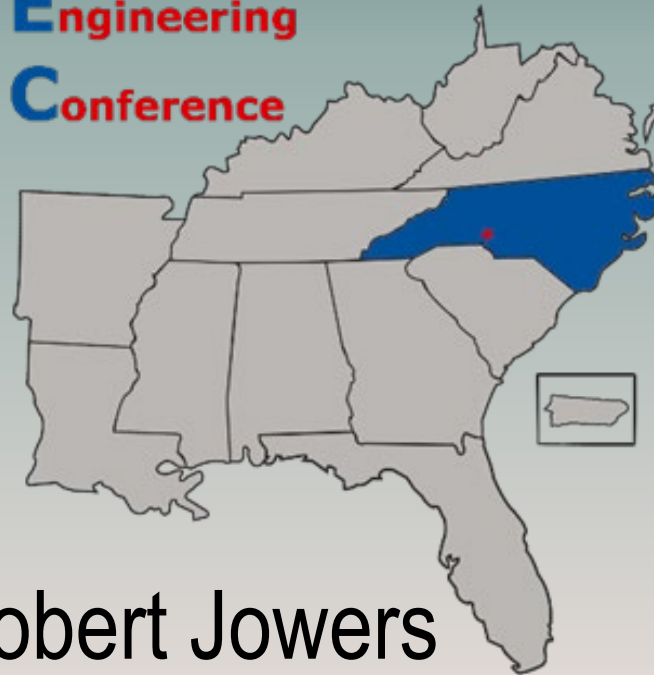


# *Fixing the Bump at the End of Bridge*

**S**outheastern  
**T**ransportation  
**G**eotechnical  
**E**ngineering  
**C**onference



**Charlotte**  
**2023**



Robert Jowers

Tennessee Department of Transportation





# Presentation Overview

- What is the Problem?



# Presentation Overview

- What is the Problem?
- How is it Caused?



# Presentation Overview

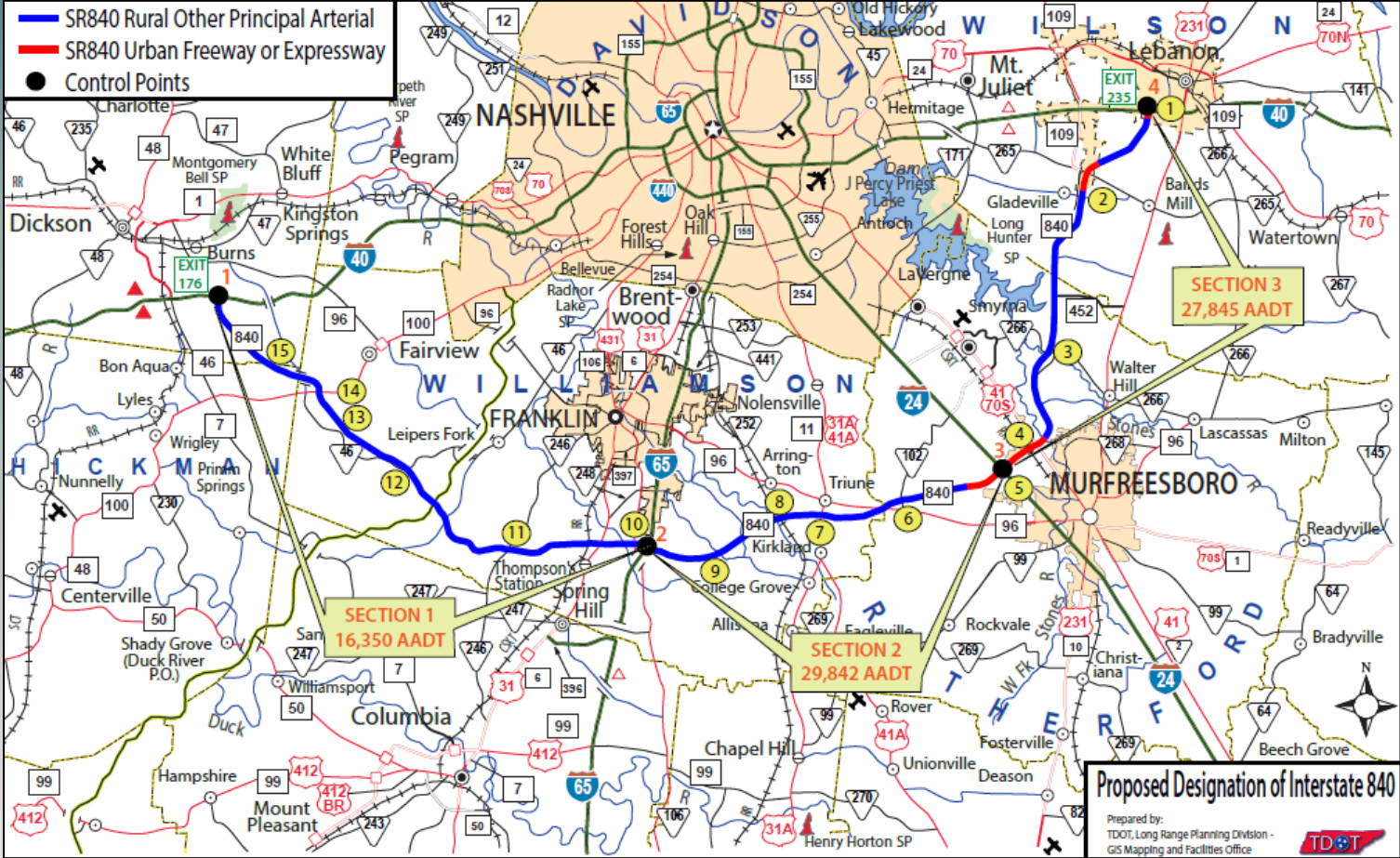
- What is the Problem?
- How is it Caused?
- What is TDOT doing to Fix the Bump



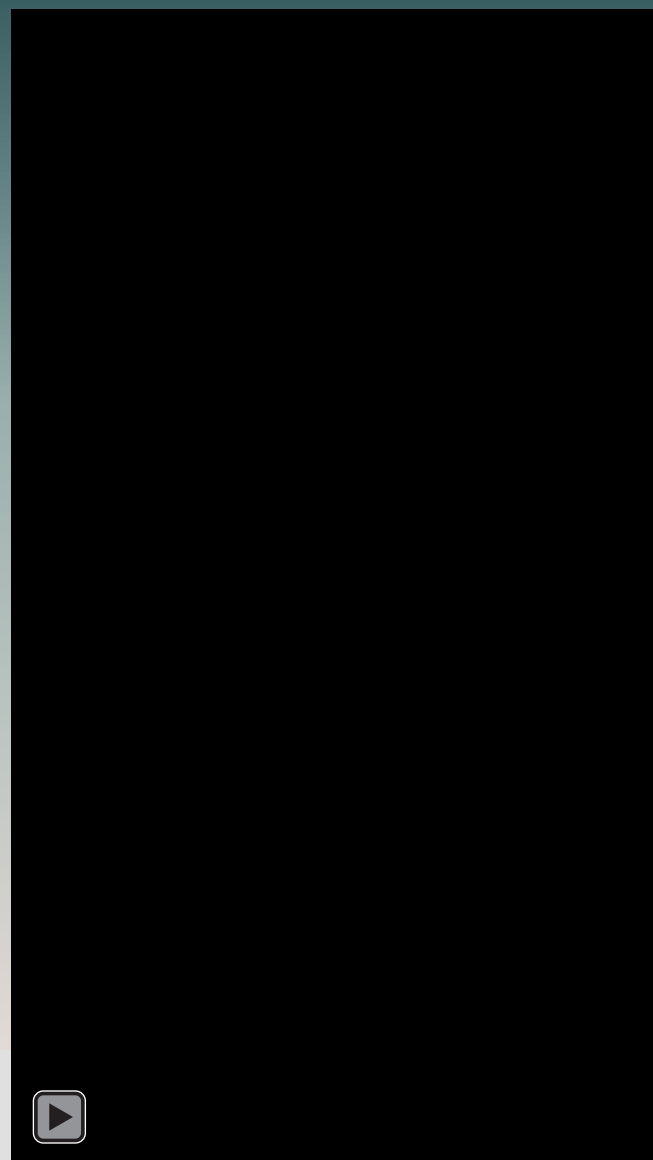
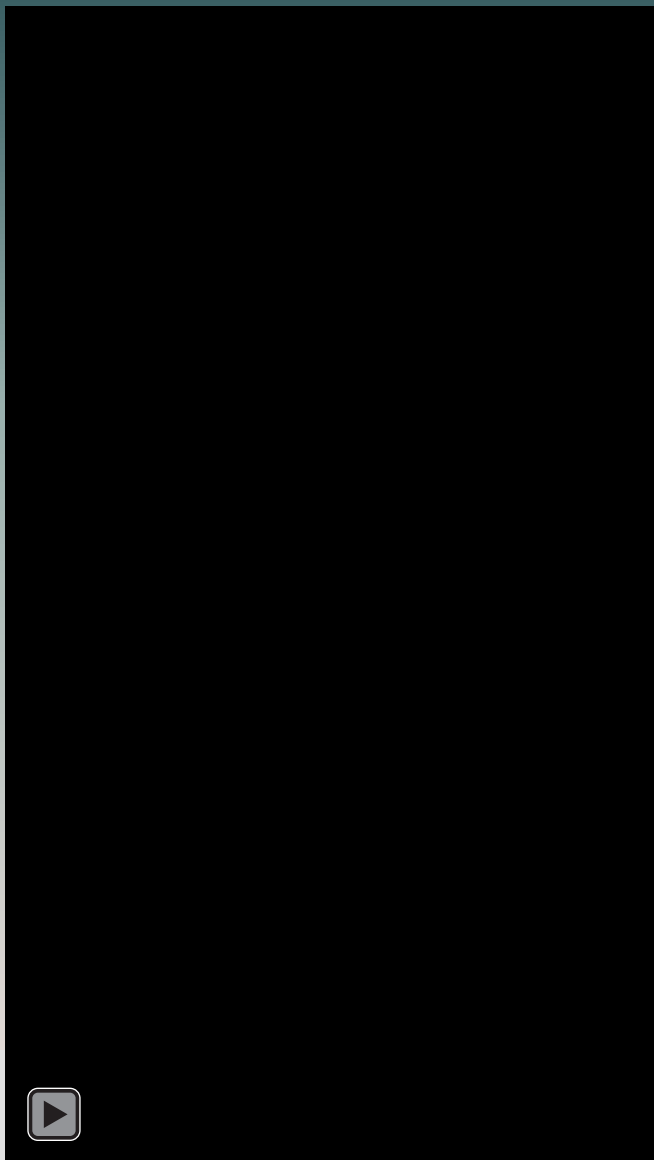


