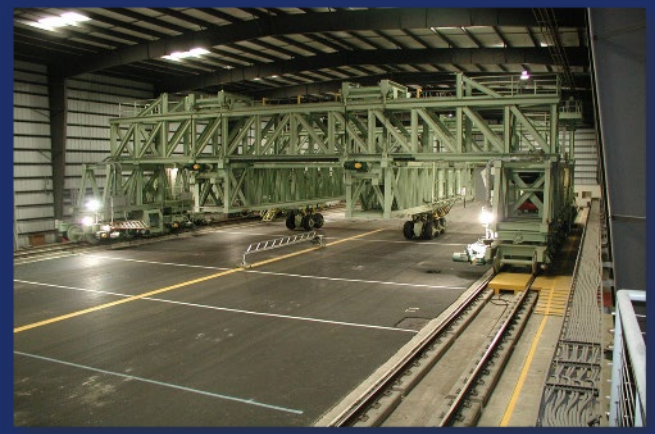
Airport Pavement Research at FAA's Accelerated Pavement Test Facilities



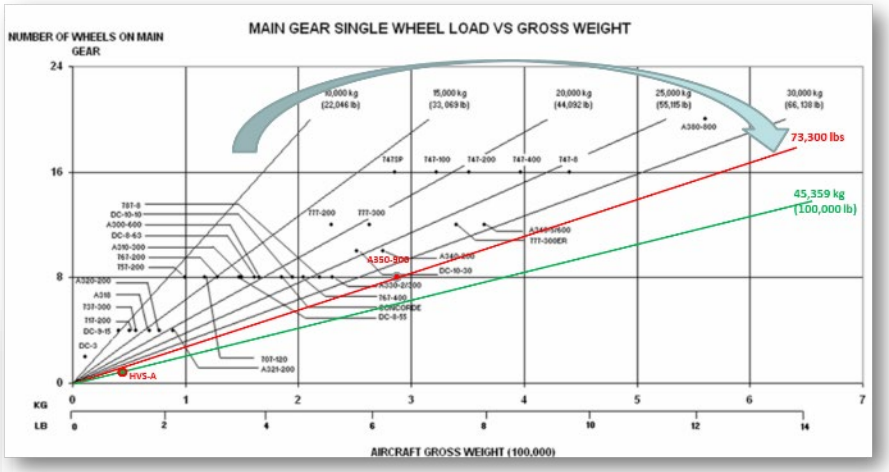
Presented to: Monthly APT Webinar

By: Navneet Garg, Ph.D.
NAPMRC Program Manager
Federal Aviation Administration (FAA)

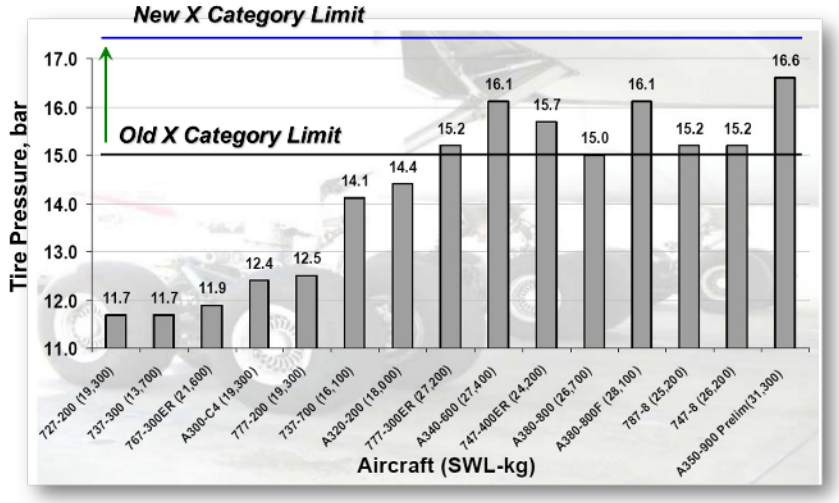
Date: December 14, 2023

Outline

- Introduction
- Research Facilities
- Research at NAPMRC
- Research at NAPTF
- New Research Initiatives



[Published by the International Industry Working Group (IIWG), 2010]



U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Standard Specifications for Construction of Airports
Date: 12/21/2018
Initiated By: AAS-100
AC No: 150/5370-10H
Change:

1 **Purpose.**
The standard specifications contained in this advisory circular (AC) relate to materials and methods used for construction on airports. Items covered in this AC include general provisions, earthwork, flexible base courses, rigid base courses, flexible surface courses, rigid pavement, fencing, drainage, turf, and lighting installation.

2 **Cancellation.**
This AC cancels AC 150/5370-10G, *Standards for Specifying Construction of Airports*, dated July 21, 2014.

3 **Application.**
The Federal Aviation Administration (FAA) recommends the guidelines and specifications in this AC for materials and methods used in airfield development for construction and rehabilitation projects on airports.

This AC does not constitute a regulation and is not mandatory, however the following applies:

a. The standard specifications contained in this AC are practices that the FAA recommends for the construction of pavements and airport development serving aircraft greater than 30,000 pounds (13,600 kg).

b. This AC contains methods and procedures for compliance with 14 CFR part 139 that are acceptable to the Administrator.

c. The use of this AC is mandatory for all projects funded under Federal grant assistance programs, including the Airport Improvement Program (AIP). See Grant Assurance No. 34., *Policies, Standards, and Specifications*.

d. This AC is mandatory, as required by regulation, for projects funded with the Passenger Facility Charge program. See PFC Assurance #9, *Standards and Specifications*.

For building construction, the General Contract Provisions are applicable, in addition applicable laws and local building codes shall serve as construction standards acceptable to the FAA.

- Standards for Specifying Construction of Airports.
- Most recent version – released December 21, 2018.
- Required to be used for all projects funded under an Airport Improvement Program (AIP) grant (U.S.).
- Available at: http://www.faa.gov/airports/resources/advisory_circulars/

FAA Airport Technology R&D Program

- Research conducted at the FAA William J. Hughes Technical Center, Atlantic City, NJ, USA.
- Sponsor: FAA Office of Airport Safety and Standards (AAS110), Washington, DC.
- Provide support for development of FAA pavement standards (Advisory Circulars).

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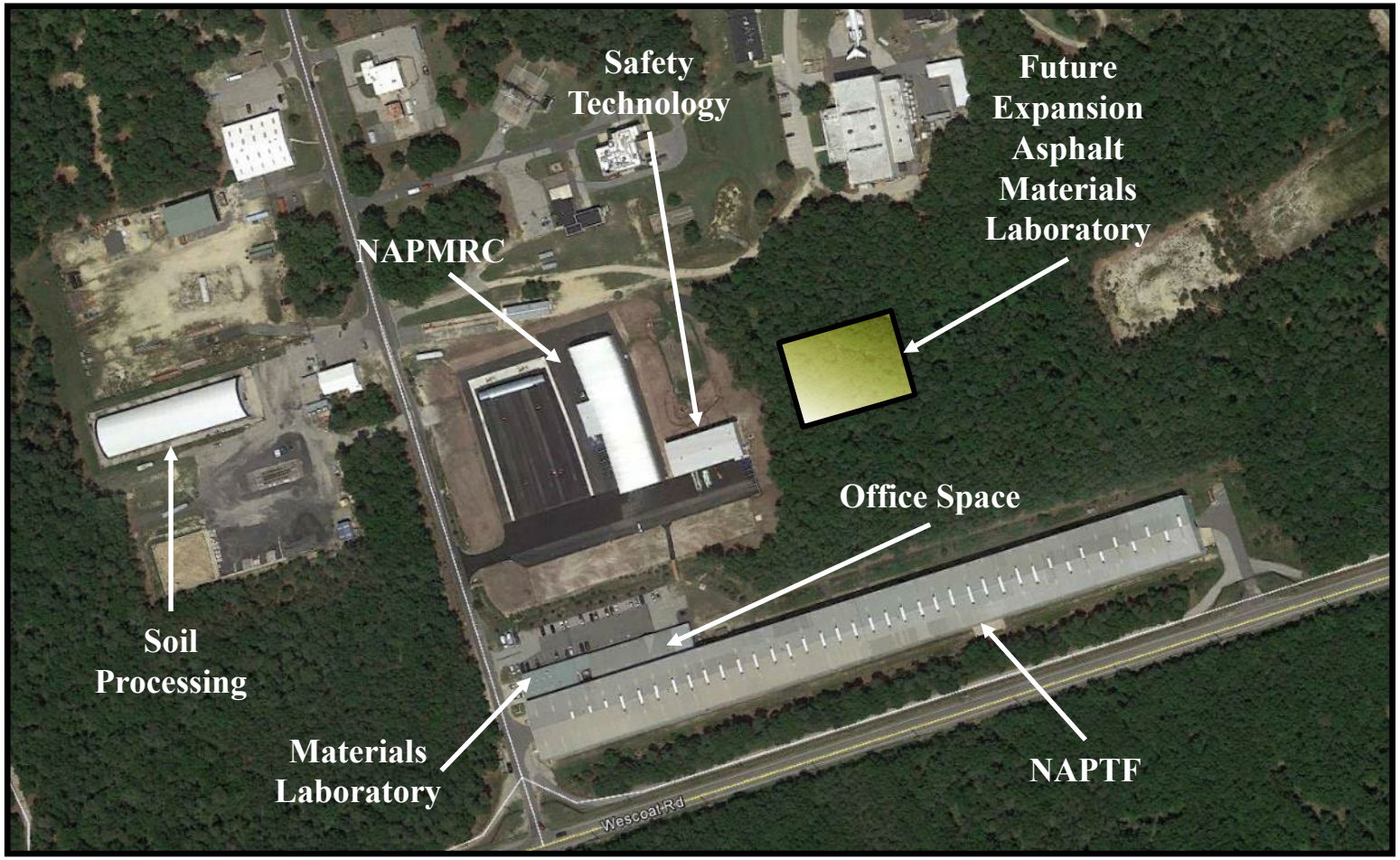
Airport Pavement R&D Program - Facility Layout



