



SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

Real-Time Smoothness Technology for Improving Concrete Pavement Smoothness

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U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
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Real-Time Smoothness for Concrete Paving

- Overview of Real-Time Smoothness Technology
- SHRP2 RTS Implementation Support Program
- Using RTS Systems to Achieve Smoothness Requirements
- Observations from RTS Equipment Loan Projects

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What is Real-Time Smoothness?

Real-time Smoothness (RTS) refers to measuring and evaluating the concrete pavement surface profile during construction, somewhere along the paving train while the concrete surface is still wet (plastic).

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RTS Profilers

Paver-Mounted GOMACO Smoothness Indicator (GSI)

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RTS Profilers

Ames Engineering Paver-Mounted Real Time Profiler (RTP)

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RTS Profilers

Stand-Alone GOMACO GSI Machine

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Real-Time Feedback

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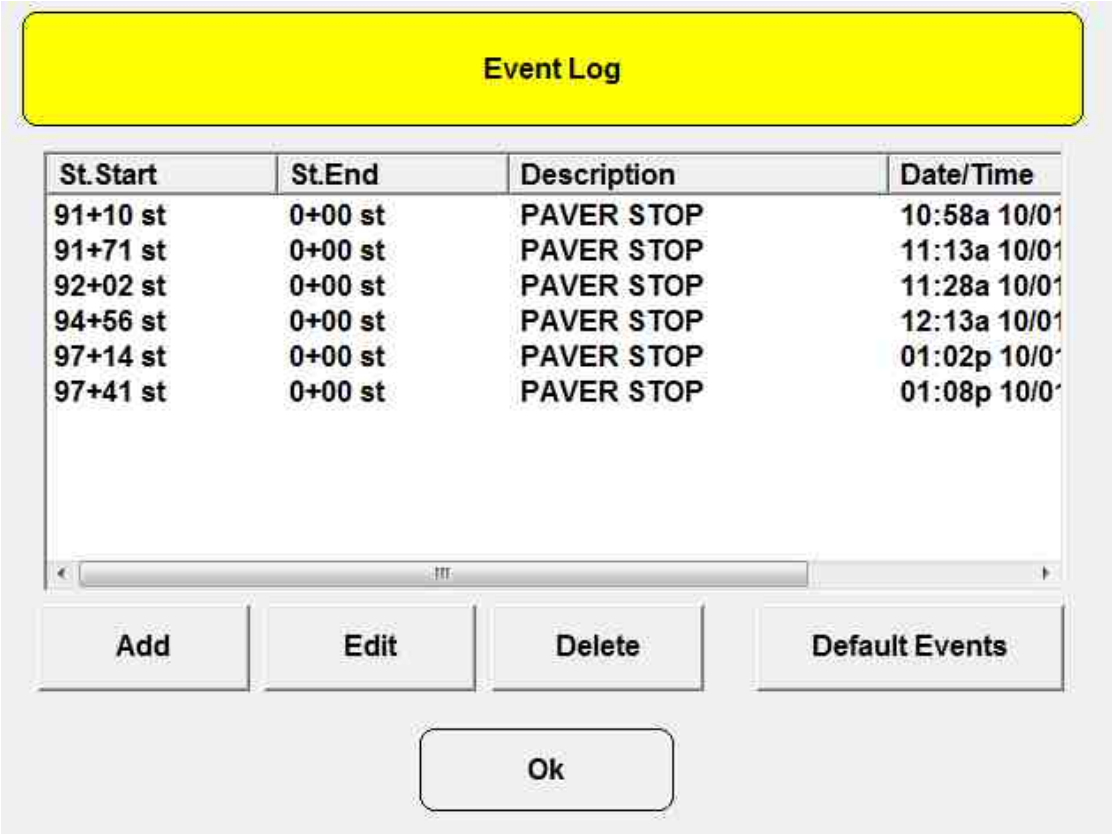
Real-Time Tracking of “Events”



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Reasons for Using RTS Equipment

- Reduce Disincentives and Increase Incentives
- Increase Production(?)
- Anticipated change in smoothness acceptance requirements
  - PI to IRI
  - Change in localized roughness specification limits

Benefits of Real-Time Smoothness

- Opportunity to identify real-time and correct objectionable profile features caused by:
  - Stringline/stringless system disturbance
  - Padline variability
  - Non-uniformity of concrete

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Benefits of Real-Time Smoothness

- Validation of adjustments in 1 hour vs. 12 to 24 hours:
  - Hydraulic sensitivity relative to machine control input (stringline and stringless)
  - Vibrator frequencies
  - Paving speed
  - Concrete head
  - Concrete mixture proportions
  - Others

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Limitations of Real-Time Smoothness

- Not a replacement for conventional profiling for acceptance.
- Not a replacement for better practices to construct smoother pavements.

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Real-Time Smoothness
SHRP2 Implementation Support

RTS Implementation Support Activities

Task 1: Equipment Loan Program (2015 - 2017)

- Full use of an RTS system for two weeks
- On-site technical support and training
- 11 equipment loans nationwide (ID, NE, MI, TX, PA, IA, IL, UT[2], CA to date)

Task 2: Regional Showcase (Open House)

- One day classroom presentations with an on-site RTS demonstration
- In conjunction with an equipment loan project
- Aug. 9 2016 (Salt Lake City, Utah)

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RTS Implementation Support Activities

Task 3: Workshops

- Four hour workshops (UT, CA to date)

Task 4: Documentation of Results/Case Studies

- Synthesis of contractors' experience
- Case study – Comparing real-time measurements to QA results
- Case study – Long-term performance of RTS
- Documentation of equipment loans and lessons learned

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RTS Implementation Support Activities

Task 5: Specification Refinement

- QC approach
- Process improvement

Task 6: Outreach Materials

- Quick field reference guide
- Brochures
- Project updates (30 minute briefings)

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Using RTS Systems

- Step 1 – Establish a baseline
  - Monitor results for 1 to 2 days.
  - Keep processes static, but make ordinary adjustments.
  - Observe typical responses to the ordinary adjustments and make notes or add event markers in the RTS.
    - Mixture
    - Vibrators
    - Speed
    - Head
    - Paver stops
    - Etc.

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Using RTS Systems

- The RTS results are higher than the QC hardened profiles – what's up with that?
  - Don't panic
  - Just focus on making the RTS results better (lower IRI)
  - QC profiles will improve as well

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Using RTS Systems

- Step 2 – Pick the low hanging fruit
- Eliminate large events that cause excessive localized roughness.
  - Stringline/stringless interference
  - Paver stops
  - Padline issues
  - Etc.

