Synthesis of Effective Treatments to Address Settlement Beneath Bridge Approach Slabs

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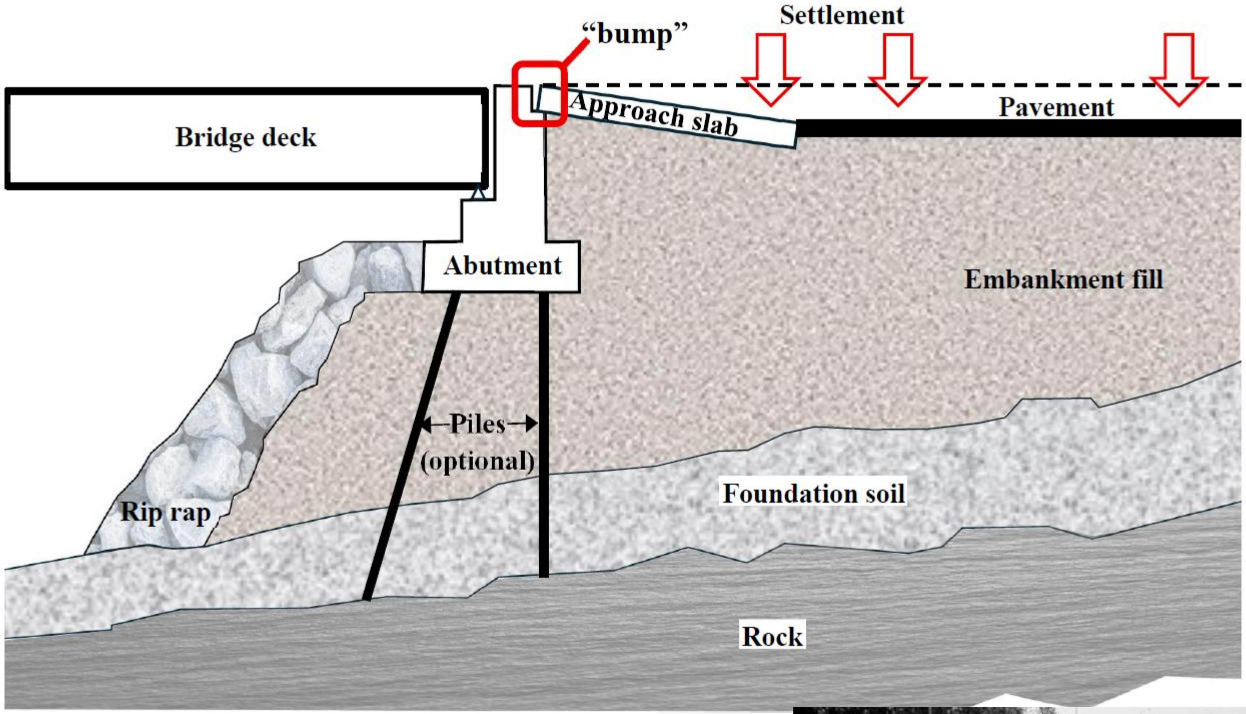
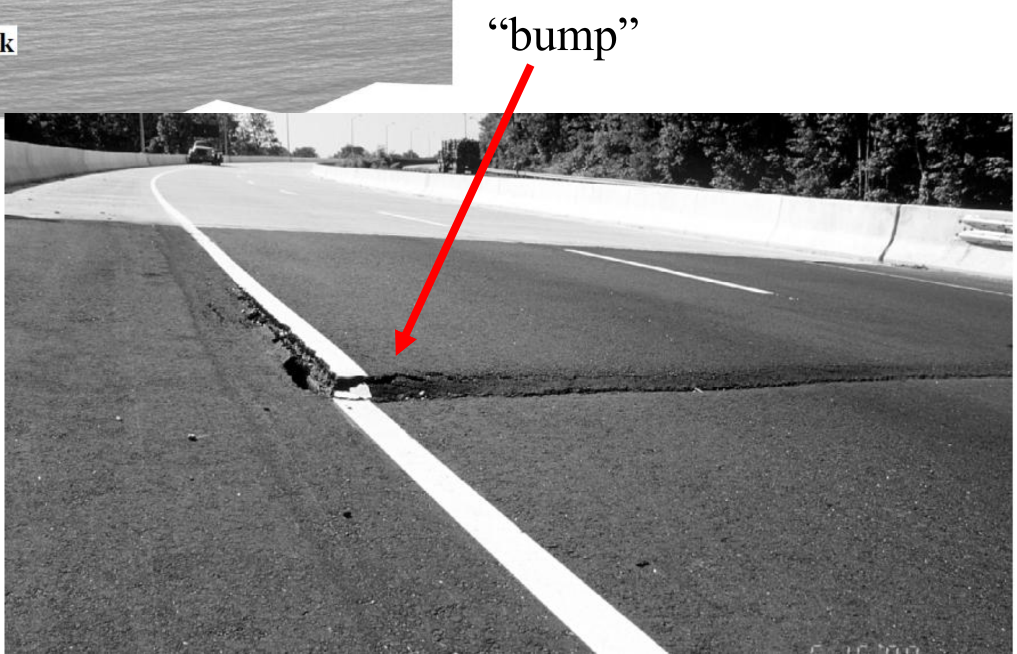
Contract #: BED34, TWO 977-02

