
VDOT
Virginia Department of Transportation

PAVEMENT AND BRIDGE OVERVIEW

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- Brief overview
- Pavement and Bridge State of the Practice
  - Current trends
  - Performance history
  - Current conditions
  - Challenges
  - Actions and techniques implemented
- Next Steps

PAVEMENT OVERVIEW

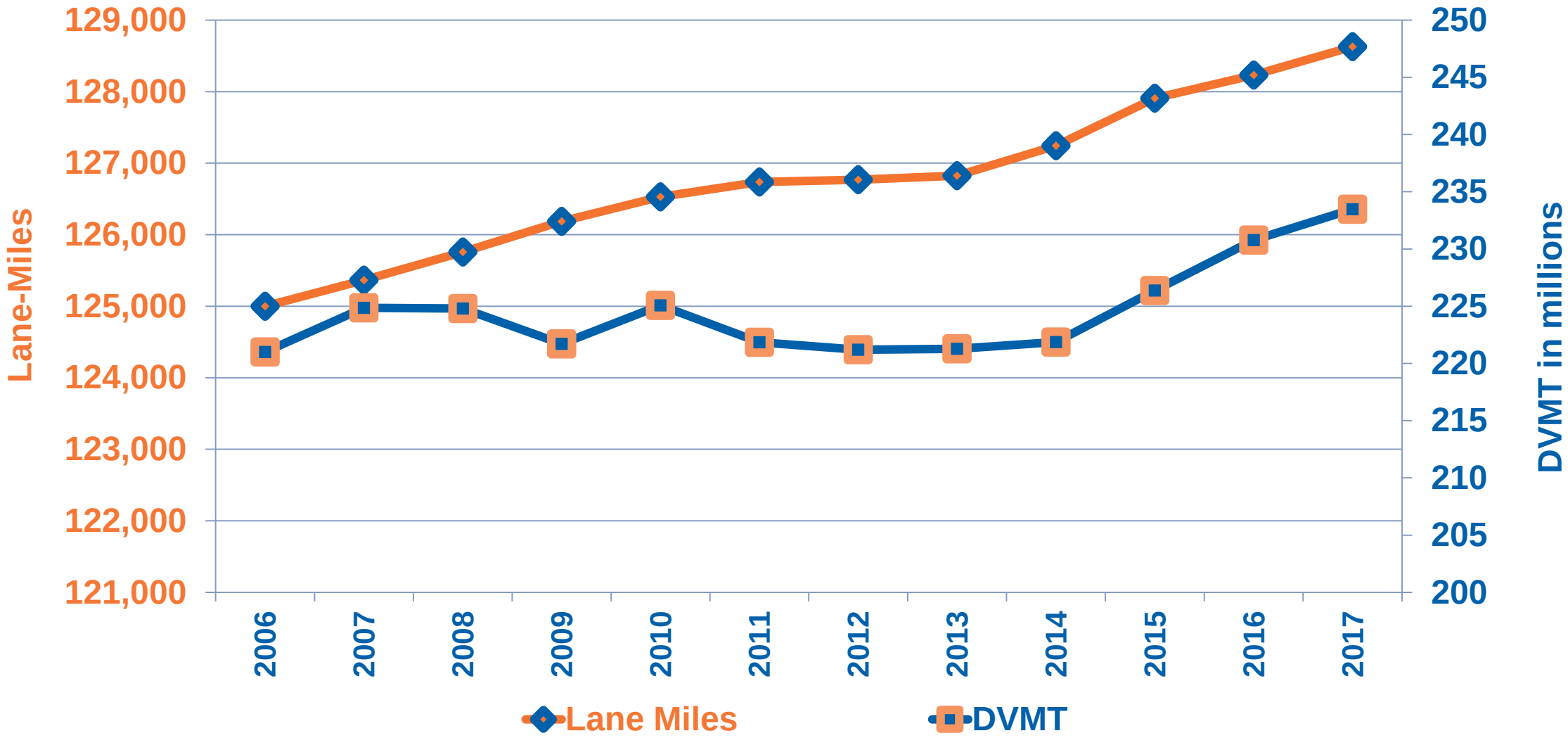
State of the Practice

Pavement Inventory (2017)

- VDOT Maintained inventory *128,600* lane miles
  - Interstate – *5,600* lane miles
  - Primary – *22,100* lane miles
  - Secondary – *100,300* lane miles
  - Frontage – *600* lane miles

- Federal Focus - NHS
  - NHS Inventory *18,700* lane miles
    - All Interstates
    - Approx. half of all Primaries
    - Few Secondaries
  - NHS Inventory Maintenance
    - VDOT *15,700* lane miles
    - Locality *3,000* lane miles

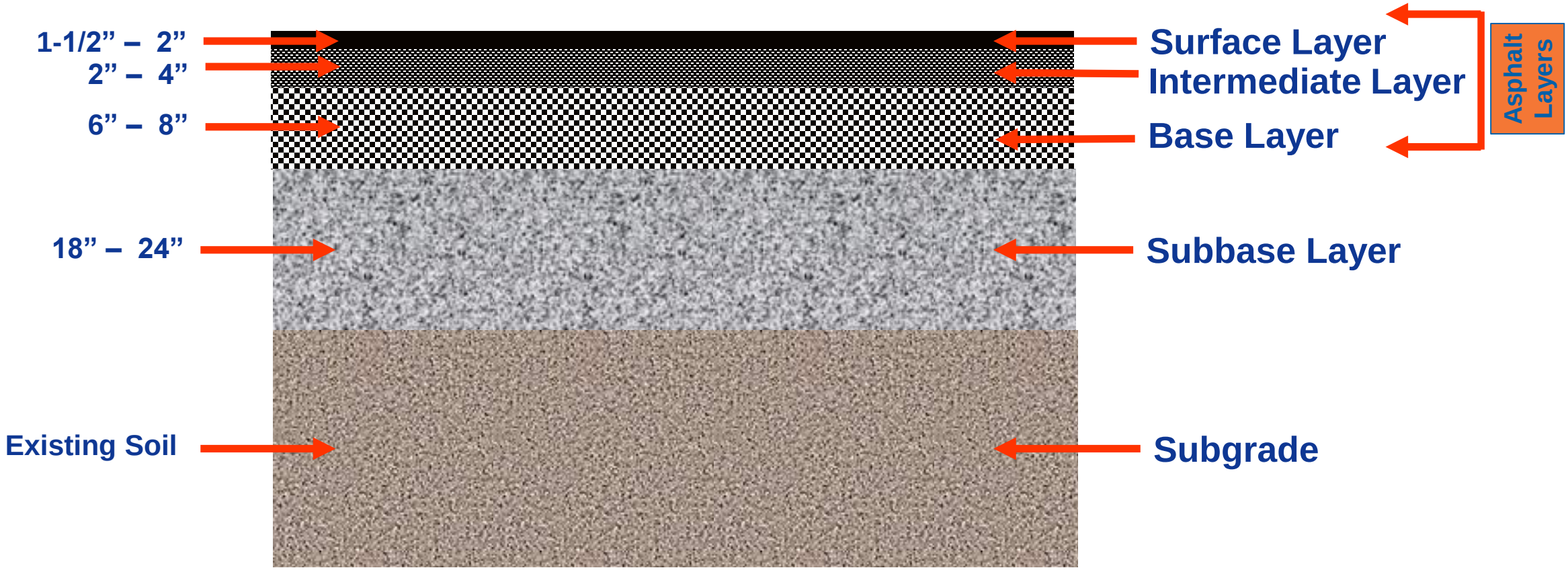
Current Trends
State Maintained Lane Miles & Daily Vehicle Miles Traveled



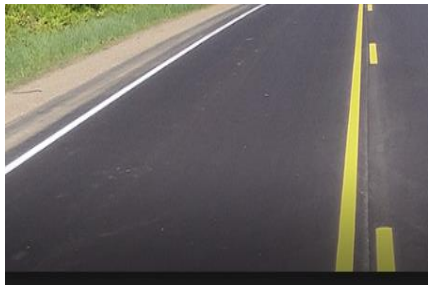
Current Trends
Truck Loads

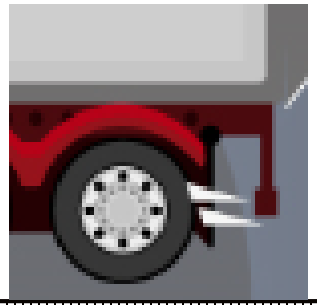
- **Trucks are getting heavier and the inventory is aging**
  - **Many pavements and bridges were designed for 80,000 lbs. or less**
  - **91,000 lb. legal loads have been proposed**

Pavement Structure
Typical Full-Depth Asphalt



Pavement Structure Stress Distribution



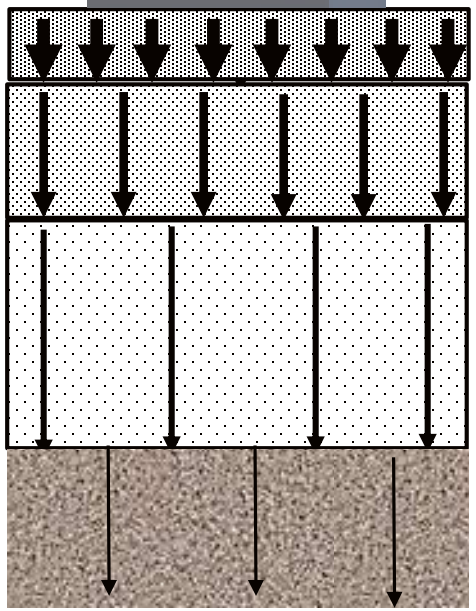


Highest stress @ top layer

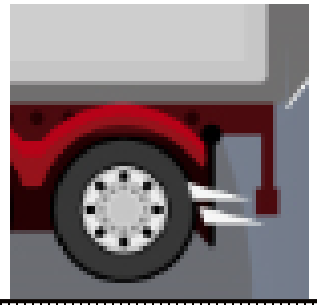
Stress reduced

Further reduction in stress

Substantial reduction in stress



Pavement in *good* condition: Proper stress distribution through different layers

