Polymer- Modified Bridge Deck Waterproof Surface Mix

Pennsylvania Asphalt Pavement Association

60th Annual Paving Conference

Hershey, PA

January 22, 2020

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Associated Asphalt®

Requirements for an Asphalt Surface Mix For Bridges

- Mix designed to provide rut resistance
- Mix designed to provide extreme fatigue resistance – may experience much greater vertical movement than on a roadway
- Mix designed to achieve density without vibratory compaction
- Mix designed to have extremely low permeability - “water proof”
- Mix designed to have excellent workability

Requirements for an Asphalt Surface Mix For Bridges

- Challenge in the past to maintain rut resistance and extreme flexibility at the same time
- Industry has used Styrene-Butadiene-Styrene (SBS) polymers to modify asphalt for over 25 years
  - Styrene is a hard plastic material - provides stiffness
  - Butadiene is man-made rubber – provides flexibility

Requirements for an Asphalt Surface Mix For Bridges

- In the past, SBS dosage levels above 4% have created asphalt binders with poor workability
- New formulations of SBS polymer now allow dosages >7% with excellent workability
- Now possible to provide high levels of rut and fatigue resistance at the same time with high levels of SBS polymer modification
- Associated Asphalt formulated a highly modified asphalt to meet NJDOT specification for bridge deck applications – StellarFlex BD

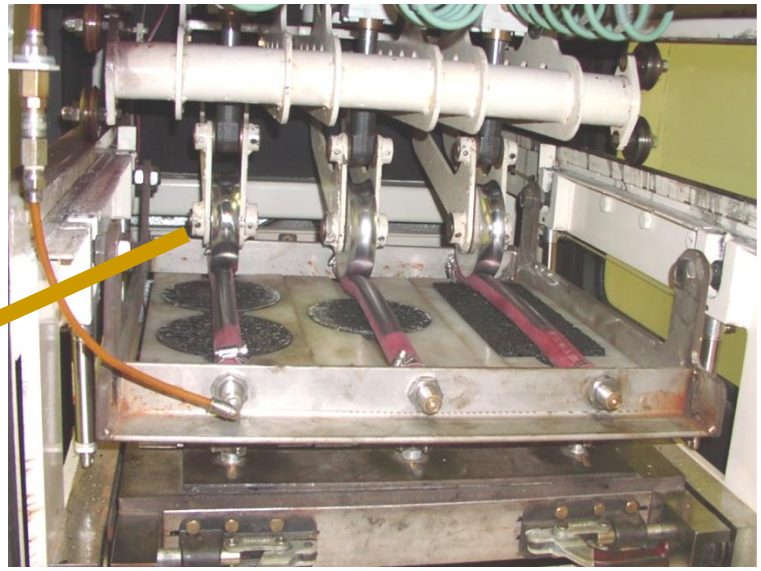
Requirements for an Asphalt Surface Mix For Bridges

- NJDOT and Rutgers University developed a Bridge Deck Waterproof Surface Course (BDWSC) mix to utilize highly polymer-modified asphalt
  - 3/8” mix designed at 1% air voids to provide impermeable mix
  - Mixture rut test specification
  - Mixture fatigue cracking test specification
  - No specification for PG grade of asphalt binder – requires polymer modified binder that allows mix to pass rutting and fatigue test requirements

Bridge Deck Water Proof Wearing Surface Course - Specifications

Table 555.02.01-1 Job Mix Formula Requirements for BDWSC	
Sieve Size	**Percent Passing by Mass**
½"	100
3/8"	80-90
#4	55-85
#8	32-42
#16	20-30
#30	12-22
#50	7-16
#100	3-12
#200	2.0-6.0
Minimum Percent Asphalt Binder by Mass of Total Mix	7.0

