

# Bridge Rideability: Implementing Iowa State University Research Results

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October 25, 2011

Ohio Transportation  
Engineering Conference

# Overview

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- Causes of Poor Bridge Rideability
- Iowa State University Research
- Ensuring Good Ride both Initially & Long Term
- ProVAL Demo w/ grinding simulator
- Questions

# Leading Causes of Poor Ride Across Bridges

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## *Surface Discontinuities*

- **Decks higher/lower than surrounding pavement**
- **Settlement**
  - Approach Slabs / Deep Fills
  - Drainage/erosion material loss
- **Residual Camber in surface over spans**
- **Deck roughness**
  - Construction joints & closure pours
  - Girder / Beam deformation
  - Other anomalies

# Impacts of Poor Bridge Ride

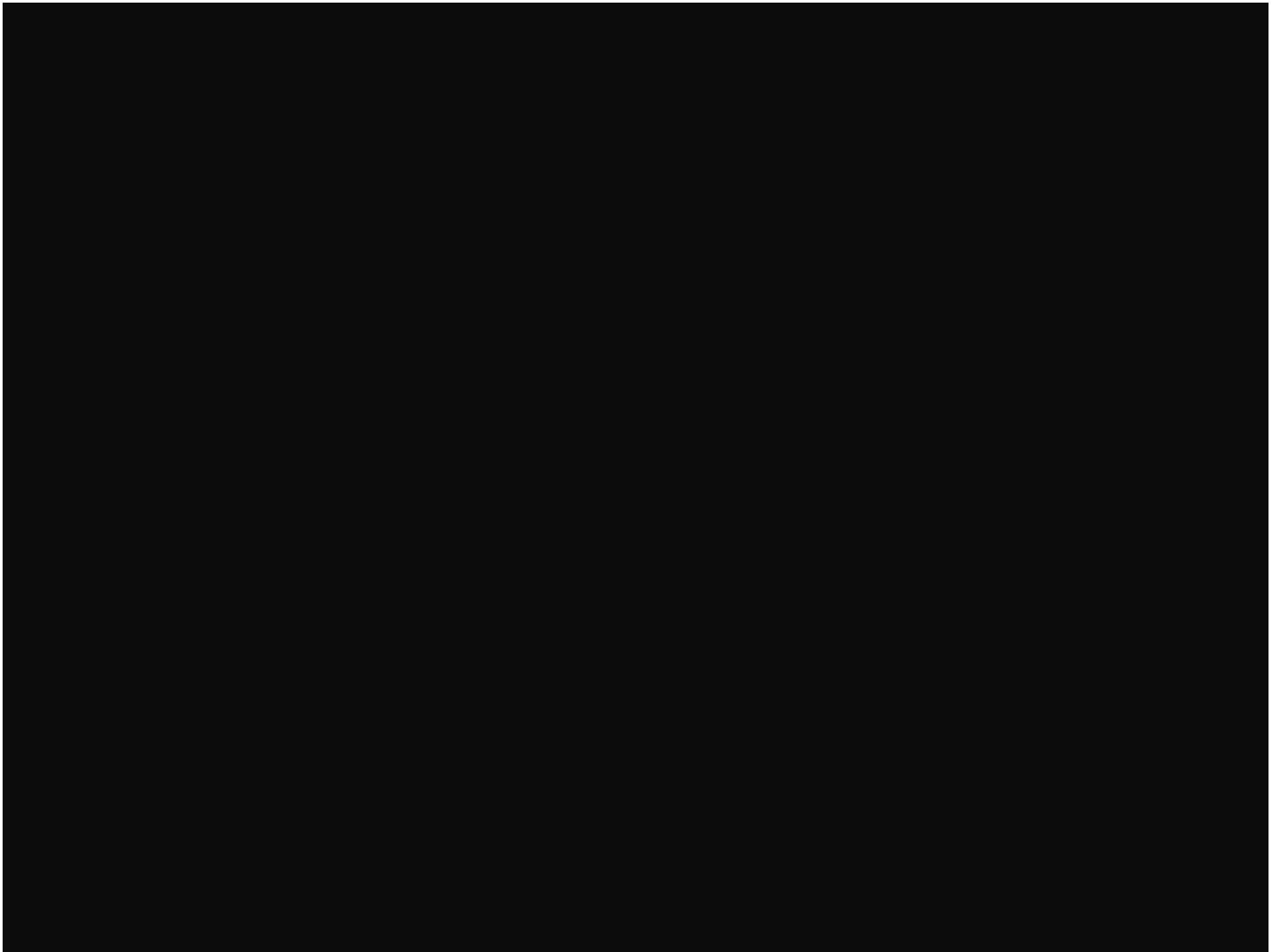
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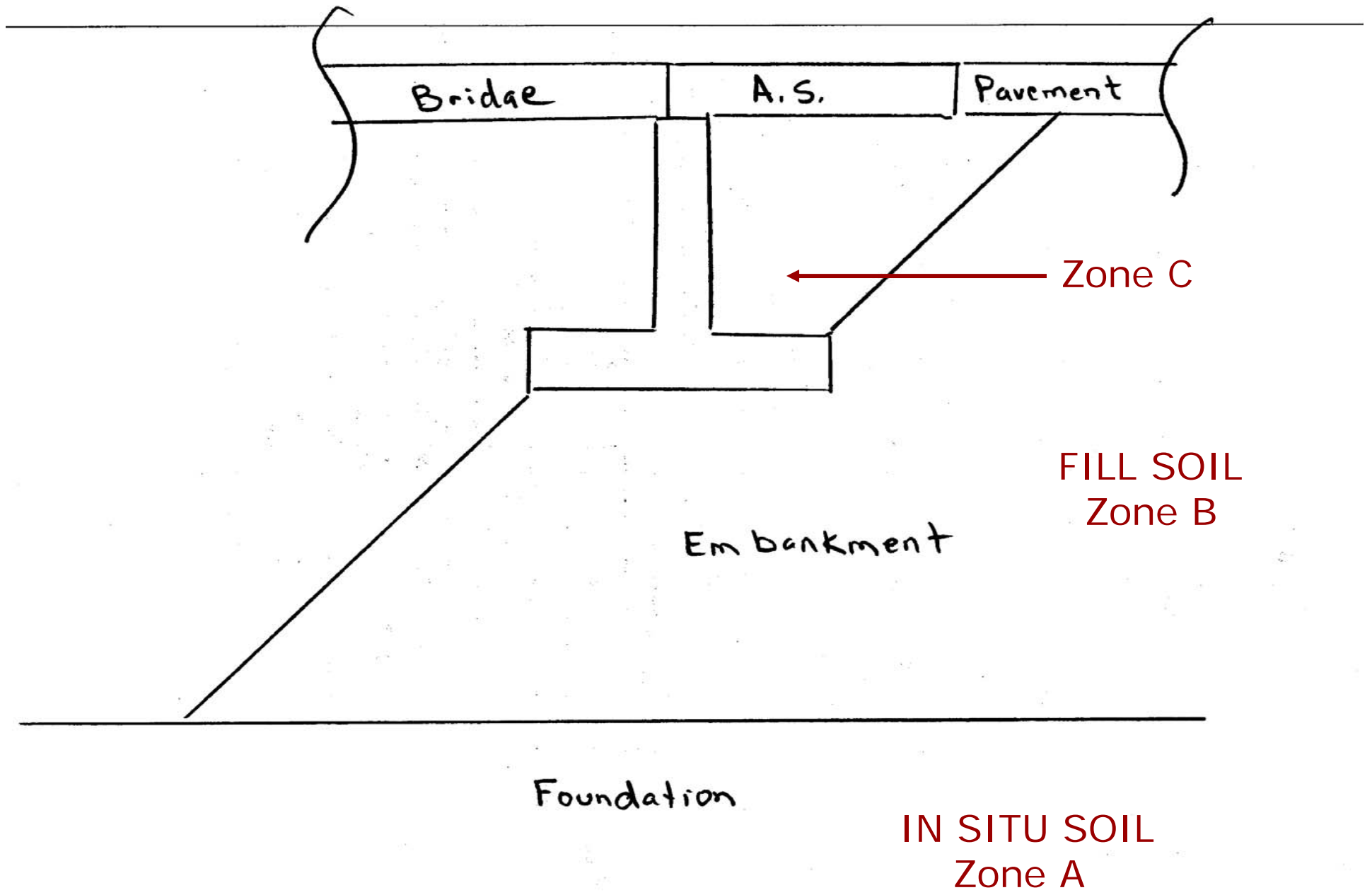
## User Costs

- ↓ User Satisfaction
- ↑ Vehicle Wear/Damage
- ↑ Cargo Damage
- ↑ Freight Costs
- ↓ Safety
  - ↓ handling/grip

