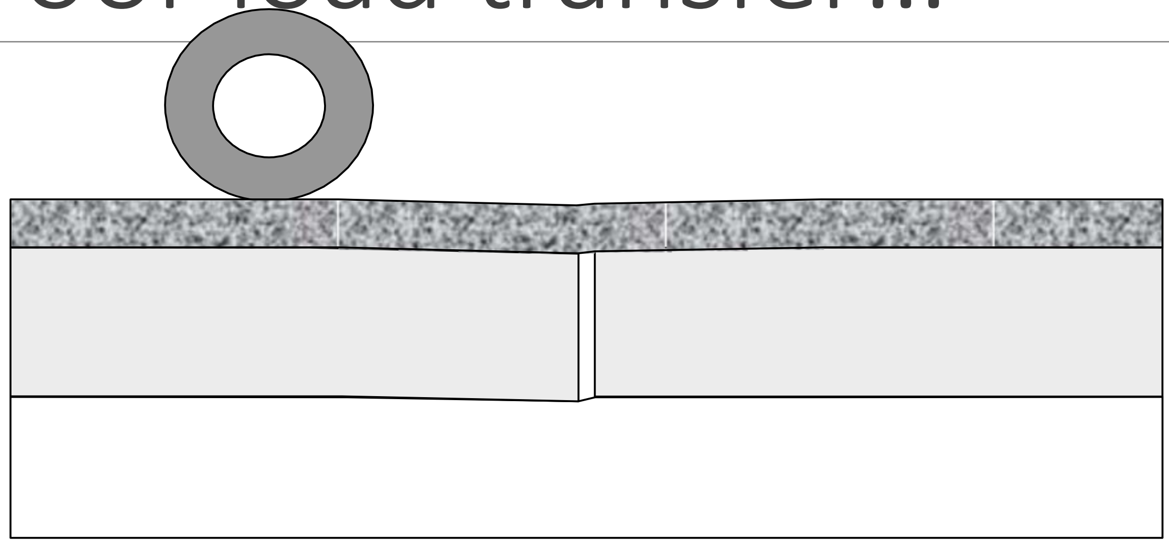

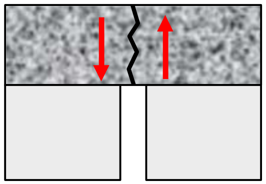

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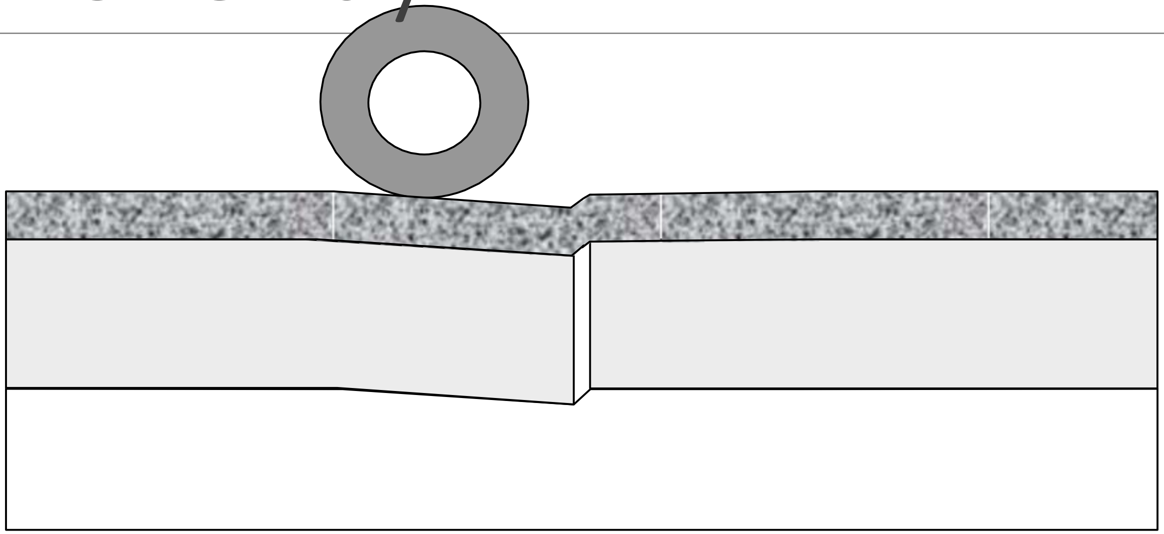

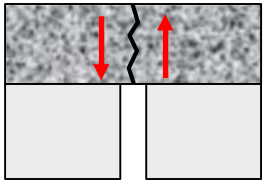

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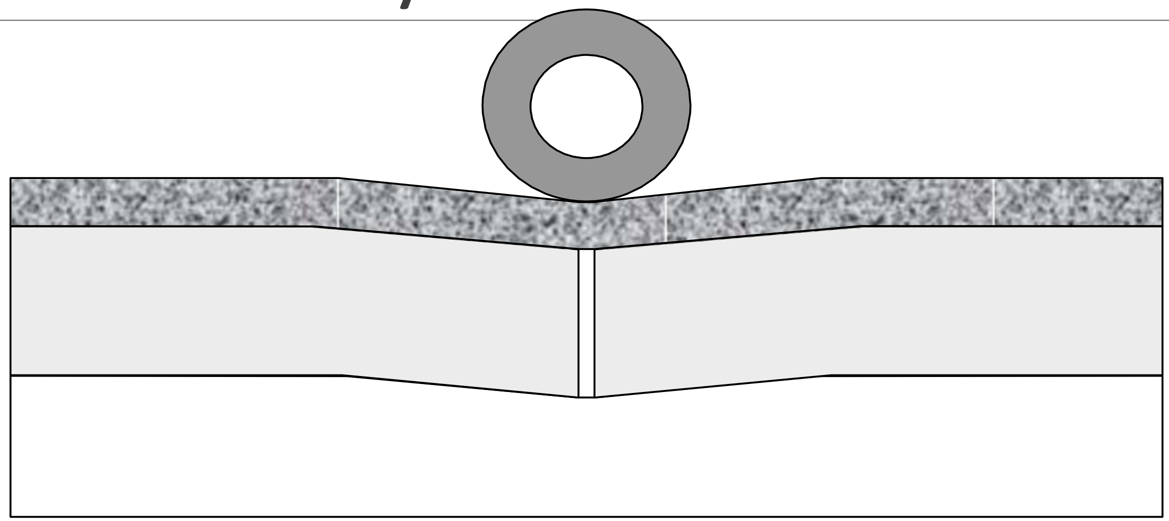

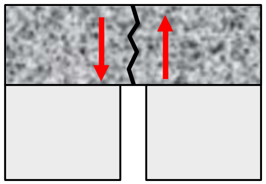

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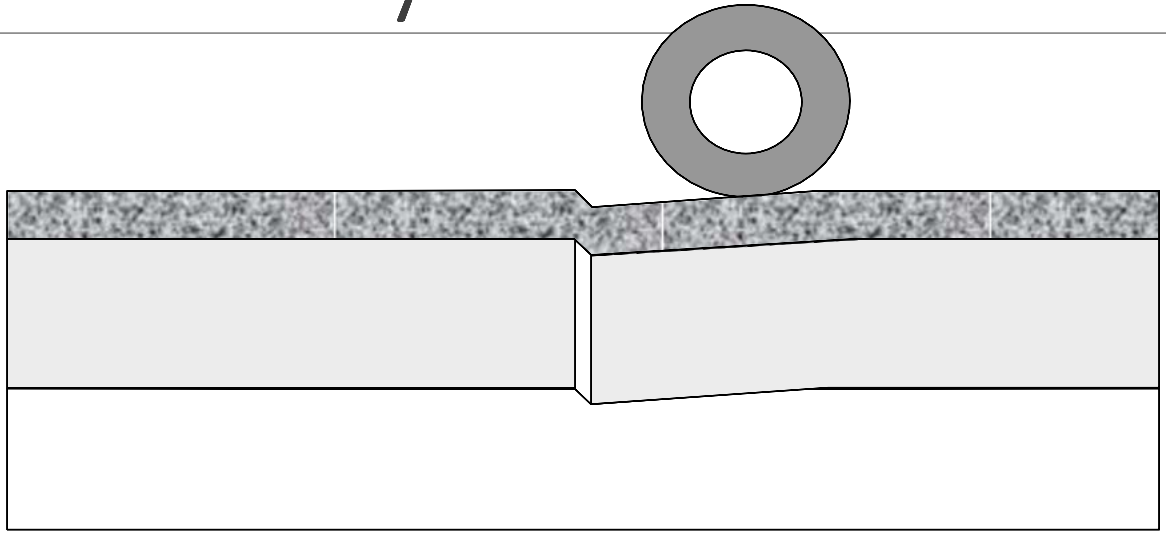

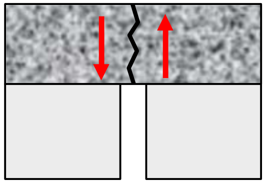

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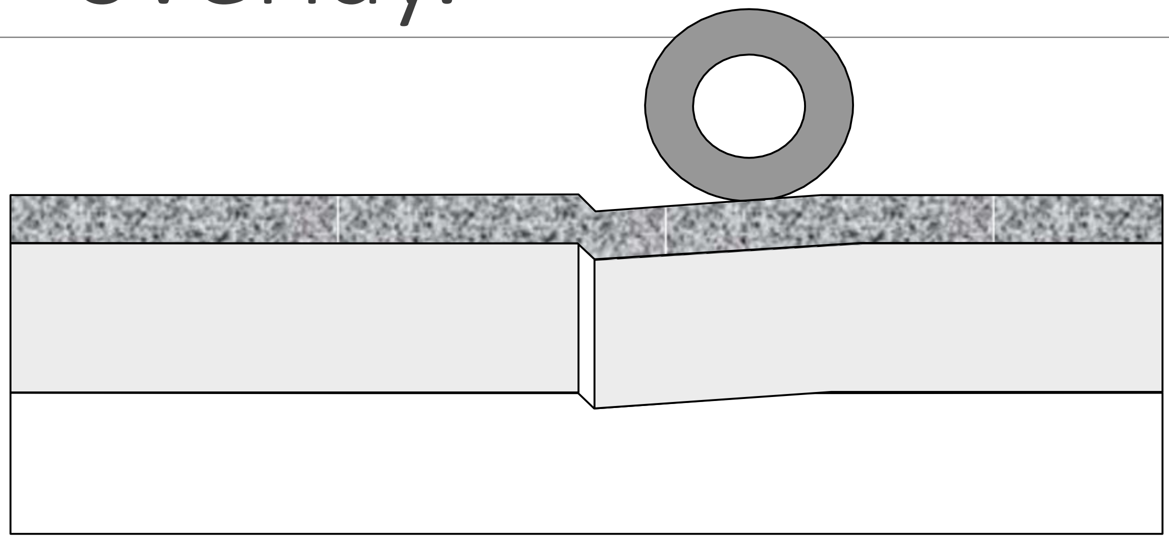

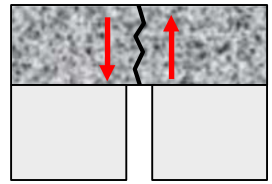

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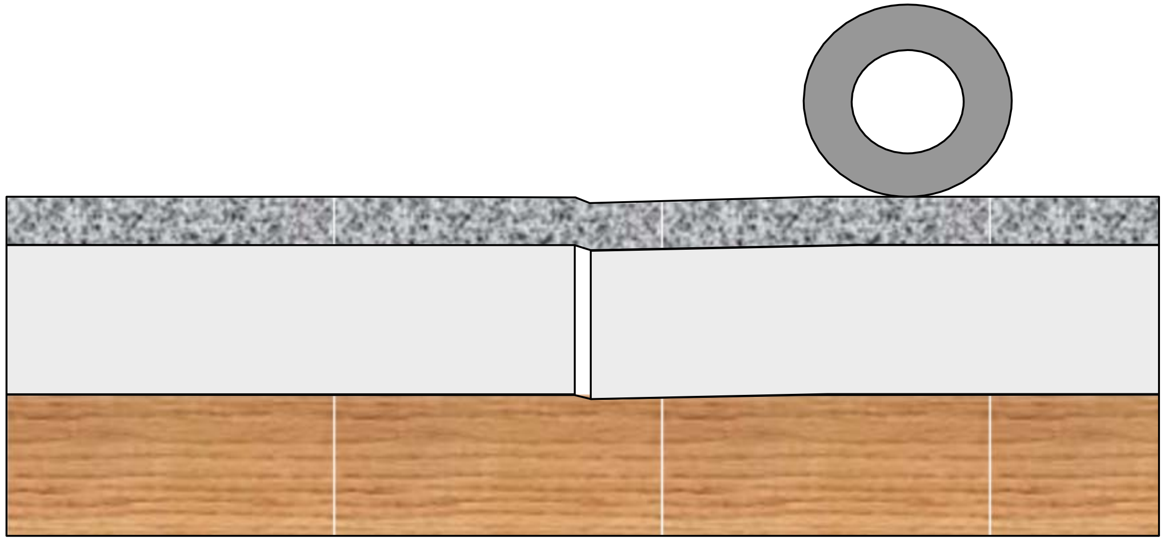

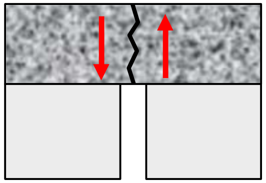

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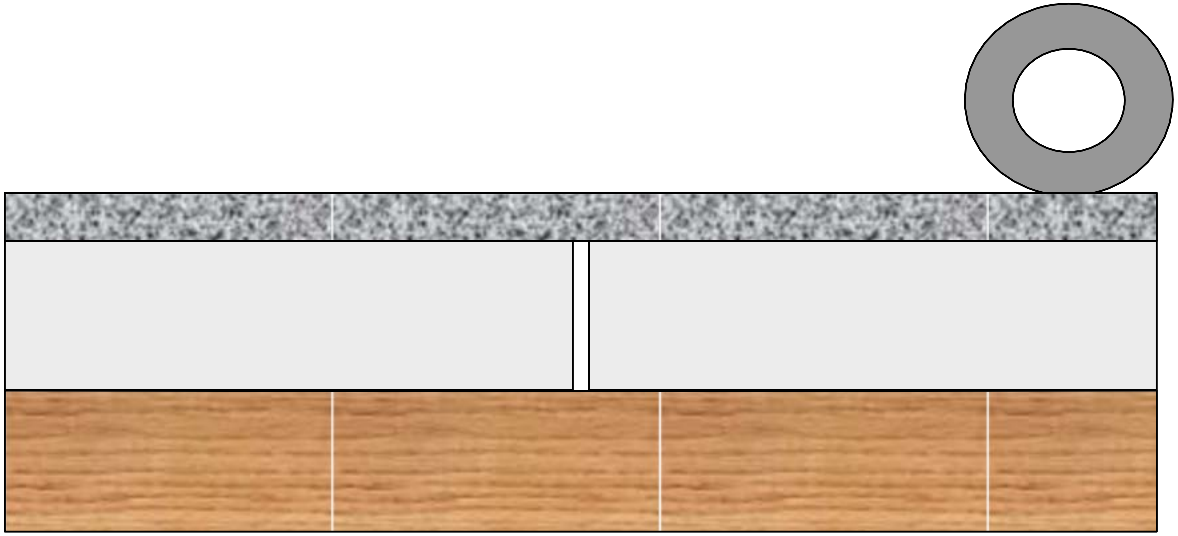