# What is the Problem ?

## Willamson Co. I-840



# What is the Problem ?



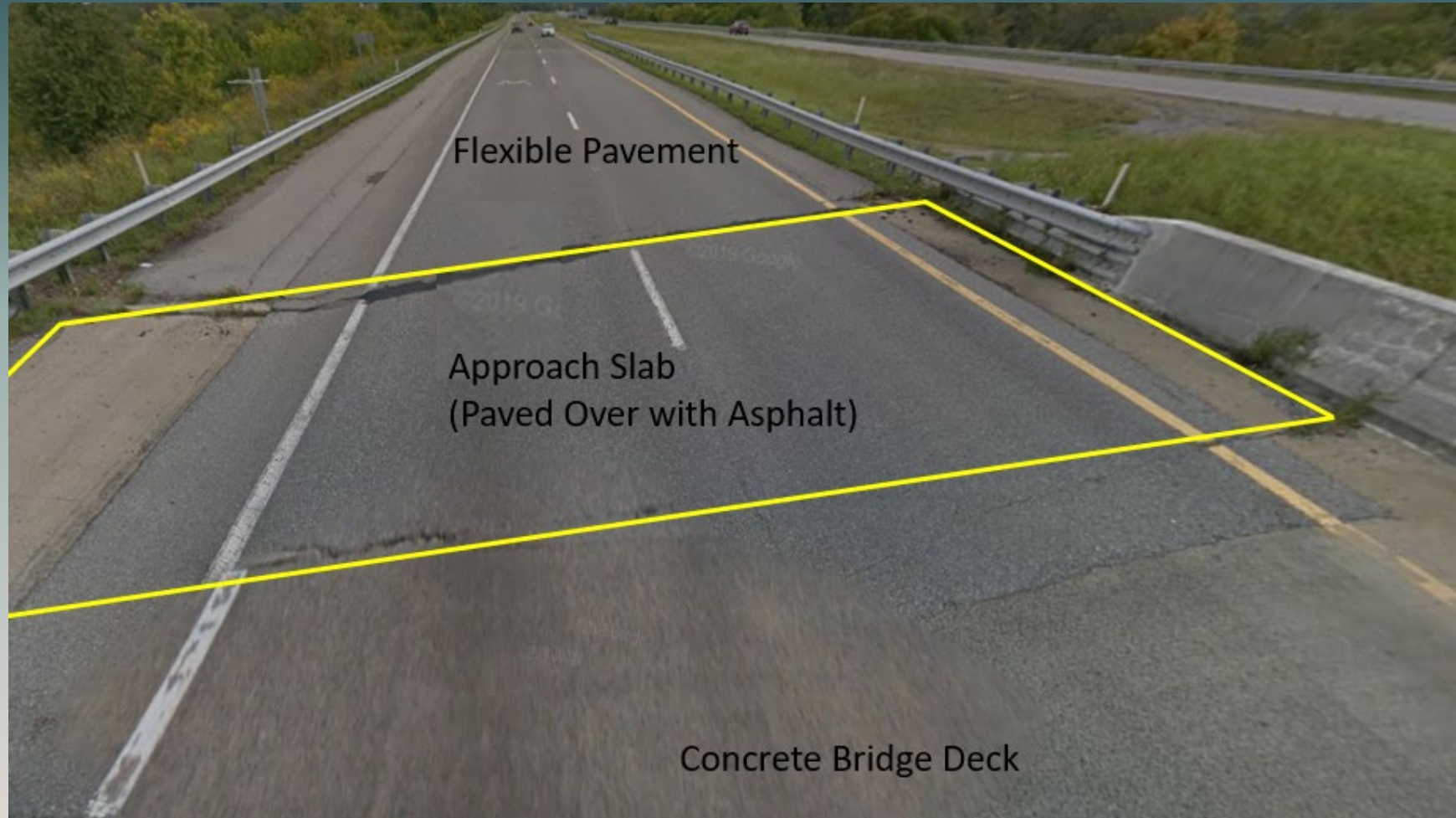
# What is the Problem ?



*Smoothing the Bump at the End of the Bridge (presentation for ASCE) , Kniazewycz, T.A., September, 2020*

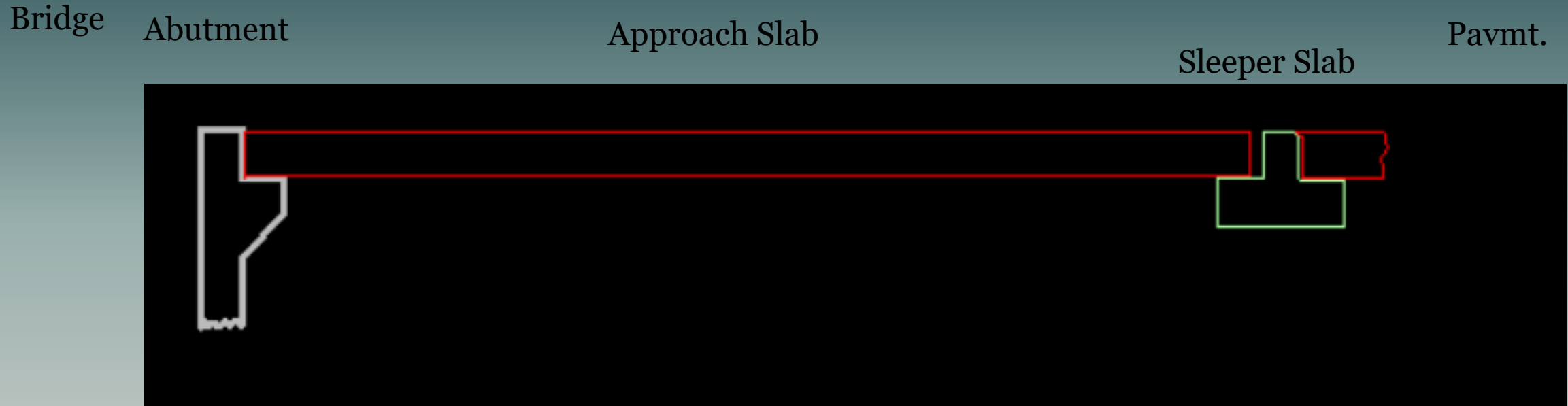


# What is the Problem ?



*Smoothing the Bump at the End of the Bridge (presentation for ASCE) , Kniazewycz, T.A., September, 2020*

# What is the Problem ?



*Smoothing the Bump at the End of the Bridge (presentation for ASCE) , Kniazewycz, T.A., September, 2020*

# What is the Problem ?





# What is the Problem ?



The Bump at the  
end of the

end of the road right a bump at the end of the  
road right there and it's a bit problematic for

*Image: The Bump at the End of a Bridge, YouTube Video, Tall Bridgeguy, May, 2023.*

# What is the Problem ?

Problem: Concrete Bridge Approach Slab Cracks

# Why Should We Care?



# Why Should We Care?

TDOT receives numerous complaints



# Why Should We Care?

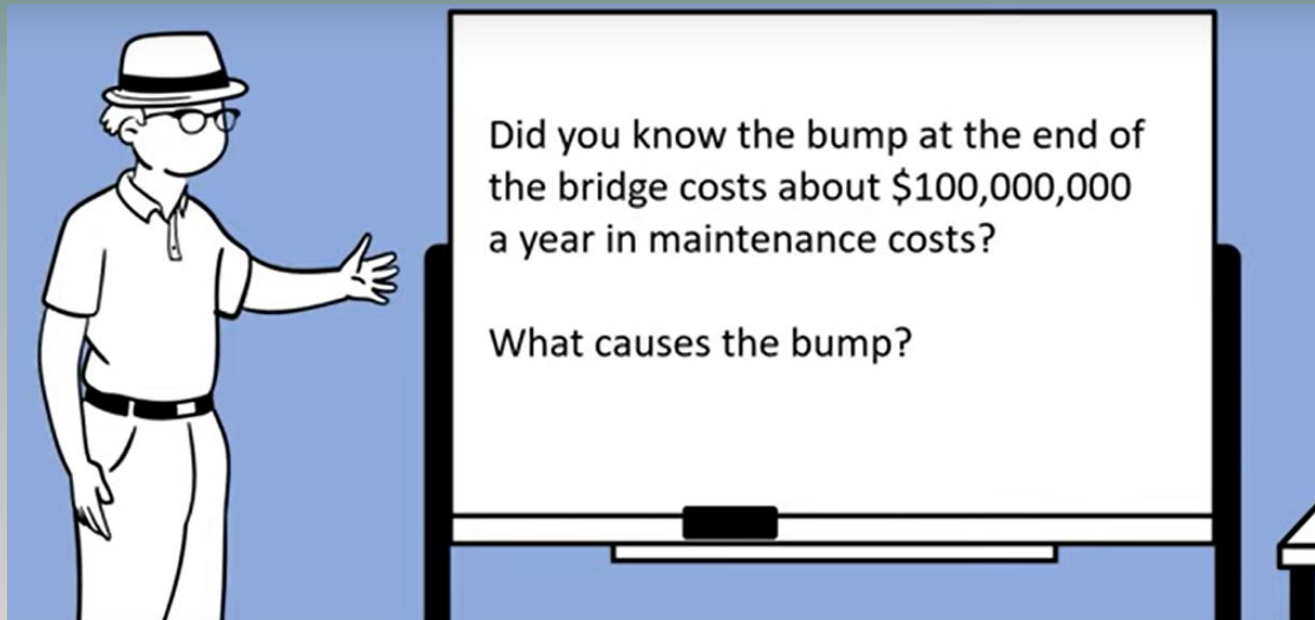
Safety

# Why Should We Care?

Damages vehicles

# Why Should We Care?

Cost: Most research documents \$100M repair per year

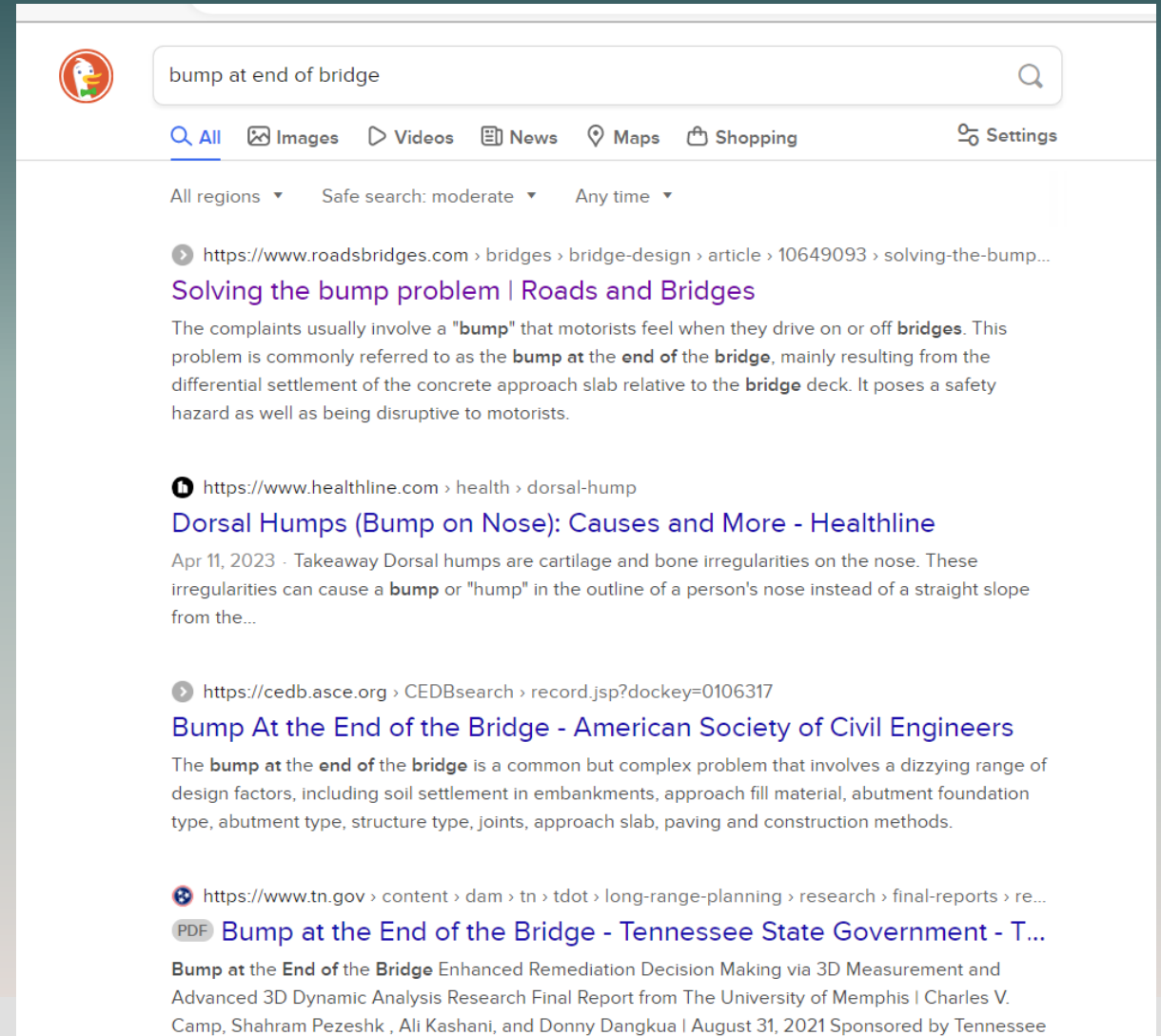


*Image: The Bump at the End of a Bridge, YouTube Video, Tall Bridgeguy, May, 2023.*

# How is it Caused?

# How is it Caused?

- Countless research has been sponsored over the years
- Use any Search engine...type in 'bump at end of bridge'



The screenshot shows a search engine interface with the query "bump at end of bridge" entered in the search bar. The search bar includes a magnifying glass icon and a search button. Below the search bar, there are navigation options: "All", "Images", "Videos", "News", "Maps", "Shopping", and "Settings". The search results are filtered by "All regions", "Safe search: moderate", and "Any time".