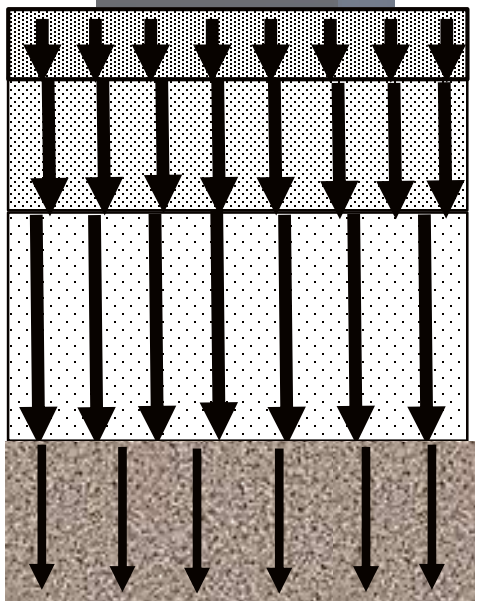


Highest stress @ top layer

Stress does not reduce but transferred to lower layer

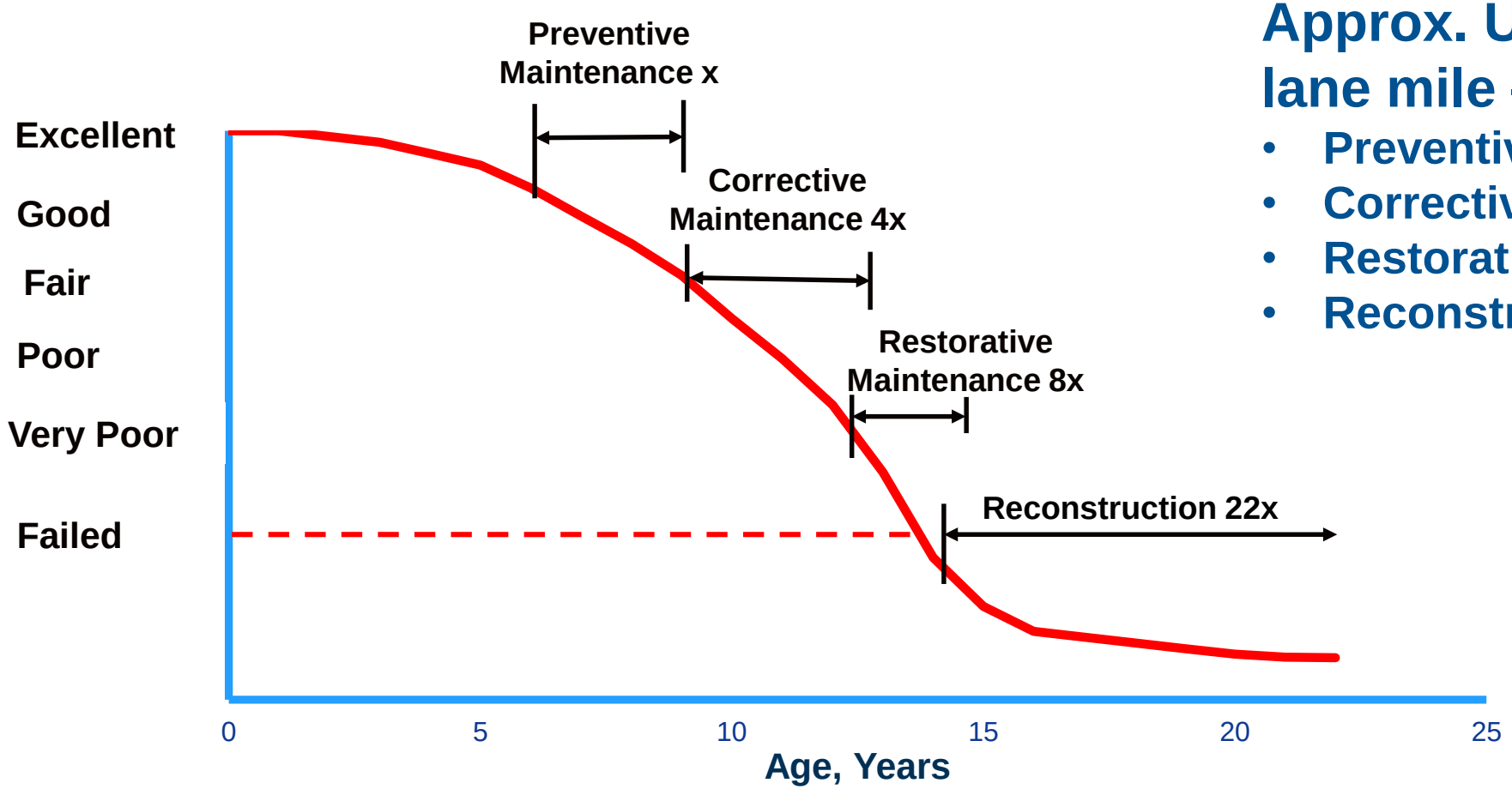
Stress does not reduce significantly and transferred to lower layers

Substantial stress on soil & subgrade



Pavement in *poor* condition: Significant stress damaging bottom layers

Pavement Treatment - Overlay
Typical Service Life
Treatment Categories and Relative Costs



Approx. Unit Cost, per lane mile – Interstate

- Preventive - $ 45K
- Corrective - $ 180K
- Restorative – $ 340K
- Reconstruction – $ 1M

Pavement Treatment - Maintenance Activities

Preventive

Surface Layer (covered)
Intermediate Layer
Base Layer
Subbase Layer
Subgrade

Preserves good pavements in good condition at low costs

Corrective

Surface Layer (replaced)
Intermediate Layer
Base Layer
Subbase Layer
Subgrade

Addresses moderate distresses

Restorative

Surface Layer (replaced)
Int. Layer (replaced)
Base Layer
Subbase Layer
Subgrade

Addresses moderate to heavy distresses

Reconstruction

Surface Layer (replaced)
Int. Layer (replaced)
Base Layer (replaced)
Subbase Layer (replaced)
Subgrade

Addresses pavements under heavy distresses or in failed condition

Pavement Treatment
Example: Selection, Costs and Service Lives

Optimal Treatment
(15 Year Service Life Cost: $330K/lane-mile)

- Restorative Maintenance (e.g. 4” mill and fill) is the appropriate treatment
- Cost: $330 K/ lane-mile
- Expected service life: 15 years
- Actual service life: 15 years

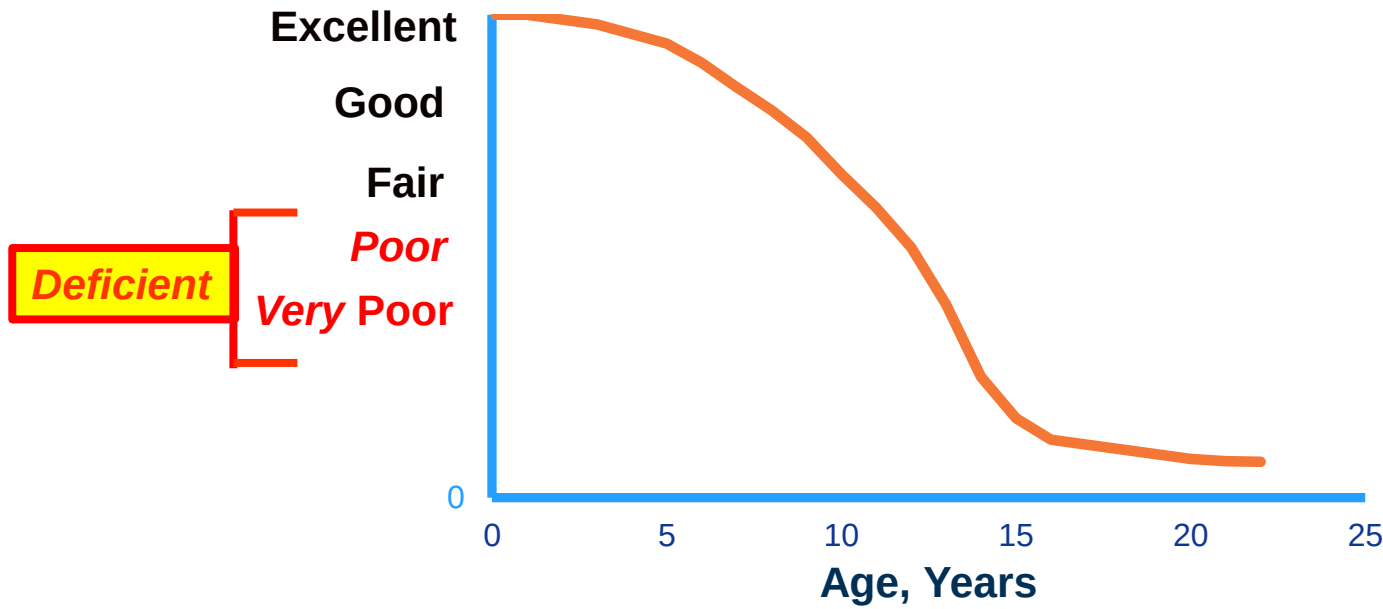
Sub-optimal Treatment
(15 Year Service Life Cost: $450K/lane mile)

- Corrective Maintenance (e.g. 1.5” mill and fill)
- Cost: $180 K/ lane-mile
- Expected service life: 10 years
- Actual service life: 6 years

PAVEMENT PERFORMANCE MEASURES

Pavement Performance Measures
VDOT Condition Categories

- **Pavement Critical Condition Index (CCI) is calculated on a scale of 0 to 100**
- **Pavement condition categories:**
  - **Excellent (≥ 90 CCI)**
  - **Good (Between 70 and 89 CCI)**
  - **Fair (Between 60 and 69 CCI)**
  - **Poor (Between 50 and 59 CCI)**
  - **Very Poor (≤ 49 CCI)**



Pavement Performance Measures
Brief History in VDOT

- In 2007-2008
  - Interstate: >82% fair or better
  - Primary: >82% fair or better

- Considerations in selecting targets (in 2007- 2008):
  - Existing pavement condition
  - Available funding
  - Review of other state practices

- In 2011-2012
  - Secondary: >65% fair or better

CTB – June 2017 Presentation
Pavement Statewide Performance Measures

Performance Measure Description	Current Policy (Percent Sufficient)*	Updated Policy (Percent Sufficient)	Current Performance 2016 (rounded) (Percent Sufficient)
Interstate	82% No Section CCI less than 30	82% ***No Section CCI less than 35***	90%
Primary	82%	82%	84%
Secondary	65%	65%	60%
Current funding sustains interstate and primary condition			
Additional funding required to achieve secondary target			

***Sufficient means "Fair" or better**

NOTE: Objective is to *sustain or improve* current performance on the interstate and primary and achieve target on the secondary

Texas (Performance Measures & Targets)

Performance Target	Statewide Performance	
90% in good or better condition. * Good >=70 On a 0-100 scale	Interstate	87.9%
	US Highways	88.2%
	State Highways	86.7%
	Farm to Market Highways	87.4%