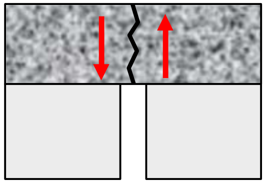

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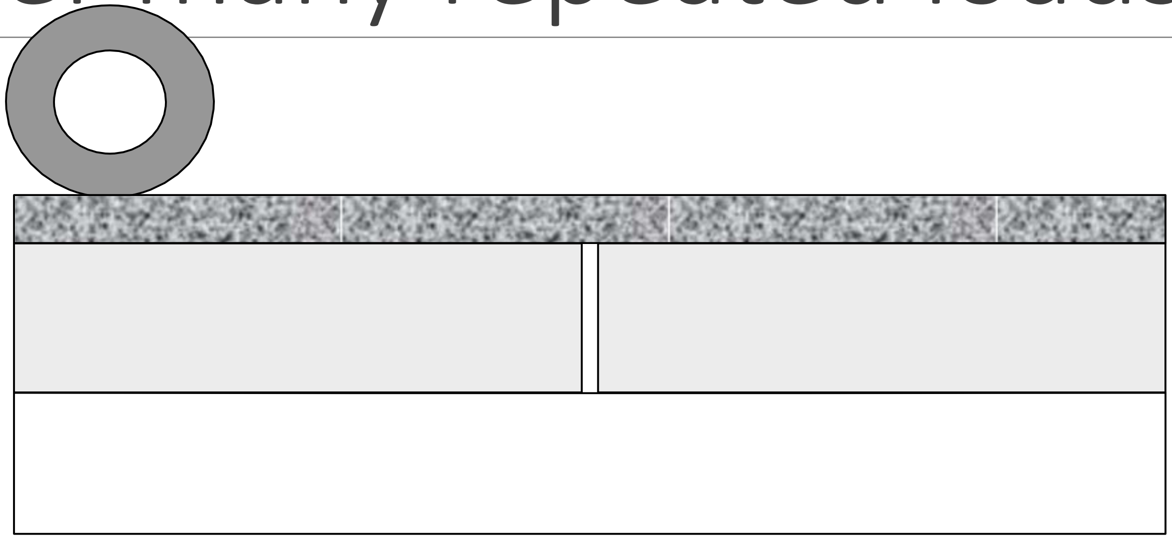

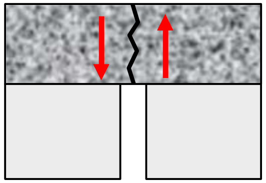

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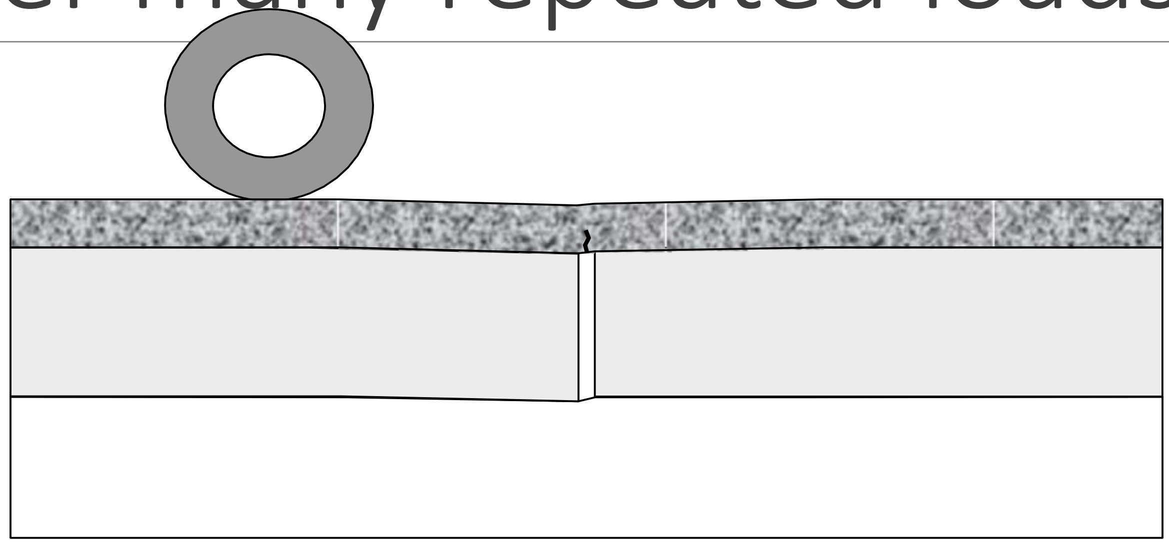

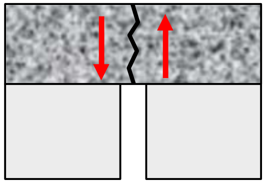

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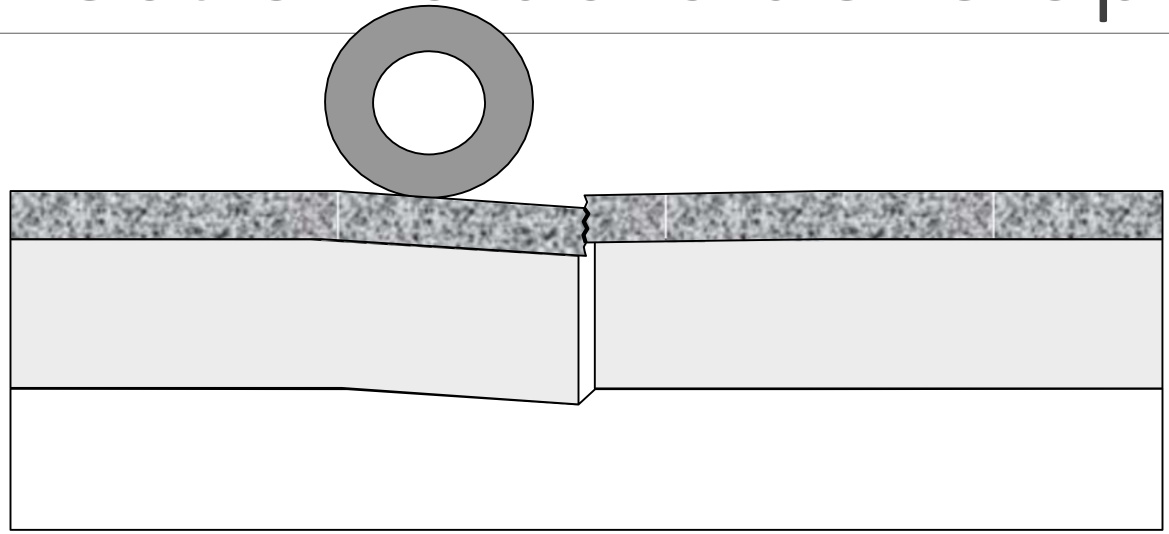

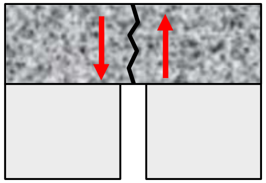

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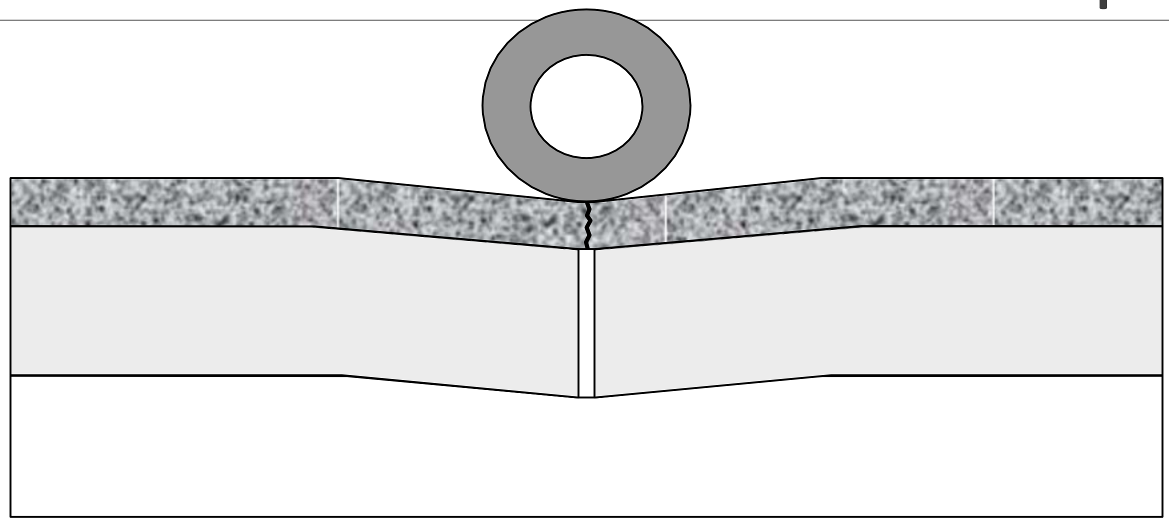

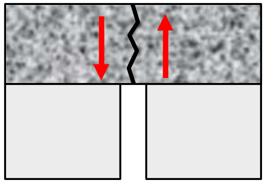

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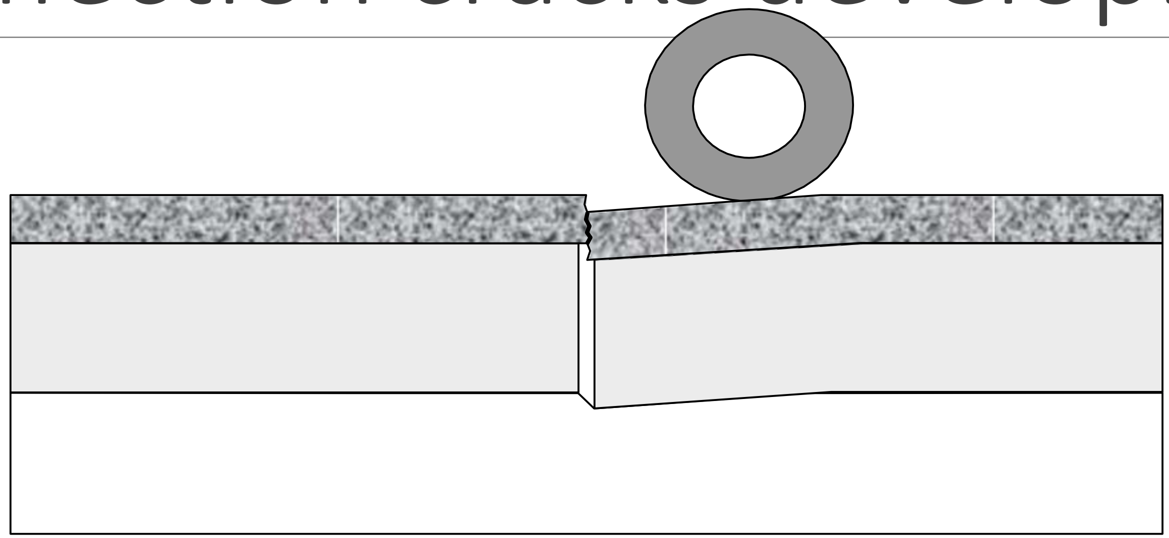

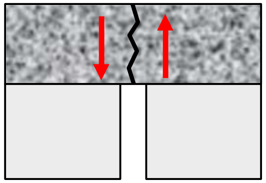

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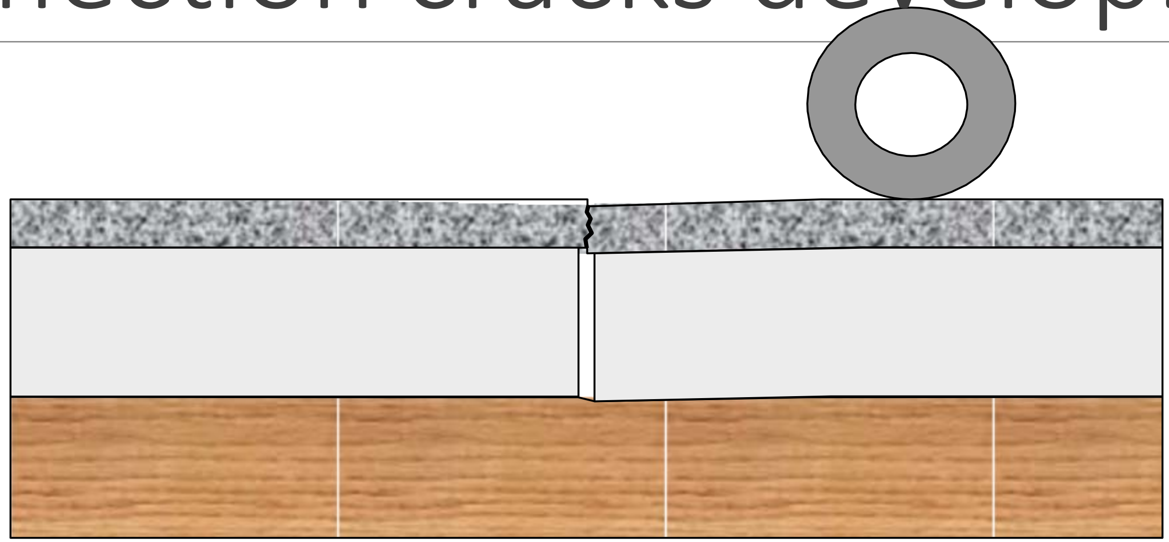