The first search result is from <https://www.roadbridges.com> with the title "Solving the bump problem | Roads and Bridges". The snippet reads: "The complaints usually involve a **'bump'** that motorists feel when they drive on or off **bridges**. This problem is commonly referred to as the **bump at the end of the bridge**, mainly resulting from the differential settlement of the concrete approach slab relative to the **bridge** deck. It poses a safety hazard as well as being disruptive to motorists."

The second search result is from <https://www.healthline.com> with the title "Dorsal Humps (Bump on Nose): Causes and More - Healthline". The snippet reads: "Apr 11, 2023 · Takeaway Dorsal humps are cartilage and bone irregularities on the nose. These irregularities can cause a **bump** or 'hump' in the outline of a person's nose instead of a straight slope from the..."

The third search result is from <https://cedb.asce.org> with the title "Bump At the End of the Bridge - American Society of Civil Engineers". The snippet reads: "The **bump at the end of the bridge** is a common but complex problem that involves a dizzying range of design factors, including soil settlement in embankments, approach fill material, abutment foundation type, abutment type, structure type, joints, approach slab, paving and construction methods."

The fourth search result is from <https://www.tn.gov> with the title "Bump at the End of the Bridge - Tennessee State Government - T...". The snippet reads: "Bump at the End of the Bridge Enhanced Remediation Decision Making via 3D Measurement and Advanced 3D Dynamic Analysis Research Final Report from The University of Memphis | Charles V. Camp, Shahram Pezeshk , Ali Kashani, and Donny Dangkoa | August 31, 2021 Sponsored by Tennessee"



# How is it Caused?

## DOT Syntheses Results

- Differential Settlement
  1. Foundation (Natural) Soils
  2. Embankment Soils
  3. Bridge\Pavement Interface
- Horizontal Movement

NCHRP Synthesis 234

Settlement of Bridge Approaches  
(The Bump at the End of the Bridge)

TABLE 2

CAUSES OF BRIDGE APPROACH PROBLEMS CATEGORIZED (after 29)

*Differential Settlement*

Compression of natural soils

Primary consolidation, secondary compression, and creep

Compression of embankment soils

Volume changes and distortional movements/creep of embankment soils

Local compression at bridge/pavement interface

Inadequate compaction at bridge/pavement interface, drainage and erosion problems, rutting/distortion of pavement section, traffic loading, and thermal bridge movements

*Movement of Abutments*

Vertical movement

Settlement of soil beneath, downdrag, erosion of soil beneath and around abutment

Horizontal movement

Excessive lateral pressures, thermal movements, swelling pressures from expansive soils, and lateral deformation of embankment and natural soils

*Design/Construction Problems*

Engineer-related

Improper materials, lift thickness, and compaction requirements

Contractor-related

Improper equipment, overexcavation for abutment construction, and survey/grade errors

Inspector-related/Poor quality control

Lack of inspection personnel and improper inspection personnel training

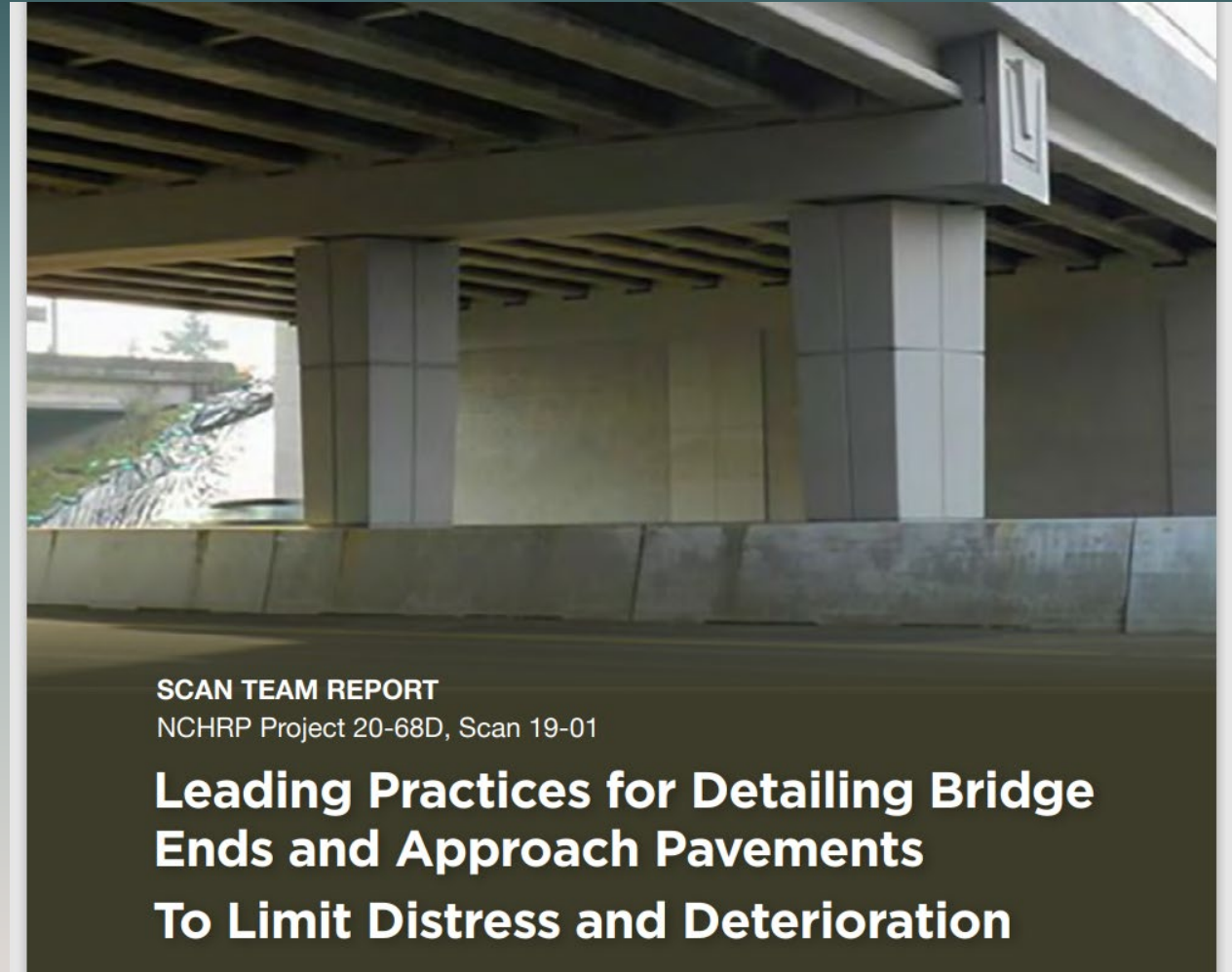
Design-related

No provision for bridge expansion/contraction spill-through design resulting in the migration of fill material from behind the abutment

# How is it Caused?

## SCAN Team Rpt 20-19

- Prepared by twelve state DOT's
- Different than Syntheses

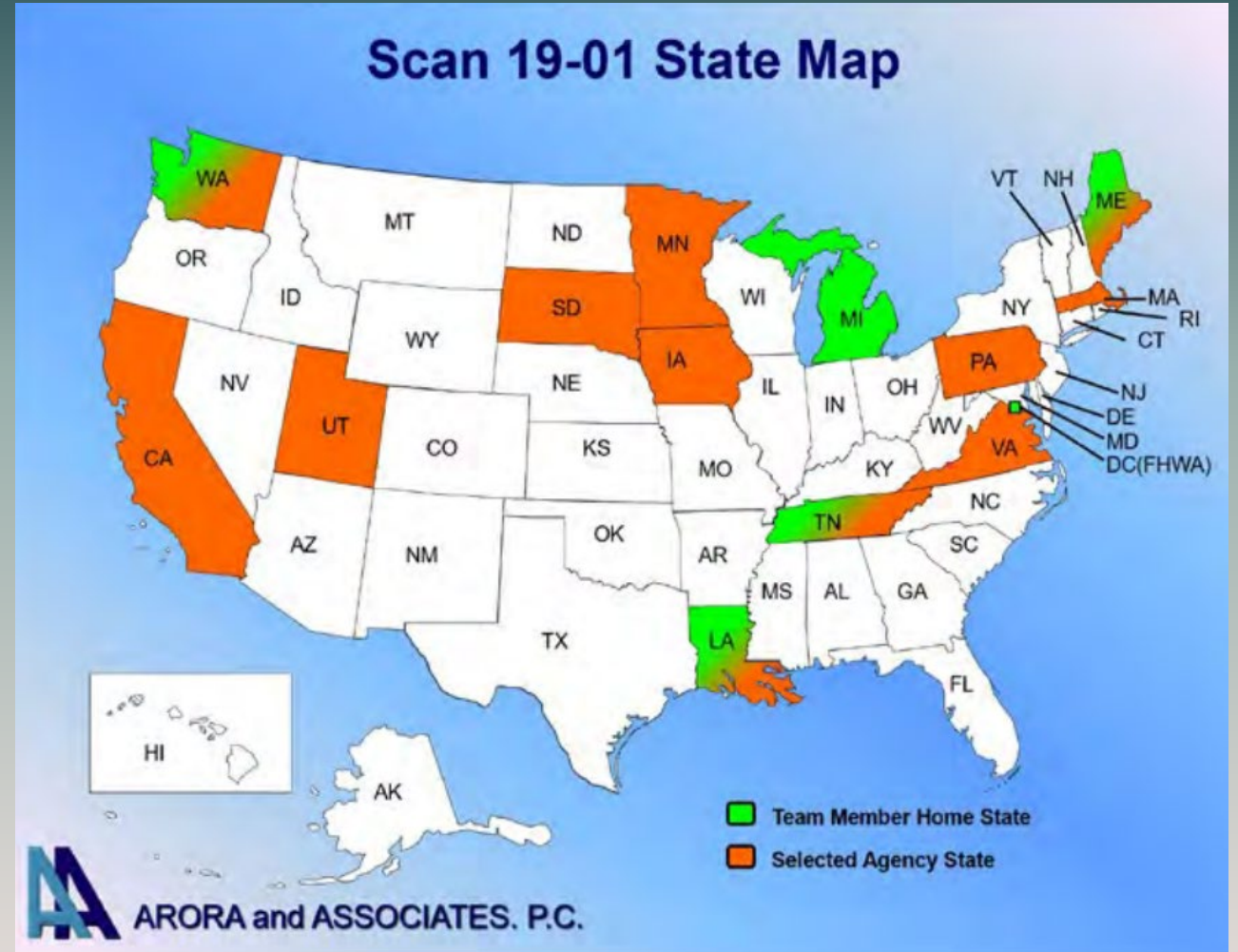


*Scan Team Report 19-01, NCHRP Project 20-68D, Leading Practices for Detailing Bridge Ends and Approach Pavements to Limit Distress and Deterioration, DeRuyver, J., Eaton, D., Garcia, R.R., October, 2020*