- *VDOT performance measures are set based on "Fair"or better (i.e. CCI > 60)*
- *Texas "Good" is roughly equivalent to or slightly better than Virginia "Fair"*

North Carolina (Performance Measures &Targets)

System	Performance Target (Good or Better)	Statewide Performance
Interstate	86%	90%
Primary	80%	71%
Secondary	75%	81%
* Good => 80 on a scale of 0-100		

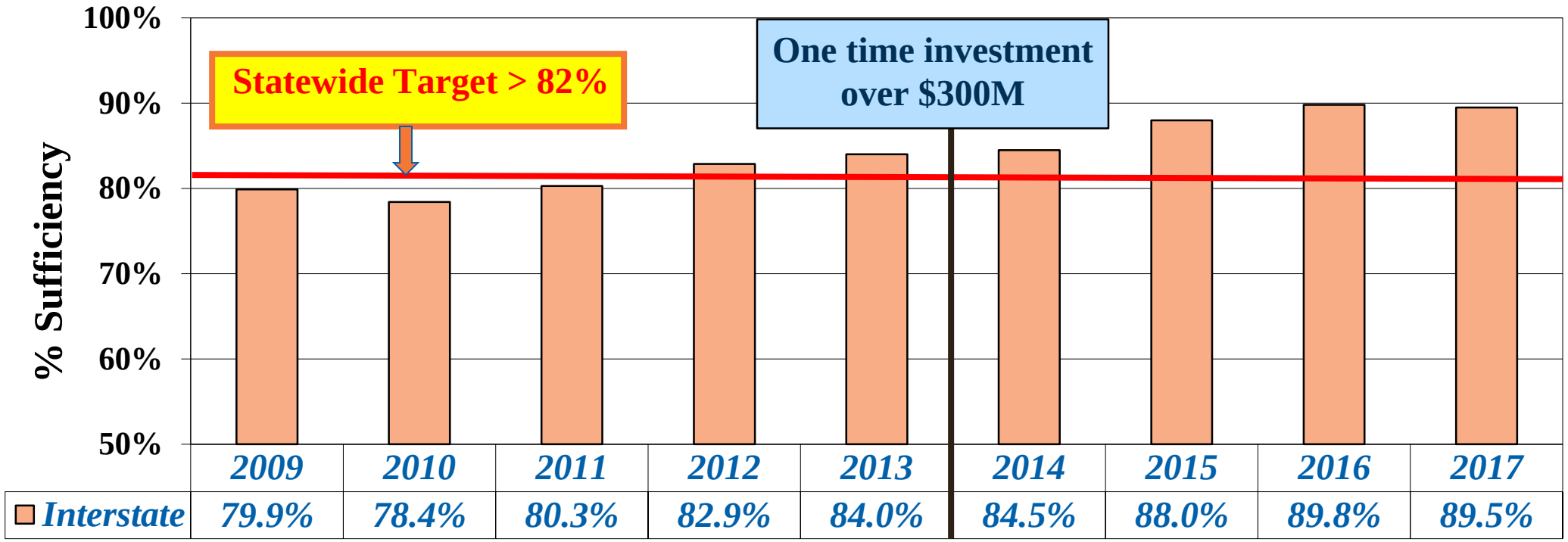
- *VDOT performance measures are set based on "Fair" or better (i.e. CCI > 60)*
- *North Carolina "Good" is better than Virginia "Fair"*

Georgia (Performance Measures and Targets)

System	Performance Target (Fair or Better)	Statewide Performance
Interstate	90%	74%
Primary	90%	71%
* Fair => 70 on a scale of 0-100		

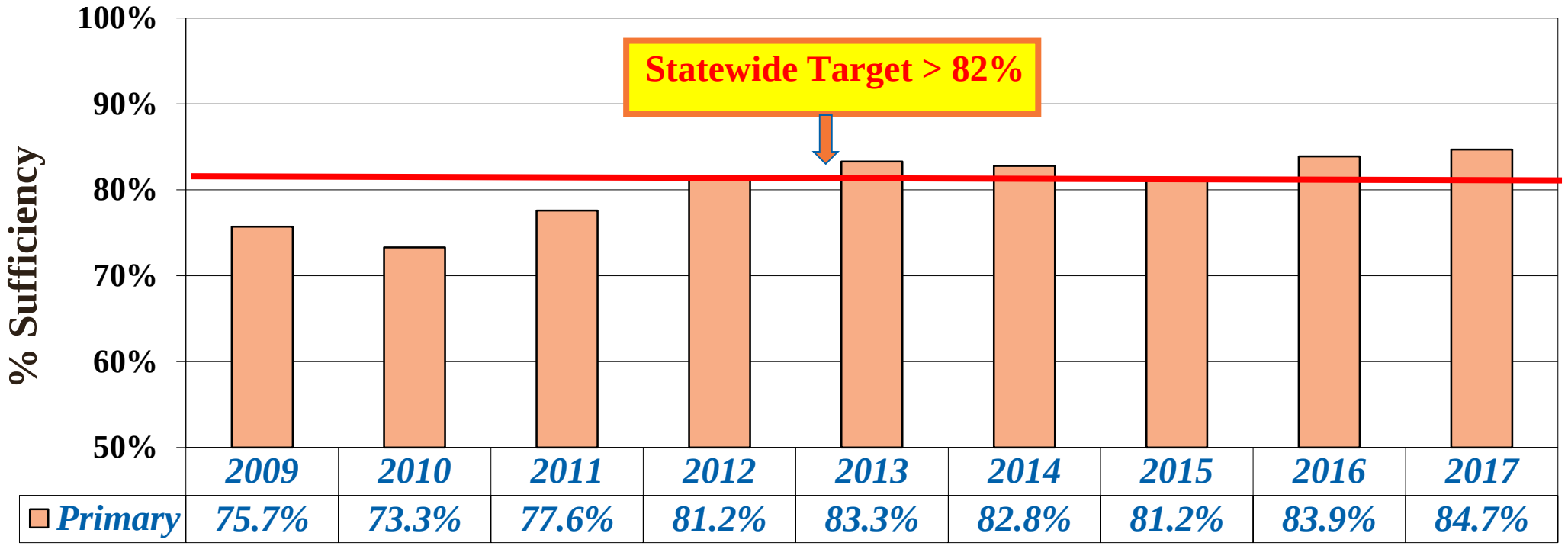
- *VDOT performance measures are set based on "Fair" or better (i.e. CCI > 60)*
- *Georgia "Fair" is roughly equivalent to or slightly better than Virginia "Fair"*

VDOT Pavement Performance History
% Sufficient – Interstate



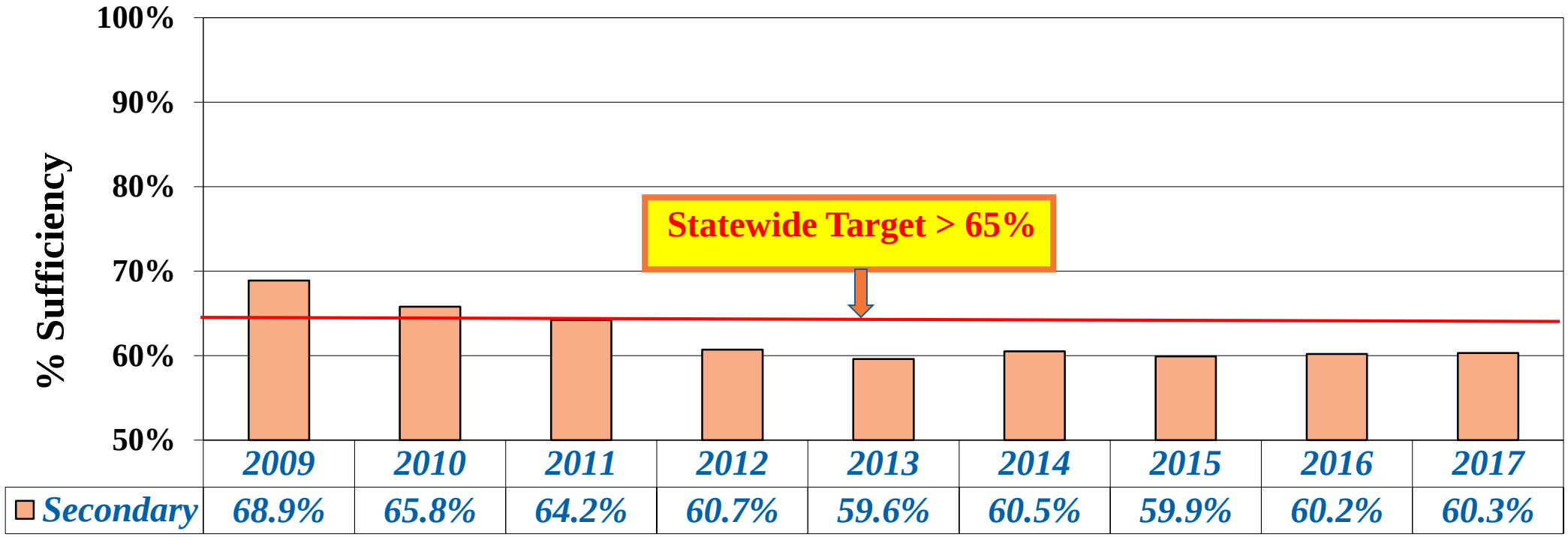
	2009	2010	2011	2012	2013	2014	2015	2016	2017
Interstate	79.9%	78.4%	80.3%	82.9%	84.0%	84.5%	88.0%	89.8%	89.5%

VDOT Pavement Performance History
% Sufficient – Primary



	2009	2010	2011	2012	2013	2014	2015	2016	2017
Primary	75.7%	73.3%	77.6%	81.2%	83.3%	82.8%	81.2%	83.9%	84.7%