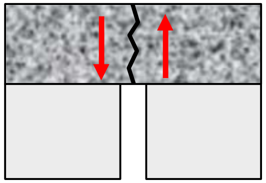

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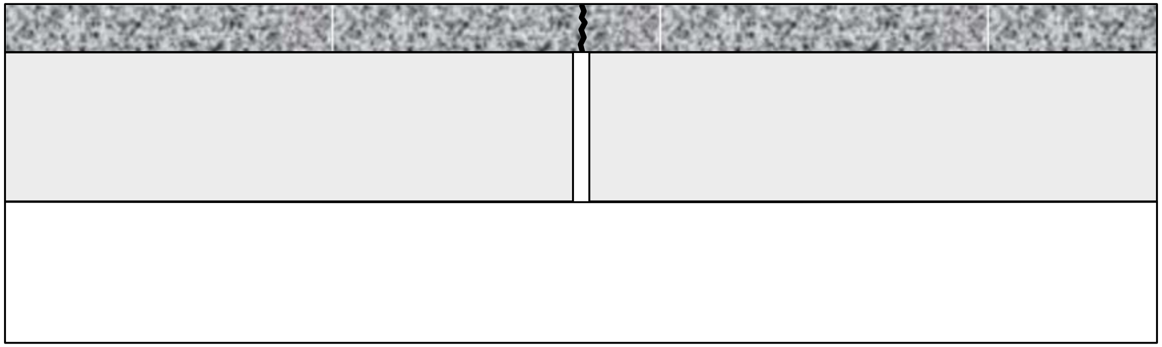
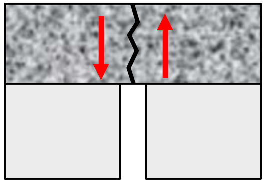


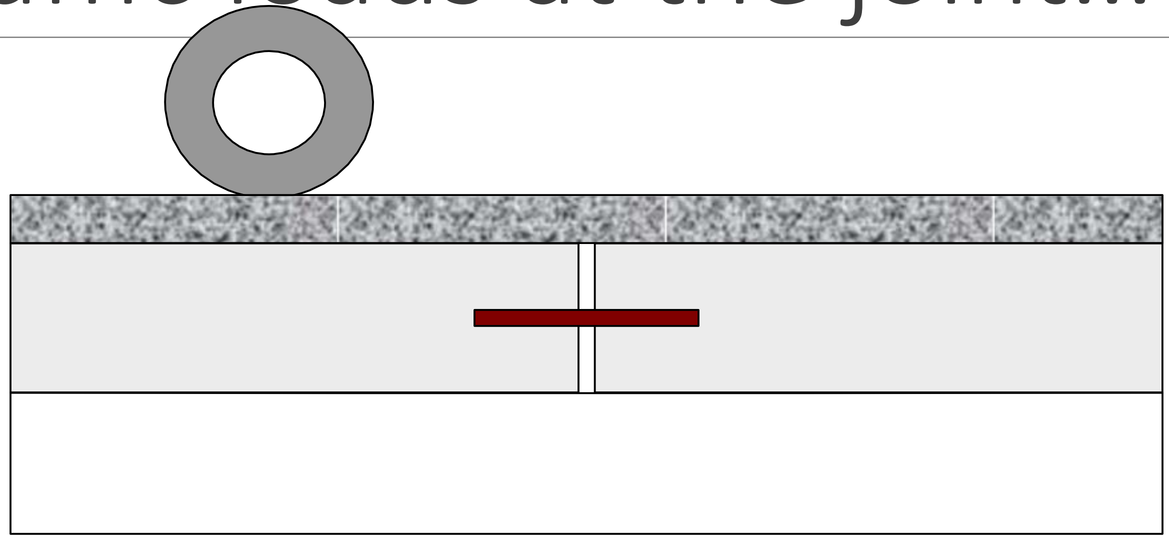


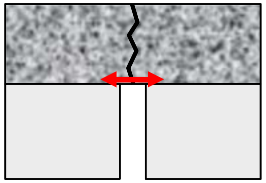
Mode 1: Vertical Shear Stress

Reflective Cracking: Mode 2

- Mode 2 - Tensile stress at bottom of AC layer
  - Poor support
  - Weak base
  - Load Associated Problem (Traffic Loading)

“Traffic loads at the joint…”





Mode 2: Horizontal Tensile Stress due to load

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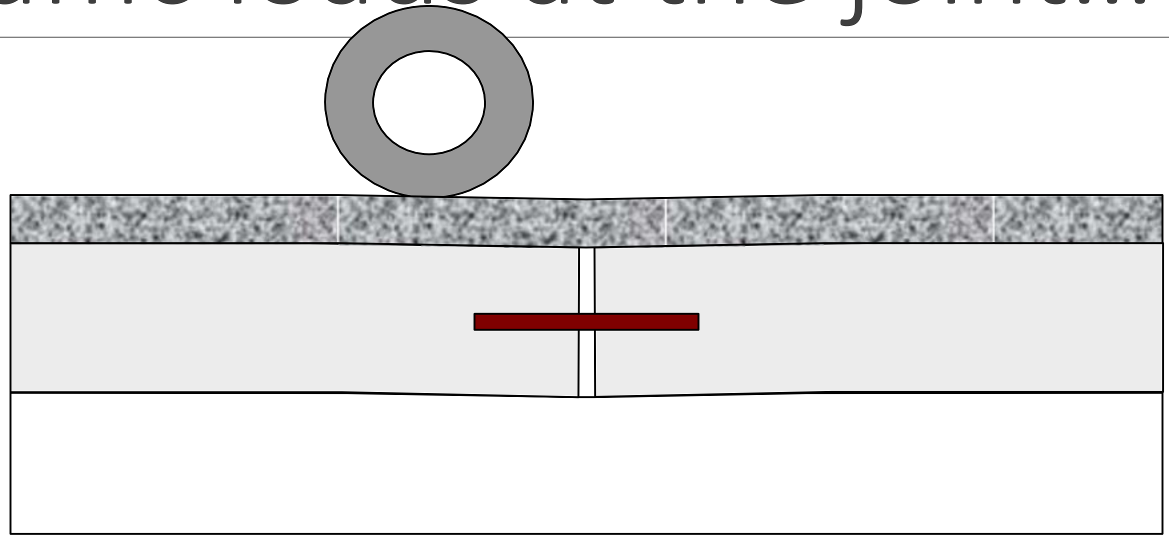

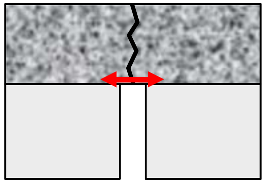

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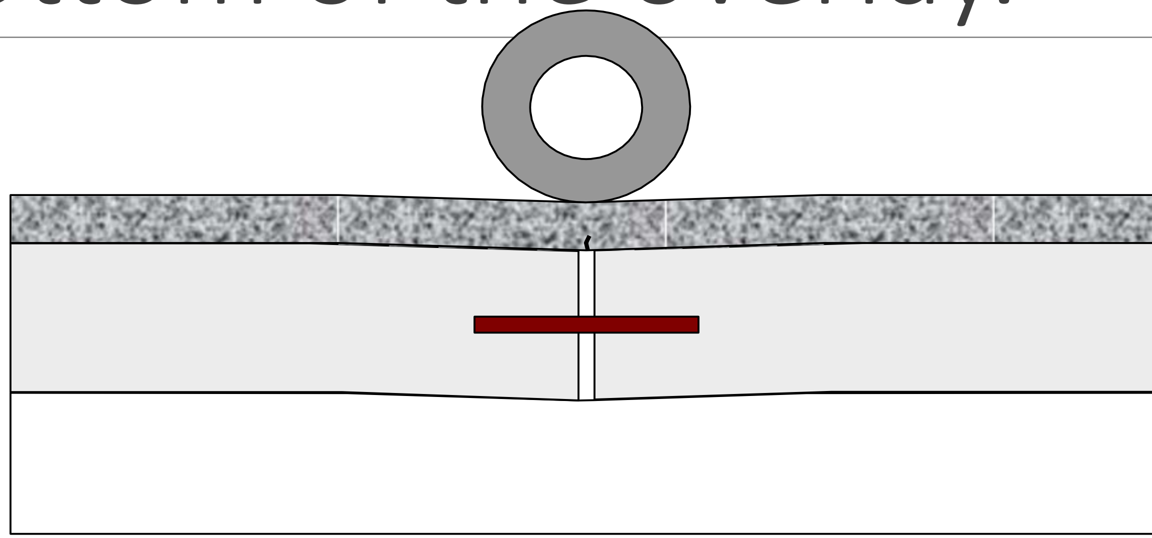

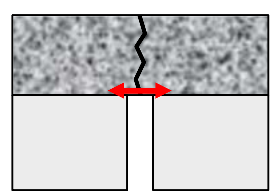

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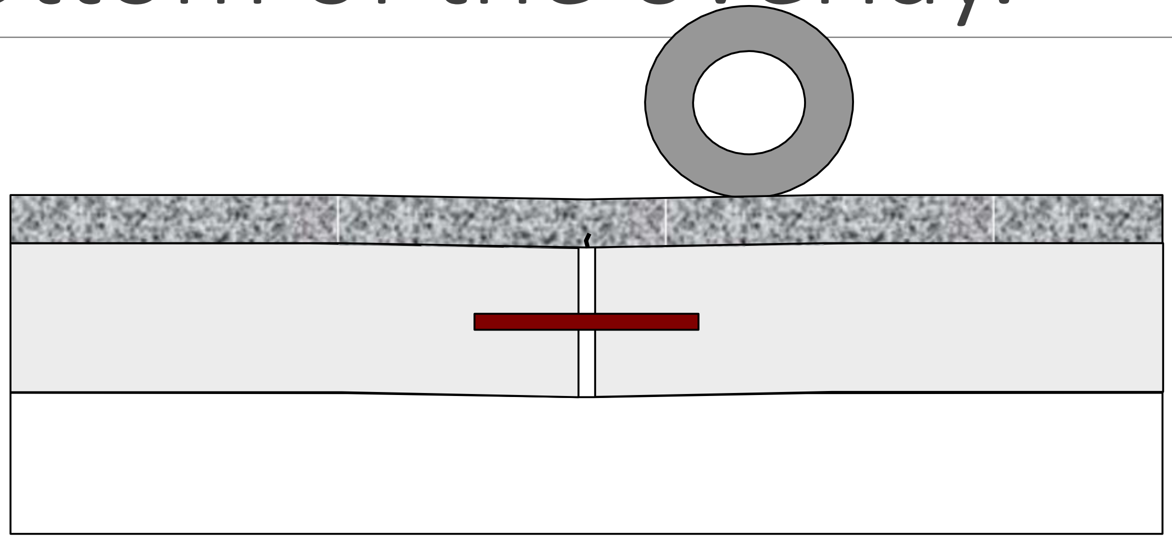

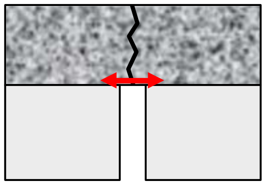

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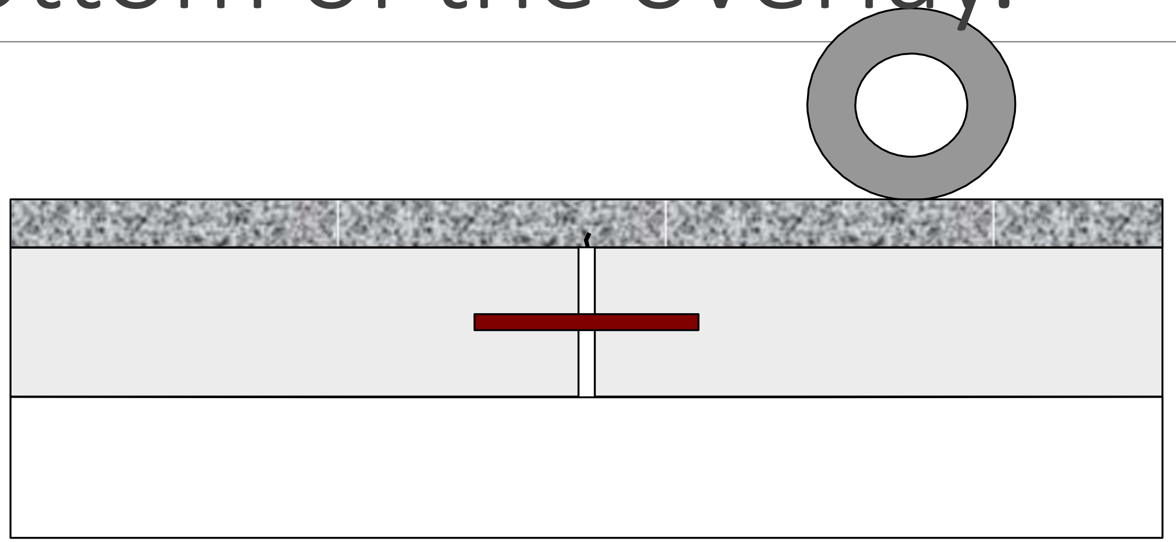

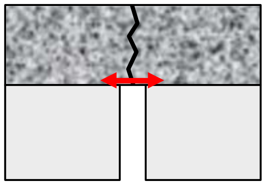

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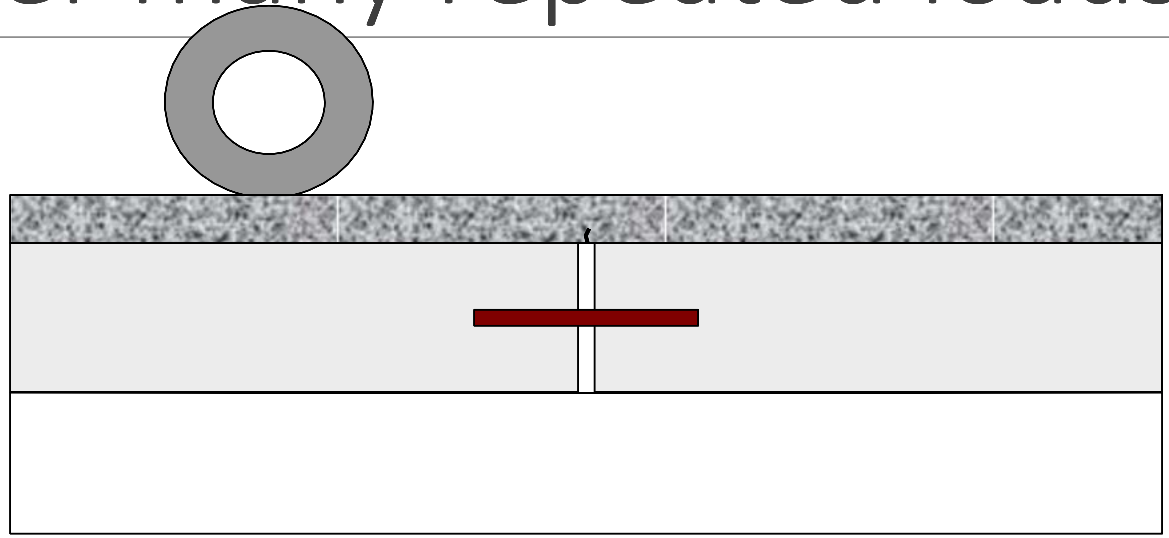