# How is it Caused?

SCAN Team Rpt 20-19

- Participating DOTs
- Including TDOT Ted Kniazewycz

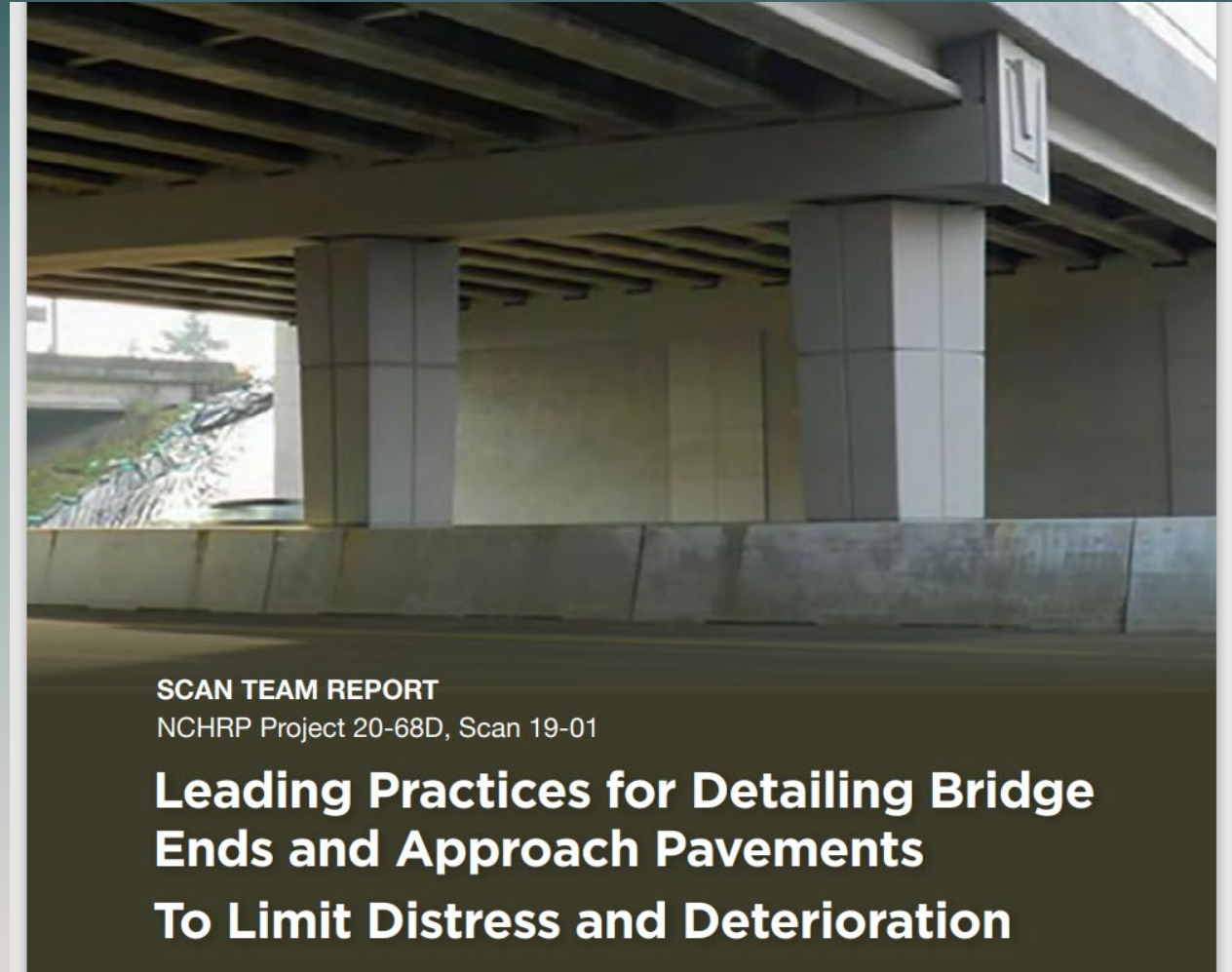


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# How is it Caused?

## SCAN Team Rpt 20-19

- Preference to eliminate bridge deck joints
- Thus transfer movement to bridge ends.



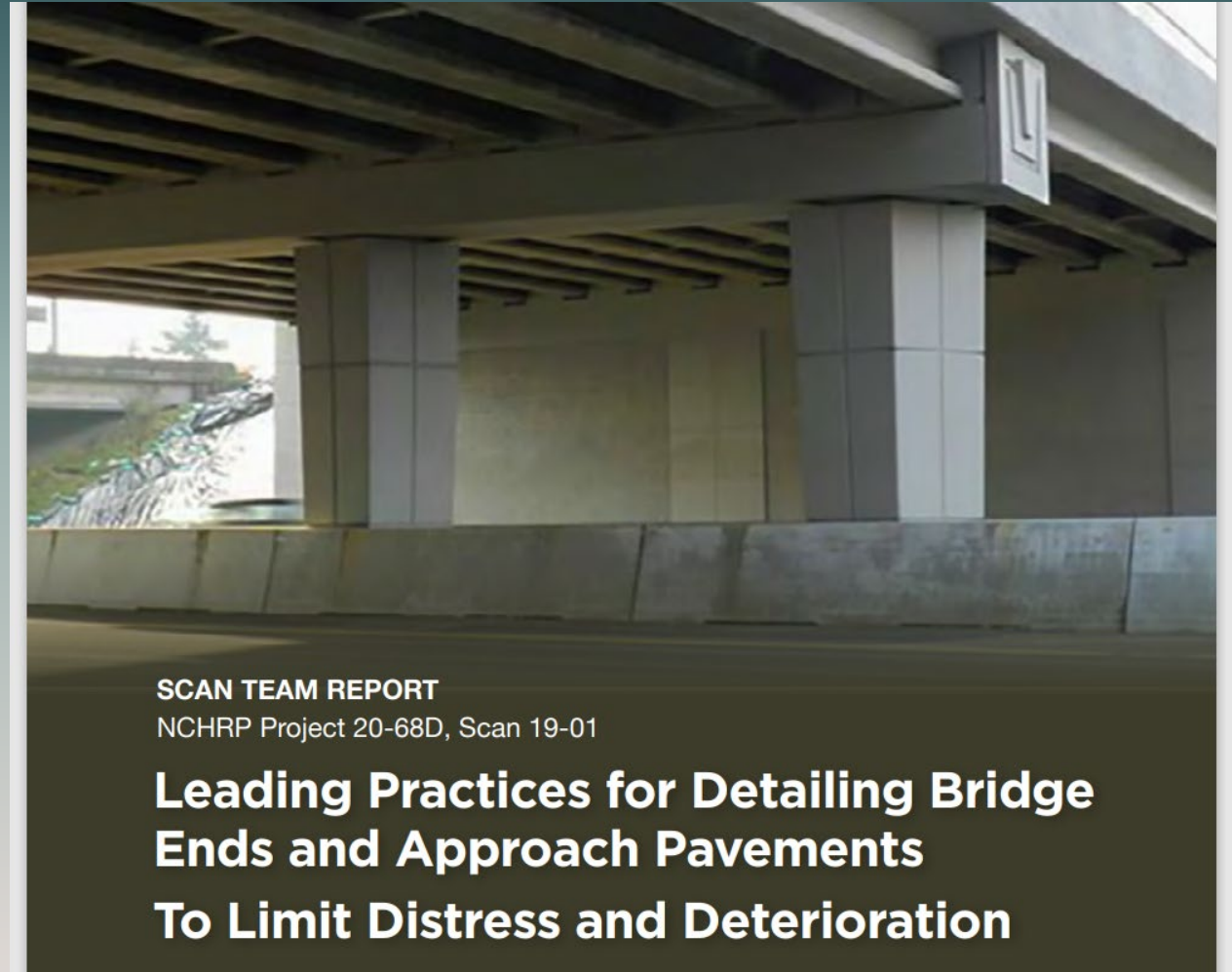
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# How is it Caused?

SCAN Team Rpt 20-19

- “Drainage” is key to longevity

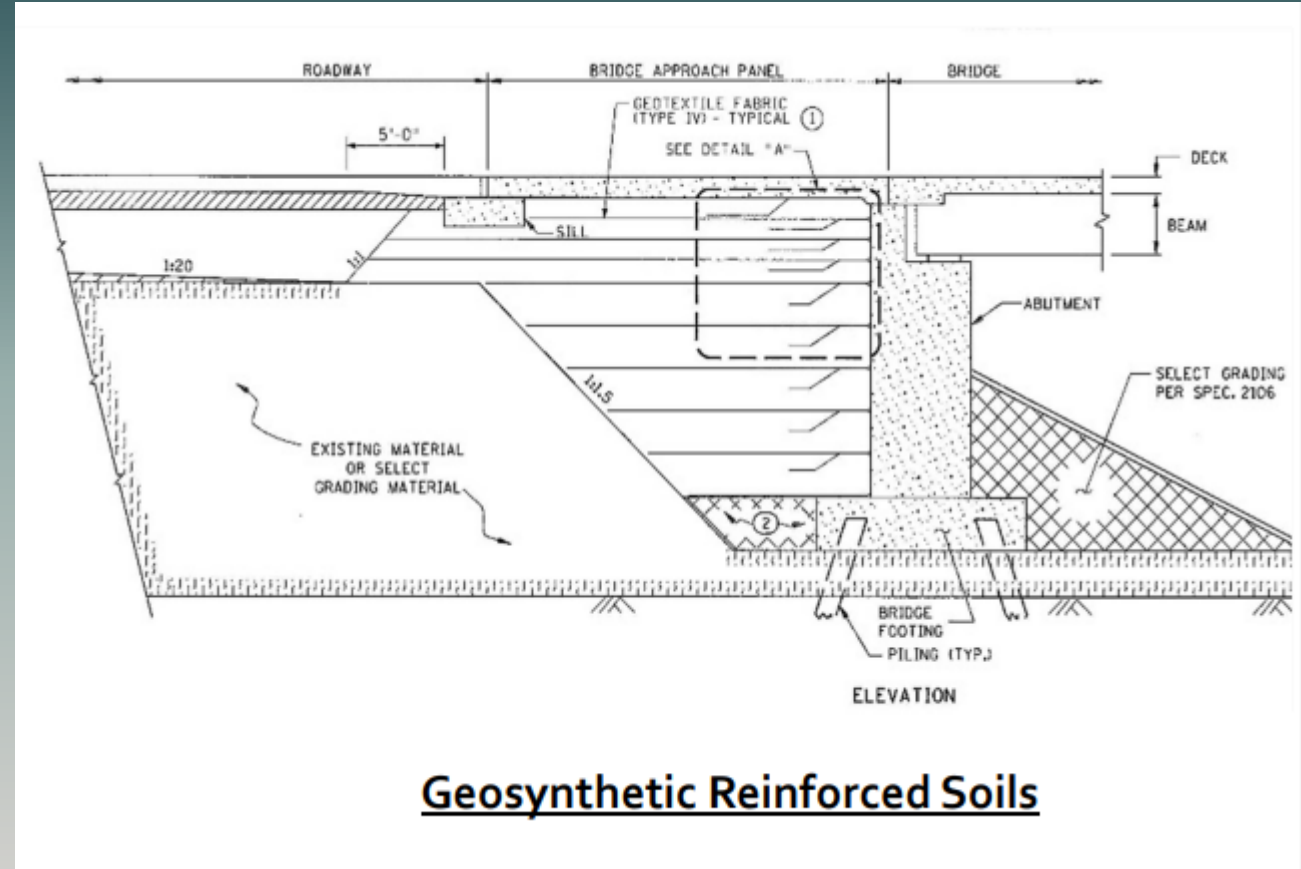


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# How is it Caused?

SCAN Team Rpt 20-19

- Inspiration of TDOT Std Dwgs



# How is it Caused?



University of Kansas' first place entry to the 2020 ASCE G-I Geo-Congress

*Bump at the End of the Bridge, The University of Kansas: Bump at the end of bridge - YouTube, 2020*



# How is it Caused?

## DOT Syntheses Results

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Design-related

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# How is it Caused?