National Airport Pavement Test Facility (NAPTF)

Facility Facts:

- FAA / Boeing (CRDA) Partnership at $21M
- Opened April 1999
- Fully Enclosed Facility
- Accelerated Traffic Testing
- 900 ft. x 65 ft. of Test Pavement Surface
- Full-scale Pavement Structures and Landing Gear Loads

Test Vehicle Facts:

- Fully Automated & Programmed Wander Patterns
- Up to 5-dual wheel configuration
- Roughly 1.3 Million lbs.
- Up to 75,000 lbs. per wheel

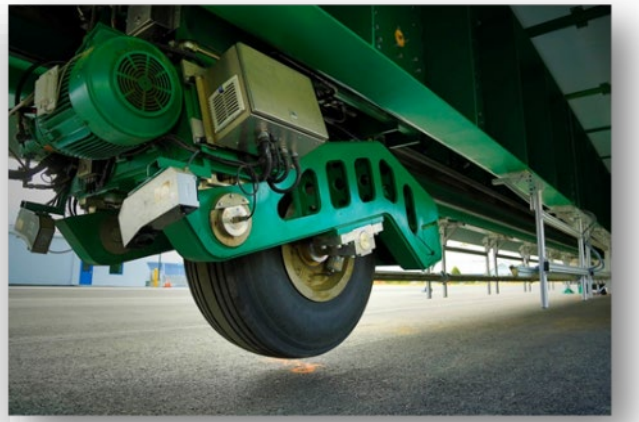
National Airport Pavement Materials Research Center (NAPMRC)

Facility Facts:

- Dedication Ceremony August 2015
- Indoor and Outdoor Testing Capability
- Accelerated Traffic Testing
- Outdoor: 150ft. x 300ft. & Indoor: 72ft. x 300ft.
- Accelerated resurfacing

HVS-A Facts:

- Wheel loads - 10,000 (44.48 kN) to 100,000 lbs (444.8 kN).
- Pavement temperatures up to 150°F (67°C)
- Test speeds - 0.17 to 5 mph (0.27 to 8 kmph)
- Single and Dual-Wheel configuration.
- Single wheel - radial aircraft tire size 52x21.0R22
- Dual wheel assembly (B-737-800)
- Wander Width – 6 feet (1.83 m)



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Test Cycle-2 (TC2) Objectives

- Compare WMA performance with P401 HMA performance (rutting);
- Compare WMA performance with P401 HMA performance (fatigue);
- Compare performance (rutting & fatigue) of different WMA additives;
- Evaluate performance of RAP+WMA


L-3
WMA 76-22
SASOBIT
L-4
WMA 76-22
ADVERA

Test Cycle-2 (TC2)

OUTDOOR LANES

Lane-1 – HMA
Lane-2 – WMA Chemical
Lane-3 – WMA Organic
Lane-4 – WMA Hybrid

INDOOR LANES

Lane-5
3-in WMA Organic
6-in WMA Organic + RAP

Lane-6
9-in WMA Organic + RAP

Test Cycle 2 (TC2) – Traffic Tests

- **Tire pressure 254 psi (1.75 MPa)**
- **Wheel Load 61,300 lbs (272.7 kN)**
- **High Temperature Rutting Tests**
  - Pavement Temperature: 120 deg. F (49 deg.C) measured at a depth of 2-inch (50 mm) below pavement surface.
  - Failure criterion: 1 inch (2.54 cm) surface rut
- **Low Temperature Fatigue Tests**
  - Pavement Temperature: 68 deg. F (20 deg.C) measured at a depth of 2-inch (50 mm) below pavement surface.
  - Failure criterion: evidence of fatigue cracking

Fatigue Tests

AGING OF TEST AREA:

- Pavement Temperature: 120 deg. F measured at a depth of 2-inch below pavement surface.
- Test Lane will be subjected to these conditions for a period of 336 hours (14 days).
- After 336 hours of aging, heaters will be turned off and insulation panels removed.
- Wait till the pavement temperature stabilizes to ambient conditions.
- Place insulation panels back and prepare for Response Tests & Traffic Tests.
- Fatigue Test Pavement Temperature – 68 deg. F.


FAA Airport Technology R&D
Made in USA

Test Cycle-2 (TC2) – Test Section Layout

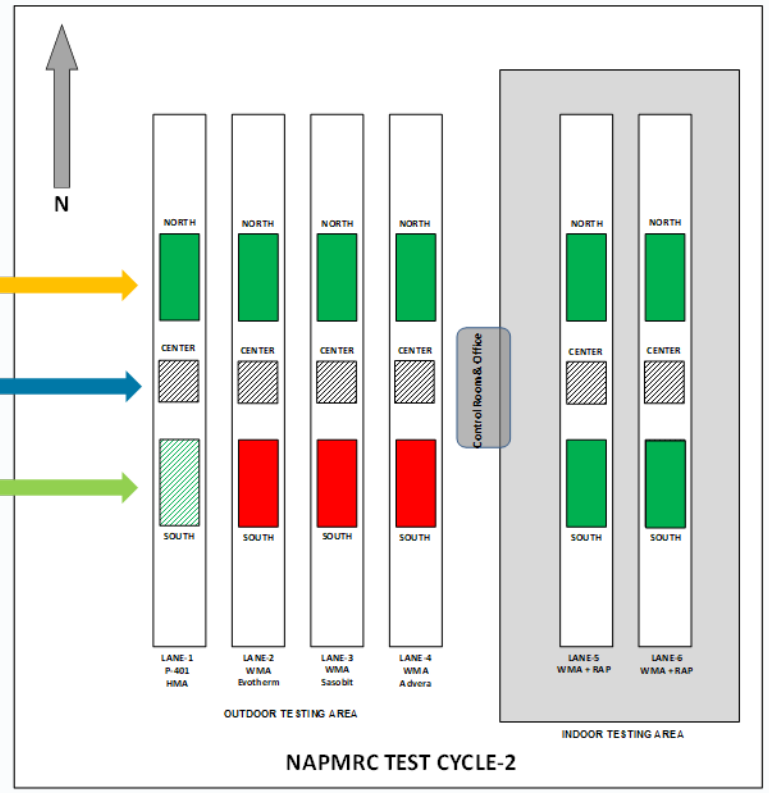
High Temperature (120 deg.F) Rutting Tests

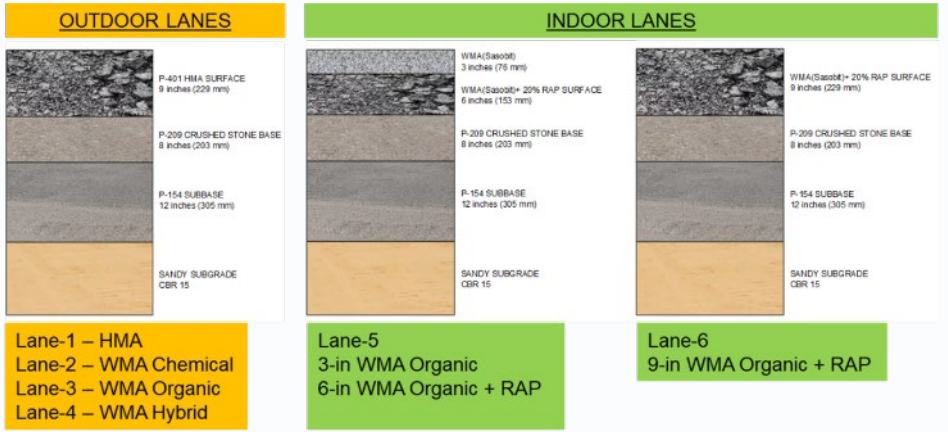
Variable Temperature & High Temperature Rutting Tests