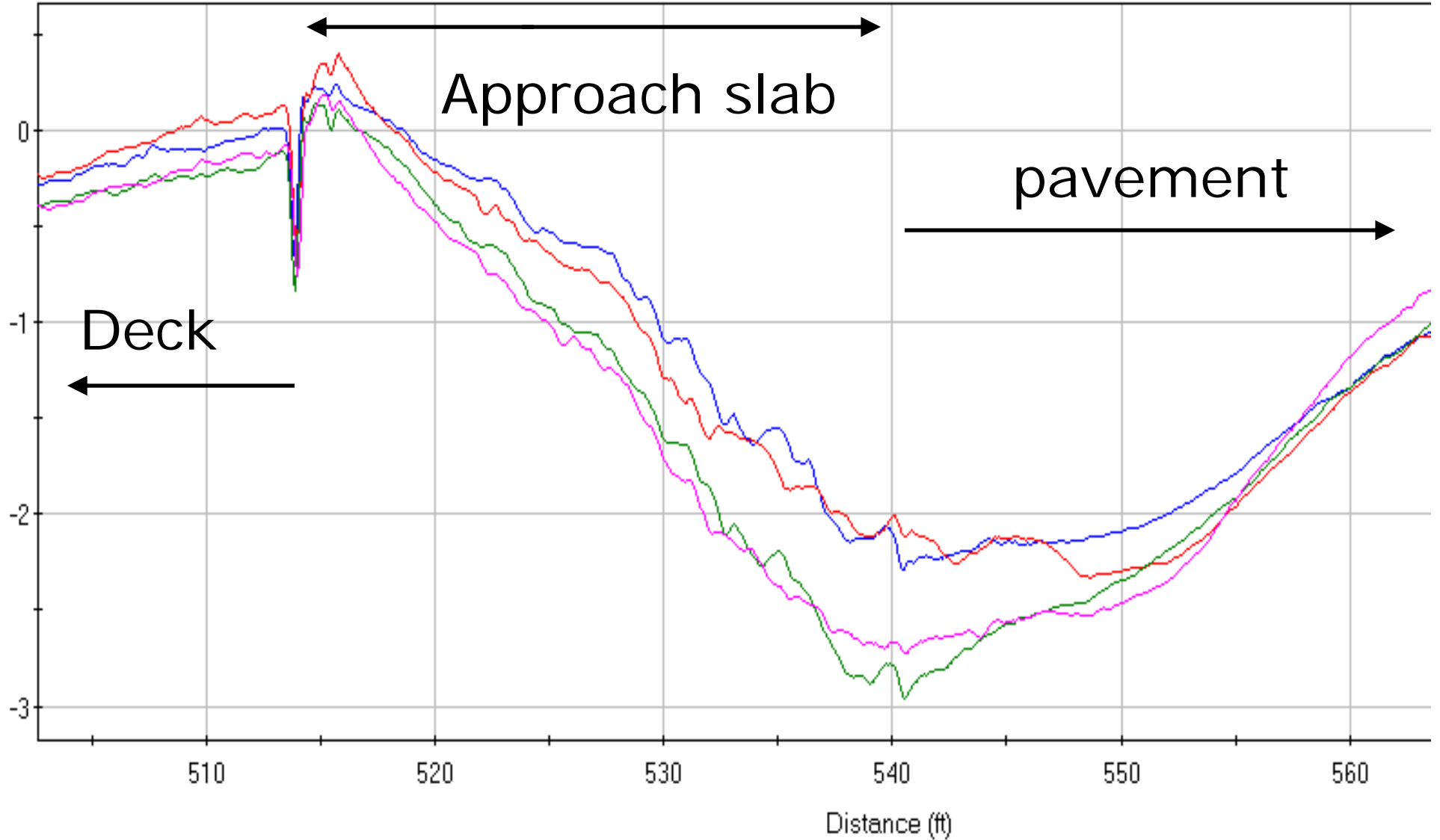
## Agency Costs

- ↓ Pavement Life
- ↓ Bridge Life
- ↑ Maintenance Costs
- Snow/Ice Removal
  - ↓ efficiency
  - ↑ costs





Elevation (in)



— RS207BGE - 1767.6 to 2429.3 ft: Right	— RS207BGE - 1767.6 to 2429.3 ft: Left
— R207AGEF - 2465.8 to 3129.7 ft: Right	— R207AGEF - 2465.8 to 3129.7 ft: Left



**MAY 22 2008**  
**9:55:55 AM**

# New or Renewed Paradigm

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*"Ability to safely carry loads  
and  
good rideability  
are NOT  
mutually exclusive goals  
for our structures!"*

# Research Proposal: PS-08-03

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*Identification and Evaluation  
of Pavement-Bridge  
Interface Ride Quality  
Improvement and  
Corrective Strategies*

# Iowa State University

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Multi-disciplined Approach  
from Design, Construction,  
Maintenance, Material,  
Geotechnical, etc.  
perspectives to improve  
Bridge rideability.

# Research Results and Bridge Rideability Symposium

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## Identification Evaluation of Pavement-Bridge Interface Ride Quality Improvement and Corrective Strategies

**State Job Number:** 134375

**Report Number:** FHWA/OH-2011/1

Final Report, January 2011

Executive Summary

Ohio Bridge Rideability Research Seminar, March 17, 2011

Training Session led by Research Team, March 14-16, 2011

Bridge owners have long recognized that the approach pavement at bridges is prone to exhibiting both settlement and cracking, which manifest as the "bump at the end of the bridge." This deterioration requires considerable on-going maintenance expenditures, added risk to maintenance workers, increased distraction to drivers, reduced steering control, increased damage to vehicles, a negative public perception of the highway system, and a shortened useful bridge life. The objective of this work is to assist the Ohio Department of Transportation (ODOT) in the development of pre-construction, construction, and post-construction strategies that will help eliminate or minimize the "bump at the end of the bridge."

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# Research Results and Bridge Rideability Symposium



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**Division of Planning**  
**Statewide Planning & Research**  
**Research Section**

He who does not look ahead,  
remains behind.  
Spanish Proverb

## **Training**

### **Ohio Bridge Rideability Research Seminar**

To view the Ohio Bridge Rideability Research Seminar presented March 17, 2011 by the ODOT Innovation, Research and Implementation Section and the Ohio LTAP Center and/or to download presentations, click [here](#).

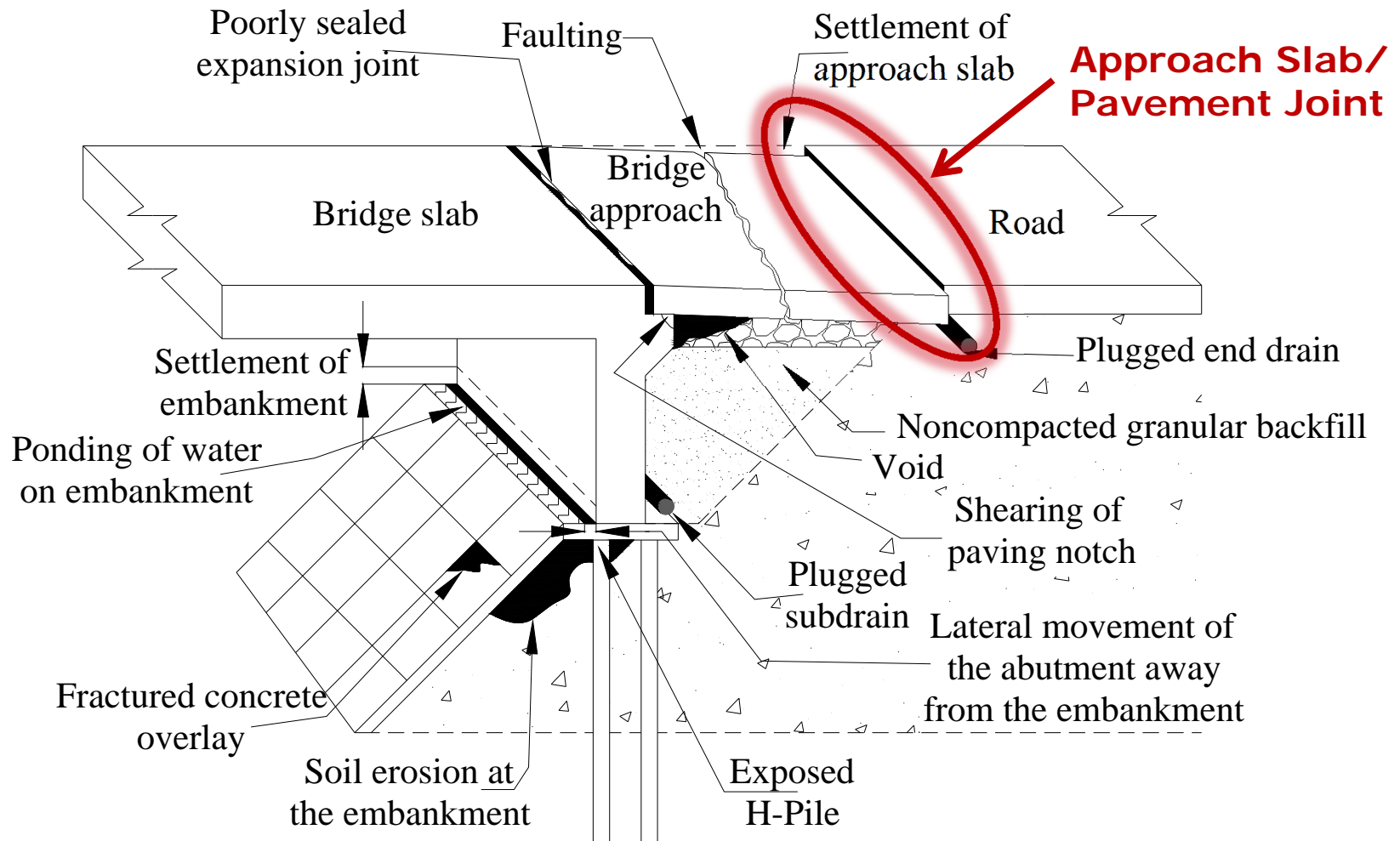
Click below to view the ODOT-designed training session:

Training Session led by Research Team, March 14-16, 2011



The Ohio Department of Transportation  
1980 West Broad Street, Columbus Ohio, 43223  
[John R. Kasich, Governor](#) | [Jerry Wray, ODOT Director](#)

