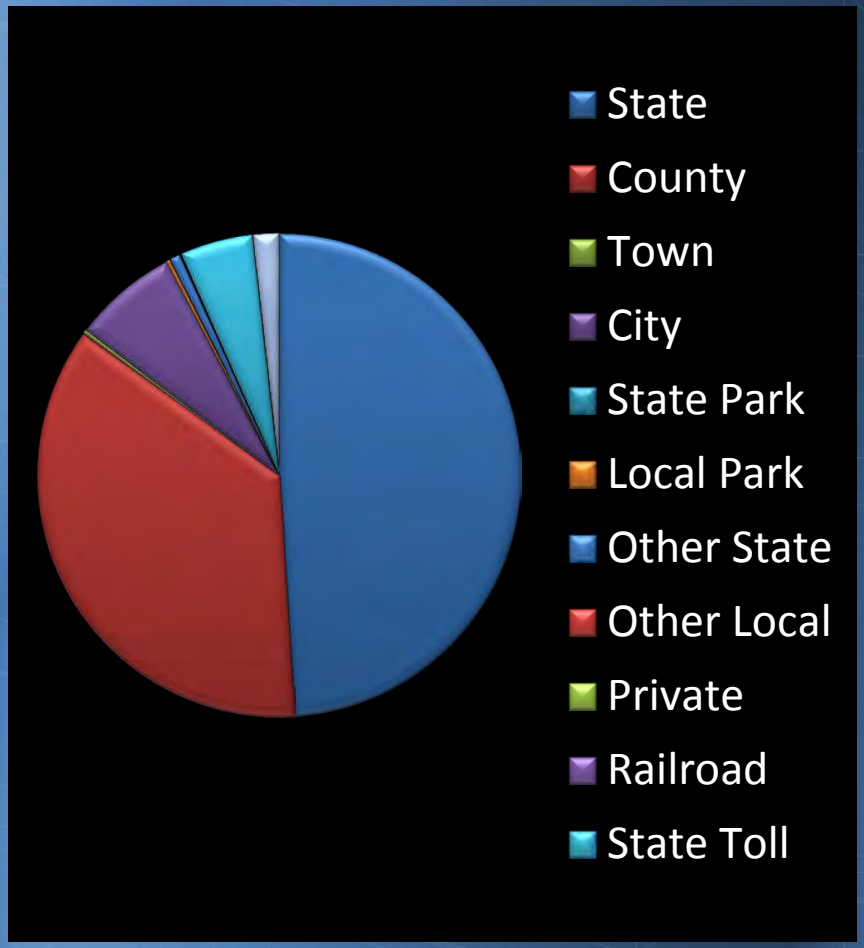
Accelerated Bridge Construction for Local Bridge Systems

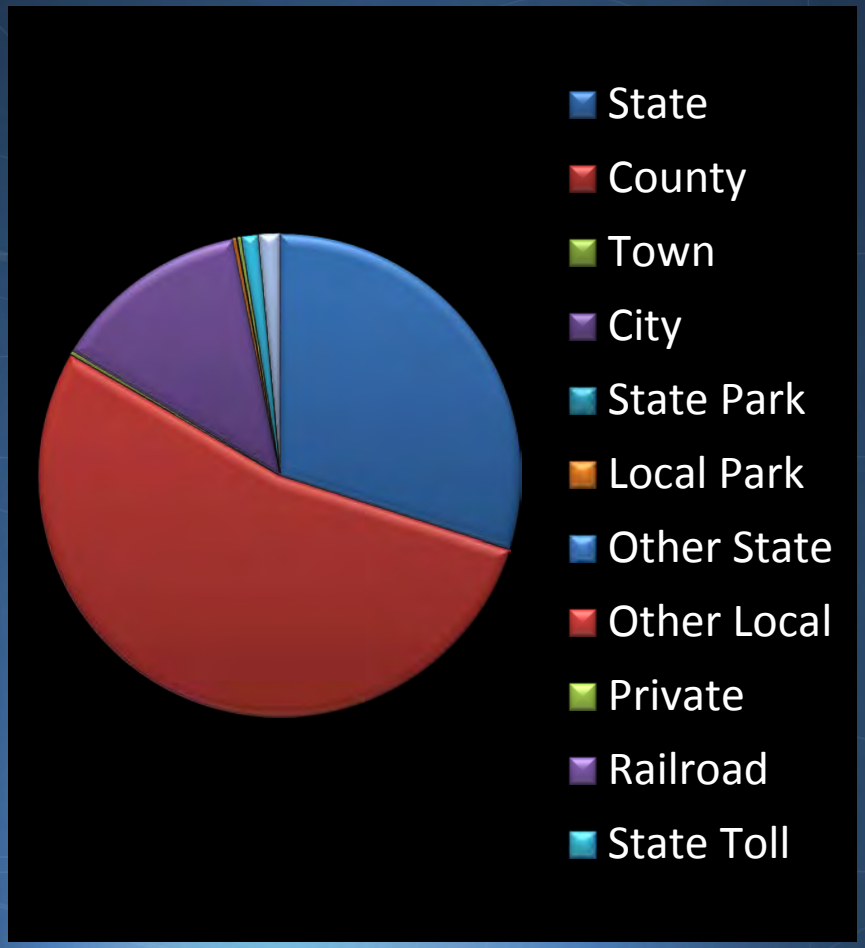
Timothy H. Cupples, PE, DBIA
Federal Highway Administration

Maryland Bridge Inventory

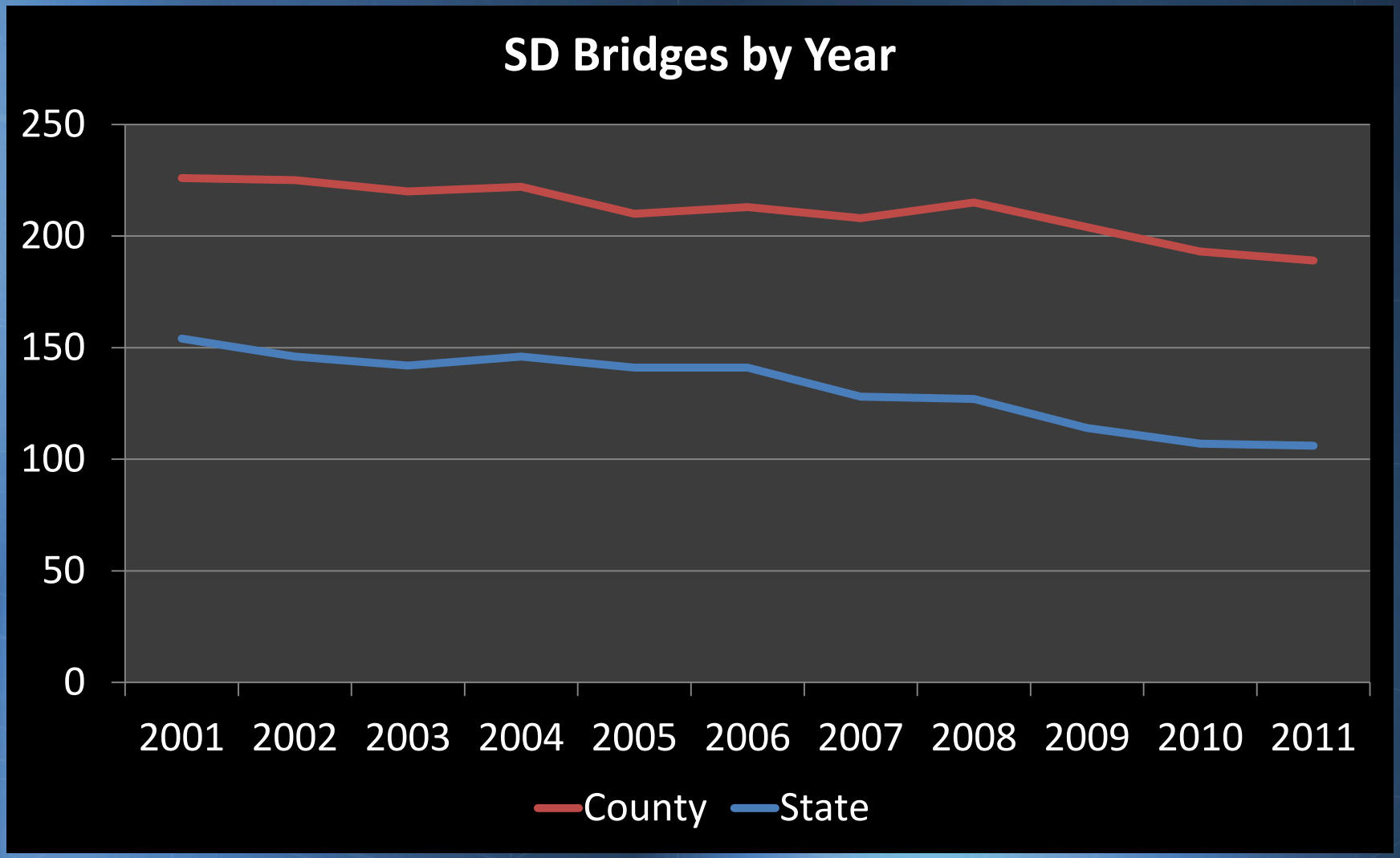
Bridge Ownership



Structurally Deficient Bridges



Progress on Reducing Structurally Deficient Bridges



FHWA Strategic Goals

- National Leadership
  - Advance Innovation
- Program Delivery
  - Streamline Project Delivery
    - Planning
    - Design
    - Construction
- System Performance
  - Improve Performance and Condition

