

# Transportation Research: From Theory to Practice

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# Outline

- Background
- 18-3P: Flood damaged roadways
- 12-7C: Roller compacted concrete
- 17-6SS: e-Construction
- Summary
- Discussion



# Background

- LTRC's role
  - Conduct a comprehensive, high quality, research program
  - Foster innovative solutions to complex transportation problems
  - Benefit DOTD, local entities, consultants, contractors, and traveling public
- Research to practice
  - How long does it take?
- Barriers to implementation?



# 18-3P: Flooded Roadways

- Best practices for assessing roadway damages caused by flooding
- Contractor
  - Mingjiang Tao and Rajib Mallick
  - Department of Civil and Environmental Engineering
  - Worcester Polytechnic Institute



# How to Evaluate Flood Damage?



Freeways in the downtown Houston area with continuously reinforced concrete pavement (CRCP) remained intact after Hurricane Harvey. "It is the joint area where many distresses occur in concrete pavement. This could certainly be one of the reasons why CRCP outperforms jointed concrete pavement," says TxDOT spokesman Danny Perez.

Source: TxDOT.



# Objectives

- Determine best practices for assessing roadway damages
- Develop multiple levels of roadway damage assessment protocols

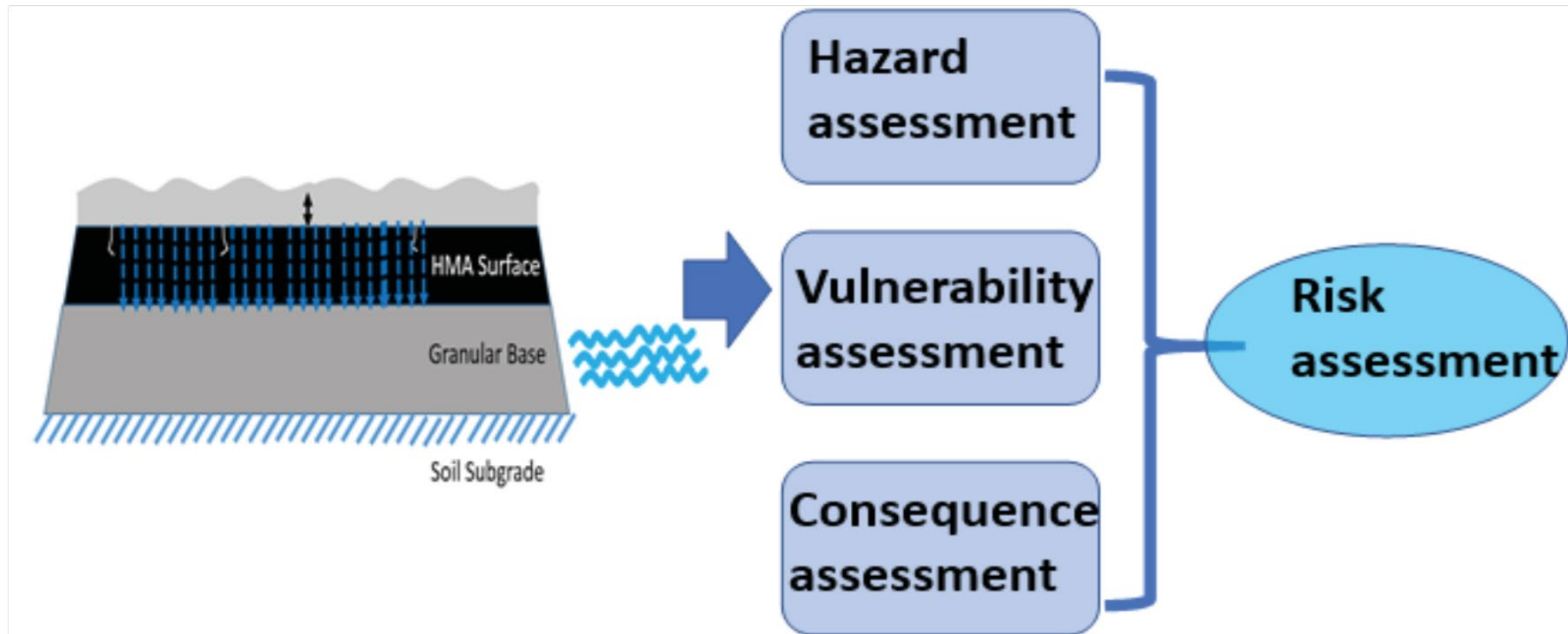


# Methodology

- Literature review
- Questionnaire survey
- Development of engineering protocol levels
  - Topic of today's discussion