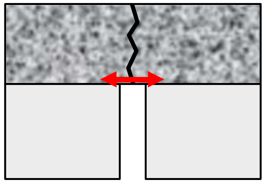

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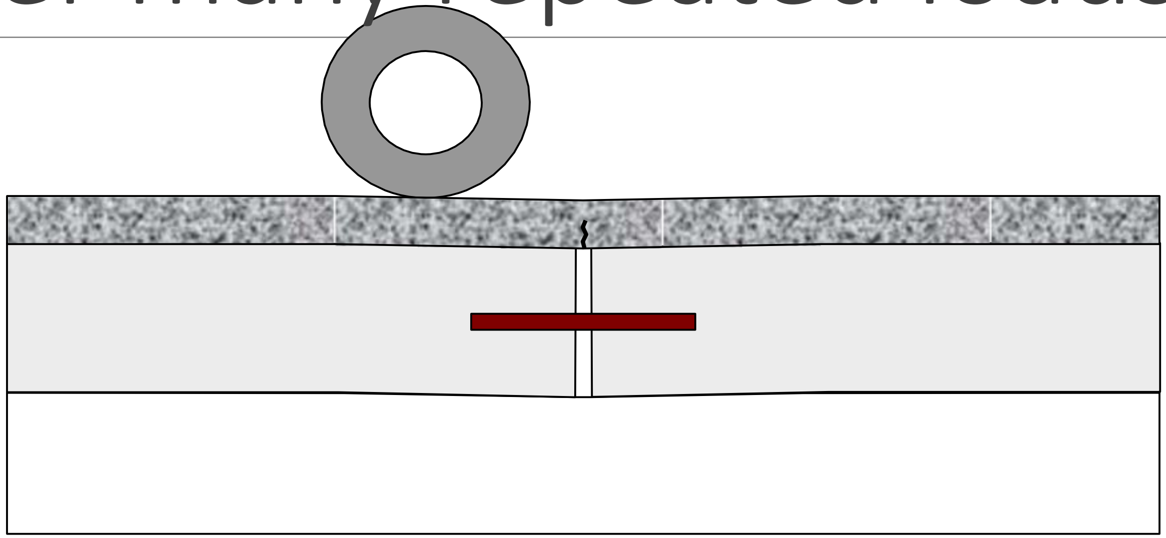

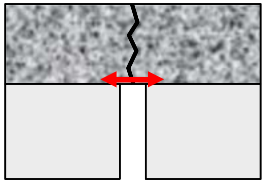

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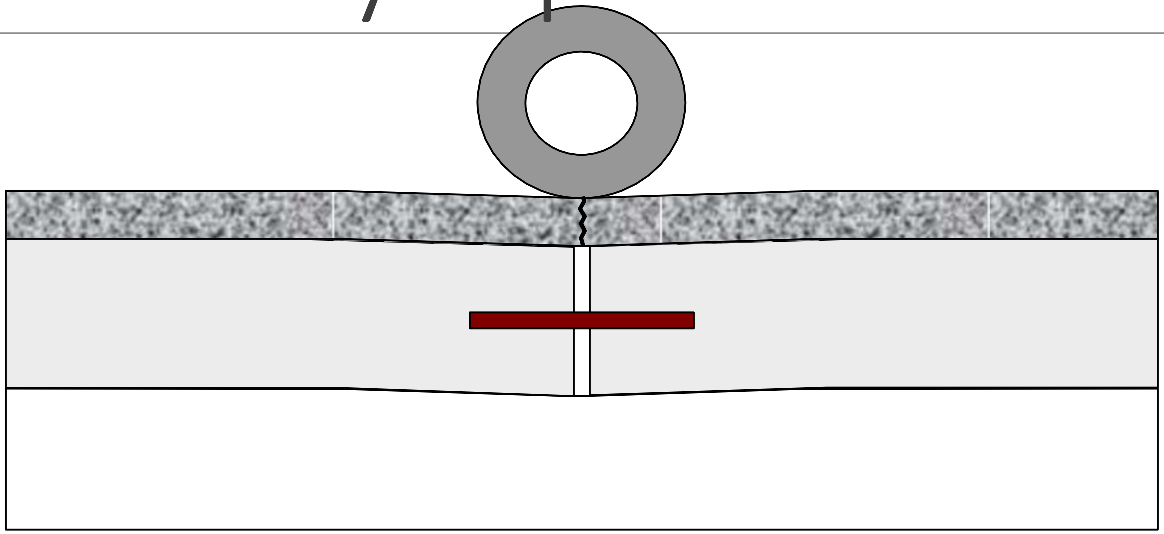

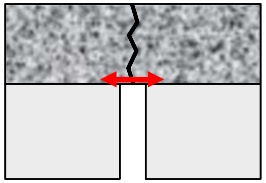

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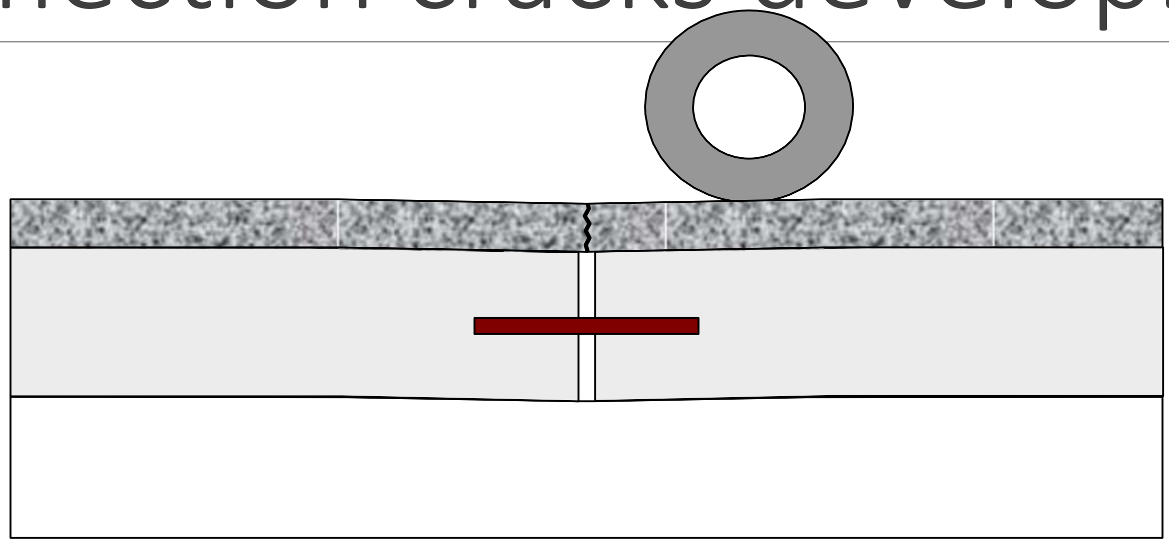

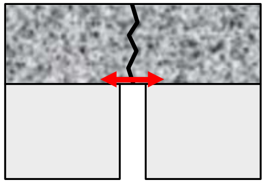

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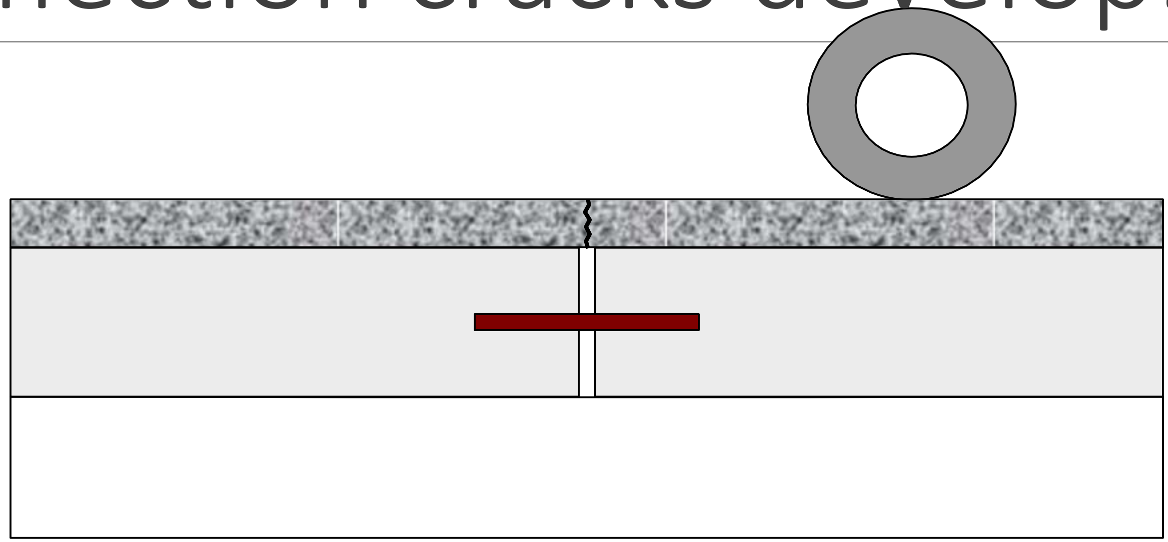

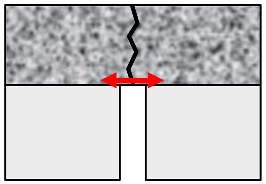

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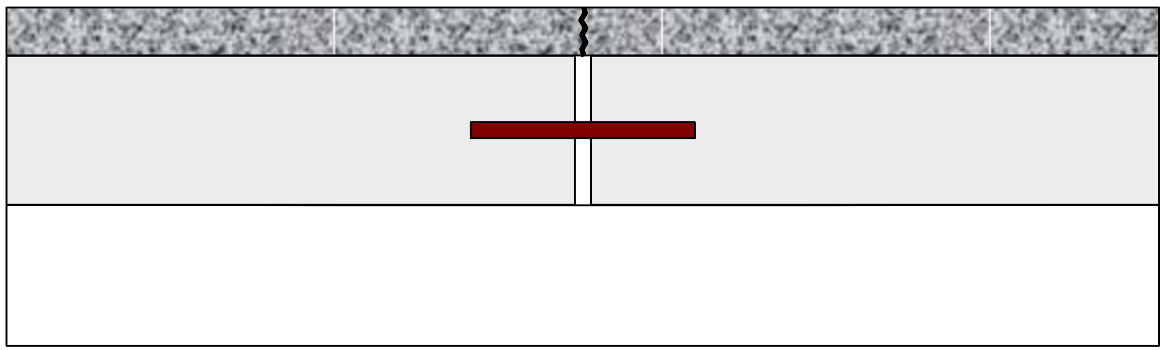
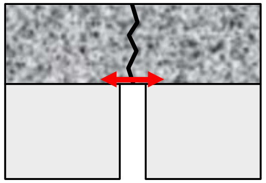


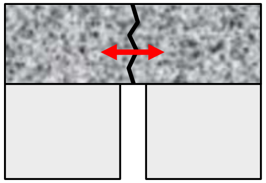


Mode 2: Horizontal Tensile Stress due to load

Reflective Cracking: Mode 3

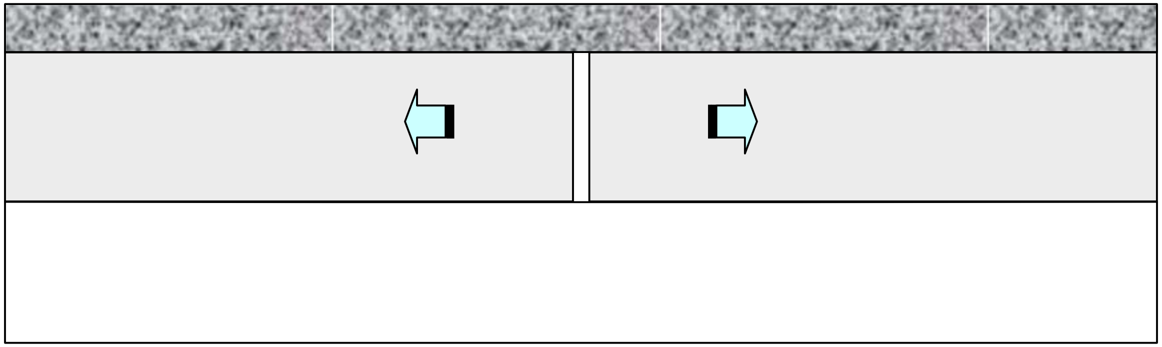
- **Mode 3 – Horizontal Tensile Stress**
  - **Thermally Induced stresses**
  - **Magnitude depends on Slab length (or Crack spacing), 24 hour temperature change, and coefficient of thermal expansion of PCC**

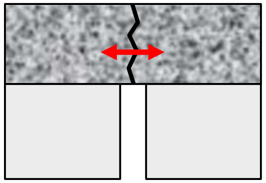
“Slab shrinkage under cooling temperature…”



Mode 3: Horizontal Tensile Stress due to climate

"Slab shrinkage under cooling temperature…"





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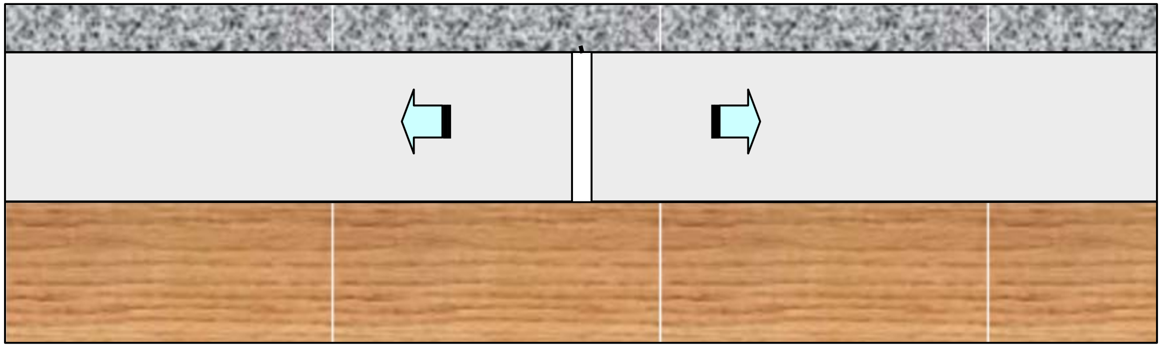