Every Day Counts

- Identify and Deploy Innovation
- Shorten Project Delivery
- Enhance Safety
- Protect Environment

EDC Components

- Shortening Project Delivery Toolkit
- Accelerating Project Delivery Methods
- Accelerating Technology Innovation & Deployment

Accelerating Technology Innovation & Deployment

- Prefabricated Bridge Elements and Systems

- Geosynthetic Reinforced Soil Integrated Bridge System

PBES Defined

- Structural Components
- Built Offsite or Near-Site
- Reduce Onsite Construction Time
- Reduce Mobility Impacts

Elements vs. Systems

Elements

- Single, Prefab Component
- Deck Panel
- Adjacent Prefab Beams
- Modular Deck/Beam Unit
- Prefab Footing
- Prefab Pier Cap/Column
- Prefab Abutment

Elements vs. Systems

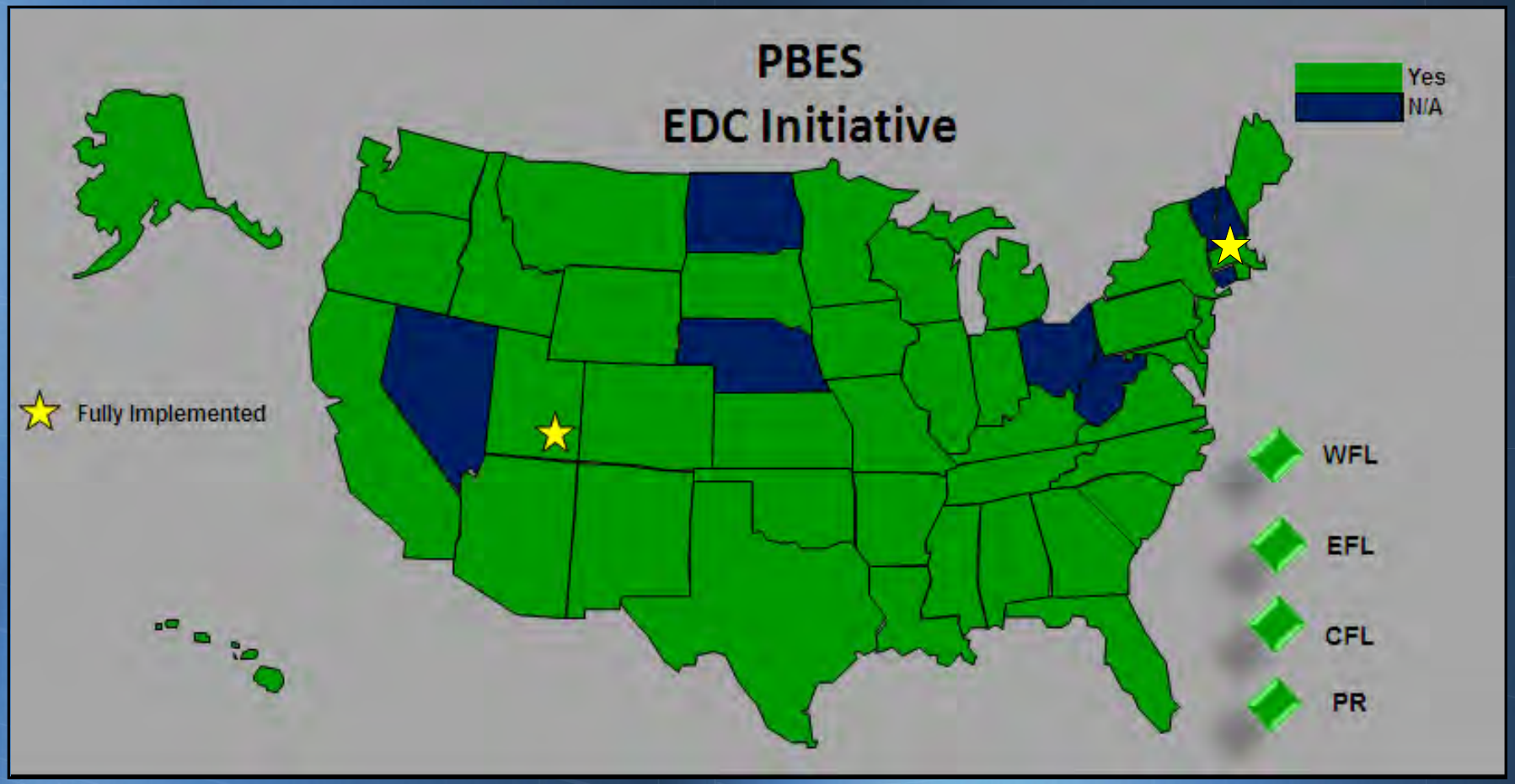
Systems

- Entire Superstructure
- Entire Substructure Unit
- Total Bridge

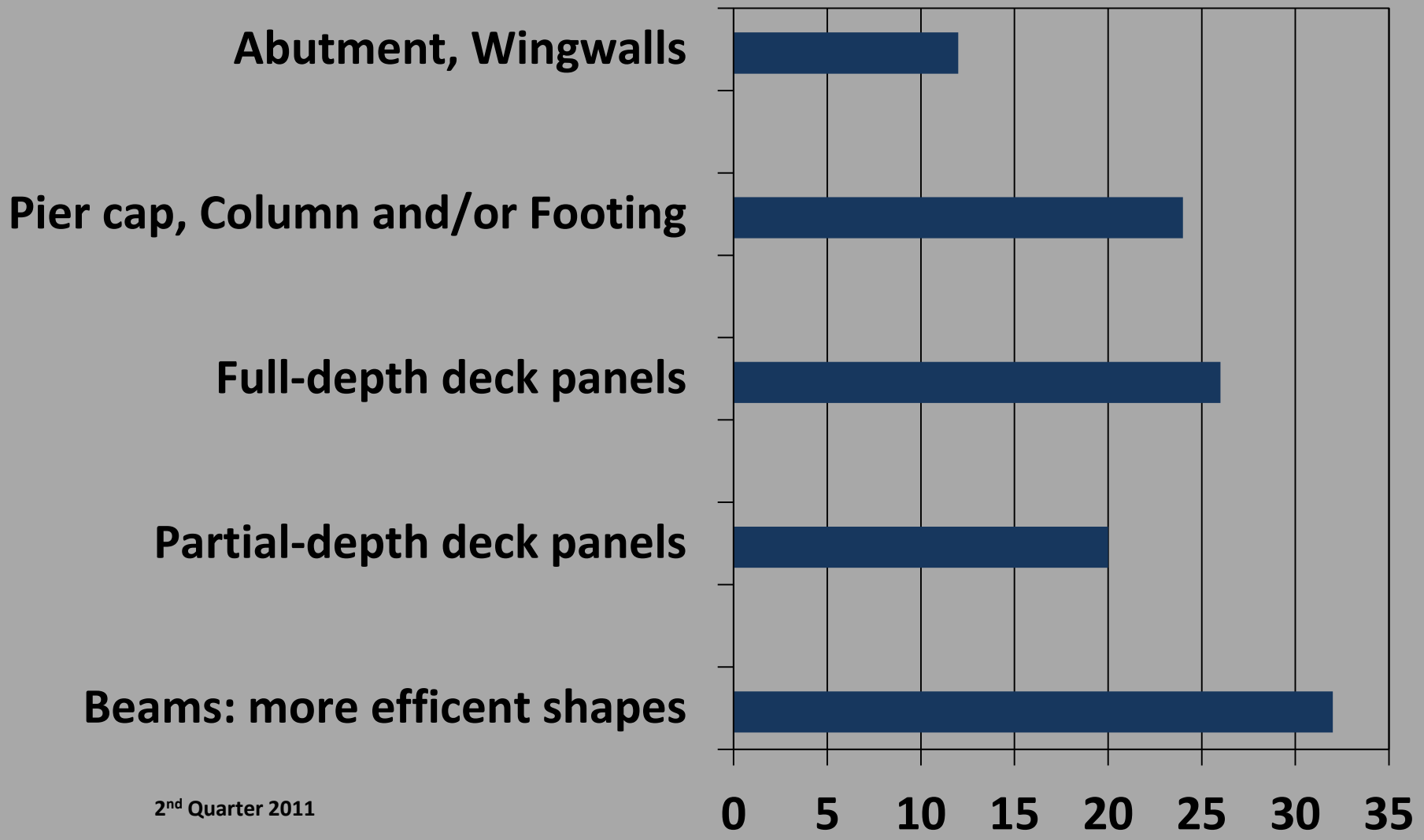
2012 – PBES Deployment Goals

- 100 Cumulative PBES Bridges
- 25% of Federal Aid Bridges Utilize PBES

PBES Deployment Status



What PBES Elements are DOT's Selecting?