## I-840 Abutment Wall

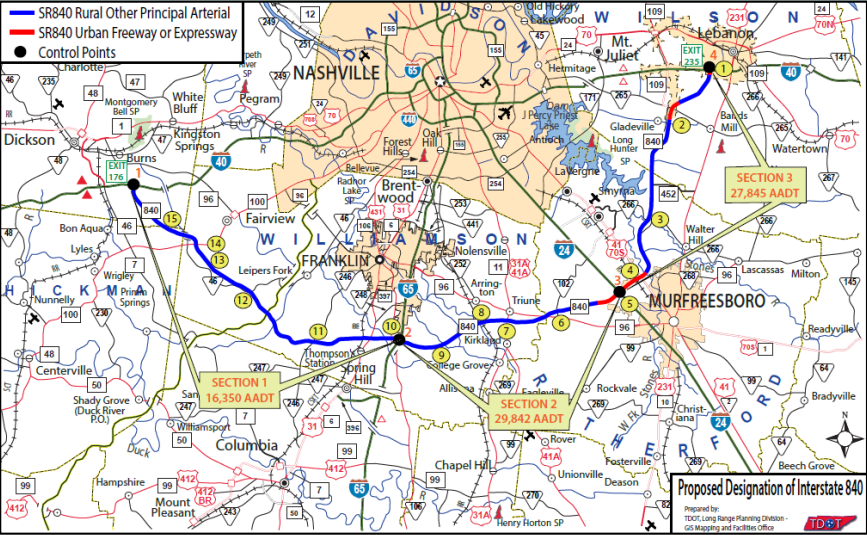


Photo: Rivers, B. 08/19/2021



# How is it Caused?

SR-14, Shelby Co.  
Abutment Wall



*Photo: Jowers, R. 10/07/2022*



# How is it Caused?

SR-14, Shelby Co.  
Abutment Wall



*Photo: Jowers, R. 10/07/2022*



# How is it Caused?

SR-14, Shelby Co.  
Abutment Wall



*Photo: Jowers, R. 10/07/2022*



# How is it Caused?

SR-14, Shelby Co.  
Abutment Slab



*Photo: Jowers, R. 10/07/2022*



# What is TDOT doing to Fix It ?

# What is TDOT doing to Fix It ?



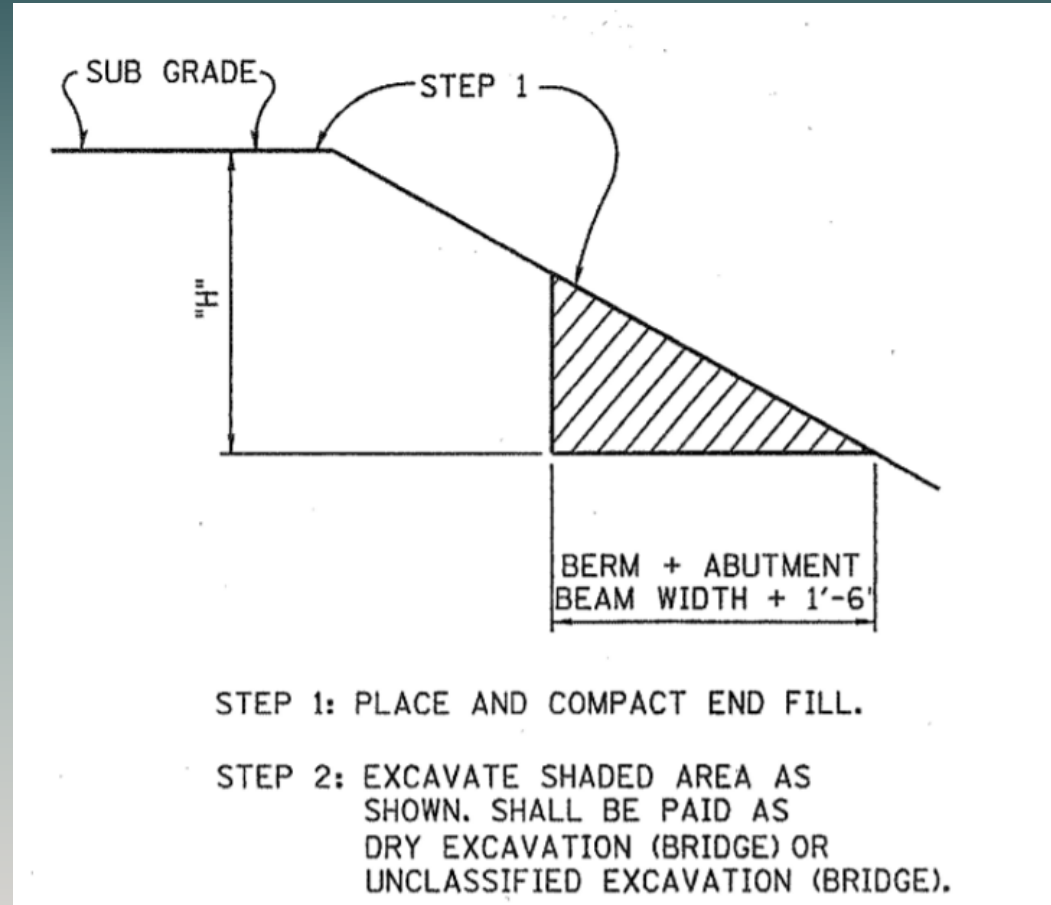
## Smoothing the Bump at the End of the Bridge

September 24, 2020

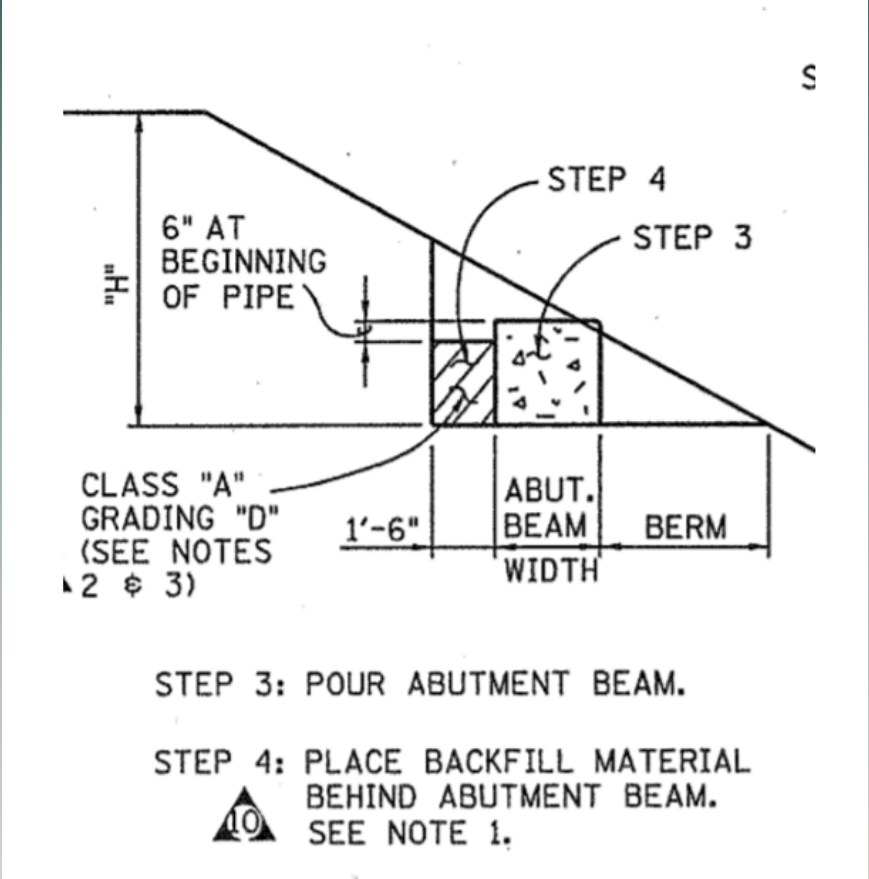
Ted A. Kniazewycz, P.E. – Civil Engineering Director – Structures Division

*Smoothing the Bump at the End of the Bridge (presentation for ASCE) , Kniazewycz, T.A., September, 2020*