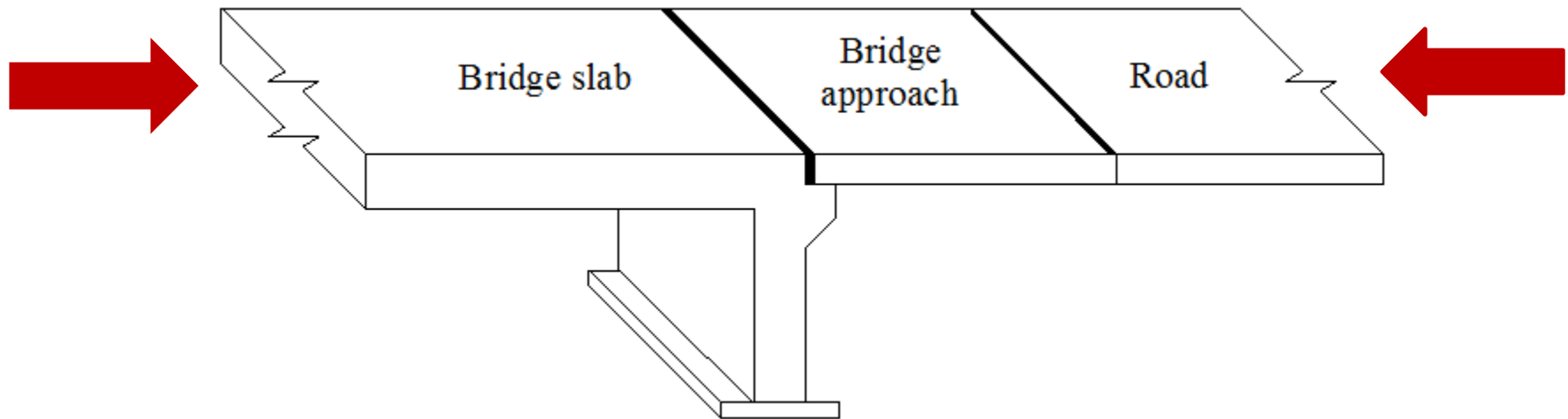
# Summary of Observed Problems



***Schematic summarizing the frequent problems observed at the inspected bridges***

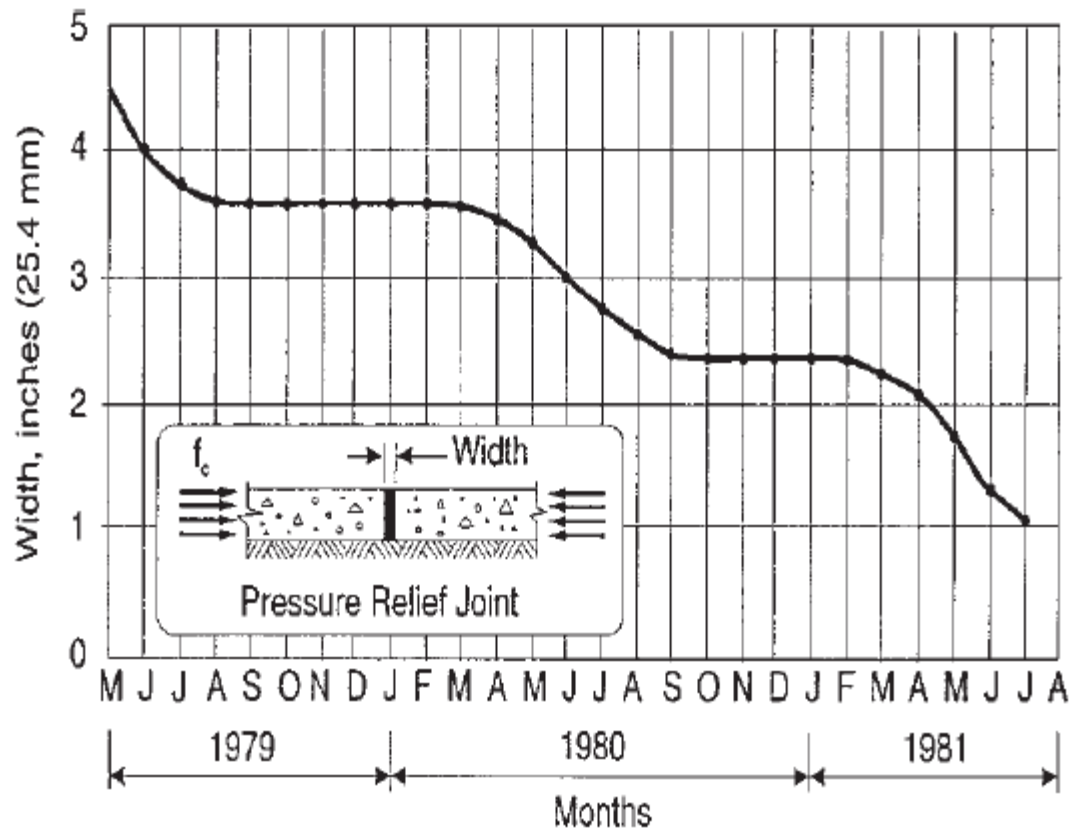
# Sources of Joint Movement

- Pavement Growth
- Superstructure Expansion/Contraction
  - Jointed Superstructures
  - Integral/Semi-integral Abutments



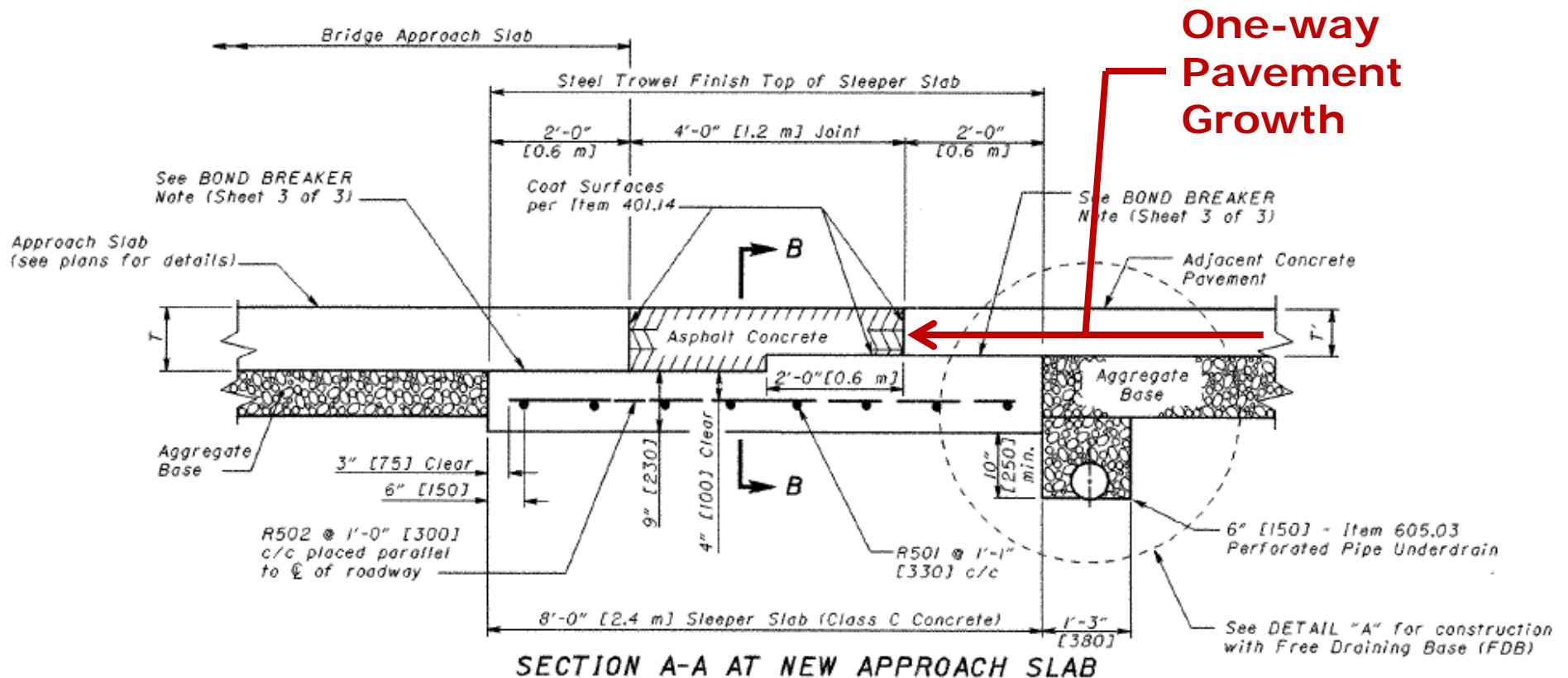
# Pavement Growth

Pavement Growth tends to be one way due to infiltration of incompressible solids at contraction joints.