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Localized Roughness Events

- Stringless system interference

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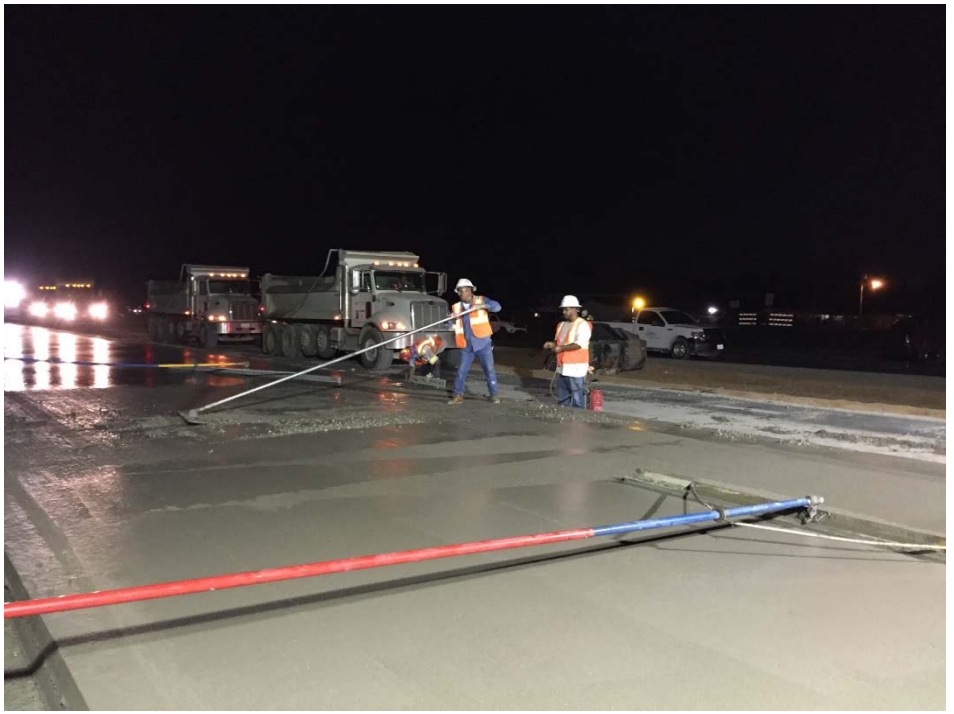
Localized Roughness Events

- Running the paver out of concrete



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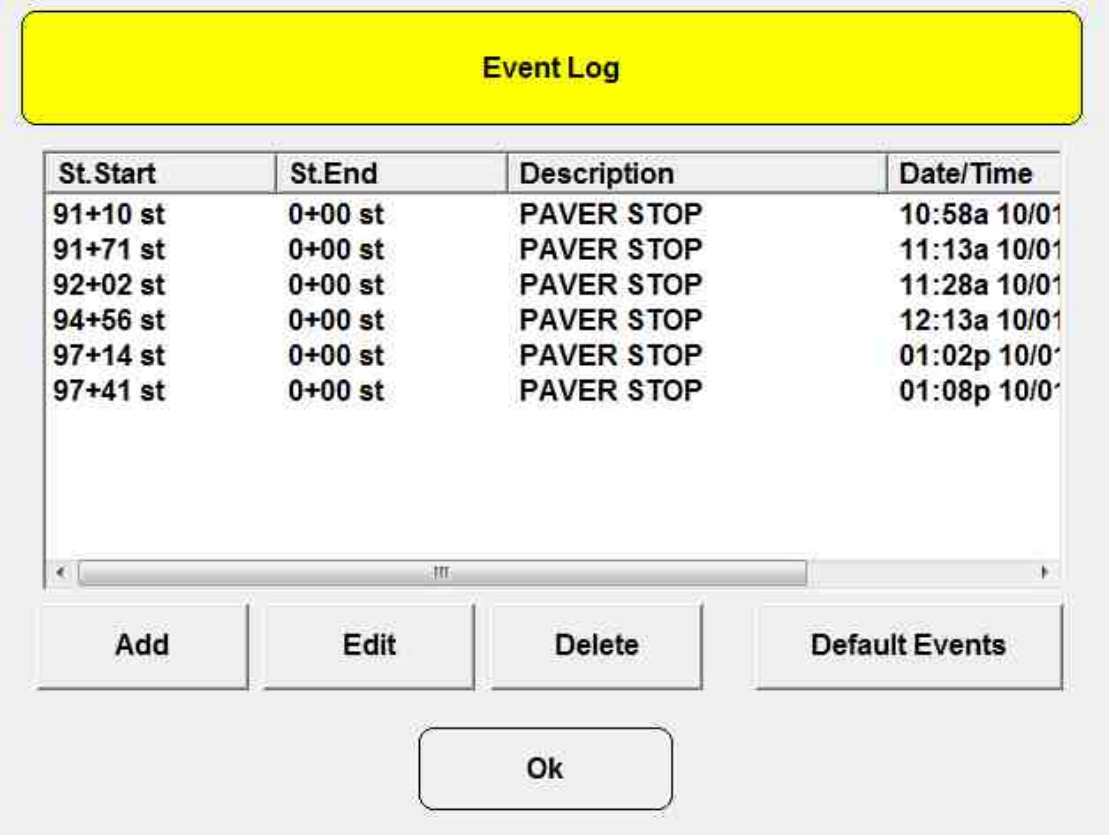
Localized Roughness Events

- Stopping the paver



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Using RTS Systems

- Step 3 – Adjust the paving process to improve overall smoothness
  - Maintain a consistent head
  - Lead/draft to get the paver as flat as possible
  - Sensitivities
  - Vibrators (height and frequency)
  - Mixture
  - Paver operation
  - Paving speed

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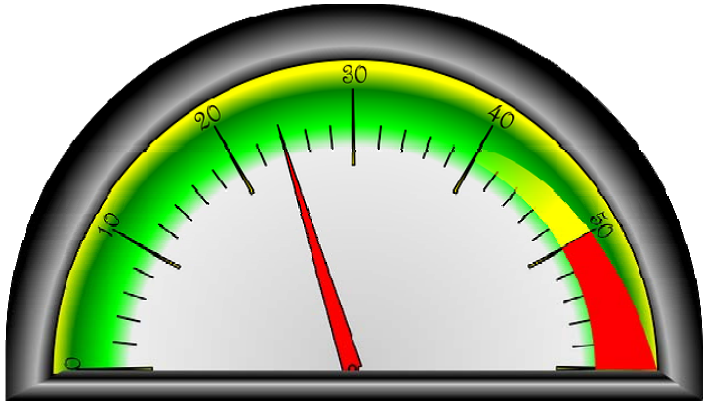
Overall Smoothness

- Eliminating big events gives you a new “baseline” to adjust from.
  - Systematically make changes in small increments.
  - Get a minimum of 0.1 mile with consistent paving (no big events) and then evaluate if the adjustment made things smoother.
  - Continue adjusting in small increments and evaluating every 0.1 mile.



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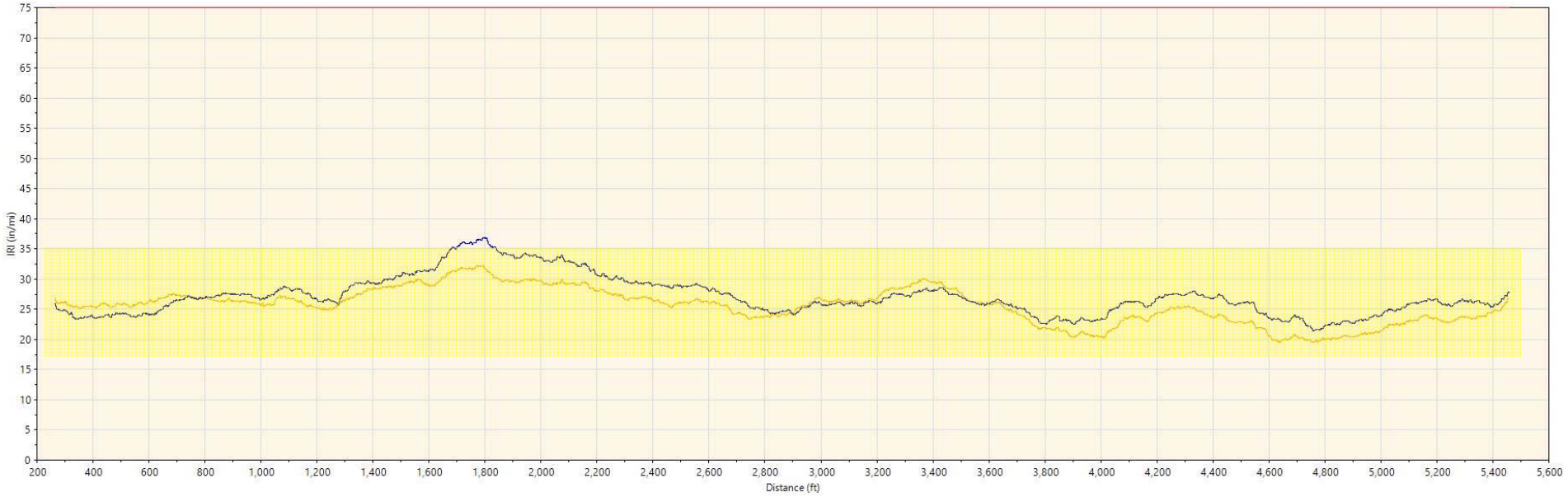
Overall Smoothness