VDOT Pavement Performance History
% Sufficient – Secondary

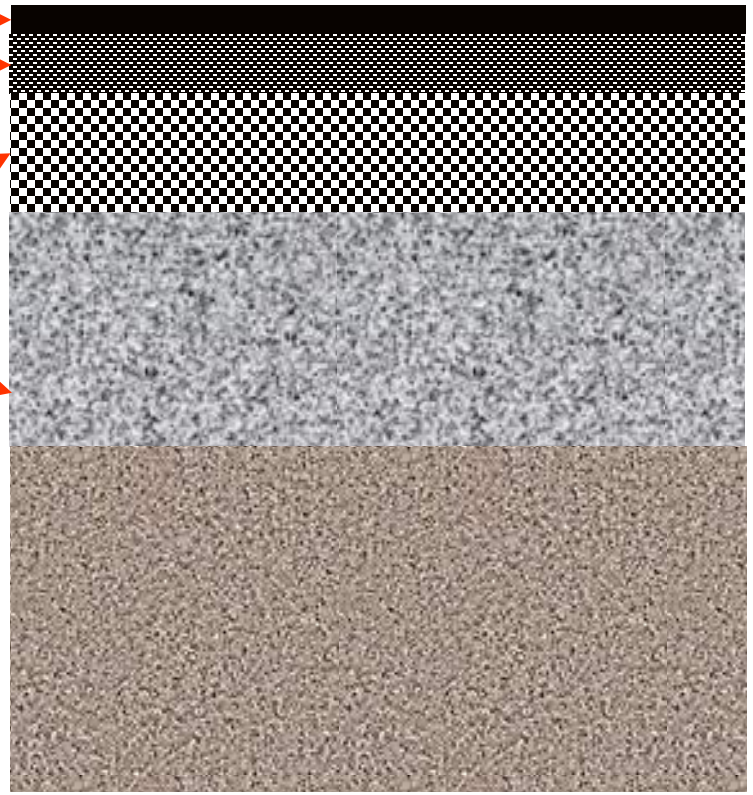


	2009	2010	2011	2012	2013	2014	2015	2016	2017
Secondary	68.9%	65.8%	64.2%	60.7%	59.6%	60.5%	59.9%	60.2%	60.3%

Pavement Maintenance Current Practice

80% – 90% of the work focused on top 2 layers

10% - 20% of work focused on restorative



Surface Layer *(1.5” – 2”)*
Intermediate Layer *(2” – 4”)*

Base Layer *(6” – 8”)*

Subbase Layer *(18” – 24”)*

Subgrade *(Existing Soil)*

Pavement Challenges

- Aging Infrastructure - majority past the design life
- Factors Increasing:
  - Inventory lane-miles
  - Vehicle Miles Traveled (VMT)
  - Truck loading
  - Reconstruction needs
- VDOT continues to maintain the pavement network – current strategy primarily limited to replacing surface layers

Implemented Actions and Techniques

- Take advantage of low asphalt prices
- Implement innovative materials and techniques
  - RAP (Recycled Asphalt Products)
  - New recycling techniques
  - High polymer mixes
  - Thin lift asphalt mixes
- Collaborate with industry to reduce costs
- Incentivize high quality and durable work

In-Place Recycling and Reclamation

High Polymer Mixes

Thin Hot Mix Asphalt

Importance of Maintenance

Impacts of rough pavements on vehicle operating costs (NCHRP 730, 2016)

Federal Report (NCHRP Report 720)	Estimated %Change Due to Very Rough Pavements
Fuel Efficiency	Drops 12%
Tire Wear	Increase 5%
Repair and Maintenance	Increase 70%
Total net effect on vehicle operating cost	Increase 22%

Estimated costs for a medium sized car (Oregon Study, 2013)

Estimated Cost	On Smooth Roads	On Rough Roads
Oregon Repair	$380	$646
Oregon Gas	$942	$1,055
Total	$1,322	$ 1,701

Importance of Maintenance Attracting Autonomous Vehicles

- Nationwide competition to attract autonomous vehicles
- Autonomous vehicle companies have stated clearly that their primary needs are:
  - Good pavement
  - Good bridges
  - Good striping

Secondary Pavements

Year (CY)	Northern Virginia		
	% Sufficiency	Expenditures (in millions)	% of Statewide Secondary Expenditures
2014	30%	21.2	17.7%
2015	31%	39.3	27.4%
2016	36%	93.4	51.4%
2017	38%	102.5	45.6%
2018 (predicted)	*41%*	*88.1*	*51.7%*
2019 (predicted)	*45%*	---	---

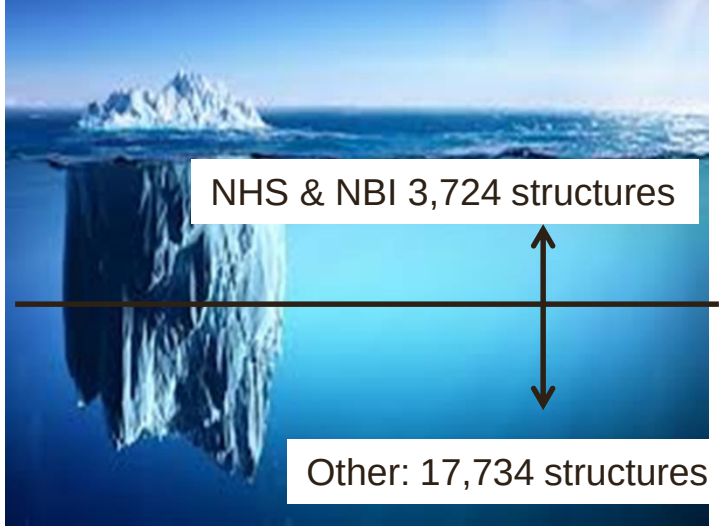
FY 2019 State of Good Repair Distribution Percentages		
District	Minimum %	Approved %
Culpeper	5.5%	6.39%
Lynchburg	5.5%	6.39%
Northern Virginia	***5.5%***	***6.39%***

BRIDGE OVERVIEW

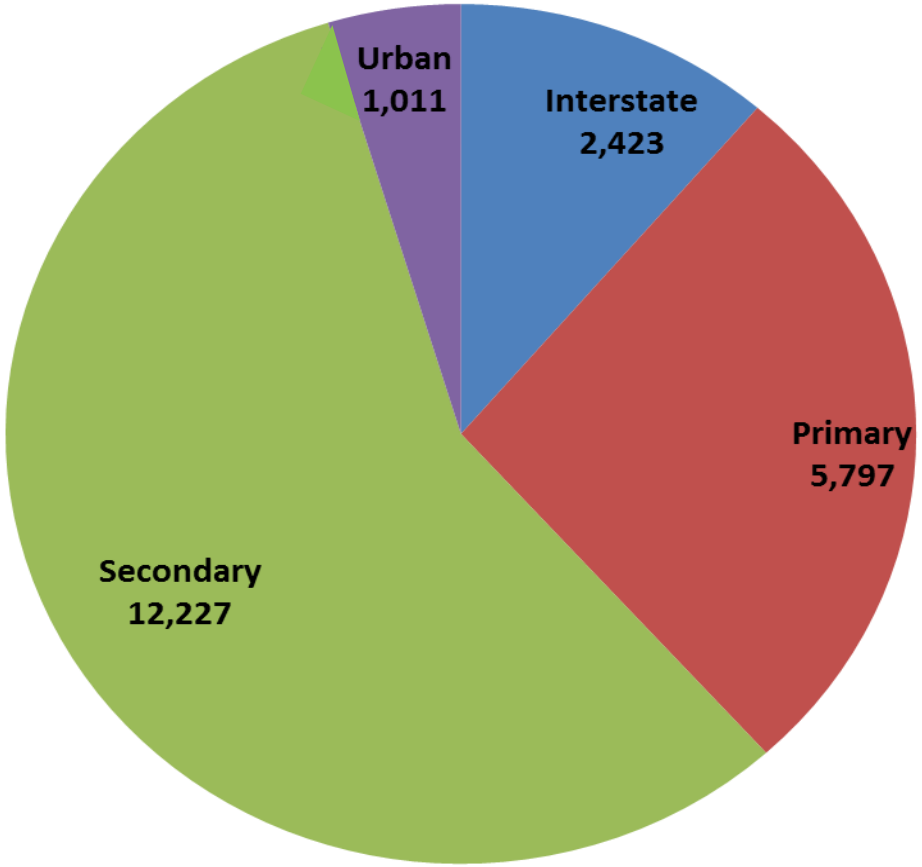
State of the Practice

Bridge Inventory

Virginia: 3rd Largest State-Maintained Bridge Inventory



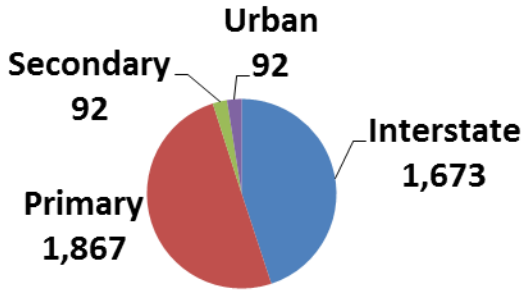
Count of All Virginia Structures by Highway System



21,458 Structures

- NBI = Bridges on National Bridge Inventory (>20')
- NHS= National Highway System

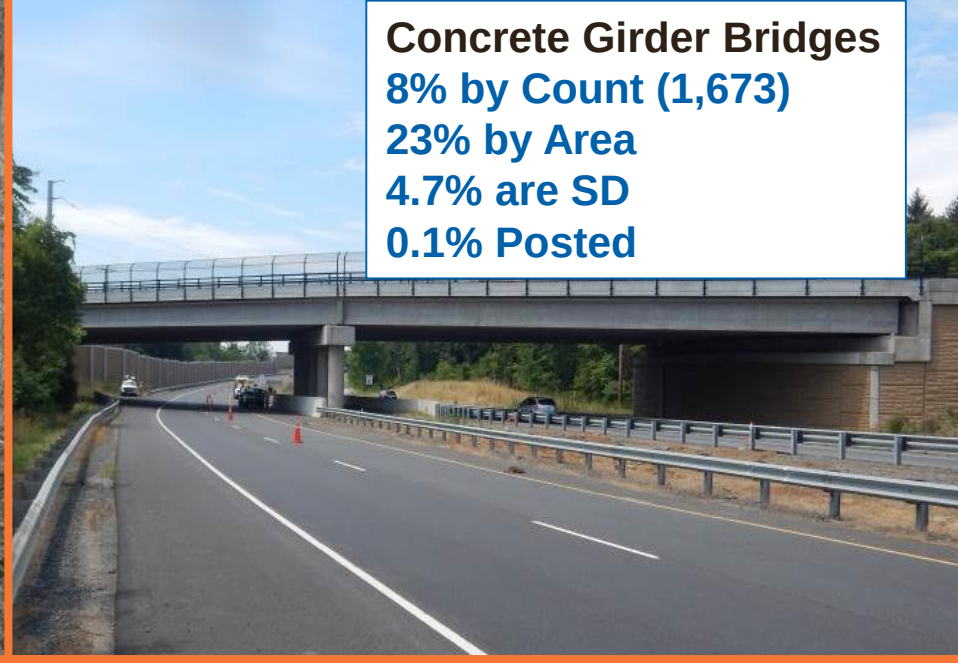
Count of Structures Associated with Federal Performance Measures (NBI Bridges on NHS)