# What is TDOT doing to Fix It ?



# How is it Caused?

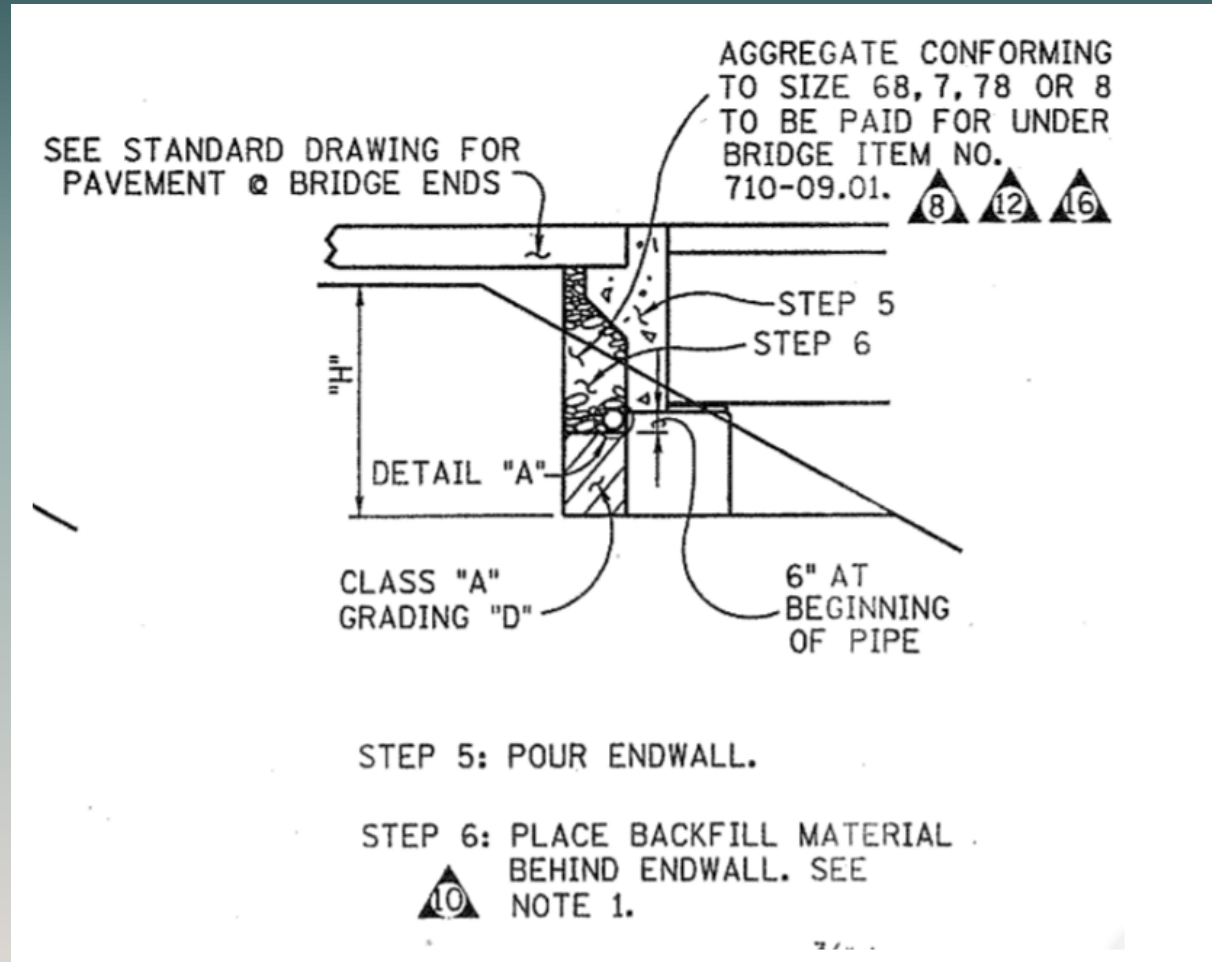


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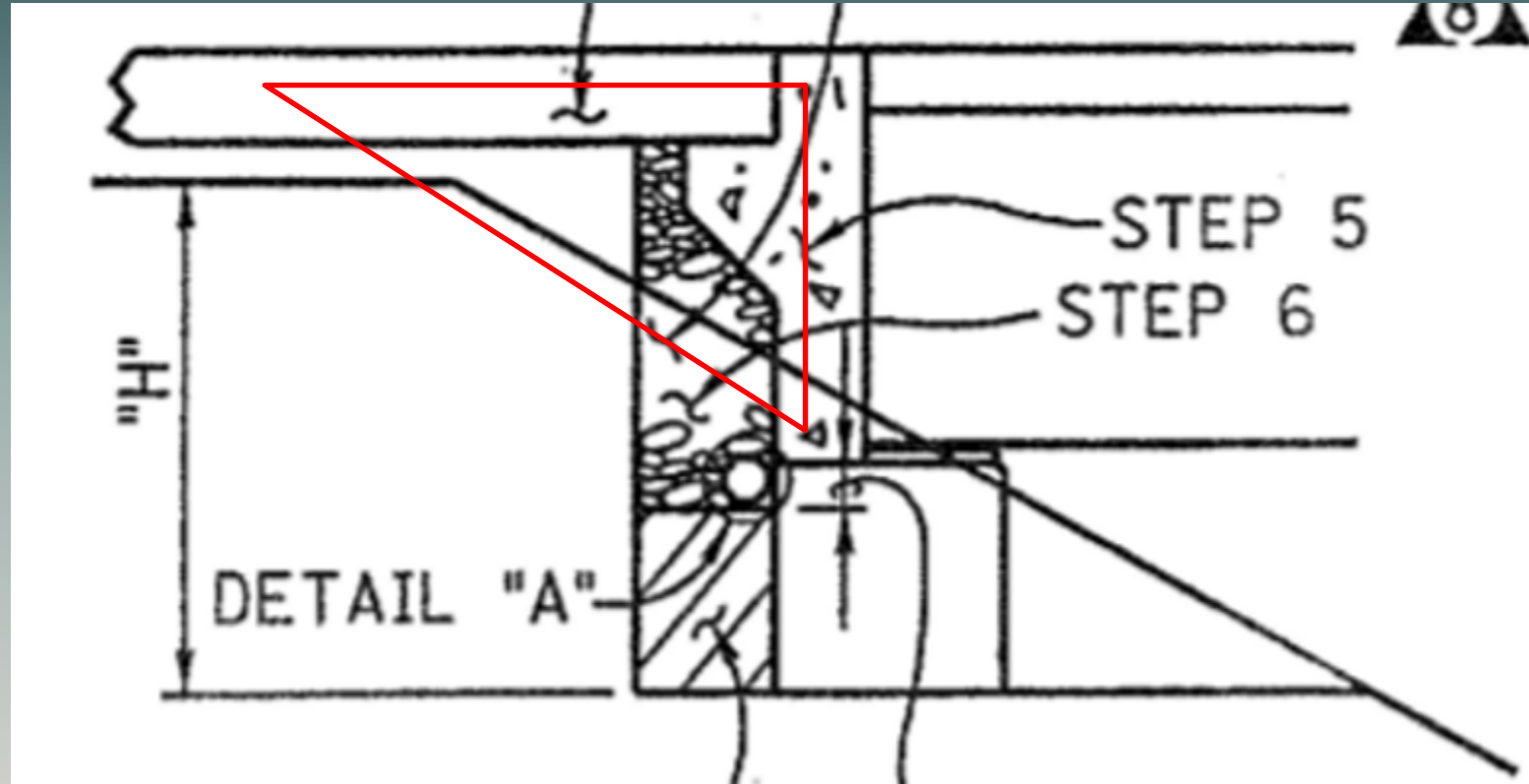
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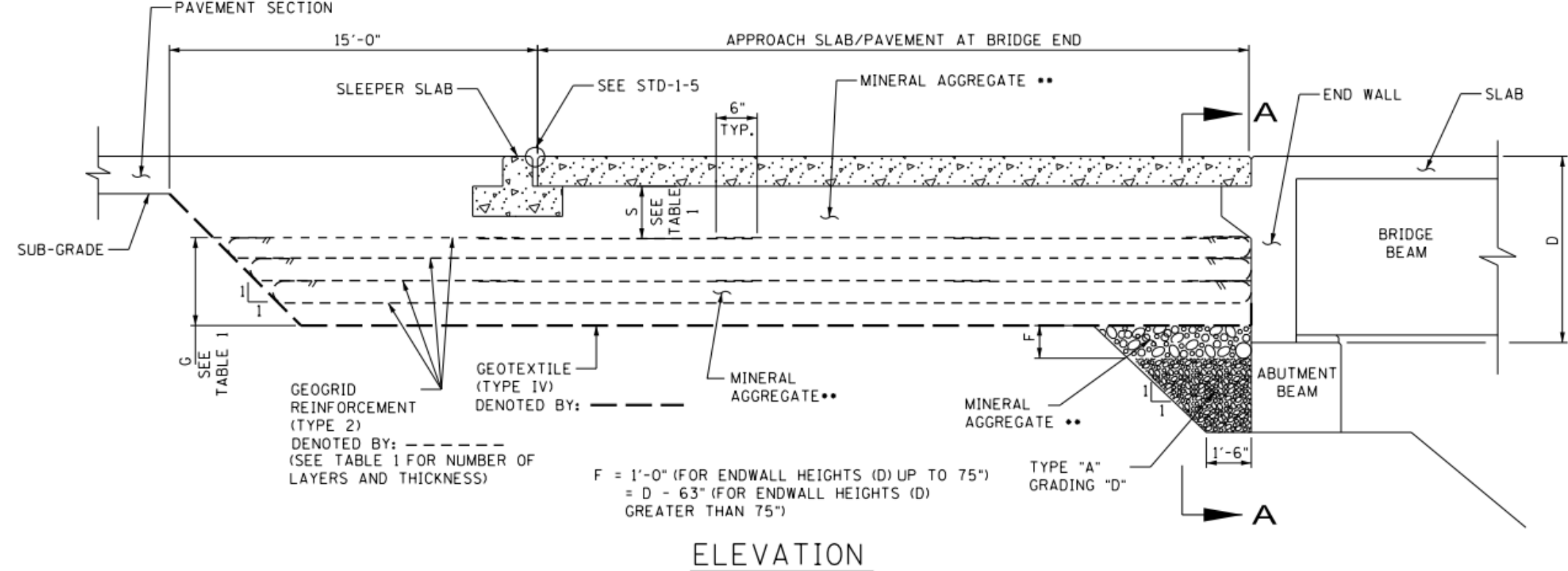




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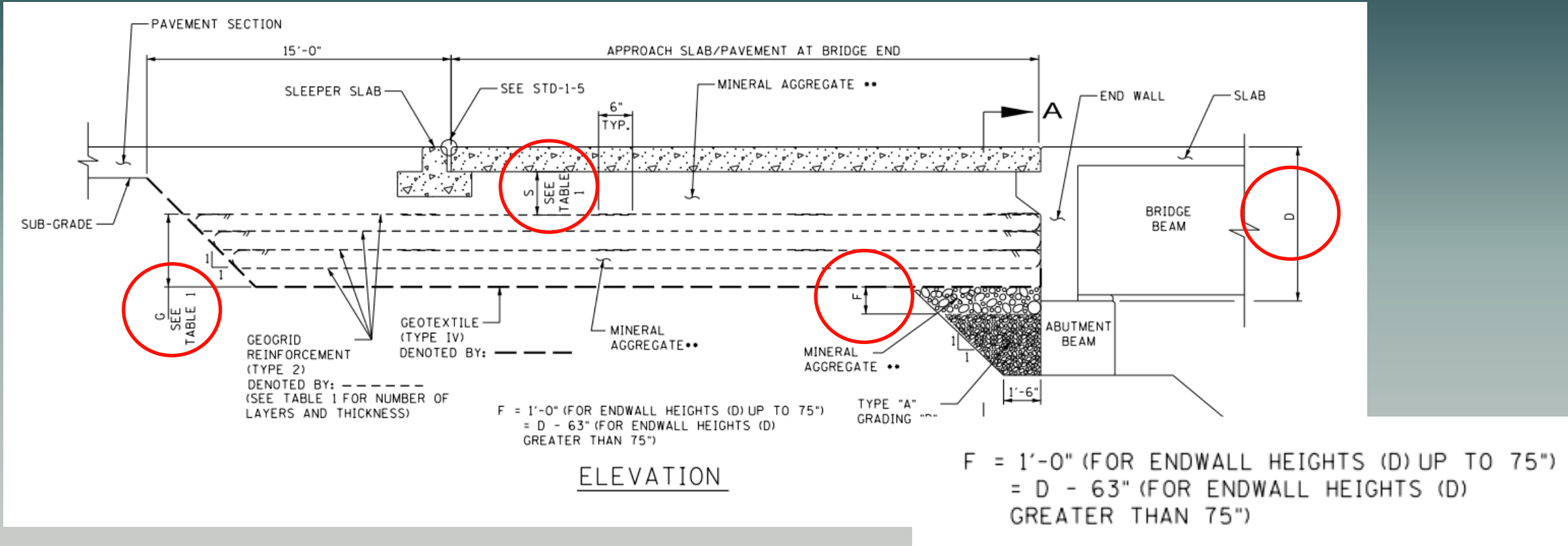


# What is TDOT doing to Fix It ?



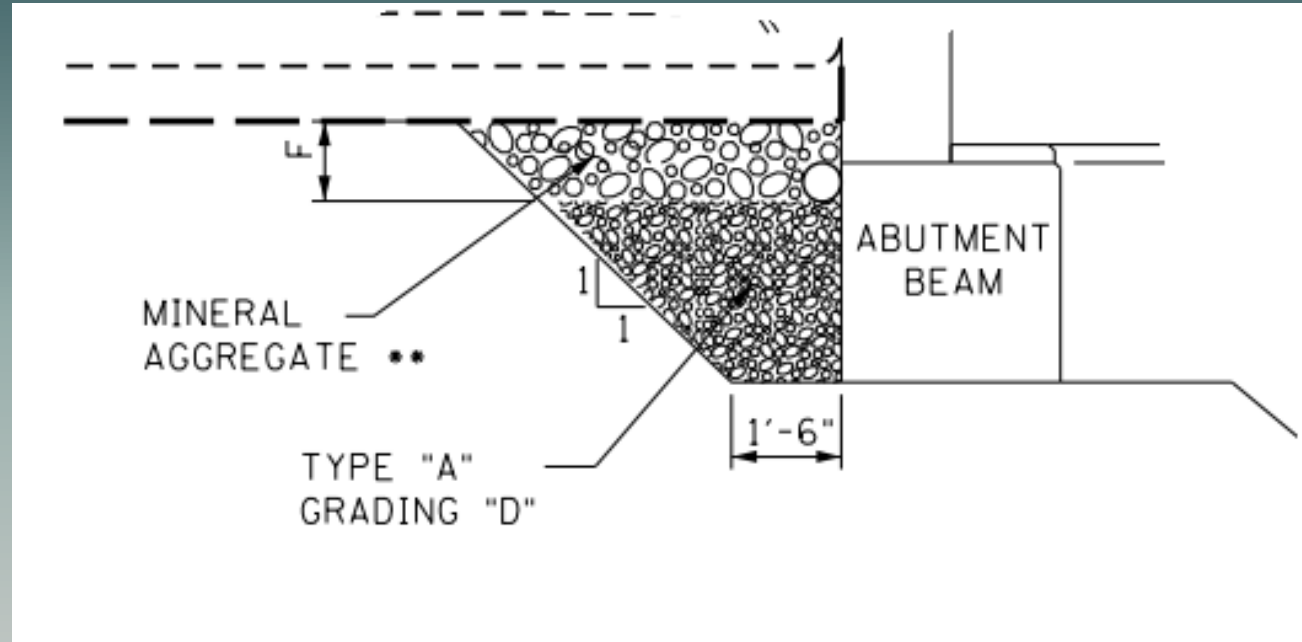
- STD-10-2 Misc. Abutment and Pavement at Bridge Ends Backfill Details, 2020
- Being implemented on new bridge projects and Resurfacing projects (as deemed necessary)
- Application is known as PABE (pavement at bridge ends) by Bridge Rehab unit

# What is TDOT doing to Fix It ?



- Overly with Graded Stone and a perforated pipe

# What is TDOT doing to Fix It ?



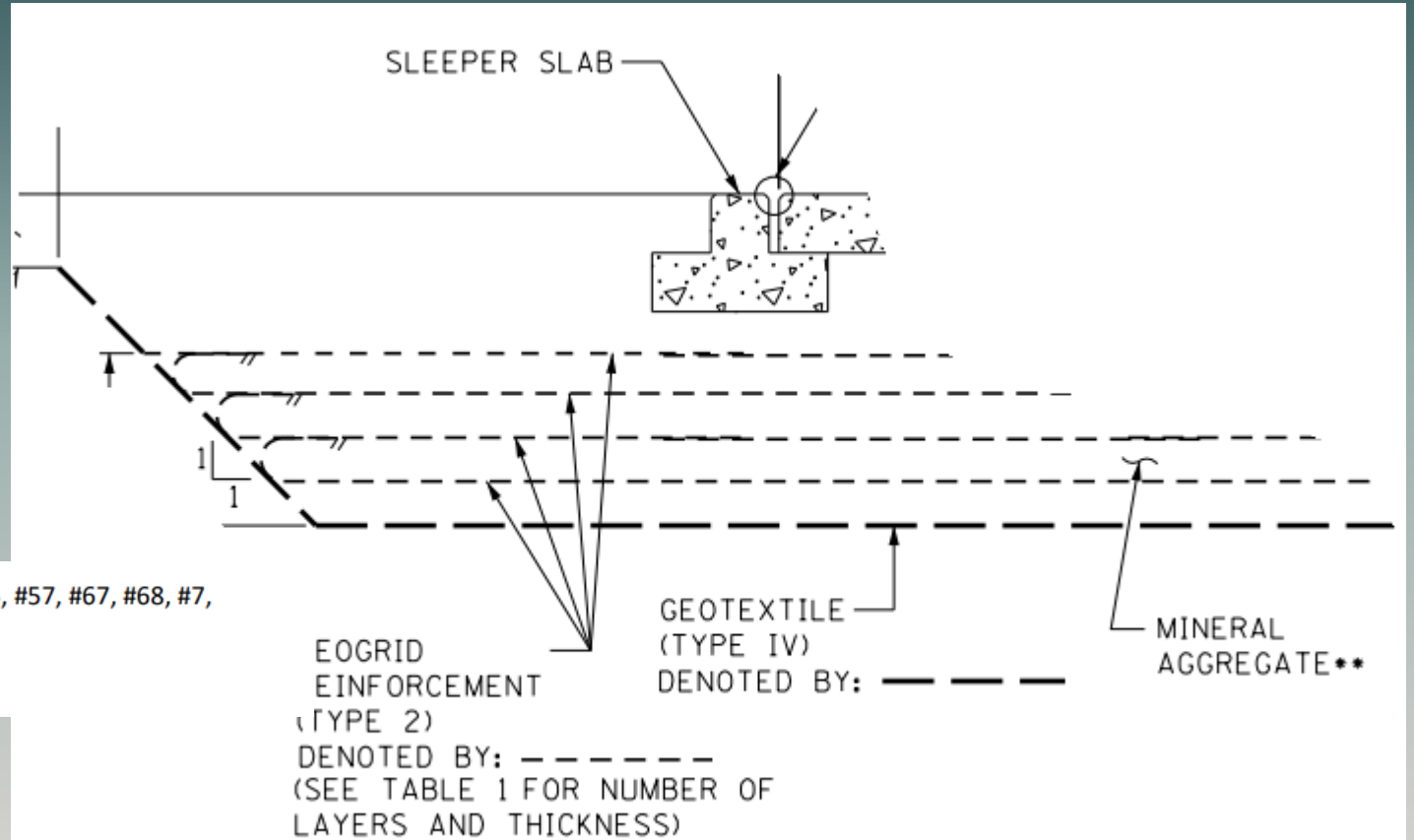
- 301-01 Base Stone –Behind abutment beam (less permeable)
- How Deep ?  $D = S + G + F$