Presentation Outline

- Project Background
- Project Objectives
- Project Tasks
- Literature Review Summary
- Highlights of Survey Results
- Case Studies
- Recommendations

Project Background

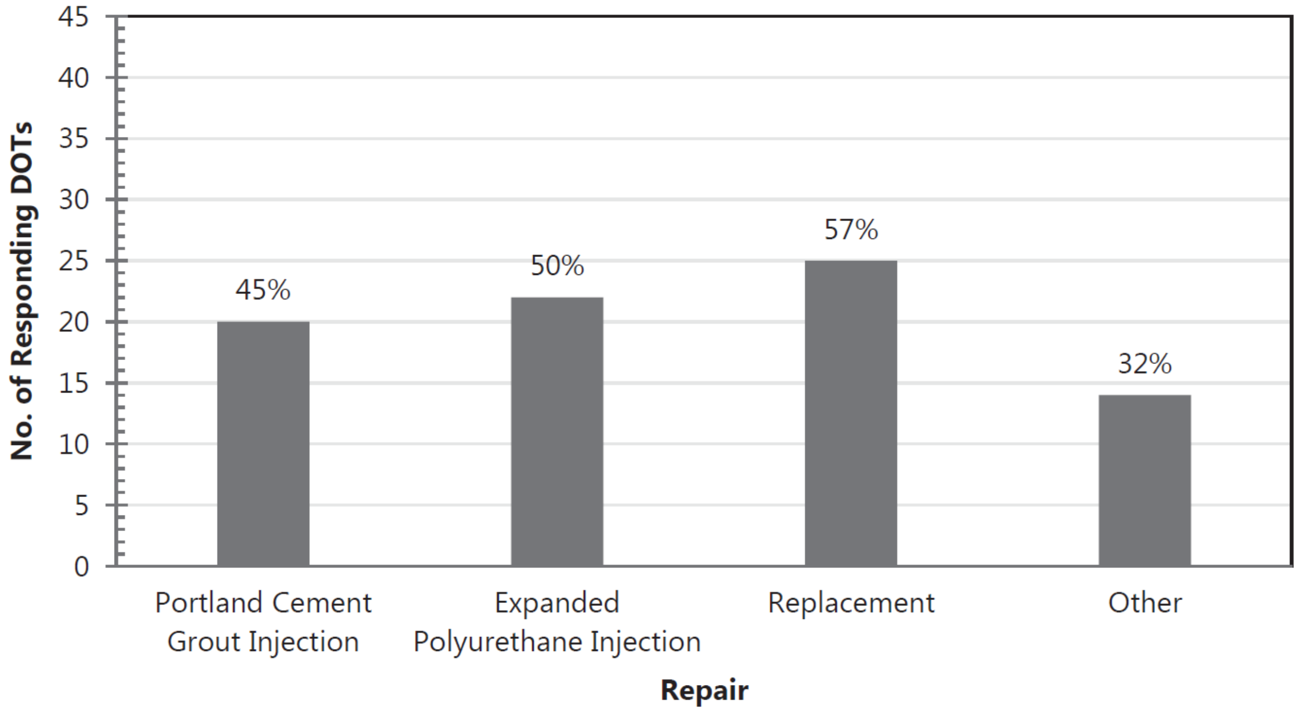




- Decreased ride quality
- Increased safety concerns for motorists
- Damage to bridge and joints
- Additional maintenance costs

Project Background

- Common Rehabilitation Techniques
  - Polyurethane injection
  - “Mud jacking”
  - Asphalt overlay
  - Approach slab replacement