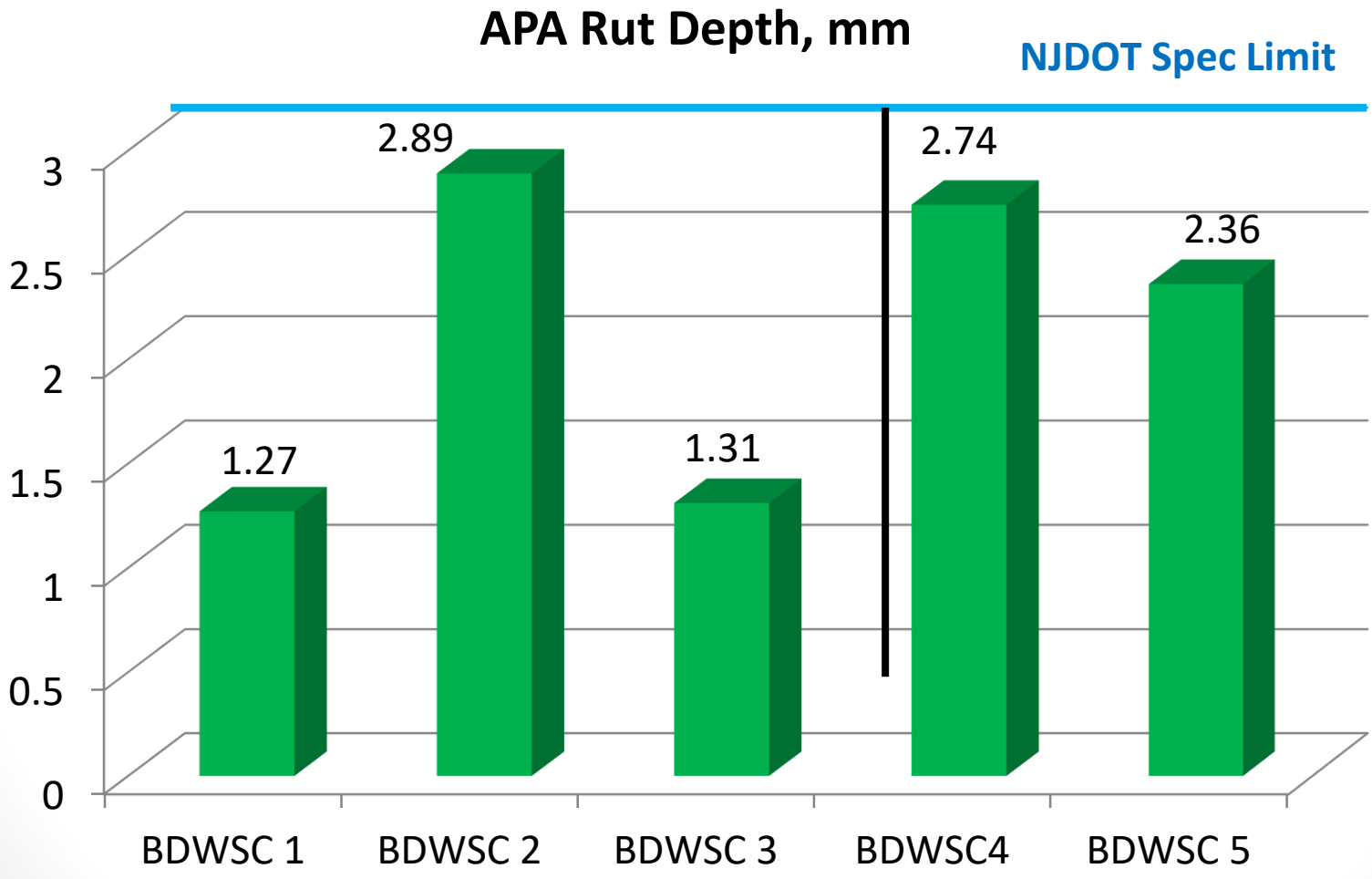
BDWSC Rut Testing



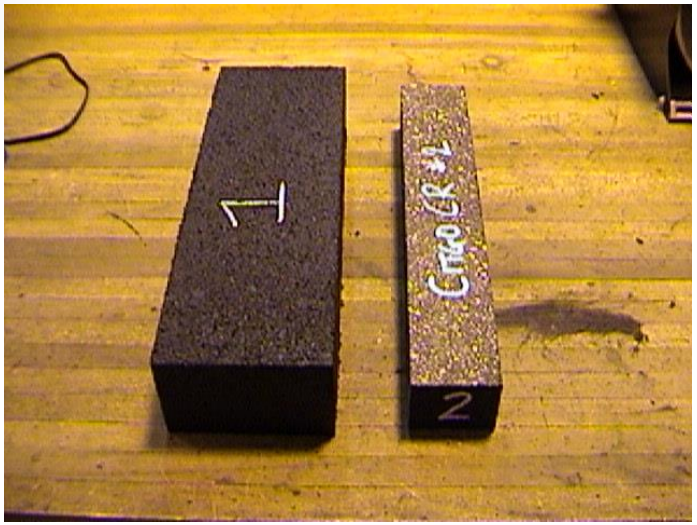
Asphalt Pavement Analyzer
AASHTO TP 63

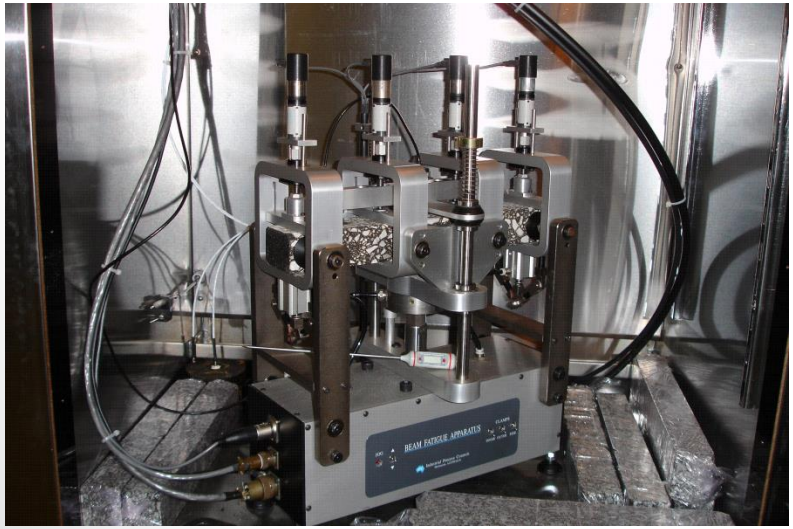
- **100 lb. wheel load; 100 psi hose pressure**
- **Tested at 64°C for 8,000 loading cycles**
- **Measures rut depth**
- **NJDOT BDWSC specification rutting ≤ 3 mm**