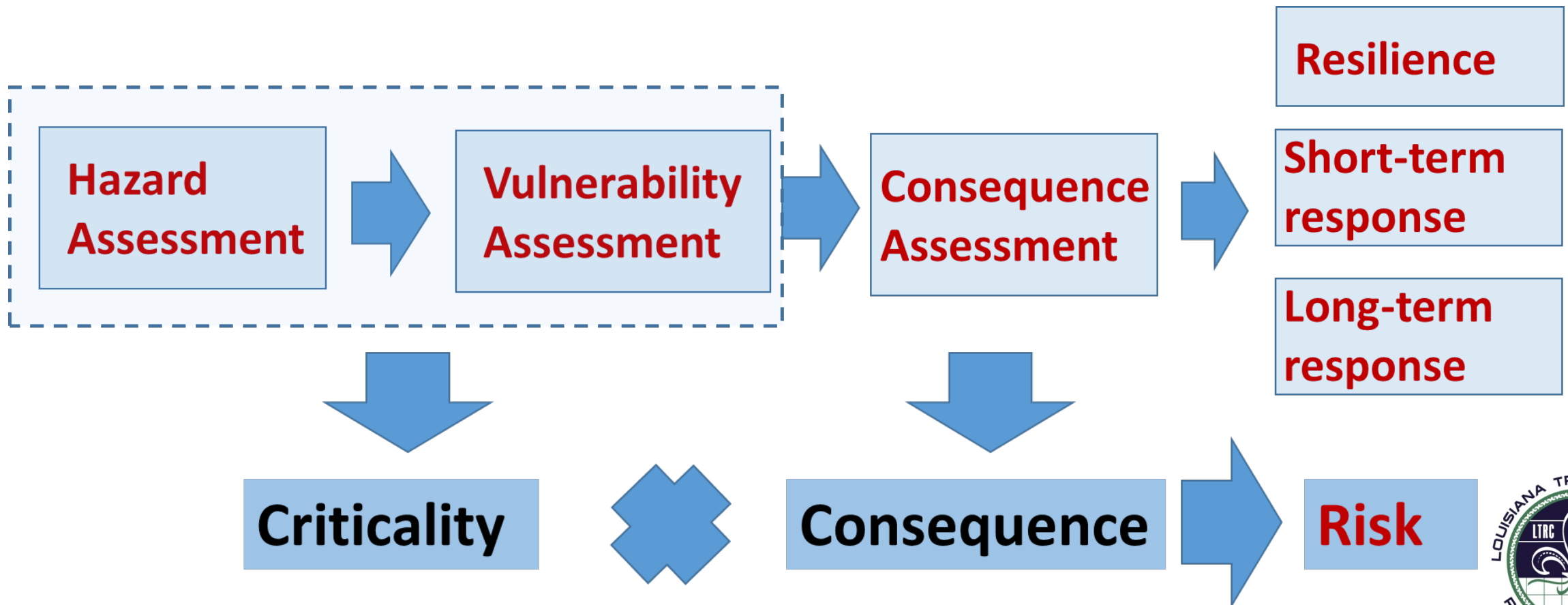
# Parameters in Engineering Protocol Levels





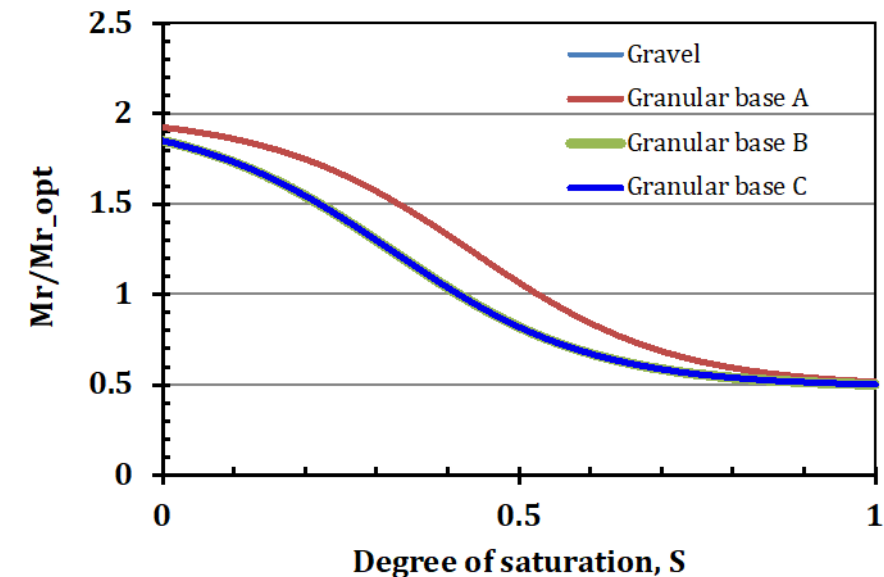
# Risk Factor (RF) – A Composite Indicator

$$RF = \text{Hazard Factor} \times \text{Vulnerability Factor} \times \text{Consequence Factor}$$



# Damage Mechanisms During Flooding

- Base, subbase, and subgrade lend strength
- Flooding reduces strength by reduction in stiffness
- Erosion
- Deterioration in HMA (reduced adhesion and cohesion)