Low Temperature (68 deg.F) Fatigue Tests

Aged Test Section Ready for Fatigue Tests

Currently testing



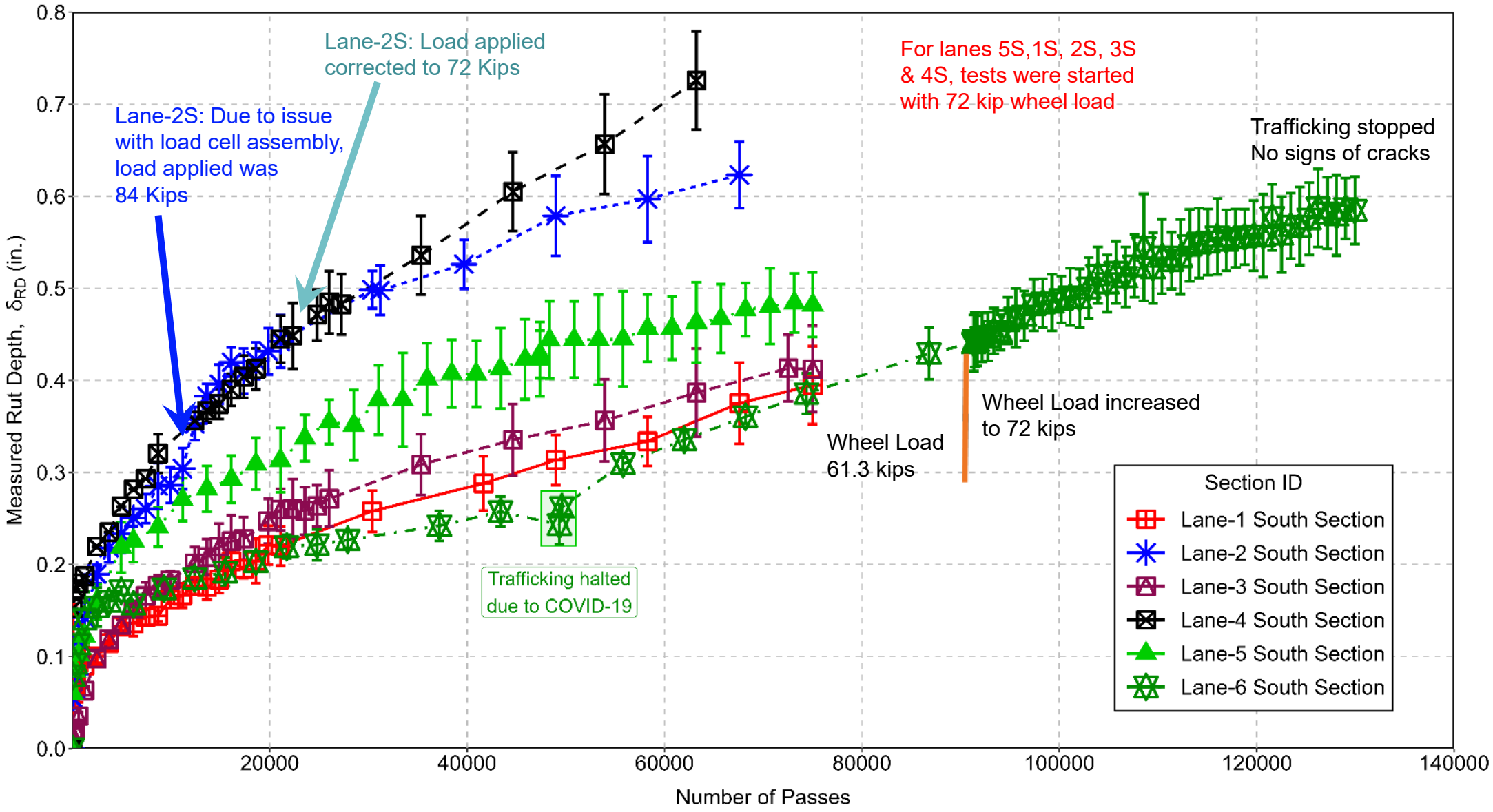


Lane-1 – HMA
Lane-2 – WMA Chemical
Lane-3 – WMA Organic
Lane-4 – WMA Hybrid

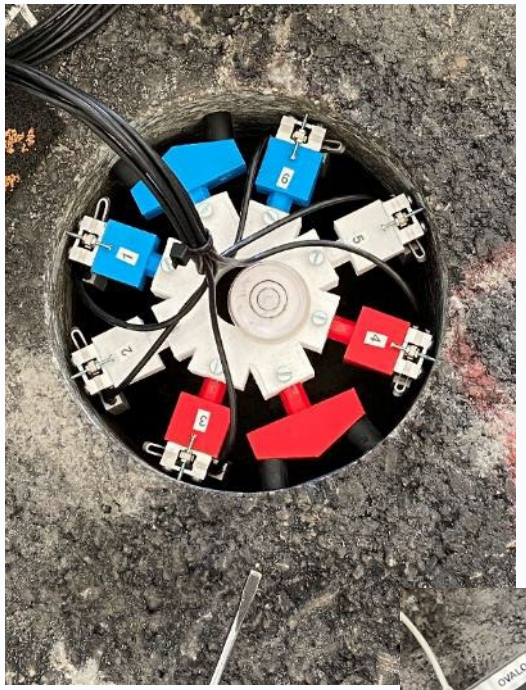
Lane-5
3-in WMA Organic
6-in WMA Organic + RAP

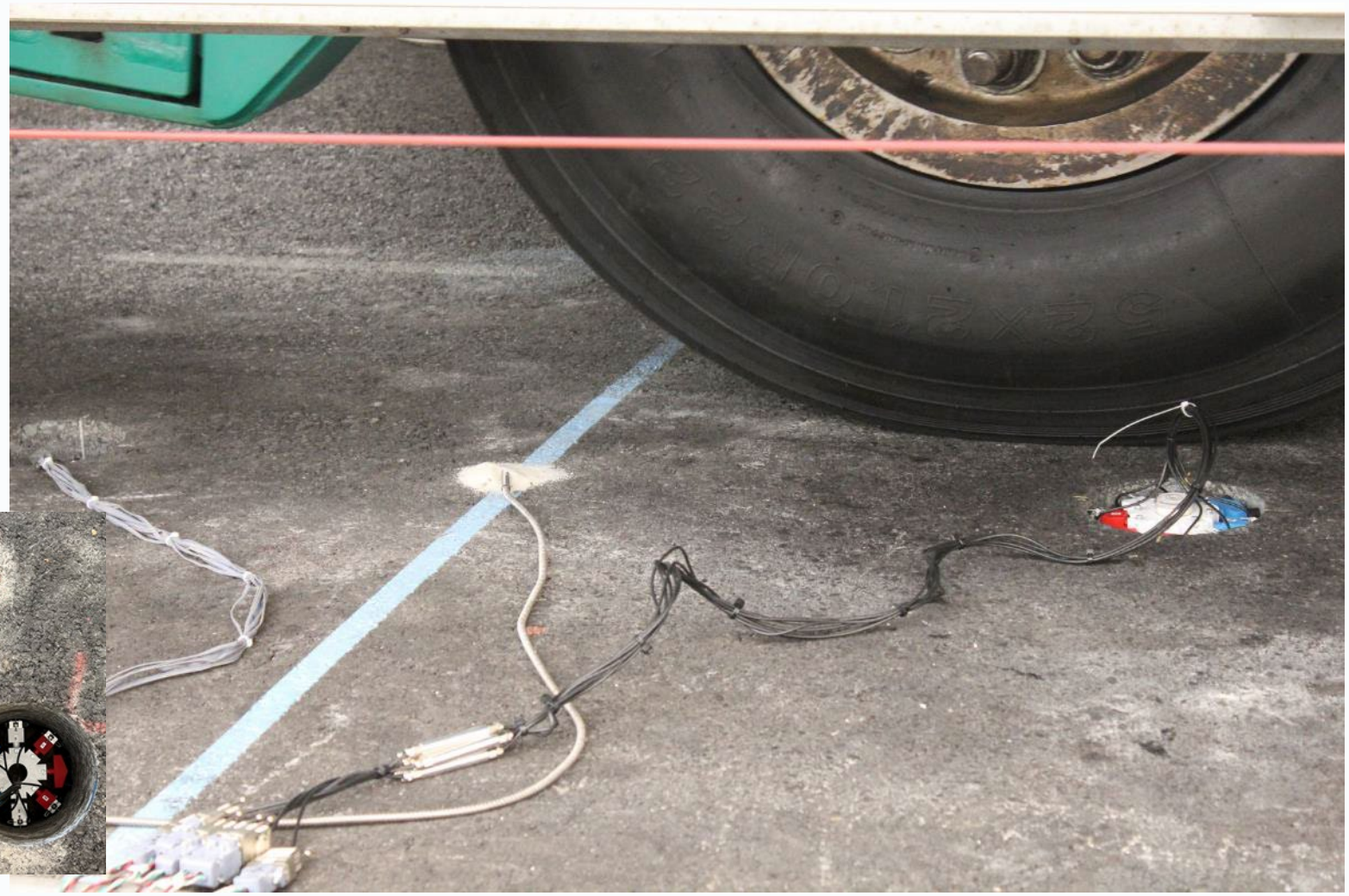
Lane-6
9-in WMA Organic + RAP

- Figure above shows status of testing as of presentation made in December 2022.
- Fatigue testing on all South sections were completed in September 2023.
- No signs of fatigue cracking in any lane.