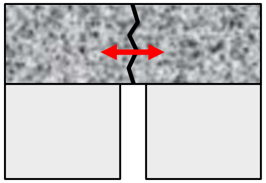

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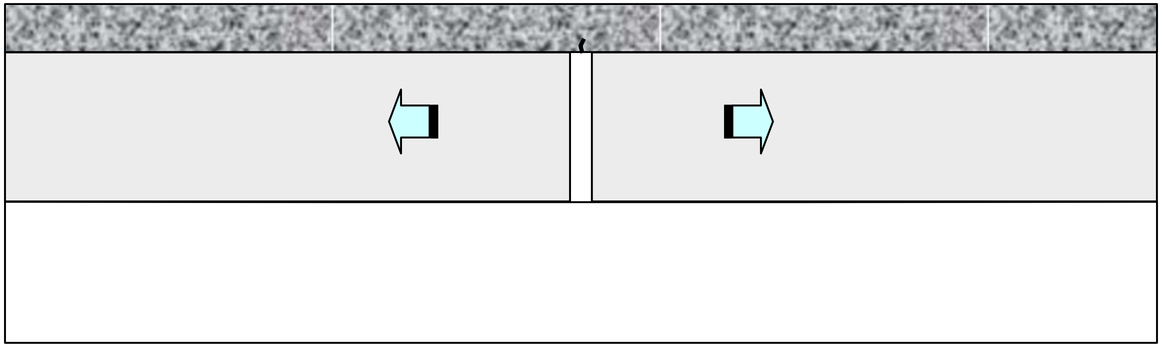

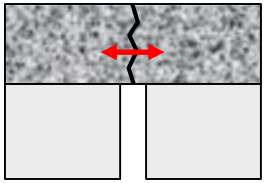

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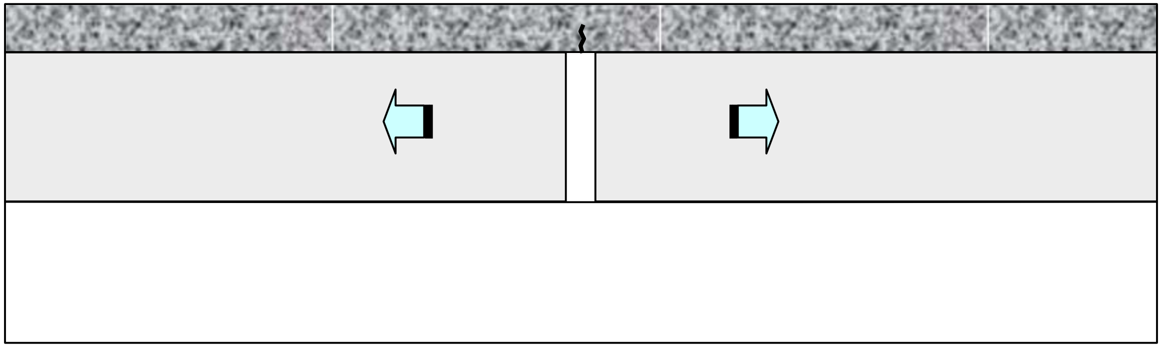

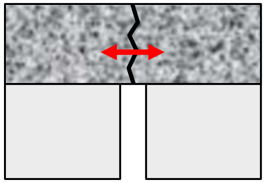

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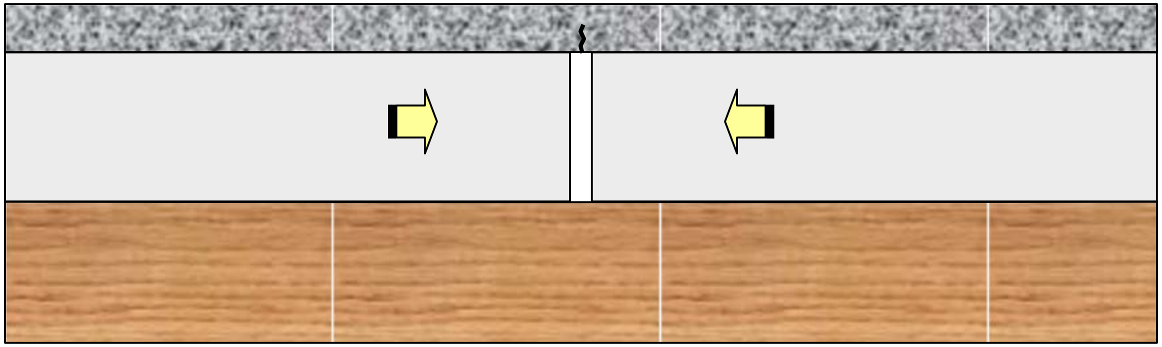
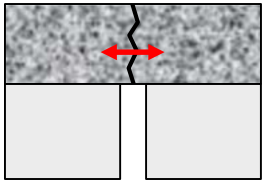
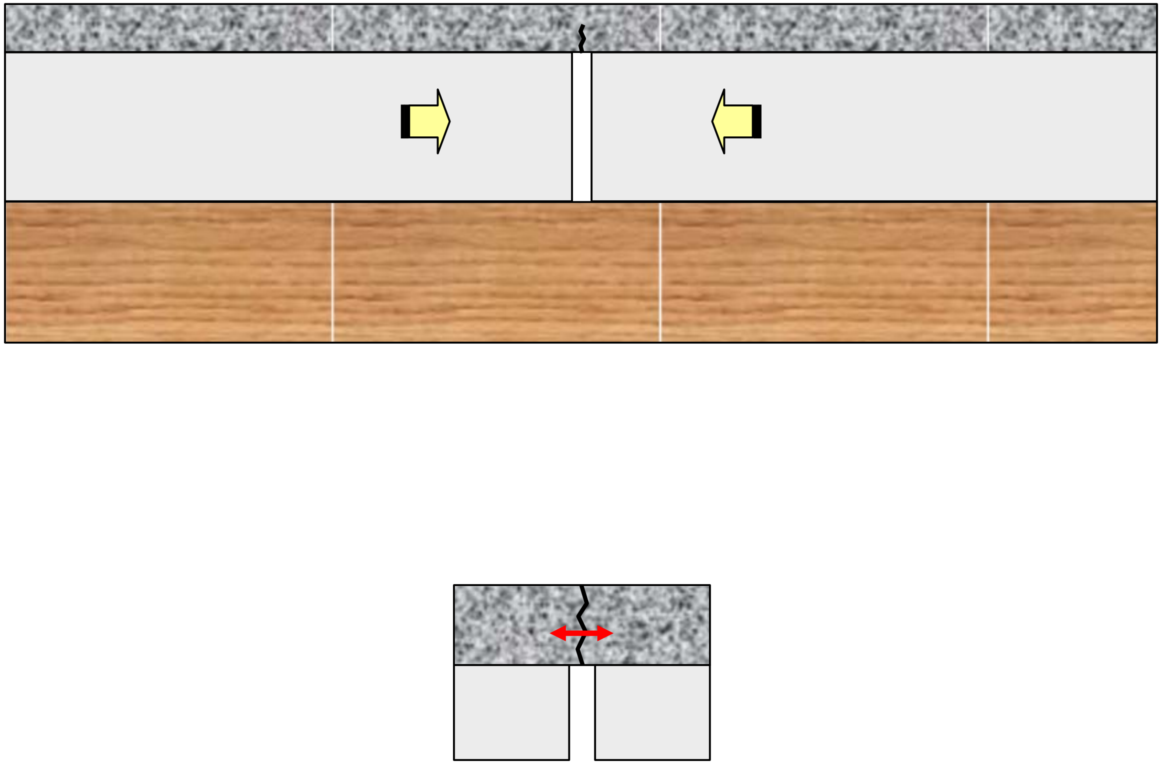
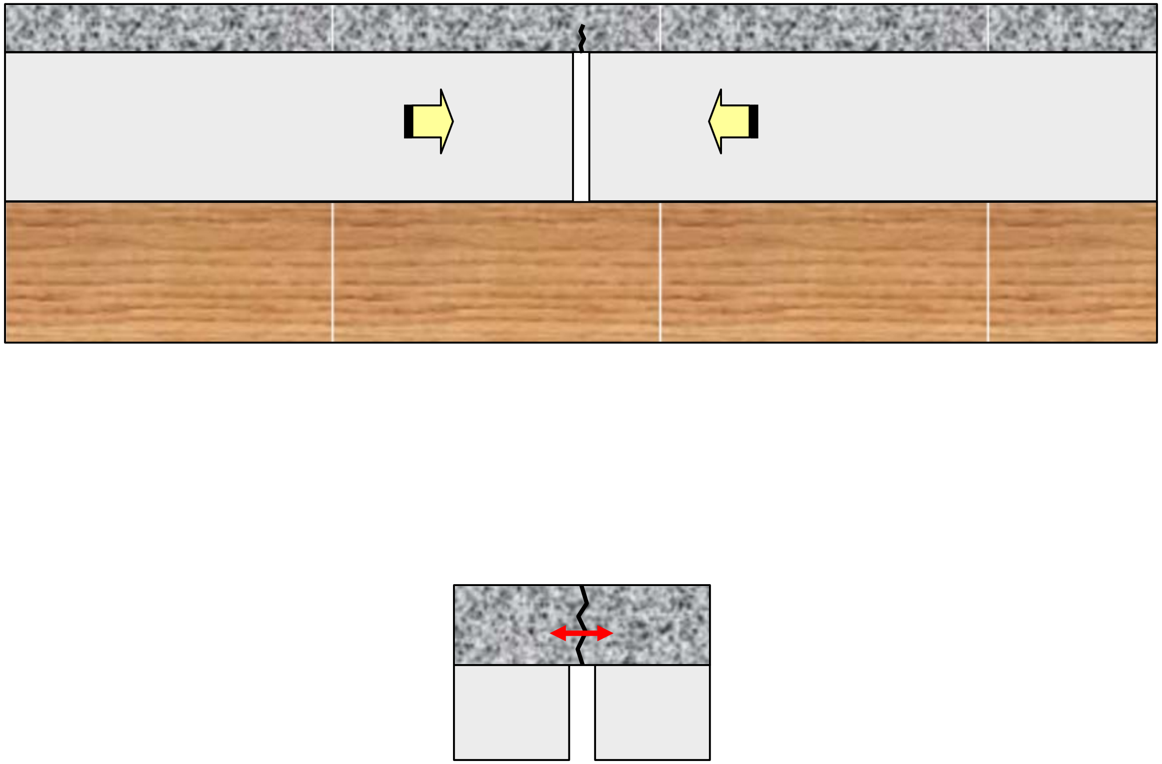




Mode 3: Horizontal Tensile Stress due to climate

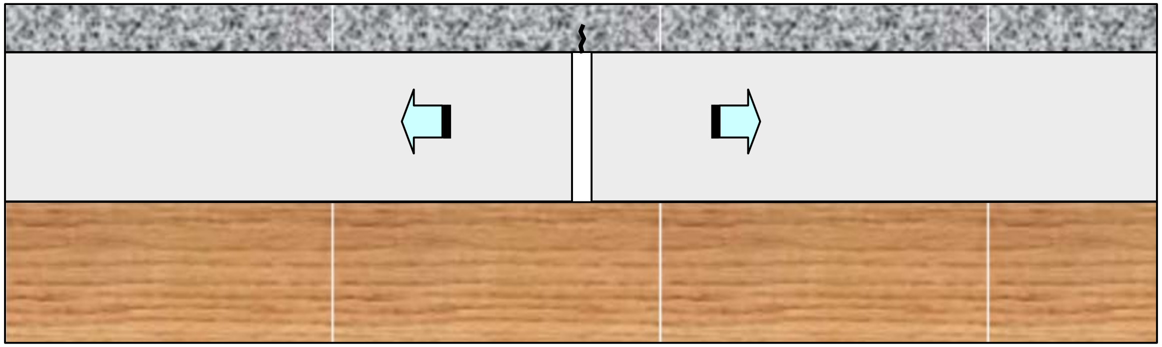


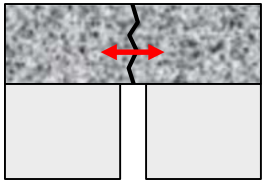
Mode 3: Horizontal Tensile Stress due to climate



Mode 3: Horizontal Tensile Stress due to climate

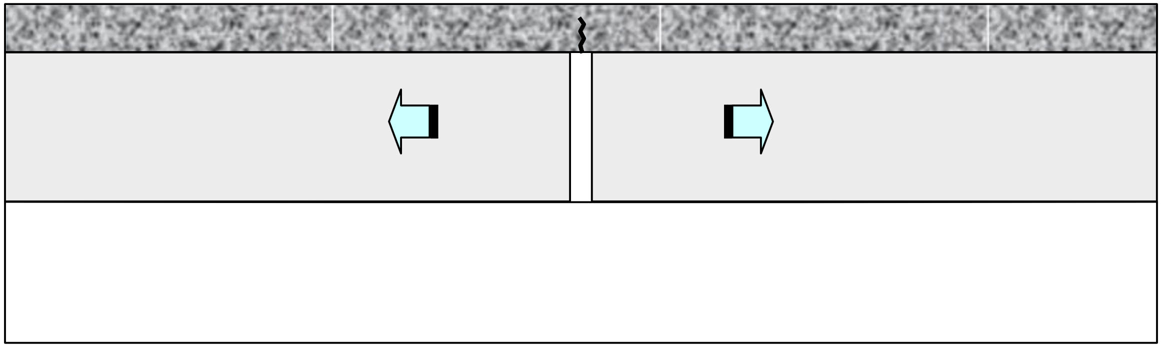
“Over many cycles…”