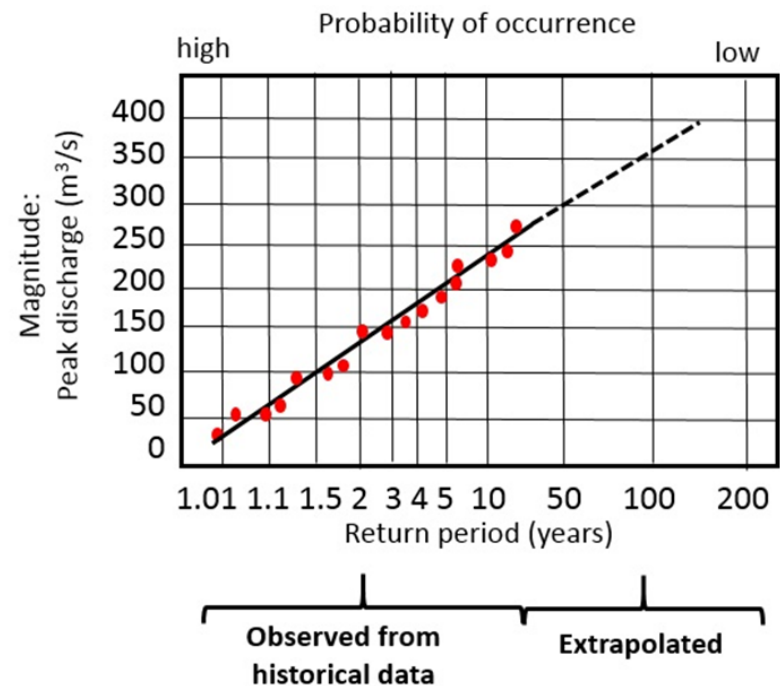
# Common Techniques for Structural Assessment

- FWD
- GPR
- DCP
- Visual Inspection



# Hazard Assessment (Hazard Factor)

- Parameters are unit-less with changeable weighting factors per site conditions
- Detailed procedures and formulas are in the report



Flood characteristics	Hazard factor
100-year flood	5
50-year flood	3
10-year flood	1



# Vulnerability Assessment (Vulnerability Factor)

- VF<sub>1</sub> (0 or 1): Flooding (1) or no flooding (0)
  - Based upon FEMA flood maps
- VF<sub>2</sub> (1-5): Structural loading capacity
  - Based on drainage, subgrade type, and surface layer conditions

$$VF = VF_1 \times VF_2$$

- Detailed formulas and procedures are in the report



# Consequence Factor (CF)

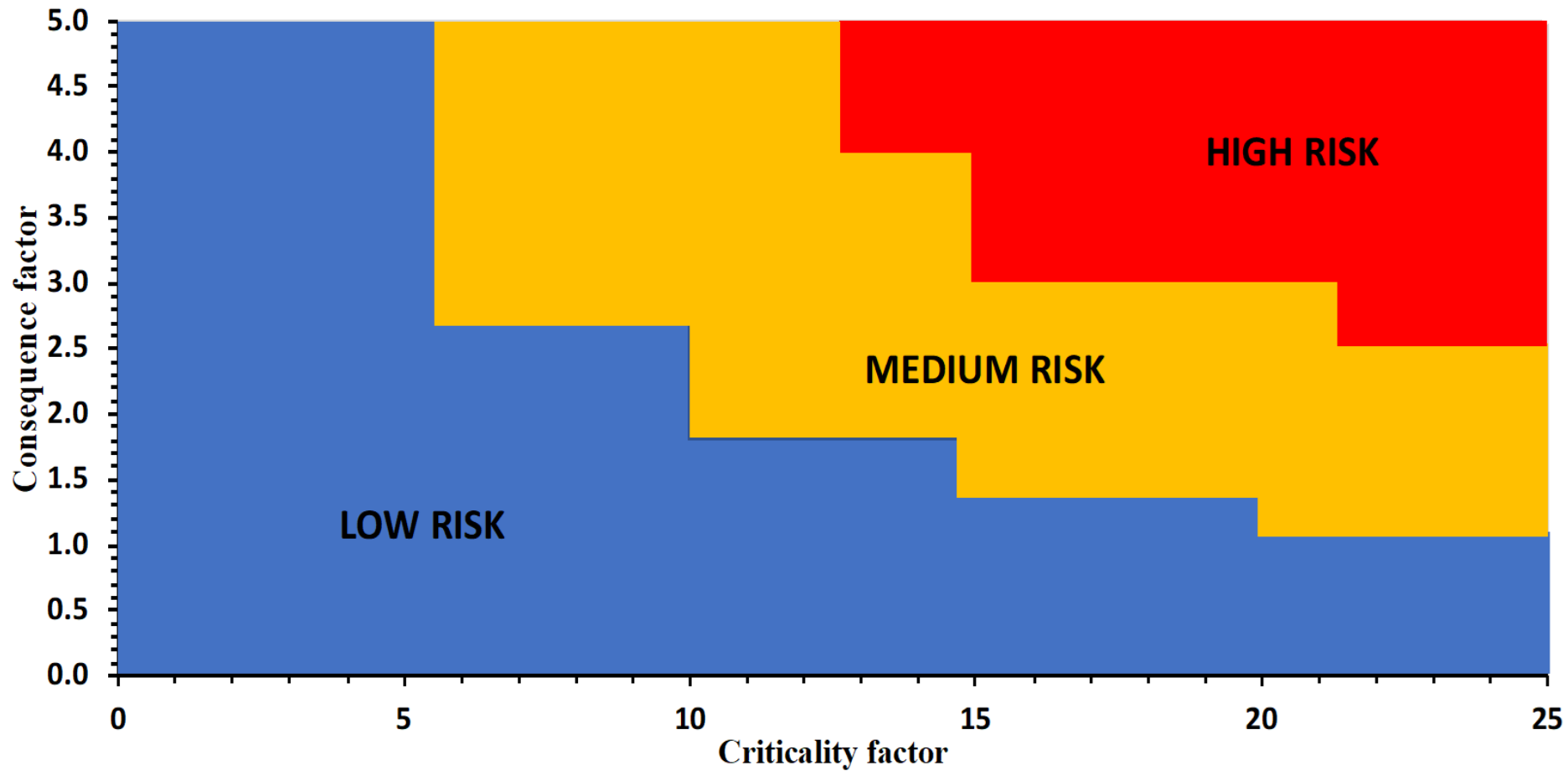
- Weighted sum (w) of the parameters related to replacement / repair cost (RC) and the cost of service restriction to drivers (CD)