Project Objectives

- Advance FDOT's understanding of effective treatments to mitigate settlement in approach slabs
  - Survey other states to determine approach slab rehabilitation methods
  - Provide summary of effective rehabilitation methods
  - Present case studies of effective rehabilitation methods

Project Tasks

- Task 1 – Literature Review
- Task 2 – Survey Development
- Task 3 – Administration of Survey
- Task 4 – Development of Case Studies
- Task 5a – Preparation of Draft Final Report
- Task 5b - Closeout Teleconference
- Task 6 – Submission of Final Report

Literature Review Summary

- Bridge Approach Settlement Causes
  - Structural
    - Approach slab
      - Improper design
      - Poor performance
    - Approach slab - bridge deck interface
      - Temperature induced stresses
    - Abutment
      - Settlement
      - Abutment type and design
  - Geotechnical
    - Foundation soil
      - Settlement
    - Embankment fill
      - Poor drainage
      - Deformation of embankment fill

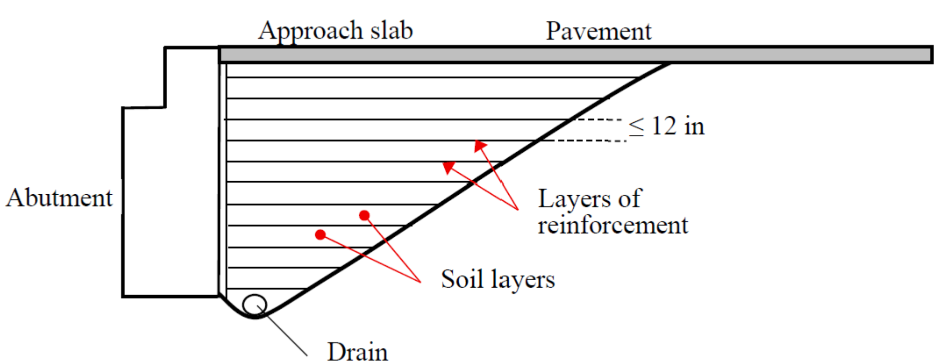
Literature Review Summary

BAS Settlement Causes

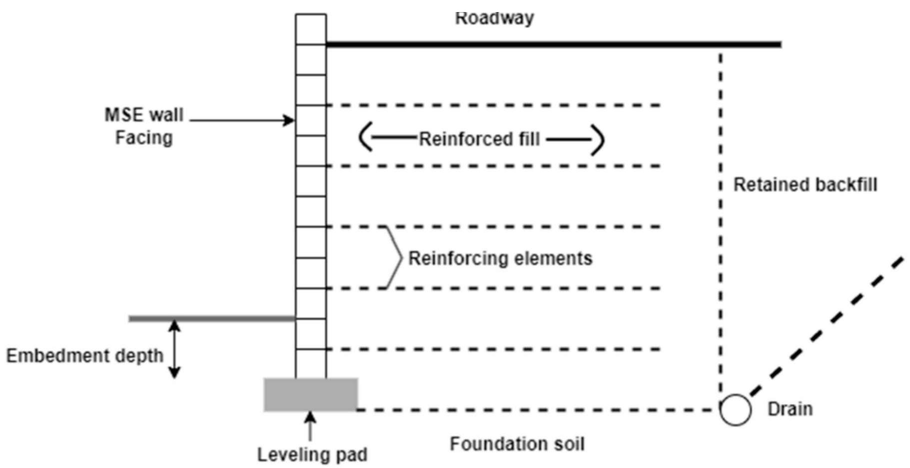
- Geotechnical
  - Foundation soil settlement
  - Deformation of embankment fill
  - Poor drainage of embankment fill

Literature Review Summary

- Design based strategies to reduce approach slab settlement in new bridges
  - Compression of embankment fill
    - More stringent backfill and compaction specification
    - Geosynthetic Reinforced Soils (GRS)
    - Mechanically Stabilized Earth (MSE)
    - Lightweight fill materials
    - Flowable Fills



GRS



MSE

Assessment of Soil–Structure Interaction Approaches in Mechanically Stabilized Earth Retaining Walls: A Review

Literature Review Summary

- Design based strategies to reduce approach slab settlement in new bridges
  - Consolidation of foundation soils
    - Ground improvement methods