- Stay focused and incredible things can happen

Over a mile paved per day – average IRI = 28 in/mi:



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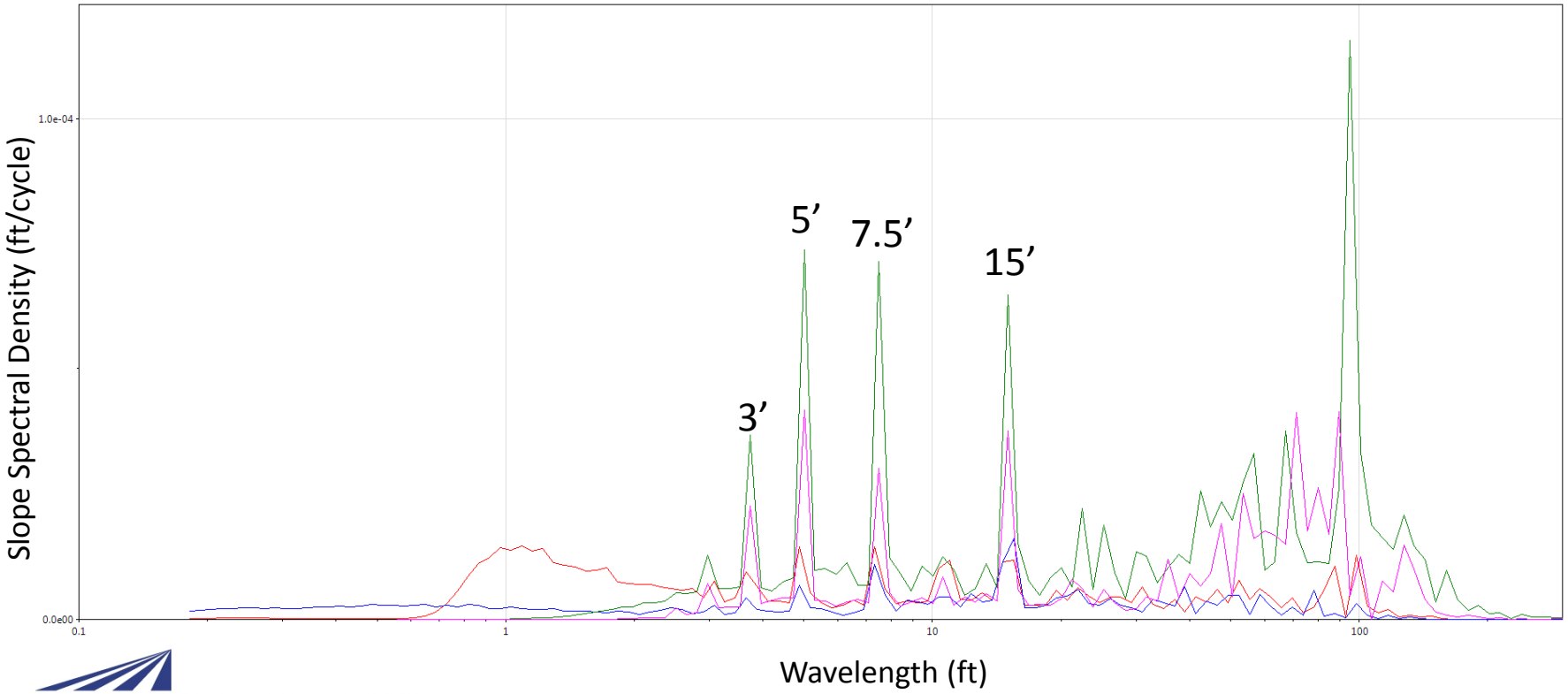
Using RTS Systems

- Step 4 – Identify repeating features using a ProVAL PSD plot and adjust processes when possible.
  - Joints
  - Dumping/Spreading loads
  - CRCP bar supports

Repeating Features

- What repeating feature shows up here?
- What can you do to mitigate this feature?



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SHRP2-FHWA RTS Equipment Loans

Equipment Loans to Date

- Idaho, I-84
- Nebraska, I-80
- Michigan, I-69
- Texas, SH99
- Pennsylvania, I-81
- Iowa, Lyon Co. L-26
- Illinois, I-90 Tollway
- Utah, I-15
- Utah, I-215
- California, SR46

- 7 JPCP, 2 CRCP, 1 Thin Overlay
- Varying slab thickness and base/subbase types
- Daytime and nighttime paving
- Varying paver types and setup (paver width, concrete delivery, finishing operations)
- Varying mix designs
- Dowel baskets and DBI
- All but one project stringless

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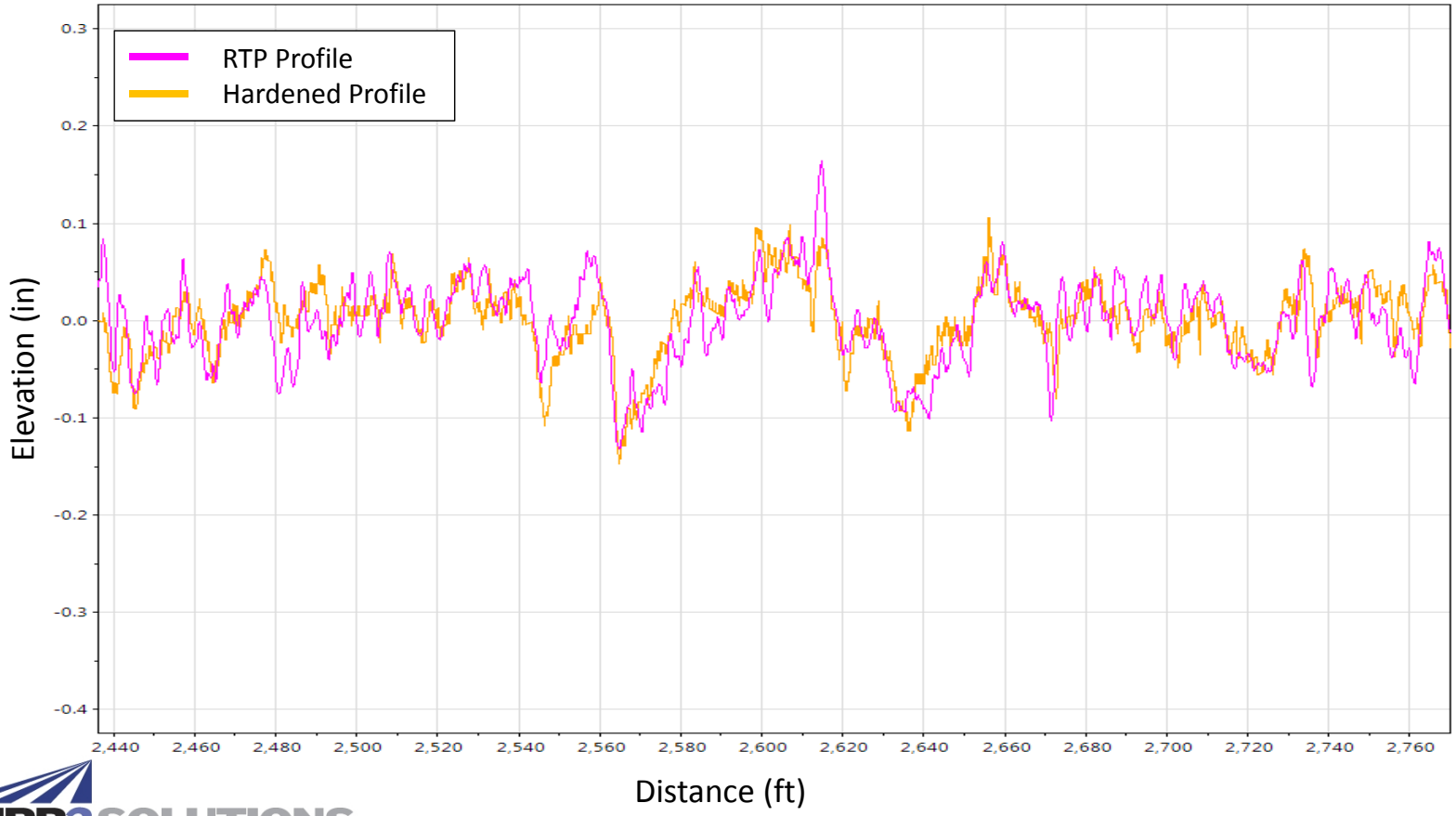
Equipment Loan Observations