3,724 Structures (17% of All Virginia Structures)

Metal Culverts
9% by Count (1,933)
1% by Area
6.1% are SD
0.1% Posted

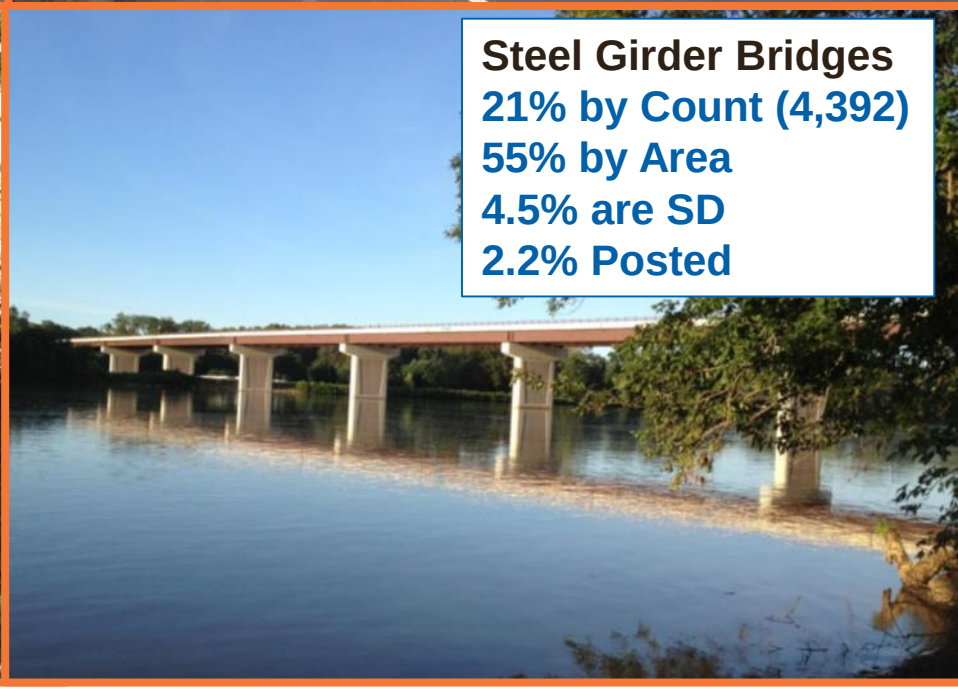
Timber Deck Bridges
12% by Count (2,459)
2% by Area
12.2% are SD
25% Posted



Concrete Girder Bridges
8% by Count (1,673)
23% by Area
4.7% are SD
0.1% Posted

Concrete Slab Bridges
19% by Count (3,989)
6% by Area
2.5% are SD
1.5% Posted

Concrete Culverts
28% by Count (6,036)
4% by Area
0.2% are SD
0% Posted



Steel Girder Bridges
21% by Count (4,392)
55% by Area
4.5% are SD
2.2% Posted

Bridge Inventory – by Type

*SD – Structurally Deficient

Current Trends
Truck Loads

- Majority of existing bridges were designed ≤ 80,000 pounds
- Strengthening required due to federally-mandated special hauling vehicles
- 91,000 pound legal loads have been proposed
- Trucks have severe effects on bridge

BRIDGE PERFORMANCE MEASURES

CTB – June 2017 Presentation
Bridge Statewide Performance Measures

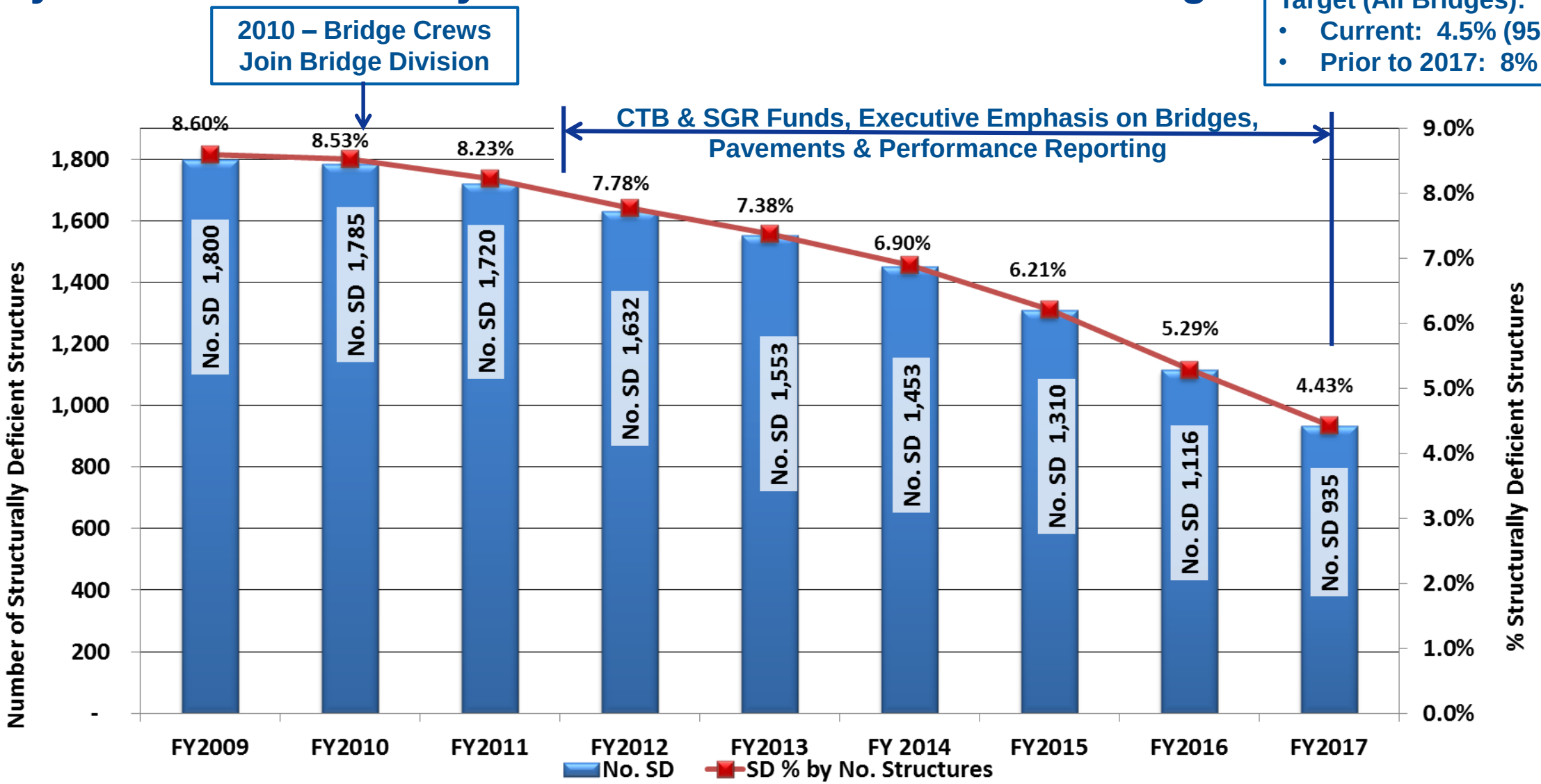
Performance Measure Description	Current Policy (Percentage Not Structurally Deficient)*	Updated Policy (Percentage Not Structurally Deficient)	Current Performance (VDOT and Localities) (Percentage Not Structurally Deficient)
Statewide	92%	***95.5%***	95.4%
Interstate	97%	***99%***	98.5%
Primary	94%	***96%***	96.4%
Secondary	89%	***94%***	94.7%
Updated Performance Goals are Predicted to be Attained with Current Funding by the End of FY18			

***Bridges that are not Structurally Deficient are in a "Fair" or "Good" Condition.**

NOTE: Objective is to *sustain or improve* current performance on the interstate and primary and achieve target on the secondary

Performance Measures
All Systems – Structurally Deficient - Number and Percentage

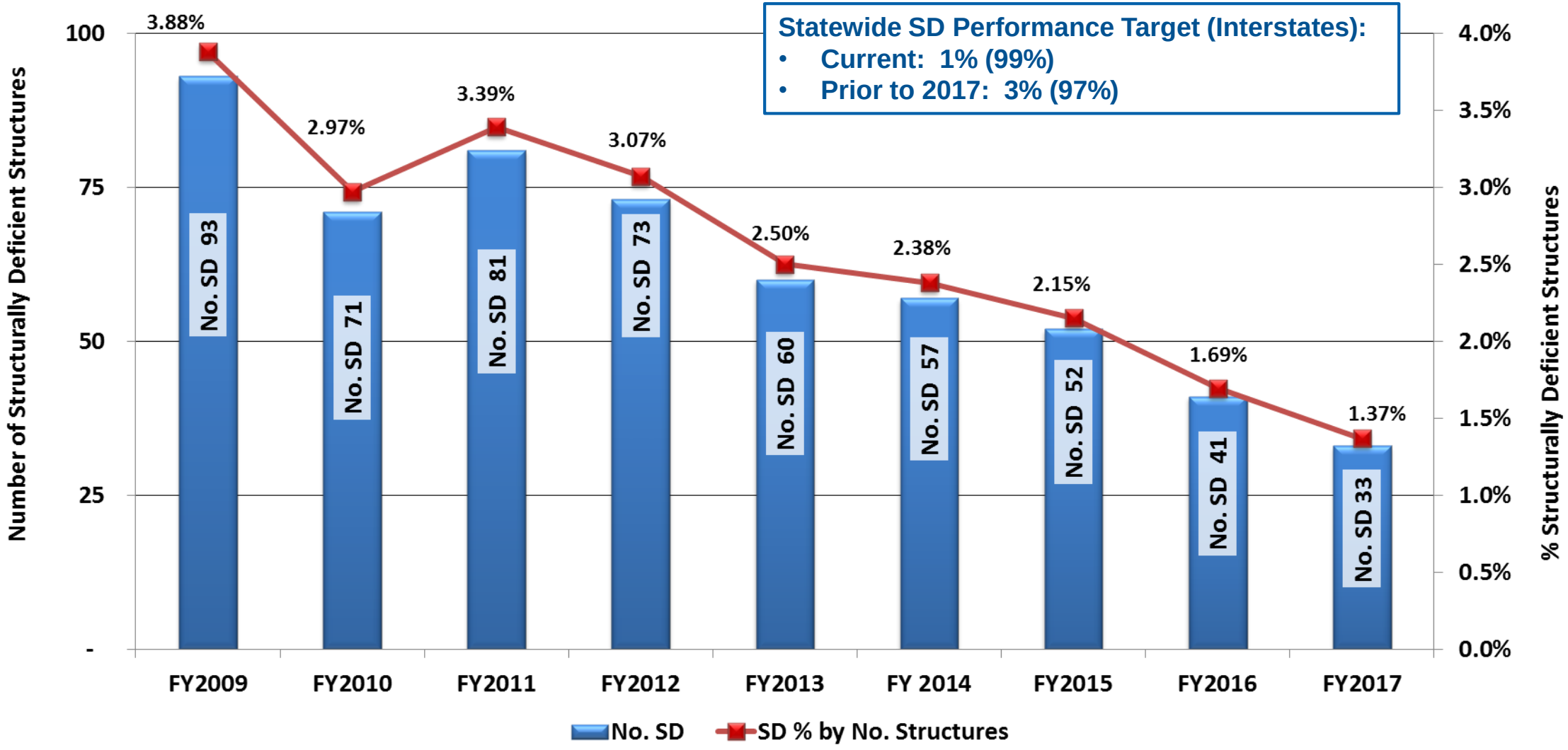
Statewide Performance SD Target (All Bridges):
- Current: 4.5% (95.5%)
- Prior to 2017: 8% (92%)