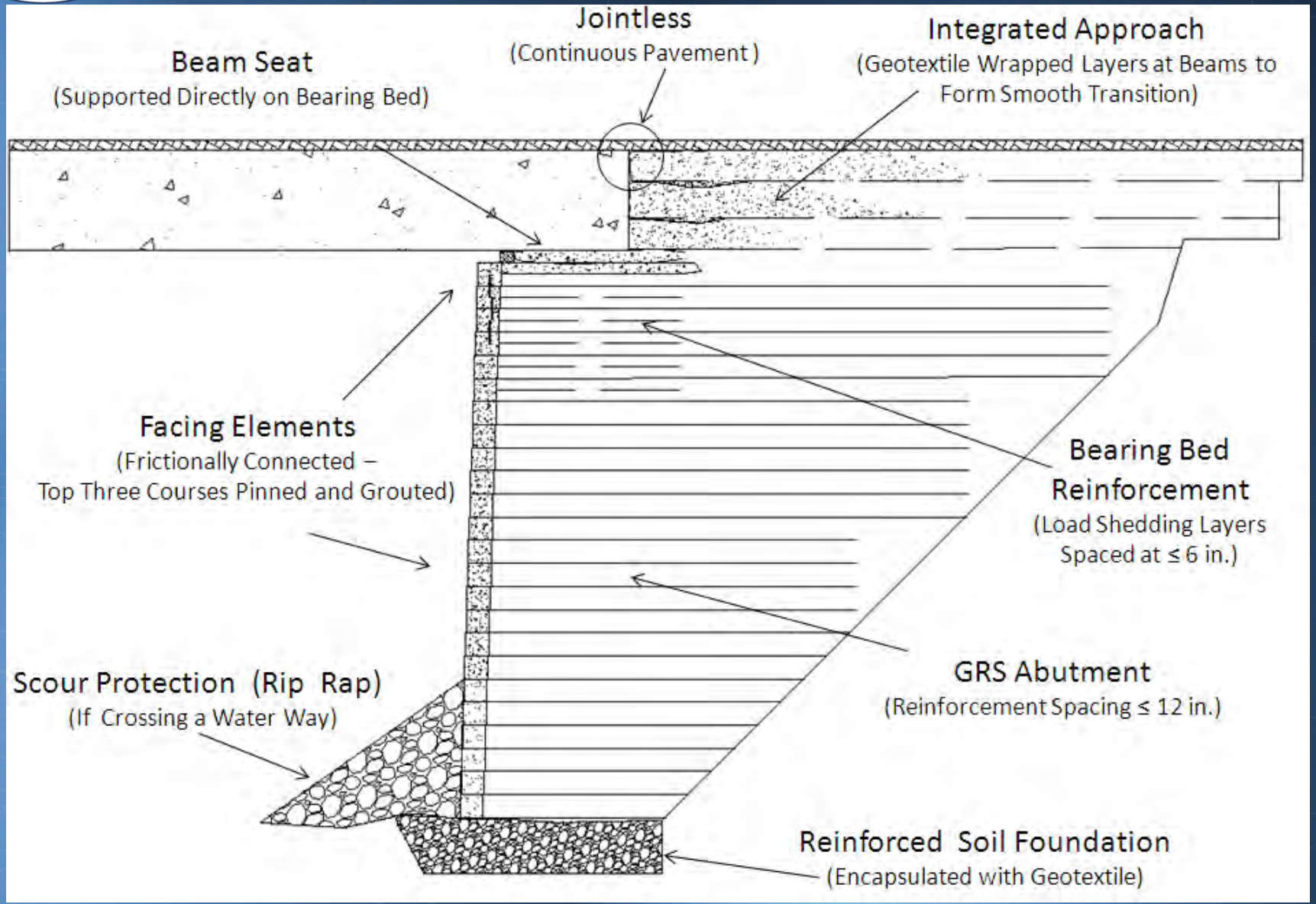
2nd Quarter 2011

GRS-IBS Defined

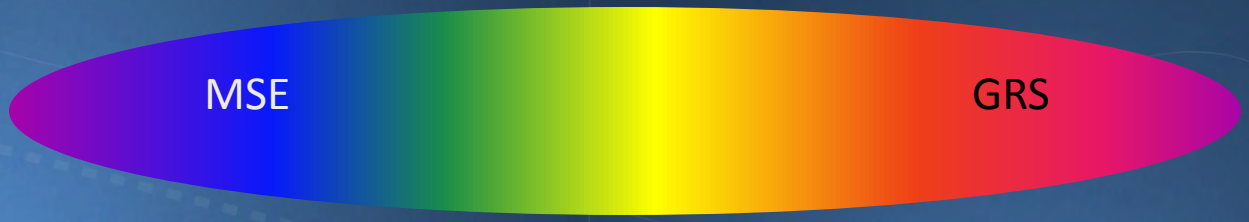
- GRS - Geosynthetic Reinforced Soil
  - An engineered fill of closely spaced (< 12”) alternating layers of compacted granular fill material and geosynthetic reinforcement
- IBS - Integrated Bridge System
  - A fast, cost-effective method of bridge support that blends the roadway into the superstructure using GRS technology

Cut-away of a GRS Mass

Cross-Section of GRS-IBS



Degree of Composite Behavior



<u>Reinforcement spacing</u>

36” 30” 24” 18” 12” 6”


0.5 ksf
(25 kPa)


3.1 ksf
(148 kPa)


4.1 ksf
(196 kPa)


4.9 ksf
(235 kPa)


5.9 ksf
(282 kPa)


6.8 ksf
(326 kPa)

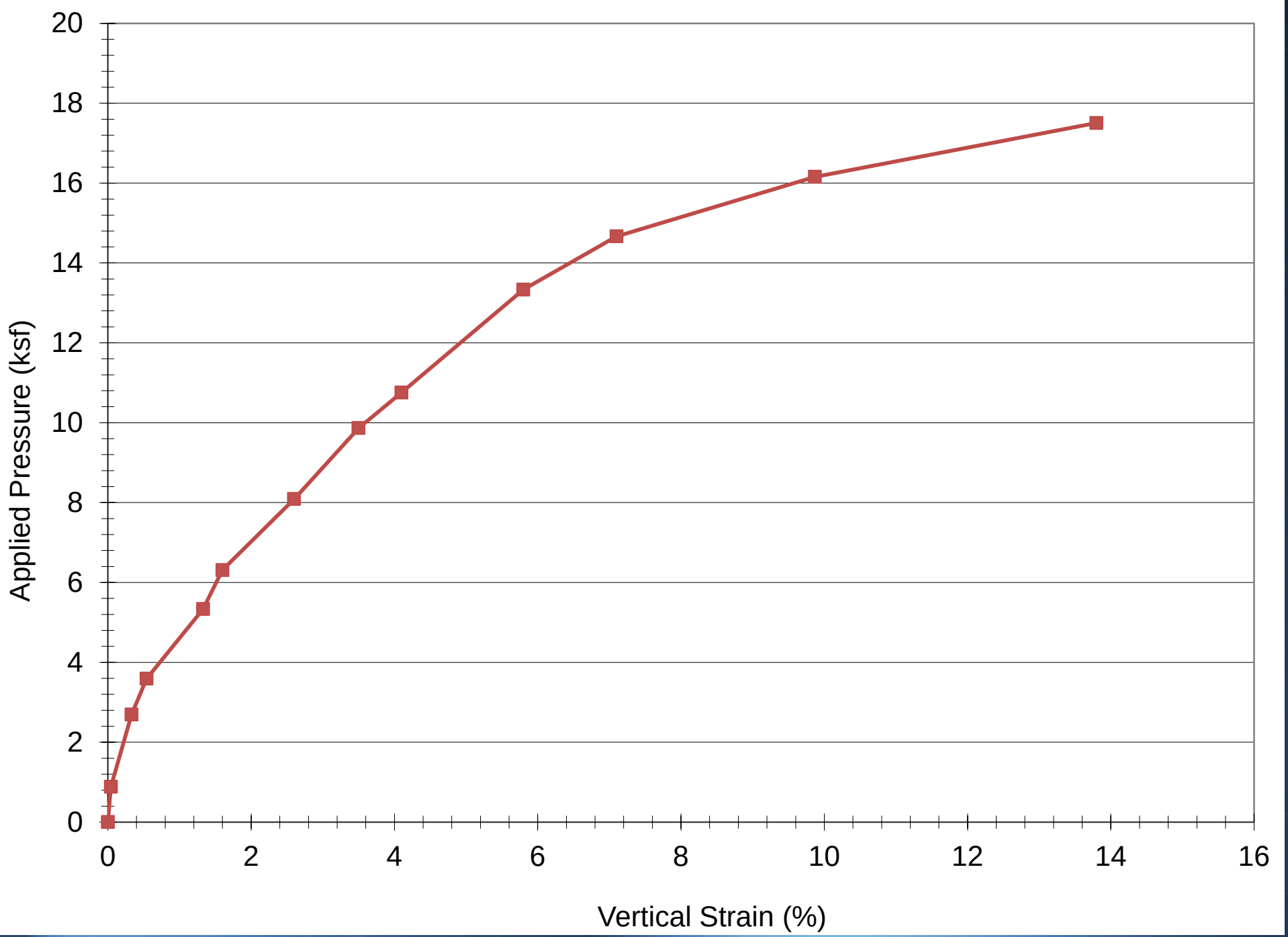

8.5 ksf
(407 kPa)