- Real-time and hardened profiles parallel each other



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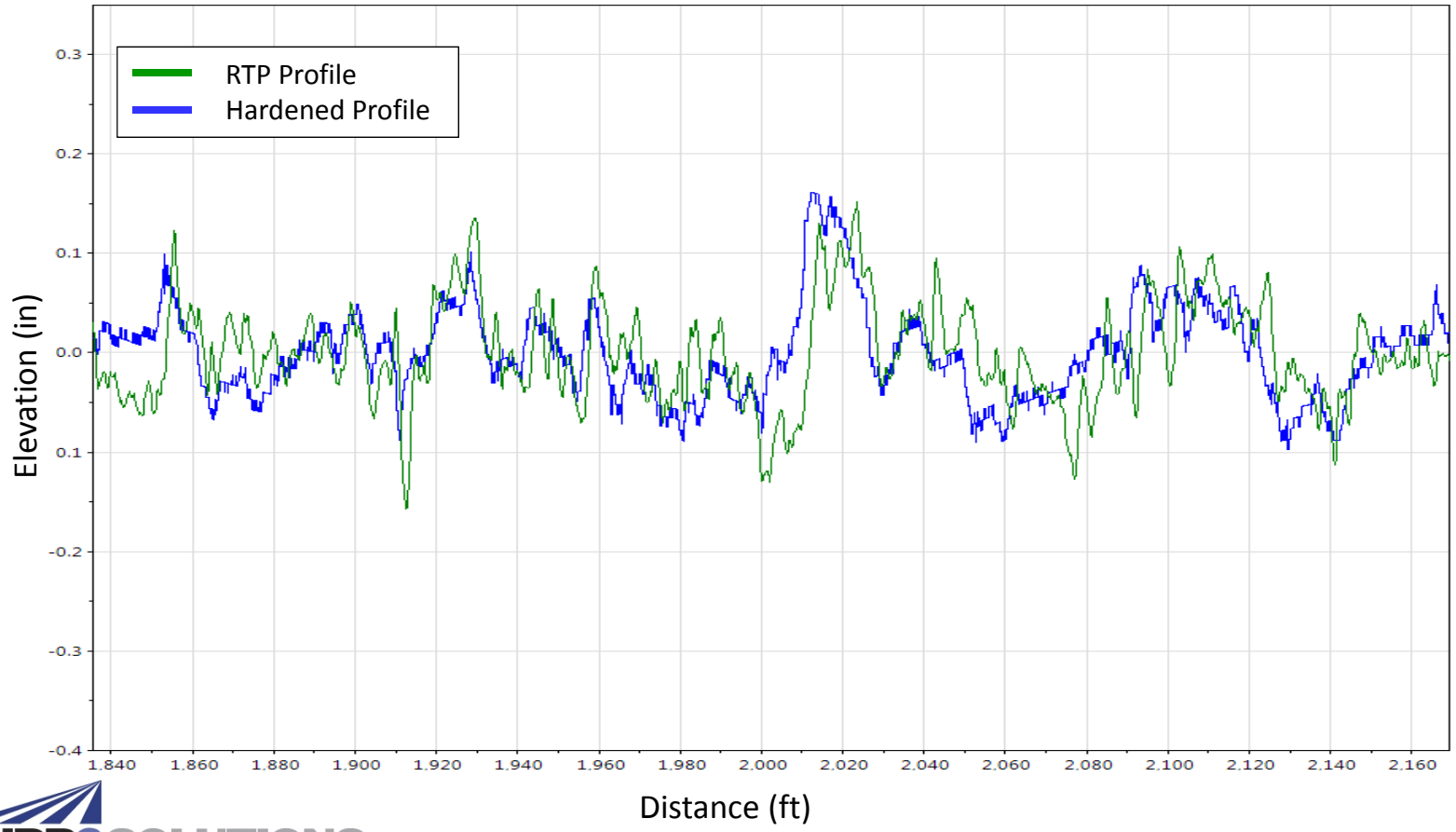
Equipment Loan Observations

- Short wavelength features in RTS that are not in hardened.