Lane-2S: Load applied corrected to 72 Kips
Lane-2S: Due to issue with load cell assembly, load applied was 84 Kips
For lanes 5S,1S, 2S, 3S & 4S, tests were started with 72 kip wheel load
Trafficking stopped No signs of cracks
Wheel Load increased to 72 kips
Wheel Load 61.3 kips
Trafficking halted due to COVID-19
Section ID
Lane-1 South Section
Lane-2 South Section
Lane-3 South Section
Lane-4 South Section
Lane-5 South Section
Lane-6 South Section
Measured Rut Depth, δ_{RD} (in.)
Number of Passes
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
20000
40000
60000
80000
100000
120000
140000

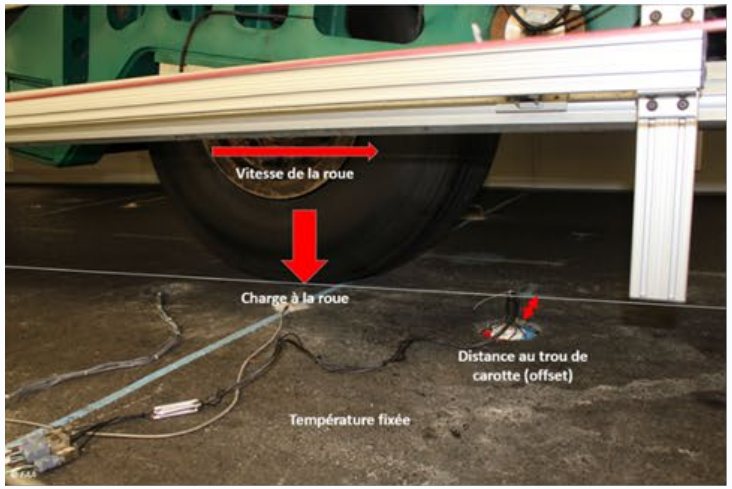
French Ovalization Device

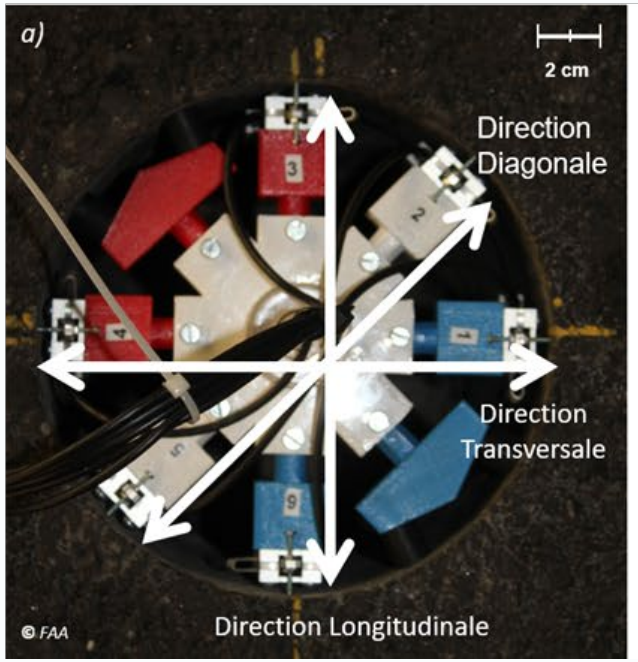


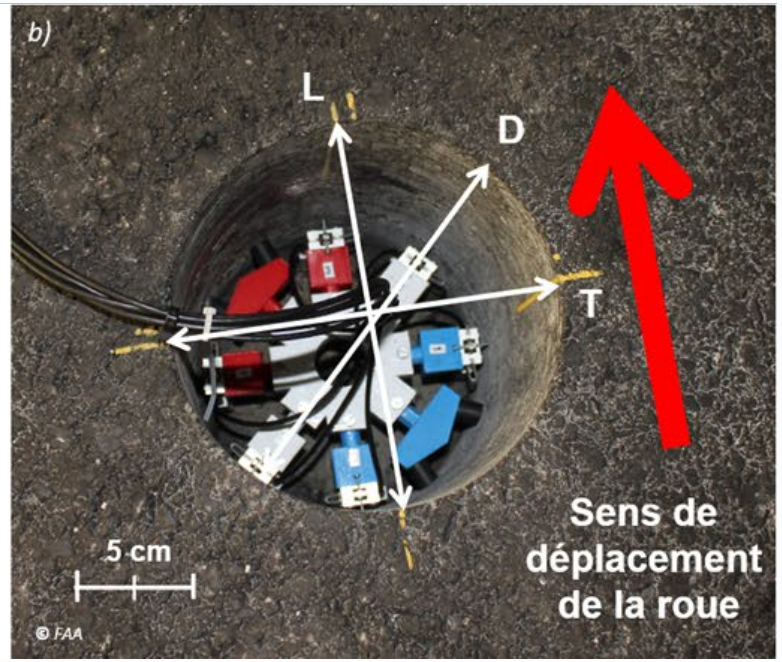


French Ovalization Device

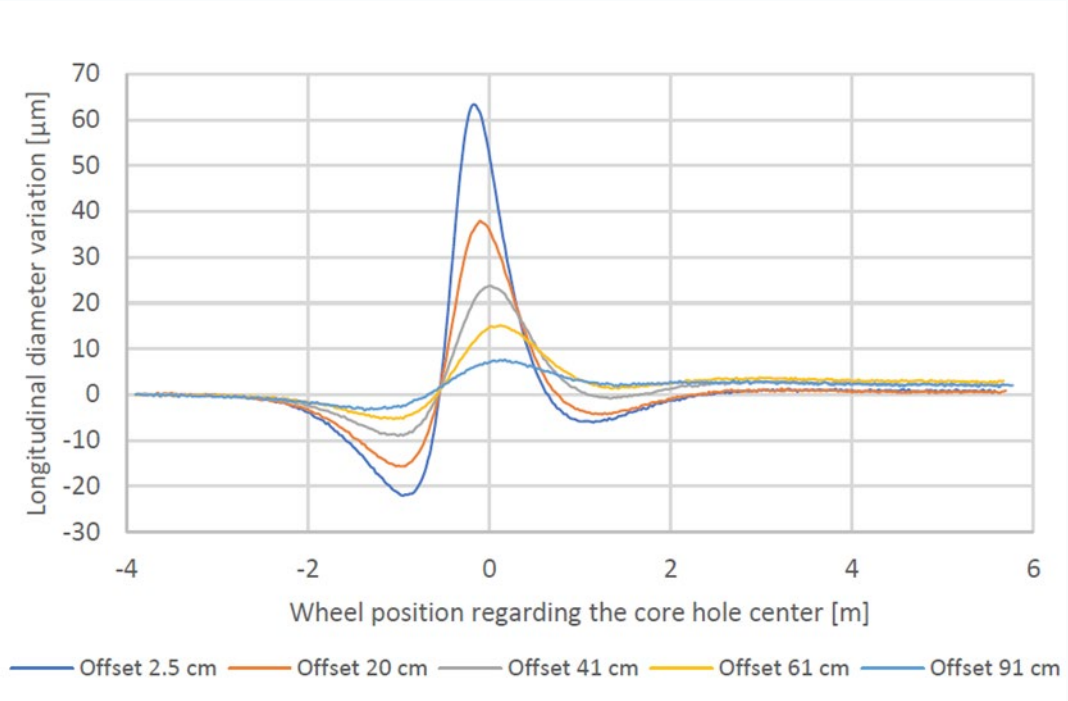
French Ovalization Device





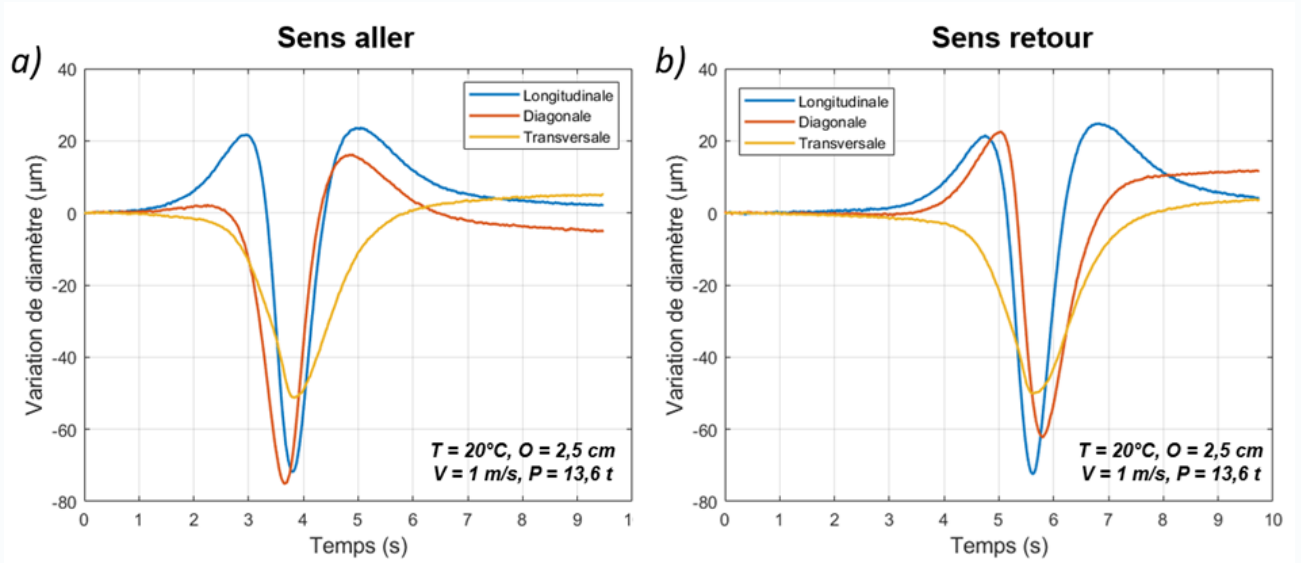


French Ovalization Device