10.3 ksf
(493 kPa)


11.3 ksf
(541 kPa)


13.9 ksf
(666 kPa)


15.3 ksf
(733 kPa)

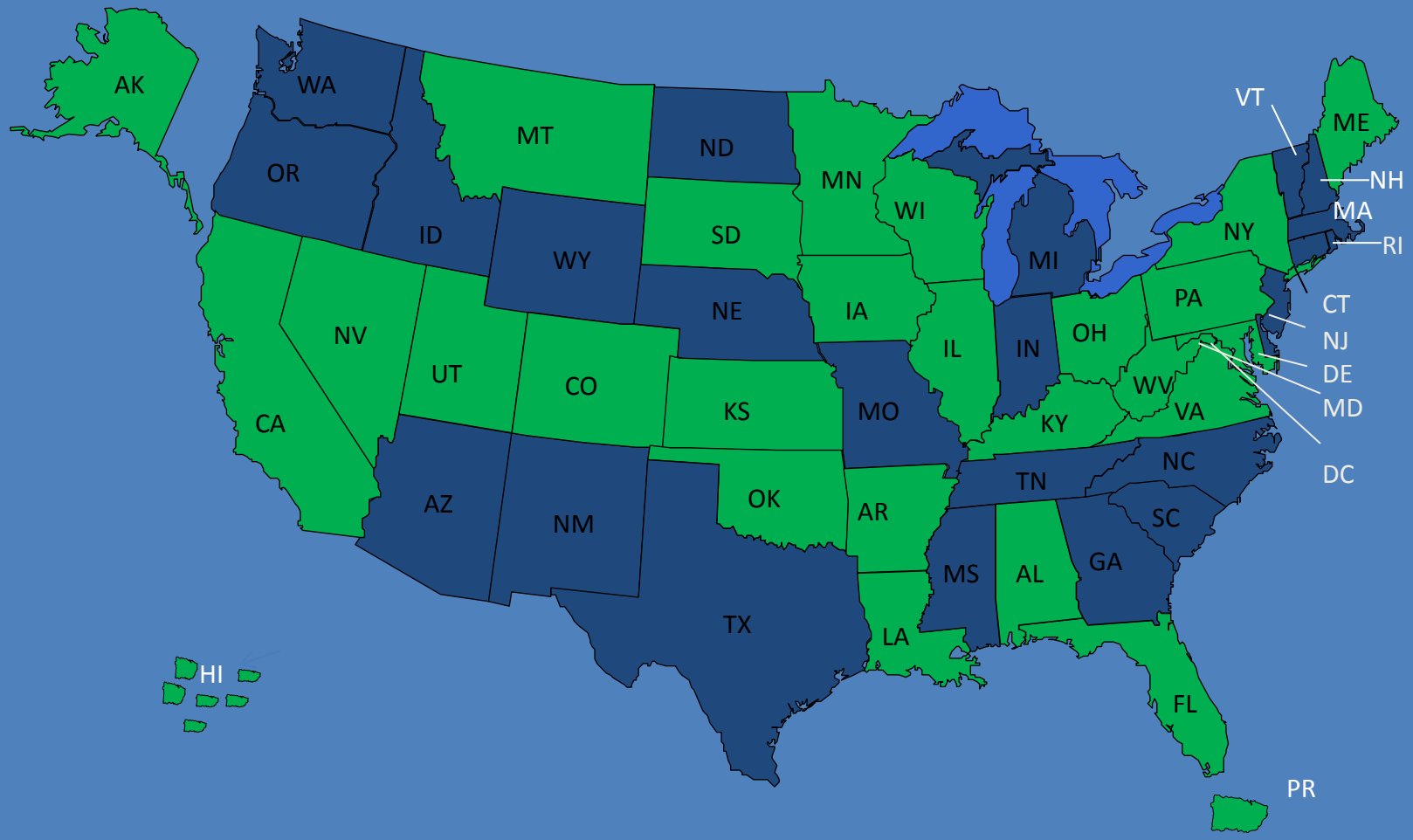

Applied Pressure (ksf)
0
2
4
6
8
10
12
14
16
18
20
Vertical Strain (%)
0
2
4
6
8
10
12
14
16

2012 Deployment Goals

- December 2012:
  - 30 bridges have been designed and/or constructed using GRS-IBS on the NHS within 20 states
  - 75 bridges have been designed and/or constructed using GRS-IBS off the NHS

State DOT Deployment

Total of 56 projects in 28 states at some stage of development from conceptual to construction



GRS IBS Implementation policy memos

Florida DOT

Florida Department of Transportation

RICK SCOTT
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

OFFICE OF THE
SECRETARY

FROM: Robert V. Robertson, P. E., State Structures De

COPIES: Brian Blanchard, David Sadler, David O'Hagar
Charles Boyd, Tom Andres, Sam Fallaha, Denr
Jonathan Van Hook, Garry Roufa, Peter Lai, Rc
Chris Richter (FHWA), Jeffrey Ger (FHWA), E

SUBJECT: Mandatory Evaluation of Suitability of Geosynt
Abutments for Single Span Bridges

DESIGN REQUIREMENTS

1. Section 3.12 of the **January 2011 Structures Design Guideline**
   3.12.12 Geosynthetic Reinforced Soil (GRS) Walls and Abutme
   A. GRS abutments are a shallow foundation and retaining wall
   significantly reduce the construction time and cost of single
   B. GRS walls and abutments, like MSE walls, are very adaptabl
   conditions and can tolerate a greater degree of differential settlement than CIP walls.
   GRS walls, however, are also not appropriate for all sites.
   foundations and or other wall types may be required.

2. Section 3.13.2 of the **January 2011 Structures Design Guidelines** is expanded as follows:
   P. GRS Walls and Abutments
   Commentary: **FHWA Publication No.** FHWA-HRT-11-026 "Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide" (GRS Guide) contains background information and design steps for GRS walls and abutments. (Refer to this guide for Figures referenced below)

Colorado DOT

COLORADO DEPARTMENT OF TRANSPORTATION STAFF BRIDGE BRIDGE DESIGN MANUAL	Subsection: 7.4 Effective: May 15, 2011 Supersedes: New
GEOSYNTHETIC REINFORCED SOIL (GRS) ABUTMENTS	
POLICY	COMMENTARY

7.4.1 GENERAL

Mechanically Stabilized Earth (MSE) or Geosynthetic Reinforced Soil (GRS) abutments are acceptable alternatives for deep foundations and are required by Item 5 in subsection 19.1.3B to be considered in the structure type selection report. See Figure 7.4-1 for an illustration of a GRS abutment. (C1)