$$CF = w_{RC} * RC + w_{CD} * CD$$

Functional class of roadways	replacement/ repair cost	Traffic volume (AADT)	cost of service restriction to drivers
Interstates & Other Arterials	5	>3,000	5
Collectors	3	400-3,000	3
Local roads	1	<400	1



# Risk Assessment



# 12-7P: Roller Compacted Concrete

- Results from LTRC's Accelerated Loading Facility
- Contractor
  - Zhong Wu and Tyson Rupnow
  - LTRC and LSU





# Background and Methodology

- Need exists for a low volume roadway solution for heavy trucks, agriculture equipment, and shale gas / oil exploration
- Several successful projects around the US
  - 10" RCC near Aiken, SC
  - 7" and 8" RCC in Northern Arkansas

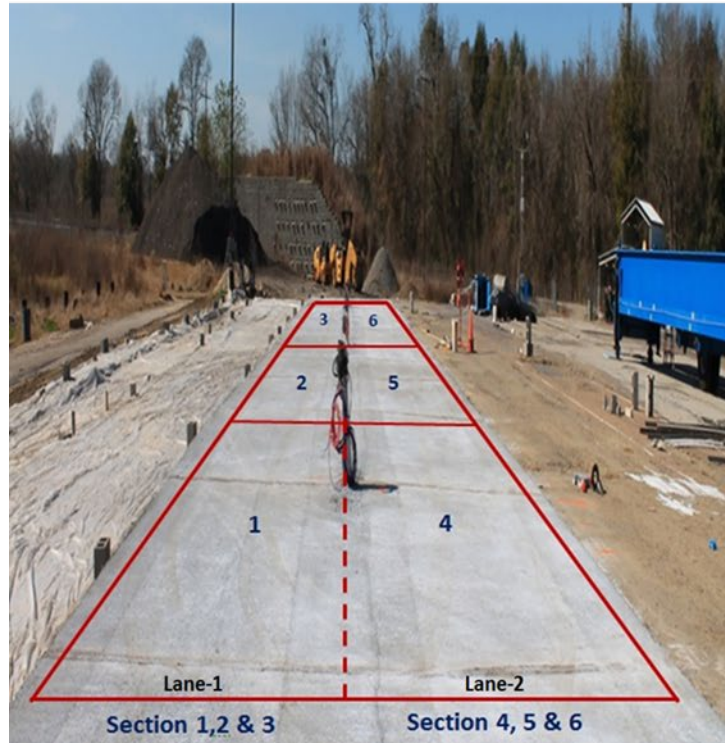


# Objectives

- Determine structural performance with failure mechanism(s) and load carrying capacity of thin RCC surface pavements
- Determine the applicability of using thin RCC pavement structures (with cement treated or stabilized base) as a design option for low and high volume pavement design in Louisiana