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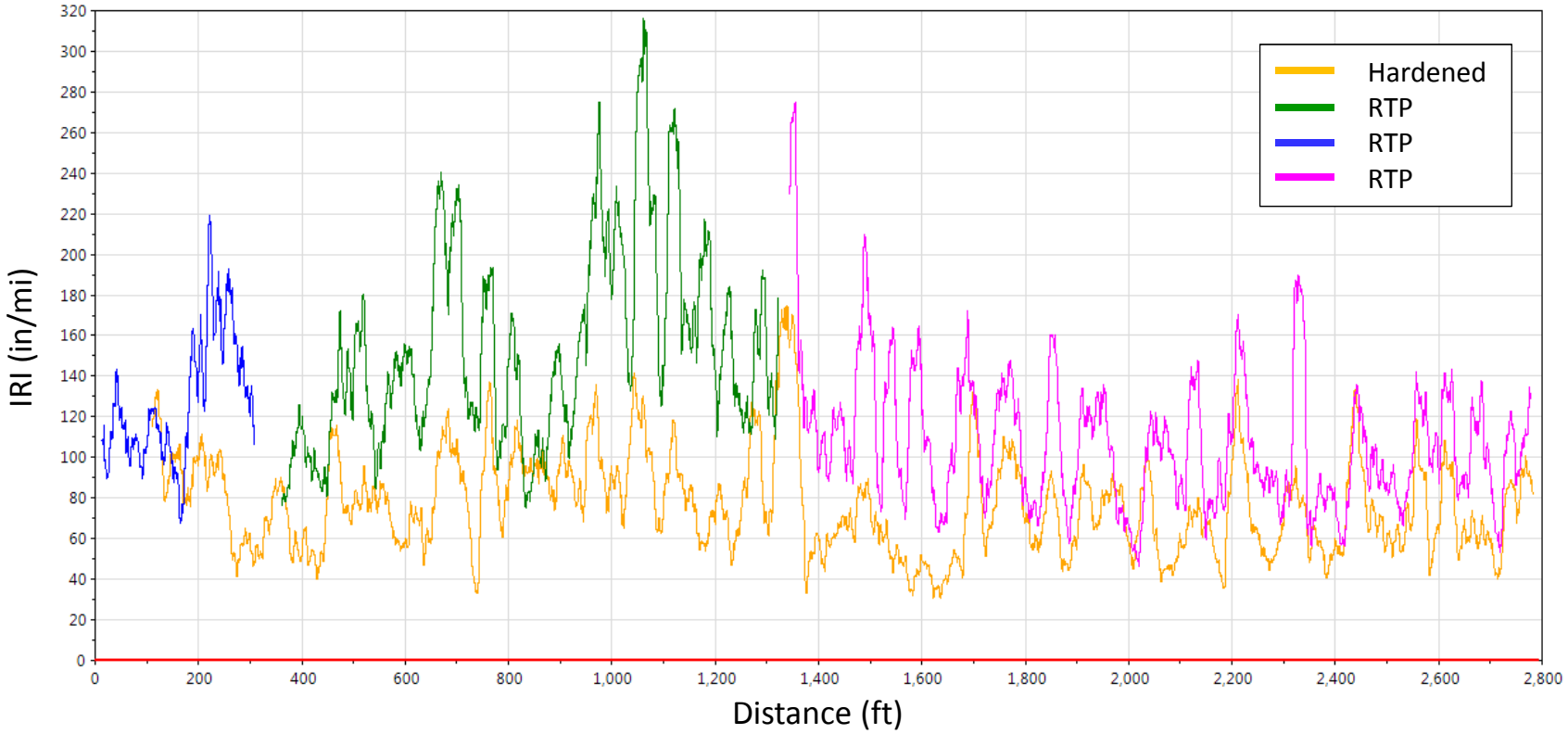
Equipment Loan Observations

- RTP consistently measured higher roughness than hardened (20-80 percent higher).



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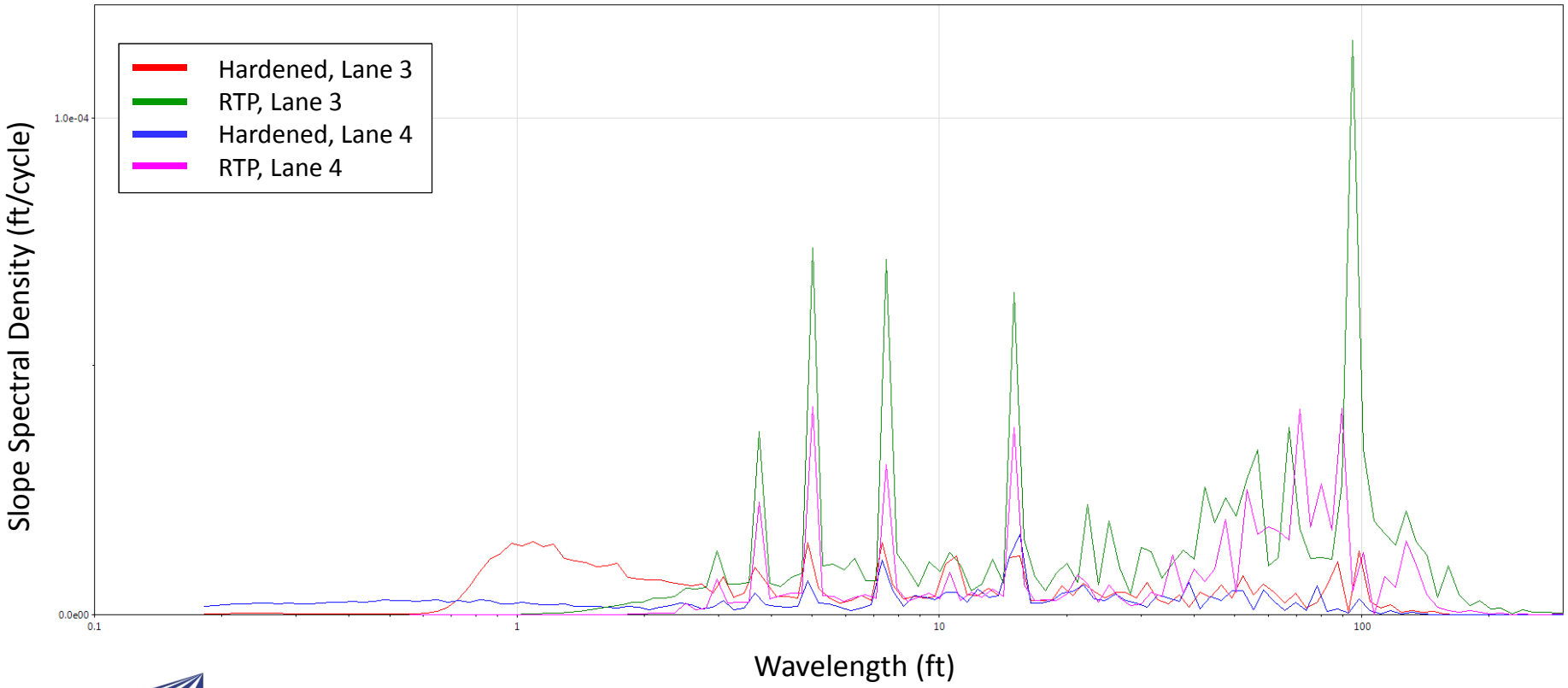
Equipment Loan Observations

- Joint spacing (with dowel baskets) generally dominant content in hardened and RTP PSD, but less dominant in hardened.



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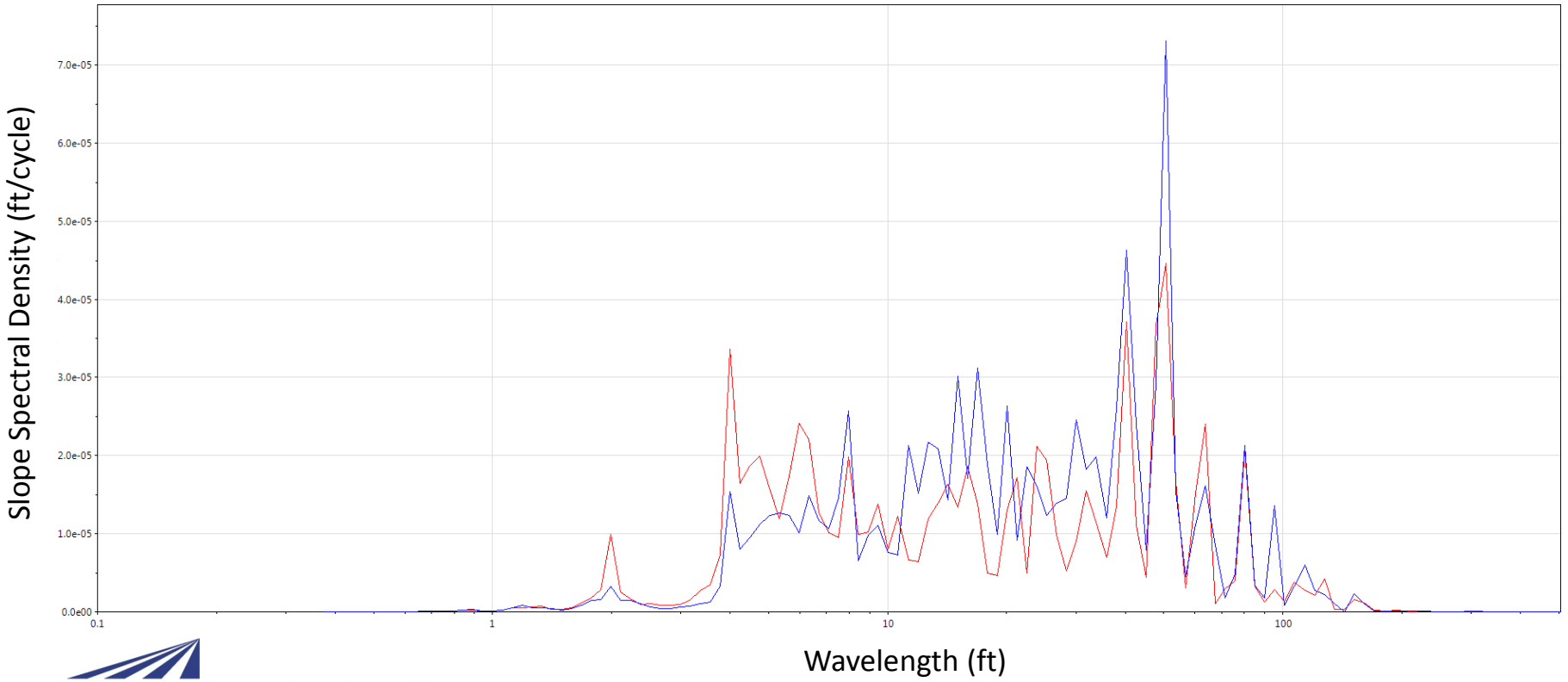
Equipment Loan Observations