# What is TDOT doing to Fix It ?

## ROADWAY PAY ITEMS

303-10.04	MINERAL AGGREGATE (SIZE **)	-----	TON
740-10.04	GEOTEXTILE (TYPE IV) (STABILIZATION)	-----	S.Y.
740-07.04	GEGRID REINFORCEMENT TYPE 2	-----	S.Y.

\*\* ALLOWABLE GRADATIONS FOR THE MINERAL AGGREGATE BACKFILL ARE #4, #5, #57, #67, #68, #7, #78, AND #8.



- Geosynthetics \ Stone
- Type 2 equivalents -Tencate\Mirafi 10XT, StrataSG1200, Huesker Fortrac110T



# What is TDOT doing to Fix It ?



- 840 Abutment Approach ReWork

*Image: Region 3 TDOT*



# What is TDOT doing to Fix It ?



- 840 Abutment Approach ReWork

*Image: Region 3 TDOT*



# What is TDOT doing to Fix It ?



*Image: Region 3 TDOT*

- 840 Abutment Approach ReWork

# What is TDOT doing to Fix It ?

- Roadway Profiler

- Measures IRI value
- Resurfacing projects must meet minimum

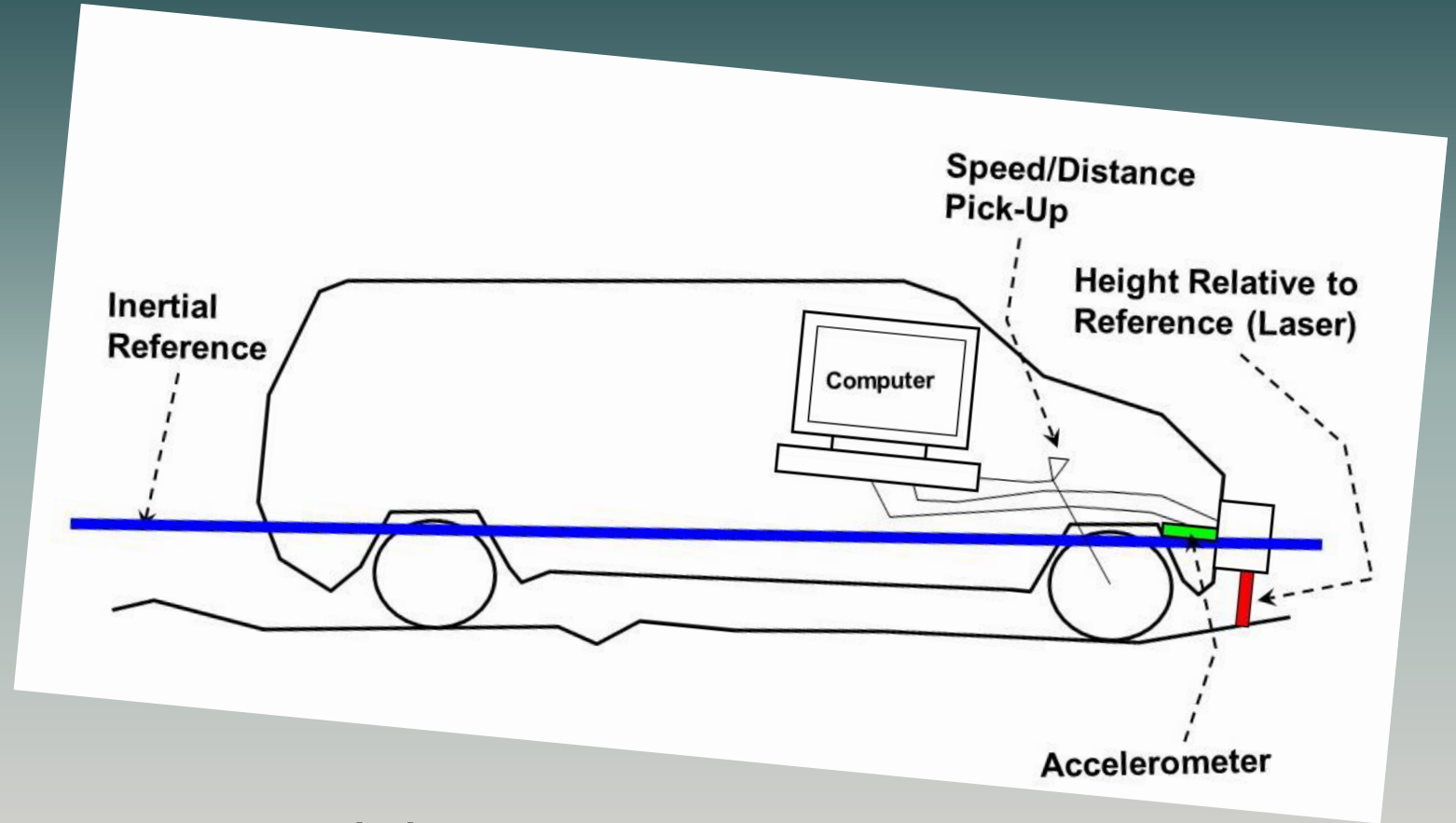


Image credit: TDOT Materials and Tests

# What is TDOT doing to Fix It ?

- IRI – International Roughness Index
  - ASTM measurement of road surface roughness, typically in inches per mile in the US.
  - The lower the IRI, the smoother. The higher the IRI, the rougher.
  - FHWA IRI Categories, anything over 170 is unacceptable.
  - TDOT specifications for Mean Roughness for a bridge, including the approaches, is 130.

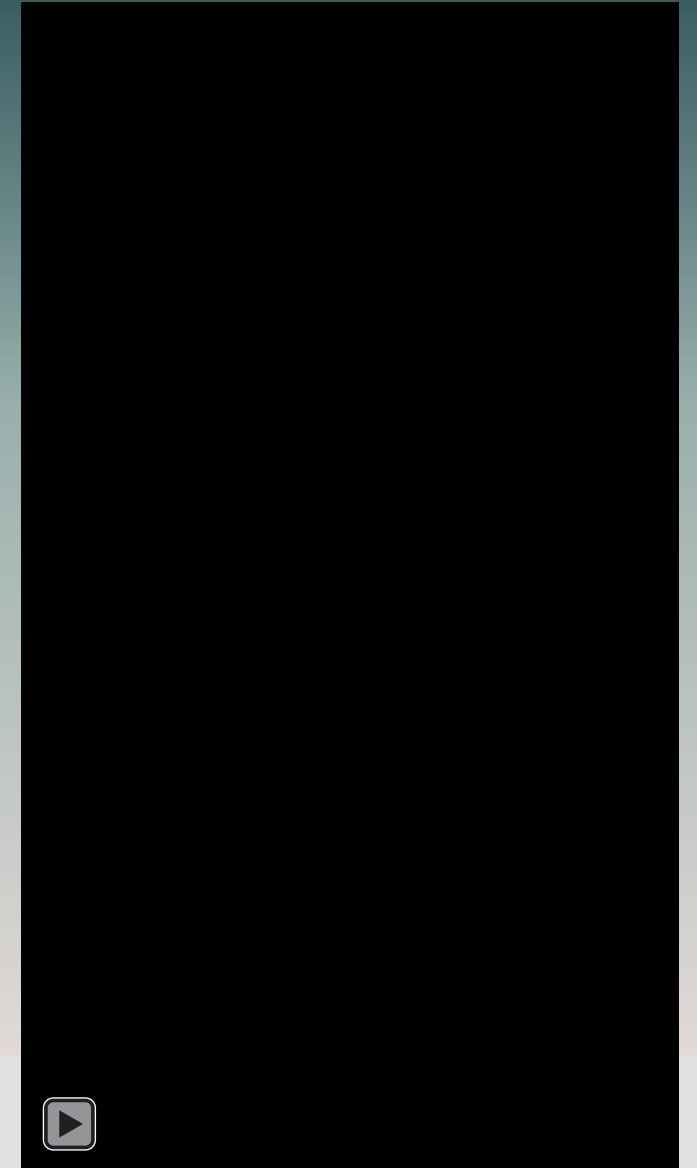
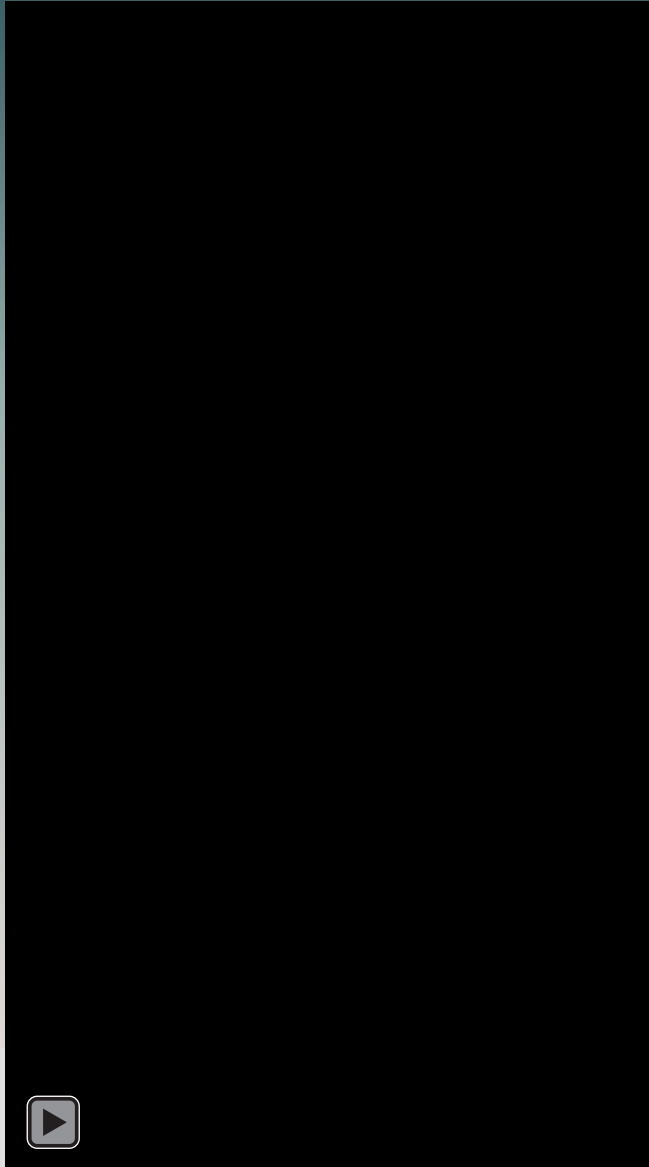