# Constructed Sections



8 " RCC
12 "Cement Treated Base
Existing Subgrade

Section 1

6 " RCC
12 "Cement Treated Base
Existing Subgrade

Section 2

4"RCC
12 "Cement Treated Base
Existing Subgrade

Section 3

8 " RCC
8.5" Soil Cement Base
10" Cement Treated Subgrade
Existing Subgrade

Section 4

6 " RCC
8.5" Soil Cement Base
10" Cement Treated Subgrade
Existing Subgrade

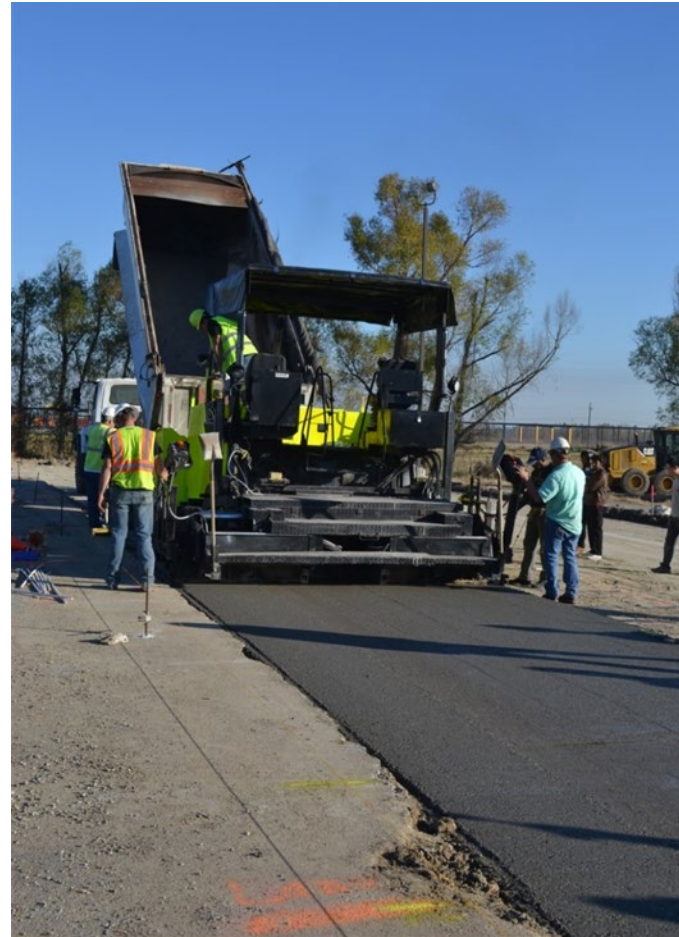
Section 5

4"RCC
8.5 "Soil Cement Base
10" Cement Treated Subgrade
Existing Subgrade

Section 6

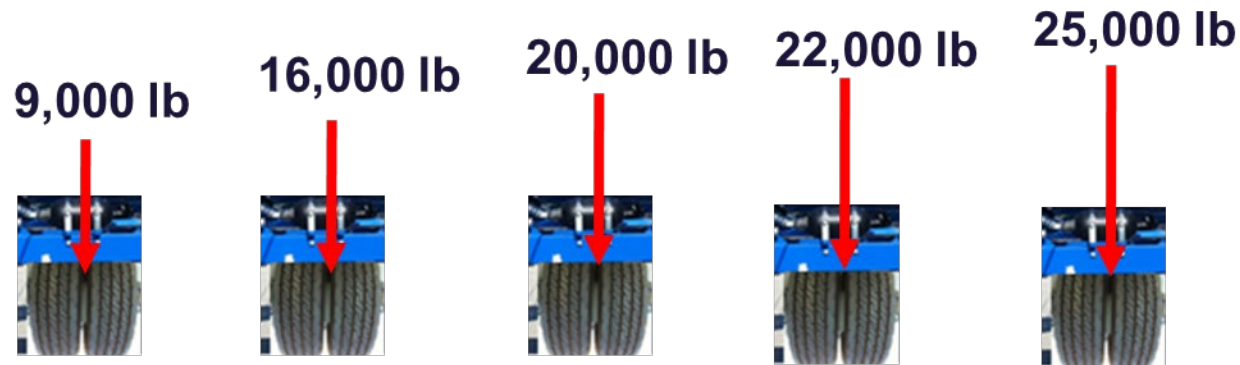


# Pictures



# Accelerated Loading Testing

- 78,000 passes for each load level
  - ~1 week per level



# Distress Observed (8+8.5RCC) – Section 4

- Approximately after 392,500 load repetition (11.28 million equivalent ESALs), no significant damage was observed
- Due to the high load repetitions received on section 6+8.5RCC to fatigue failure, the test was discontinued



# Distress Observed (6+8.5RCC) – Section 5

- Visual Distresses
- Longitudinal cracks were observed along the wheel path and at the edge of the tire print
- Pumping action was observed through cracks and joints
- 87.4 million ESALs to failure
- ***1.9 million ESALs predicted***



# Distress Observed (4+8.5RCC) – Section 6

- Visual Distresses
- Longitudinal cracks were observed along the wheel path and at the middle of the tire print
- Pumping action was observed through the cracks and joints
- 19.2 million ESALs to failure
- ***0.7 million ESALs predicted***