BDWSC Rut Testing



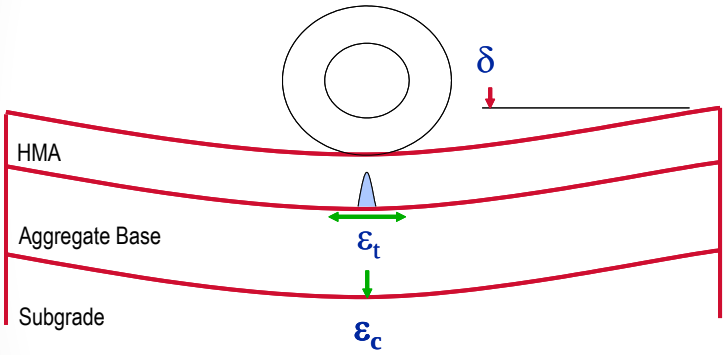
BDWSC Fatigue Test





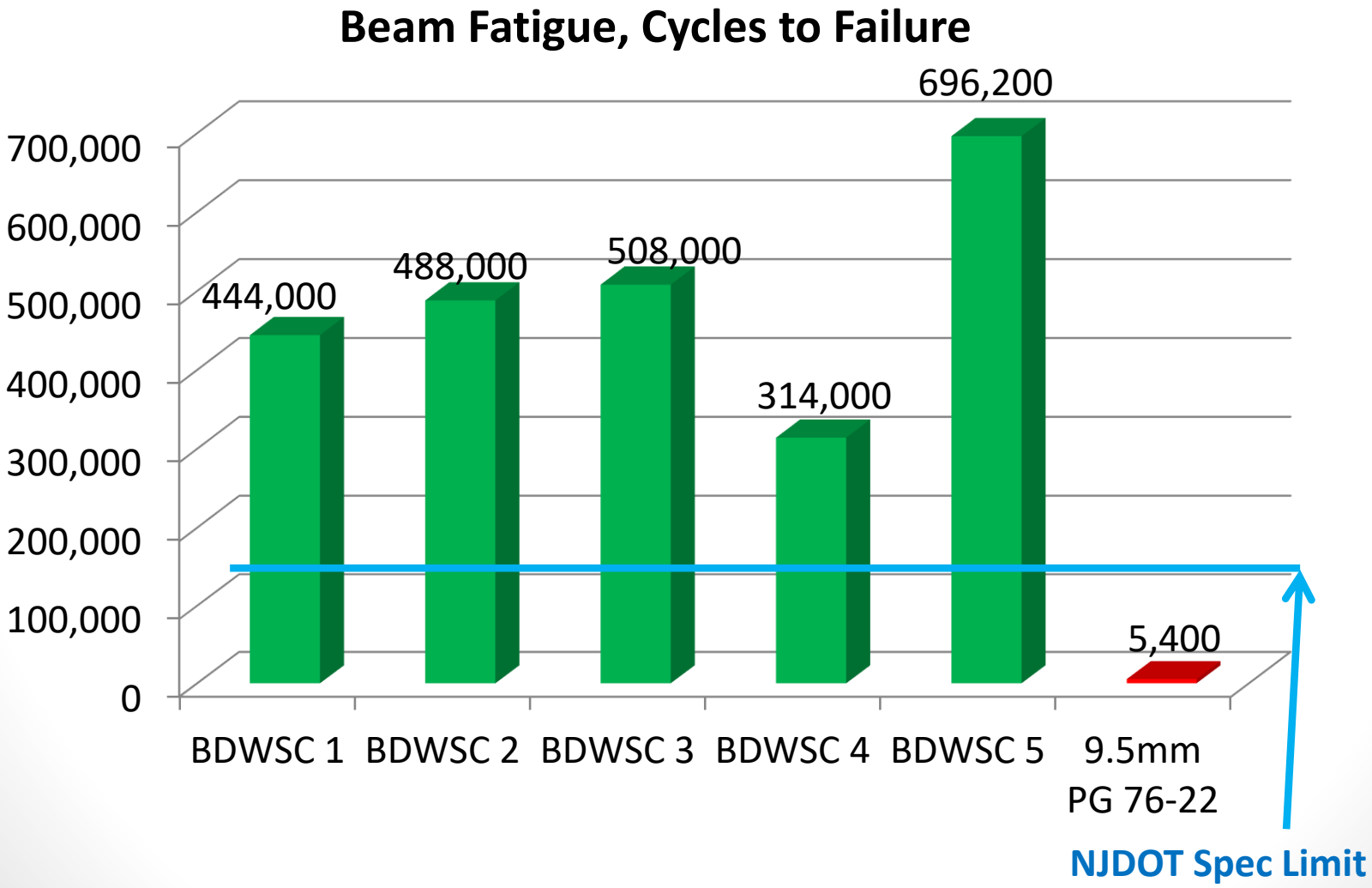
- Flexural Beam Fatigue Device, AASHTO T-321
  - Tests mix's ability to withstand repeated bending which causes fatigue failure
  - Data = number of loading cycles to failure (loss of stiffness)