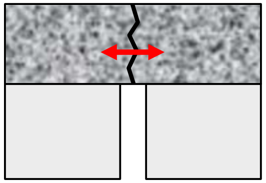




Mode 3: Horizontal Tensile Stress due to climate

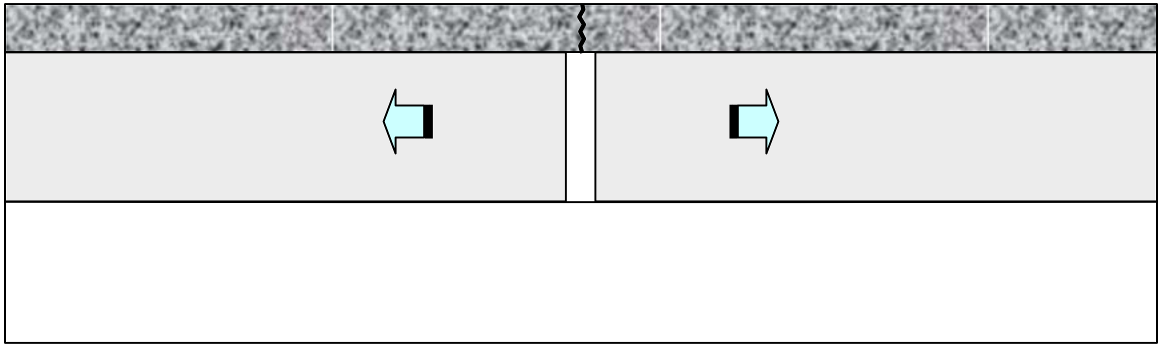
"Over many cycles…"

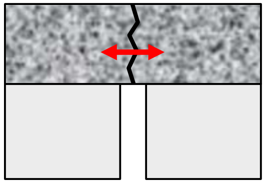




Mode 3: Horizontal Tensile Stress due to climate

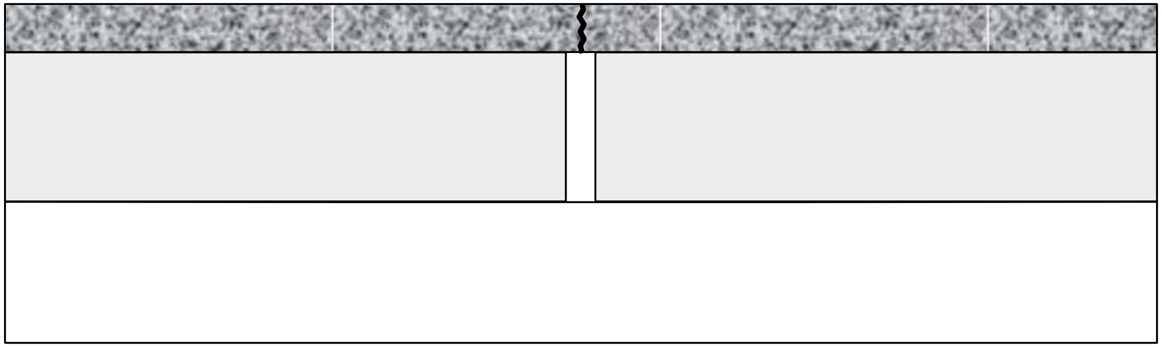
“reflection cracks develop.”

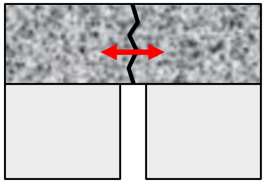




Mode 3: Horizontal Tensile Stress due to climate

“reflection cracks develop.”





Mode 3: Horizontal Tensile Stress due to climate

Composite Pavement Rehabilitation Strategies

Composite Pavement Rehabilitation Strategies

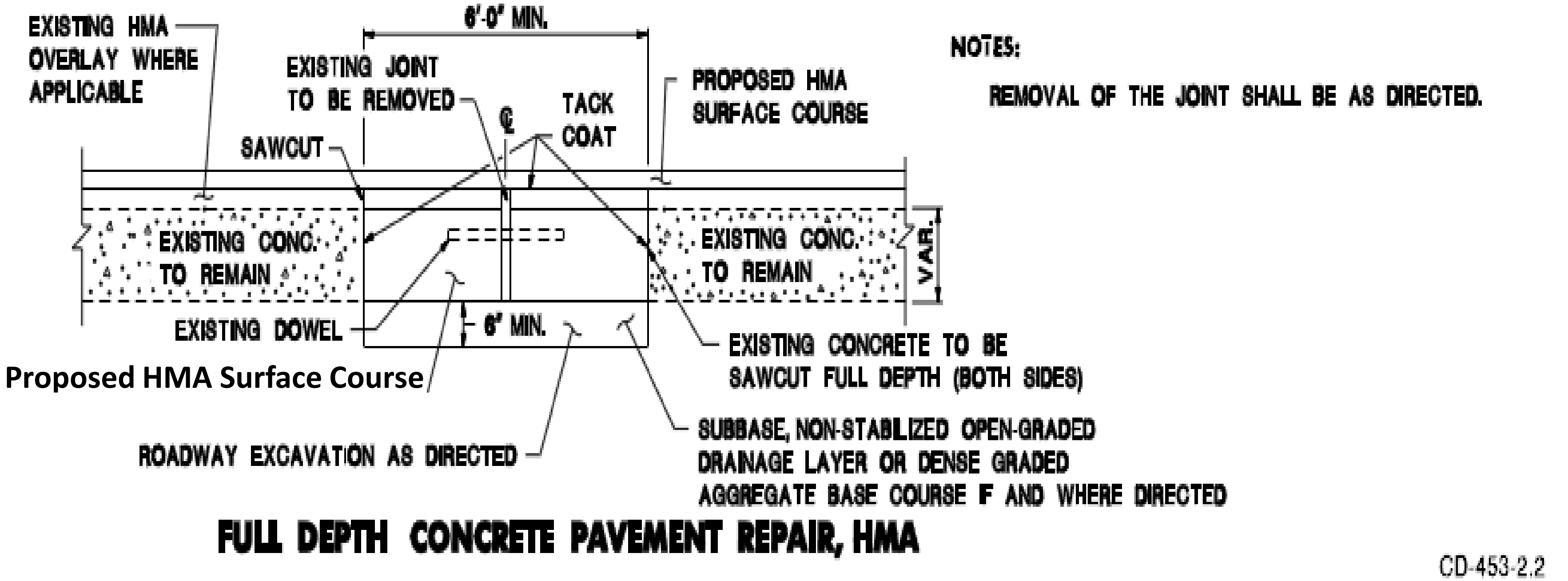
Full Depth Repairs before Milling

- **Full Depth Concrete Pavement Repair, HMA (453006)**
- **Hot Mix Asphalt Pavement Repair (401021)**

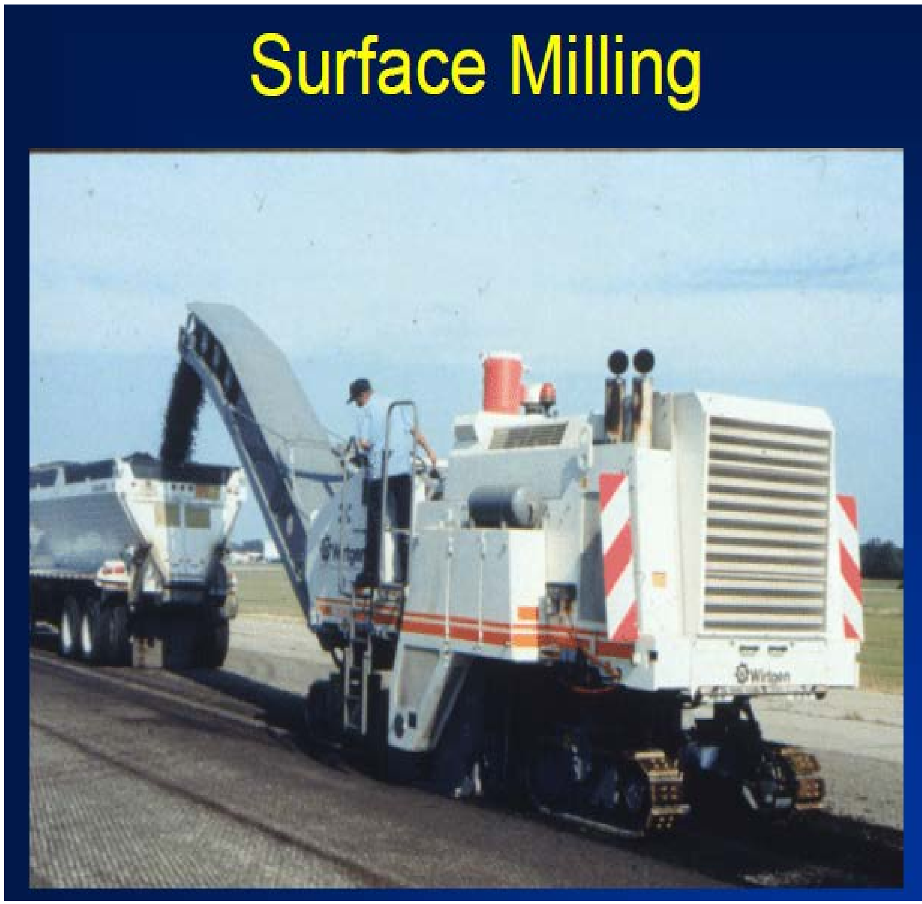
Mill and Overlay with Better Mixes

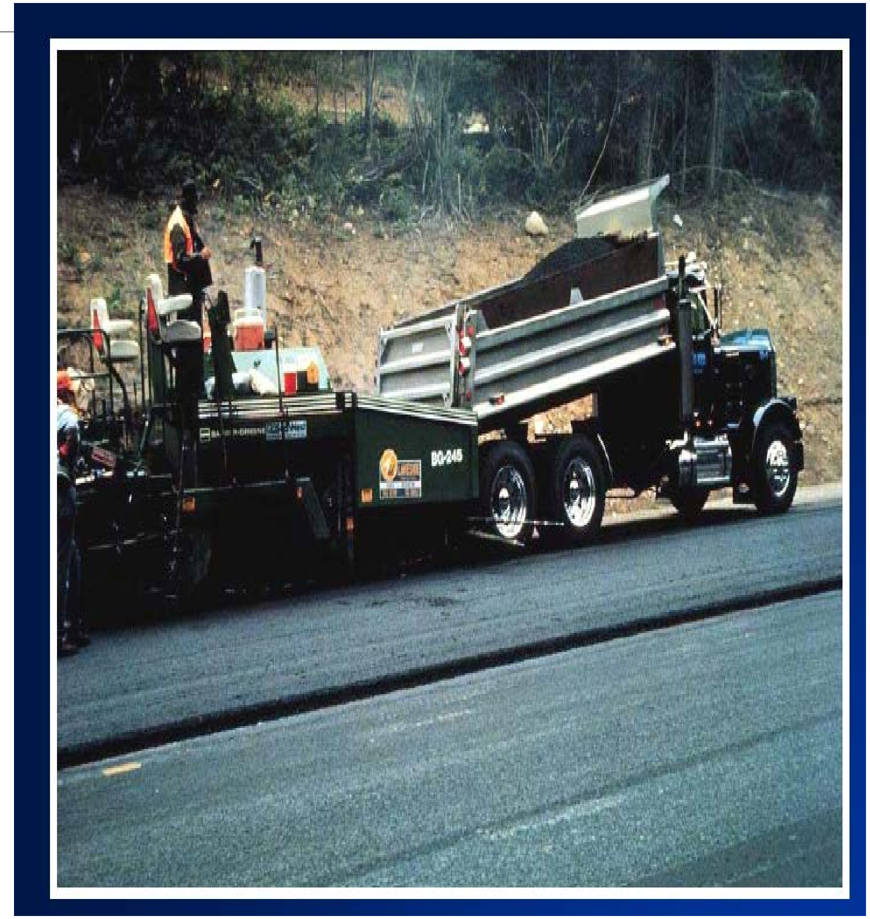
- **AROGFC**
- **Polymer modified HMA**
- **HPTO**
- **SMA**
- **Reflective Crack Relief Interlayer (RCRI) or Strata**
- **Binder Rich Intermediate Course, 4.75 MM**

Full Depth Repair with HMA (typically before milling)



Mill & Overlay with HMA





Why premium mixes?