- Both single or continuous span bridges where competent foundation is near the surface

n alternative to

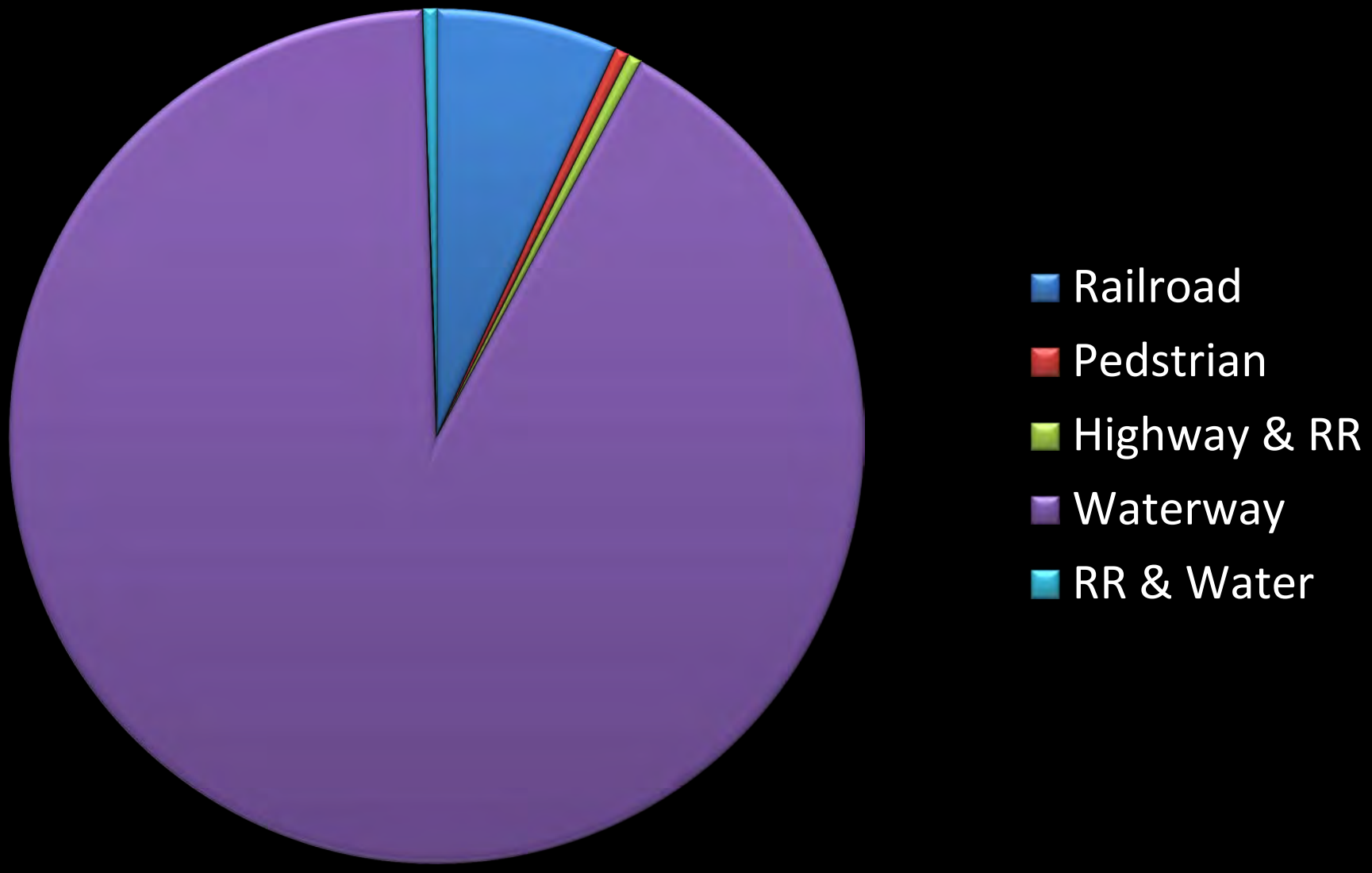
- Both single or continuous span bridges where competent foundation is near the surface
- Single span bridges where foundation short-term settlement from sandy gravel can be calculated and compensated for by adjusting the girder seat elevation to meet vertical clearance requirement
- Single span bridges where

To assure the clearance for bridge underpass meets the minimum requirement, avoid lengthy interaction processes between structural depths, roadway vertical profile, and hydraulic freeboard and anticipate allowable long-term settlement from geotechnical engineer, deep foundation is usually utilized. In general deep foundation is straight forward in design process than spread footing. Deep foundation such as caissons at pier for water crossing is more economic and easier than shallow

Why Use ABC/PBES/GRS-IBS?

- Save Time
- Save Money
- Reduce Environmental Impacts
- Enhance Safety
- Improve Constructability & Quality