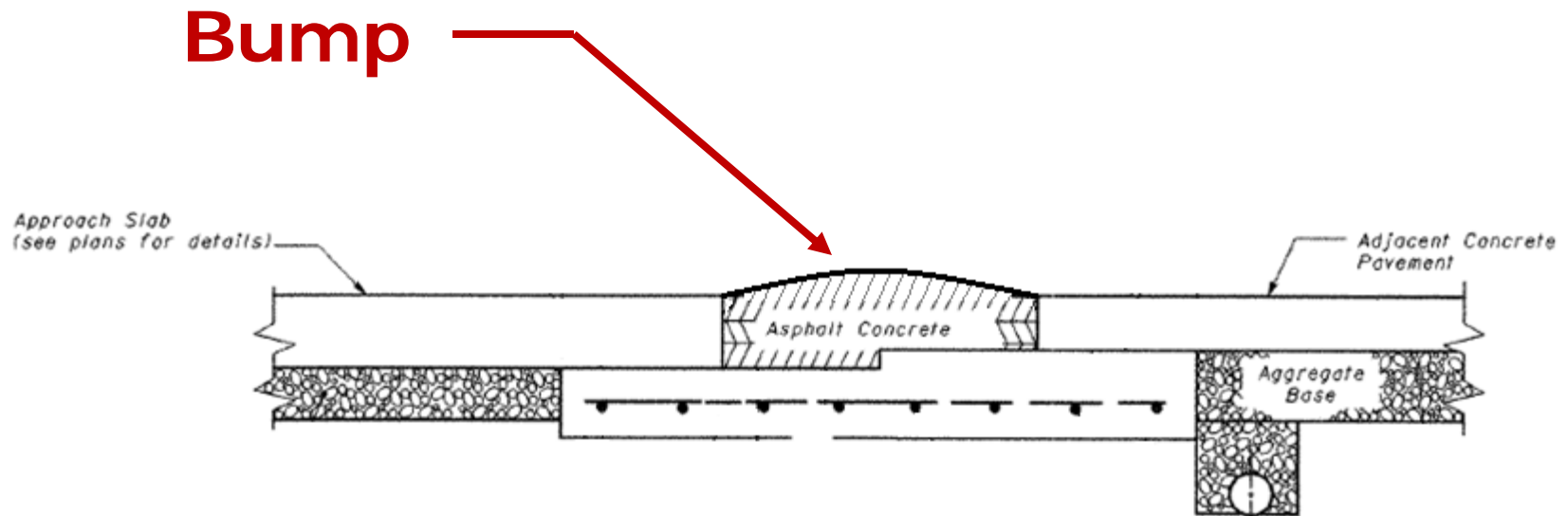


# Pressure Relief Joints – BP-2.3



Accommodates continual pavement growth without stressing bridge

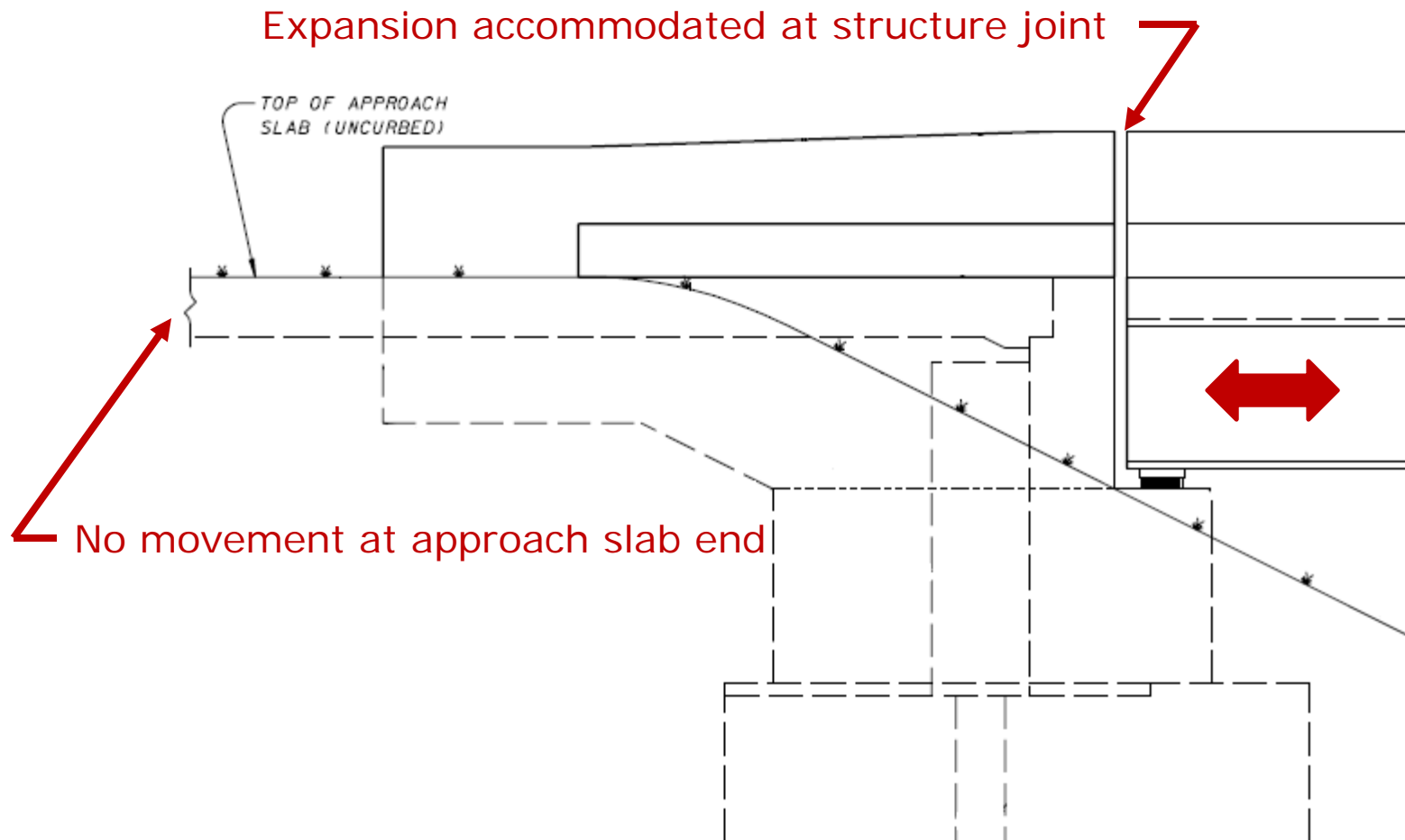
# Pressure Relief Joint Issues



Rideability

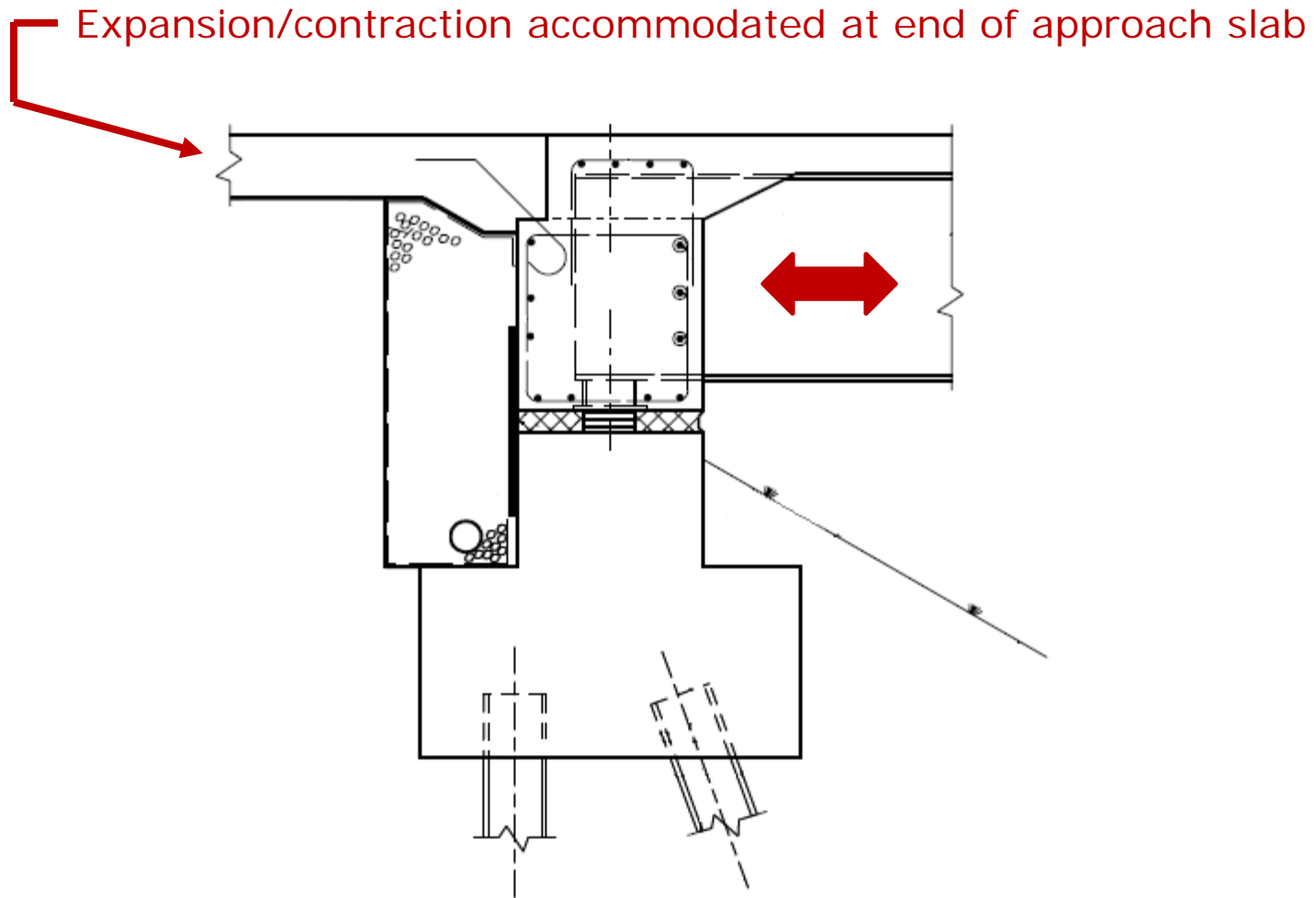
# Superstructure Expansion/Contraction

## Jointed Superstructures



# Superstructure Expansion/Contraction

## Integral/Semi-integral Abutments



# Integral/Semi-integral Issues



Rideability

# Integral/Semi-integral Issues



Drainage

# Integral/Semi-integral Issues



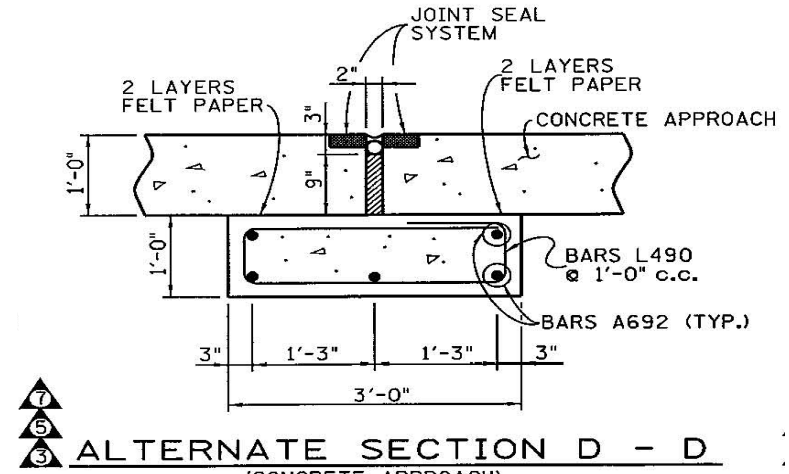
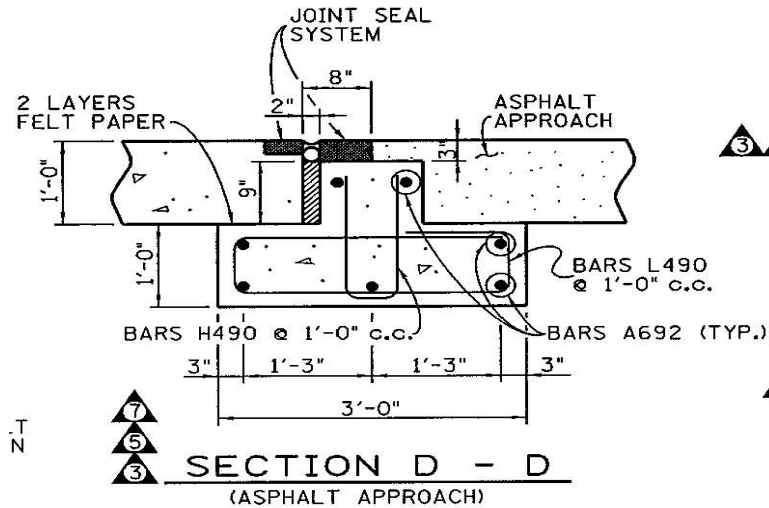
Erosion

# Research Recommendations

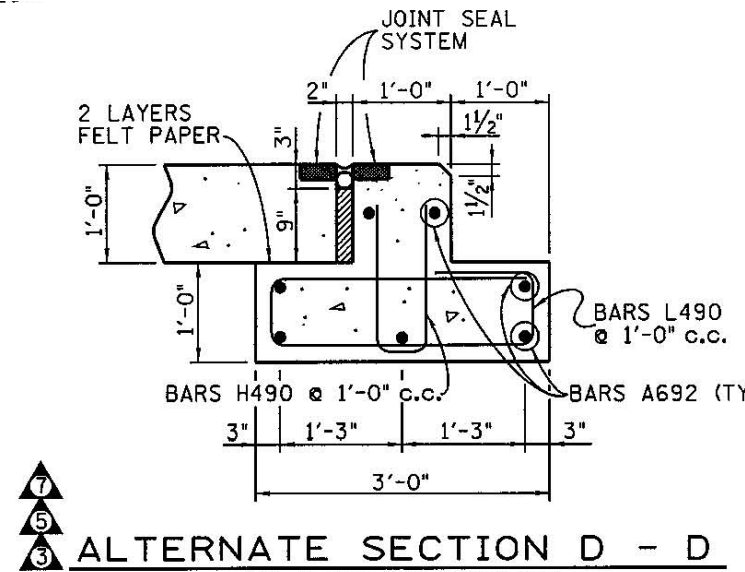
Regardless of the mainline approach type, support the approach slab on a sleeper slab

- The use of a sleeper slab is intended to improve the support structure of the approach slab.
- The use of a sleeper slab reduces the impact that material compaction may have on bridge rideability.
- Consider the following details:

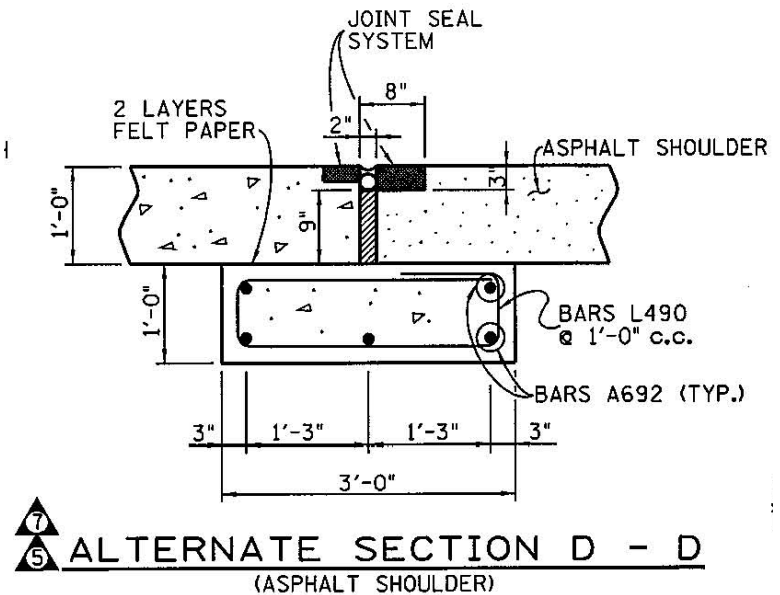
# Research Recommendations



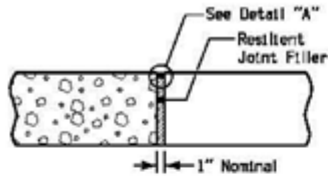
☆ OMIT BARS H490 & 2 BARS A692 WHEN USING THIS ALTERNATE SECTION D - D.