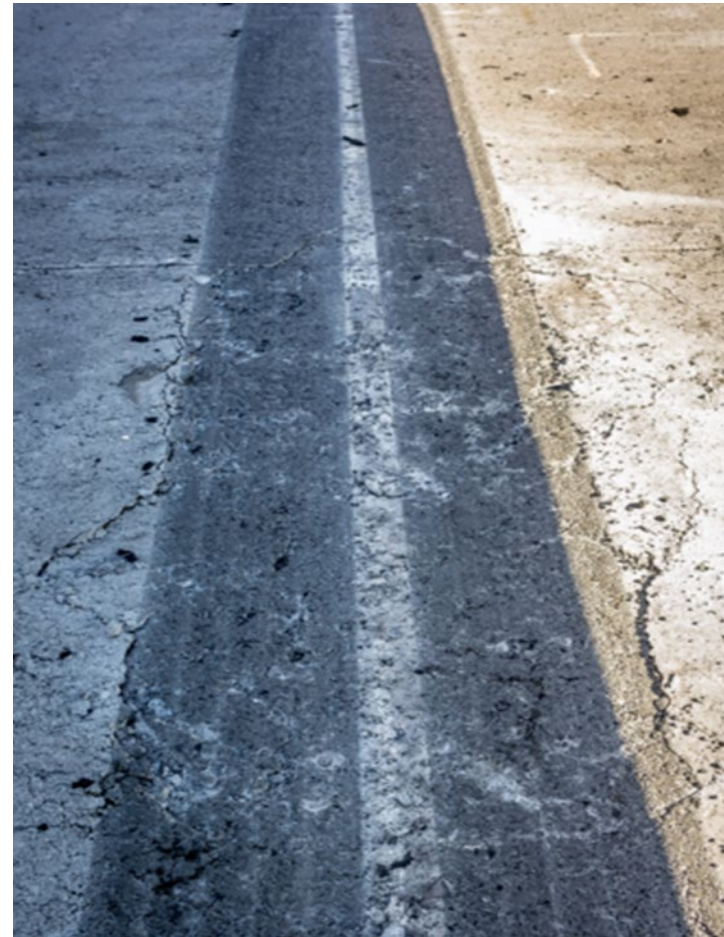
# Distress Observed (4+12RCC) – Section 3

- Due to relatively weaker support, an early longitudinal crack was observed after 55,000 passes under 9 loading
- About 3 million ESALs to failure
- ***Predicted 0.7 million ESALs to failure***



# Distress Observed (6+12RCC) – Section 2

- Longitudinal cracks
- Pumping and Local failure
- About 19 million ESALs to failure
- ***Predicted 1.9 million***



# Construction Cost Analysis

- 13-ft wide , 1 mile length
  - RCC = \$198,082
  - HMA = \$311,169
- Typical 2-lane, 10 mile long project
  - 5-in RCC vs. 7-in HMA
  - Total cost savings up to \$2,261,740



# Implementation

- The ATLaS30 loading results generally indicate that
  - a thin-RCC over soil cement pavement structure has a superior load carrying performance
  - Recommendation to select and build several field RCC test sections on those Louisiana highways where the pavements are often encountered by heavy truck loading
    - To validate the APT performance and provide further implementation guidelines
  - ***Will not test the 8-inch sections to failure!***
- **LCG paving three sections this weekend!**



# 17-6SS: E-Construction Inspection Technology

- Current project delivery
  - Resource intensive
  - Valuable information
  - Heavily paper based
- Future project delivery
  - Leverage existing technologies
  - Accumulated project intelligence = asset intelligence