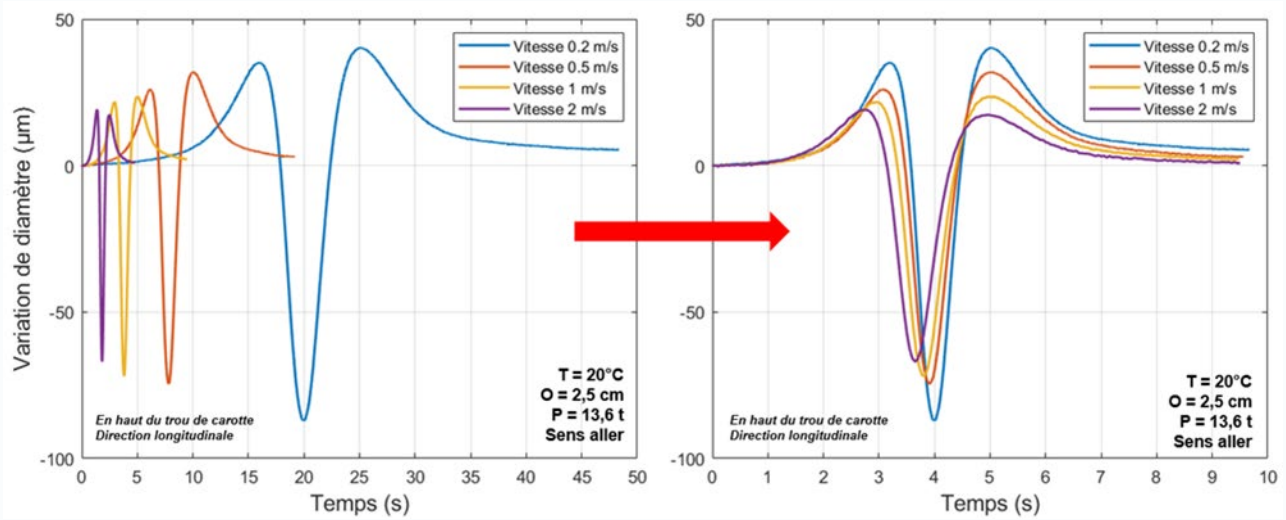
Diameter variation below the 2nd interface as a function of the wheel position, for an offset varying from 2.5 cm to 91 cm.

French Ovalization Device



Variations in diameter as a function of time
for the direction: a) outward b) return

French Ovalization Device



Variations in diameter in longitudinal direction with position of the wheel relative to the center of the core hole with variable speed

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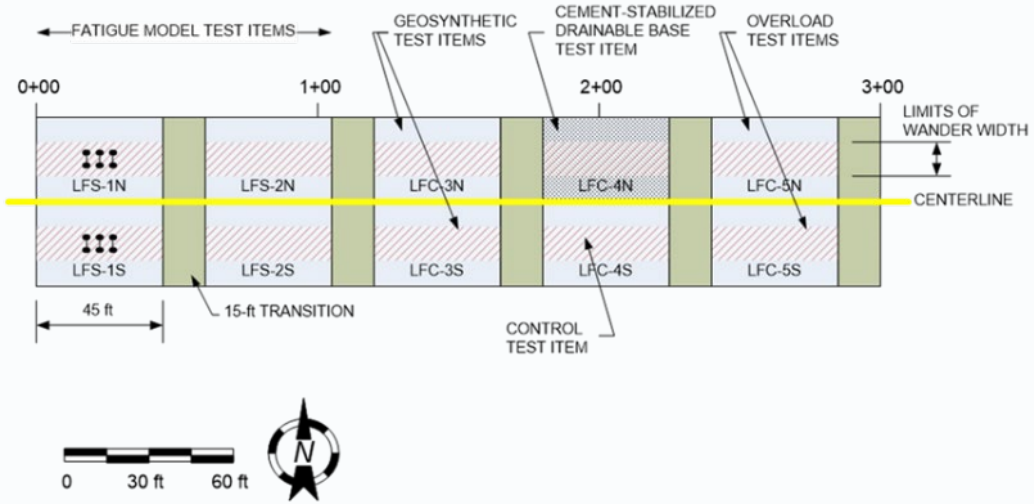
NAPTF: CC-9

Objectives

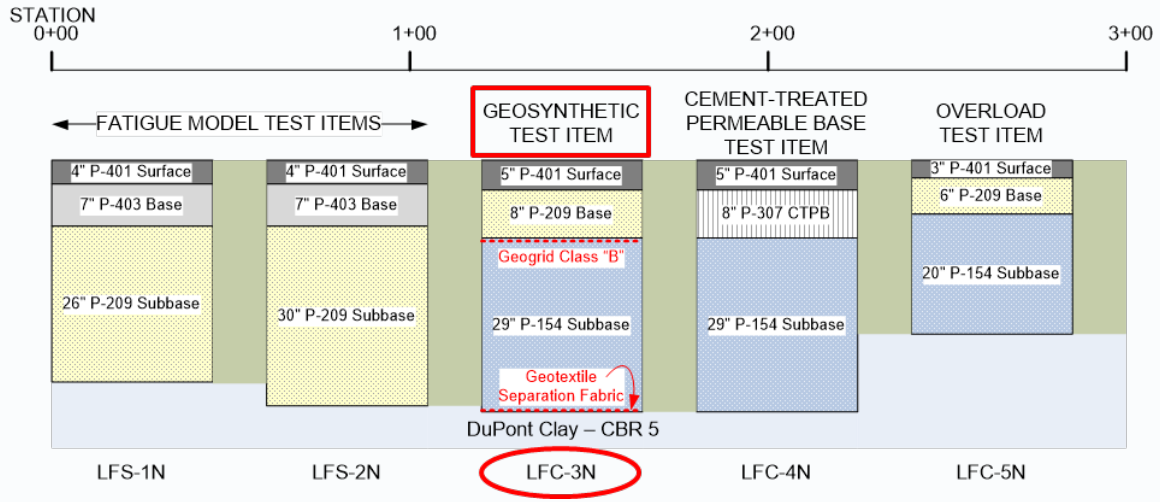
- Verify/Refine/Modify fatigue model based on the ratio of dissipated energy change (RDEC)
- Effect of P-209 Layer Thickness on Pavement Life
- Effect of Geosynthetics use on Flexible Pavement Performance
- Cement Treated Permeable Base Performance
- Strain Criterion for Allowable Overload