BDWSC Fatigue Test

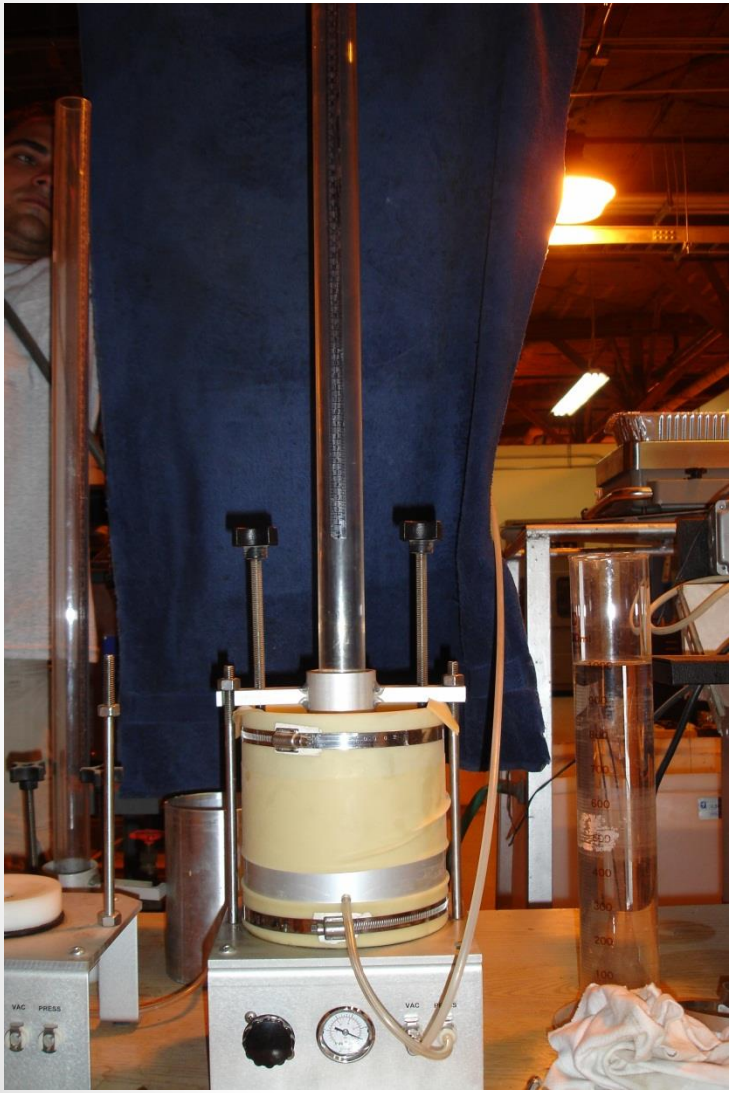


- Beam Fatigue Test typically run at 900 μ-strain and 10 Hz (high deflection, slow moving vehicle)
- For additional vertical movement in bridge decks, test for BDWSC is run at 1500 μ-strain
- NJDOT requires > 100,000 cycles to failure

BDWSC Beam Fatigue



BDWSC Permeability Test



- Falling Head Permeability Test
  - Most commonly used for asphalt
  - Can test 4 or 6” diameter cores
  - Rubber membrane forced on side of samples (15 psi) to prevent side leakage

BDWSC Permeability Testing

- BDWSC mixture was found to be "impermeable" – could not get water to flow through sample

Samples cored from 6-inch diameter gyratory sample

BDWSC Projects – NJ Route 87

- NJ Route 87 Absecon Inlet Bridge
- Paved in 2008 with BDWSC mix
- 2008 National Asphalt Pavement Association (NAPA) “Quality in Construction” award winner

BDWSC Projects – George Washington Bridge (GWB)

- GWB presents extreme challenge to asphalt mix
- Orthotropic steel deck – substantial vertical movement
- Most heavily trafficked bridge in the world – 108 million vehicles per year
- BDWSC mix performing well after seven years

BDWSC Projects – NYSDOT Robert Moses Causeway

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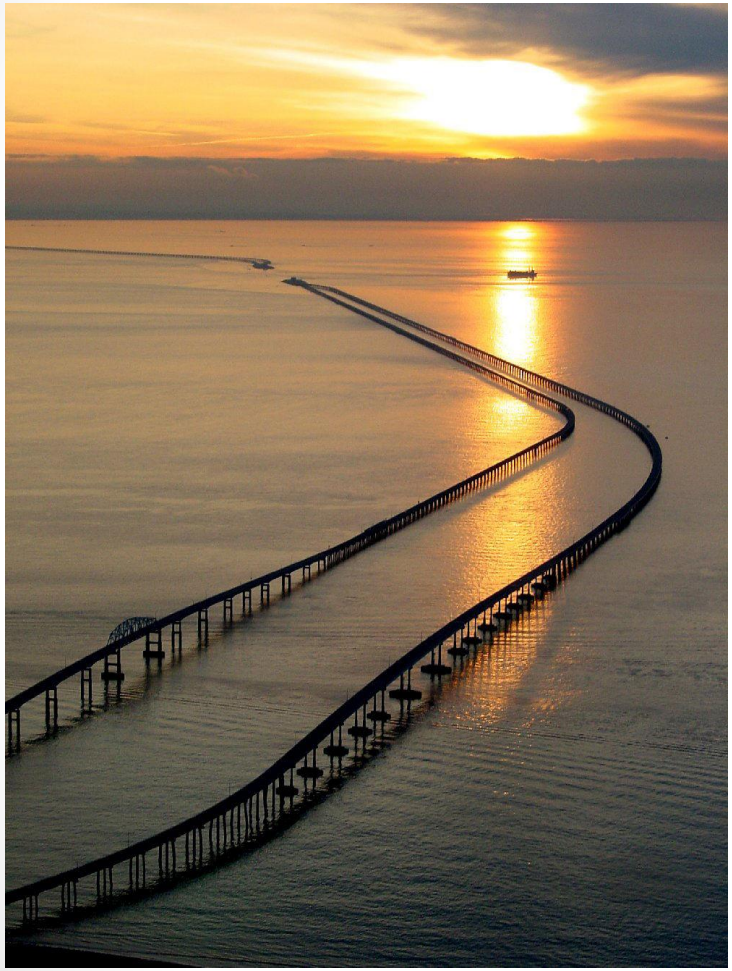
Chesapeake Bay Bridge Tunnel