Technique	Soil Type
Removal and replacement	Cohesive
Preloading w/ or w/o surcharge	Cohesive
Wick Drains	Cohesive
Dynamic compaction	Cohesionless
Compaction piles	Cohesionless
Stone columns	Both
Geopiers	Both
Driven piles	Both
Deep soil mixing (DSM)	Both
Concrete injected columns (CIC)	Cohesive

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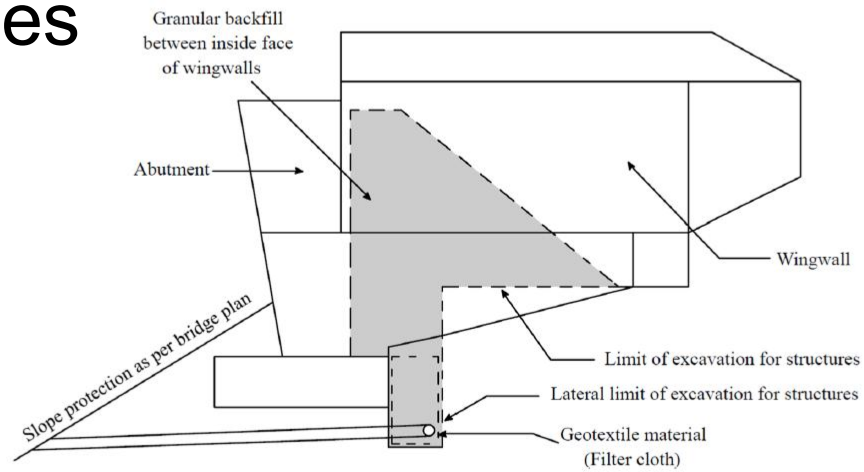
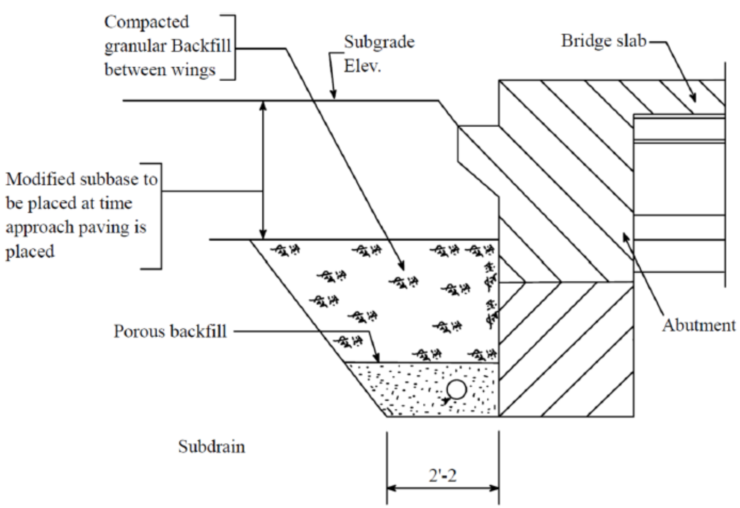
Literature Review Summary

FDOT

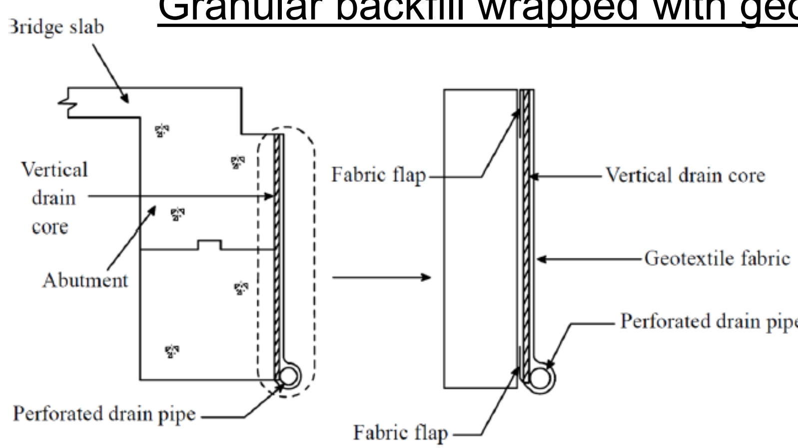
- Design based strategies to reduce approach slab settlement in new bridges
  - Improve drainage
    - Surface drainage
    - Subsurface drainage
    - Maintenance