- PSD content sporadic on days with poor smoothness results.



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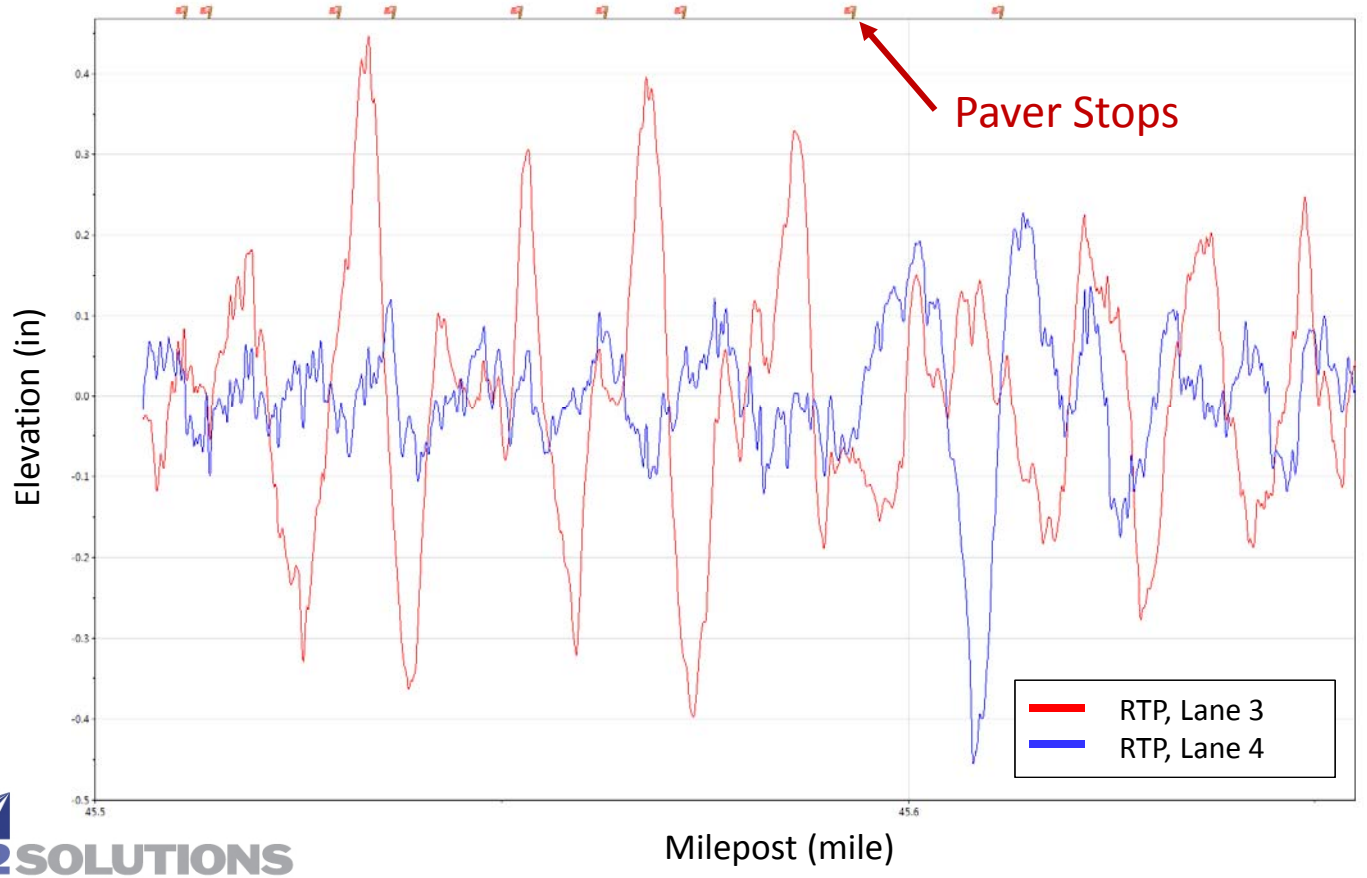
Equipment Loan Observations

- Paver stops appear to have some effect on RTP measurements, but it is not consistent.



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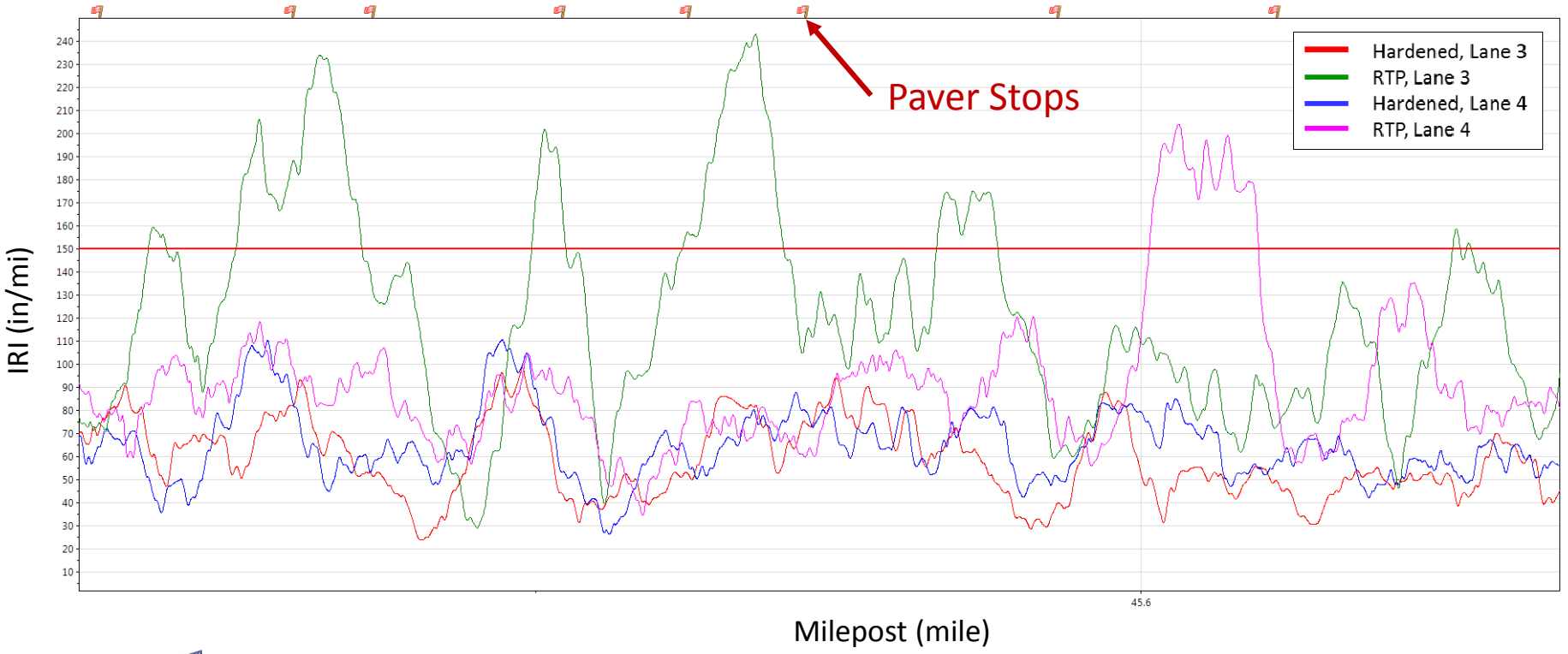