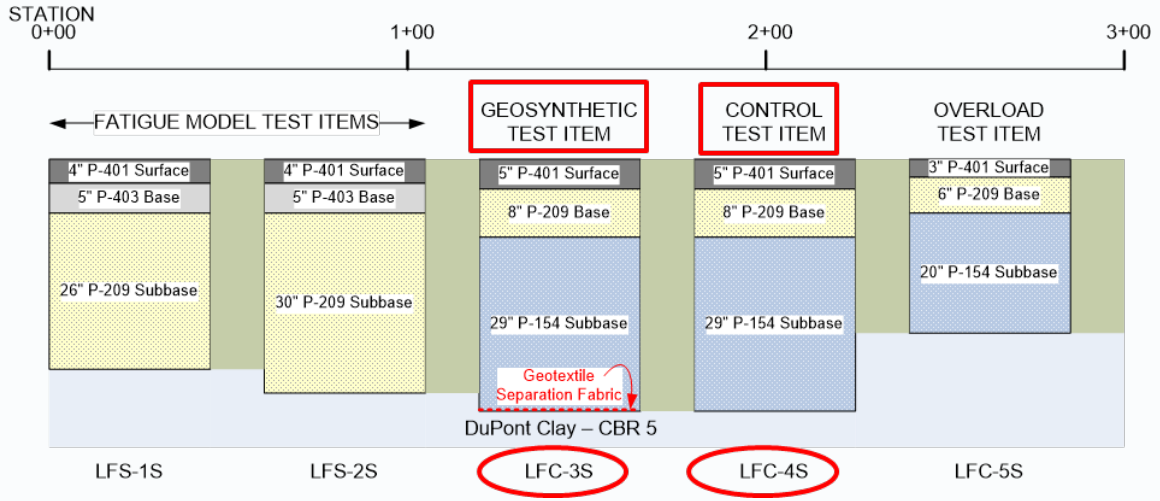
NAPTF: CC-9

Construction Cycle 09 Layout



Pavement Cross Section - North

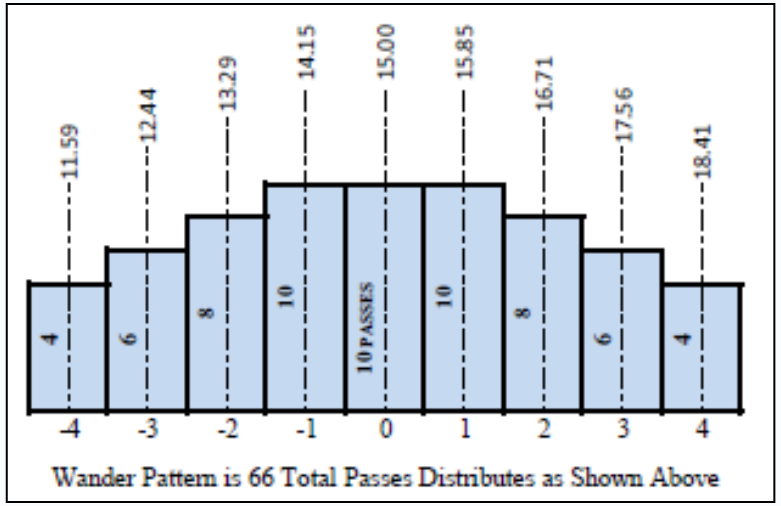




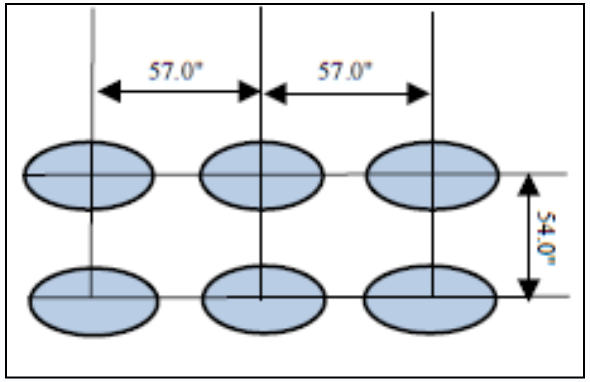
Pavement Cross Section - South

NAPTF: CC-9

Started: April 5, 2021

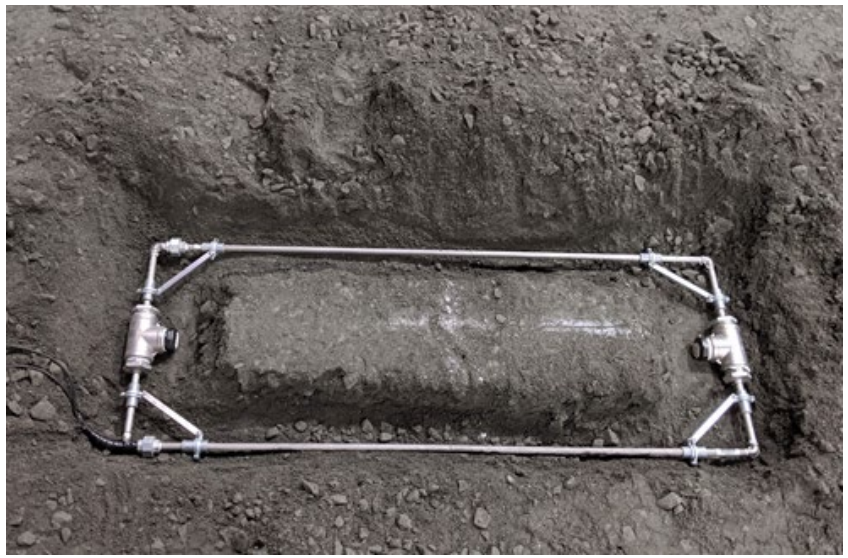


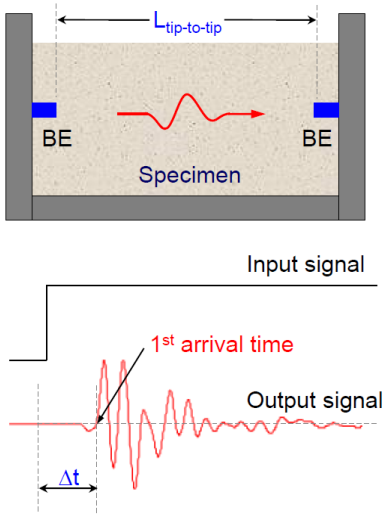
Standard NAPTV Wander Pattern



Standard NAPTV
Gear Configuration
58,000 lbs/wheel

BENDER ELEMENTS





$$V_s = \frac{L_{tip\text{-}to\text{-}tip}}{\Delta t}$$

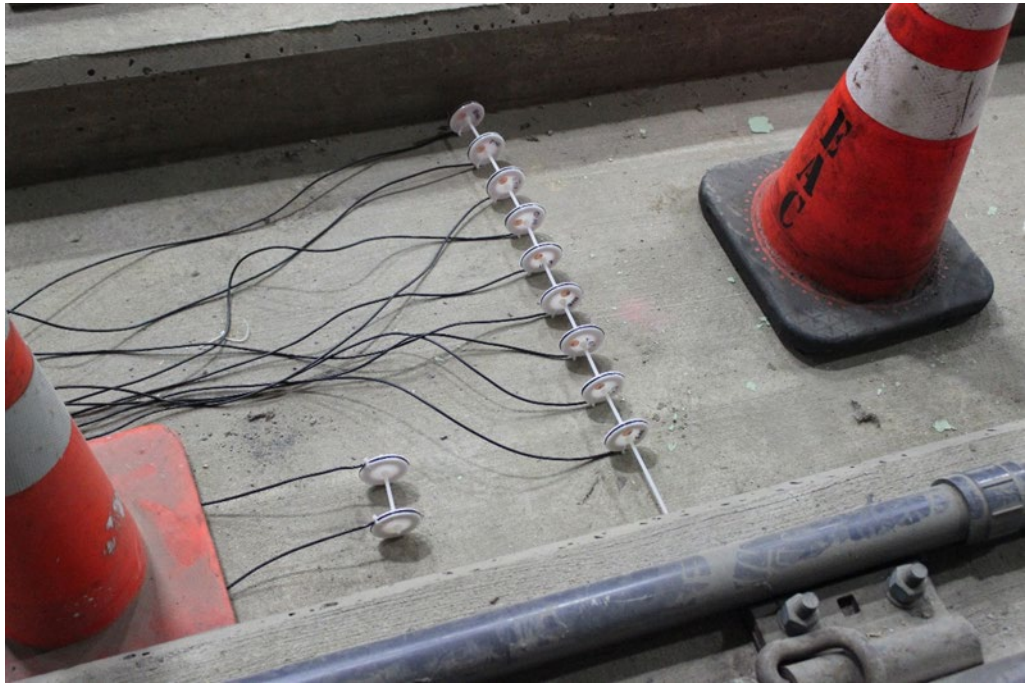
Byun and Tutumluer (2017)