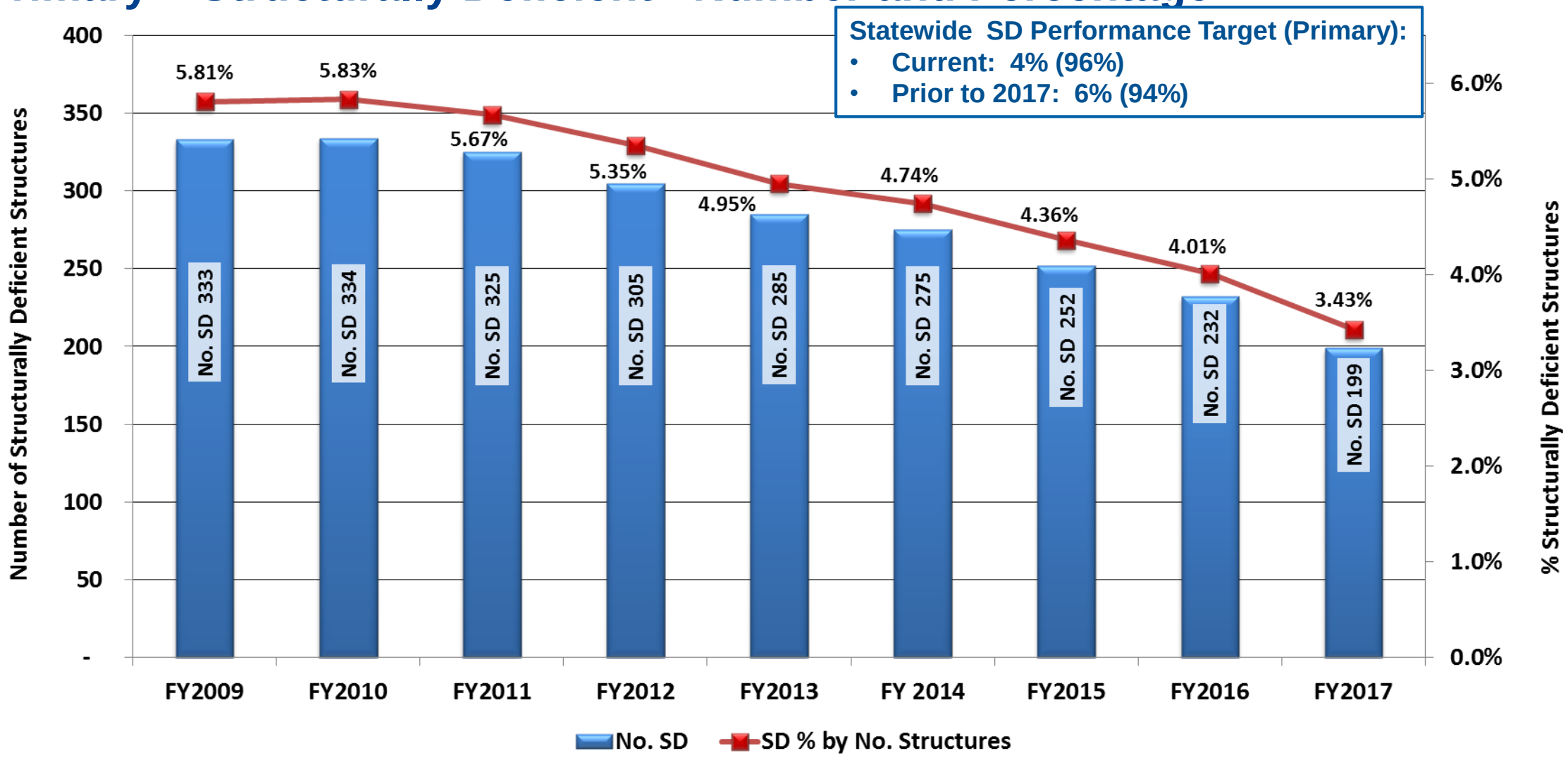
SD % and Number: All Virginia Bridges

Performance Measures
Interstate – Structurally Deficient - Number and Percentage

Statewide SD Performance Target (Interstates):
- **Current: 1% (99%)**
- **Prior to 2017: 3% (97%)**