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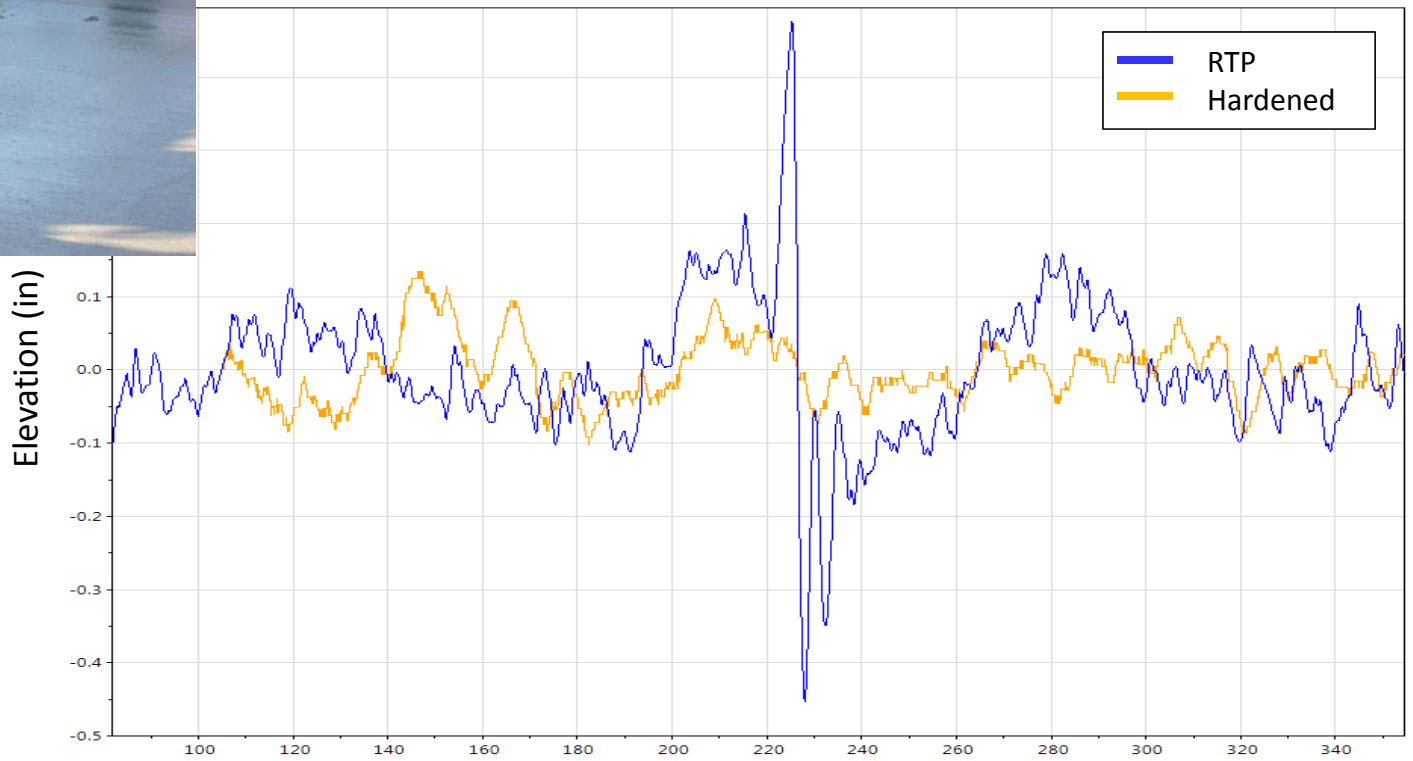
Equipment Loan Observations

- Benefits of good finishing processes



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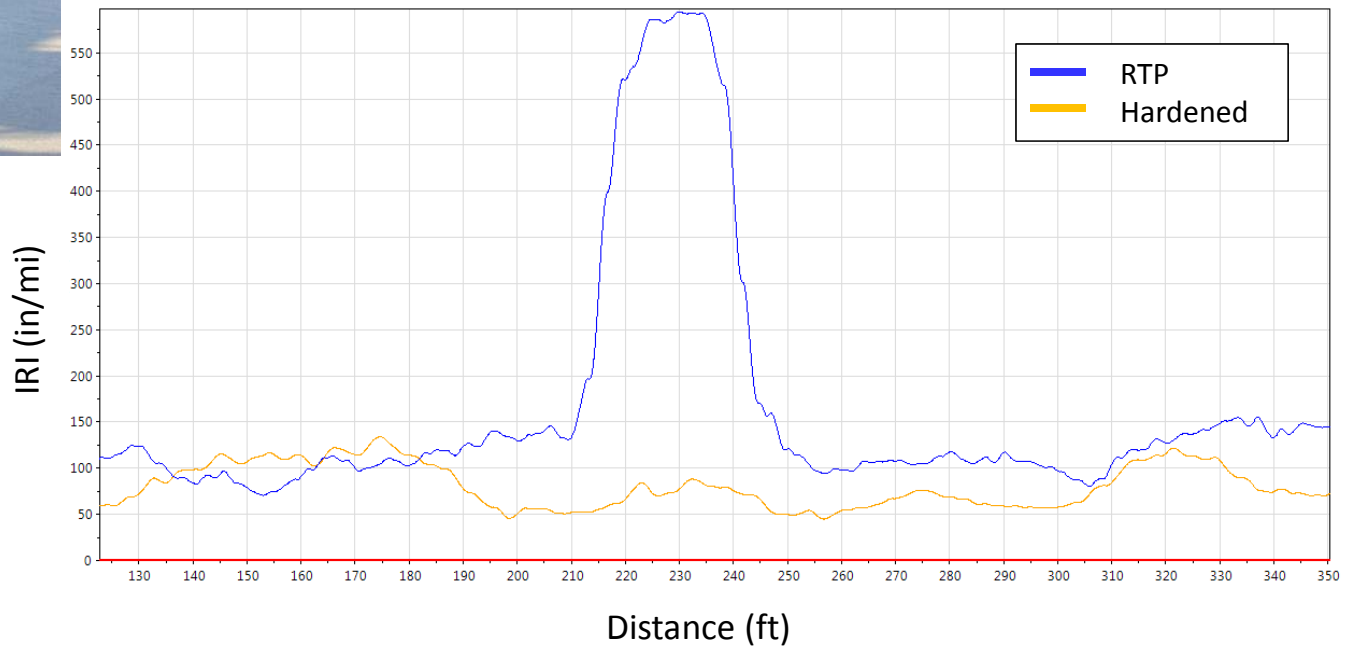
Equipment Loan Observations