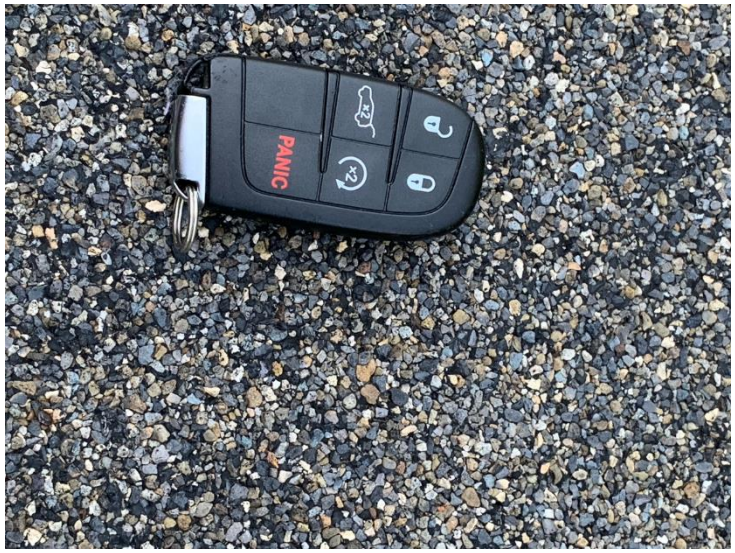
- PAPA member Allan Myers is currently repaving the 18 mile long Chesapeake Bay Bridge Tunnel with StellarFlex® Bridge Deck Binder

BDWSC Summary

- BDWSC binder and mix is very attractive product for bridge deck paving
  - Excellent workability
  - Liquid asphalt delivered to contractor ready-to-use
    - No additives at asphalt plant
    - Liquid asphalt is delivered and certified to meet requirements prior to use
  - Excellent rut resistance
  - Superior fatigue resistance
  - Excellent compactibility
  - Environmentally friendly
  - Economical

Questions?

StellarFlex FR® Binder For High Friction Chip Seals



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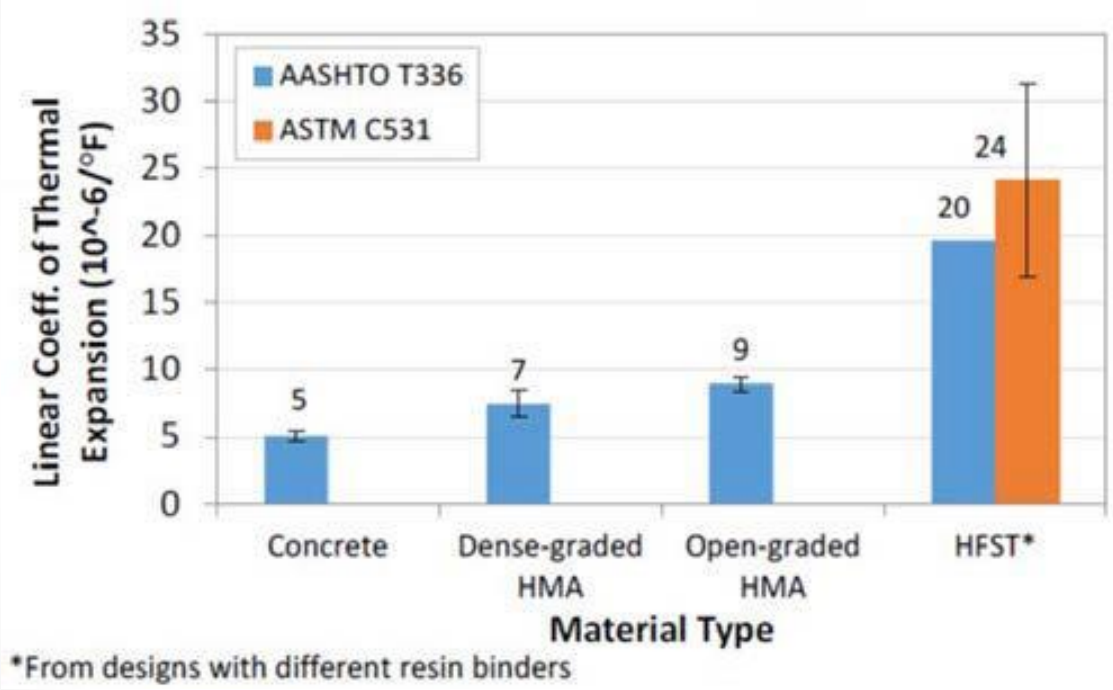
High Friction Surface Treatment (HFST)