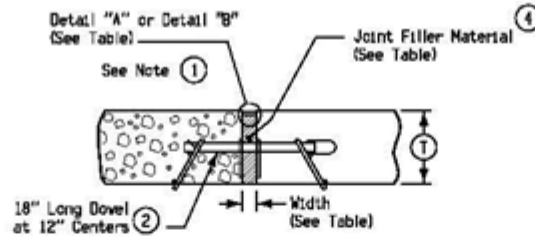
NOTE: TO BE USED ONLY WHEN ROADWAY PAVING IS NOT INCLUDED IN PROJECT.



# Research Recommendations

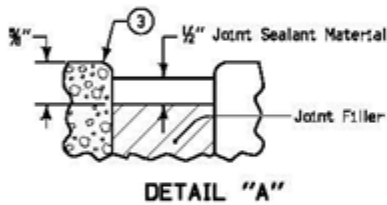


'E'  
1" EXPANSION JOINT

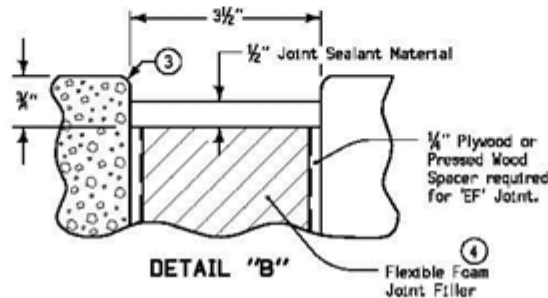


'ED', 'EE', 'EF'  
DOWELED EXPANSION JOINT

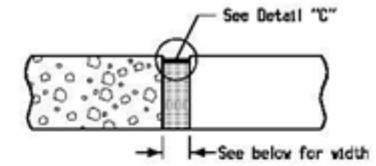
DOWELED EXPANSION JOINTS		
TYPE	WIDTH	FILLER MATERIAL (4)
ED	1"	Resilient (Detail "A")
EE	2"	Flexible Foam (Detail "A")
EF	3½"	Flexible Foam (Detail "B")



DETAIL "A"

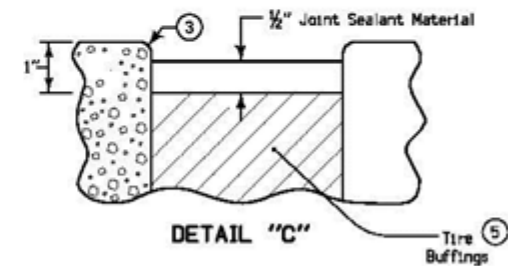


DETAIL "B"



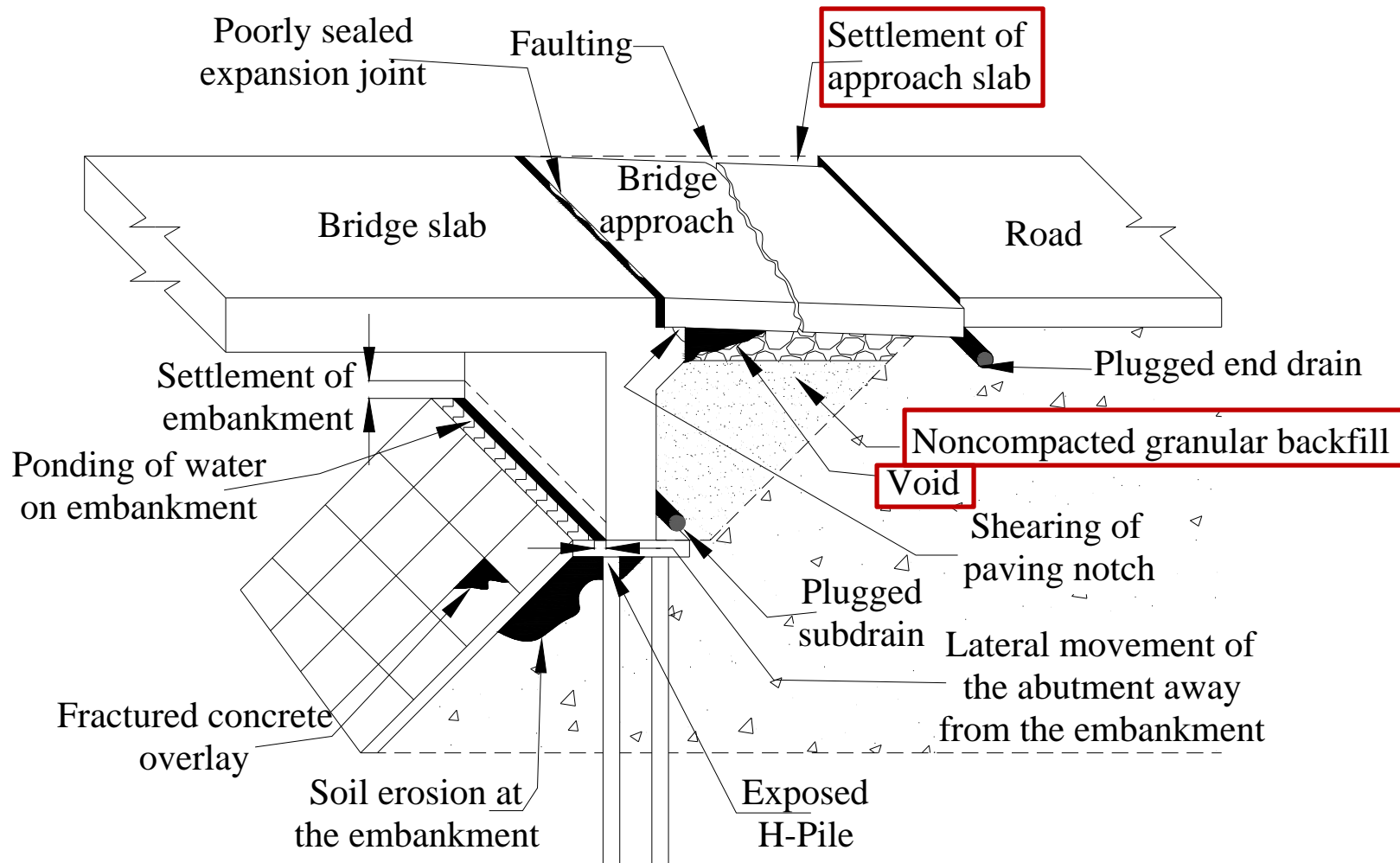
'CF' JOINT

TYPE	WIDTH
CF-1	2"
CF-2	2½"
CF-3	3"
CF-4	3½"



DETAIL "C"

# Summary of Observed Problems



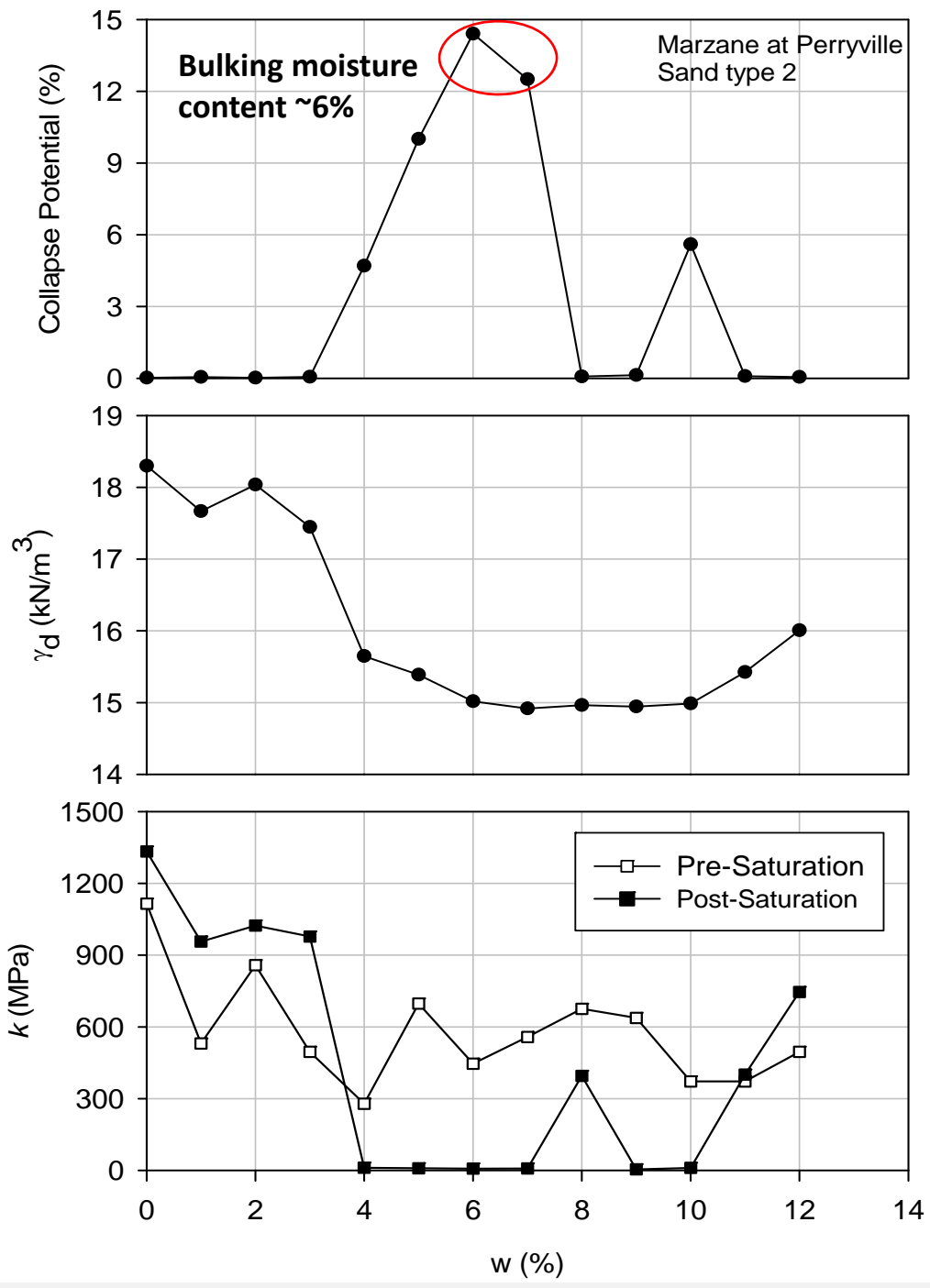
***Schematic summarizing the frequent problems observed at the inspected bridges***

# Settlement of Granular Materials

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## Bulking Moisture Content

Range of moisture content in material in which surface tension of water requires significantly more compaction force in order to re-align particles.