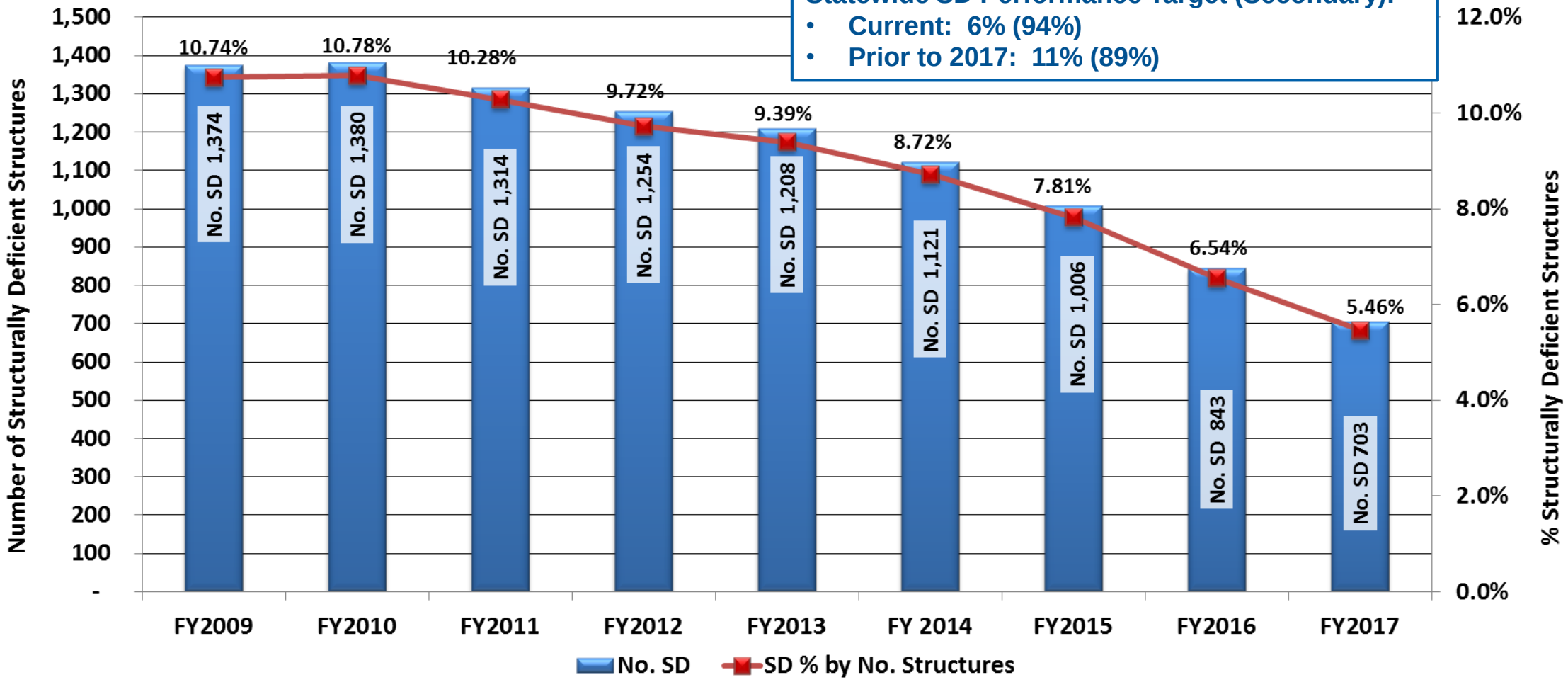


Performance Measures
Primary – Structurally Deficient - Number and Percentage



Performance Measures
Secondary – Structurally Deficient - Number and Percentage

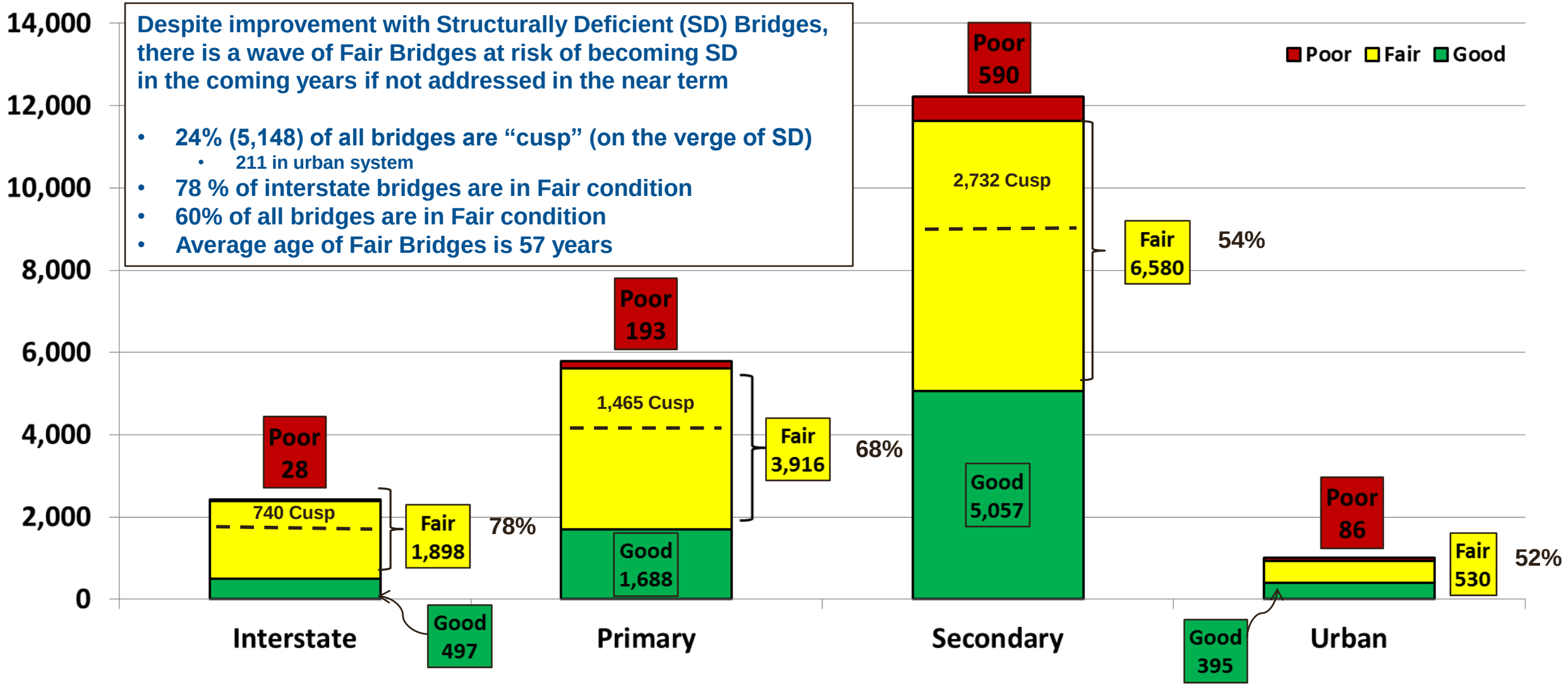
Statewide SD Performance Target (Secondary):
- **Current: 6% (94%)**
- **Prior to 2017: 11% (89%)**



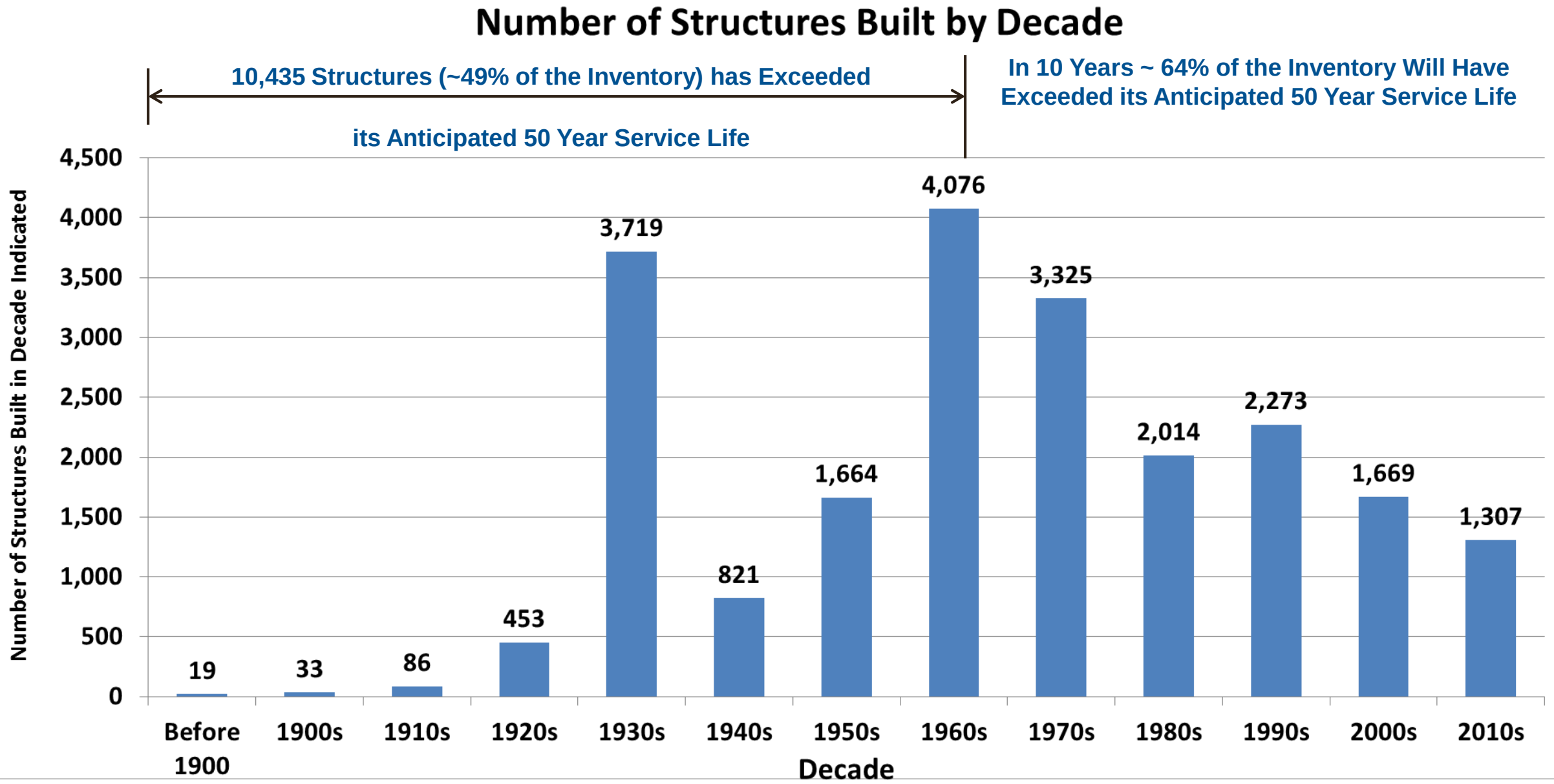
Bridge Inventory
Current Conditions and Concerns for the Future

Despite improvement with Structurally Deficient (SD) Bridges, there is a wave of Fair Bridges at risk of becoming SD in the coming years if not addressed in the near term

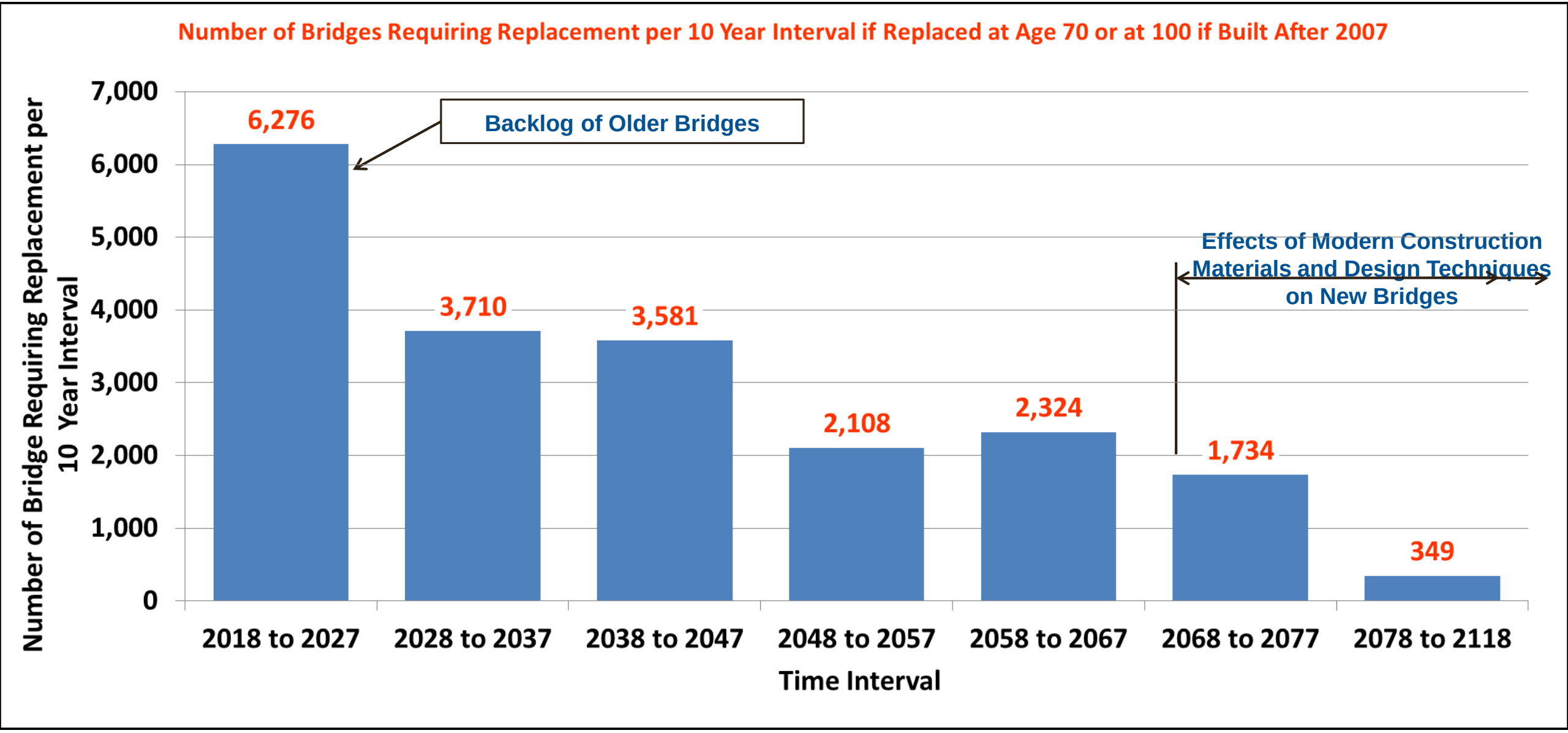
- 24% (5,148) of all bridges are "cusp" (on the verge of SD)
  - 211 in urban system
- 78 % of interstate bridges are in Fair condition
- 60% of all bridges are in Fair condition
- Average age of Fair Bridges is 57 years