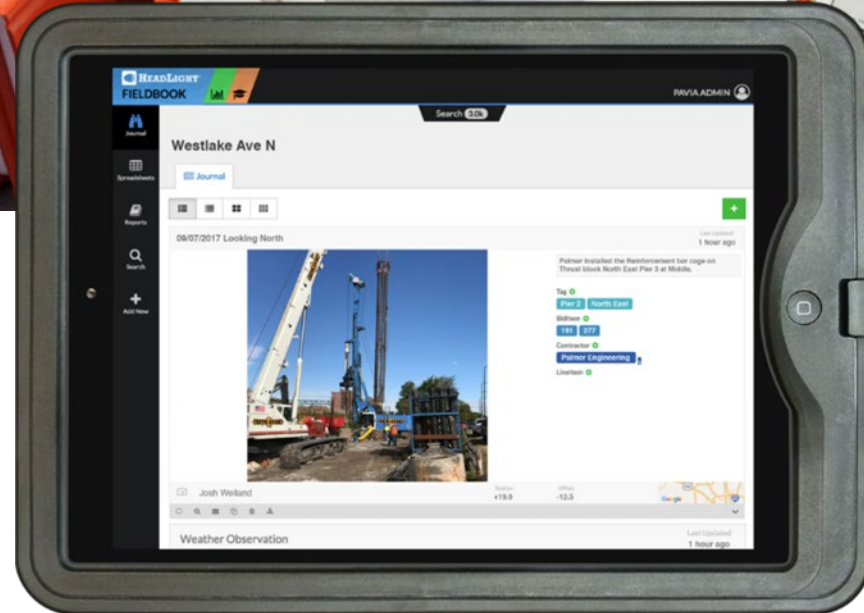
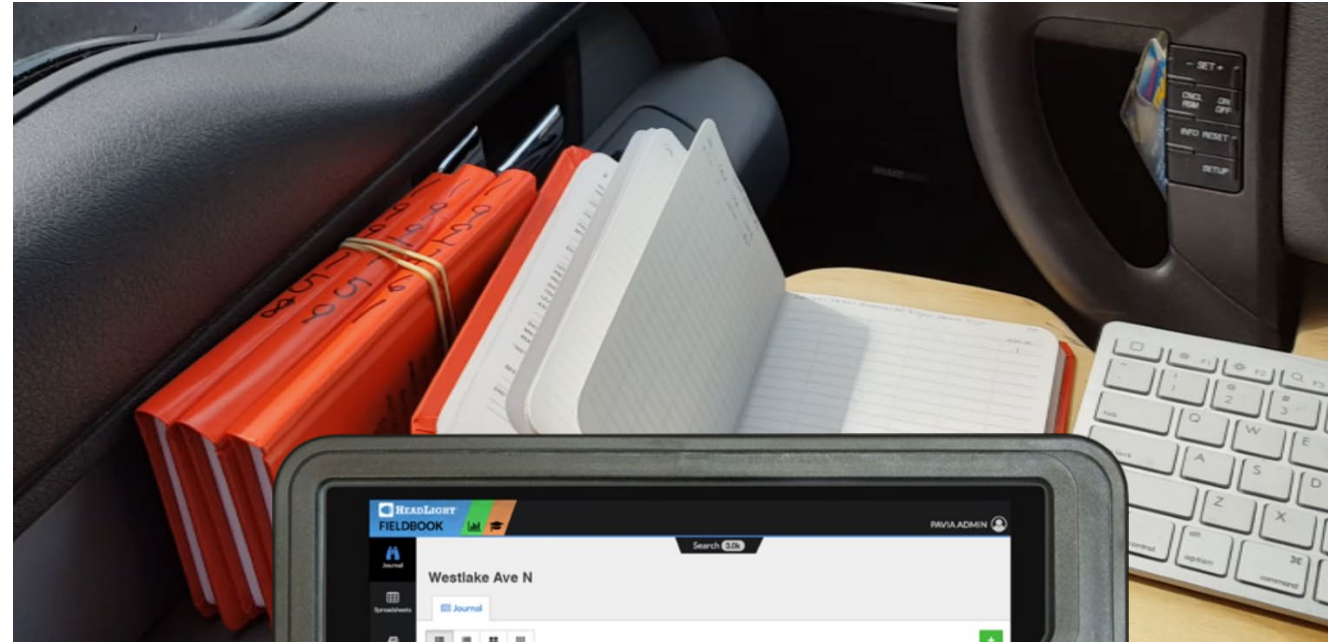


# Background

- Move Louisiana forward
- More timely submission of DWRs
- Potential to lower claims
- All lead to
  - Reduced risk
  - Accelerated delivery
  - Increased accountability
  - Increased efficiency



# Equipment



# Observations



The screenshot shows the Fieldbook mobile application interface. At the top, the "Fieldbook" header includes a search bar and a user profile icon labeled "LF". The main title of the entry is "H.009012.6: LA 10 & LA 67 INTERSECTION WIDENING". A sidebar on the left contains navigation icons for Journal, Spreadsheets, Reports, and New. The main content area displays the title "Storm drain" and a "Last Updated 3 months ago" timestamp. Below this is a photo of the storm drain pipe with a "28'" measurement arrow, and a smaller inset of the technical drawing. To the right of the photo, there is a list of "LineItems" including "0014 Storm Drain Pipe (15\" R...)", "Tags" such as "02-General Remarks", "Concrete", "Drainage", and "Measurements", and "Contractors" including "Barber Bros. Contracting Co...". At the bottom, the user's name "Lester Fletcher" is shown along with stationing "110+95", offset "Rt", and location coordinates "30.8657, -91.0151".





# Observations



Journal

H.009012.6: LA 10 & LA 67 INTERSECTION WIDENING

Select +

Dip in curb grade Last Updated 3 weeks ago

Noticed a dip in curb grade while inspecting forms. Informed superintendent of issue. He stated the grade was to plans. After review of plans, I informed the superintendent about the finished asphalt grades in this area (on sheet 16) indicate a steady rise in elevation. Barry shot the grade of the forms with a sight level and discovered a bad hub at the dip. Contractor adjusted the elevation and corrected forms.

LineItems  
0116 Combination Concrete...

Tags  
Does Not Meet Specifications

Equipment

Contractors  
Barber Bros. Contracting Co...