Granular backfill wrapped with geotextile



Porous fill surrounding perforated pipe



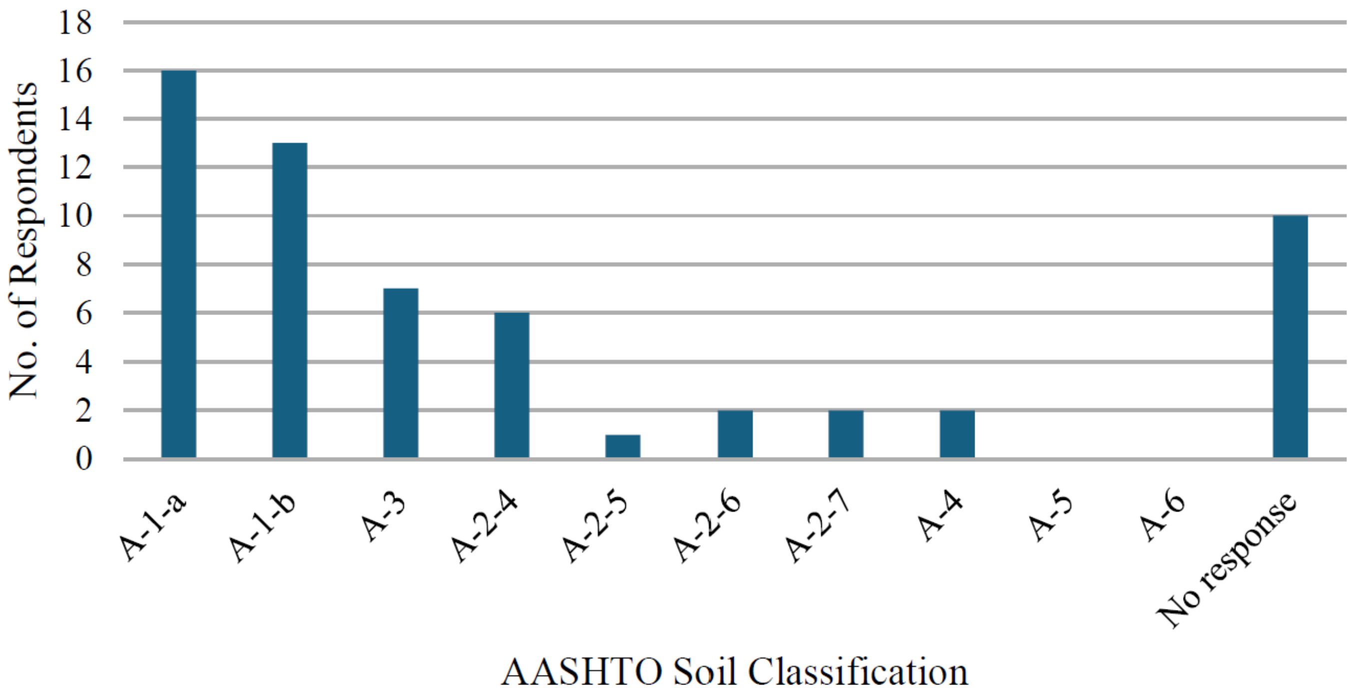
Geocomposite vertical drain wrapped with filter fabric

Highlights of Survey Results

States	No. of bridges in state	No. in state network	No. of locally owned/maintained
Alabama	16,000	6,000	10,000
Arizona	8,039		
California	25,537	12,840	12,697
Colorado	3,500		
Delaware	400		
Florida	13,056		
Idaho	4,100	1,850	2,250
Iowa	23, 685	4,214	19,471
Kansas	25,000	5,000	
Louisiana	14,000		
Maryland	5,200		
Massachusetts	5,195		
Michigan	11,314	4,511	6,803
Minnesota	20,000		
Missouri	10,400		
Montana	5,000+		
Nebraska		3,500	
New Hampshire	3,861		
North Carolina	13,500+		
Ohio	26,729		
Oregon	6,700		
Tennessee	20,048	8,389	11,659
Texas	55,000+		
Vermont	3,942	2,342	1,600
Wyoming	1,635		
Ontario, Canada	3,000		