**Summarized Collapse potential tests results for material: Marzane at Perryville Sand 2 at every 1% moisture incremental**

**IDENTIFICATION OF THE BEST PRACTICES FOR DESIGN, CONSTRUCTION,  
AND REPAIR OF BRIDGE APPROACH SECTIONS**

Iowa DOT Project TR-481

CTRE Project 02-118

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Assistant Professor, Iowa State University

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Center for Transportation Research and Education.

**Center for Transportation Research and Education**

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<http://www.ctre.iastate.edu/research/reports.cfm>

January 2005

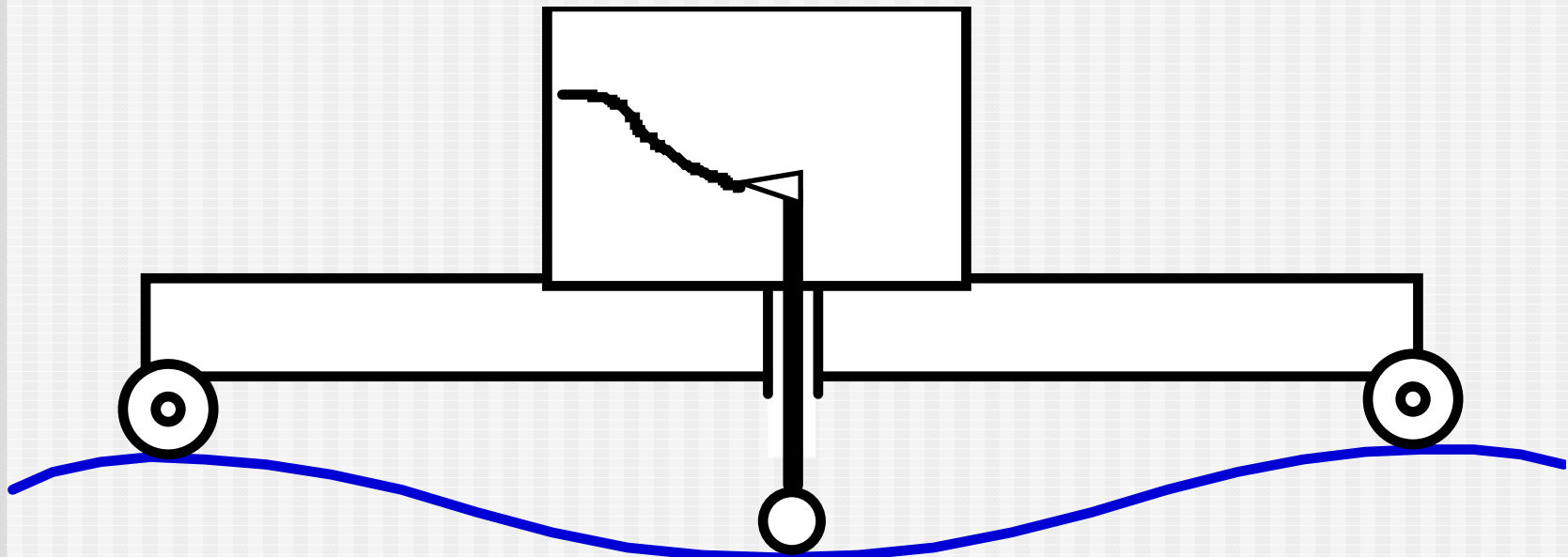
# Initial Rideability

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- Smoothness spec for Pavements  
(was CA PI now IRI)
- Rolling Straightedge spec for approach slabs and decks
- No specs covering transitions between pavement to approach slab to deck
- Solution: IRI spec for entire bridge encounter

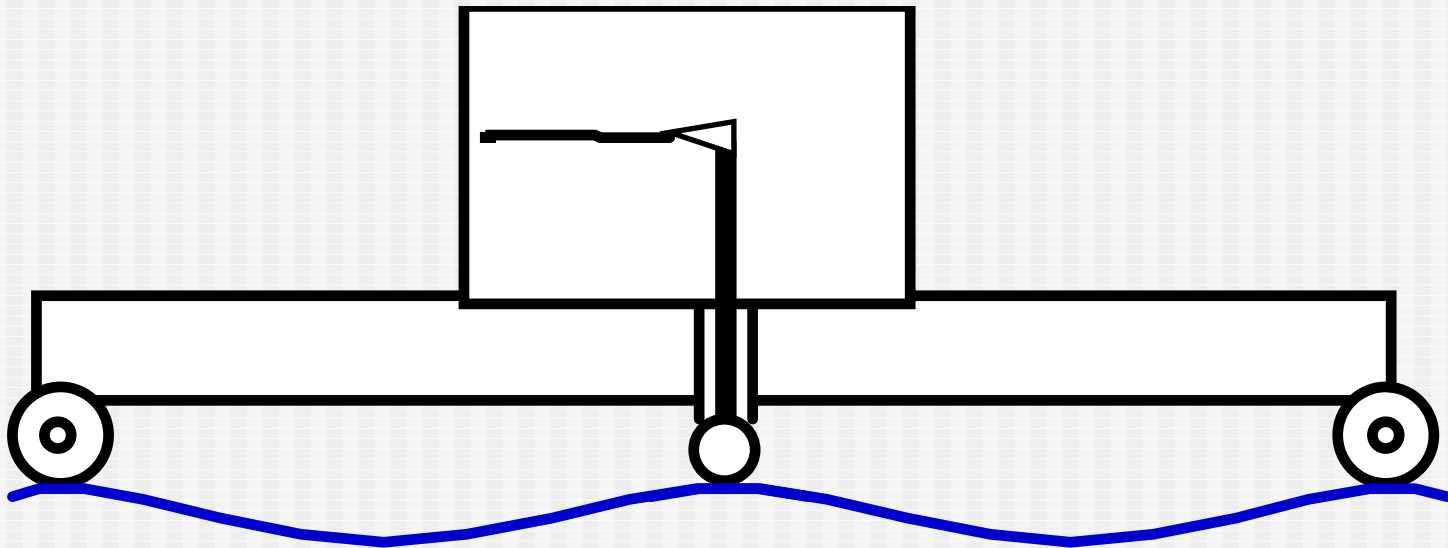
# Rolling Straightedge Response

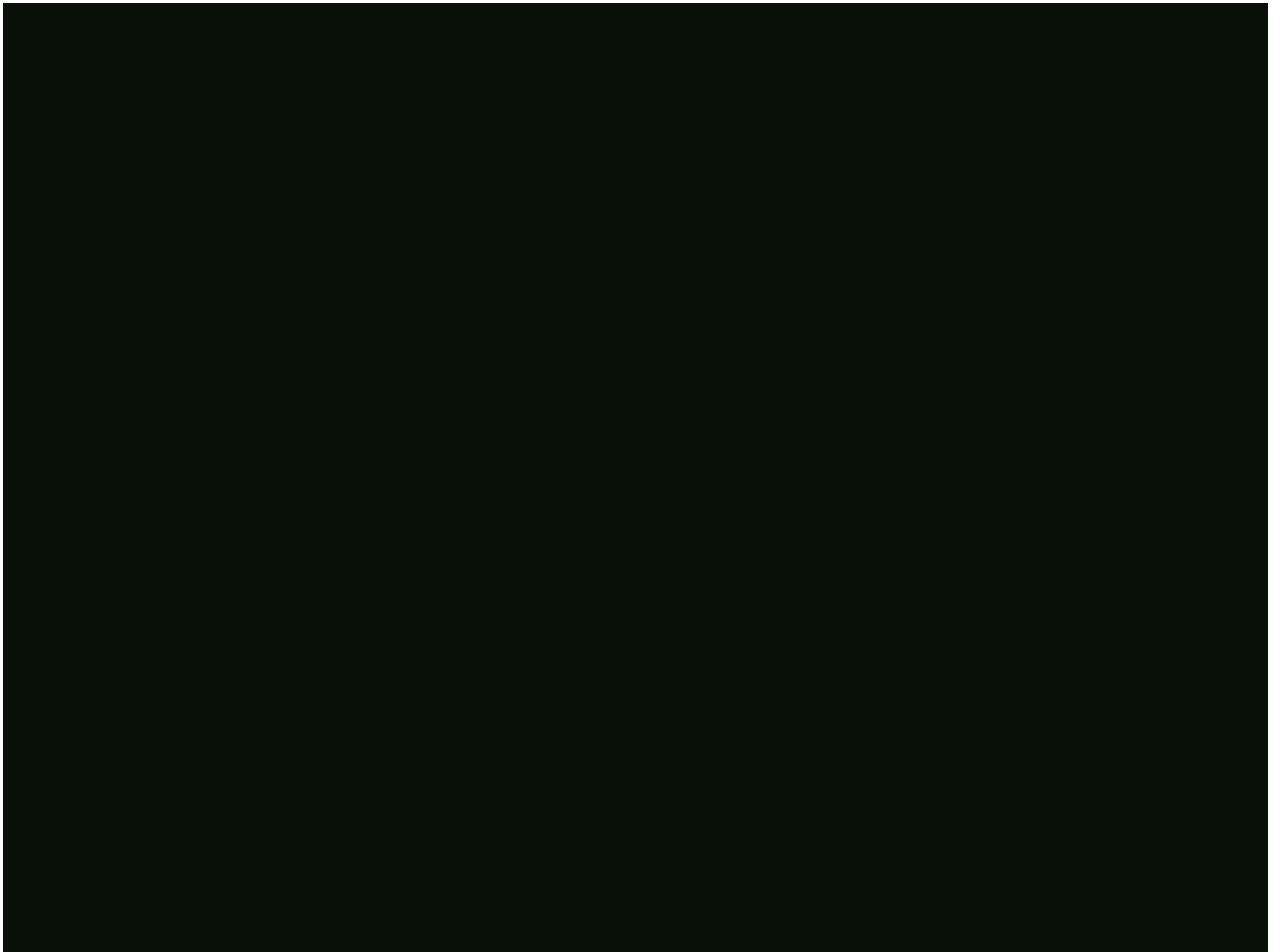
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# Rolling Straightedge Response