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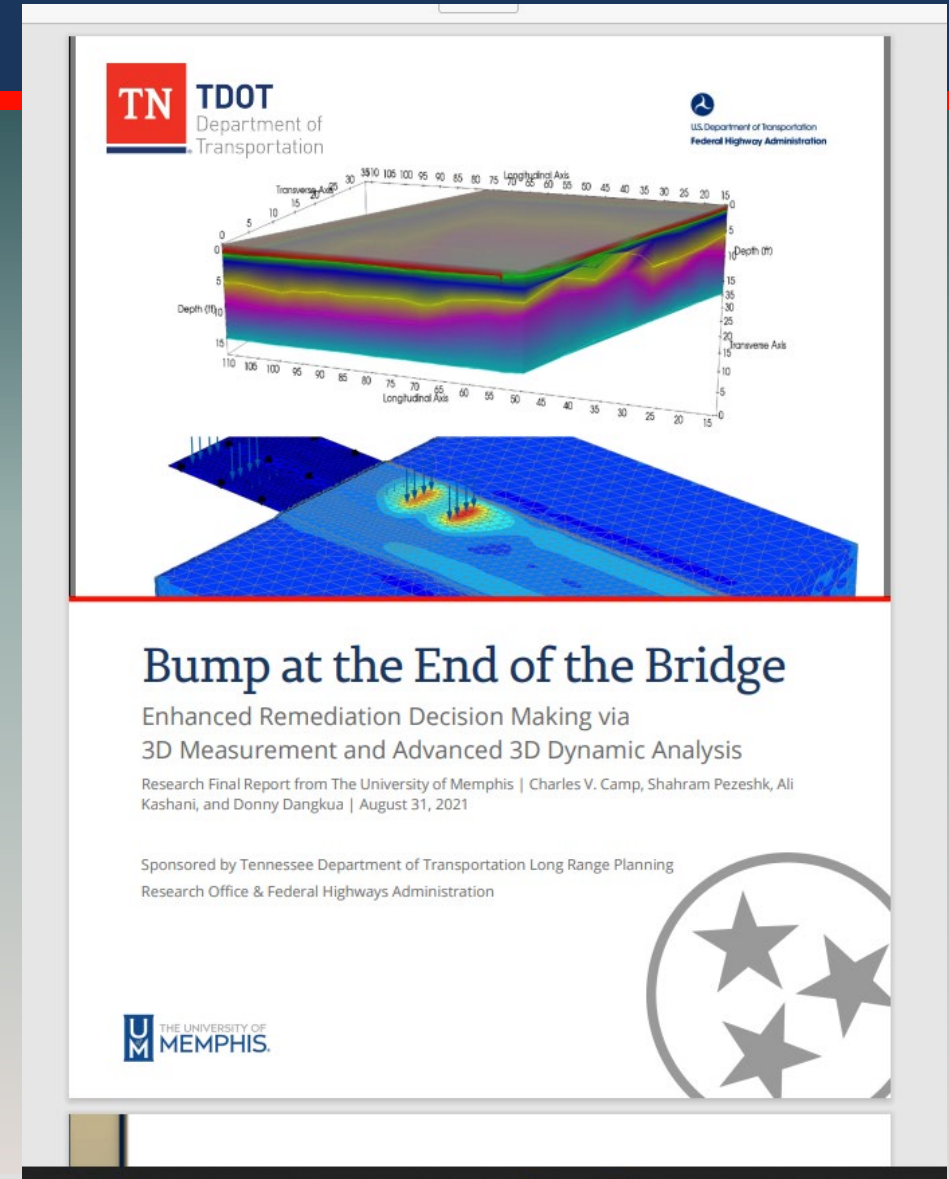
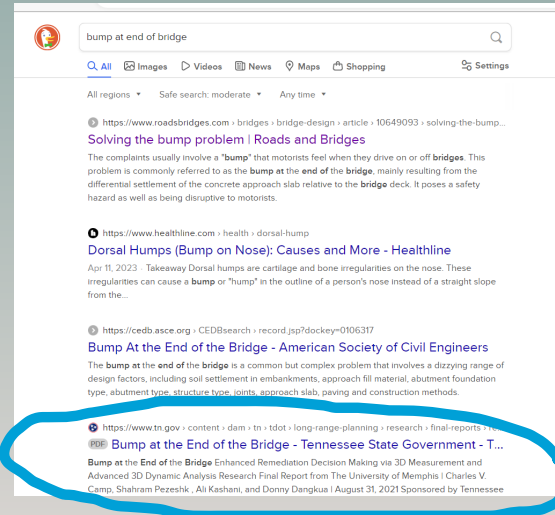
EB MM 16.5/ LM10.5

- Left: 8/13/21 \ IRI 950
- Right: 3/23/23 \ IRI 425



# What is TDOT doing to Fix It ?

- UM performed Research
  - Performed GPR on approach slab
  - Analyzed using finite elements



*Bump at the End of the Bridge, Enhanced Remediation Decision Making via 3D Measurement and Advanced 3D Dynamic Analysis, Camp, L., 2020*

# What is TDOT doing to Fix It ?

- Higher IRI scores could justify GPR prior to investing in reworking an abutment.
- TDOT has advertisement for pavement testing that closes 11/10/23

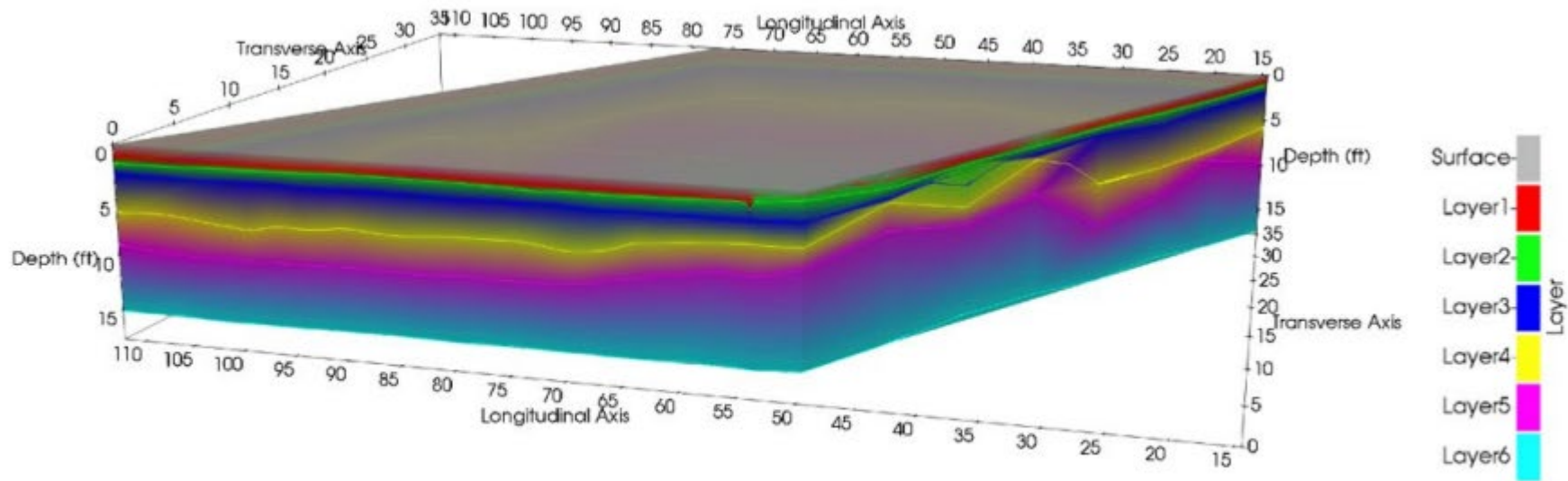


Figure 4-1. 3D soil layer model for I-269 at Fletcher Creek Bridge



## Wrapping it Up.

- Implementing TDOT's Bump End of Bridge Solution
  - Abutments on new bridges will be installed using Std Dwg 10-2
  - Abutments on Resurfacing List will be IRI evaluated for PABE

# Wrapping it Up.

## TEAMWORK

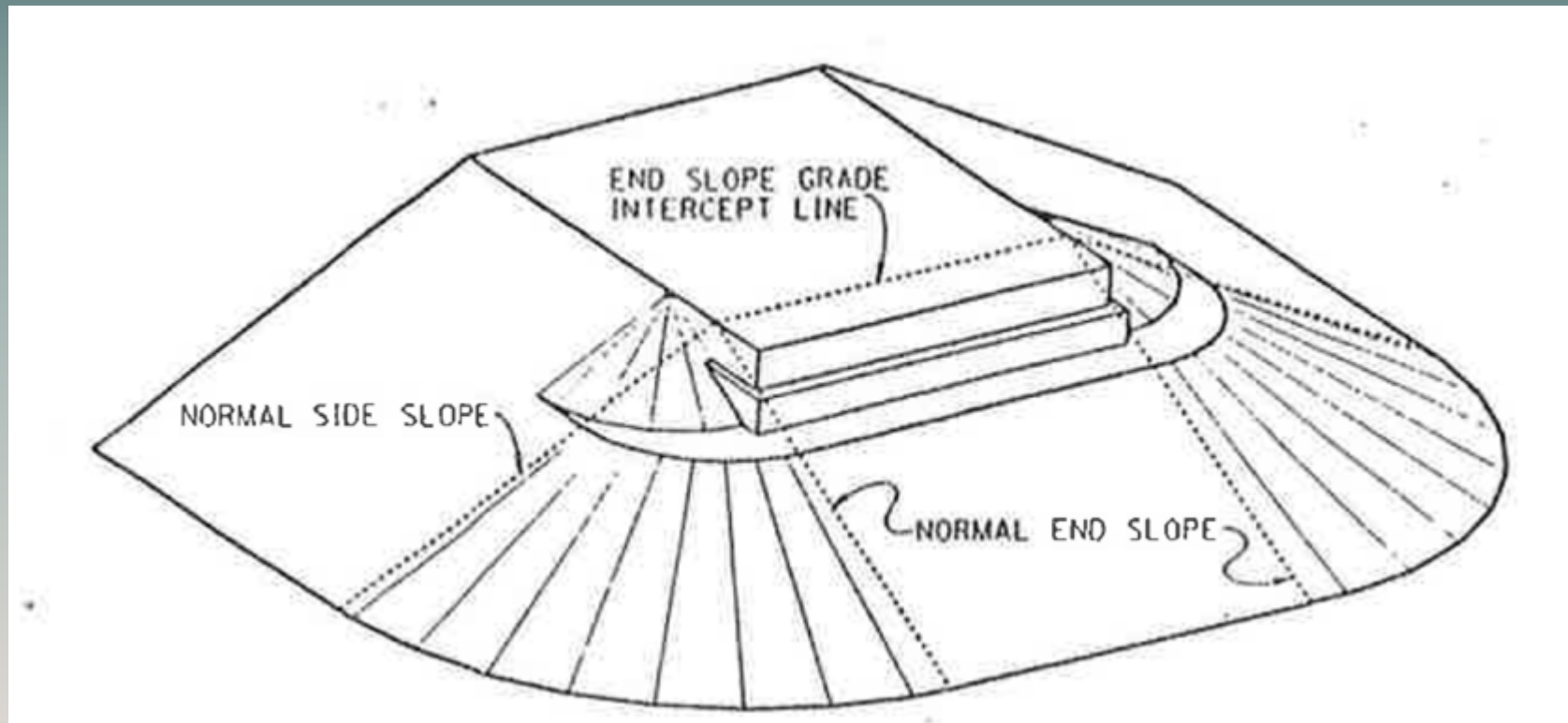
geotechnical engineering issues.

Third, teamwork and open-mindedness are very helpful. Where best practice is observed, meetings take place and information flows to all affected parties, existing approaches are challenged if they have not been successful and new approaches are considered. The bump develops at the connection between a geotechnical engineer's design—the embankment, and a structural engineer's design—the bridge. Note here that a proper foundation and embankment design should include a thorough site and soil testing investigation. Furthermore, proper construction is paramount and maintenance can be significantly impacted. The maintenance engineer, the construction engineer, the structural engineer, the pavement engineer, and the geotechnical engineer must act as a team.

Fourth, settlement calculations are carried out unless it is obvious that settlement is not a

Wrapping it Up.

# TEAMWORK



*Smoothing the Bump at the End of the Bridge (presentation for ASCE) , Kniazewycz, T.A., September, 2020*