$$G_{max} = \rho \bullet V_s^2$$

$$E_{BE} = 2G_{max}(1 + \upsilon)$$

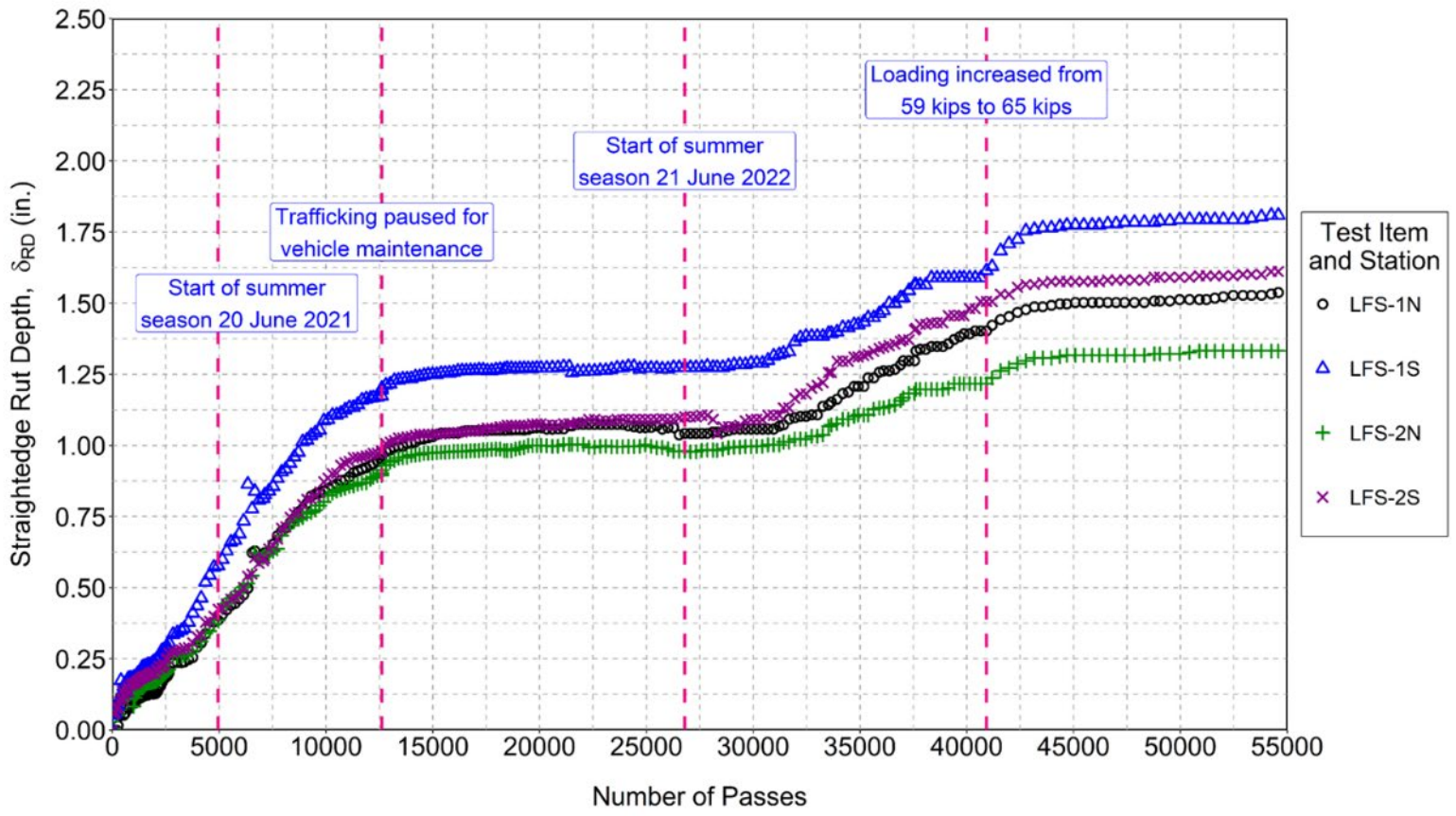
Bender Element Sensor developed by UIUC Team led by Dr. Erol Tutumluer