Typical Crossing for Structurally Deficient County Bridge in MD



Time Saving Techniques

GRS-IBS

Slide

Heavy Lift

SPMT

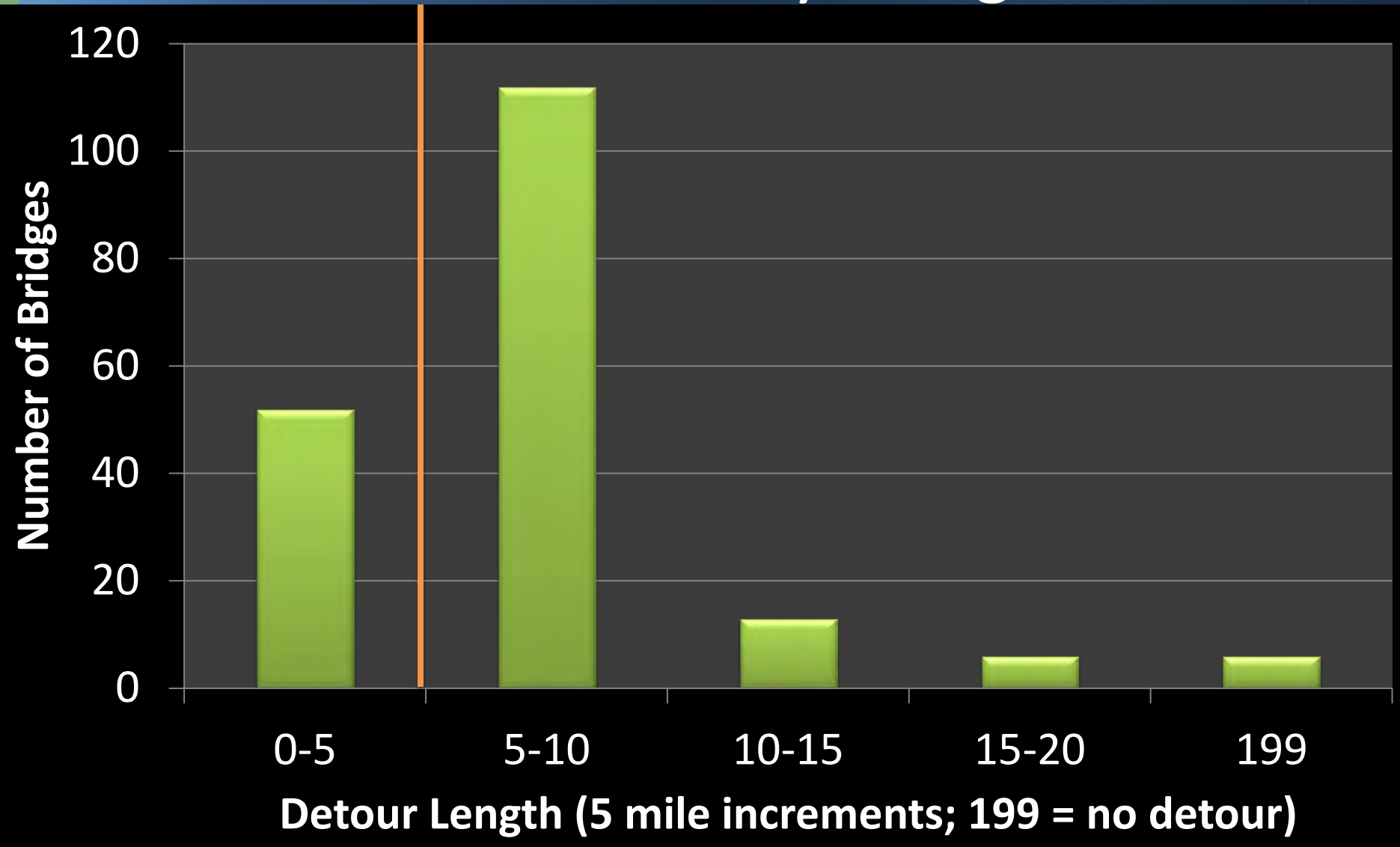
Launch

Save Time

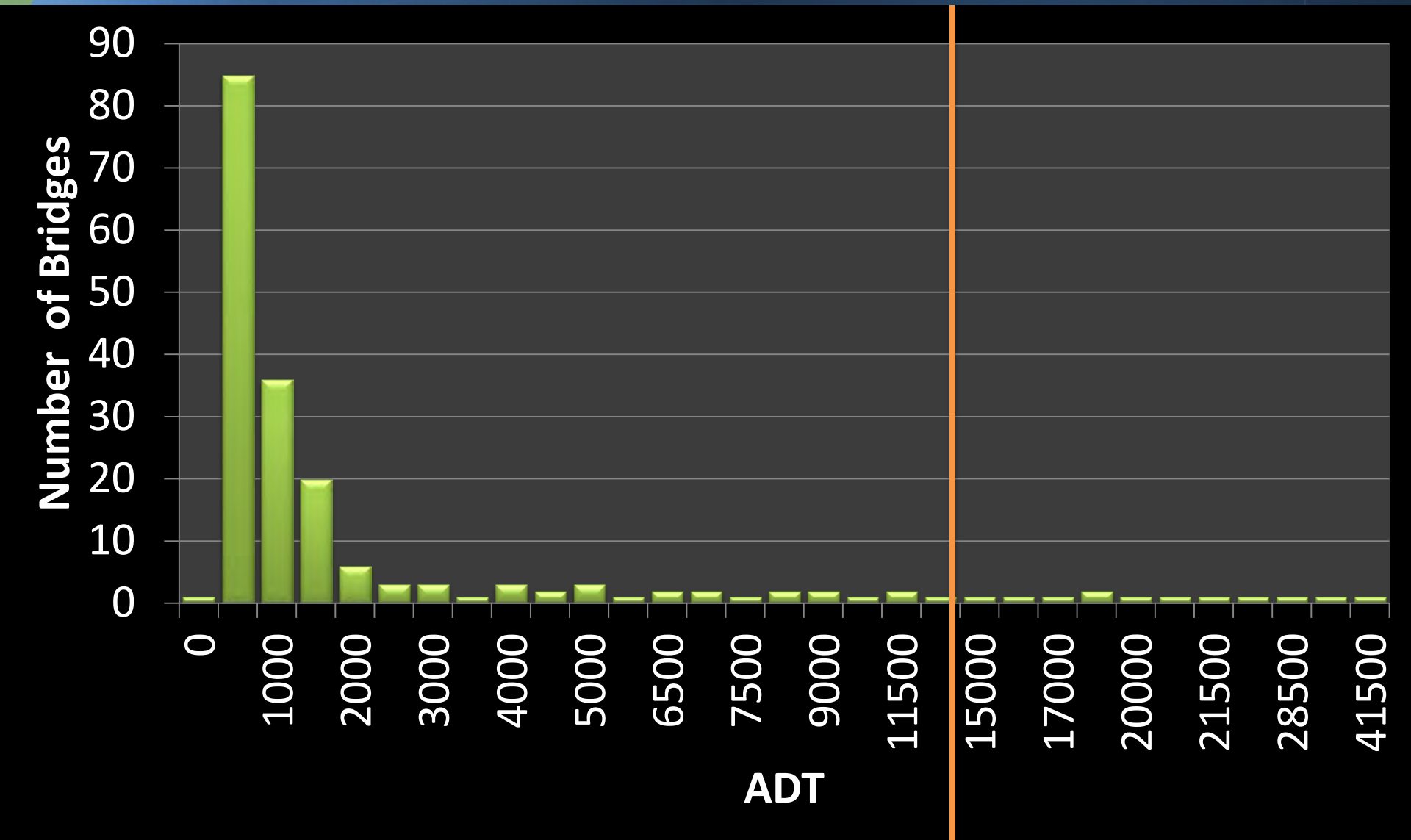
Tier	Mobility Impacts
1	1 -24 hours
2	< 3 days
3	< 2 weeks
4	< 3 months
5	> 3 months

- Reduced Apparent Construction Duration
- Reduced Mobility Impacts – Road Users
- Reduced Overall Construction Duration

Detour Length for Structurally Deficient County Bridges in MD



ADT on Structurally Deficient County Bridges in MD



Other Time Factors

- Evacuation Route
- School Route
- Emergency Response Route
- Railroad
- Remote Site
- External Deadline

Time Saving Example

- 4 Span, 4 Lane Bridge
- BRAC Imposed External Deadline
- Replaced in 8 Weeks using PBES
- Incentive/Disincentive Clause
- Opened 18 Days ahead of schedule

Save Money

- Total Cost to Agency
  - Construction (Hard Costs)
  - Staff and Consultant (Soft Costs)
  - Utility Relocation
  - Right of Way
  - Rail Road Flagging
- Economic Impact of Construction
  - Work Zone Road User Costs

Money Saving Examples

GRS-IBS: 20% - 60% Substructure Savings

Saved $72K on RR & ROW; $135K on Structure

Environmental Impacts

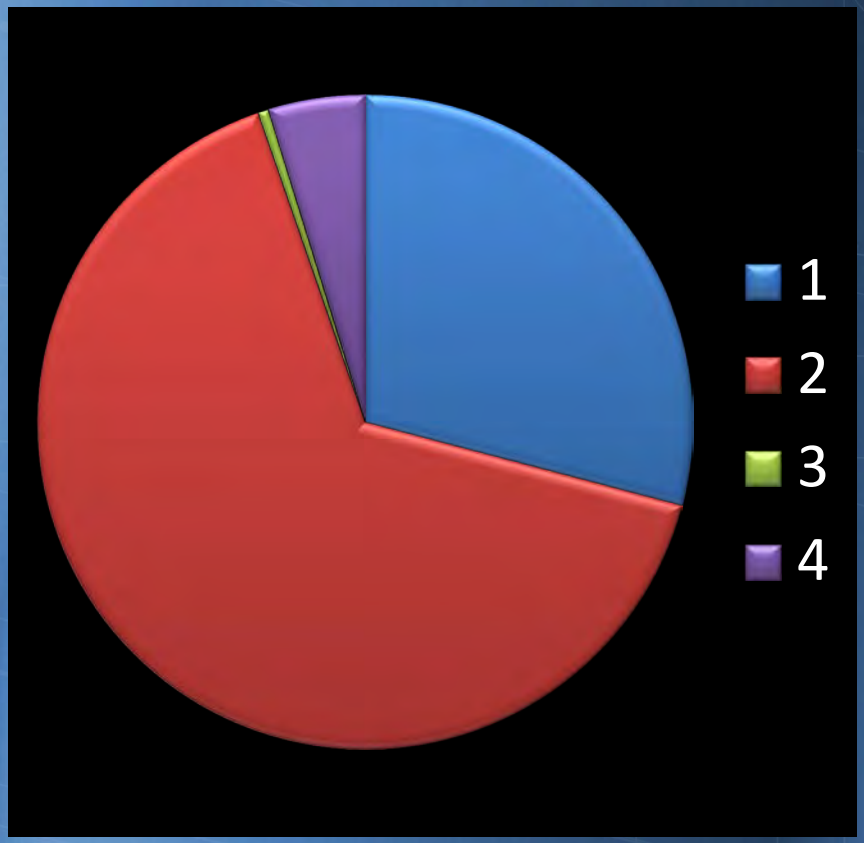
- Lower Fuel Consumption
- Reduced CO_2 Emissions
- Avoid Environmentally Sensitive Areas

Enhance Worker Safety

- 44% of Bridge Construction Worker Injuries Involve a Vehicle Travelling Through a Work Zone *(OSHA Type 1622, 1984-2010)*
- 2/3 are Fatal
- 28% of Worker Injuries Involve Construction Vehicles
- ***No Work Zone = No Accident***