Better fatigue life

Better durability

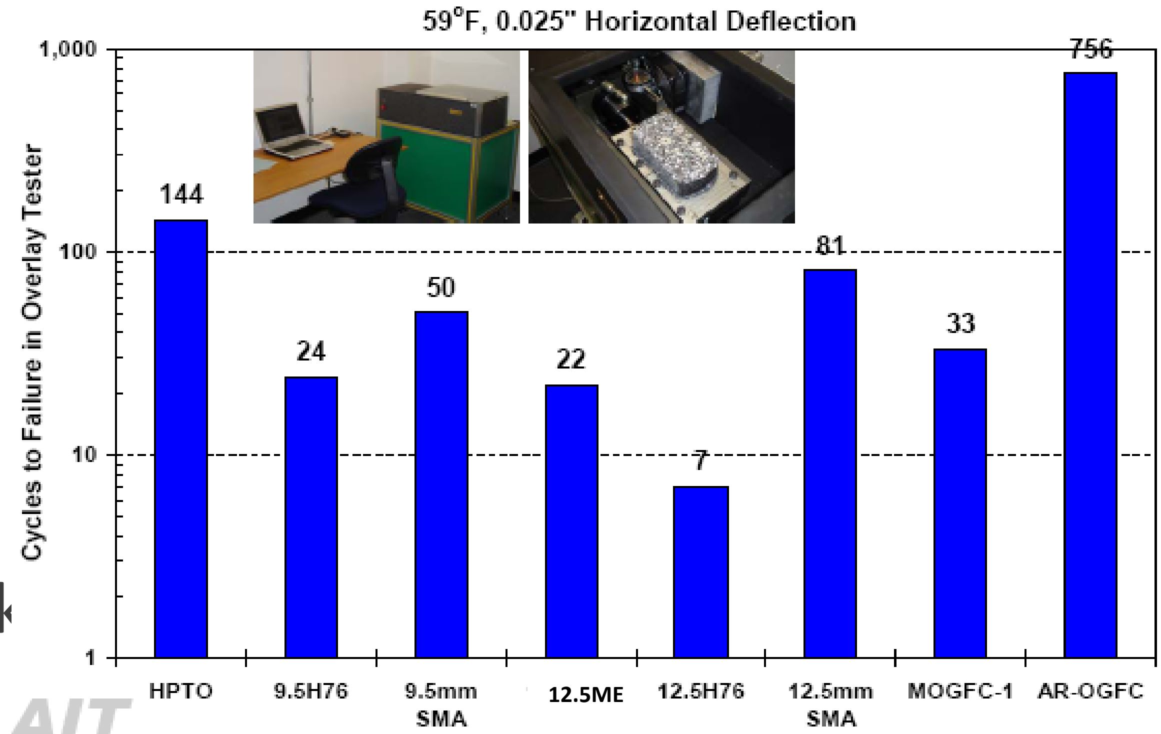
Increased skid/safety

Reduced noise

Increased customer satisfaction

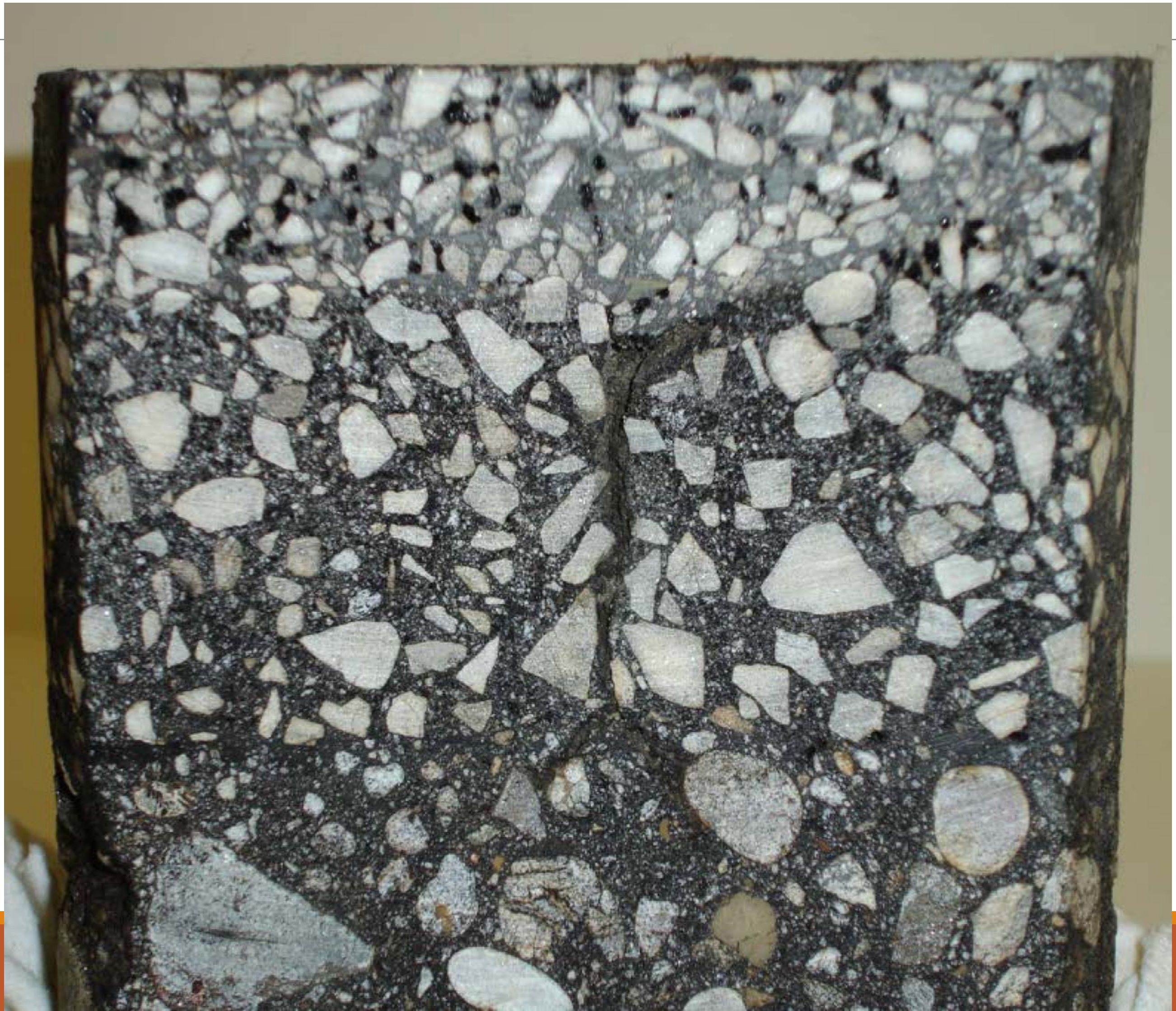
Better reflective crack resistance

NJDOT Surface Course Mixes



Asphalt Rubber Open Graded Friction Course

High Performance Thin Overlay



SMA 12.5mm Surface Course

Rt.202 SB (MP 13.4-17.03) – Maintenance Resurfacing Contract No. 268 (2007)

Rt.202 SB – Maintenance Resurfacing Contract No. 268 (2007)

Visual Survey of JRC Pavement

Rehab. Design of Asphalt Outside Shoulder

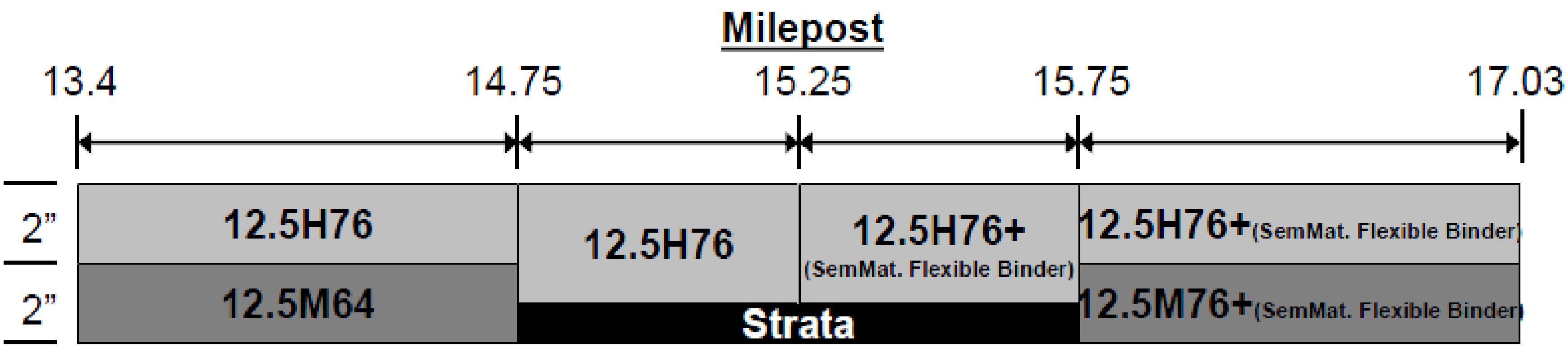
- Roadway Excavation
- Pave with 3” min. & var. HMA 25M64 Base Course
- Pave with 4” (2 lifts) of high quality HMA

Full Depth Concrete Repairs with Very Early Strength Concrete

Overlay Design with 4” (2 lifts) of high quality HMA

3 test sections and 1 control section

Rt.202 SB – Maintenance Resurfacing Contract No. 268 (2007)



Proposed Pavement Design (8/07)

Rt.202 SB – Maintenance Resurfacing Contract No. 268 (2007)

BEFORE REHAB

SDI = 2.07

Ride Quality

- MP 13.4-14.75, IRI=197.2
- MP 14.75-15.25, IRI=154.7
- MP 15.25-15.75, IRI=143.8
- MP 15.75-17.03, IRI=151.5
- Ride Quality for the project, IRI=168.6

AFTER REHAB

SDI = 5.0

Ride Quality

- MP 13.4-14.75, IRI=88.3
- MP 14.75-15.25, IRI=78.0
- MP 15.25-15.75, IRI=77.7
- MP 15.75-17.03, IRI=75.0

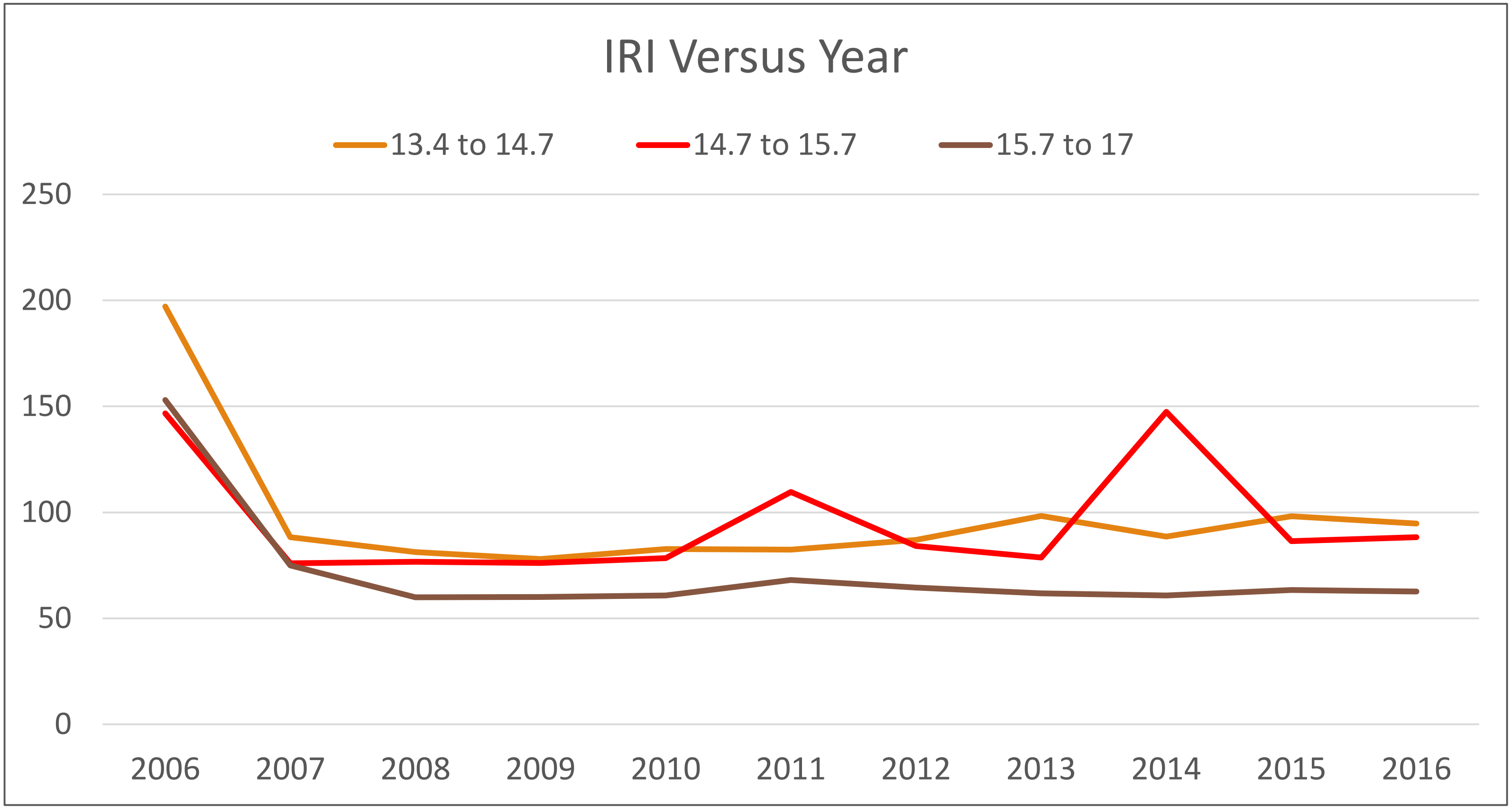
Ride Quality for the project, IRI=80.4

Rt.202 SB – Maintenance Resurfacing Contract No. 268 (2007)

BEFORE REHAB

AFTER REHAB

Rt.202 SB – Maintenance Resurfacing Contract No. 268 (2007)



Rt.70 (MP8.61-12.06)- Maintenance Roadway Repair Contract No. 327 (2007)

Rt.70 (MP8.61-12.06)- Maintenance Roadway Repair Contract No. 327 (2007)

Located high deflection joints (> 15 mils deflection) with FWD during construction

Failed joints were successfully (reduced deflection < 10 mils) grouted with HDP by Uretek

Full Depth Repairs with HMA were performed on high severity joints/areas

Rt.70 (MP8.61-12.06)- Maintenance Roadway Repair Contract No. 327 (2007)

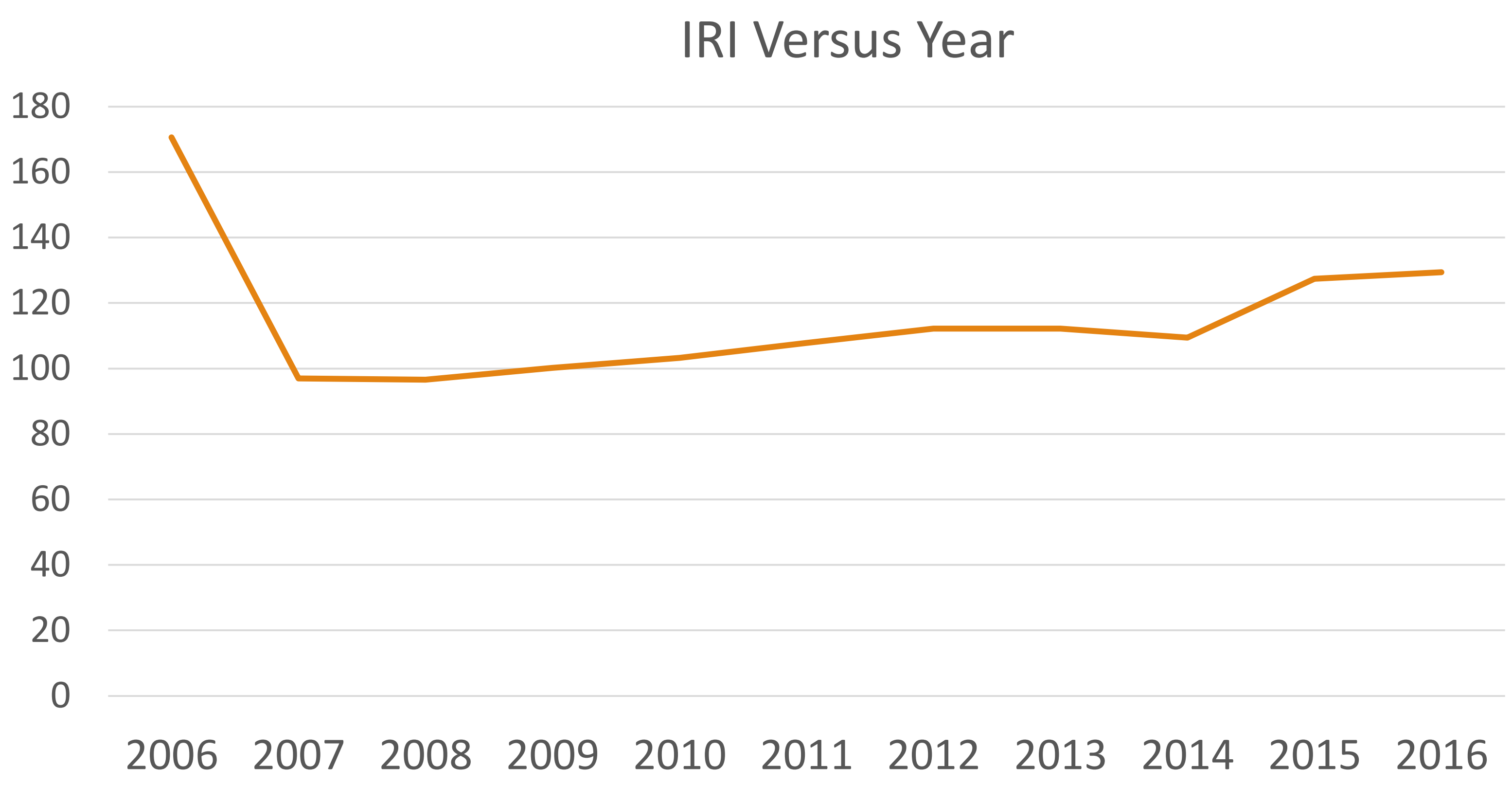
BEFORE REHAB	AFTER REHAB
SDI = 1.56	**SDI = 4.9**
Ride Quality IRI = 157	**Ride Quality IRI = 94**