Bridge Inventory - Age



Number of Bridges Requiring Replacement Due to Age



Implemented Actions and Techniques

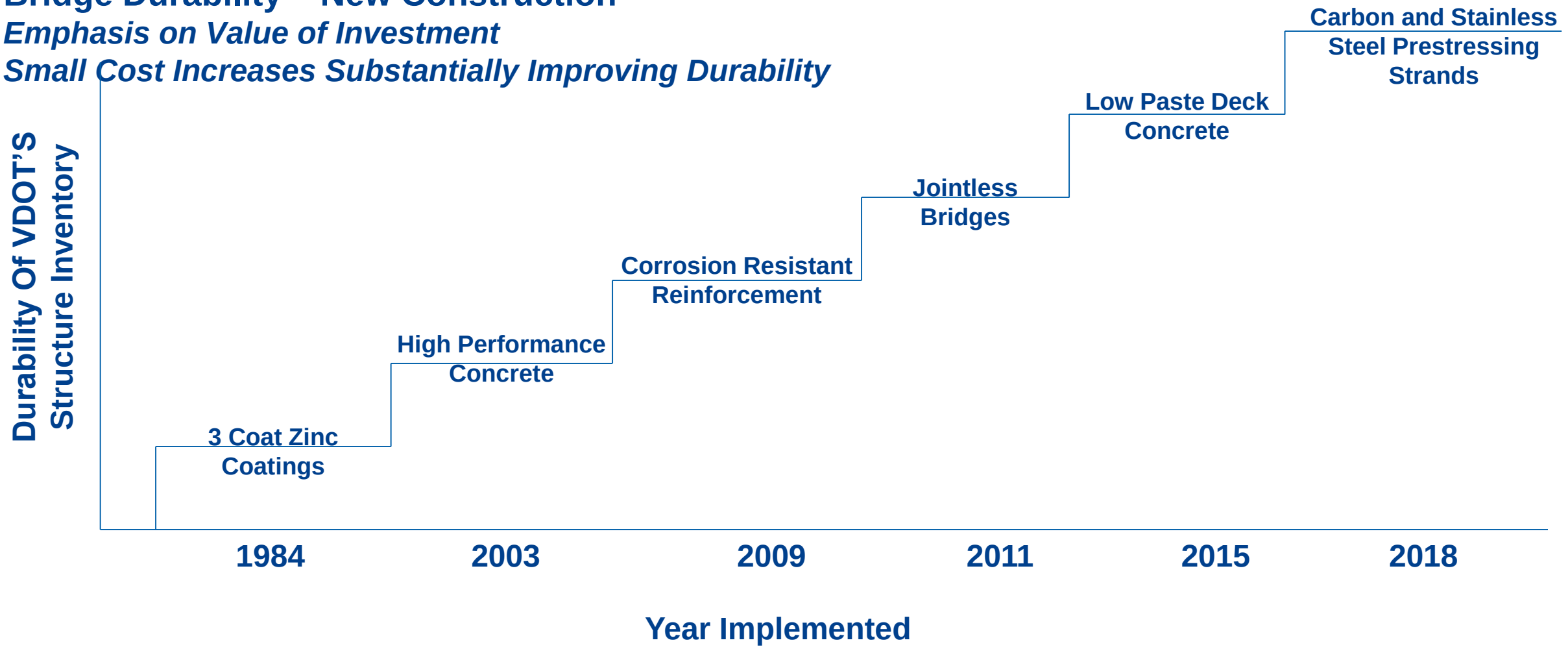
- **Proactive Rehabilitation**
  - Nationwide emphasis on preservation
- **Timely Intervention**
- **Maximize Efficiency**
  - New materials
  - New techniques
  - Treatments that provide high Return on Investment (ROI)

Implemented Actions and Techniques

Bridge Durability – New Construction

Emphasis on Value of Investment

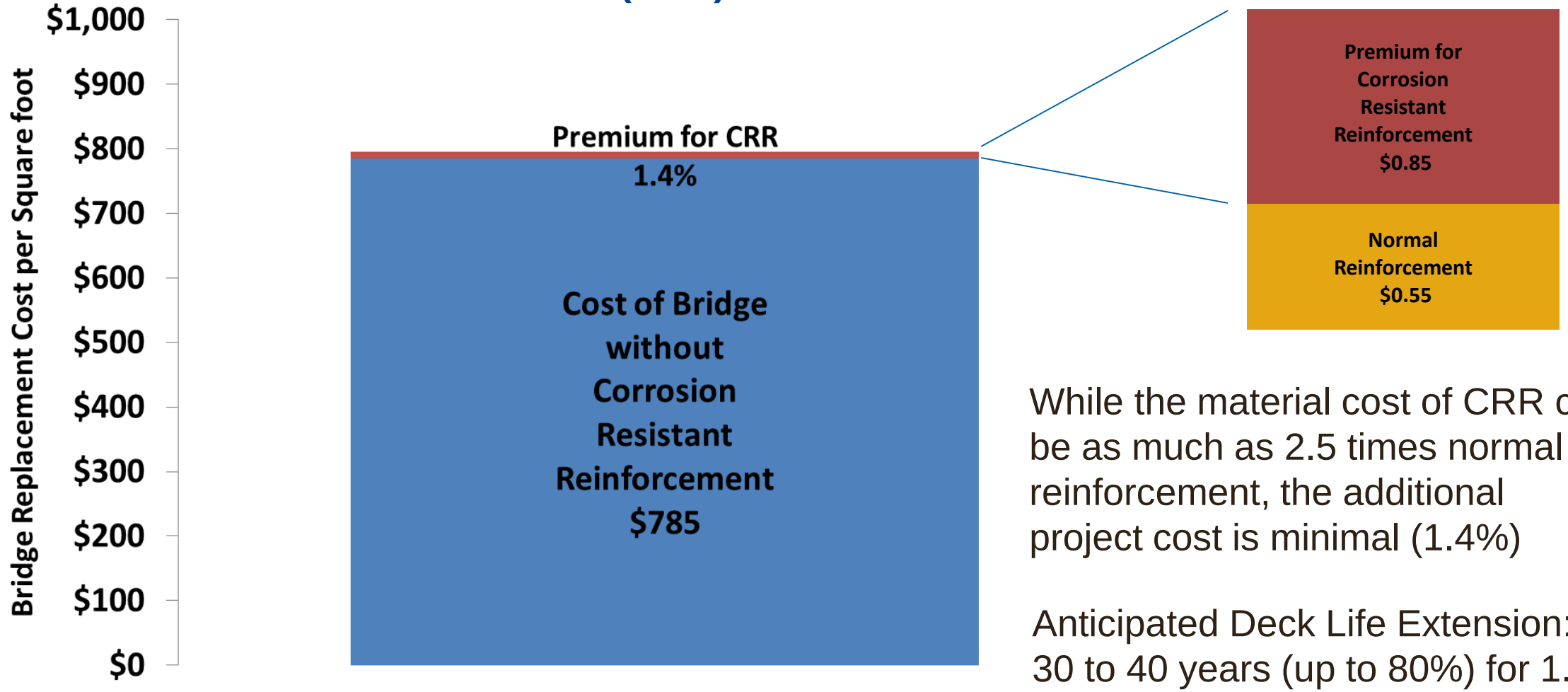
Small Cost Increases Substantially Improving Durability



Implemented Actions and Techniques

Using Available Funds Effectively

Corrosion Resistant Reinforcement (CRR)



While the material cost of CRR can be as much as 2.5 times normal reinforcement, the additional project cost is minimal (1.4%)

Anticipated Deck Life Extension:
30 to 40 years (up to 80%) for 1.4% cost

Action and Techniques Joint Elimination with “Flexible” Concrete

The Value of Rehabilitation: I-64 over Shockoe Valley

Prior to Treatment

Prior to Treatment

Rehabilitation: $10M
versus
Replacement: $140M

I-64 over Shockoe Valley after Rehabilitation
40 Year Life Extension

Safety: Deck Blowouts

With age and deterioration, bridge decks become susceptible to sudden, full depth failure

- Serious economic and life safety implications
- Often unpredictable. Caused by a combination of condition, age, and truck traffic history
- Occurring with greater frequency, particularly on interstates
- Creates an average 7 mile backup on an interstate for 12 - 18 hours (user costs up to $400,000 per event)

I-81 Mainline
Staunton District

I-77 over Rt. 52
Bristol District

I-95 over Meherrin River
Richmond District

Safety: Risks to Motorists Below Bridge

Concrete falling from the bottom of decks creates risk for motorists and pedestrians below

- **Maintaining the bottom of a bridge deck is exceedingly costly due to access difficulties**
- **Distress on the bottom of a deck usually indicates deck replacement is required**

Bottom of a Badly Deteriorated Bridge Deck

Safety: Fatigue Cracks – 5,500 Susceptible Bridges

- Heavy, repeated loads lead to fatigue cracks
- Fatigue life can be “reset” with timely action, but after cracks develop remediation costs escalate exponentially
- Problems will continue to worsen with age

Consequences of Load Limitations (Postings) Effecting Virginia's Competitiveness

- Load-restricted bridges is proportional to the number of SD bridges
- 40% of SD Structures are posted
- Posting interstate bridges impacts Virginia's economy
- Federally Mandated Special Hauling Vehicles and Emergency Vehicles will require load-posting or strengthening of interstate and primary bridges
- Effects of postings
  - Homeowner's insurance
  - Access for school buses
  - Emergency vehicles
  - Fire trucks
  - Propane
  - Trash pickup
  - Basic Commercial Deliveries

16 Ton Posting – Caroline County Dead End Road

Real World Effects of Postings: Non-NHS Bridges

14 Ton Posting – Loudon County
Prohibited Garbage Pickup Service

9 Ton Posting – Augusta County Dead End
Most School Buses, Fire Trucks, and Ambulances Prohibited

Importance of Maintenance
Virginia's Economic Competiveness – Bridge Aesthetics

- Visitors' lasting impression of Virginia is usually from the roads and bridges
- VA tourism generates $25 billion in visitor spending, supports 232,000 jobs, and generate $1.7 billion in state and local taxes *(Virginia Tourism Corporation)*

Bridge over I-95 Daytona, FL


Rt. 301 over I-95 Richmond, VA

Importance of Maintenance
Virginia's Competitiveness - Attracting Autonomous Vehicles

- Nationwide competition to attract autonomous vehicles
- Autonomous vehicle companies have stated clearly that their primary needs are:
  - Good pavement
  - Good bridges
  - Good striping

Today's Discussion

- Nationwide trends
  - Aging inventory, increasing VMT and truck loads
  - Well rounded preventive maintenance program imperative
- Virginia's inventory size
  - Federal measures – small portion
  - Statewide measures necessary
- Long term focus and strategy
  - Steps today will be realized by future generations
  - Using limited resources for best ROI

Next Steps/Schedule

CTB Meeting	Description
June – Today	Present current state of the practice
July	Present proposed targets – statewide and federal Present overview of Special Structures
September	Request adoption from CTB of targets
Future meetings	Continued conversation of performance and investment opportunities

PAVEMENT AND BRIDGE OVERVIEW

June 19, 2018