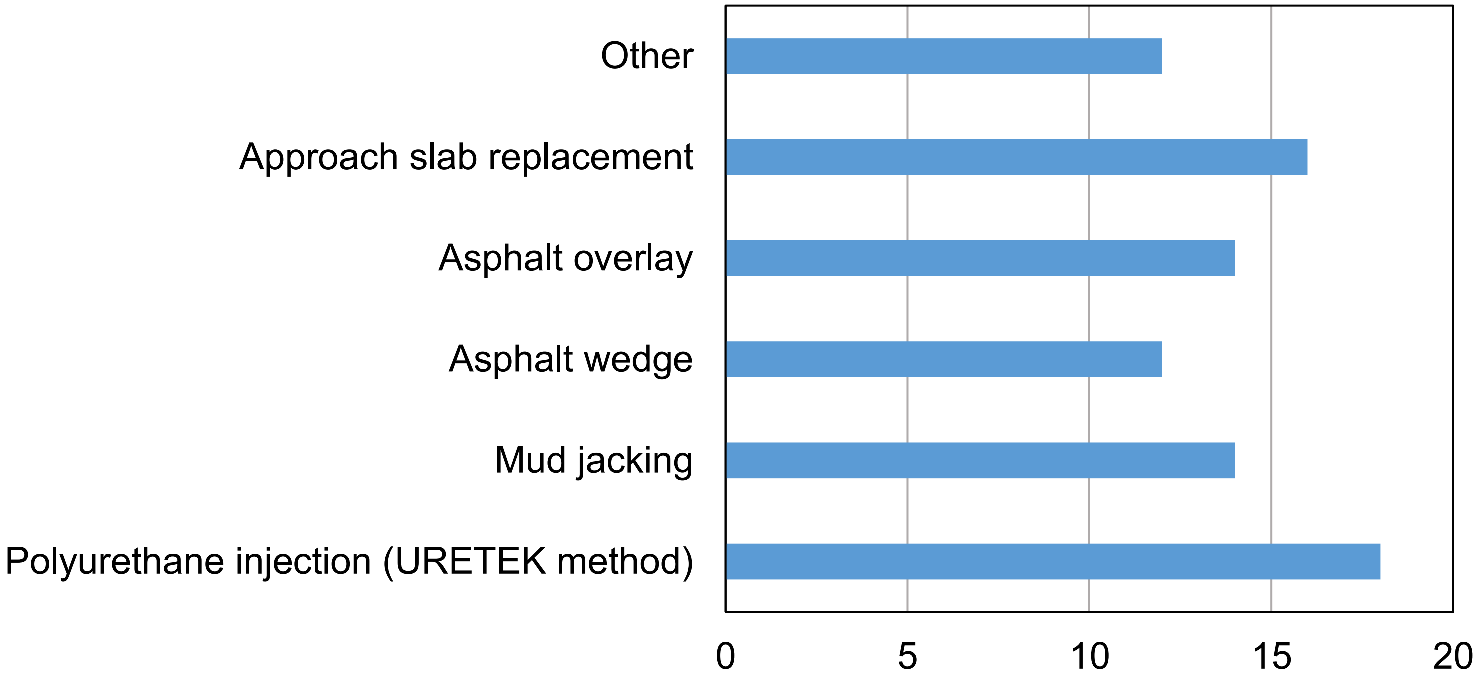
Highlights of Survey Results

- 50% of respondents indicated that they always use bridge approach slabs
- 23% respondents frequently experience settlements on most bridges and 58% occasionally experience settlements
- Type of backfill beneath BAS



Highlights of Survey Results

- Top 3 causes of BAS settlement: poor construction practices, erosion or drainage problems, poor compaction of backfill
- Most commonly used BAS settlement rehabilitation methods