- Benefits of good finishing processes are apparent



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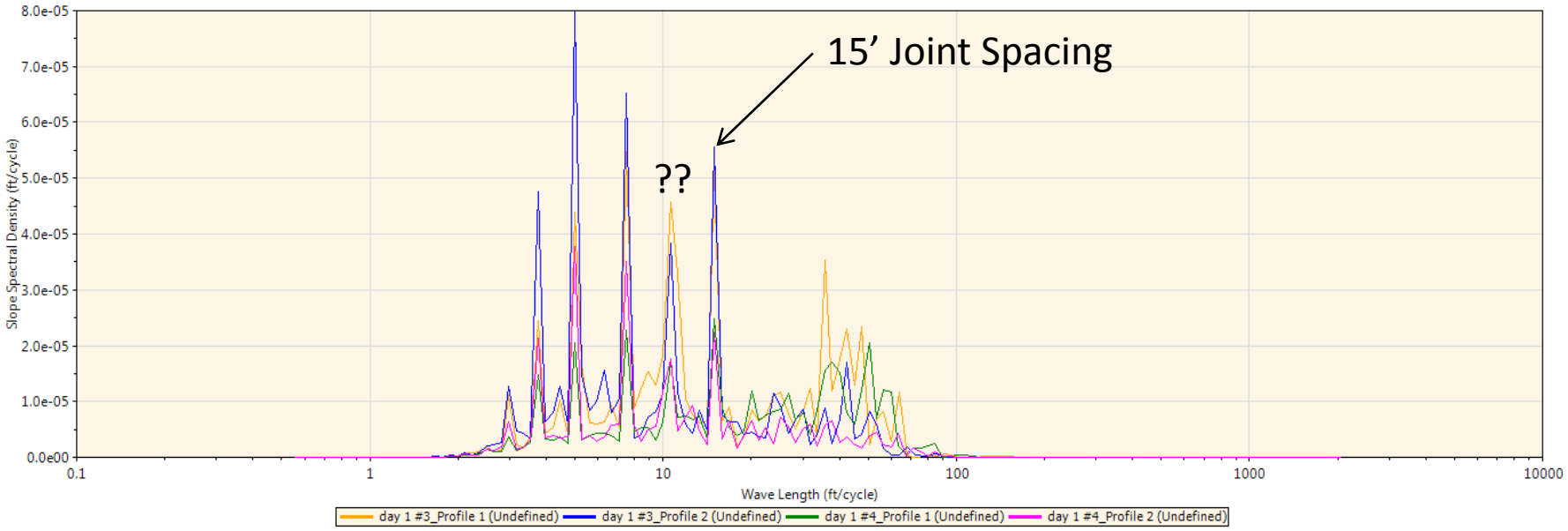
Equipment Loan Observations

- Dominant features in RTS PSD plot
- What happening at 10.5-’11’?



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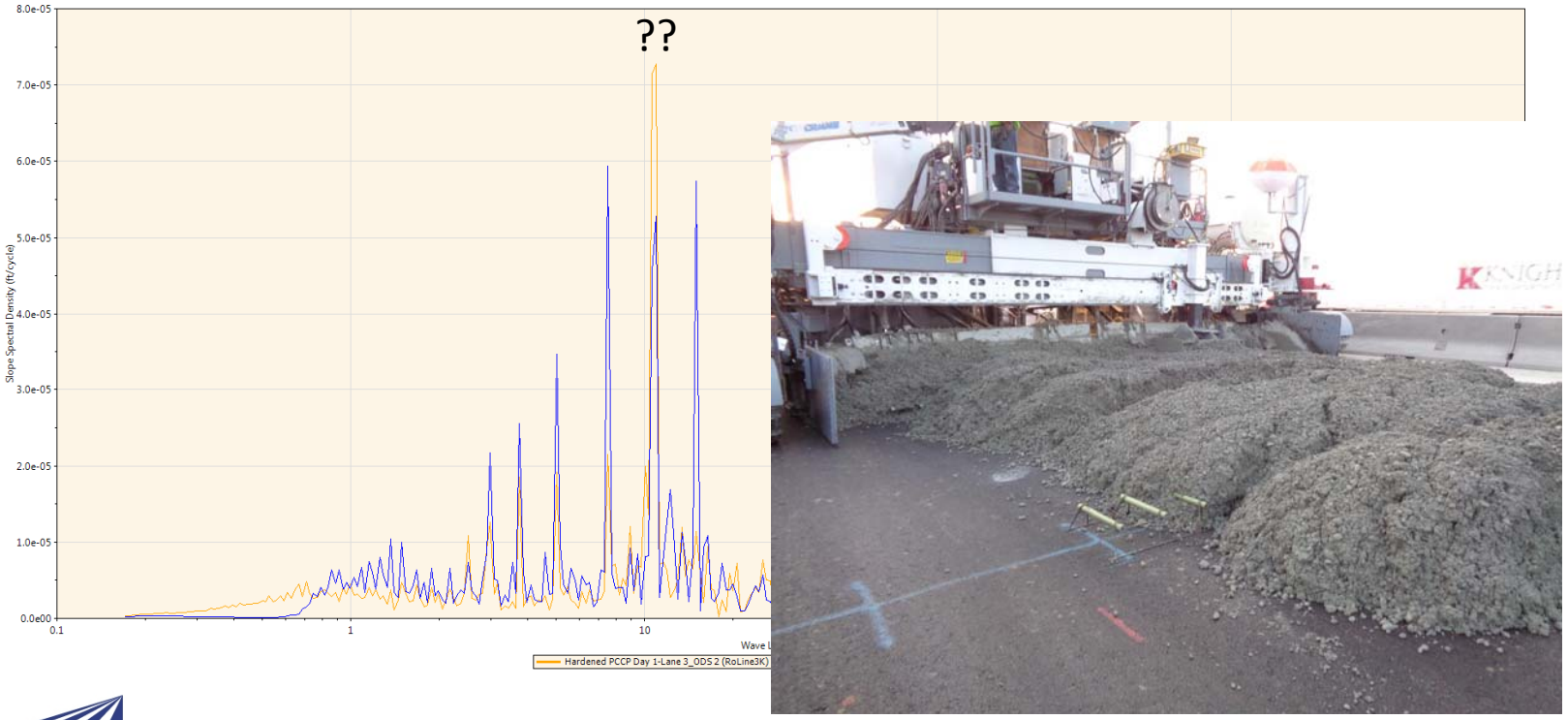
Equipment Loan Observations

- Hardened profile data
- What happening at 10.5-’11’?



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Equipment Loan Observations

- Roughness “spikes” every 350-450 ft
- What is it?

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Equipment Loan Observations

- RTS is a valuable tool for contractor QC during paving.
  - Identification of effects of paving process adjustments.
  - Identification of effects of construction artifacts.
  - Achieving better hardened profile results.
- RTS cannot be used in a vacuum – correlation to hardened profile data is essential.
- Several contractors have seen the value of this tool and purchased systems.

Real-Time Smoothness for Concrete Paving

Questions and Discussion

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