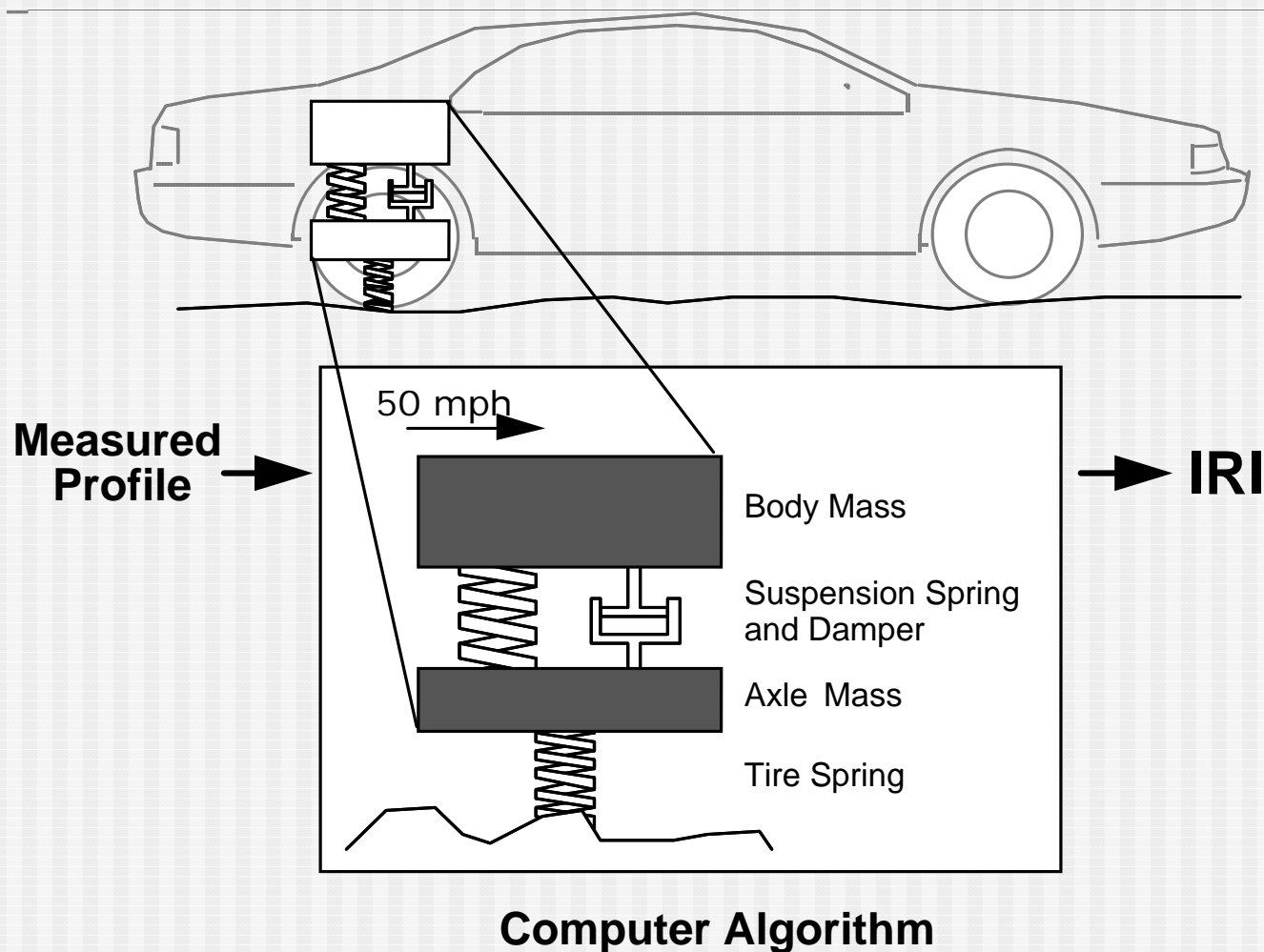
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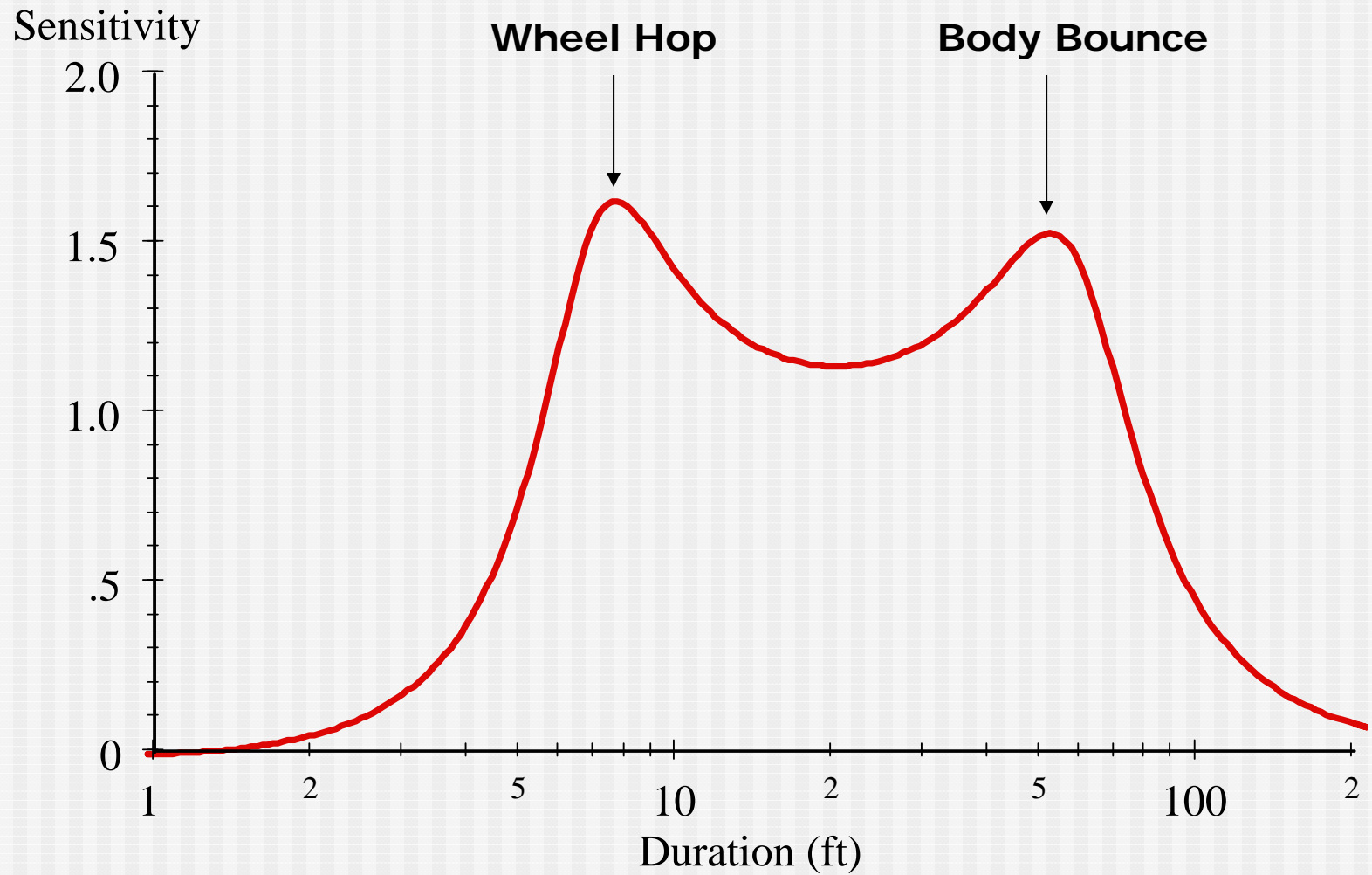


# International Roughness Index (IRI)

## Using profiles to simulate vehicle response (What the public "feels")



# IRI Sensitivity



# IRI Thresholds

## Overall – Entire Encounter

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- Looked at range of in-service structures
- Experimental Bridge Ride Spec
  - is achievable/attainable?
  - Inclusive of Armored Joints, Finger Joints, Sliding Plate expansion joints, etc.
- Minimum Encounter Length = 265'
  - compared to pavement w/ 0.10 mile lots

# IRI Thresholds

## Localized – Cont. 25' baselength

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- Continuous sliding baselength and calculation throughout encounter
- What is reasonable, achievable, and relevant?
  - Quantitative – looked at limits on numerous newly constructed bridge encounters
  - Qualitative – complaints and oil staining
  - Nearly twice the localized limit in our pavement smoothness spec (160 "/mile in 25')

# Specification Details

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- Holistic Approach: Thinking of the pavement and bridge as integral parts of the highway system; no longer treating them individually
- IRI across the entire bridge encounter (25 ft pave, deck and approach slabs, 25 ft pave)
- Overall and Localized IRI requirements

# Specification Details

- Overall IRI Encounter Requirement of **130** in/mile or less for each lane
  - If not met, correct to **100** in/mile or less
  - Not applied if bridge encounter is less than 265 feet in length
- Localized IRI limit of **250** in/mile using **25** ft continuous/sliding baselength
  - Limit is increased to **350** in/mile in any area where the baselength includes **steel armor joints**
  - Correct to 250 or 350 in/mile
  - One size fits all bridges: jointed, integral, semi-integral structures
  - Arrived at these values quantitatively and qualitatively

# Specification Details

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- Currently no positive or negative pay adjustments based on IRI
  - How do you establish \$ levels and IRI levels?
  - Do you allow contactors to correct into positive pay adjustments?
- Correction plans must be submitted and approved by ODOT
  - Reinforcing steel cover (grinding)
  - Grinding alone may not fix the problem
- Data must be collected by ODOT certified equipment and operator