Highlights of Survey Results

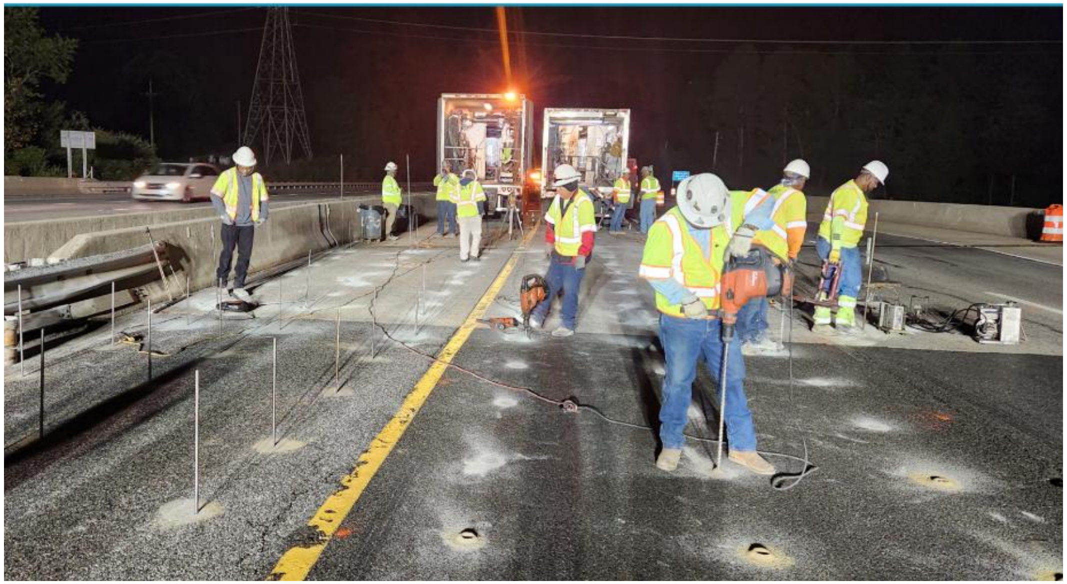
- Most used BAS design innovations
  - Sleeper slabs
  - Reinforced or otherwise strengthened slabs
  - Integral abutment designs
  - Geosynthetics in backfill

Highlights of Survey Results

- 46% of respondents measure BAS settlement
- 15 of 16 agencies that responded to Question 12 said they use visual inspection every two years to measure BAS settlement (multiple answers)
  - 6 survey
  - 4 use IRI
  - 1 uses sensors
  - 1 uses a zip level
- Triggers for prompting rehab measures include
  - No trigger
  - Poor rideability
  - Judgement of engineer or inspector
  - Motorist complaints
  - IRI data
  - Condition of approach slab

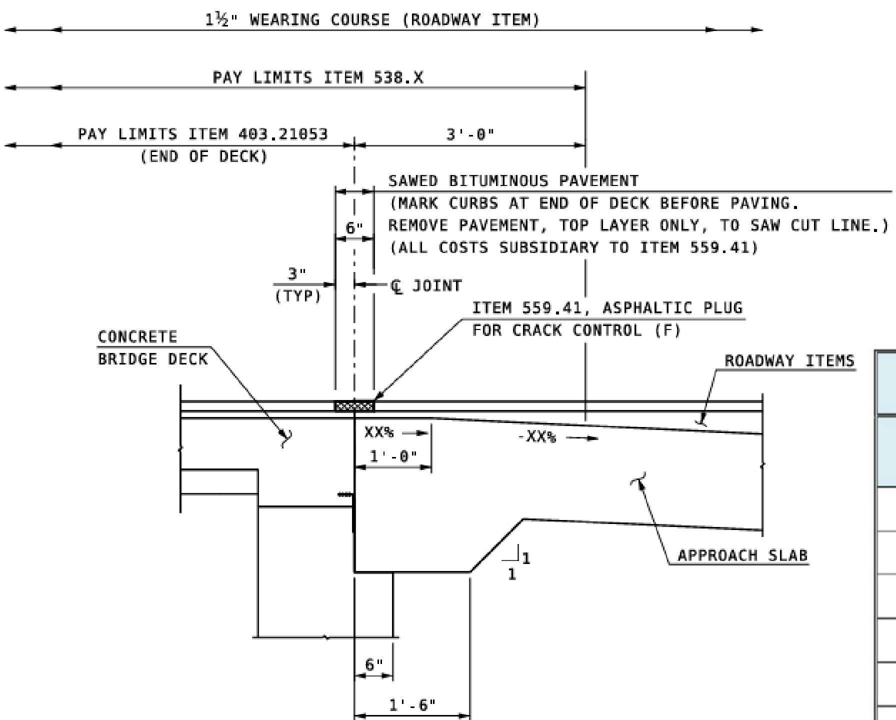
Case Studies

- Delaware – URETEK 486 STAR
- Florida – Precast concrete panels on I-10 in Gadsden county
- Idaho – 2 bridges
  - URETEK 6R
  - Polyester Polymer Concrete (PPC 1121) wedge