Lester Fletcher Station 111+40 Offset Rt Location 30.8657, -91.0151



HEADLIGHT Fieldbook

Search

H.009012.6: LA 10 & LA 67 INTERSECTION WIDENING

Select +

Lester Fletcher 107+00 Rt 30.8657, -91.0172

Curb measurement/form corrected Last Updated 3 weeks ago

76 LNFT curb and gutter.

LineItems  
0116 Combination Concrete...

Tags  
Correction Made  
Measurements

Equipment

Contractors  
Barber Bros. Contracting Co...

Lester Fletcher Station 111+00-111+76 Offset Rt Location 30.8658, -91.0151

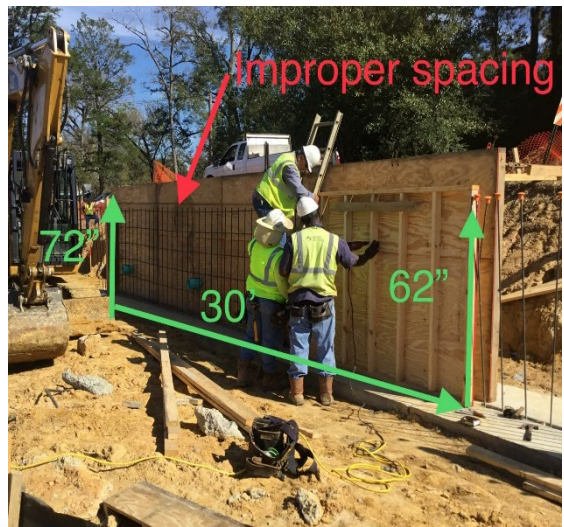
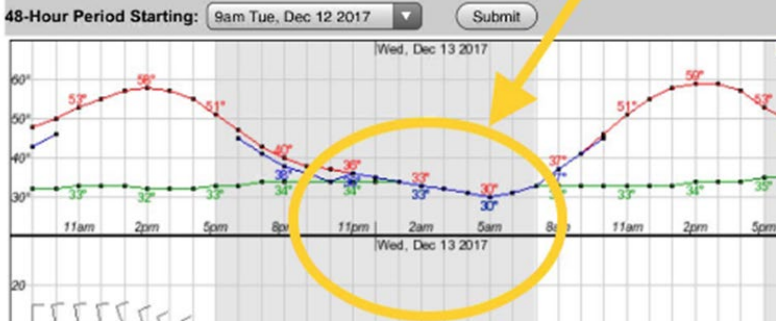


# Documentation

National Weather Service Forecast Office  
**New Orleans/Baton Rouge, LA**  
 Home News Organization Search for: [ ] NWS All NOAA  
 Point Forecast: Clinton LA  
 6N 91.03W Last Update: 8:17 am CST D  
 Daily Weather Forecast Graph

Weather Elements	Fire Weather
<input checked="" type="checkbox"/> Temperature (°F)	<input type="checkbox"/> Mixing Height x100ft
<input checked="" type="checkbox"/> Dewpoint (°F)	<input type="checkbox"/> Lightning Activity Level
<input checked="" type="checkbox"/> Wind Chill (°F)	<input type="checkbox"/> Trans. Wind mph
<input checked="" type="checkbox"/> Surface Wind mph	<input type="checkbox"/> 20ft Wind mph
<input checked="" type="checkbox"/> Sky Cover (%)	<input type="checkbox"/> Atmospheric Dispersion Index
<input checked="" type="checkbox"/> Precipitation Potential (%)	<input type="checkbox"/> Low Visibility Occurrence Risk Index
<input checked="" type="checkbox"/> Relative Humidity (%)	
<input checked="" type="checkbox"/> Rain	
<input checked="" type="checkbox"/> Thunder	
<input checked="" type="checkbox"/> Snow	
<input checked="" type="checkbox"/> Freezing Rain	
<input checked="" type="checkbox"/> Sleet	
<input type="checkbox"/> Fog	

Below 35 deg



# Initial Findings

- Reduced claims
- Future assent management
- Training opportunities
- More complete documentation
- 1.25 more hours of work in the field
- Increased dialogue between Department and Contractors
- Accountability



# Summary

- Final reports
  - ▣ [http://www.ltrc.lsu.edu/pubs\\_final\\_reports.html](http://www.ltrc.lsu.edu/pubs_final_reports.html)
- Technical Summaries
  - ▣ [http://www.ltrc.lsu.edu/pubs\\_final\\_reports.html](http://www.ltrc.lsu.edu/pubs_final_reports.html)
- Project Capsules
  - ▣ [http://www.ltrc.lsu.edu/pubs\\_projectcapsules.html](http://www.ltrc.lsu.edu/pubs_projectcapsules.html)



# Summary

- ALWAYS looking for subject matter experts to serve on Project Review Committees (PRC's)
  - Review scope of work, research team qualifications, and review deliverables
- ALWAYS looking for potential implementation avenues for completed research products
  - LCG has been a GREAT ally in this arena in the past decade