- FHWA has been promoting HFST for safety
- HFST consists of epoxy binder and bauxite aggregate
- NJDOT placed sections of HFST in 2018 and experienced severe delamination of epoxy binder

NJDOT HFST Study



*From designs with different resin binders

- NJDOT hired Rutgers University to investigate
- Major cause – epoxy expands and contracts at a much higher rate than asphalt pavement
- Causes tearing and cracking resulting in delamination
- Aged pavements are less able to withstand stresses

NJDOT HFST Study

Crack @ HFST Terminus Due to Thermal Contraction

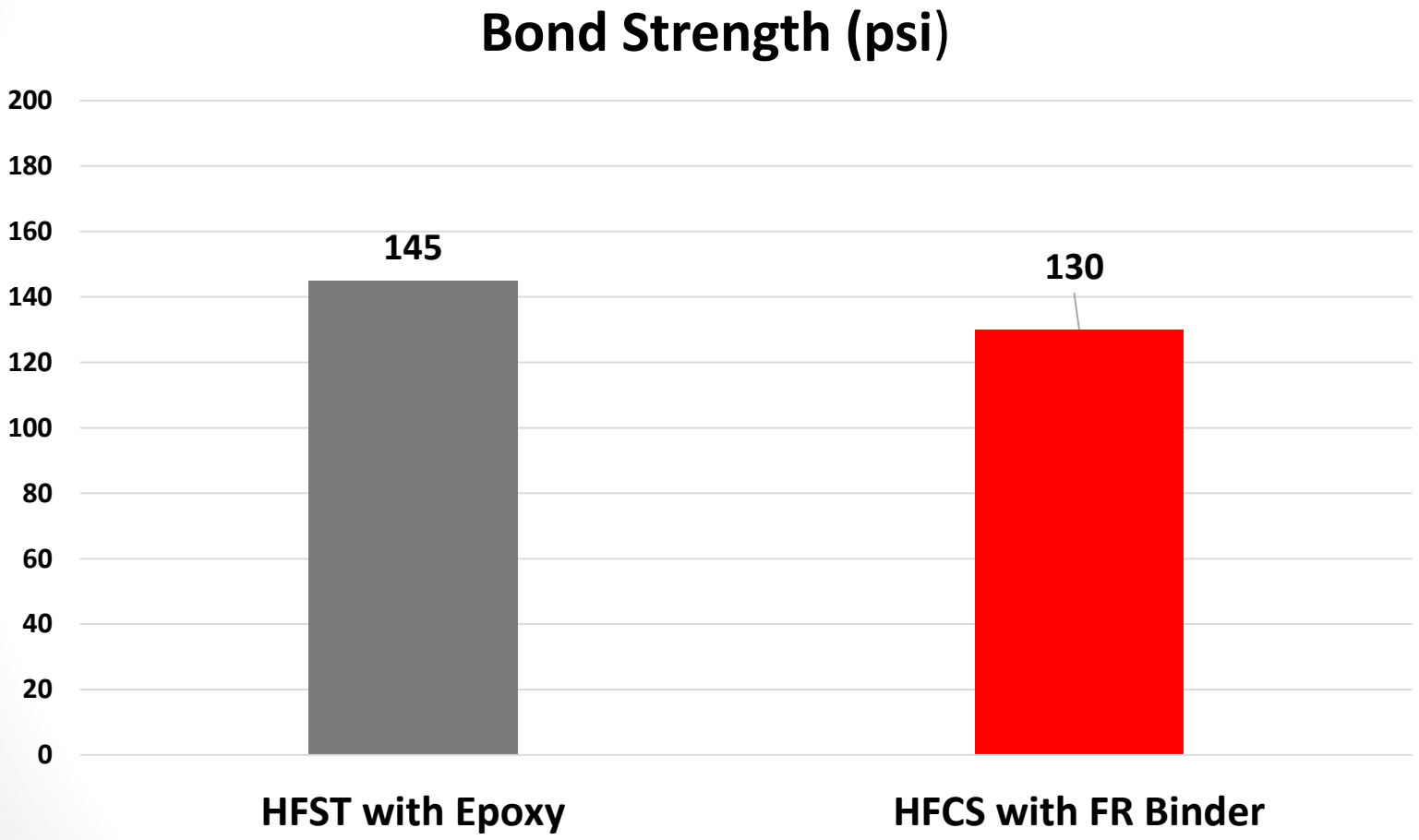
NJDOT HFST Study

- Delamination caused by thermal contraction stresses

NJDOT HFST Study

- Rutgers proposed to replace the epoxy with PG 88-22FR asphalt binder used by FAA (actually grades as a PG 94-22)
- NJDOT placed sections of High Friction Chip Seal (HFCS) using FR binder with bauxite aggregate and local trap rock aggregate in 2018
- Excellent performance after one year