Lanes on Structure

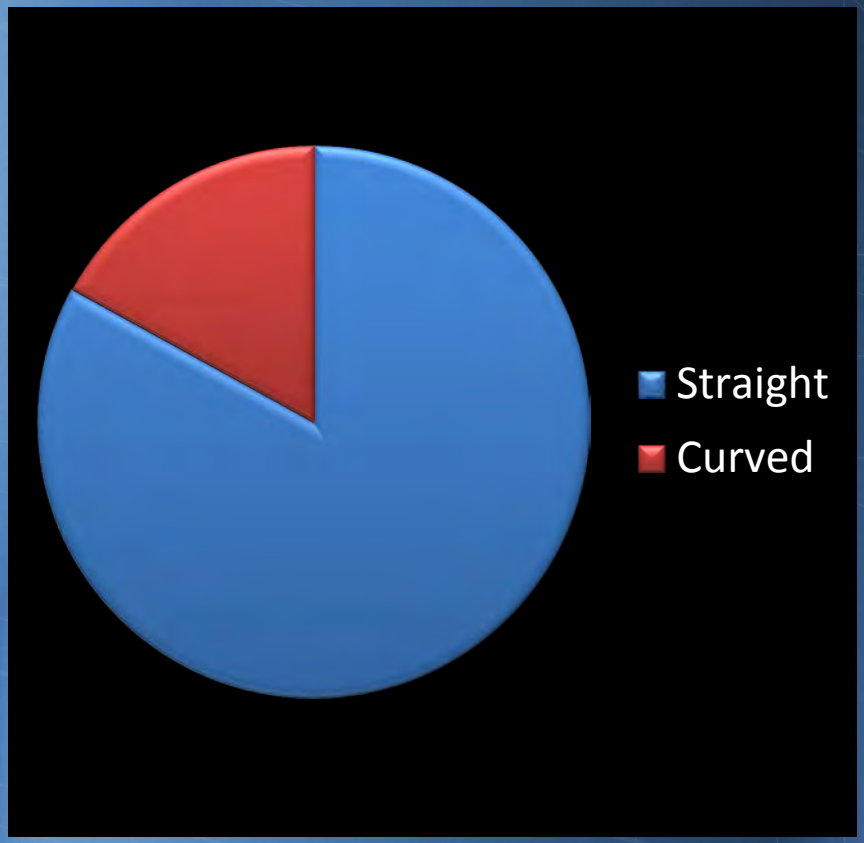
Lanes on County SD Structures



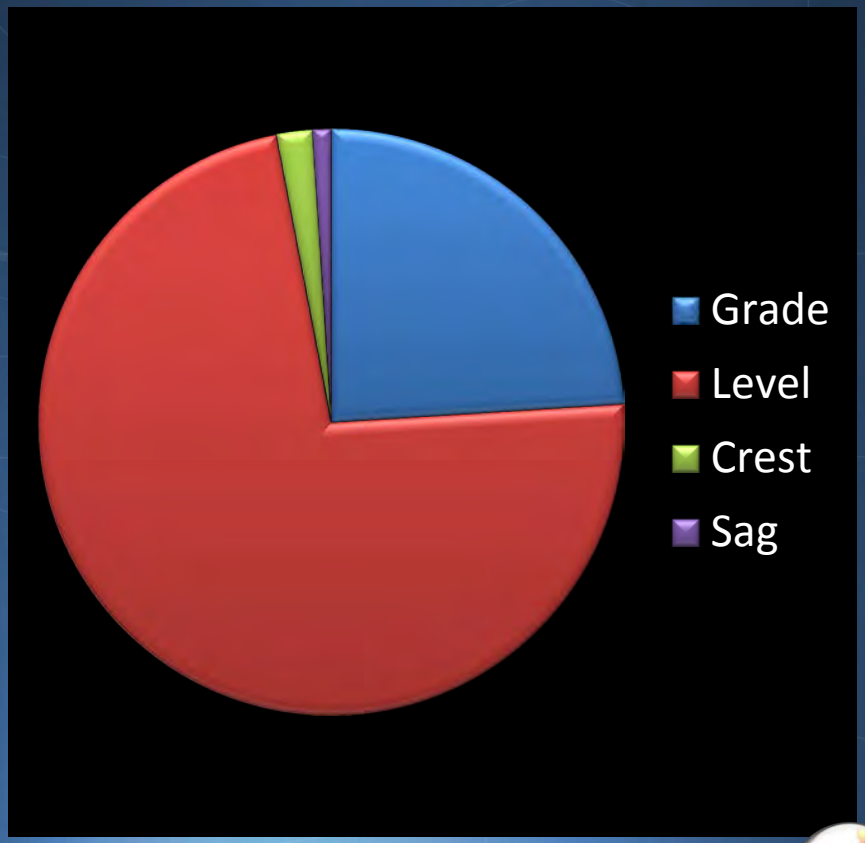
- 2,000 Fatal Traffic Accidents/Yr in Work Zones (FARS 1999-2008)
- *67% Occur on 2-Lane Roads*

Fatal WZ Accidents - Geometry

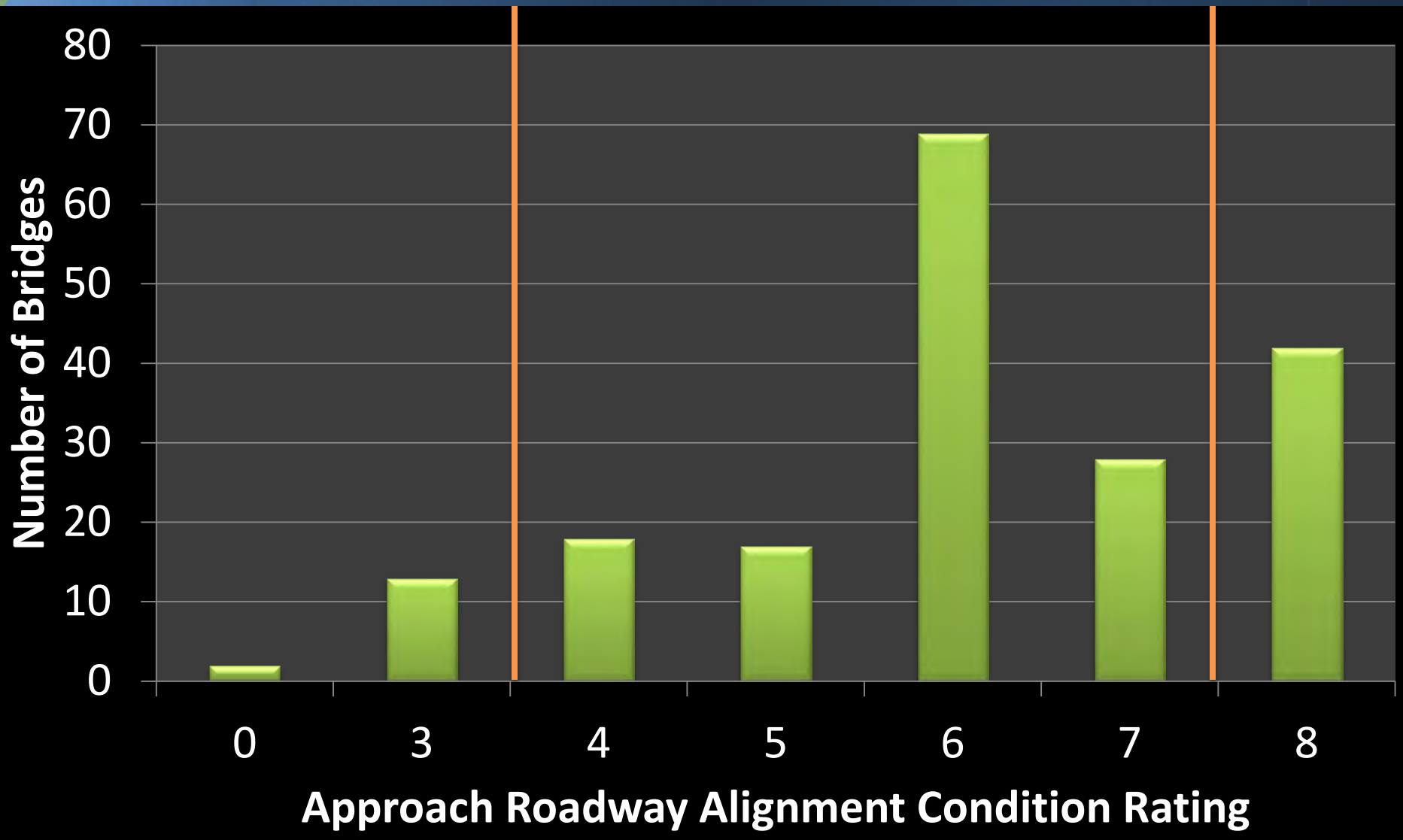
Horizontal



Vertical



Approach Roadway Alignment



Safe Solutions

- Site Distance Concerns
- Sag Vertical Curve/Overpass
- 18 months/3 Phase w/ Conventional
- 8 weeks/no traffic w/ PBES

- Bridge over Railroad
- Workers on Ground/out of Traffic/Not over RR
- Safer and reduced Flagging Costs