Case Studies

- New Hampshire – new approach slab detail



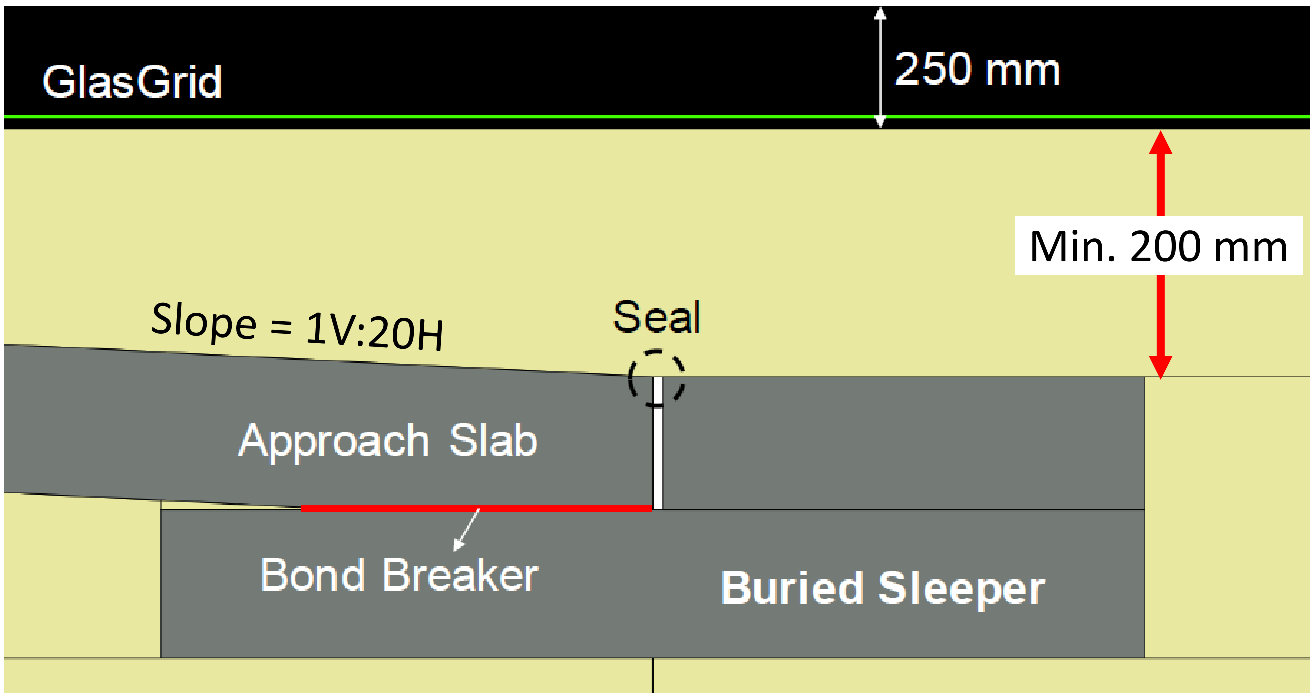
APPROACH SLAB REINFORCING			
APPROACH SLAB LENGTH *	APPROACH SLAB THICKNESS	SKEW	BOTTOM REINFORCING (spaced perpendicular to CL construction)
10-ft.	15-in.	0° - 45°	#7 sp. @ 12-in.
15-ft.	15-in.	0° - 45°	#8 sp. @ 12-in.
20-ft.	15-in.	0° - 25°	#6 sp. @ 6-in.
		26° - 45°	#7 sp. @ 6-in.
25-ft.	15-in.	0° - 25°	#7 sp. @ 6-in.
		26° - 45°	#8 sp. @ 6-in.
30-ft.	15-in.	0° - 25°	#8 sp. @ 6-in.
		26° - 45°	#9 sp. @ 6-in.

APPROACH SLAB % SLOPE		
ROADWAY SLOPE	DOWNHILL APPROACH SLAB SLOPE	UPHILL APPROACH SLAB SLOPE
0%	-5%	-5%
0% < SLOPE ≤ 1%	-6%	-5%
1% < SLOPE ≤ 2%	-7%	-5%
2% < SLOPE ≤ 3%	-8%	-5%
3% < SLOPE ≤ 4%	-9%	-5%
4% < SLOPE ≤ 5%	-10%	-5%
5% < SLOPE ≤ 6%	-11%	-5%
6% < SLOPE ≤ 7%	-12%	-5%
7% < SLOPE ≤ 8%	-13%	-5%
8% < SLOPE ≤ 9%	-14%	-5%
9% < SLOPE ≤ 10%	-15%	-5%

Case Studies

- Ontario, Canada – new approach slab detail

Reinforced asphalt



Recommendations

- Explore use of sleeper slabs
- Explore alternate embankment fill materials well.
- Explore alternative URETEK products
- Explore PPC overlays
- Instrument test BAS to track settlement