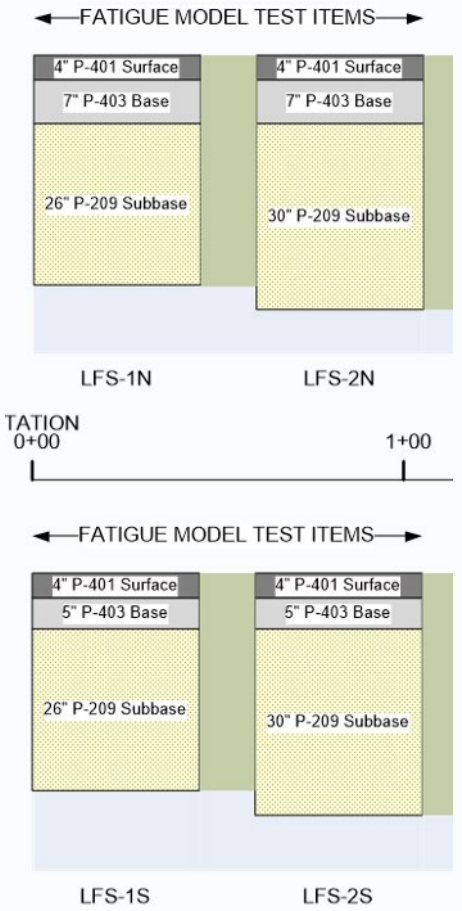
EMU COILS



NAPTF: CC-9

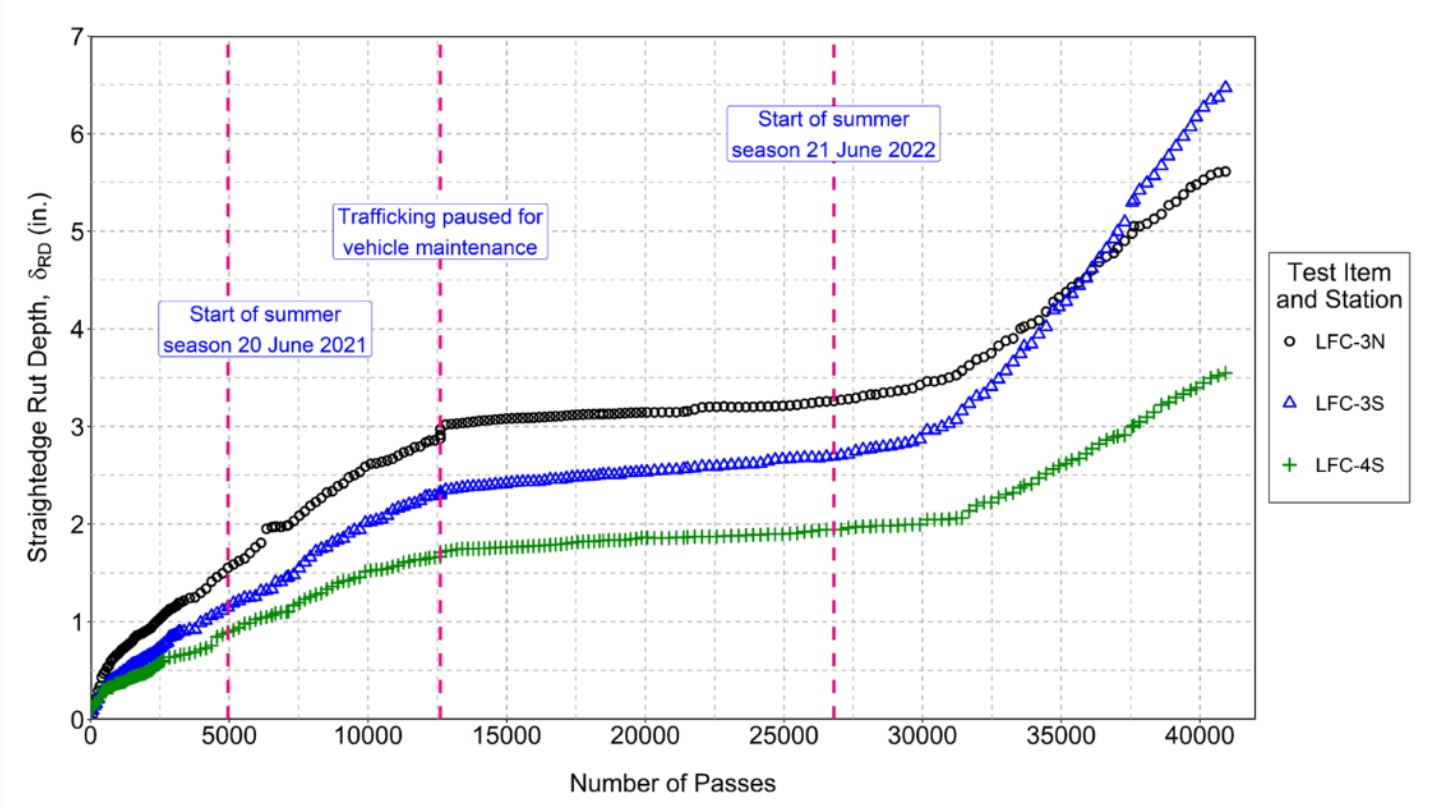
Fatigue Test Items

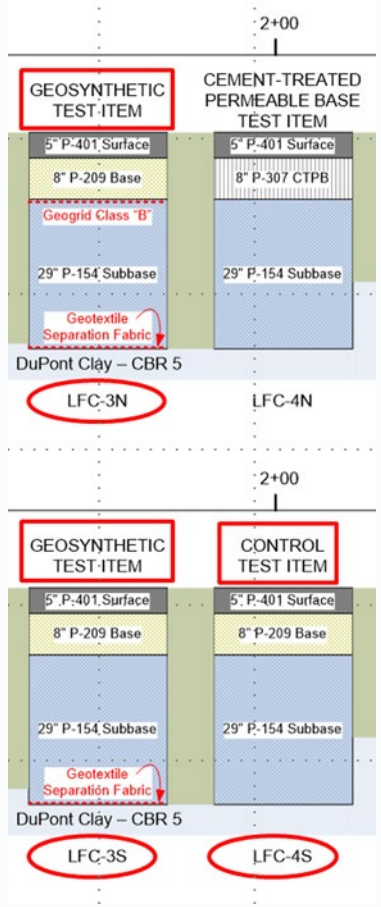




NAPTF: CC-9

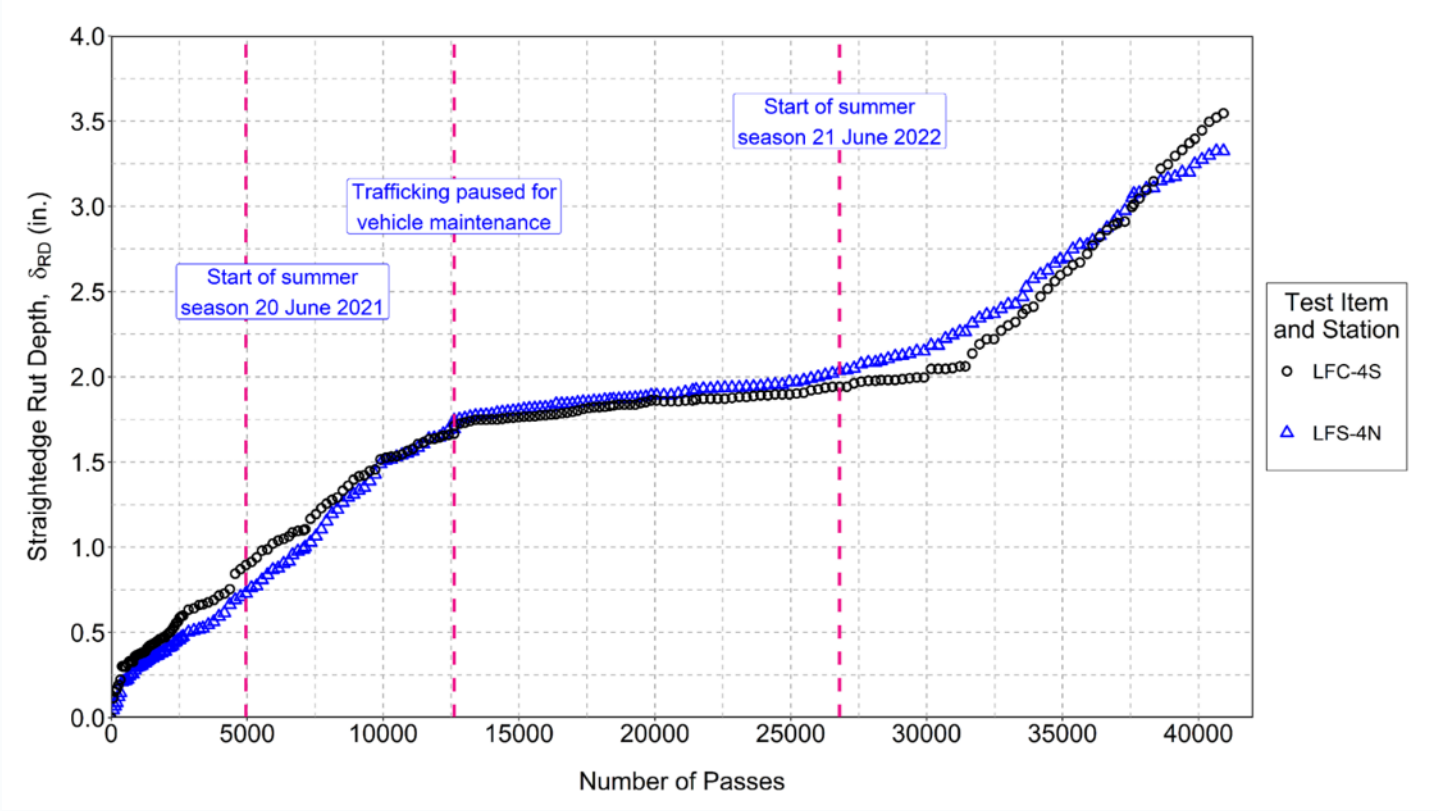
Geosynthetics Test Items

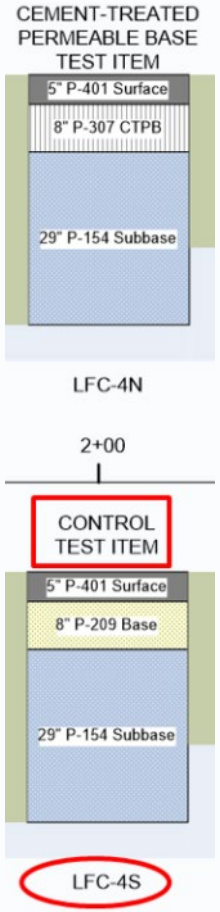




NAPTF: CC-9

Cement Treated Permeable Base (CTPB) Test Item





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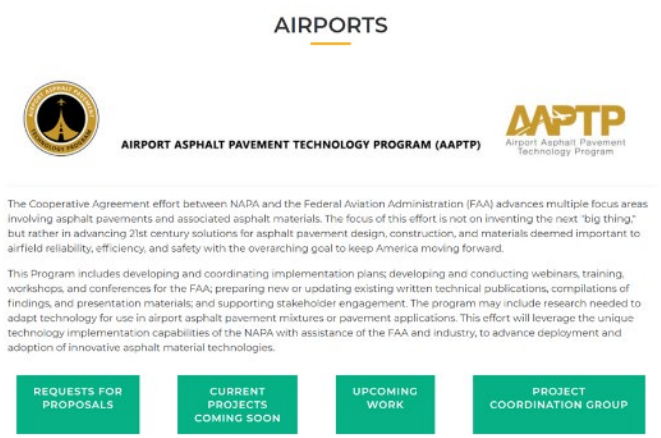
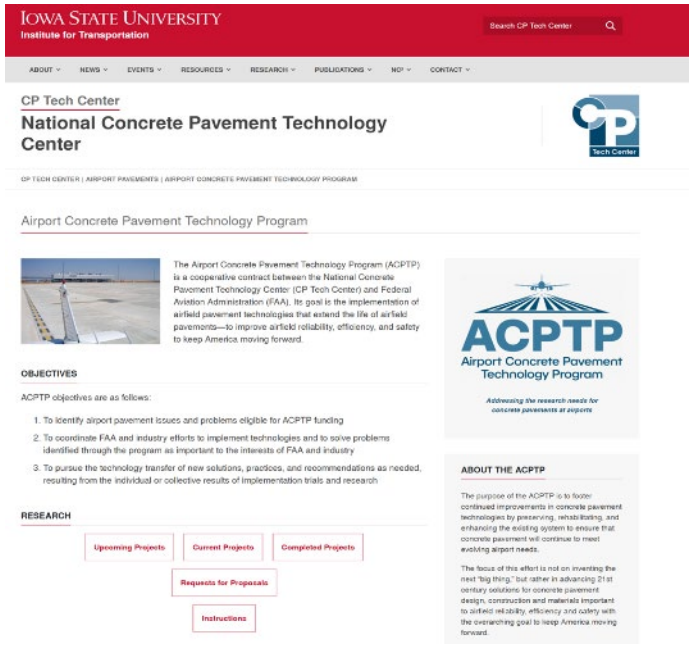


https://www.asphaltpavement.org/expertise/engineering/airports



https://cptechcenter.org/airport-pavements/acptp/

Directive Topics	Synopsis	Legislative Source	Deadline	LOB Responsible	Status	Comments
Airport technology research	Not less than $39,224,000 shall be available for Airport Technology Research	Conference Bill H.R. 1865 (p. 409)	N/A	ARP		
	The Committee recommendation includes a minimum of $33,210,000 for the FAA's airport technology research program to conduct research on topics such as concrete and asphalt airport pavement in accordance with section 744 of the FAA Reauthorization Act (P.L. 115–254); airport marking and lighting; airport rescue and firefighting; airport planning and design; wildlife hazard mitigation; and visual guidance.	House Report 116-106 (p.28)				
	The Committee recommends $39,224,000 for Airport Technology Research. Of this amount, $6,000,000 is for the airfield pavement technology program authorized under section 744 of Public Law 115–254, of which $3,000,000 is for concrete pavement research and $3,000,000 is for asphalt pavement research.	Senate Report 116-109 (p.43)				

- Asphalt Pavements
  - new Airport Asphalt Pavement Technology Program (AAPTP)
  - Administered by NAPA.
- Concrete Pavements
  - Administered by the National Concrete Pavement Technology Center at Iowa State University

AAPTP

FEASIBILITY OF COLD CENTRAL PLANT RECYCLING (CCPR) ASPHALT MIXTURES FOR AIRPORTS

With the Administration setting the goal that the United States will be carbon neutral by 2050, all industries are being asked to consider how they can contribute to making this goal reality. Recently, Cold Central Plant Recycling (CCPR) has been used by some agencies to reduce energy demands and research has suggested that CCPR mixtures can perform well on highways; however, little research has been conducted to show the feasibility for this type of mixture on airfields. The objective of this project is to assess the feasibility and potential benefits of using CCPR asphalt mixtures at all categories of airports.

Principal Investigator: David Jones, PhD. (University of California, Davis)

Test sections will be constructed and tested at FAA's NAPMRC (Spring'24)

NAVNEET GARG, PH.D.
PROGRAM MANAGER

Tel: +1 609 485 4483
Email: Navneet.Garg@faa.gov
Website: http://www.airporttech.tc.faa.gov

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Wilfredo Villafane

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