Constructability/Quality

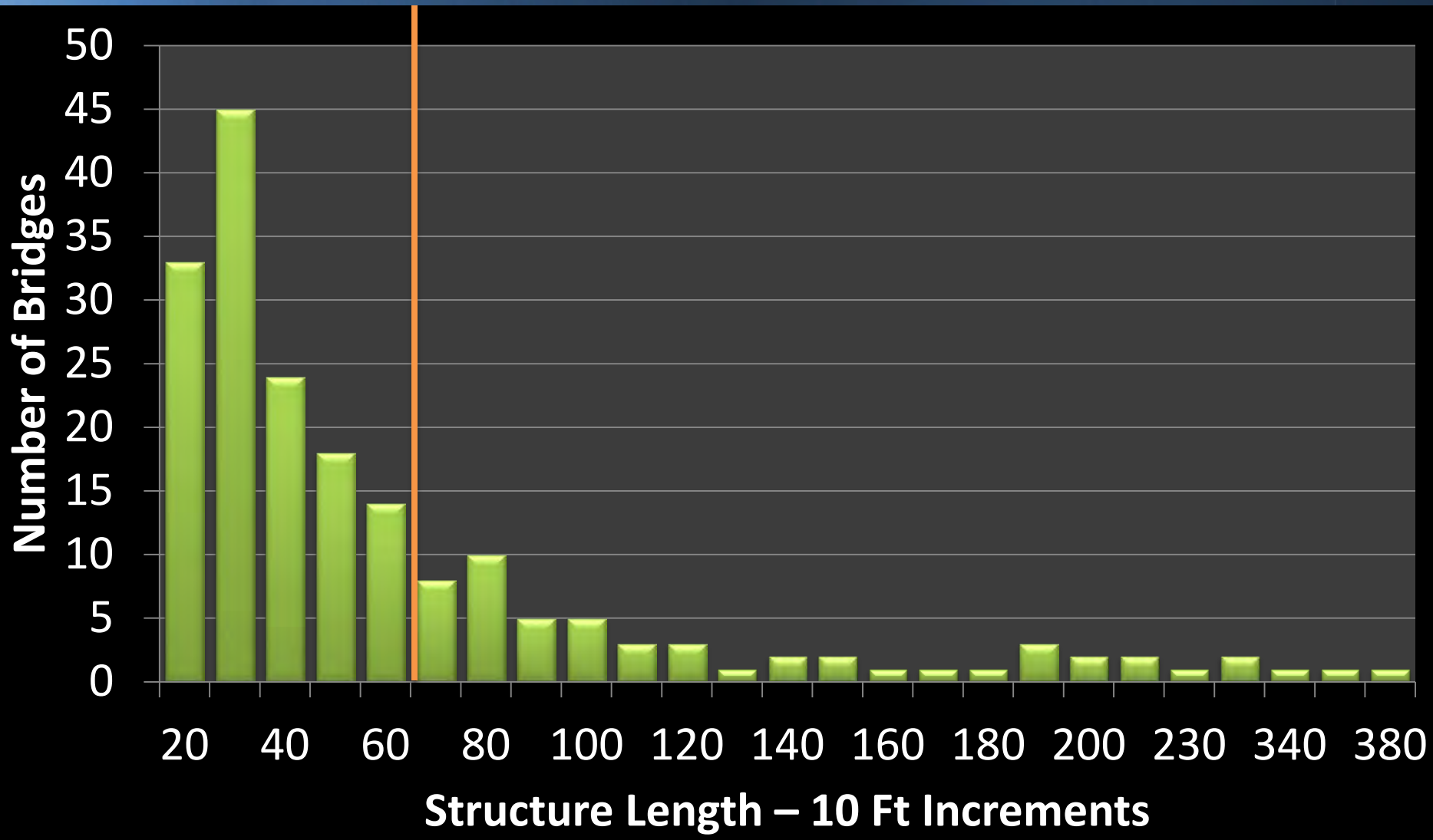
- Prefabrication
  - Controlled Environment
  - Quality Control
- Room to Operate
  - Work from Ground Level
  - Optimize Equipment Position
- Increased Productivity
  - No restricted work hours
  - No MOT Setup/Take Down

U.S. Department of Transportation
Federal Highway Administration

Every Day Counts
innovation ingenuity invention imagination

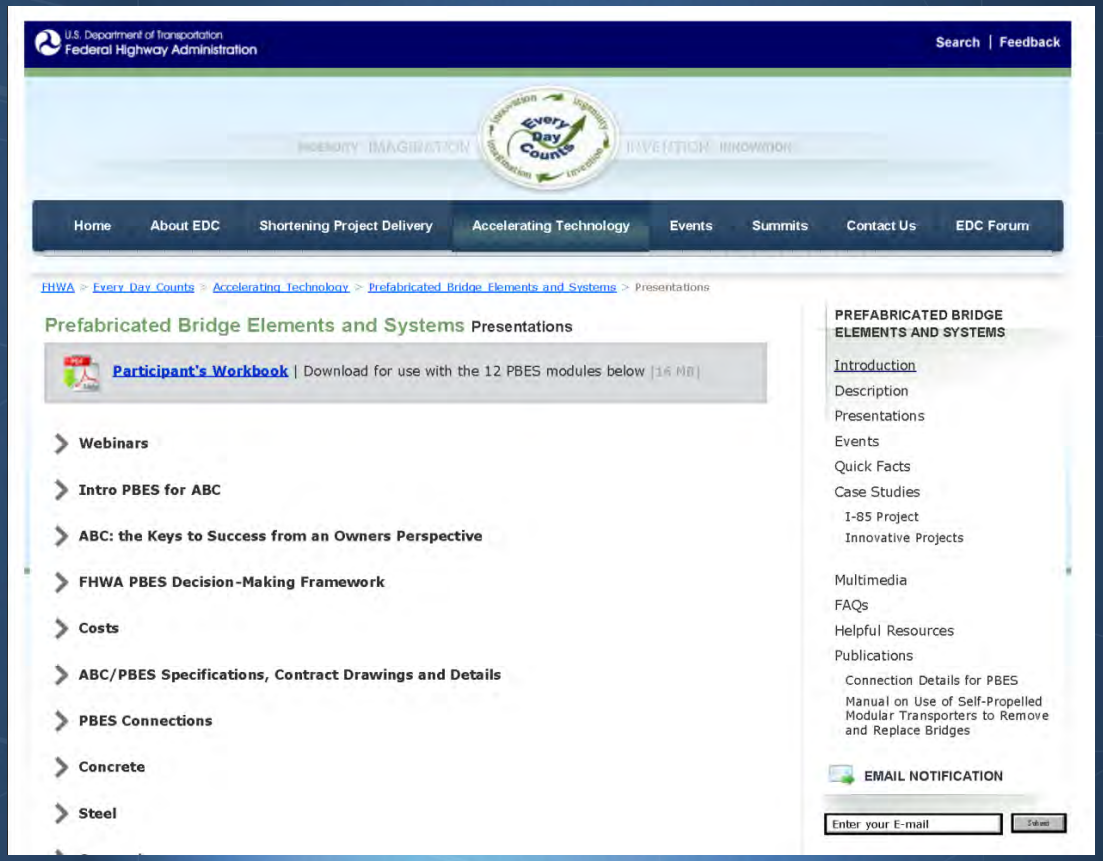
GRS-IBS VIDEO

Length of Structurally Deficient MD County Bridges



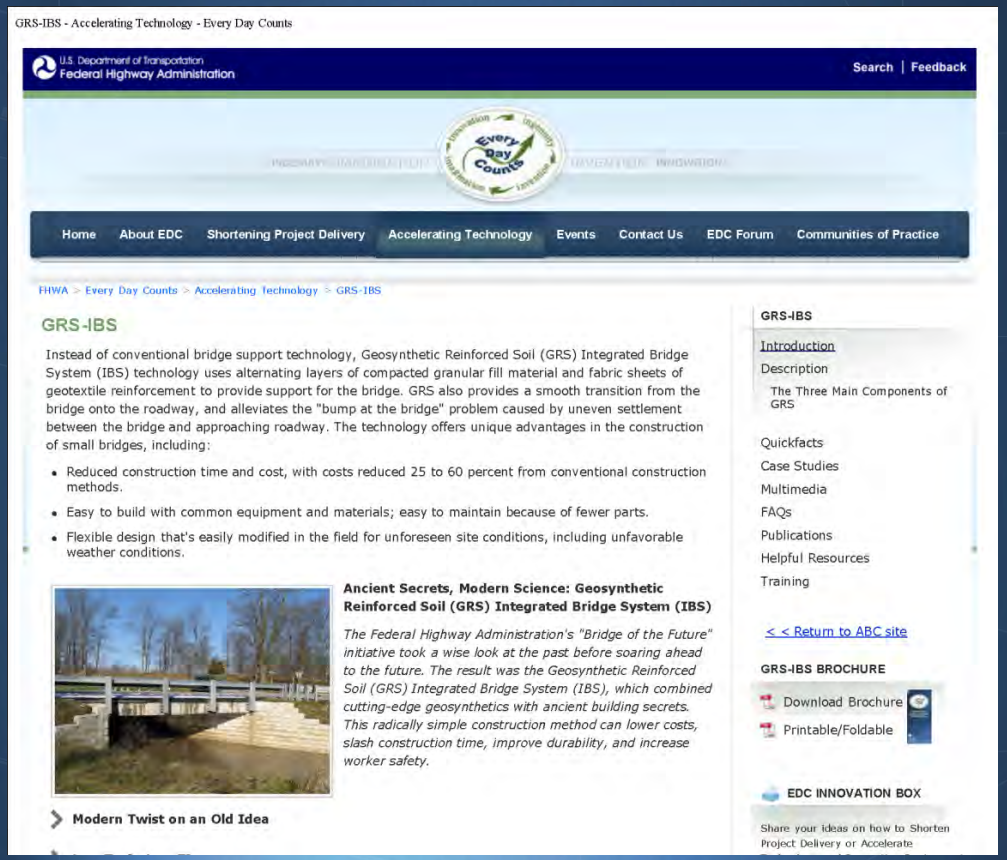
PBES Resources

- benjamin.beerman@dot.gov
- http://www.fhwa.dot.gov/everydaycounts/
- Presentations
- Webinars
- Details
- Cost Information
- Decision Tools
- Case Studies



GRS-IBS Resources

- daniel.alzamora@dot.gov
- http://www.fhwa.dot.gov/everydaycounts/
- Presentations
- Webinars
- Standard Plans
- Design Guide
- Construction Guide
- Case Studies



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Federal Highway Administration

THANK YOU!
QUESTIONS?

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