Rt.70 (MP8.61-12.06)- Maintenance Roadway Repair Contract No. 327 (2007)

BEFORE REHAB

AFTER REHAB

Rt.70 (MP8.61-12.06)- Maintenance Roadway Repair Contract No. 327 (2007)



Case Study-Route 130

Route 130 Main St to Rt 1 Resurfacing -2016

Limit of the project:

MP 72.68 to MP 74.12

MP 76.03 to MP 80.97

MP 81.59 to MP 83.58

Total Lane Miles of the project: 33.56

Prime Contractor: Trap Rock Industries, LLC

Letting Date: June 23, 2015

Project Completed: June 17, 2016

Route 130 Main St to Rt 1 Resurfacing -2016

Visual Survey of Composite Pavement

Cores performed to establish proper milling depth

Full Depth Repair areas identified by visual survey during final design

Calculated approximately 20 million ESAL's

Overlay Design consisted of milling 3" depth and resurfacing with:

- 2" Stone Matrix Asphalt 12.5 MM Surface Course
- 1" Binder Rich Intermediate Course, 4.75 MM

BRIC - SPECIFICATION

Table 902.09.03-1 JMF Requirements for BRIC

Sieve Sizes	**Percent Passing**[1]	**Production Control Tolerances**[2]
3/8"	100	±0%
No. 4	90-100	±4%
No. 8	55-90	±4%
No. 30	20-55	±4%
No. 200	4-10	±2%
Asphalt Binder Content (Ignition Oven)	7.4 % minimum	±0.40%
Maximum Lift Thickness	1.5 inch	

1. Aggregate percent passing to be determined based on dry aggregate weight.
2. Production tolerances are for the approved JMF and may fall outside of the wide band gradation limits.

BRIC - SPECIFICATION

Table 902.09.03-2 Volumetric Requirements for Design and Control of BRIC					
	Required Density (% of Max Sp. Gr.)		Voids in Mineral Aggregate	Dust to Binder Ratio	Draindown AASHTO T 305
	@ N_{des} (50 gyrations)	@ N_{max} (100 gyrations)	(VMA)		
Design Requirements	97.5	$\leq$ 99.0	$\geq$ 18.0 %	0.6 – 1.2	$\leq$ 0.1 %
Control Requirements	96.5 – 98.5	$\leq$ 99.0	$\geq$ 18.0 %	0.6 – 1.3	$\leq$ 0.1 %

BRIC - SPECIFICATION

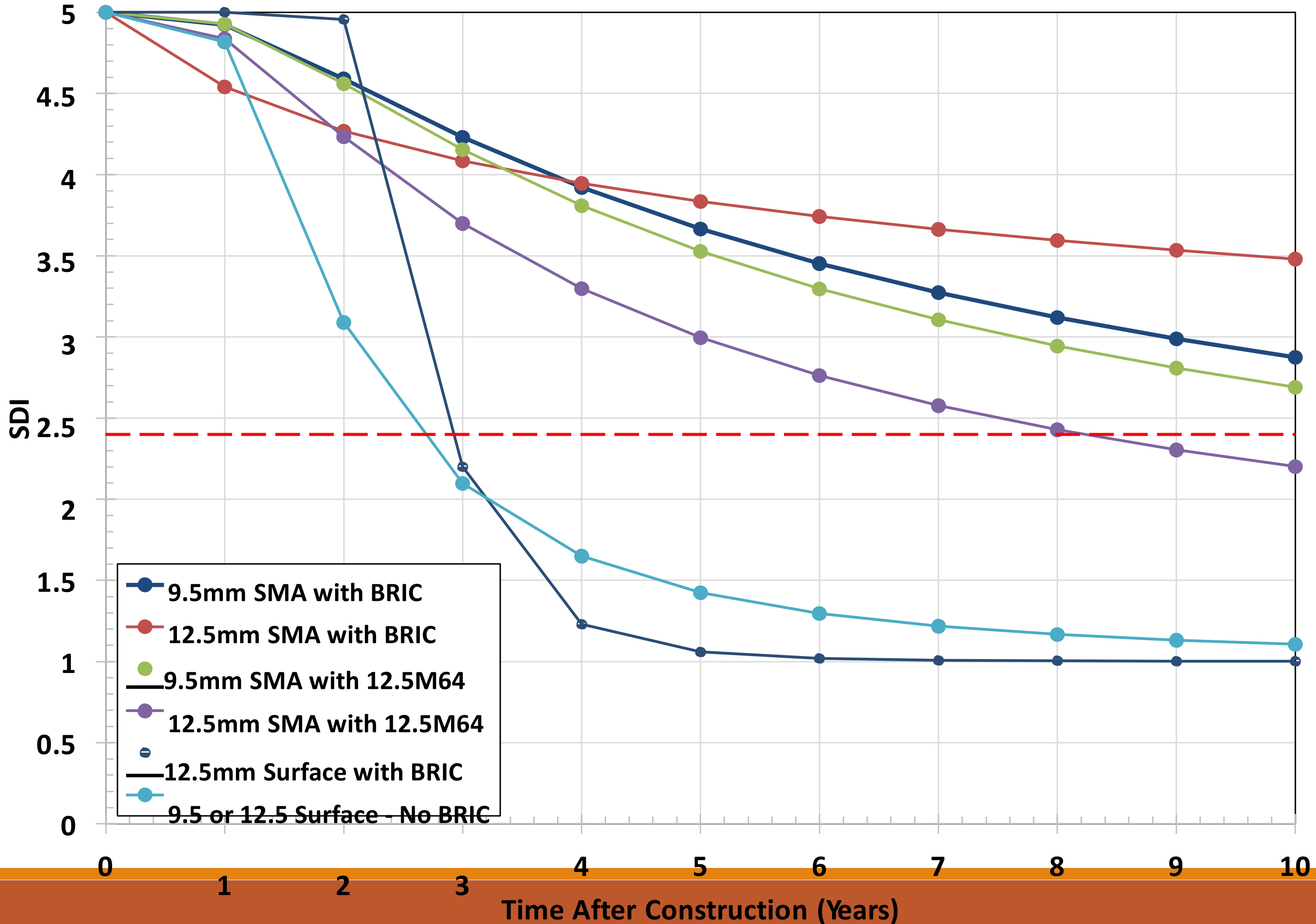
Table 902.09.03-3 Mix Design Performance Testing Requirements for BRIC	
Test	**Requirement**
Asphalt Pavement Analyzer (AASHTO T 340)	< 6 mm@ 8,000 loading cycles
Overlay Tester (NJDOT B-10)	>700 cycles

Table 902.09.03-4 Production Performance Testing Requirements for BRIC	
Test	**Requirement**
Asphalt Pavement Analyzer (AASHTO T 340)	< 7 mm@ 8,000 loading cycles
Overlay Tester (NJDOT B-10)	> 650 cycles

BRIC – Performance Analysis

- **Evaluated changes in SDI to evaluate performance of BRIC on New Jersey pavement sections**
- **BRIC analysis difficult as always overlaid with a surface course**
  - **Analysis looked at performance with and without BRIC**
  - **Analysis looked at different surface courses**
- **Compared performance life for different scenarios**
  - **All data averaged for same “system” compared**
  - **An SDI value of 2.4 is a trigger for rehabilitation**

BRIC – Performance Analysis



BRIC – In- Service Life Evaluation

- Performance of BRIC material highly dependent on the surface course overlaying the BRIC
  - SMA overlays performed best
    - Still "flexible" enough to withstand residual vertical straining
  - Dense graded overlays performed the worst
    - Too "stiff" – can not withstand residual flexing
- SMA alone provides a good alternative
  - Not as good performance but could be beneficial for areas of "good" concrete conditions

Route 130 Main St to Rt 1 Resurfacing -2016

BEFORE REHAB

SDI = 2.4

Ride Quality IRI = 178

AFTER REHAB

SDI = 5

Ride Quality IRI = 65

Route 130 Main St to Rt 1 Resurfacing -2016

Route 130 Main St to Rt 1 Resurfacing (MP72.68-83.58)-2016

Application of New Technique:

- **Thermal Profile System (Item# 401019P)**
- **Intelligent Compaction (Item# 401023P)**

Special Mix for Skid Resistance:

- **High Friction Surface Treatment (Item# 423003M)**

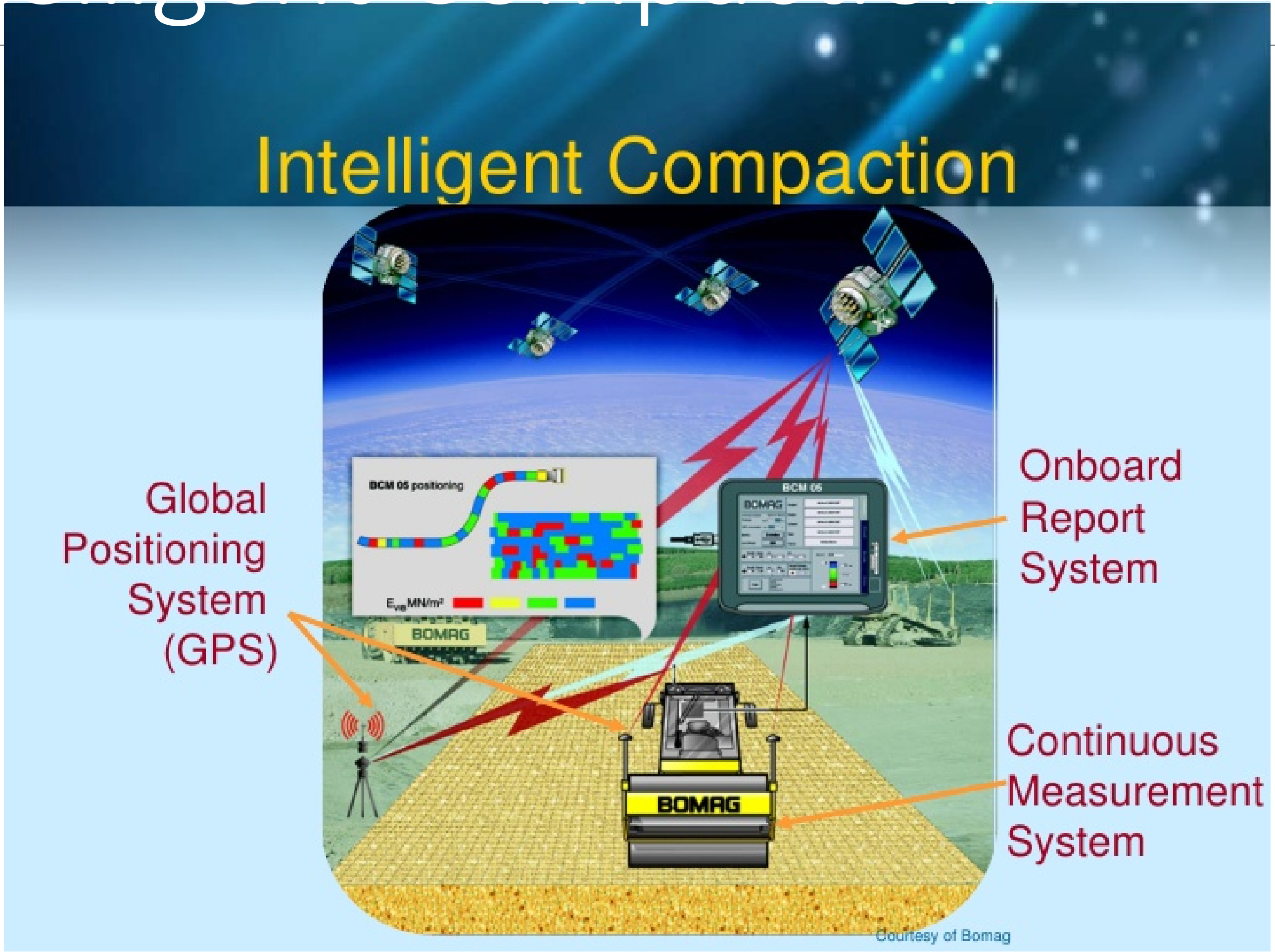
Thermal Profile System

Paver Mounted Thermal Profile (PMTP) Method:

A system that continually monitors the surface temperature readings of the mat immediately behind the paver screed during placement operations.

Intelligent Compaction

IC rollers are vibratory rollers equipped with instrumentation fed to a documentation and feedback control system that processes compaction data in real time for the roller operator.



Intelligent Compaction
Global Positioning System (GPS)
Onboard Report System
Continuous Measurement System
BCM 05 positioning
BCM 05
BOMAG
BOMAG
Courtesy of Bomag

HFST

High friction surface treatments (HFST) are pavement treatments that dramatically and immediately reduce crashes, injuries, and fatalities associated with friction demand issues, such as:

- **A reduction in pavement friction during wet conditions, and/or**
- **A high friction demand due to vehicle speed and/or roadway geometrics.**

HFST

HFST

HFST

HFST

QUESTIONS?

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Thanks