NJDOT HFST Study



Source – Rutgers University Study

High Friction Chip Seal

- Chip seal installation contractor raves about FR binder as chip adhesive
  - Sprays easily
  - Excellent chip retention
  - No broken windshields
  - No bleeding

High Friction Chip Seal

High Friction Chip Seal

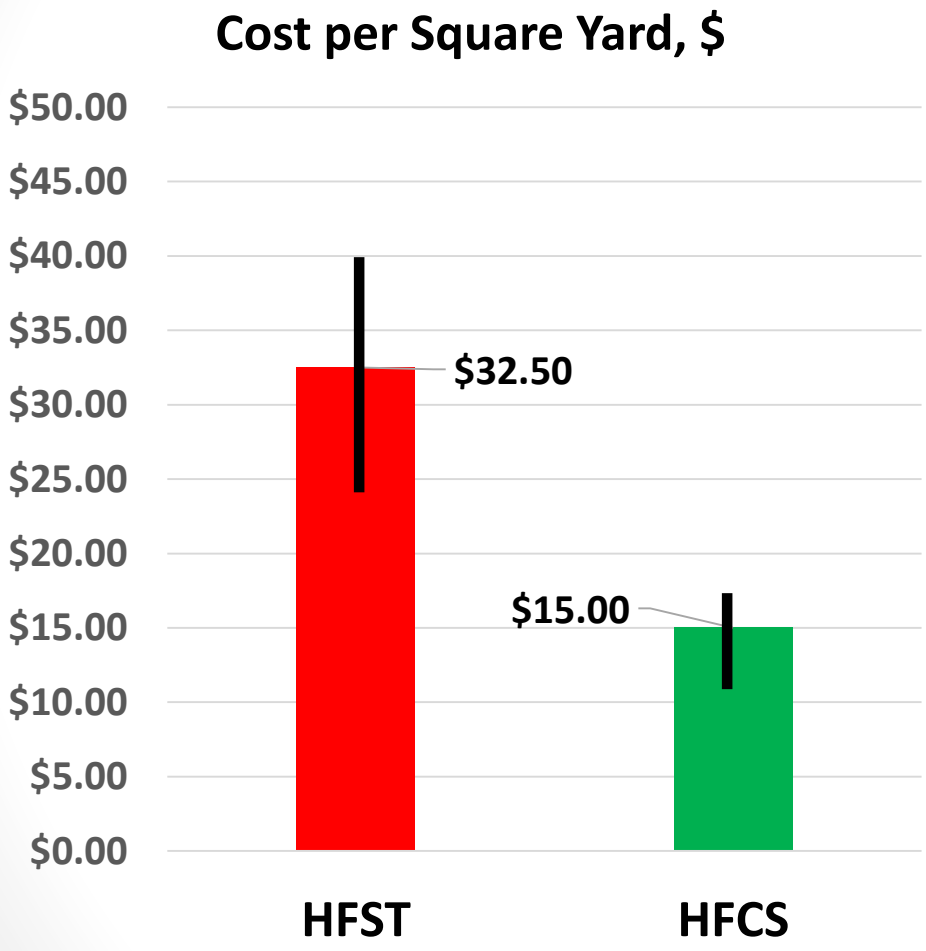
High Friction Chip Seal

NJ Route 68 - One year old HFCS With FR Binder

High Friction Chip Seal

- NJDOT measured initial skid number of SN = 70

HFCS Cost Compared to HFST



- PG 88-22FR Binder provides excellent performance at a lower cost
- Cost data courtesy NJDOT

Summary

- HFCS using PG 88-22FR asphalt binder eliminates HFST epoxy coefficient of expansion incompatibility – which is major cause of delamination
- HFCS application becomes a standard chip seal installation
- Comparable bond strength to epoxy
- Excellent performance to date
- Substantial cost savings

Questions?