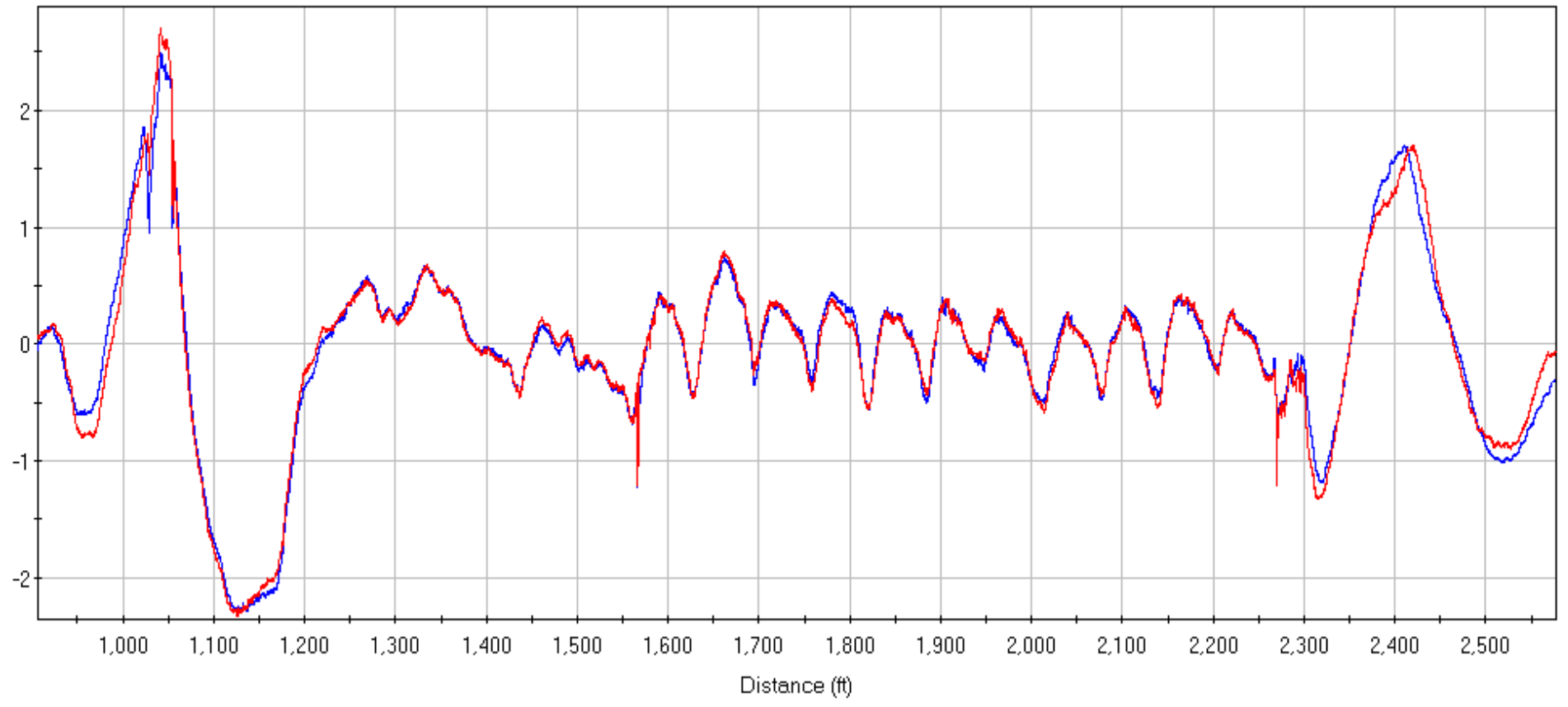
# Other Issues

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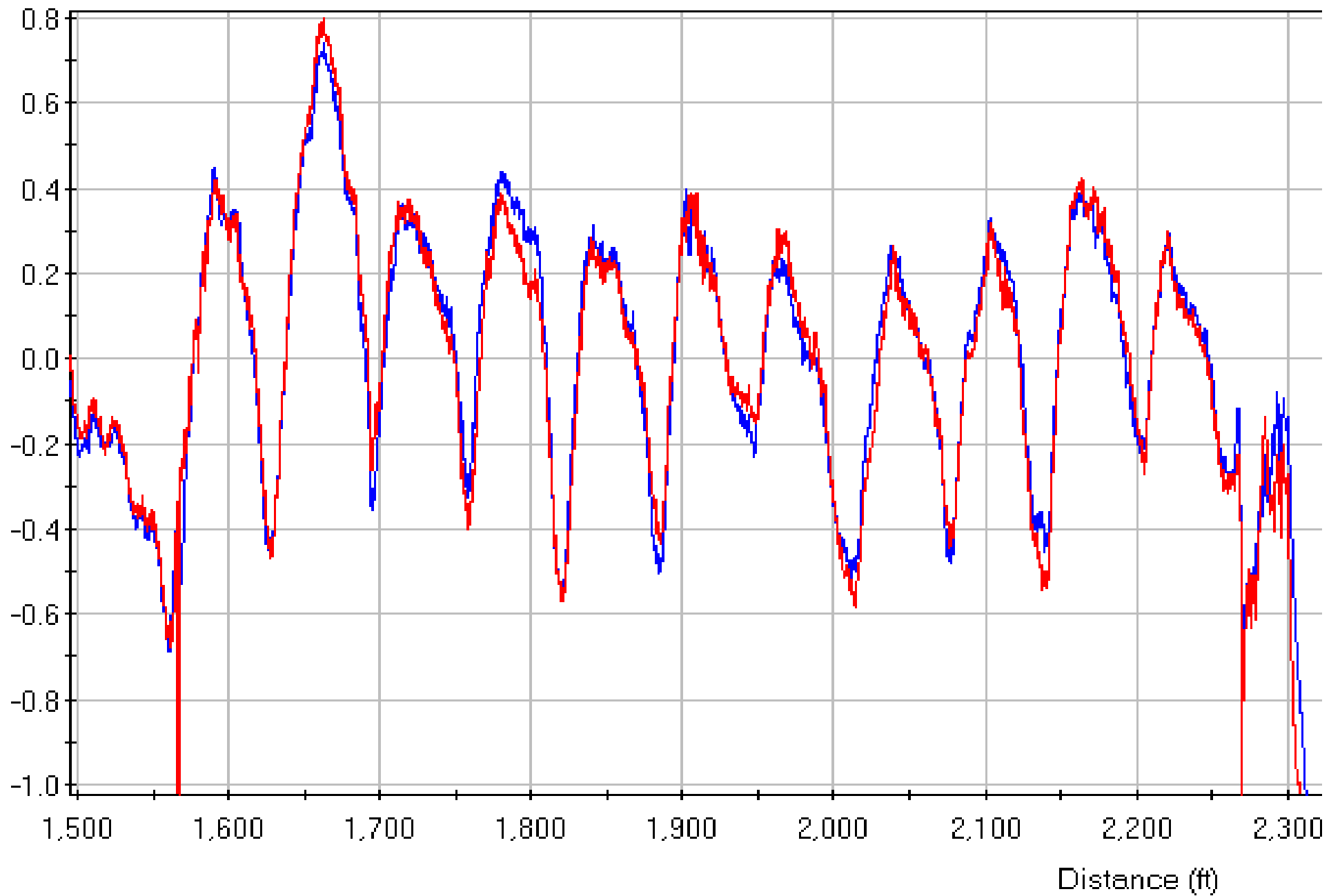
- Micro-fracturing of Diamond Ground concrete decks
  - Concern largely due to snow/ice removal chemicals
  - Diamond grooving all decks
- If diamond grinding as corrective action is required, do you require full width/length of the bridge/encounter to be ground?
  - Surface uniformity
  - Increase rideability improvement

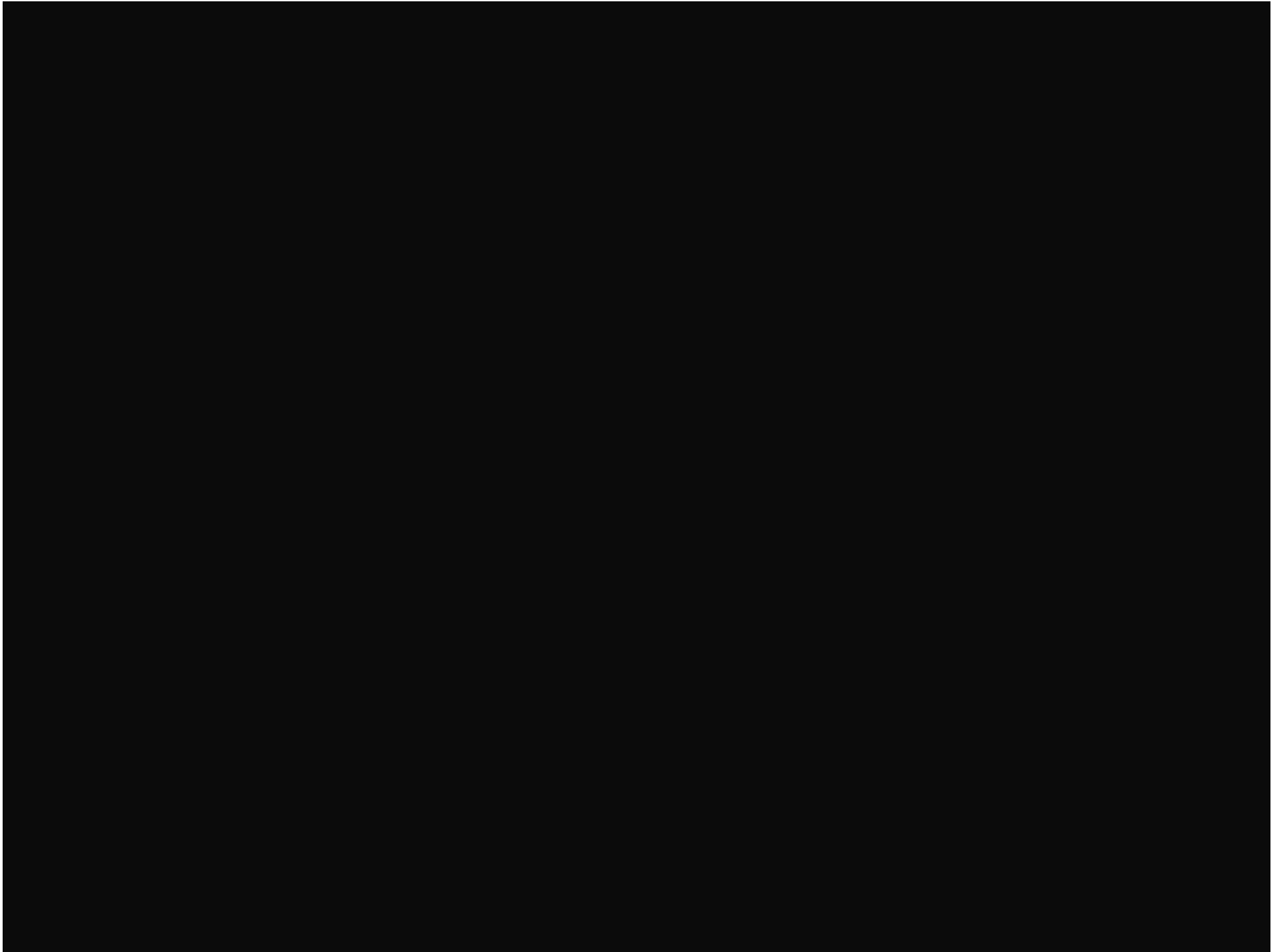
Default

Elevation (in)



Elevation (in)





# ProVAL Demonstration

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# Questions ????????

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# THANK YOU